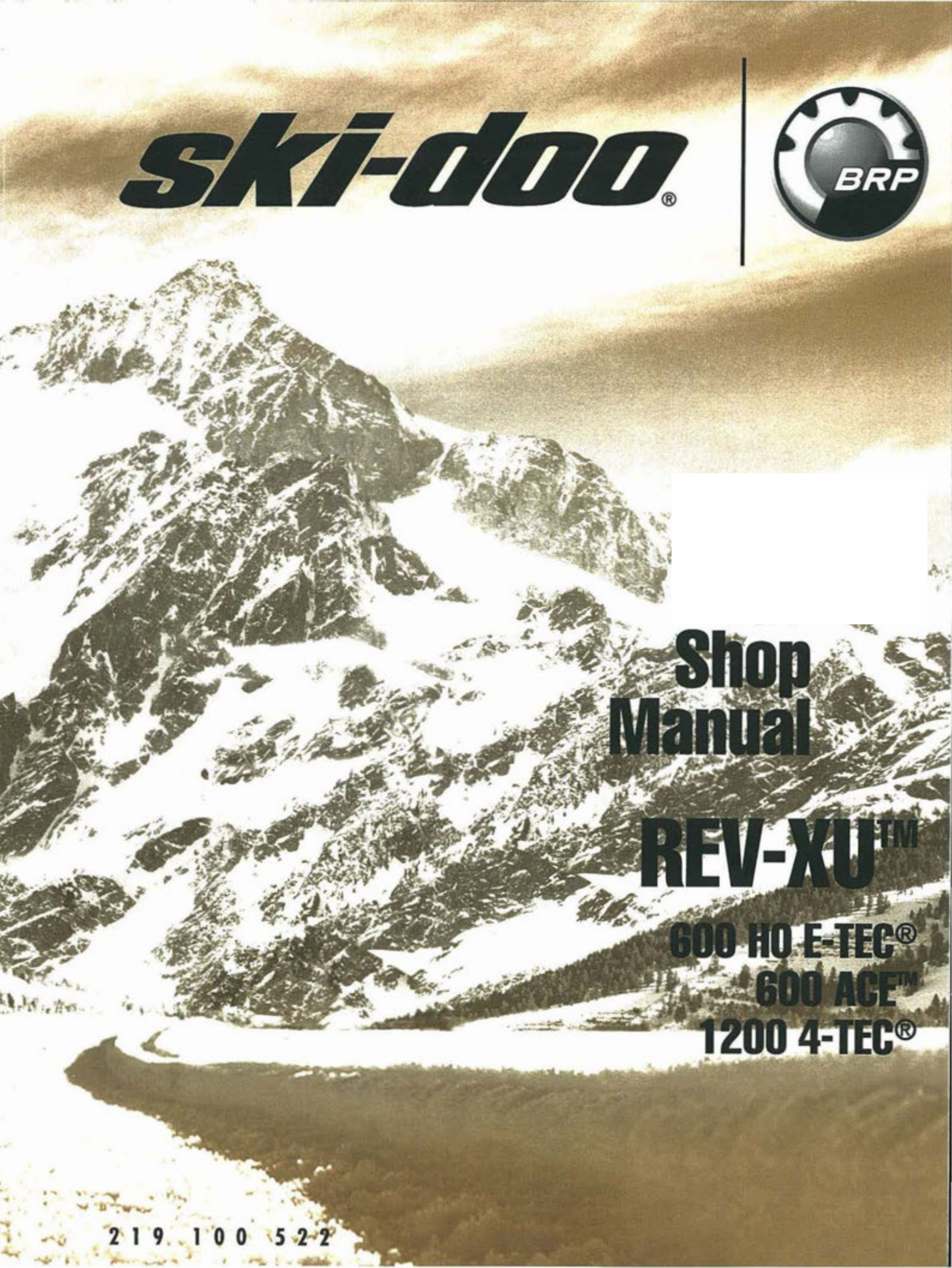
ski-doo
BRP
Shop
Manual
REV-XU™
600 HO E-TEC®
600 ACE™
1200 4-TEC®
219 100 522

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SAFETY NOTICE

This manual has been prepared as a guide to correctly service and repair Ski-Doo® snowmobiles described in the list in the *INTRODUCTION*.

This edition was primarily published to be used by technicians who are already familiar with service procedures relating to Bombardier Recreational Products Inc. (BRP) products. Mechanical technicians should attend continuous training courses given by B.R.P.T.I.

Please note that the instructions will apply only if proper hand tools and special service tools are used.

The content depicts parts and procedures applicable to the particular product at time of writing. *SERVICE* and *WARRANTY BULLETINS* may be published to update the content of this manual. Make sure to read and understand them. Dealer modifications that were carried out after manufacturing of the product, whether or not authorized by BRP, are not included.

In addition, the sole purpose of the illustrations throughout the manual, is to assist identification of the general configuration of the parts. They are not to be interpreted as technical drawings or exact replicas of the parts.

The use of BRP parts is most strongly recommended when considering replacement of any component. Dealer and/or distributor assistance should be sought in case of doubt.

The engines and the corresponding components identified in this document should not be utilized on product(s) other than those mentioned in this document.

It is understood that certain modifications may render use of the vehicle illegal under existing federal, provincial and state regulations.

This manual emphasizes particular information denoted by the wording and symbols:

⚠ WARNING

Indicates a potential hazard that, if not avoided, could result in serious injury or death.

⚠ CAUTION Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE Indicates an instruction which, if not followed, could result in severe damage to vehicle components or other property.

NOTE: Indicates supplementary information required to fully complete an instruction.

Although the mere reading of such information does not eliminate the hazard, your understanding of the information will promote its correct use. Always use common shop safety practice.

It is understood that this manual may be translated into another language. In the event of any discrepancy, the English version shall prevail.

BRP disclaims liability for all damages and/or injuries resulting from the improper use of the contents. We strongly recommend that any services be carried out and/or verified by a highly skilled professional mechanic.

INTRODUCTION

This shop manual covers the following BRP made Ski-Doo snowmobiles.

MODEL	ENGINE TYPE	CHASSIS
Skandic™ WT 600 HO E-TEC	593	REV-XU
Skandic™ WT 600 ACE	602	REV-XU
Expedition™ SE/LE 600 ACE	602	REV-XU
Expedition™ SE/LE 1200 4-TEC	1203	REV-XU

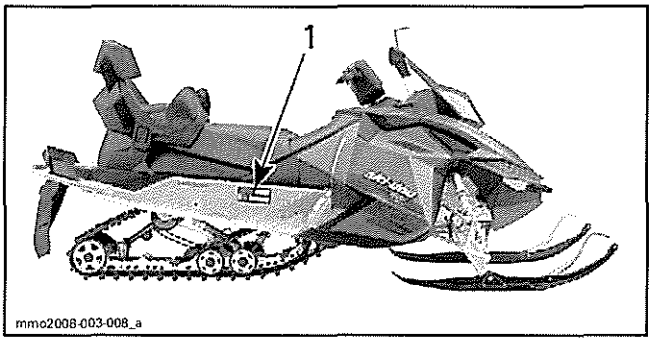
The information and component/system descriptions contained in this manual are correct at time of writing. BRP however, maintains a policy of continuous improvement of its products without imposing upon itself any obligation to install them on products previously manufactured.

Due to late changes, there may be some differences between the manufactured product and the description and/or specifications in this document.

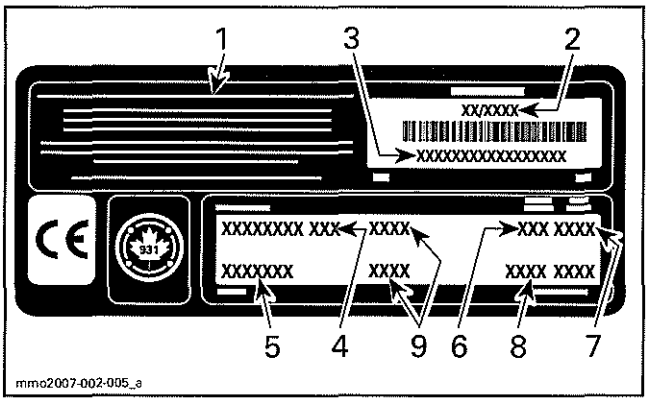
BRP reserves the right at any time to discontinue or change specifications, designs, features, models or equipment without incurring obligation.

VEHICLE INFORMATION

VEHICLE IDENTIFICATION NUMBER (VIN)

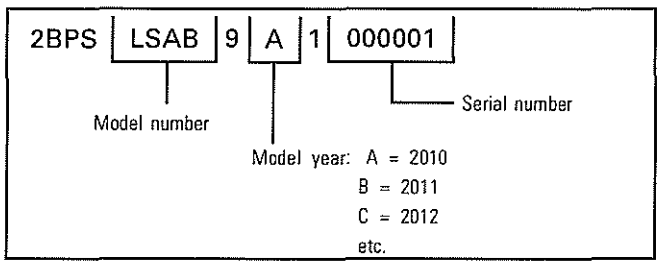


TYPICAL
1. *Vehicle description decal*

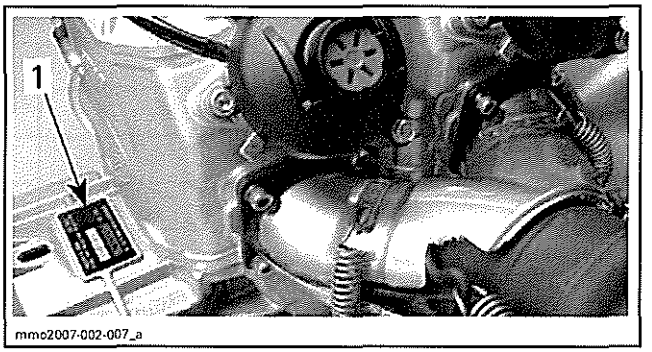


VEHICLE DESCRIPTION DECAL
1. *Manufacturer name*
2. *Manufacturing date*
3. *Vehicle identification number (VIN)*
4. *Model name*
5. *Option package*
6. *Engine type*
7. *Model year*
8. *Color codes*
9. *Vehicle weight/engine power (European models)*

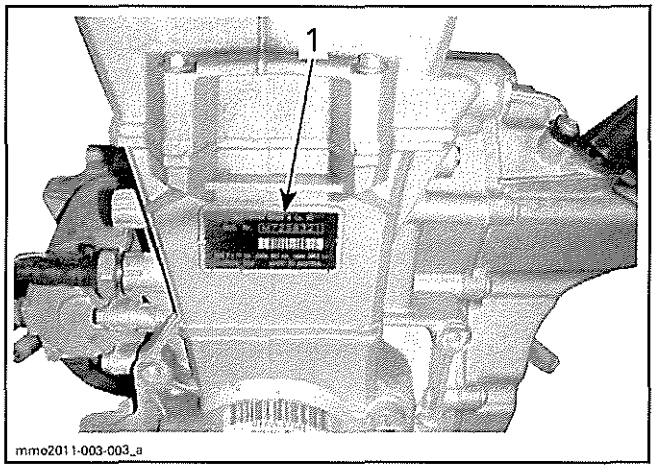
Identification Number Description



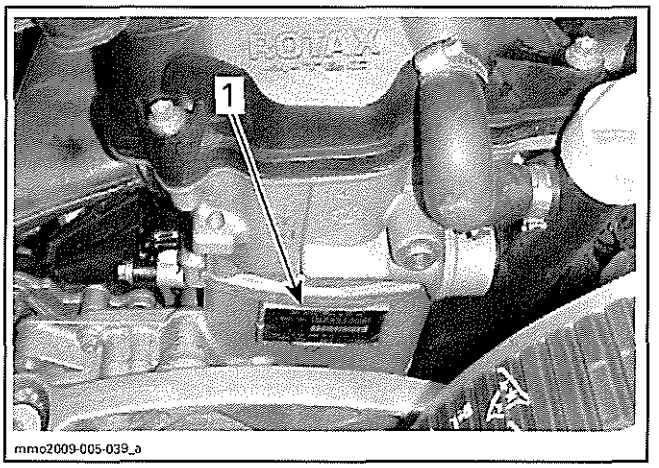
ENGINE SERIAL NUMBER



TYPICAL - 600 HO E-TEC ENGINE
1. *Engine serial number*



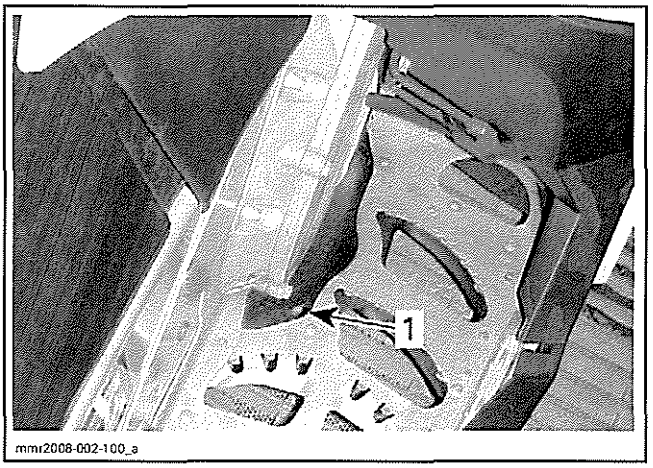
600 ACE
1. *Engine serial number*



1200 4-TEC
1. *Engine serial number*

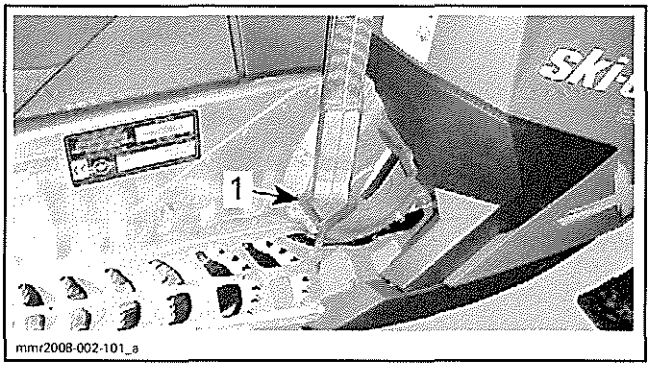
SNOWMOBILE LIFTING

To lift the snowmobile securely, it is important to use the reinforced footrest holes.



1. Reinforced holes in footrest

Install lifting tool hooks in holes as shown.



1. Hook of lifting tool

⚠ WARNING

Do not use footrest openings or steering column to lift the snowmobile. These parts are not designed to support the snowmobile weight. Frame or steering system could be seriously damaged and serious injury or death could happen.

ENGINE EMISSIONS INFORMATION

Manufacturer's Responsibility

Manufacturers of engines must determine the exhaust emission levels for each engine horsepower family and certify these engines with the United States of America *ENVIRONMENTAL PROTECTION AGENCY (EPA).* An emissions control information label, showing emission levels and engine specifications, must be placed on each vehicle at the time of manufacture.

Dealer Responsibility

When performing service on snowmobiles that carry an emissions control information label, adjustments must be kept within published factory specifications.

Replacement or repair of any emission related component must be executed in a manner that maintains emission levels within the prescribed certification standards.

Dealers are not to modify the engine in any manner that would alter the horsepower or allow emission levels to exceed their predetermined factory specifications.

Exceptions include manufacturer's prescribed changes, such as altitude adjustments for example.

Owner Responsibility

The owner/operator is required to have engine maintenance performed to maintain emission levels within prescribed certification standards.

The owner/operator is not to, and should not allow anyone to modify the engine in any manner that would alter the horsepower or allow emissions levels to exceed their predetermined factory specifications.

EPA Emission Regulations

Some Ski-Doo snowmobiles manufactured by BRP are certified to the EPA as conforming to the requirements of the regulations for the control of air pollution from new snowmobiles engines. This certification is contingent on certain adjustments being set to factory standards. For this reason, the factory procedure for servicing the product must be strictly followed and, whenever practicable, returned to the original intent of the design.

The responsibilities listed above are general and in no way a complete listing of the rules and regulations pertaining to the EPA requirements on exhaust emissions for snowmobiles products. For more detailed information on this subject, you may contact the following locations:

For All Courier Services:
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
1310 L Street NW
Washington D.C. 20005

Regular US Postal Mail:
1200 Pennsylvania Ave. NW
Mail Code 6403J
Washington D.C. 20460

Internet: http://www.epa.gov/otaq/

E-Mail: otaqpublicweb@epa.gov

MANUAL INFORMATION

MANUAL PROCEDURES

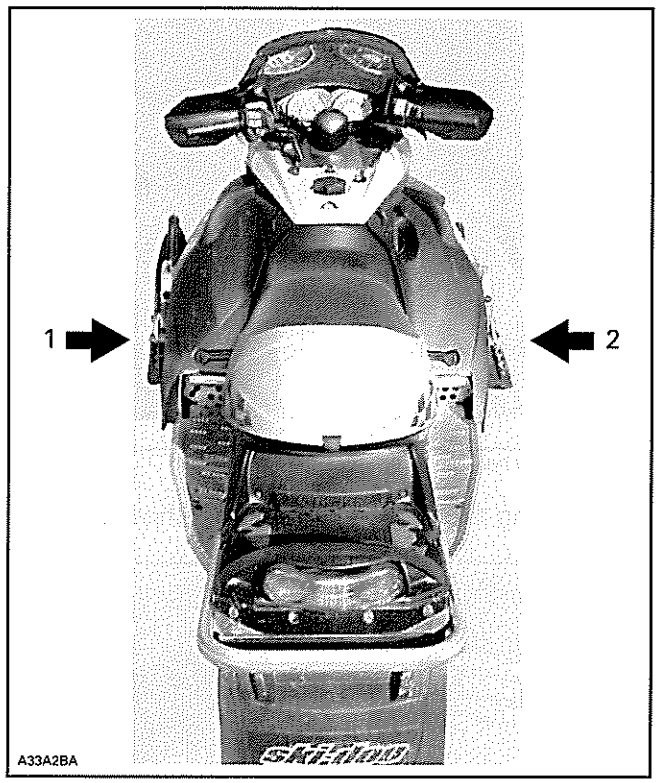
Many of the procedures in this manual are interrelated. Before undertaking any task, you should read and thoroughly understand the entire section or subsection in which the procedure is contained.

⚠ WARNING

Unless otherwise specified, the engine should be turned OFF and cold for all maintenance and repair procedures.

A number of procedures throughout the book require the use of special tools. Before starting any procedure, be sure that you have on hand all required tools, or their approved equivalents.

The use of RIGHT and LEFT indications in the text are always referenced to the driving position (sitting on the vehicle).



TYPICAL
1. Left
2. Right

This manual uses technical terms which may be different from the ones of the *PARTS CATALOGS.*

When ordering parts always refer to the specific model *PARTS CATALOGS.*

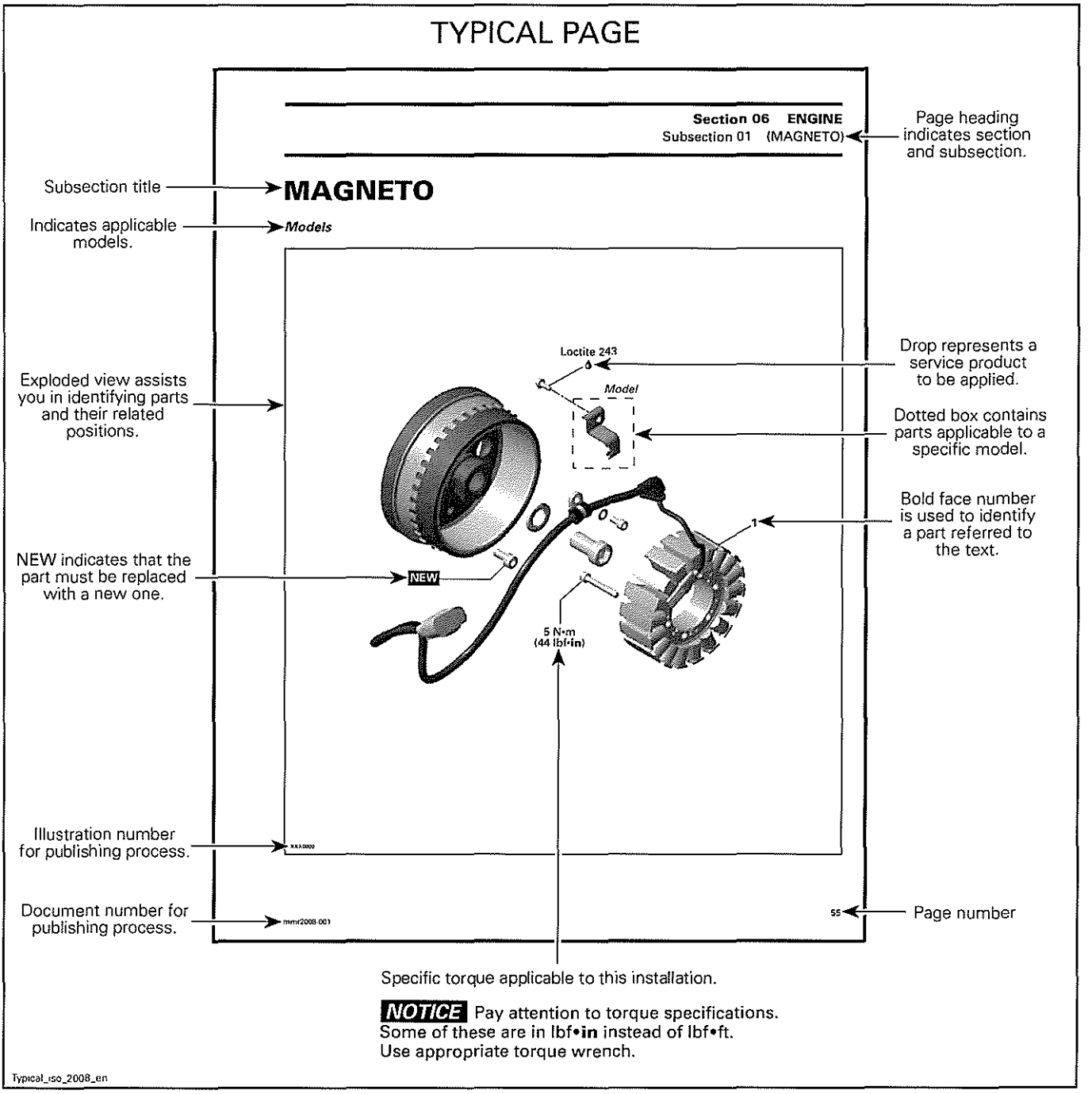
MANUAL LAYOUT

This manual is divided into many major sections as can be seen in the main table of contents at the beginning of the manual.

Each section is divided into various subsections, and again, each subsection has one or more divisions.

Illustrations and photos show the typical construction of various assemblies and, in all cases, may not reproduce the full detail or exact shape of the parts used in a particular model vehicle. However, they represent parts which have the same or a similar function.

TYPICAL PAGE



TYPICAL PAGE

Tittle in bold indicates category of information to be carried out.

Reference to a specific section or subsection.

Indicates component procedures apply to.

Indicates specific procedure to be carried out.

"TYPICAL" indicates a general view which may not represent exact details.

Call-outs pertaining to above illustration.

Illustration always follows text to which it applies.

Italic bold face type-setting indicates a procedure applicable to a specific model(s).

Bold face number following part name refers to exploded view at beginning of subsection.

GENERAL

NOTE: The following procedures can be done without removing the engine.

During assembly/installation, use the torque values and service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* sections at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices (e.g.: locking tabs, elastic stop nuts, self-locking fasteners, etc.) must be replaced with new ones.

PROCEDURES

MAGNETO FLYWHEEL

Magneto Flywheel Cleaning

Clean all metal components in a non-ferrous metal cleaner.

CAUTION: Clean magneto flywheel using only a clean cloth.

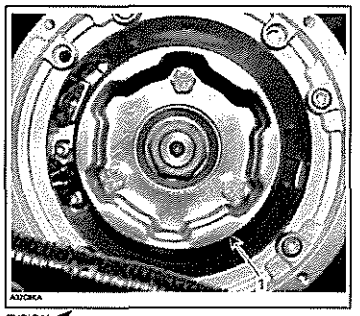
Magneto Flywheel Removal

Remove muffler, refer to the *EXHAUST SYSTEM* section.

Remove acoustic panel.

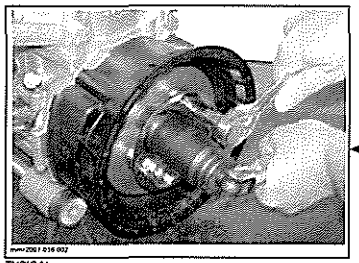
Remove rewind starter.

Remove starting pulley no. 2.



TYPICAL
1 Starting pulley

NOTE: To remove starting pulley bolts, hold magneto flywheel with a socket as shown.



TYPICAL

Models

Remove the connecting flange retaining the rewind starter to the engine housing.

typical_txt_2008_en

TIGHTENING TORQUE

Tighten fasteners to the torque specified in the exploded view(s) and/or in the written procedure. When a torque is not specified, refer to the following table.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, self-locking fasteners, cotter pins, etc.) must be replaced.

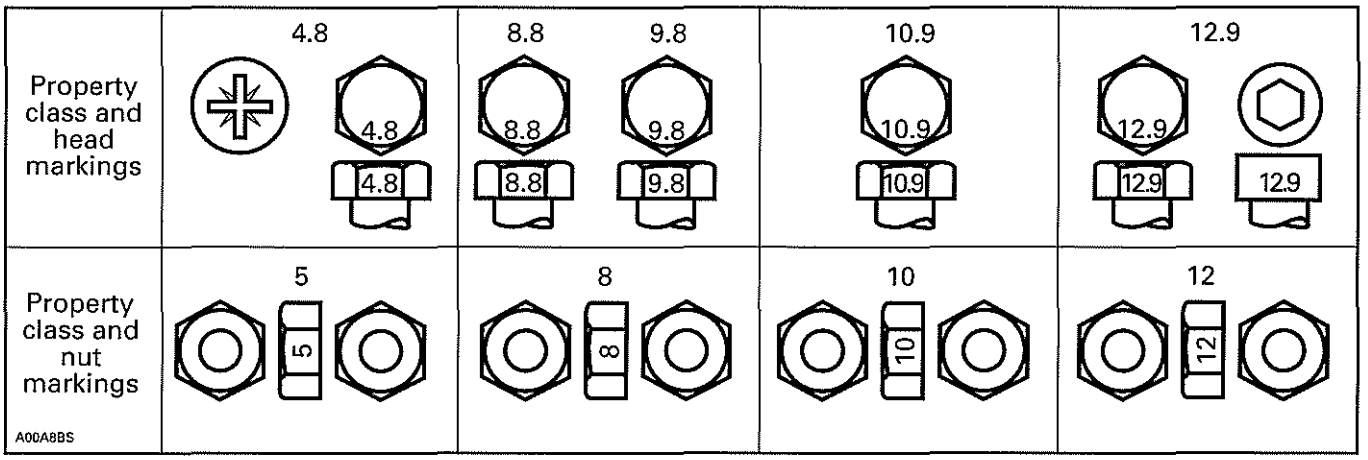
In order to avoid a poor assembly, tighten screws, bolts, or nuts in accordance with the following procedure:

1. Manually screw all screws, bolts and/or nuts.
2. Apply half the recommended torque value.
3. Tighten fastener to the recommended torque value.

NOTICE Be sure to use the recommended tightening torque for the specified fastener used.

NOTE: When possible, always apply torque on the nut.

NOTE: Always torque screws, bolts and/or nuts using a crisscross pattern when multiple fasteners are used to secure a part (eg. a cylinder head). Some parts must be torqued according to a specific sequence and torque pattern as detailed in the installation procedure.



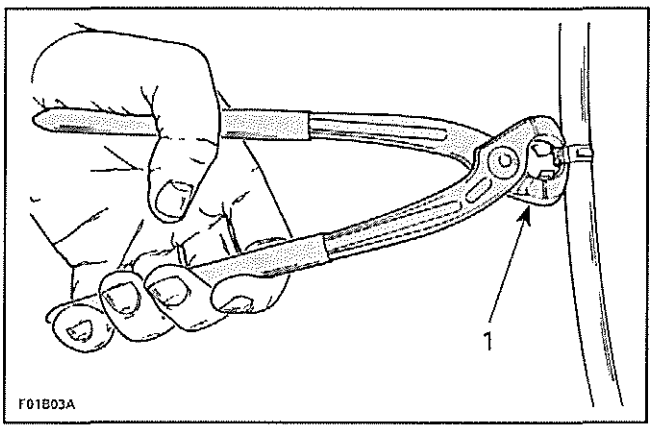
FASTENER SIZE	FASTENER GRADE/TORQUE			
	5.8 Grade	8.8 Grade	10.9 Grade	12.9 Grade
M4	1.5 – 2 N•m (13 – 18 lbf•**in**)	2.5 – 3 N•m (22 – 27 lbf•**in**)	3.5 – 4 N•m (31 – 35 lbf•ft)	4 – 5 N•m (35 – 44 lbf•ft)
M5	3 – 3.5 N•m (27 – 31 lbf•ft)	4.5 – 5.5 N•m (40 – 47 lbf•ft)	7 – 8.5 N•m (62 – 75 lbf•ft)	8 – 10 N•m (71 – 89 lbf•ft)
M6	6.5 – 8.5 N•m (58 – 75 lbf•ft)	8 – 12 N•m (71 – 106 lbf•ft)	10.5 – 15 N•m (93 – 133 lbf•**in**)	16 N•m (142 lbf•**in**)
M8	15 N•m (133 lbf•**in**)	25 N•m (18 lbf•ft)	32 N•m (24 lbf•ft)	40 N•m (30 lbf•ft)
M10	29 N•m (21 lbf•ft)	48 N•m (35 lbf•ft)	61 N•m (45 lbf•ft)	73 N•m (54 lbf•ft)
M12	52 N•m (38 lbf•ft)	85 N•m (63 lbf•ft)	105 N•m (77 lbf•ft)	128 N•m (94 lbf•ft)
M14	85 N•m (63 lbf•ft)	135 N•m (100 lbf•ft)	170 N•m (125 lbf•ft)	200 N•m (148 lbf•ft)

FASTENER INFORMATION

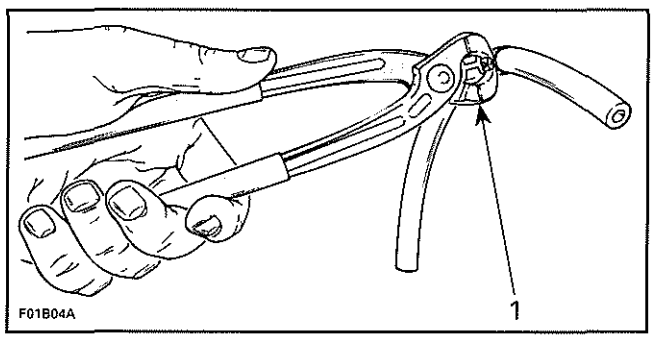
NOTICE Most fasteners are metric. Mismatched or incorrect fasteners could cause damage to the vehicley. Consult the appropriate *PARTS CATALOG* to obtain the correct fasteners.

OETIKER CLAMP REPLACEMENT

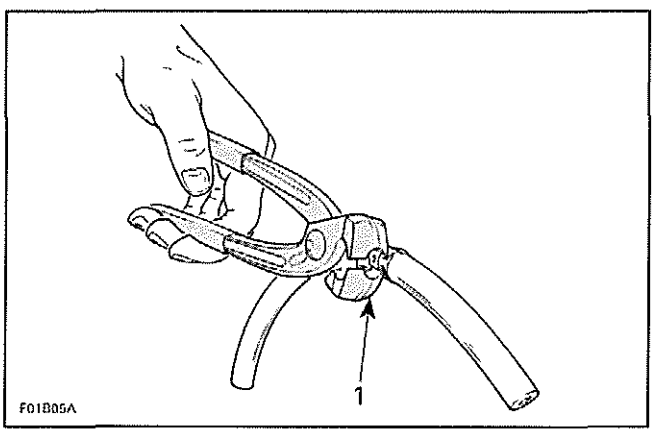
To secure or cut Oetiker clamps, use OETIKER PLIERS (P/N 295 000 070).



1. Cutting clamp

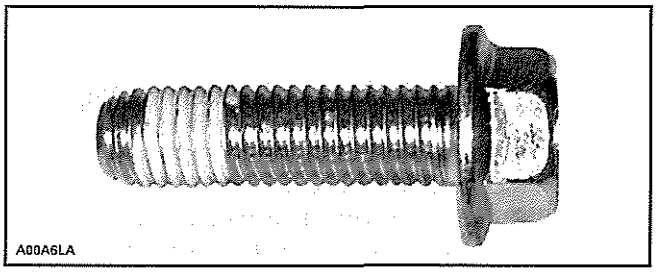


1. Securing clamp



1. Securing clamp in limited access

SELF-LOCKING FASTENERS PROCEDURE



TYPICAL — SELF-LOCKING FASTENER

The following describes common procedures used when working with self-locking fasteners.

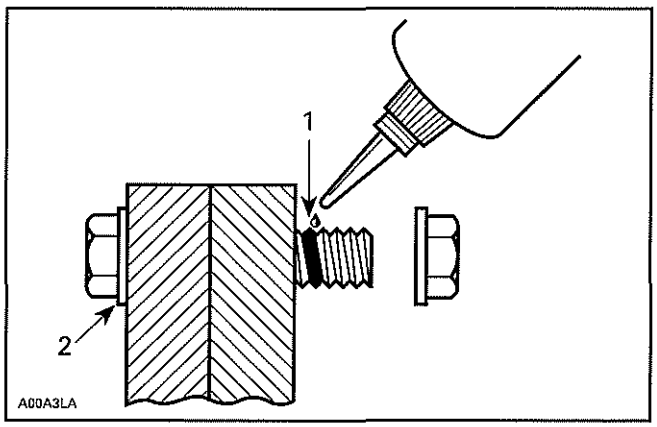
Use a metal brush or a tap to properly clean a threaded hole, then use a solvent. Allow the solvent time to act, approximately 30 minutes, then wipe off. Solvent utilization is to ensure proper adhesion of the product used for locking the fastener.

LOCTITE® APPLICATION PROCEDURE

The following describes common procedures used when working with Loctite products.

NOTE: Always use proper strength Loctite product as recommended in this shop manual.

Threadlocker Application for Uncovered Holes (Bolts and Nuts)

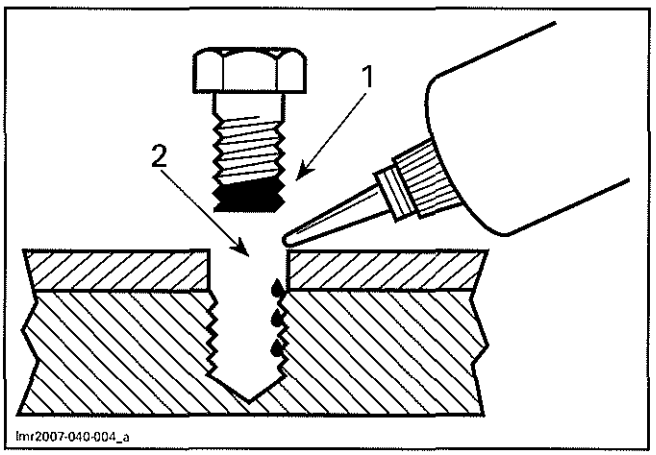


1. Apply here
2. Do not apply

1. Clean threads (bolt and nut) with solvent.
2. Apply LOCTITE PRIMER N (P/N 293 800 041) on threads and allow to dry.
3. Choose proper strength Loctite threadlocker.

4. Fit bolt in the hole.
5. Apply a few drops of threadlocker at proposed tightened nut engagement area.
6. Position nut and tighten as required.

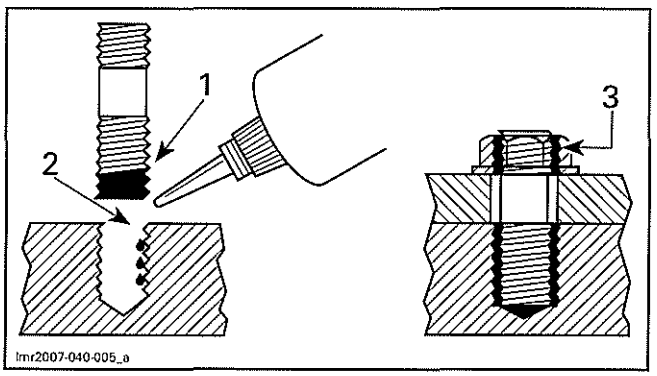
Threadlocker Application for Blind Holes



1. On fastener threads
2. On threads and at the bottom of hole

1. Clean threads (bolt and hole) with solvent.
2. Apply LOCTITE PRIMER N (P/N 293 800 041) on threads (bolt and nut) and allow to dry for 30 seconds.
3. Choose proper strength Loctite threadlocker.
4. Apply several drops along the threaded hole and at the bottom of the hole.
5. Apply several drops on bolt threads.
6. Tighten as required.

Threadlocker Application for Stud Installation in Blind Holes



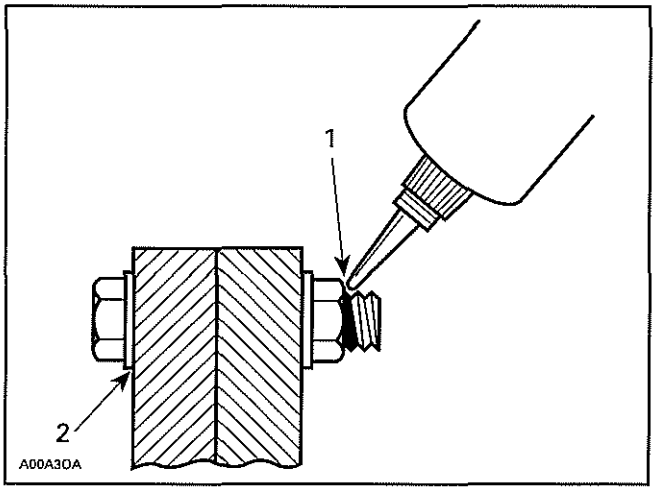
1. On stud threads
2. On threads and in the hole
3. On retaining nut threads

1. Clean threads (stud and hole) with solvent.
2. Apply LOCTITE PRIMER N (P/N 293 800 041) on threads and allow to dry.
3. Put 2 or 3 drops of proper strength Loctite threadlocker on female threads and in hole.

NOTE: To avoid a hydro lock situation, do not apply too much Loctite.

4. Apply several drops of proper strength Loctite on stud threads.
5. Install stud.
6. Install cover, part, etc.
7. Apply a few drops of proper strength Loctite on uncovered stud threads.
8. Install and tighten retaining nut(s) as required.

Threadlocker Application for Pre-Assembled Parts

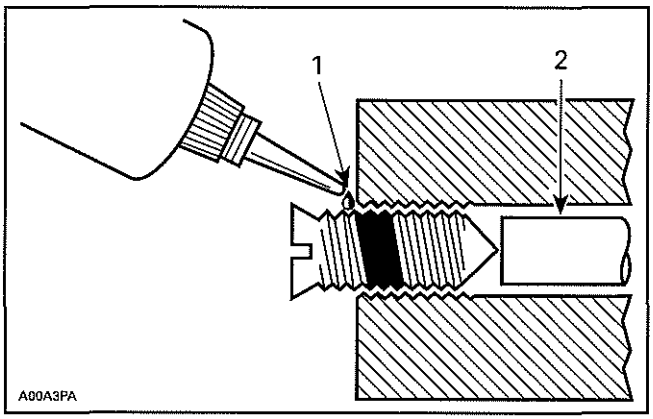


1. Apply here
2. Do not apply

1. Clean bolts and nuts with solvent.
2. Assemble components.
3. Tighten nuts.
4. Apply a few drops of proper strength Loctite on bolt/nut contact surfaces.
5. Avoid touching metal with tip of flask.

NOTE: For preventive maintenance on existing equipment, retighten nuts and apply proper strength Loctite on bolt/nut contact surfaces.

Threadlocker Application for an Adjustment Screw

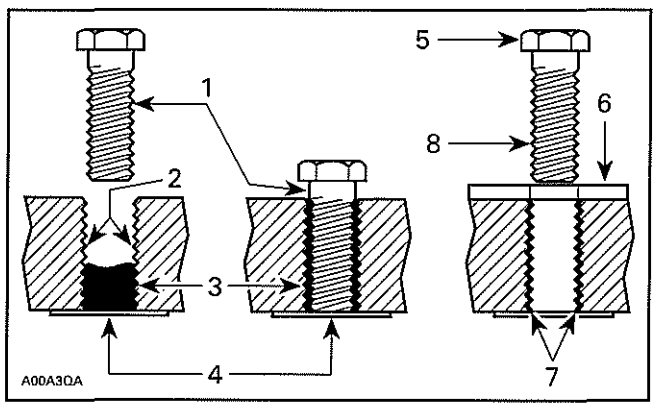


1. Apply here
2. Plunger

1. Adjust screw to proper setting.
2. Apply a few drops of proper strength Loctite threadlocker on screw/body contact surfaces.
3. Avoid touching metal with tip of flask.

NOTE: If it is difficult to readjust, heat screw with a soldering iron (232°C (450°F)).

Application for Stripped Thread Repair



1. Release agent
2. Stripped threads
3. Form-A-Thread
4. Tapes
5. Cleaned bolt
6. Plate
7. New threads
8. Threadlocker

Standard Thread Repair

Follow instructions on Loctite FORM-A-THREAD 81668 package.

If a plate is used to align bolt:

1. Apply release agent on mating surfaces.
2. Put waxed paper or similar film on the surfaces.
3. Twist bolt when inserting it to improve thread conformation.

NOTE: NOT intended for engine stud repairs.

Repair of Small Holes/Fine Threads

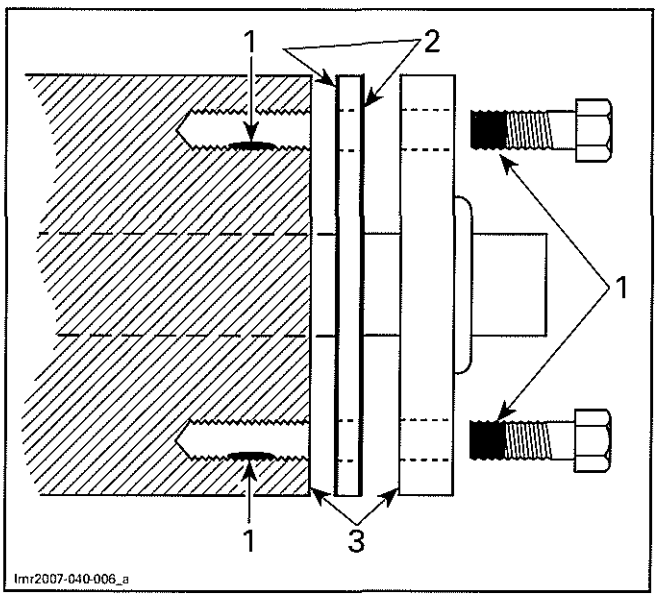
Option 1: Enlarge damaged hole, then follow *STANDARD THREAD REPAIR* procedure.

Option 2: Apply FORM-A-THREAD on the screw and insert in damaged hole.

Permanent Stud Installation (Light Duty)

1. Use a stud of the desired thread length.
2. DO NOT apply release agent on stud.
3. Follow Standard Thread Repair procedure.
4. Allow 30 minutes for Loctite FORM-A-THREAD to cure.
5. Complete part assembly.

Gasket Compound Application



1. Proper strength Loctite
2. Loctite Primer N (P/N 293 800 041) and Gasket Eliminator 518 (P/N 293 800 038) on both sides of gasket
3. Loctite Primer N only

1. Remove old gasket and other contaminants using LOCTITE CHISEL (GASKET REMOVER) (P/N 413 708 500). Use a mechanical means only if necessary.

NOTE: Avoid grinding.

2. Clean both mating surfaces with solvent.
3. Spray Loctite Primer N on both mating surfaces and on both sides of gasket and allow to dry 1 or 2 minutes.
4. Apply LOCTITE 518 (P/N 293 800 038) on both sides of gasket, using a clean applicator.

5. Place gasket on mating surfaces and assemble parts immediately.

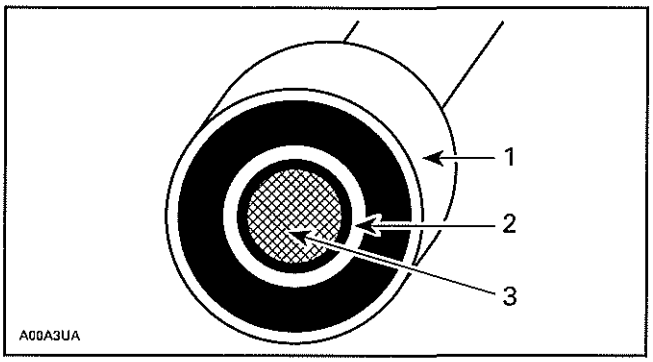
NOTE: If the cover is bolted to blind holes, apply proper strength Loctite in the hole and on threads. Tighten fastener.

If holes are sunken, apply proper strength Loctite on bolt threads.

6. Tighten as usual.

Threadlocker Application for Mounting on a Shaft

Mounting with a Press



1. Bearing
2. Proper strength Loctite
3. Shaft

1. Clean shaft external contact surface.
2. Clean internal contact surface of part to be installed on shaft.
3. Apply a strip of proper strength Loctite on circumference of shaft contact surface at insertion or engagement point.

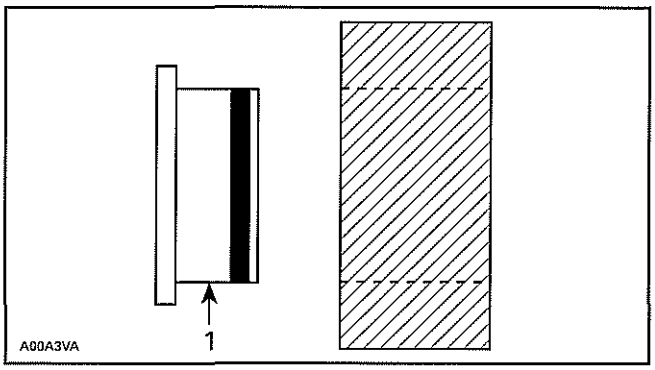
NOTE: Retaining compound is always forced out when applied on shaft.

4. DO NOT use antiseize Loctite or any similar product.
5. No curing period is required.

Mounting in Tandem

1. Apply retaining compound on internal contact surface (bore) of parts to be installed.
2. Continue parts assembly as per previous illustration.

Threadlocker Application for Case-In Components (Metallic Gaskets)



1. Proper strength Loctite

1. Clean inner housing diameter and outer gasket diameter.
2. Spray housing and gasket with LOCTITE PRIMER N (P/N 293 800 041).
3. Apply a strip of proper strength Loctite on leading edge of outer metallic gasket diameter.

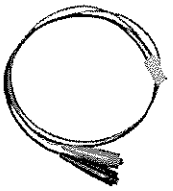
NOTE: Any Loctite product can be used here. A low strength liquid is recommended as normal strength and gap are required.

4. Install according to standard procedure.
5. Wipe off excess product.
6. Allow 30 minutes for product to cure.

NOTE: Normally used on worn-out housings to prevent leaking or sliding.

It is generally not necessary to remove gasket compound applied on outer gasket diameter.

12 V BATTERY SUPPLY CABLE
(P/N 529 035 997)



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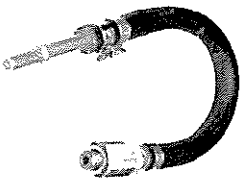
ADAPTER HOSE
(P/N 529 035 652)

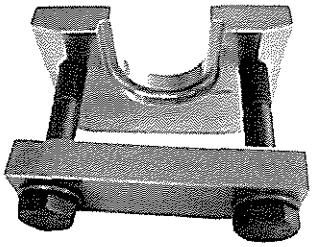


Page: 174, 309

ALIGNMENT BAR
(P/N 529 036 157)

Page: 738

BALL JOINT EXTRACTOR
(P/N 529 035 827)



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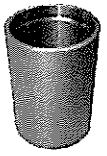
BALL JOINT INSTALLER
(P/N 529 035 975)



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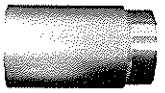
BALL JOINT REMOVER SUPPORT
(P/N 529 036 121)



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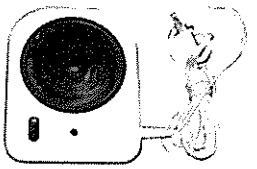
BEARING HEATER
(P/N 529 035 969)



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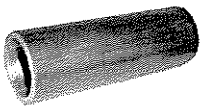
BEARING INSTALLER (PTO)
(P/N 529 035 990)



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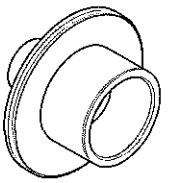
BUSHING PULLER/INSTALLER
(P/N 529 031 200)



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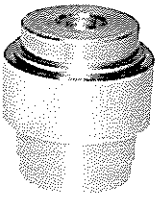
BUSHING REMOVER/INSTALLER
(P/N 529 035 931)



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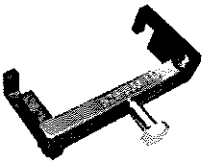
CALIPER PULLER
(P/N 529 036 145)



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CAMSHAFT LOCKING TOOL
(P/N 529 036 149)

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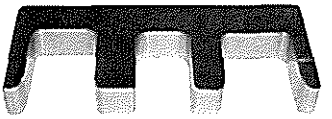
CAMSHAFT LOCKING TOOL
(P/N 529 036 206)



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CENTER BOLT
(P/N 529 036 154)

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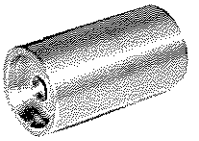
CERAMIC SEAL INSTALLER
(P/N 529 036 014)



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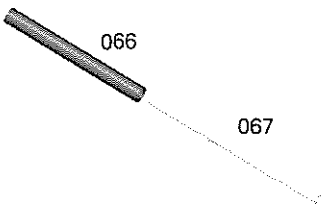
COUNTERSHAFT BEARING
INSTALLER
(P/N 529 036 066)



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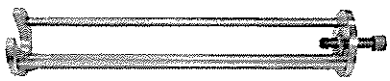
SERVICE TOOLS INDEX

COUNTERSHAFT BEARING REMOVER
(P/N 529 036 065)



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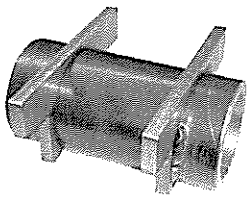
COUNTERSHAFT RETAINING TOOL
(P/N 529 036 165)



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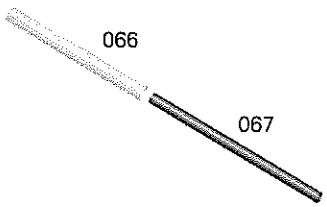
COUNTERSHAFT SUPPORT
(P/N 529 036 067)



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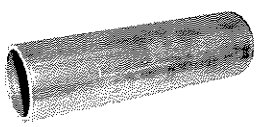
CRANKSHAFT BEARING INSTALLER (MAG)
(P/N 529 035 980)



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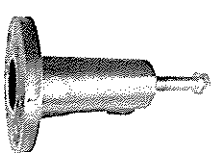
CRANKSHAFT BEARING PULLER
(P/N 529 036 004)



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CRANKSHAFT DISTANCE GAUGE
(P/N 529 035 968)

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CRANKSHAFT LOCKING BOLT
(P/N 529 036 148)

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CRANKSHAFT LOCKING TOOL
(P/N 529 036 205)

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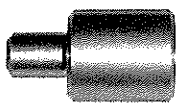
CRANKSHAFT PROTECTOR (MAG SIDE)
(P/N 529 036 160)



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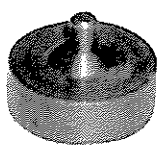
CRANKSHAFT PROTECTOR (MAG)
(P/N 420 876 557)



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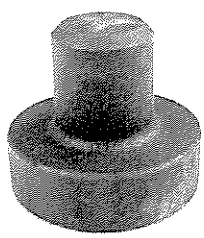
CRANKSHAFT PROTECTOR (PTO)
(P/N 420 876 552)



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CRANKSHAFT PROTECTOR
(P/N 529 036 213)

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CRIMPING TOOL (HEAVY GAUGE WIRE)
(P/N 529 035 730)

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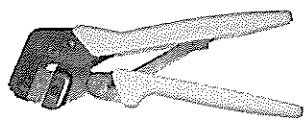
CRIMPING TOOL (KOSTAL)
(P/N 529 035 909)



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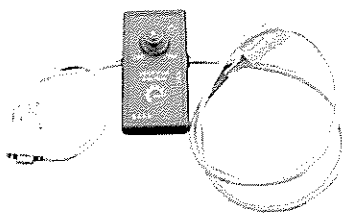
D.E.S.S. POST INTERFACE
(P/N 529 036 019)



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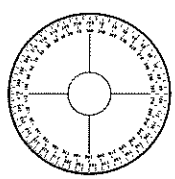
DEGREE WHEEL
(P/N 529 035 607)



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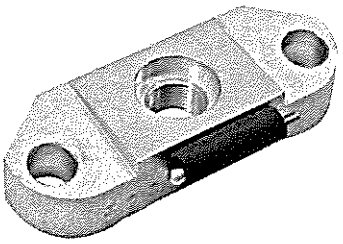
DIAL INDICATOR ADAPTER
(P/N 529 036 132)



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DIAL INDICATOR ADAPTER
(P/N 529 036 159)

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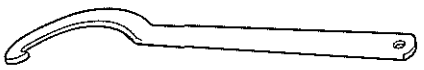
DRIVE PULLEY HOLDER (CVT)
(P/N 529 006 400)



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DRIVE PULLEY HOLDER
(P/N 529 035 674)

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DRIVE PULLEY PULLER
(P/N 529 000 064)

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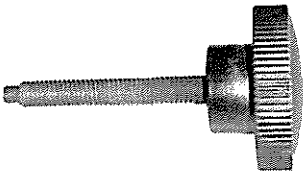
DRIVEN PULLEY OPENING TOOL
(P/N 529 017 200)



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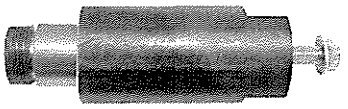
DRIVEN PULLEY SPRING COMPRESSOR
(P/N 529 036 064)



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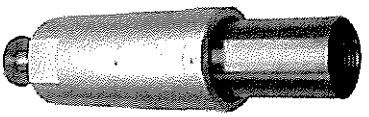
DRIVEN PULLEY SPRING COMPRESSOR
(P/N 529 036 182)



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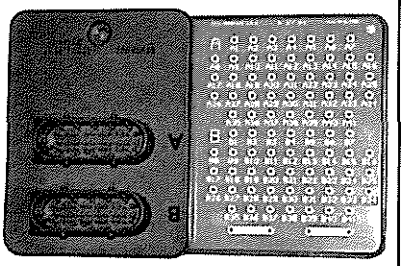
ECM ADAPTER TOOL
(P/N 420 277 010)



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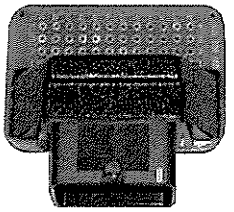
ECM ADAPTER TOOL
(P/N 529 036 166)



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ECM TERMINAL REMOVER 2.25
(P/N 529 036 175)

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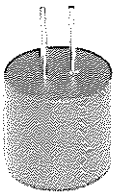
ECM TERMINAL REMOVER 3.36
(P/N 529 036 174)



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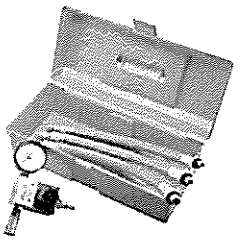
ENGINE LEAK DOWN TEST KIT
(P/N 529 035 661)



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SERVICE TOOLS INDEX

ENGINE LIFTING HOOK
(P/N 529 035 829)

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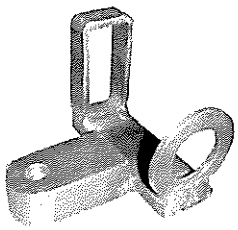
ENGINE LIFTING TOOL
(P/N 529 036 131)



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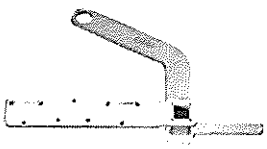
ENGINE LIFTING TOOL
(P/N 529 036 151)



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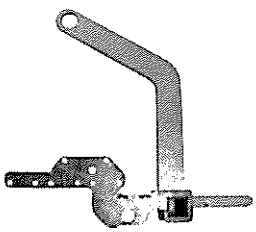
ENGINE LIFTING TOOL
(P/N 529 036 217)



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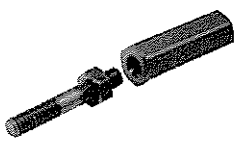
EXTRACTOR ADAPTOR
(P/N 529 036 136)



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FLUKE 115 MULTIMETER
(P/N 529 035 868)

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FLYWHEEL PULLER
(P/N 420 976 235)

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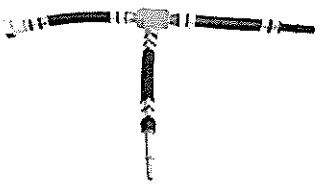
FUEL HOSE ADAPTER
(P/N 529 036 023)



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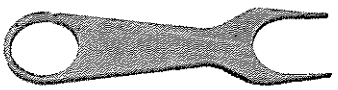
FUEL HOSE DISCONNECT TOOL
(P/N 529 036 037)



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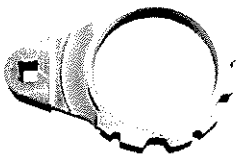
FUEL PUMP NUT TOOL
(P/N 529 036 118)



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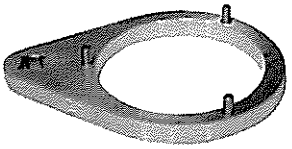
FUEL PUMP NUT TOOL
(P/N 529 036 214)



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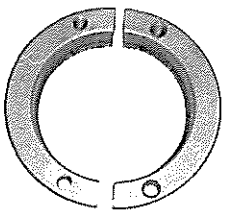
HALF-RINGS
(P/N 420 977 479)



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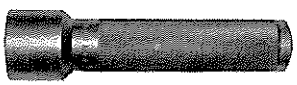
HANDLE
(P/N 420 877 650)



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IGNITION TIMING TOOL
(P/N 529 036 129)

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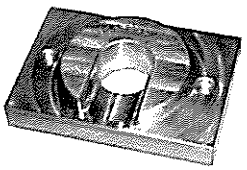
INJECTOR RETAINER PLATE
(P/N 529 036 137)



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INTAKE PLUG
(P/N 529 036 203)

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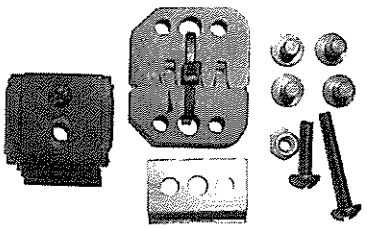
KOSTAL DIE
(P/N 529 035 906)



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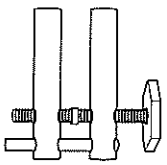
LARGE HOSE PINCHER
(P/N 529 032 500)



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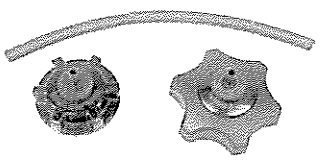
LEAK TEST KIT
(P/N 529 033 100)



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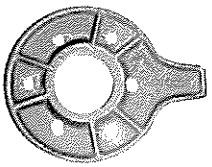
MAGNETO PULLER RING
(P/N 420 876 081)



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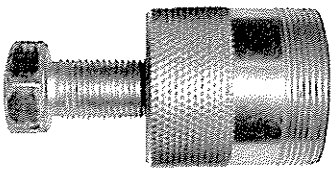
MAGNETO PULLER
(P/N 529 035 547)



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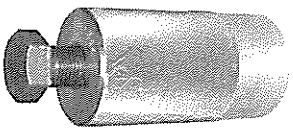
MAGNETO PULLER
(P/N 529 035 748)



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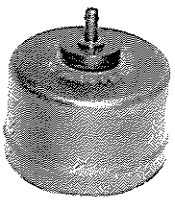
MANIFOLD PLUG 63 MM (2-1/2")
(P/N 529 035 961)



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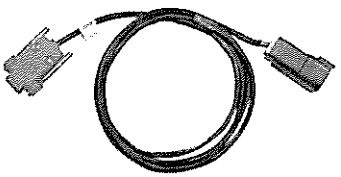
MPI-2 DIAGNOSTIC CABLE
(P/N 710 000 851)



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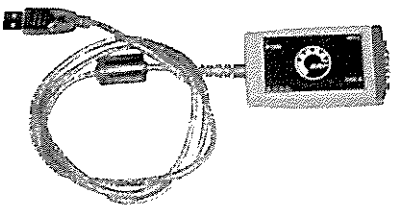
MPI-2 INTERFACE CARD
(P/N 529 036 018)



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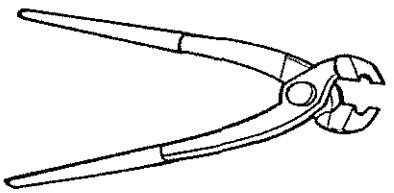
OETIKER PLIERS
(P/N 295 000 070)



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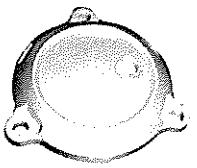
OIL PRESSURE TEST CAP
(P/N 529 036 158)



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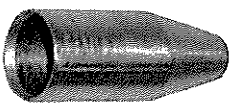
OIL SEAL GUIDE
(P/N 529 035 822)



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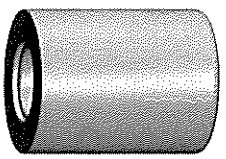
OIL SEAL INSTALLER
(P/N 529 036 155)



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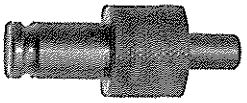
SERVICE TOOLS INDEX

OIL SEAL PUSHER
(P/N 529 035 757)



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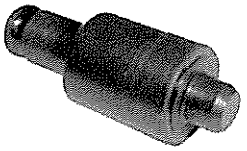
OIL SEAL PUSHER
(P/N 529 036 210)



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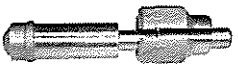
PISTON CIRCLIP INSTALLER
(P/N 529 035 686)



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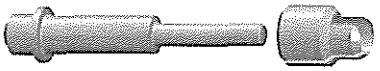
PISTON CIRCLIP INSTALLER
(P/N 529 036 153)



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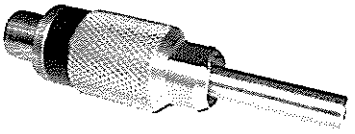
PISTON CIRCLP INSTALLER
(P/N 529 036 207)



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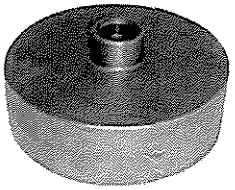
PISTON PROJECTION
(P/N 529 036 215)



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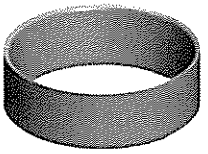
PISTON RING COMPRESSOR
(P/N 529 036 156)



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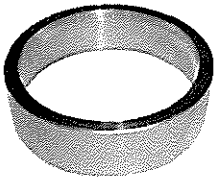
PISTON RING COMPRESSOR
(P/N 529 036 208)



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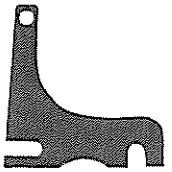
PRELOAD TESTER
(P/N 529 036 164)



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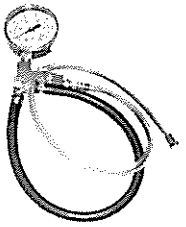
PRESSURE GAUGE
(P/N 529 035 709)



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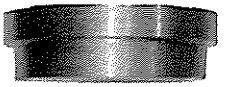
PROTECTIVE CAP
(P/N 529 036 150)



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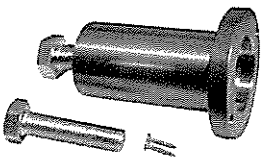
PTO OIL SEAL INSTALLER
(P/N 529 036 216)



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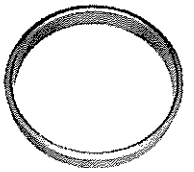
PULLER RING
(P/N 420 977 494)



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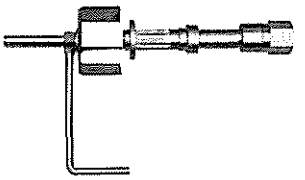
PULLEY SPRING COMPRESSOR TOOL
(P/N 529 036 012)



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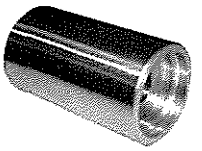
ROTARY SEAL INSTALLER
(P/N 529 036 211)



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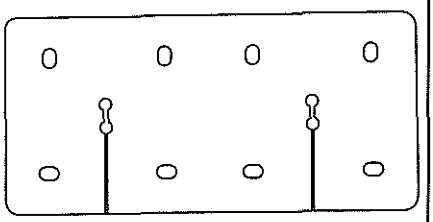
RUBBER PAD PROTECTOR
(P/N 529 023 400)



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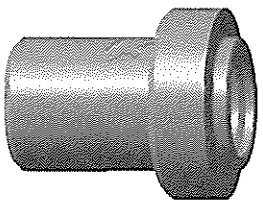
SEAL PUSHER
(P/N 529 035 766)



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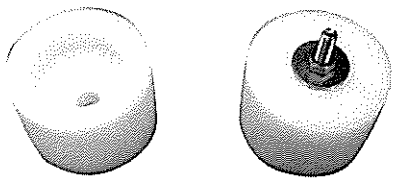
SHOCK ABSORBER SUPPORTS
(P/N 529 036 186)



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SLIDER SHOE FORK
(P/N 529 005 500)

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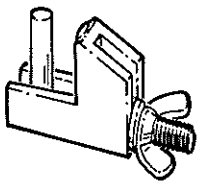
SMALL HOSE PINCHER
(P/N 295 000 076)



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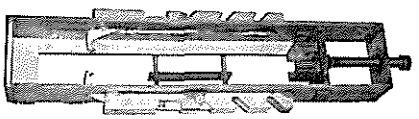
SPRING COMPRESSOR
(P/N 529 036 184)



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SPRING INSTALLER/REMOVER
(P/N 529 035 983)

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SUCTION PUMP
(P/N 529 035 880)

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SUPERTANIUM DRILL BIT 3/16"
(P/N 529 031 800)

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SUPPORT PLATE
(P/N 529 035 976)

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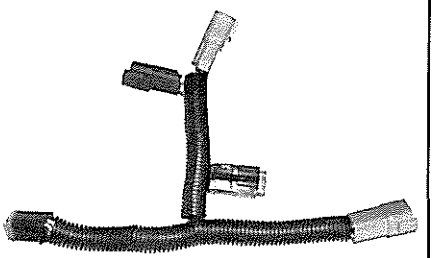
T-HARNESS
(P/N 529 035 869)



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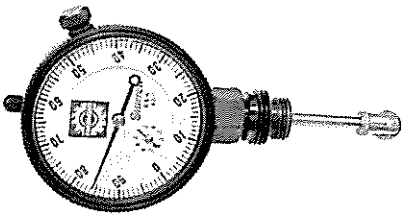
TDC DIAL INDICATOR
(P/N 295 000 143)



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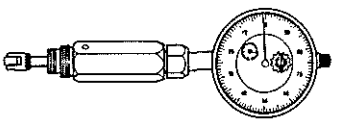
TDC DIAL INDICATOR
(P/N 414 104 700)



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TEMPERATURE INDICATOR STICK
(P/N 529 035 970)

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TENSIOMETER
(P/N 414 348 200)

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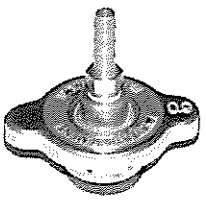
TEST CAP
(P/N 529 035 991)



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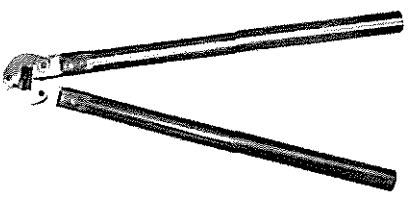
TRACK CLEAT INSTALLER
(P/N 529 036 044)



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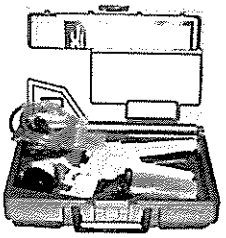
SERVICE TOOLS INDEX

VACUUM/PRESSURE PUMP
(P/N 529 021 800)



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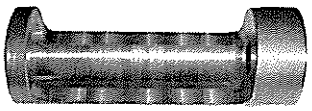
VALVE SPRING COMPRESSOR CUP
(P/N 529 036 161)



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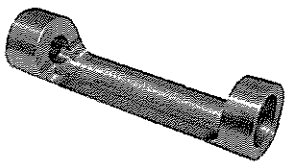
VALVE SPRING COMPRESSOR CUP
(P/N 529 036 209)



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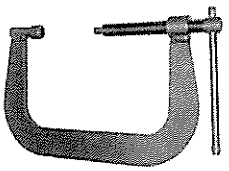
VALVE SPRING COMPRESSOR
(P/N 529 035 724)



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BREAK-IN INSPECTION

Procedures are detailed in *PERIODIC MAINTENANCE PROCEDURES* subsection.

BREAK-IN INSPECTION
Inspect engine seals and gaskets for leaks (600 ACE and 1200 4-TEC)
Inspect exhaust system and check for leaks
Inspect all heat shields
Check coolant level
Change engine oil and filter (600 ACE and 1200 4-TEC)
Inspect fuel lines and connections
Inspect throttle cable
Inspect drive belt
Visually inspect drive pulley
Tighten drive pulley retaining screw to specified torque
Inspect driven pulley
Check driven pulley preload
Adjust and align track
Change gearbox oil
Check brake fluid level
Inspect brake hose, pads and disk
Inspect steering mechanism
Inspect skis and runners
Inspect front suspension
Inspect rear suspension and slider shoes

PERIODIC MAINTENANCE SCHEDULE (600 HO E-TEC)

Procedures are detailed in *PERIODIC MAINTENANCE PROCEDURES* subsection.

EVERY 3 000 KM (2,000 MI) OR 1 YEAR (WHICHEVER COMES FIRST)
Inspect heat shields
Inspect engine rubber mounts
Inspect exhaust system and check for leaks
Adjust engine stopper
Visually inspect and clean drive pulley
Tighten drive pulley retaining screw to specified torque
Clean driven pulley
Adjust and align track
Inspect brake hose, pads and disk
Inspect steering mechanism
Inspect front suspension
Inspect rear suspension and stopper strap
Lubricate rear suspension (lubricate whenever the vehicle is used in wet conditions (rain, puddles))

EVERY 6 000 KM (4,000 MI) OR 2 YEARS (WHICHEVER COMES FIRST)
Inspect fuel pump strainer and replace if necessary
Replace brake fluid
Inspect throttle cable
Clean and lubricate rewind starter

EVERY 10 000 KM (6,000 MI) OR 3 YEARS (WHICHEVER COMES FIRST)
Replace spark plugs
Inspect oil pump strainer and clean if needed

EVERY 5 YEARS
Replace engine coolant
Replace in-line fuel filter

PERIODIC MAINTENANCE SCHEDULE (600 ACE AND 1200 4-TEC)

Procedures are detailed in *PERIODIC MAINTENANCE PROCEDURES* subsection.

EVERY 3 000 KM (2,000 MI) OR 1 YEAR (WHICHEVER COMES FIRST)
Inspect heat shields
Replace drive pulley O-rings (1200 4-TEC)
Visually inspect and clean drive pulley
Tighten drive pulley retaining screw to specified torque
Clean driven pulley
Check driven pulley preload
Adjust and align track
Inspect brake hose, pads and disk
Inspect steering mechanism
Inspect front suspension
Inspect rear suspension and stopper straps
Lubricate rear suspension. Lubricate whenever the vehicle is used in wet conditions (rain, puddles)

EVERY 6 000 KM (4,000 MI) OR AT PRE-SEASON (WHICHEVER COMES FIRST)
Change engine oil and filter

EVERY 6 000 KM (4,000 MI) OR 2 YEARS (WHICHEVER COMES FIRST)
Replace fuel pump outlet filter
Replace drive pulley slider shoes and inspect ramps (1200 4-TEC)
Replace brake fluid
Inspect throttle cable

EVERY 10 000 KM (6,000 MI) OR 3 YEARS (WHICHEVER COMES FIRST)
Replace spark plugs

EVERY 20 000 KM (12,500 MI)
Check valve clearance and adjust if necessary (1200 4-TEC)

EVERY 5 YEARS
Replace engine coolant

PERIODIC MAINTENANCE PROCEDURES

SERVICE TOOLS

Description	Part Number	Page
TENSIOMETER	414 348 200	34

SERVICE PRODUCTS

Description	Part Number	Page
BRAKE FLUID	293 600 131	31
BRP PREMIXED COOLANT	219 700 362	15
DIELECTRIC GREASE	293 550 004	30
PULLEY FLANGE CLEANER	413 711 809	28, 34
SUSPENSION GREASE	293 550 033	36–37
XPS SYNTHETIC CHAINCASE OIL	413 803 300	33
XPS SYNTHETIC GREASE	293 550 010	33
XPS SYNTHETIC OIL (ALL CLIMATE)	293 600 112	18

GENERAL

This subsection provides general maintenance instructions. Where detailed instructions for disassembly or reassembly is required, refer to the applicable subsection.

PROCEDURES

ENGINE

Heat Shields Inspection

Break-In	Scheduled Maintenance	Storage	Preseason
✔			

Visually inspect heat shields on exhaust system, coolant hoses, electrical harness and body panels. Replace any damaged shield.

Recommended Engine Coolant

Use BRP PREMIXED COOLANT (P/N 219 700 362) or a blend of 50% antifreeze with 50% distilled water.

To prevent antifreeze deterioration, always use the same brand. Never mix different brands unless cooling system is completely flushed and refilled.

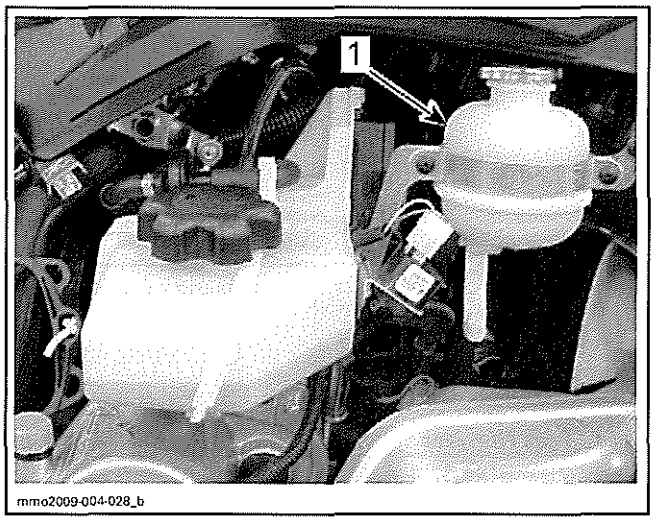
NOTICE To prevent rust formation or freezing condition, always replenish the system with the BRP premixed coolant or with 50% antifreeze and 50% water. Do not use tap water, straight antifreeze or straight water in the system. Tap water contains minerals and impurities which build up in the system. During cold weather, straight water causes the system to freeze while straight antifreeze thickens (like slush ice) and does not have the same efficiency. Always use ethylene glycol antifreeze containing corrosion inhibitors specifically recommended for aluminum engines.

Engine Coolant Level Verification

Break-In	Scheduled Maintenance	Storage	Preseason
✔			

Check coolant level at room temperature with the cap removed. Liquid should be at cold level line (engine cold) of coolant tank.

NOTE: When checking level at low temperature it may be slightly lower then the mark.



TYPICAL
1. Coolant tank

Engine Coolant Strength Verification

Break-In	Scheduled Maintenance	Storage	Preseason
			✔

Remove pressure cap.

Use an antifreeze tester to test coolant strength.

MINIMUM RECOMMENDED COOLANT STRENGTH
-30°C (-22°F)

Engine Coolant Replacement

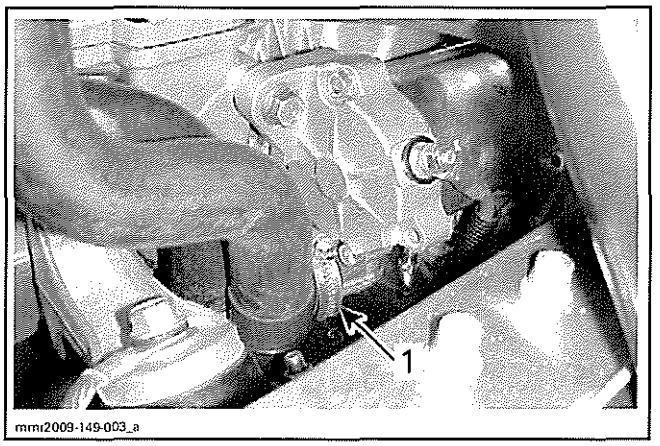
Break-In	Scheduled Maintenance	Storage	Preseason
	✔		

Cooling System Draining 600 HO E-TEC

⚠ WARNING

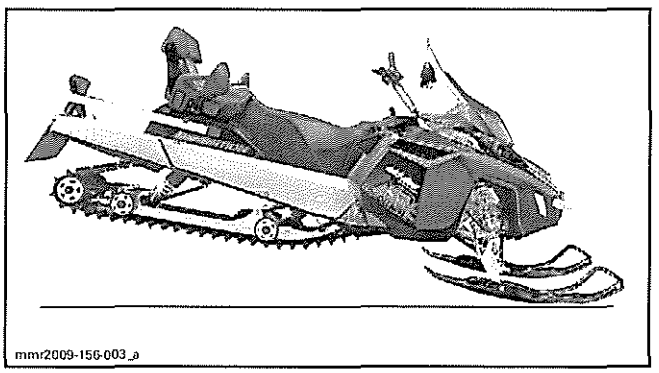
Never drain or refill the cooling system when engine is hot.

1. Remove RH side panel and hood. Refer to *BODY* subsection.
2. Remove muffler and tuned pipe. Refer to *EXHAUST SYSTEM* subsection.
3. Place a large drain pan under the vehicle bottom pan.
4. Unplug coolant hose from water pump to drain coolant.



1. Water pump hose clamp

5. When coolant level is low enough, lift the rear of vehicle to drain the heat exchangers.



6. Install and tighten coolant hose clamp on water pump.

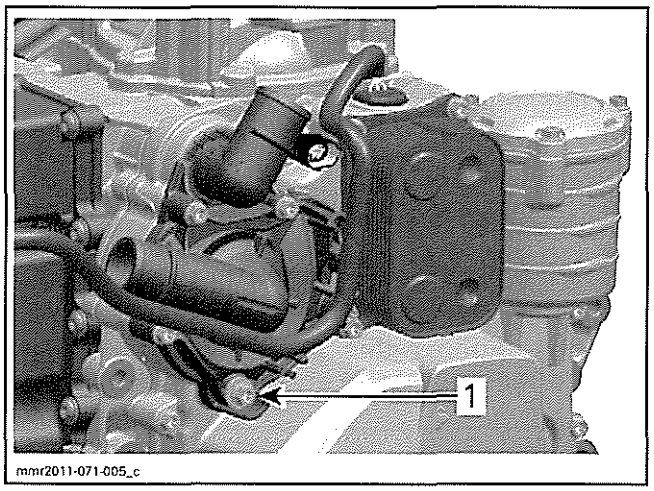
COOLANT HOSE CLAMP TORQUE
5.5 N•m (49 lbf•**in**)

Cooling System Draining (600 ACE and 1200 4-TEC)

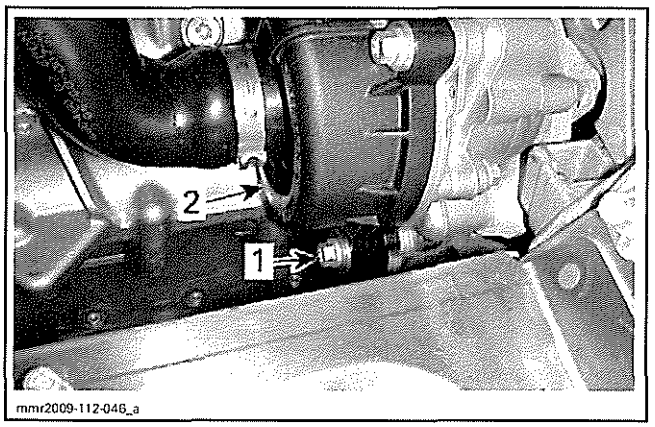
⚠ WARNING

Never drain or refill the cooling system when engine is hot.

1. Remove body parts as required to access to the water pump.
2. Place a large drain pan under the vehicle bottom pan.
3. Remove drain screw at water pump to drain coolant.

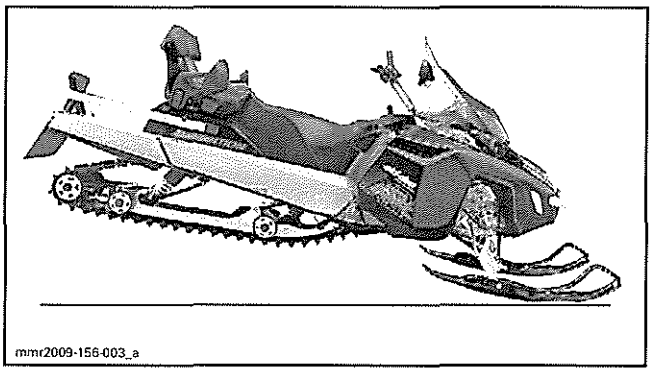


600 ACE
1. Drain screw



1200 4-TEC
1. Drain screw
2. Water pump (under exhaust manifold)

4. Remove coolant reservoir cap.
5. When coolant level is low enough, lift the rear of vehicle to drain the heat exchangers.

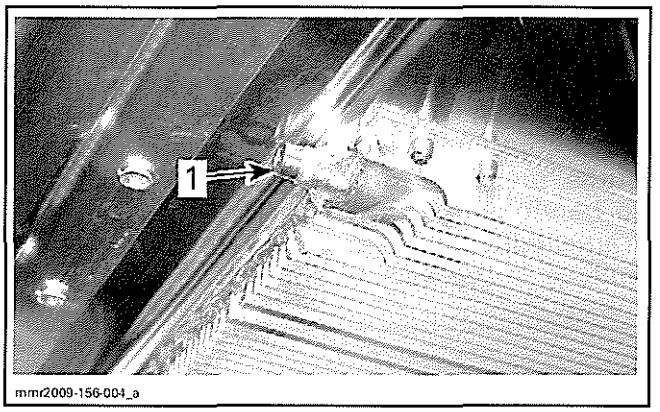


6. Install **new** sealing washer on drain screw.
7. Tighten drain screw to specification.

DRAIN SCREW TORQUE
11 N•m ± 1 N•m (97 lbf•**in** ± 9 lbf•**in**)

Cooling System Refilling and Bleeding

1. Apply parking brake.
2. From underneath the back end of the chassis, remove the heat exchanger drain plug.



1. Drain plug

3. Fill coolant reservoir until coolant comes out of heat exchanger.
4. Install drain plug and tighten it to specification.

DRAIN PLUG TORQUE
10 N•m (89 lbf•**in**)

5. Lift front of vehicle by 25 cm ± 5 cm (10 in ± 2 in) and support safely.
6. Fill coolant tank up to COLD LEVEL line.
7. Start engine.
8. Add coolant up to line while engine is idling until rear heat exchangers are warm to the touch (about 4 to 5 minutes).

NOTE: Always monitor coolant level while filling coolant tank to avoid an empty coolant reservoir, and thus allow air to enter the system.

9. Install pressure cap.

Lower vehicle back on the ground.

10. Lift rear of vehicle and support it safely.

⚠ WARNING

Before revving engine, ensure that the track is free of particles which could be thrown out while track is rotating. Keep hands, tools, feet and clothing clear of track. Always lift the snowmobile on a wide-base stand with a rear deflector panel. Ensure no one is standing in close proximity to the snowmobile, especially at the rear of the track. Centrifugal force could cause debris, damaged or loose studs, pieces of torn track, or an entire track to be violently thrown backwards out of the frame with tremendous force, possibly resulting in the loss of a leg or other serious injury.

11. Remove parking brake.
12. Activate throttle lever 3 - 4 times to bring engine speed to 7000 RPM.
13. Apply the brake.
14. Lower vehicle back on ground.
15. Stop engine.
16. Add coolant up to 15 mm (1/2 in) above the COLD LEVEL line.
17. When engine has completely cooled down, recheck coolant level in coolant tank and refill up to line if needed.
18. Perform *ENGINE COOLANT STRENGTH VERIFICATION*. See procedure in this subsection.
19. Adjust mixture if necessary.
20. Reinstall removed parts.
21. Run vehicle a few minutes then recheck coolant level.

Recommended Engine Oil (600 ACE and 1200 4-TEC)

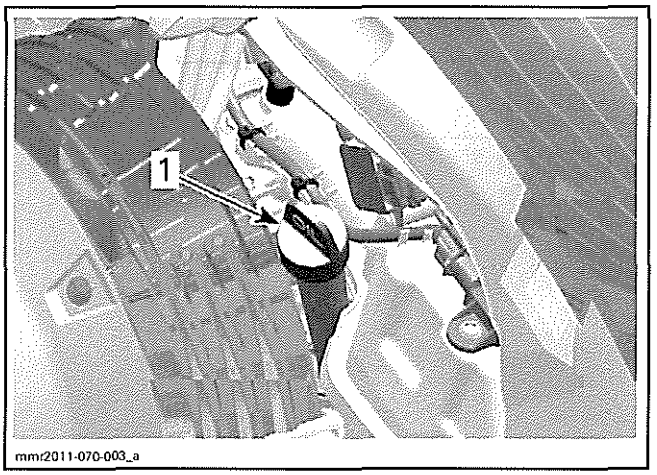
ENGINE	RECOMMENDED ENGINE OIL
600 ACE	XPS SYNTHETIC OIL (ALL CLIMATE) (P/N 293 600 112)
1200 4-TEC	

NOTICE The engine of this snowmobile has been developed and validated using the BRP XPS™ Synthetic 4-stroke oil. BRP strongly recommends the use of its XPS Synthetic 4-stroke oil at all times. Damages caused by oil which is not suitable for the engine will not be covered by the BRP limited warranty.

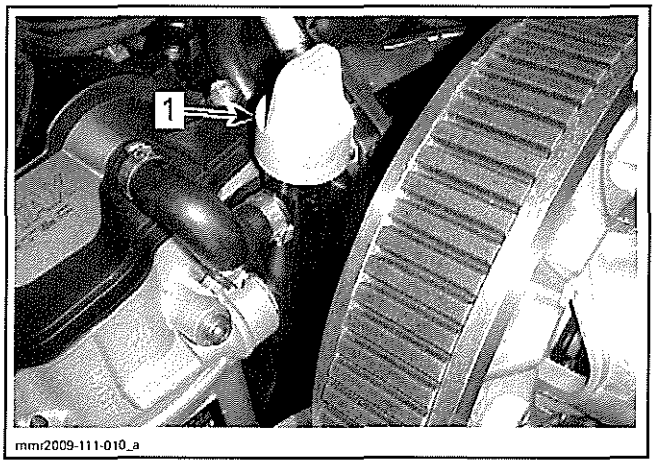
If the recommended oil is not available, use SAE 0W-40 synthetic-based oil that meets or exceeds the requirements for API service classification SM.

Engine Oil Level Verification (600 ACE and 1200 4-TEC)

NOTICE Operating the engine with an improper oil level may cause severe engine damage. Follow this procedure to obtain a precise reading of the engine oil level.



TYPICAL 600 ACE - LH SIDE
1. Oil tank dipstick

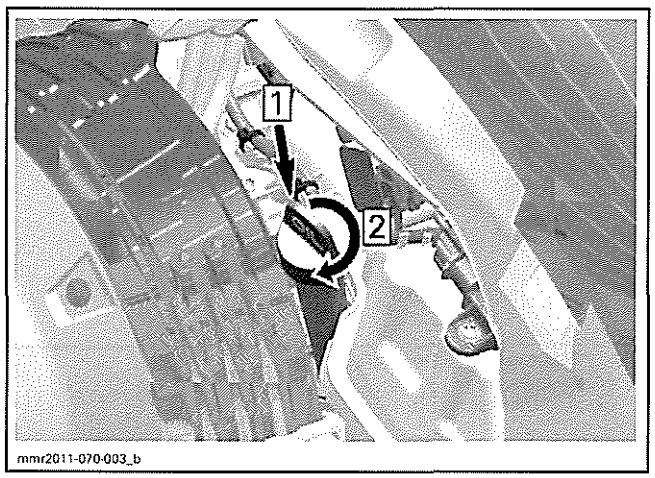


TYPICAL 1200 4-TEC- LH SIDE
1. Oil tank dipstick

With the engine at normal operating temperature, place vehicle on a level surface and proceed as follows to check oil level:

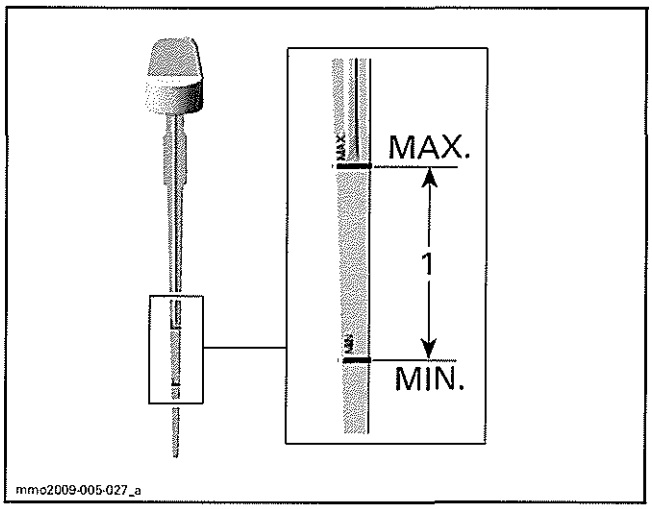
1. Start engine and let it idle for at least 20 seconds.
2. Stop engine.
3. Open the LH side panel.
4. If applicable, remove the drive belt guard. refer to *DRIVE BELT* subsection.

5. Unscrew and remove dipstick and wipe clean.
6. Insert dipstick in the filler tube and again tighten it.



TYPICAL
Step 1: Insert dipstick
Step 2: Tighten dipstick.

7. Remove dipstick again and check oil level. It should be near or equal to the upper mark.



1. Operating range

8. To add oil, place a funnel into the filler tube to avoid spillage.
   - 8.1 Add a small amount of oil and recheck oil level.
   - 8.2 Repeat the operation until oil level reaches the dipstick's upper mark. Do not overfill.

NOTE: The oil quantity between MIN. and MAX. mark is approximately 500 ml (16.9 U.S. oz).

9. Reinstall dipstick and properly tighten it.
10. Wipe off any oil spillage.
11. Install drive belt guard.
12. Close the LH side panel.

Engine Oil Replacement (600 ACE)

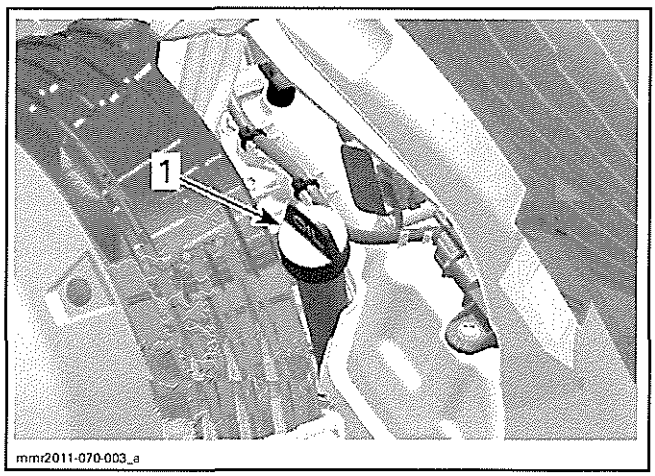
Break-In	Scheduled Maintenance	Storage	Preseason
	✔		✔

⚠ WARNING

The engine oil can be very hot. Wait until engine oil is warm.

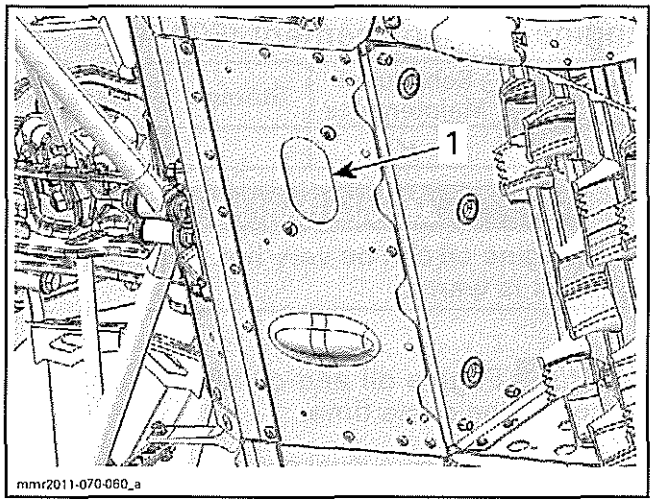
NOTICE Engine oil and oil filter must be replaced at the same time.

1. Place vehicle on a level surface.
2. Remove the LH side panel.
3. Remove dipstick.

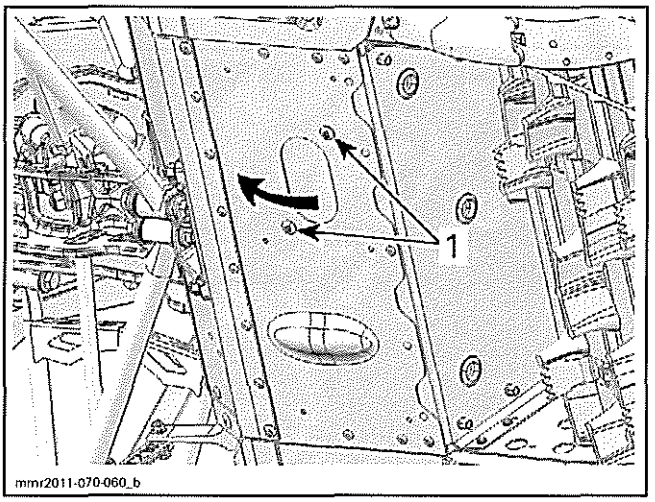


LH SIDE OF VEHICLE
1. Oil tank dipstick

4. From underneath the vehicle, access the drain plug:
   - 4.1 Remove one access cover retaining screw and loosen the other.
   - 4.2 Pivot the access cover to clear the bottom pan opening.

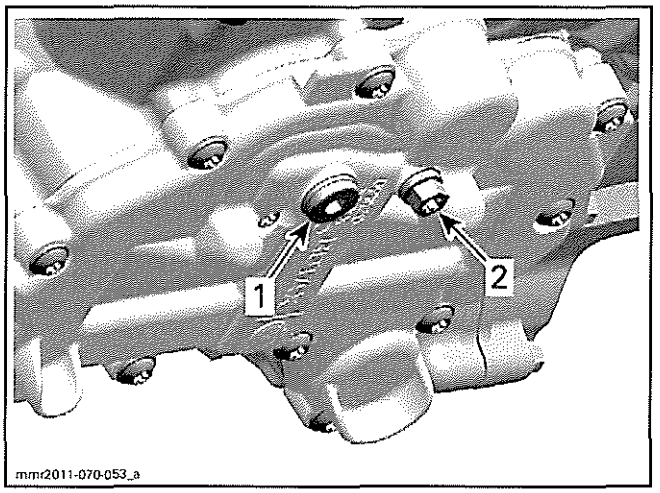


1. Drain plugs access cover



PIVOT THE ACCESS COVER
1. Retaining screws

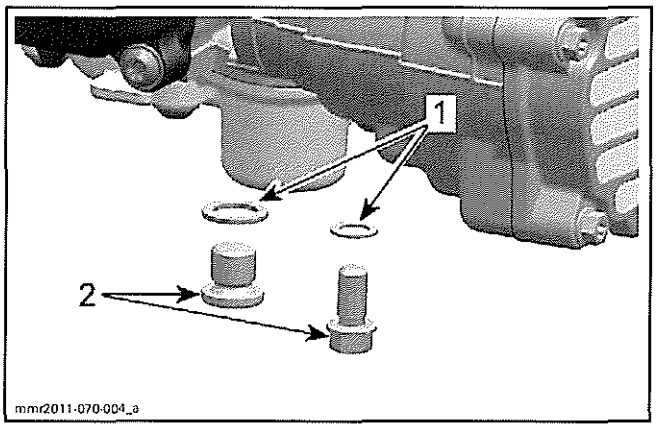
5. Clean drain plug area.
6. Place a drain pan under the bottom pan opening.
7. Remove engine drain plugs in the following order.
   7.1 Main drain plug.
   7.2 Secondary drain plug.



UNDERNEATH THE ENGINE
1. Main drain plug
2. Secondary drain plug

8. Allow oil to drain completely.
9. Install NEW sealing washers on oil drain plugs.

NOTICE Never use a sealing washer a second time. Always replace with a new one.



1. Sealing washer
2. Oil drain plug

10. Install drain plugs and tighten to the specified torque.

DRAIN PLUGS TIGHTENING TORQUE
20 N•m ± 2 N•m (15 lbf•ft ± 1.5 lbf•ft)

11. Replace *OIL FILTER*, see procedure in this subsection.
12. Refill oil tank at the proper level with the recommended oil.

APPROXIMATE ENGINE OIL CAPACITY (WITH FILTER)	
600 ACE	2.1 L (2.2 qt (U.S. liq.))

13. Reinstall dipstick in oil tank and properly tighten it.

14. Start engine and let it idle for a few minutes.
15. Ensure there are no leaks.
16. Stop engine and check oil level as explained in this subsection. Refill if necessary.
17. Dispose oil and filter as per your local environmental regulations.

Engine Oil Replacement (1200 4-TEC)

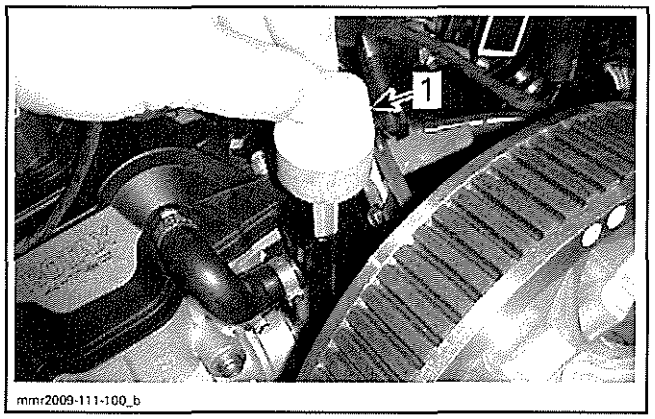
Break-In	Scheduled Maintenance	Storage	Preseason
	✔		✔

⚠ WARNING

The engine oil can be very hot. Wait until engine oil is warm.

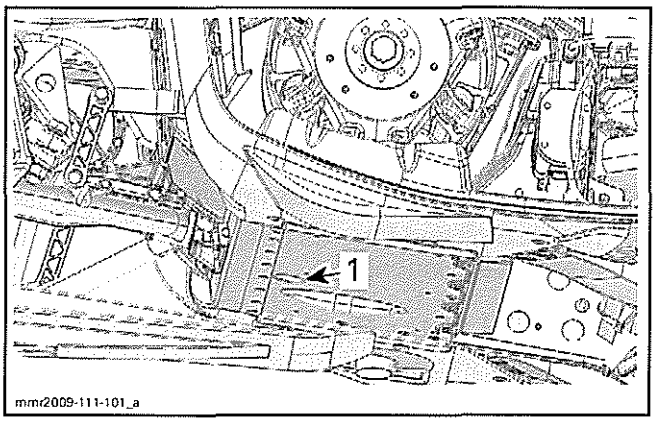
NOTICE **Engine oil and oil filter must be replaced at the same time.**

1. Place vehicle on a level surface.
2. Remove the LH side panel.
3. Remove the drive belt guard. Refer to *DRIVE BELT* subsection.
4. Remove dipstick.



LH SIDE OF VEHICLE
1. Oil tank dipstick

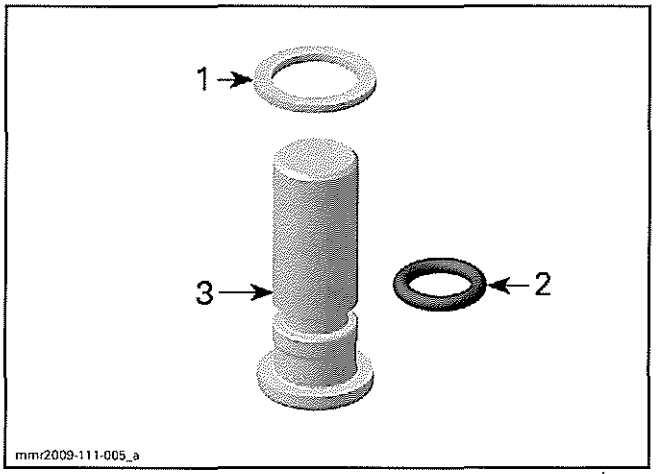
5. From underneath of vehicle, clean drain plug area.



1. Frame opening to reach drain plug

6. Place a drain pan under frame opening.
7. Remove engine oil drain plug and discard sealing washer.
8. Allow oil to drain completely.
9. Install NEW sealing washer and O-ring on oil drain plug.

NOTICE **Never use a sealing washer a second time. Always replace with a new one.**



1. Sealing washer
2. O-ring
3. Oil drain plug

10. Install drain plug and tighten to the specified torque.

DRAIN PLUG TIGHTENING TORQUE
30 N•m (22 lbf•ft)

11. Replace *OIL FILTER*, see procedure in this subsection.
12. Refill oil tank at the proper level with the recommended oil.

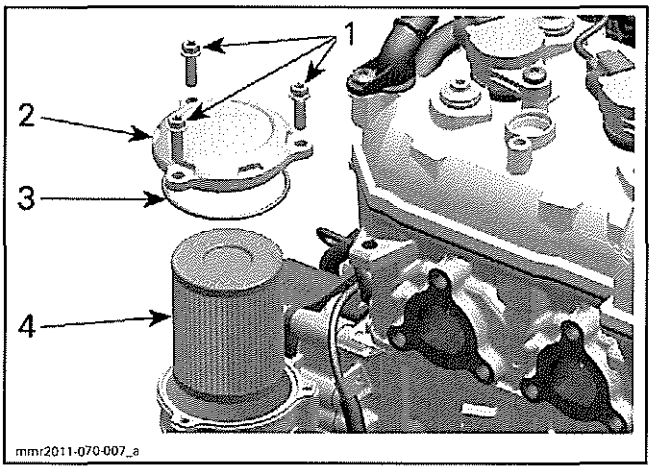
APPROXIMATE ENGINE OIL CAPACITY (WITH FILTER)	
1200 4-TEC	3.5 L (3.7 qt (U.S. liq.))

13. Reinstall dipstick in oil tank.
14. Start engine and let it idle for a few minutes.
15. Ensure there are no leaks.
16. Stop engine and check oil level as explained in this subsection. Refill as necessary.
17. Dispose oil and filter as per your local environmental regulations.

Engine Oil Filter Replacement (600 ACE)

Oil Filter Removal

1. Remove the RH side panel.
2. Clean oil filter area.
3. Remove:
   - Oil filter cover screws
   - Oil filter cover with O-ring
   - Oil filter.

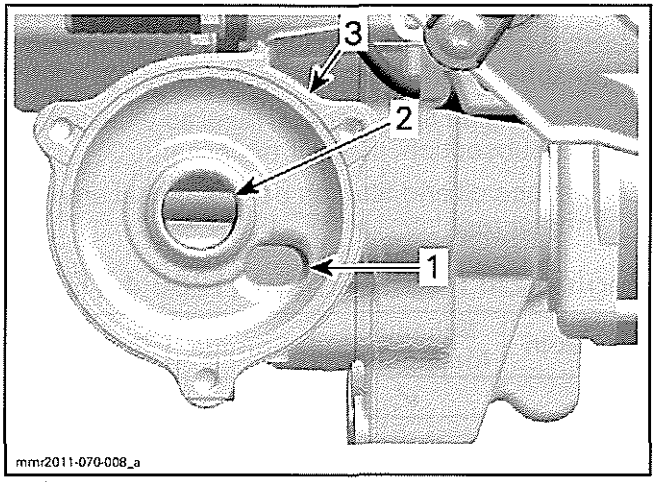


1. Oil filter cover screws
2. Oil filter cover
3. O-ring
4. Oil filter

4. Dispose filter as per your local environmental regulations.

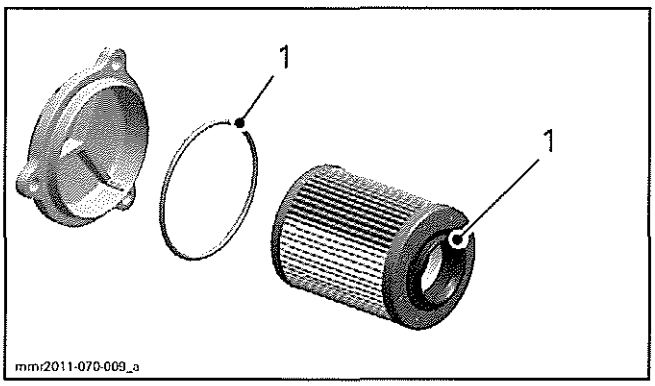
Oil Filter Installation

1. Check the oil filter inlet and outlet orifices inside oil filter receptacle (integrated part of magneto cover) for dirt and contaminations.



1. Oil inlet orifice from the oil pressure pump
2. Oil outlet orifice to the engine lubrication system
3. Oil filter receptacle

2. Install a O-ring on oil filter cover.
3. Lubricate filter seal and cover O-ring with engine oil.



1. Lubricate with engine oil

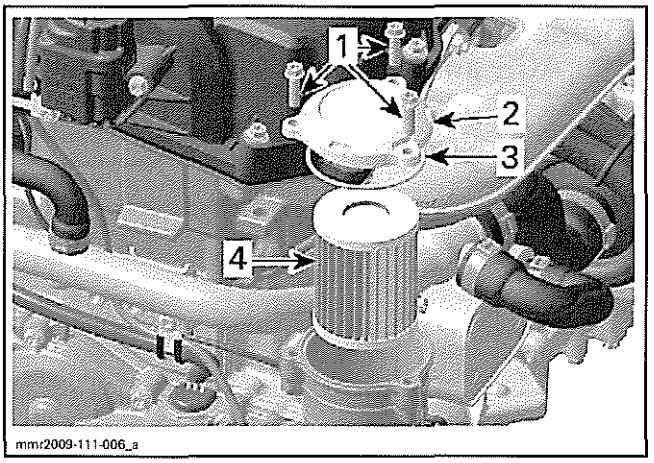
4. Install the oil filter cover.
5. Tighten oil filter cover screws to the specified torque.

OIL FILTER COVER TIGHTENING TORQUE
10 N•m ± 1 N•m (89 lbf•**in** ± 9 lbf•**in**)

Oil Filter Replacement (1200 4-TEC)

Oil Filter Removal

1. Remove the RH side panel.
2. Remove muffler, refer to *EXHAUST SYSTEM* subsection.
3. Clean oil filter area.
4. Remove:
   - Oil filter cover screws
   - Oil filter cover with O-ring
   - Oil filter.

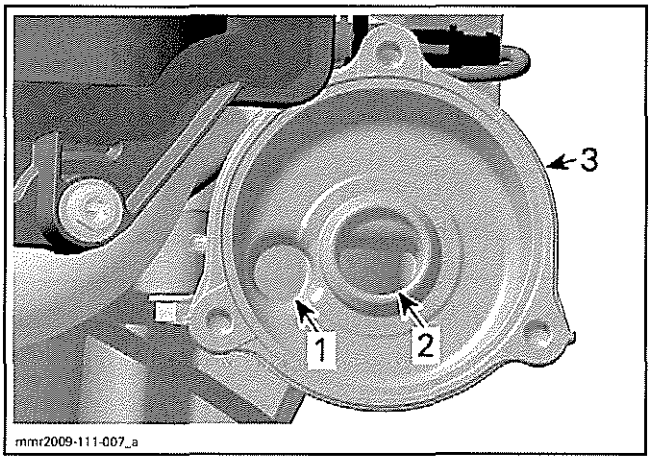


1. Oil filter cover screws
2. Oil filter cover
3. O-ring
4. Oil filter

5. Dispose filter as per your local environmental regulations.

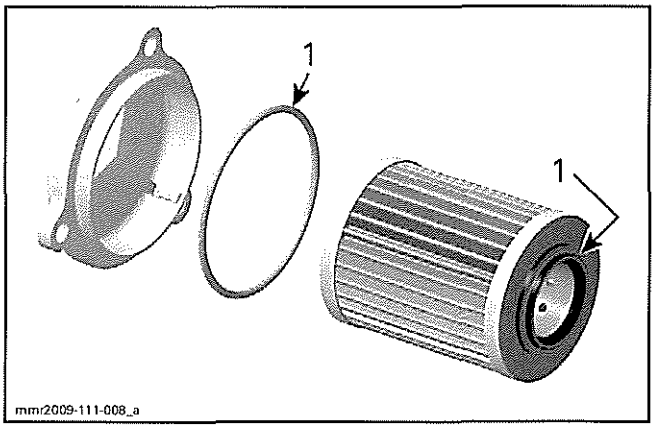
Oil Filter Installation

1. Check the oil filter inlet and outlet orifices inside oil filter receptacle (integrated part of magneto cover) for dirt and contaminations.



1. Oil inlet orifice from the oil pressure pump
2. Oil outlet orifice to the engine lubrication system
3. Oil filter receptacle

2. Install a NEW O-ring on oil filter cover.
3. Lubricate filter seal and cover O-ring with engine oil.



1. Lubricate with engine oil

4. Install the oil filter cover.
5. Tighten oil filter cover screws to the specified torque.

OIL FILTER COVER TIGHTENING TORQUE
10 N•m ± 1 N•m (89 lbf•**in** ± 9 lbf•**in**)

Engine Lubrication (600 HO E-TEC)

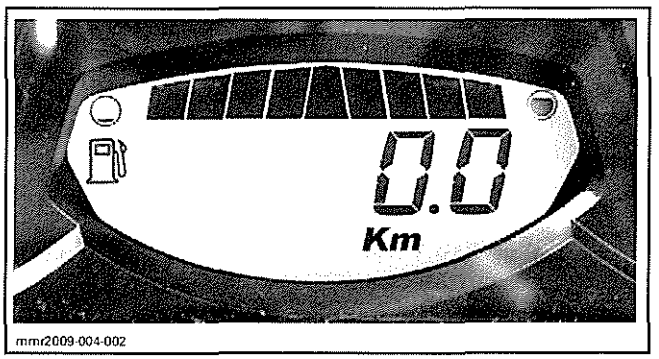
Break-In	Scheduled Maintenance	Storage	Preseason
		✔	

Engine Storage Mode (E-TEC)

Like other engines, the E-TEC has to be properly lubricated at storage for internal parts protection. The E-TEC system offers a built-in engine lubrication function can be initiated by the operator.

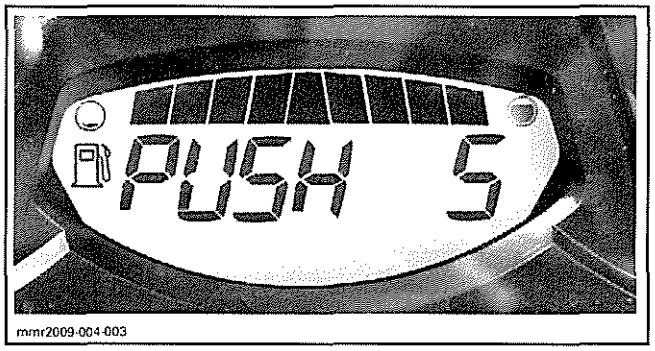
To engage procedure, do the following:

1. Place the vehicle in a well ventilated area.
2. Start the engine and let it run at idle speed until it reaches its operating temperature (watch the coolant temperature on the display).
3. Push the SET (S) button to select odometer mode.



NOTE: The storage mode does not function in other modes (trip A, trip B and hr trip).

4. Repeatedly depress the HI/LOW beam switch rapidly, then, **while doing this**, press and hold the **SET button** until PUSH "S" appears on the display.

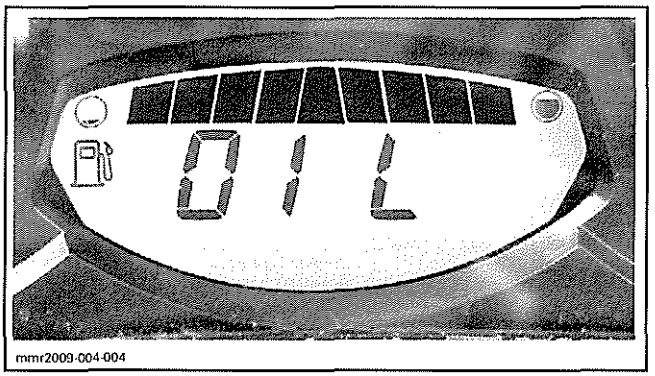


mmr2009-004-003

5. Release all buttons when gauge displays **PUSH "S"** appears.
6. Again, press and hold the SET (S) button for 2 - 3 seconds.

NOTE: The gauge will display OIL when the storage procedure is initiated.

7. When gauge displays **OIL**, release button and wait the end of the procedure.



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Do not touch anything during engine lubrication cycle.

The engine lubrication procedure takes approximately 1 minute. During this time the engine RPM will increase slightly.

At the end of engine lubrication procedure, the ECM will turn the engine off.

Remove tether cord cap from engine cut-off switch.

NOTICE Do not start the engine during storage period.

Engine Seals and Gaskets Inspection (600 ACE and 1200 4-TEC)

Break-In	Scheduled Maintenance	Storage	Preseason
✔			✔

Visually inspect the seals and gaskets area for leaks.

Crankshaft PTO seal Inspection (600 HO E-TEC)

Break-In	Scheduled Maintenance	Storage	Preseason
			✔

Check PTO seal for cracks, leaks or other damages.

Engine Rubber Mount Inspection (600 HO E-TEC)

Break-In	Scheduled Maintenance	Storage	Preseason
	✔		✔

Check rubber mounts for cracks or other damages.

Engine Stopper Adjustment (600 HO E-TEC)

Break-In	Scheduled Maintenance	Storage	Preseason
	✔		

Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.

Exhaust System Inspection

Break-In	Scheduled Maintenance	Storage	Preseason
✔			✔

Check the following components for cracks, exhaust leakage or other damage:
- Muffler
- Tuned pipe and shields
- Manifold.

Valve Clearance Inspection and Adjustment (1200 4-TEC)

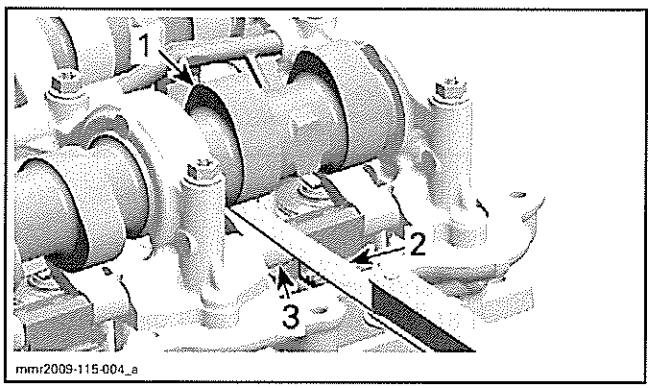
Break-In	Scheduled Maintenance	Storage	Preseason
	✔		

Check and adjust the valve clearance only on a cold engine, at room temperature.

When the valve clearance has to be measured or adjusted, the piston must be at TDC of compression stroke.

Valve Clearance Inspection

1. Remove the *VALVE COVER*, see procedure in this subsection.
2. Remove spark plugs.
3. Using the drive pulley, turn engine counterclockwise until camshaft lobes are opposite to cam followers.
4. Use a feeler gauge and check the valve clearance between camshaft and cam follower.



1. *Camshaft lobe opposite to cam follower*
2. *Feeler gauge*
3. *Cam follower*

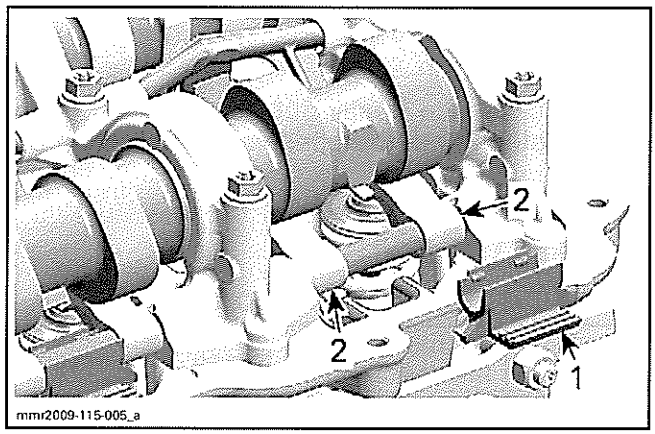
5. Repeat steps 3 and 4 for all intake and exhaust valves.
6. Adjust the valve clearance if out of specification, see *VALVE CLEARANCE ADJUSTMENT*.

VALVE CLEARANCE	
EXHAUST	0.30 mm to 0.40 mm (.0118 in to .0157 in)
INTAKE	0.10 mm to 0.20 mm (.0039 in to .0079 in)

Valve Clearance Adjustment

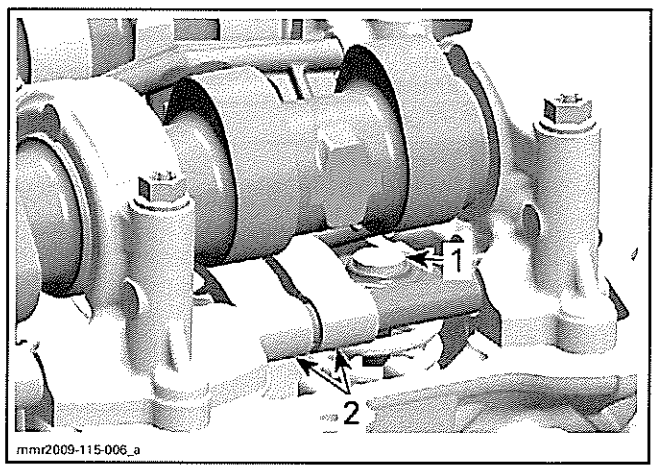
If the valve clearance is out of specification, adjust valve clearance by replacing the adjustment shim of the respective valve. Proceed as follows.

1. Turn drive pulley counterclockwise and position appropriate camshaft lobe opposite to cam follower.
2. Remove cam follower spacer.



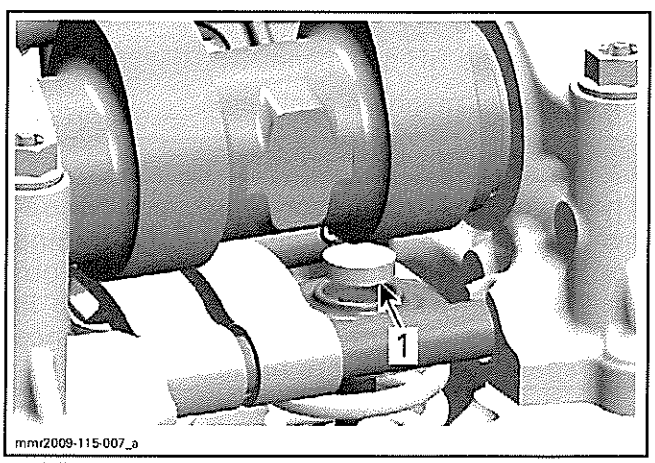
1. *Spacer*
2. *Cam followers*

3. Slide cam follower aside to gain access to the adjustment shim.



1. *Cam followers*
2. *Adjustment shim*

4. Remove adjustment shim and measure its thickness with a micrometer.



1. *Adjustment shim*

5. Choose the proper adjustment shim thickness to reach the specified valve clearance.

6. After reassembly of parts, measure the valve clearance again.

If valve clearance is still out of specification, repeat all steps until the specified clearance is obtained.

FUEL SYSTEM

Fuel Lines and Connection Inspection

Break-In	Scheduled Maintenance	Storage	Preseason
✔			✔

Visually inspect fuel lines and connections for cracks or leaks.

Fuel Pump Strainer Inspection (600 HO E-TEC)

Break-In	Scheduled Maintenance	Storage	Preseason
	✔		

Remove fuel pump, refer to *FUEL TANK AND FUEL PUMP* subsection.

Inspect strainer for cleanliness, cracks or other damage. Clean or replace if necessary.

In-line Fuel Filter Replacement (600 HO E-TEC)

Break-In	Scheduled Maintenance	Storage	Preseason
	✔		

In-line Fuel Filter Removal

1. Release fuel pressure in the system, refer to *FUEL TANK AND FUEL PUMP* subsection.
2. Remove the RH side panel.
3. Disconnect magneto connector.

⚠ WARNING

The magneto connector must be disconnected to prevent any spark in the engine compartment and to remove power from the fuel pump. Otherwise, if the engine is cranked, fuel vapors may ignite in presence of a spark creating a fire hazard.

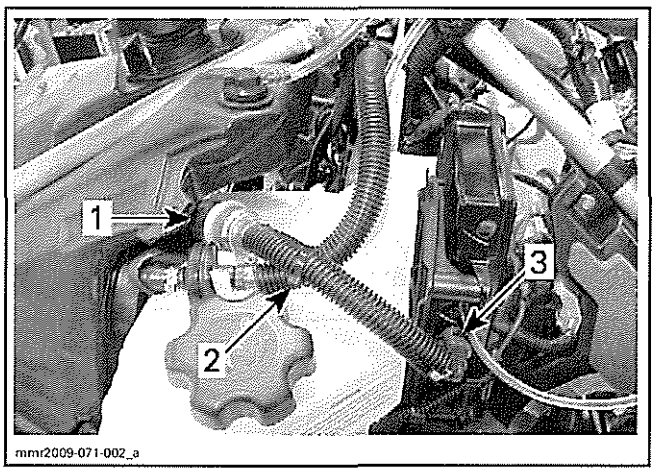
4. Cut the locking ties securing the fuel return hose to the fuel supply hose.

⚠ WARNING

Work in a well ventilated area. Wipe up all spilled fuel.

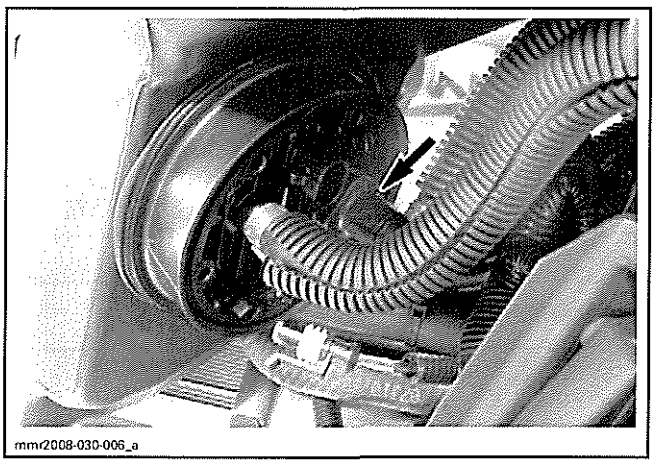
5. Press the release button on the fuel pressure hose quick disconnect fitting and slowly pull the fitting off the ECM.

NOTE: Place several shop rags and a container under the hose fitting to recover residual fuel remaining in the system.



TYPICAL
1. *In line fuel filter*
2. *Locking tie to cut*
3. *Quick disconnect fitting*

6. Place several shop rags under the quick disconnect fitting at the fuel pump and disconnect it from the fuel pump.



TYPICAL - FUEL SUPPLY LINE TO DISCONNECT

7. Remove fuel filter from vehicle.

In-Line Fuel Filter Installation

The installation is the reverse of the removal procedure.

⚠ WARNING

Ensure hose clamp is tight and that hose cannot turn on the fitting.

When reconnecting quick disconnect pressure fittings to fuel pump and ECM, be sure to pull on the each end of the hose to ensure they are properly locked and secure.

When installation is complete, carry out a fuel system leak test, refer to *FUEL SYSTEM PRESSURIZATION AND LEAK TEST* in *FUEL TANK AND FUEL PUMP* subsection.

⚠ WARNING

After working on the fuel system, carry out a fuel system pressurization and leak test to check for fuel leaks. Failure to carry out a fuel system leak test could result in severe injury or a life threatening situation should a leak occur.

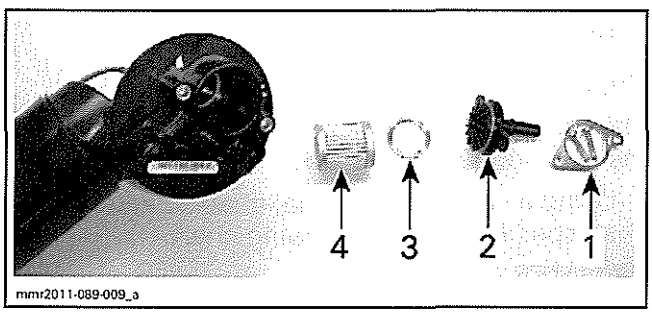
Fuel Pump Outlet Filter Replacement (600 ACE and 1200 4-TEC)

Break-In	Scheduled Maintenance	Storage	Preseason
	✔		

NOTE: The fuel pump outlet filter is housed within the mounting flange of the fuel pump module. It can be replaced without removing the fuel pump module from the fuel tank.

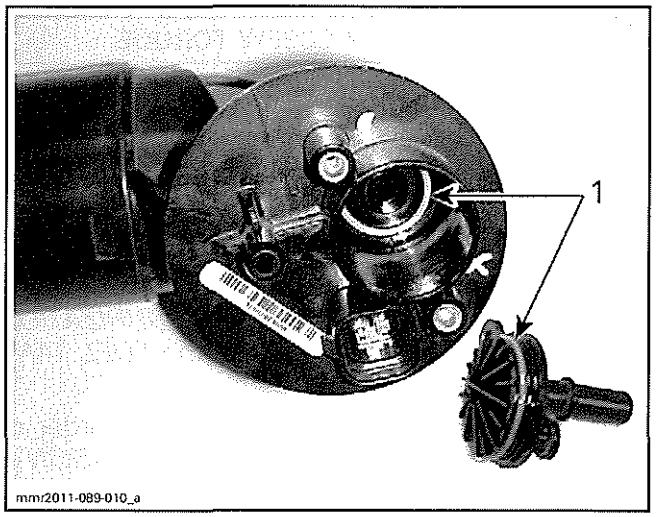
1. Disconnect fuel pump electrical connector to deactivate fuel pump.
2. Place several shop rags under the fuel pump pressure hose fitting to prevent fuel from leaking onto the connectors of the voltage regulator/rectifier unit.
3. Remove following parts from fuel pump module.

NOTE: Do not remove fuel pump module from fuel tank.



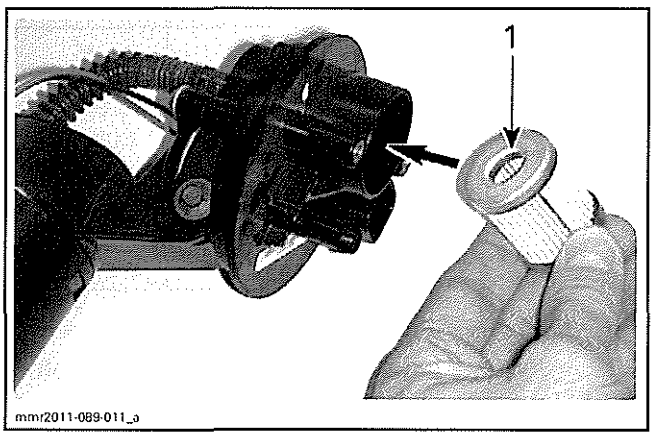
1. *Filter cover retainer with screws (2)*
2. *Filter cover*
3. *Wave spring*
4. *Filter element.*

4. Install NEW O-ring seals on filter cover and in filter housing.



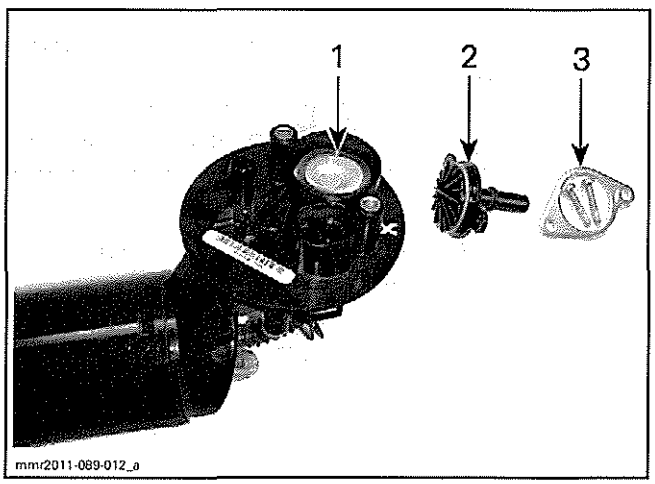
1. *New O-ring seals*

5. Insert filter element as per following illustration.



1. *This end in first*

6. Install remaining filter parts.



1. *Wave spring*
2. *Filter cover*
3. *Cover retainer with screws (2)*

FILTER COVER SCREW TORQUE
3 N•m (27 lbf•**in**)

7. Install and reconnect the fuel pump module (pressure hose and electrical connector), refer to *FUEL PUMP INSTALLATION (600 ACE AND 1200 4-TEC)* in the *FUEL TANK AND FUEL PUMP* subsection.
8. Carry out a *FUEL SYSTEM PRESSURIZATION AND LEAK TEST* as detailed in the *FUEL TANK AND FUEL PUMP* subsection.
9. Install remaining parts in the reverse order of removal, refer to *FUEL TANK INSTALLATION* in this subsection.

Throttle Body Inspection and Cleaning

Break-In	Scheduled Maintenance	Storage	Preseason
			✔

Clean throttle plates and throttle body bores using PULLEY FLANGE CLEANER (P/N 413 711 809).

Throttle Cable Inspection

Break-In	Scheduled Maintenance	Storage	Preseason
✔	✔		✔

Visually inspect cable sheath for kinks, wear other damage.

Visually inspect cable at throttle plate and throttle lever for fraying or other damage.

Make sure the throttle cable operates smoothly.

Oil injection Pump Strainer Inspection and Cleaning (E-TEC)

Break-In	Scheduled Maintenance	Storage	Preseason
	✔		

Refer to *OIL INJECTION PUMP* in *LUBRICATION SYSTEM* subsection.

ELECTRICAL SYSTEM

Battery Charging

Break-In	Scheduled Maintenance	Storage	Preseason
		✔	✔

To charge battery, refer to *CHARGING SYSTEM* subsection.

Headlights beam aiming adjustment

Break-In	Scheduled Maintenance	Storage	Preseason
			✔

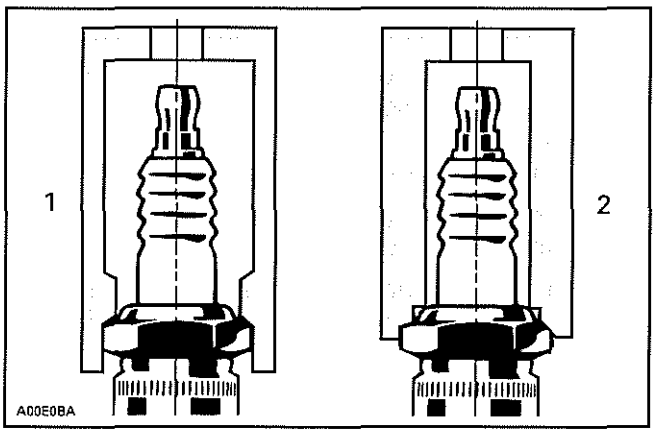
Refer to *LIGHTS, GAUGE AND ACCESSORIES* subsection.

Spark Plugs Replacement (600 ACE and 1200 4-TEC)

Break-In	Scheduled Maintenance	Storage	Preseason
✔	✔		

Spark Plug Removal

1. Remove ignition coil. Refer to *IGNITION SYSTEM* subsection.
2. Using an approved spark plug socket, release the torque applied to the spark plug and unscrew a few turns.



1. Aproved socket
2. Improper socket

3. Clean the spark plug and cylinder head with pressurize air.
4. Remove spark plug.

Spark Plug Installation

Prior to installation, ensure the contact surfaces of the cylinder head and spark plug are free of grime.

1. Using a wire feeler gauge, check electrode gap as specified in the following chart.

NOTICE Do not adjust gap on this type of spark plug. The adjustment could weaken negative electrodes which may lead to electrode breakage and severe engine damage.

ENGINE	SPARK PLUG	TORQUE	GAP mm (in)
600 ACE	NGK CR7EB	11 N•m (97 lbf•**in**)	0.7 mm (.028 in)
1200 4-TEC	NGK CR8EKB	11 N•m (97 lbf•**in**)	0.7 mm (.028 in)

2. Hand screw spark plug into cylinder head. Then, tighten the spark plug clockwise to specified torque with an approved spark plug socket.
3. Install ignition coil. Refer to *IGNITION SYSTEM* subsection.
4. Complete the installation in the reverse order of the removal.

Spark Plugs Replacement (600 HO E-TEC)

Break-In	Scheduled Maintenance	Storage	Preseason
✔	✔		

Spark Plug Removal

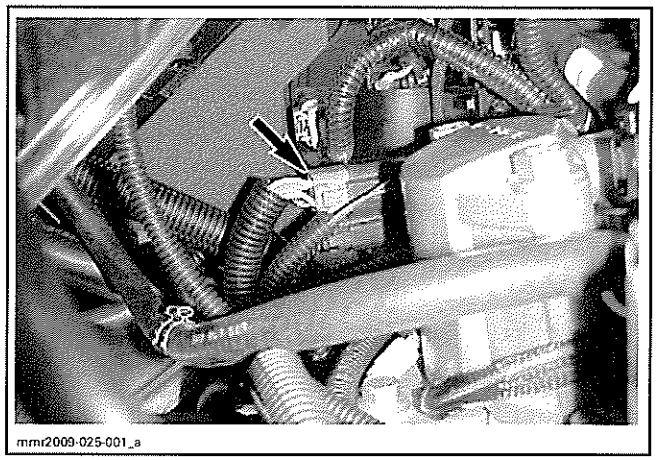
NOTICE Due to limited access, spark plugs should only be removed when absolutely required.

NOTE: Use only an approved spark plug socket for removal and installation. Extra care should be taken to avoid side stresses which could result in a broken spark plug.

1. Disconnect the magneto connector.

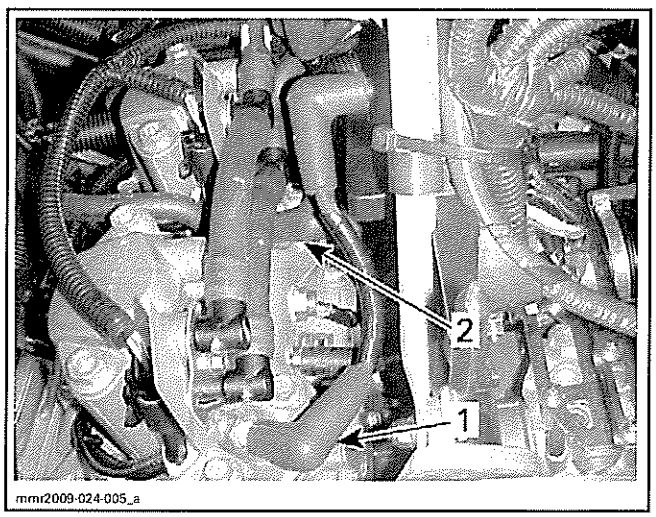
⚠ WARNING

Disconnect the magneto connector before disconnecting and removing the spark plugs. Otherwise, fuel vapors may ignite in presence of a spark creating a fire hazard.



TYPICAL — MAGNETO CONNECTOR

2. Remove spark plug cables by gently rotating the cap and pulling it off the plug.



TYPICAL
1. PTO spark plug
2. Mag spark plug

3. Clean the spark plug and cylinder head with pressurized air.

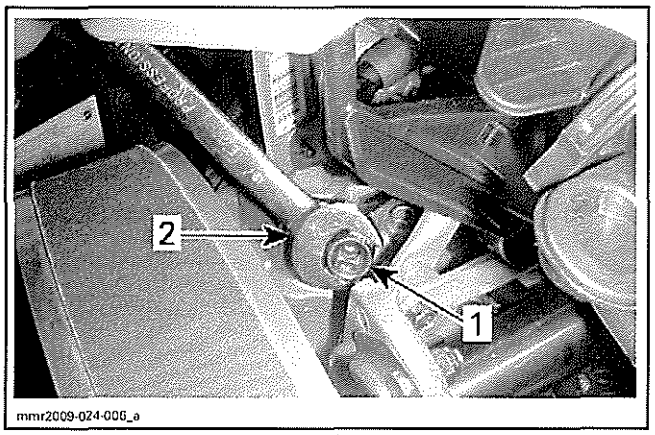
⚠ WARNING

Whenever using compressed air, always wear protective eye wear.

4. Proceed to applicable spark plug procedure (PTO or MAG side).

To remove the PTO spark plug:

1. Install an approved spark plug socket onto the spark plug.
2. Using a wrench on the spark plug socket, unscrew the spark plug just enough to break the applied torque.

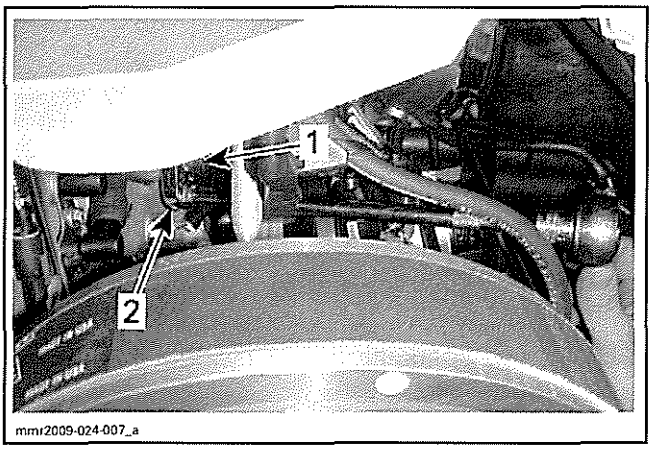


1. Spark plug socket 16 mm (5/8 in)
2. Wrench 19 mm (3/4 in)

3. Remove wrench from spark plug socket and unscrew the spark plug by hand.

To remove the MAG spark plug:

1. Remove the primary air intake silencer.
2. Install an approved spark plug socket onto the spark plug.
3. Using a ratchet wrench, extension, and a crowfoot, unscrew the spark plug just enough to break the applied torque.



1. Spark plug socket 16 mm (5/8 in)
2. Crowfoot 19 mm (3/4 in)

4. Remove wrench from spark plug socket and unscrew the spark plug by hand.

Spark Plug Installation (OEM spark plug)

1. Prior to installation, ensure the contact surfaces of the cylinder head and spark plug are free of grime.
2. Using a feeler gauge, confirm electrode gap is set to 8 mm (.31 in) If gap is incorrect, use another spark plug.
3. Hand screw spark plug into cylinder head until it bottoms out.
4. Apply specific torque using a torque wrench, crow foot, and approved spark plug socket.

NOTE: Spark plug tightening torque is particularly important on this engine as it contributes to the proper positioning of the negative electrode.

MODEL	TORQUE
600 HO E-TEC	28 N•m (21 lbf•ft)

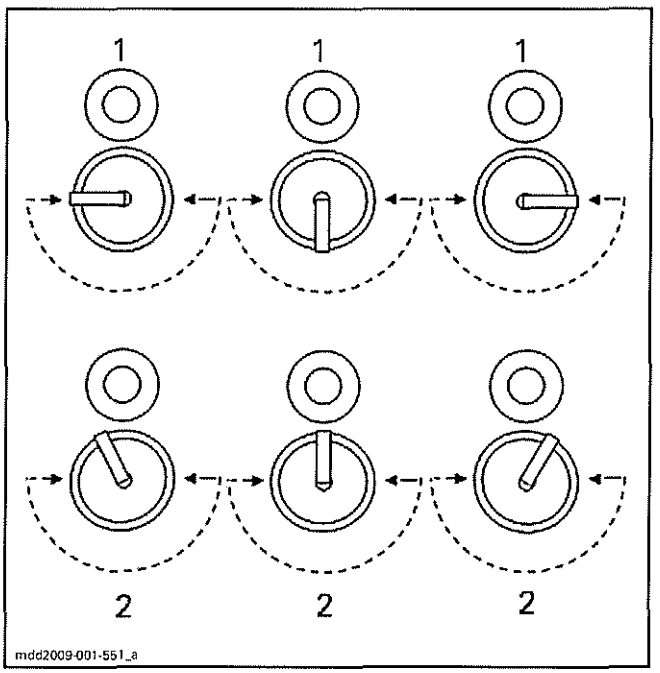
5. Apply DIELECTRIC GREASE (P/N 293 550 004) on contact in spark plug cap of the ignition cable prior to connecting it onto the spark plug.

Spark Plug Installation (Non-OEM spark plug)

NOTE: When using a non-OEM spark plug, it must be correctly indexed or engine may experience rough idling and higher emissions.

1. Using a marker, mark the open end of the negative electrode on the plug shell (above threads).
2. Ensure the contact surfaces of the cylinder head and spark plug are free of grime.
3. Install and torque the spark plug, refer to previous table for specific torque.
4. Visually check to ensure the open end of the negative electrode is facing the injector nozzle within 90° (45° each side of nozzle).

NOTE: The following illustration uses the point of attachment of the negative electrode to depict the angle. The injector is illustrated above the spark plug.

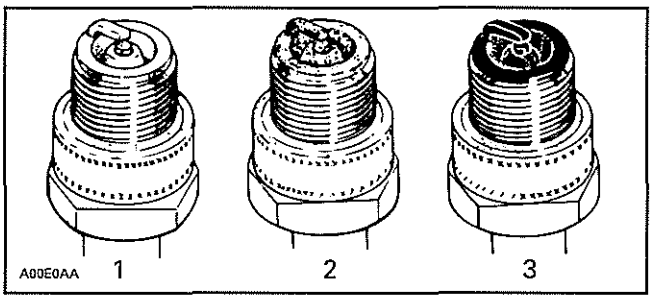


SPARK PLUG INDEXING
1. Acceptable installation
2. Unacceptable installation

If the plug indexing angle is not within specification, repeat procedure with another spark plug until correct indexing is achieved.

Spark Plug Inspection

Spark Plug Analysis



TYPICAL
1. *Overheated (light gray, white)*
2. *Normal (light brown, brown)*
3. *Fouled (black, wet or dry, dark deposits, gray, melted coating)*

The plug face reveals the condition of the engine, operating condition, method of driving and fuel mixture. For this reason it is advisable to inspect the spark plug at prescribed intervals, examining the plug face (i.e. the part of the plug projecting into the combustion chamber).

Troubleshooting a Fouled Spark Plug

Fouling of the spark plug is indicated by irregular running or misfiring of the engine, decreased engine speed due to misfiring, reduced performance, and increased fuel consumption.

Other possible causes are: a incorrect or bad fuel, defective ignition system, incorrect spark plug gap, loss of compression, or lubricating oil entering the combustion chamber.

The plug face of a fouled spark plug has either a wet or dry black carbon deposit. Such coatings form a conductive connection between the center electrode and the ground electrode.

DRIVE SYSTEM AND BRAKE

Recommended Brake Fluid

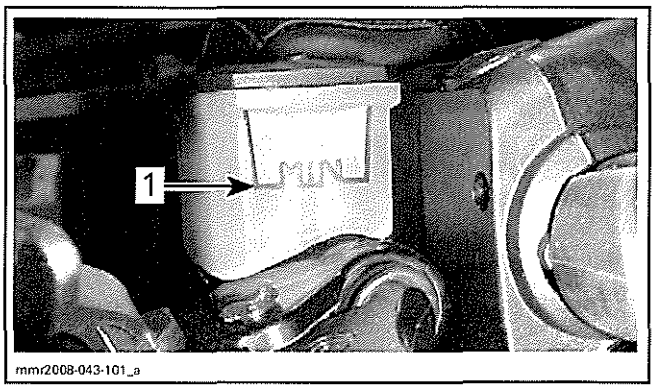
Always use brake fluid meeting the specification DOT 4 such as BRAKE FLUID (P/N 293 600 131).

Brake Fluid Level Verification

Break-In	Scheduled Maintenance	Storage	Preseason
✔			✔

With the vehicle on a level surface, position steering in straight-ahead position to ensure reservoir is level.

Brake fluid must always be above the MIN. line when brake lever is squeezed.



1. MINIMUM line

Add fluid as required. Do not overfill.

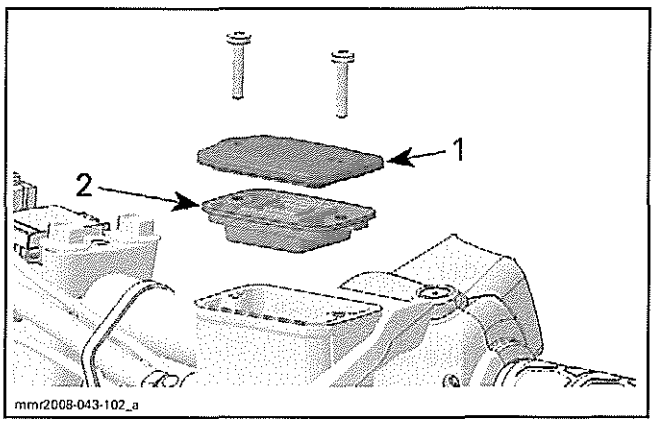
NOTE: A low level may indicate leaks or worn brake pads.

Brake Fluid Replacement

Break-In	Scheduled Maintenance	Storage	Preseason
	✔		

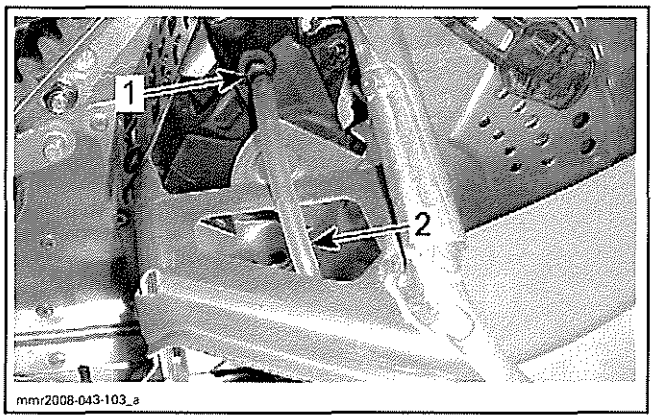
To drain brake fluid, proceed as follows:

1. Place vehicle on a level surface.
2. Remove reservoir cover with its diaphragm.



1. Reservoir cover
2. Diaphragm

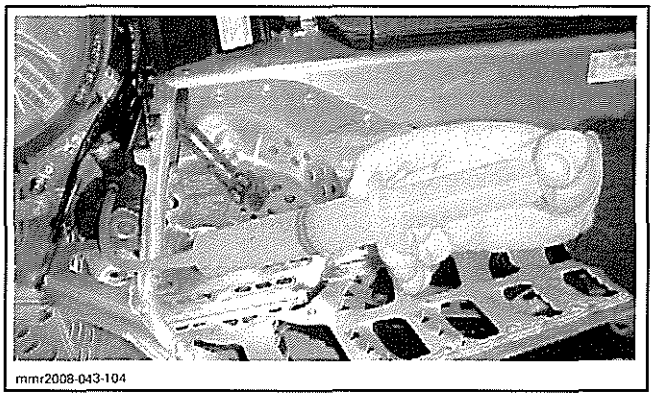
3. Connect a clear hose to caliper bleeder.
4. Place the other end of hose in a container.
5. Loosen bleeder and pump brake lever until no more fluid flows out of bleeder.



TYPICAL
1. Bleeder
2. Clear hose to catch used brake fluid

To fill brake system when it is empty, proceed as follows:

1. Ensure reservoir cover is removed.
2. Using a large syringe and a suitable tube, inject brake fluid slowly into the caliper.



TYPICAL

3. Continue to inject brake fluid until master cylinder reservoir is half full.
4. Close bleeder.
5. Fill up reservoir and install cover.
6. Squeeze brake lever.
   6.1 If brake lever is firm, bleeding of the brake system is not required. Torque bleeder as specified.

BRAKE CALIPER BLEEDER TORQUE
9 N•m (80 lbf•**in**)

   6.2 If brake lever is spongy, refer to *BRAKE SYSTEM BLEEDING* in this subsection.

Brake System Bleeding

1. Install a clear hose on bleeder.
2. Place the other end in a container partially filled with clean brake fluid.
3. Pump up brake system pressure using the brake lever until lever resistance is felt.
4. Squeeze and hold brake lever and open bleeder. When the lever touches the handlebar, do not release it and close the bleeder.
5. Release brake lever slowly.
6. Repeat the procedure until no more air bubbles appear in hose.

NOTE: Check fluid level often to prevent air from being pumped into the circuit.

7. Install cover on reservoir.
8. Squeeze brake lever.

NOTE: If brake lever feels firm; bleeding procedure is complete. Torque bleeder as specified. If brake lever is still spongy; go to step 9

BRAKE CALIPER BLEEDER TORQUE
9 N•m (80 lbf•**in**)

9. Push back brake pads with caliper still installed and squeeze brake lever.
10. Repeat step 2 to step 5.
11. Torque bleeder as specified.
12. Adjust brake fluid reservoir level.
13. Install diaphragm and cover on reservoir.

Brake Hose, Pads and Disc Inspection

Break-In	Scheduled Maintenance	Storage	Preseason
✔	✔		✔

Break-In Inspection

Visually inspect the brake hose for leaks or any damage.

Visually inspect pads and disc for abnormal wear or any damage.

Scheduled Maintenance and Preseason

Visually inspect the brake hose for leaks or any damage.

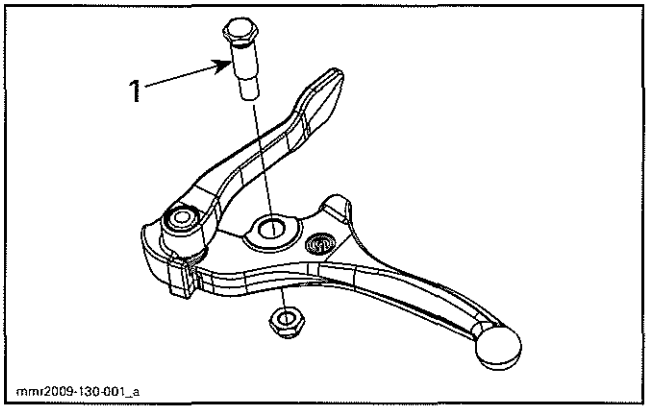
Refer to *BRAKE* subsection and carry out:
- *BRAKE PAD INSPECTION*
- *BRAKE DISC INSPECTION.*

Brake Lever Pivot Lubrication

Break-In	Scheduled Maintenance	Storage	Preseason
		✔	

1. Remove brake lever pivot bolt.

2. Lubricate brake lever pivot bolt using XPS SYNTHETIC GREASE (P/N 293 550 010).



1. Lubricate this surface

3. Install brake lever pivot bolt.
4. Torque nut on brake lever pivot bolt as specified.

PIVOT BOLT TORQUE, BRAKE LEVER
6 N•m (53 lbf•**in**)

Recommended Gearbox Oil

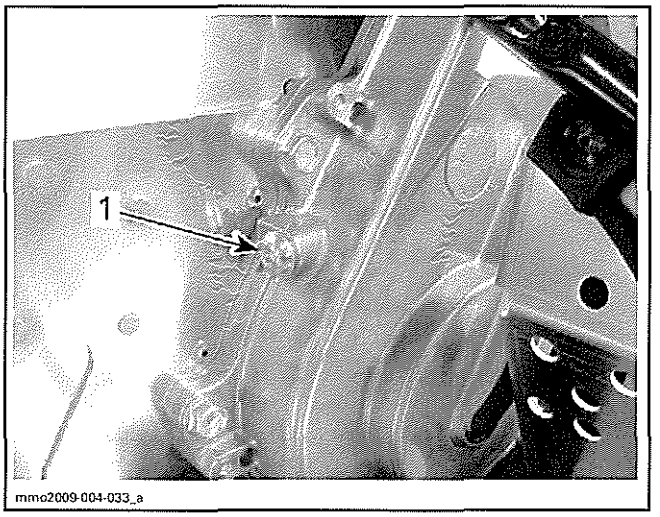
RECOMMENDED GEARBOX OIL
XPS SYNTHETIC CHAINCASE OIL (P/N 413 803 300)

NOTICE The gearbox of this snowmobile has been developed and validated using the XPS™ Synthetic chaincase oil. BRP strongly recommends the use of its XPS Synthetic chaincase oil at all times. Damages caused by oil which is not suitable for the gearbox will not be covered by the BRP limited warranty.

Gearbox Oil Level Verification

With the vehicle on a level surface, check the oil level by removing the check plug on the left side of gearbox.

Oil level must reach the threaded hole's lower edge.



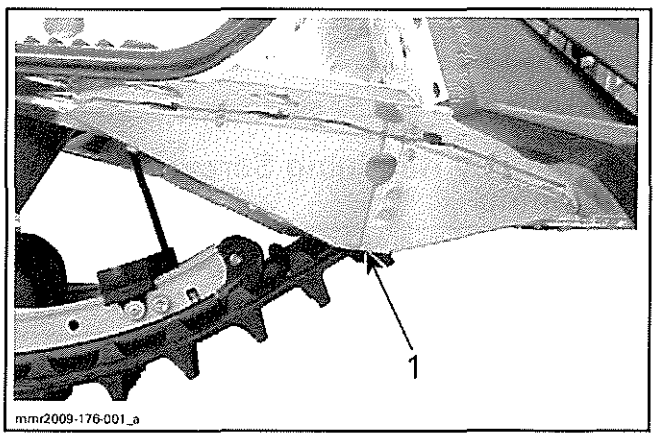
1. Check plug

1. Reinstall check plug and torque to 10 N•m ± 1 N•m (89 lbf•**in** ± 9 lbf•**in**).

Gearbox Oil Replacement

Gearbox Oil Draining

1. Place the vehicle on a level surface.
2. Place a drain pan under gearbox drain plug area.
3. Remove filler cap.
4. Remove the drain plug located at the bottom of gearbox. Reach the drain plug by the access hole.

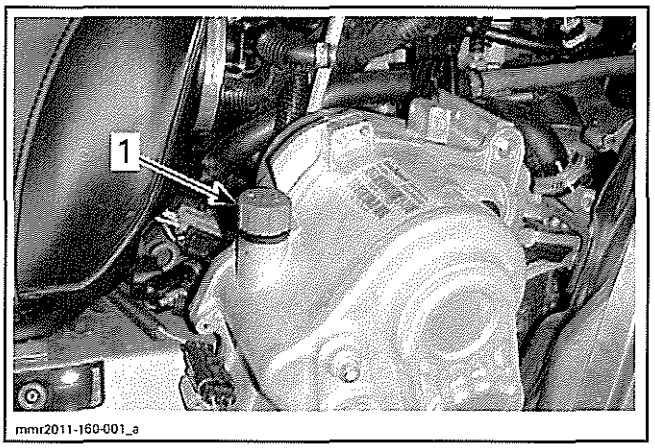


1. Drain plug access hole

5. Wait a while to allow oil to flow out of gearbox.
6. Install drain plug and torque it to 8 N•m (71 lbf•**in**).

Gearbox Oil Filling

1. Remove the filler cap.



TYPICAL
1. Filler cap

2. Pour recommended oil in gearbox by the filler hole until oil comes out by the check plug hole.
3. Reinstall check plug and torque to 10 N•m (89 lbf•**in**).

Drive Belt Inspection

Break-In	Scheduled Maintenance	Storage	Preseason
✔			✔

Refer to *DRIVE BELT* subsection.

Drive Pulley Inspection and Cleaning

Break-In	Scheduled Maintenance	Storage	Preseason
✔	✔		✔

Refer to *DRIVE PULLEY* subsection.

Drive Pulley Retaining Screw Tightening

Break-In	Scheduled Maintenance	Storage	Preseason
✔	✔		

Refer to *DRIVE PULLEY* subsection.

Drive Pulley Wear Parts Inspection and Replacement

Break-In	Scheduled Maintenance	Storage	Preseason
	✔		

Replace drive pulley wear parts as per *PERIODIC MAINTENANCE SCHEDULE*. Refer to *DRIVE PULLEY* subsection.

Driven Pulley Inspection and Cleaning

Break-In	Scheduled Maintenance	Storage	Preseason
✔	✔		✔

Inspect pulley sheaves for dirt, marks or scratches.

Test sliding sheave operation.

Use PULLEY FLANGE CLEANER (P/N 413 711 809) and a clean rag to clean pulley sheaves as necessary.

NOTE: When removing dust on the cam, avoid altering the teflon coating. Use a dry cloth only.

Driven Pulley Spring Preload

Break-In	Scheduled Maintenance	Storage	Preseason
	✔		

Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 ACE)* or *DRIVEN PULLEY AND COUNTERSHAFT (600 HO E-TEC AND 1200 4-TEC)* subsections.

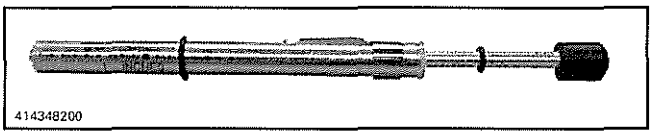
Track Adjustment and Alignment

Break-In	Scheduled Maintenance	Storage	Preseason
✔	✔		✔

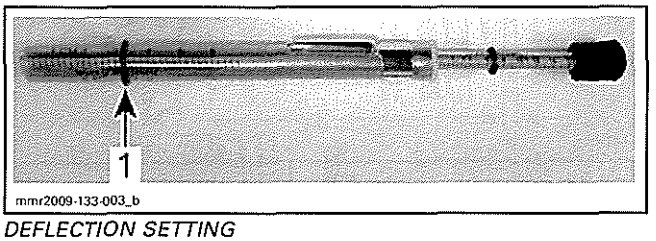
Track tension and alignment are interrelated. Do not adjust one without checking the other. Track tension procedure must be carried out prior to track alignment.

Track Tension Verification

1. Lift rear of vehicle and support it off the ground.
2. Allow rear suspension to fully extend.
3. Preset the TENSIOMETER (P/N 414 348 200) as specified in the following table.

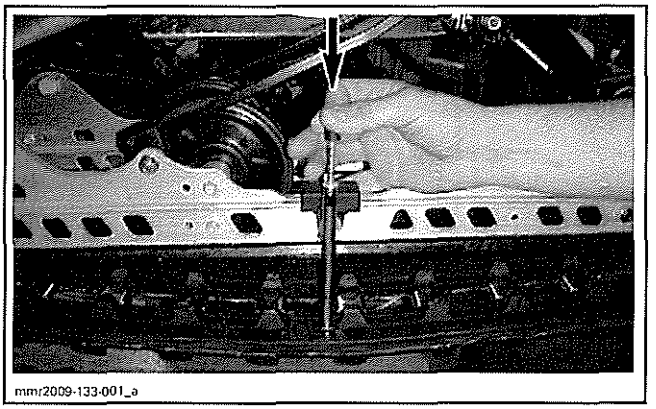


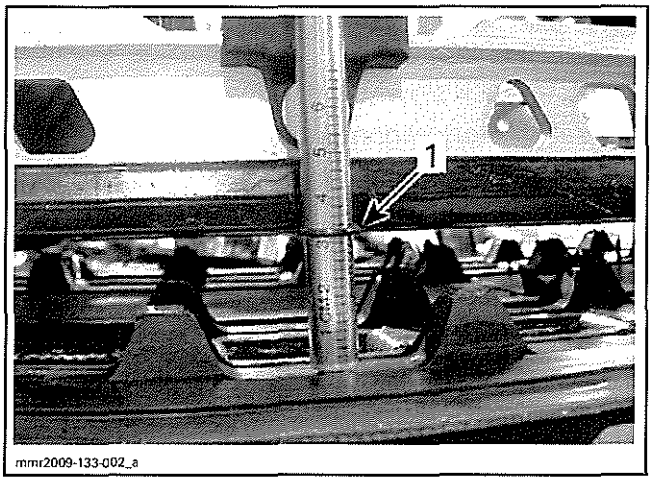
TRACK TENSIOMETER PRESETTING	
DEFLECTION O-RING (BOTTOM)	LOAD O-RING (TOP)
4.5 cm (1.772 in)	0 kgf (0 lbf)



DEFLECTION SETTING
1. Bottom O-ring

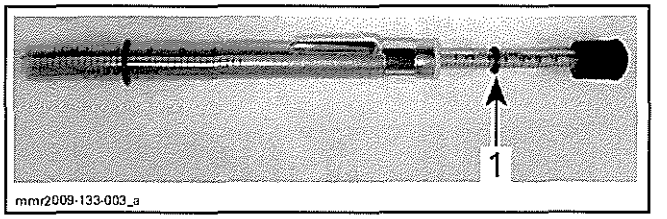
4. Position the tensiometer on track, halfway between front and rear idler wheels.
5. Push the tensiometer downwards until bottom O-ring (deflection) be aligned with the bottom of slider shoe.





1. Deflection O-ring aligned with slider shoe

6. Read load recorded by the upper O-ring on the tensiometer.



LOAD READING
1. Upper O-ring

Load reading must be as per the following table.

TRACK ADJUSTMENT SPECIFICATION	
TRACK DEFLECTION SETTING	4.5 cm (1-9/16 in)
TRACK LOAD READING	6.0 kgf to 8.5 kgf (13 lbf to 19 lbf)

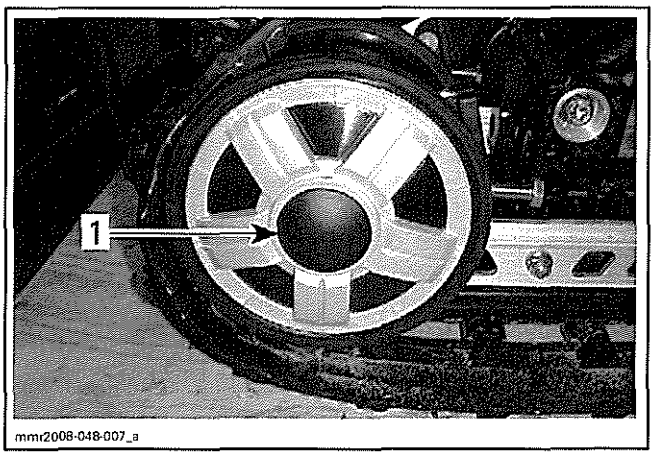
7. If load reading is not in accordance with the specification, adjust track tension. Refer to *TRACK TENSION ADJUSTMENT*.

NOTICE Too much tension will result in power loss and excessive stresses on suspension components.

Track Tension Adjustment

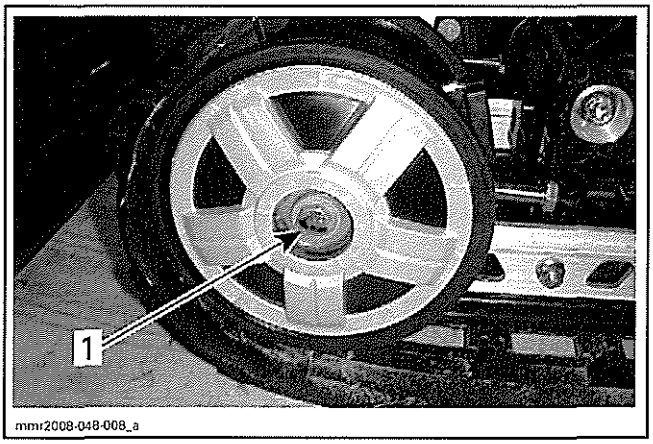
NOTE: After track tension adjustment, ride the snowmobile in snow for 15 to 20 minutes and recheck track tension.

1. Lift rear of vehicle and support it off the ground.
2. Remove rear idler wheel caps.



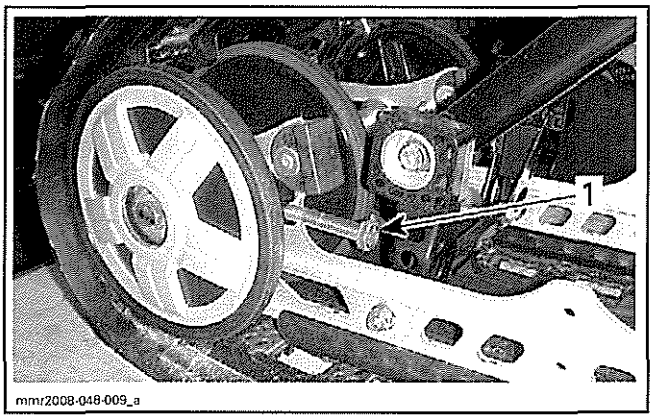
1. RH rear idler wheel cap

3. Loosen rear axle screws (one each side).



1. RH rear axle screw

4. Tighten or loosen both adjustment screws to increase or decrease track tension.



1. RH adjustment screw

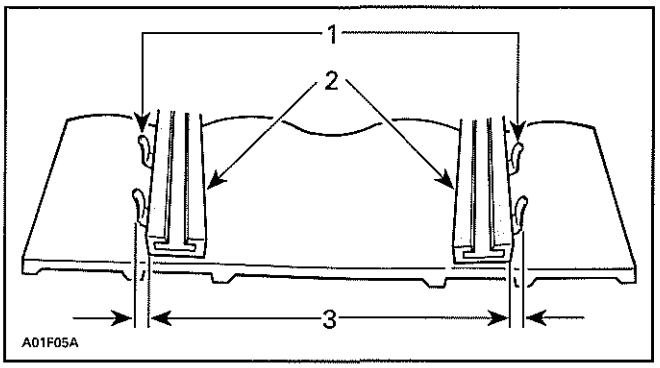
5. Verify track tension, refer to *TRACK TENSION VERIFICATION* in this subsection.

Track Alignment

⚠ WARNING

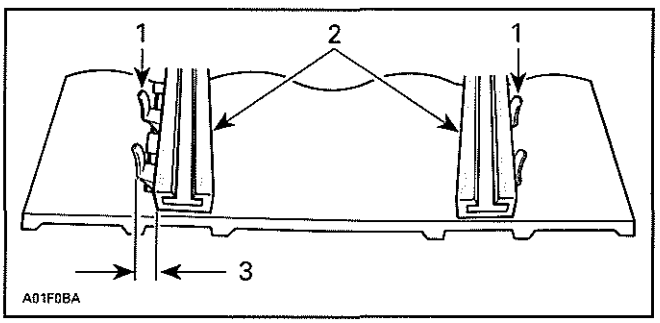
Before checking track alignment, ensure that the track is free of all particles which could be thrown out while track is rotating. Keep hands, tools, feet and clothing clear of track. Ensure no one is standing in close proximity to the vehicle. Never rotate at high speed.

1. Start engine and accelerate slightly until the track barely turns. This must be done in a short period of time (1 to 2 minutes).
2. Ensure the track is well centered; equal distance on both sides between edges of track guides and slider shoes.



1. Guides
2. Slider shoes
3. Equal distance

3. To correct track alignment:
   3.1 Stop engine.
   3.2 Loosen rear wheel screws.
   3.3 Tighten adjustment screw on side where the slider shoe is the farthest from the track inset guides.



1. Track guides
2. Slider shoes
3. Tighten on this side

4. Restart engine.
5. Rotate track slowly and recheck alignment.
6. If satisfactory alignment is achieved:
   6.1 Tighten idler wheel retaining screws.

IDLER WHEEL SCREW TIGHTENING TORQUE
48 N•m (35 lbf•ft)

   6.2 Reinstall wheel caps.

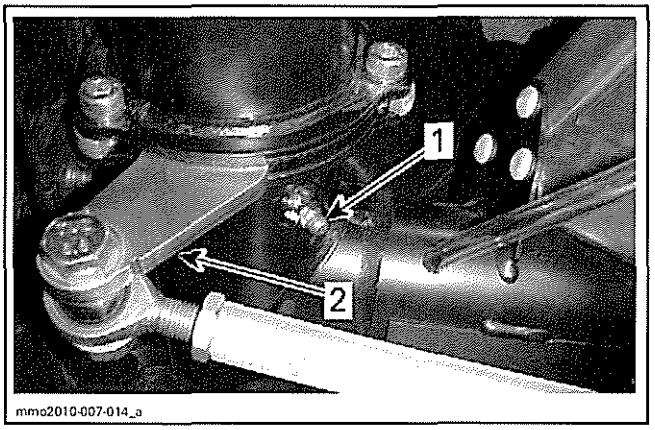
CHASSIS

Front Suspension Lubrication

Lubricate front suspension at grease fittings using SUSPENSION GREASE (P/N 293 550 033).

Generally, 4 to 5 grease gun strokes is sufficient.

NOTE: If too much grease is injected, the overflow will come out at steering levers and ski legs. Wipe off any excess of grease to avoid contact with other parts.



LH SIDE SHOWN
1. Grease fitting
2. Steering arm

Front Suspension Inspection

Break-In	Scheduled Maintenance	Storage	Preseason
✔	✔		✔

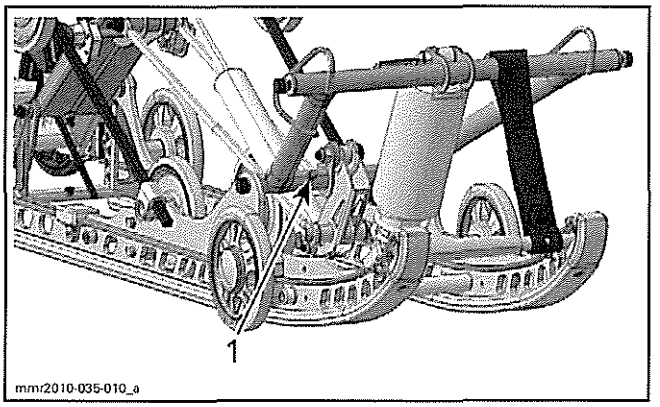
Visually inspect front suspension for tightness of components:
- Arms
- Stabilizer bar
- Shock absorbers
- Ball joints.

Rear Suspension Lubrication

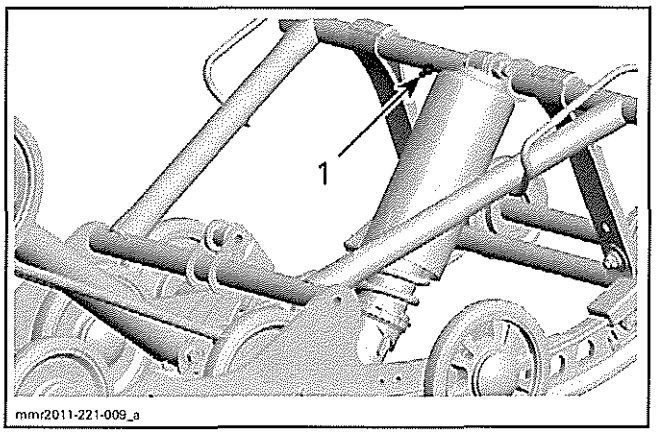
Break-In	Scheduled Maintenance	Storage	Preseason
	✔	✔	

Lubricate the following suspension pivots at grease fittings using SUSPENSION GREASE (P/N 293 550 033).

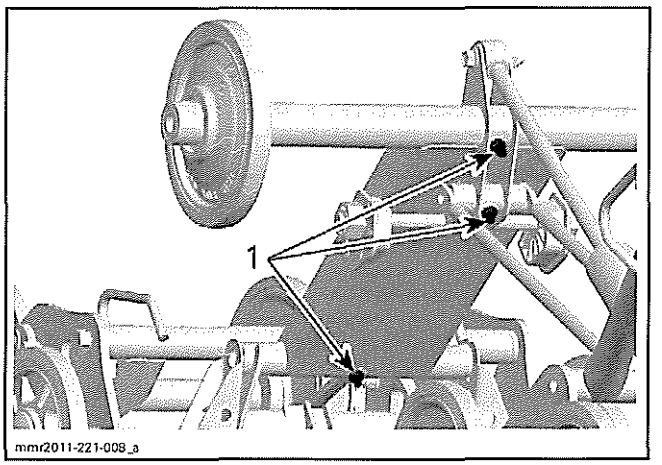
Break-In	Scheduled Maintenance	Storage	Preseason
	✔	✔	



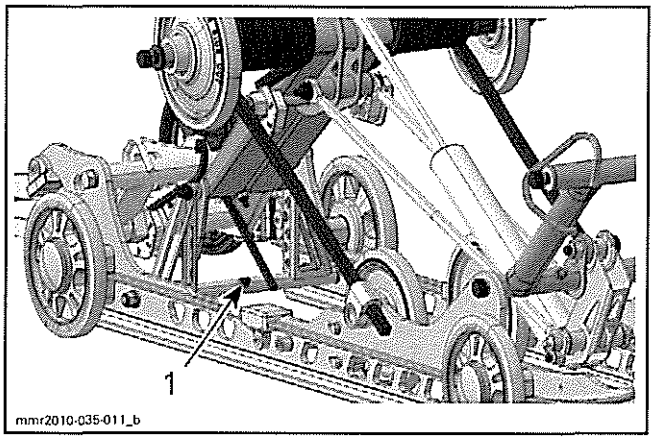
FRONT ARM - LOWER SHAFT
1. Grease fitting



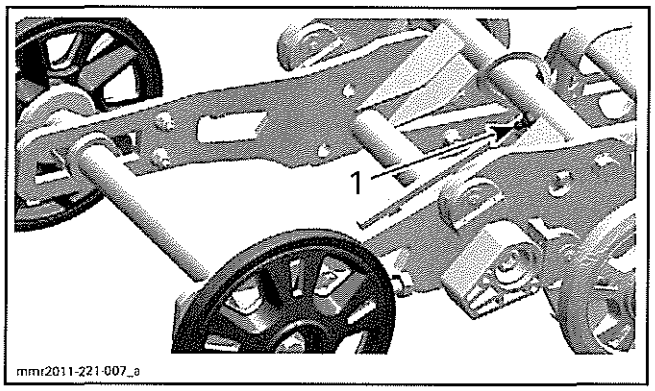
FRONT ARM - UPPER SHAFT
1. Grease fitting



REAR ARM
1. Grease fitting



PIVOT ARM
1. Grease fitting



REAR EXTENSION
1. Grease fitting

Rear Suspension, Stopper Straps and slider shoes inspection

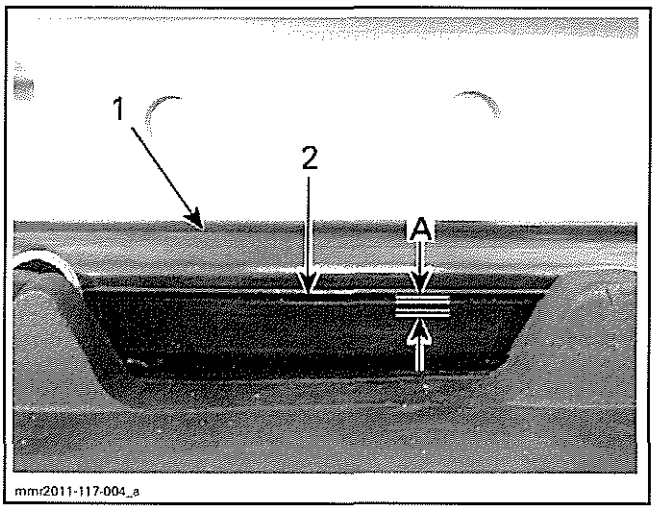
Break-In	Scheduled Maintenance	Storage	Preseason
✔	✔		✔

Rear Suspension Mechanism and Stopper Straps Inspection

1. Inspect rear suspension components for wear, deterioration or damage, replace defective parts if necessary.
2. Inspect stopper straps for wear or cracks.
3. Check bolt and nut securing straps for tightness. If loose, inspect strap holes for deformation. Replace strap if necessary.

Slider Shoe Inspection

Slider shoes are worn out and must be replaced when there is just 1 mm to 2 mm (.04 in to .08 in) of remaining material exceeding the molding line.



1. Slider shoe
2. Molding line
A. Minimum thickness: 1 mm to 2 mm (.04 in to .08 in)

NOTICE Slider shoes must always be replaced in pairs.

Ski and Runner inspection

Break-In	Scheduled Maintenance	Storage	Preseason
✔			✔

Lift the front of vehicle and check ski runners for wear or damage (missing or broken carbide). Replace if necessary.

Inspect ski for excessive wear or other damage. Replace if necessary.

Steering Mechanism Inspection

Break-In	Scheduled Maintenance	Storage	Preseason
✔	✔		✔

Visually inspect steering mechanism for tightness of components (steering arms, tie rods, ski bolts, ski legs, etc.).

STORAGE PROCEDURE

During summer, or when a snowmobile is not in use for more than three months, proper storage is a necessity.

Procedures are detailed in *PERIODIC MAINTENANCE PROCEDURES* subsection.

STORAGE
Clean the vehicle
Protect fuel system by adding fuel stabilizer to fuel following the product manufacturer recommendations Run the engine after adding the product to the fuel
Lubricate engine (600 HO E-TEC)
Lubricate brake lever pivot
Inspect and lubricate rear suspension
Lubricate front suspension (Skandic WT)
Charge battery monthly to keep it fully charge during storage
Block muffler with rags
Lift rear of vehicle until track is clear of the ground. Do not release track tension

⚠ CAUTION Use appropriate lifting device or have assistance to share lifting stress. If a lifting device is not used, use proper lifting techniques, notably using your legs force. Do not attempt to lift the rear of vehicle if it is above your limits.

NOTICE The snowmobile has to be stored in a cool and dry place and covered with an opaque but ventilated tarpaulin. This will prevent sun rays and grime from affecting plastic components and vehicle finish.

PRESEASON PREPARATION

Proper vehicle preparation is required after the summer months or when a vehicle has not been used for more than three months.

Procedures are detailed in *PERIODIC MAINTENANCE PROCEDURES* subsection.

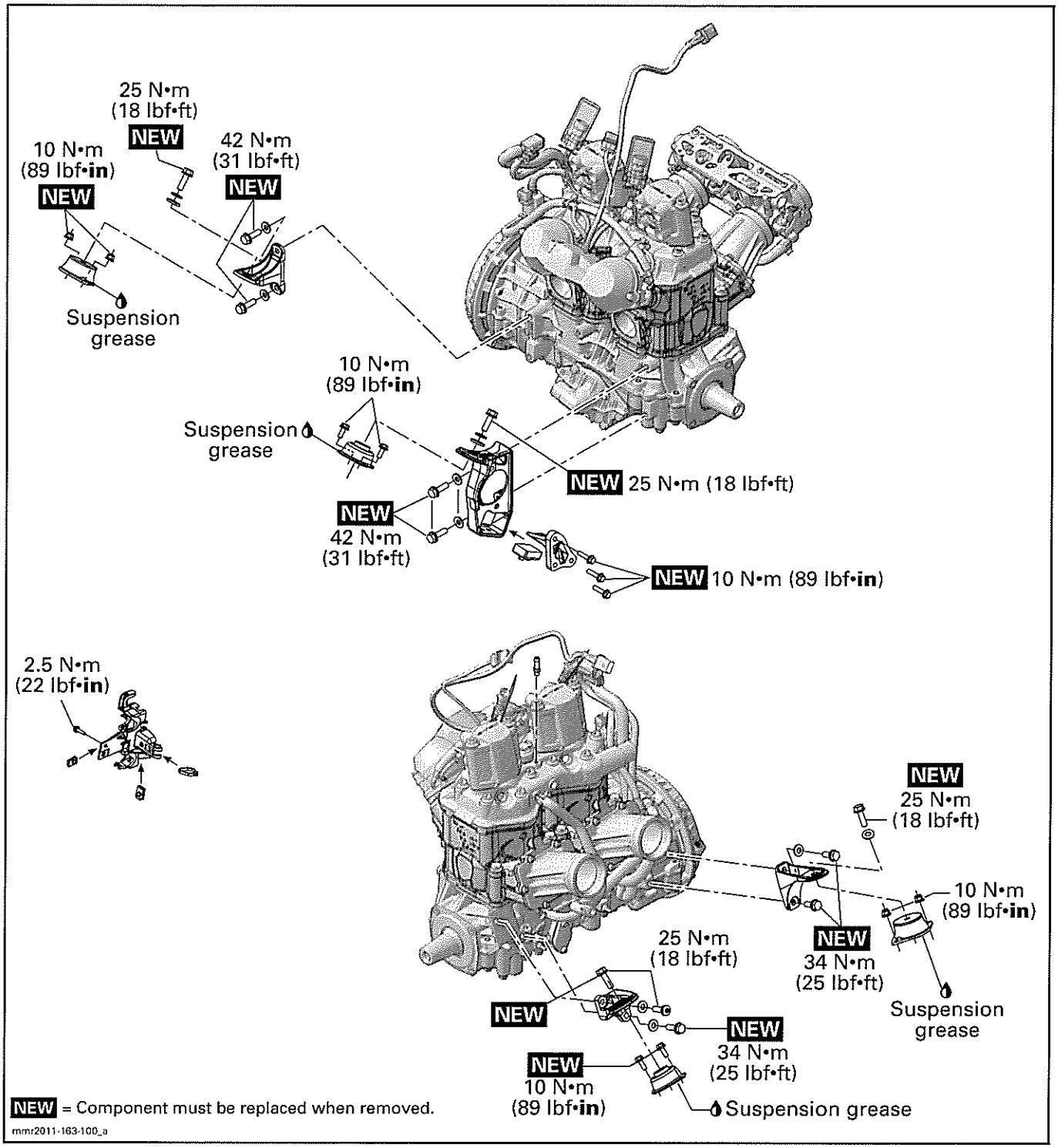
PRESEASON PREPARATION (600 HO E-TEC)
Inspect engine rubber mounts
Check exhaust system condition and check for leaks
Check coolant density
Inspect crankshaft PTO seal
Inspect fuel lines and connections
Clean and inspect throttle body (E-TEC)
Inspect throttle cable
Inspect drive belt (adjust at every drive belt replacement)
Clean and visually inspect drive pulley
Clean and inspect driven pulley
Inspect, adjust and align track
Change gearbox oil
Check brake fluid level
Inspect brake hose, pads and disk
Inspect steering mechanism
Inspect skis and runners
Inspect front suspension
Inspect rear suspension stopper straps
Charge battery
Adjust headlight beam aiming

PRESEASON PREPARATION (600 ACE AND 1200 4-TEC)
Visually inspect engine seals and gaskets and check for leaks
Check exhaust system condition and check for leaks
Change engine oil and filter
Check coolant density
Inspect fuel lines and connections
Clean and inspect throttle body
Inspect throttle cable
Inspect drive belt (adjust at every drive belt replacement)
Clean and visually inspect drive pulley
Clean and inspect driven pulley
Inspect, adjust and align track
Change gearbox oil
Check brake fluid level
Inspect brake hose, pads and disk
Inspect steering mechanism
Inspect skis and runners
Inspect front suspension
Inspect rear suspension stopper straps
Charge battery
Adjust headlight beam aiming

ENGINE REMOVAL AND INSTALLATION

SERVICE TOOLS

Description	Part Number	Page
ENGINE LIFTING HOOK	529 035 829	49, 52–53
ENGINE LIFTING TOOL	529 036 131	48, 52–53
SMALL HOSE PINCHER	295 000 076	50


25 N•m
(18 lbf•ft)
NEW
10 N•m
(89 lbf•in)
NEW
42 N•m
(31 lbf•ft)
NEW
Suspension
grease
10 N•m
(89 lbf•in)
Suspension
grease
NEW 25 N•m (18 lbf•ft)
NEW
42 N•m
(31 lbf•ft)
NEW 10 N•m (89 lbf•in)
2.5 N•m
(22 lbf•in)
NEW
25 N•m
(18 lbf•ft)
10 N•m
(89 lbf•in)
25 N•m
(18 lbf•ft)
NEW
34 N•m
(25 lbf•ft)
Suspension
grease
NEW
NEW
34 N•m
(25 lbf•ft)
NEW
10 N•m
(89 lbf•in)
Suspension grease
NEW = Component must be replaced when removed.
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GENERAL

During assembly/installation, use the torque values and service products as shown in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, cotter pin, etc.) must be replaced with new ones.

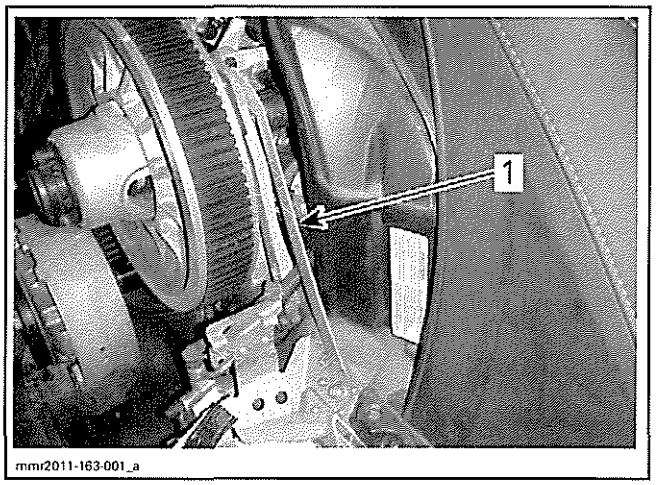
NOTICE Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.

PROCEDURES

ENGINE

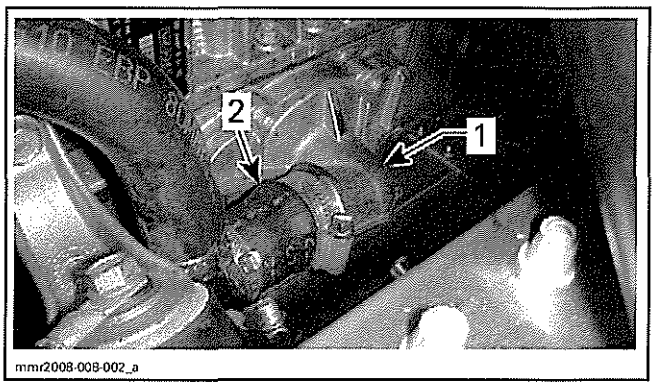
Engine Removal

1. Place vehicle at workstation that will have access to an engine-lifting hoist.
2. Release fuel pressure using B.U.D.S. software. Refer to *ELECTRIC FUEL PUMP* in *FUEL TANK AND FUEL PUMP* subsection.
3. Disconnect BLACK (–) cable from battery.
4. Refer to *BODY* subsection and remove:
   - Upper side panels
   - Lower side panels
   - Hood.
5. Remove side bar from vehicle.



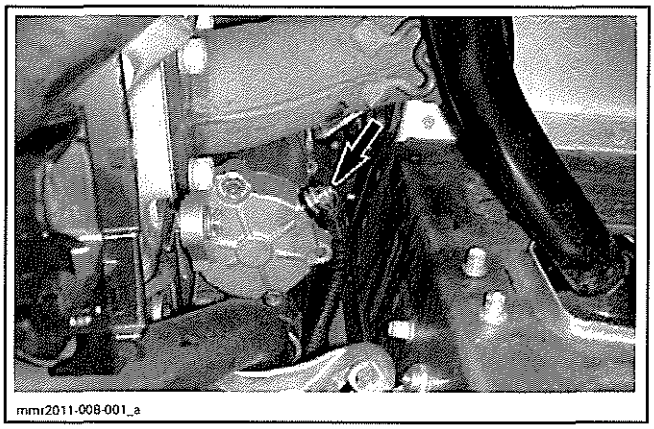
1. Side bar

6. Refer to *AIR INTAKE SYSTEM* subsection and remove:
   - Secondary air intake silencer with gauge support
   - Primary air intake silencer.
7. Refer to *EXHAUST SYSTEM* subsection and remove:
   - Muffler
   - Tuned pipe.
8. Remove drive pulley. Refer to *DRIVE PULLEY* subsection.
9. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 HO E-TEC AND 1200 4-TEC)* subsection and remove:
   - Driven pulley
   - Countershaft bearing support.
10. Place a drain pan under engine compartment.
11. Disconnect water pump hose to drain engine coolant.



1. Water pump cover
2. Remove this hose

12. Disconnect electric starter wire.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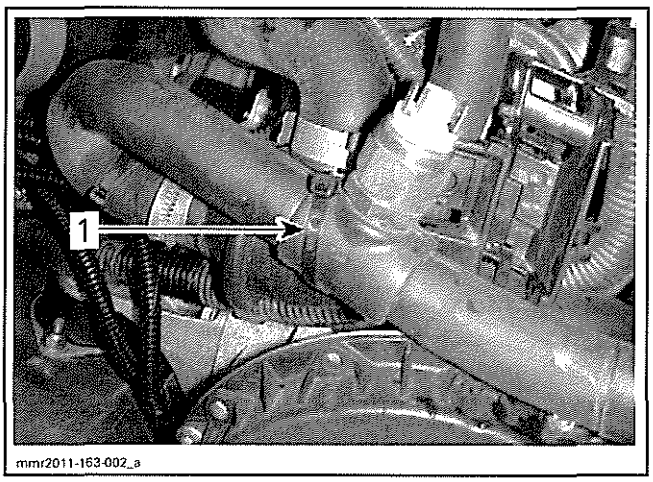
13. Cut locking ties securing coolant hoses to support.



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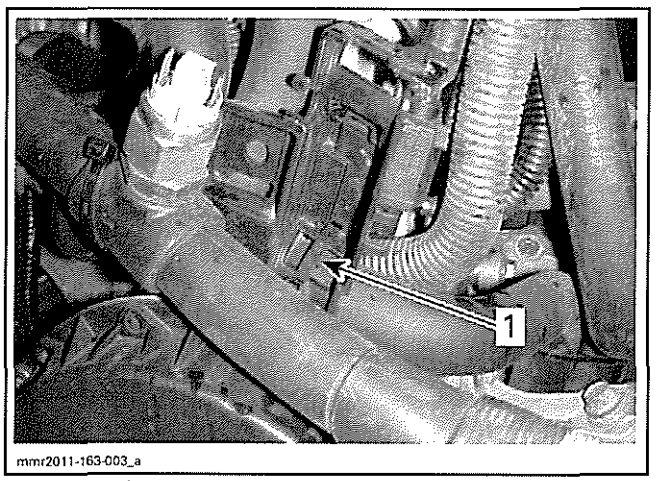
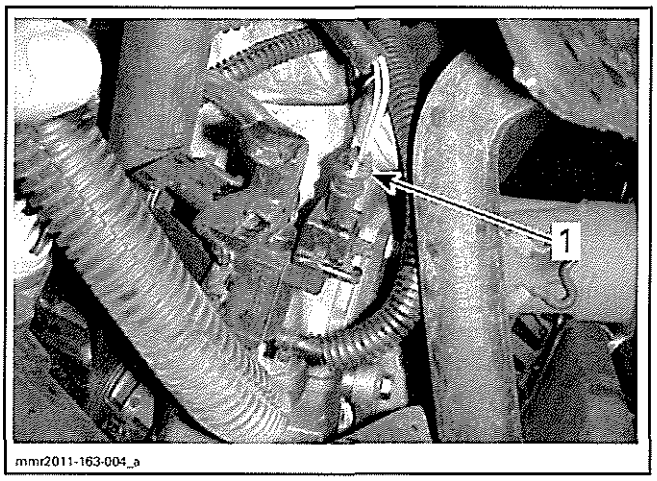
1. Locking tie to remove



mmr2011-163-003_a

1. Locking tie to remove

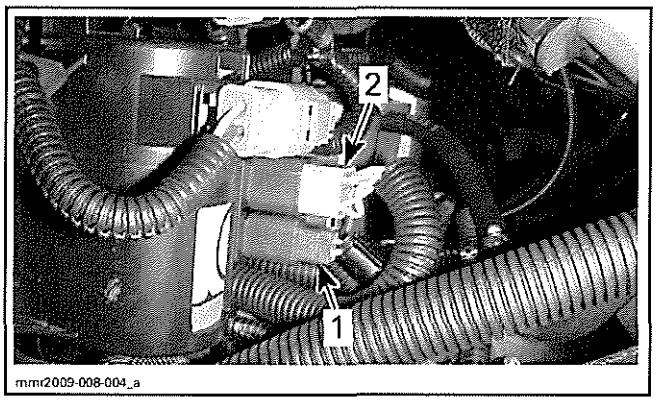
14. Detach hoses from support.
15. Disconnect 3D RAVE solenoid connector.



mmr2011-163-004_a

1. 3D RAVE solenoid connector

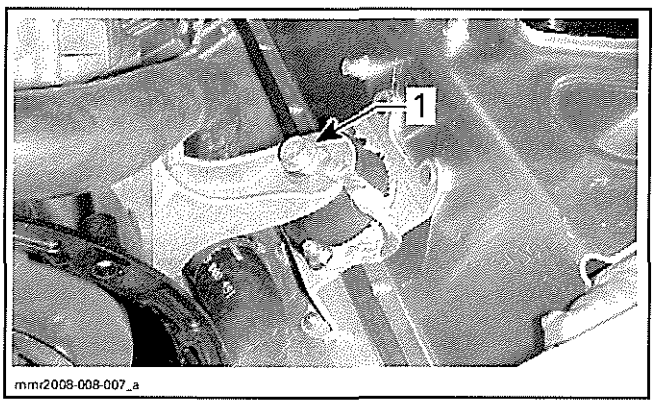
16. Disconnect CPS sensor and magneto connectors.



mmr2009-008-004_a

1. CPS sensor connector
2. Magneto connector

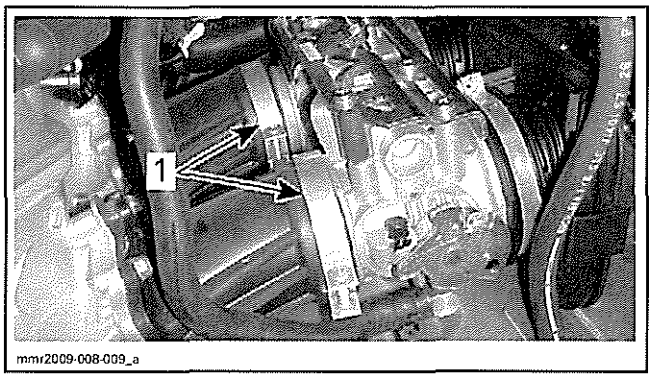
17. Remove and discard screw securing front MAG engine support to front rubber mount.



mmr2008-008-007_a

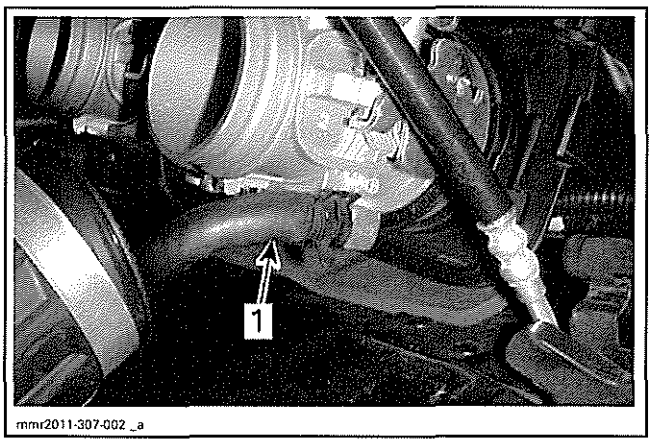
1. Front engine support screw

18. Unscrew clamps securing throttle body to intake adapters.



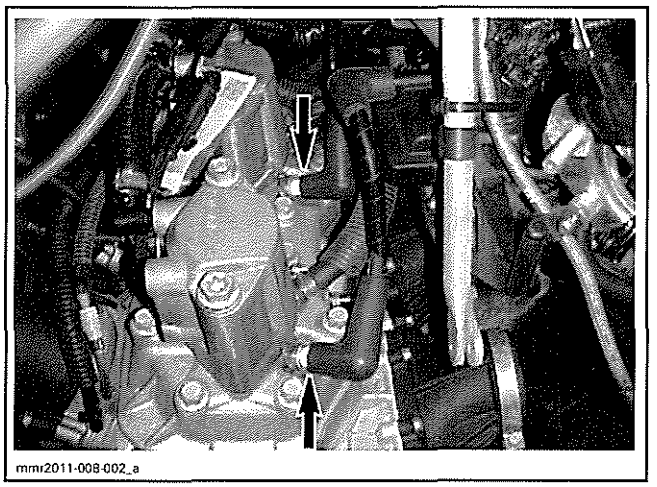
1. Throttle body clamps

19. Move and attach throttle body aside.
20. Remove throttle body heater hose from the throttle body.

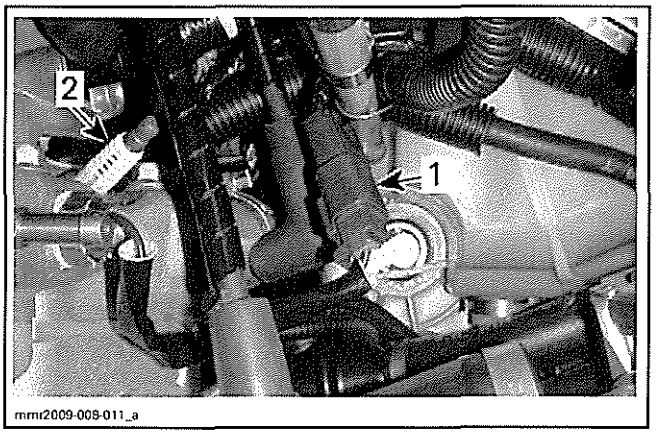


1. Throttle body heater hose

21. Disconnect spark plug cables.

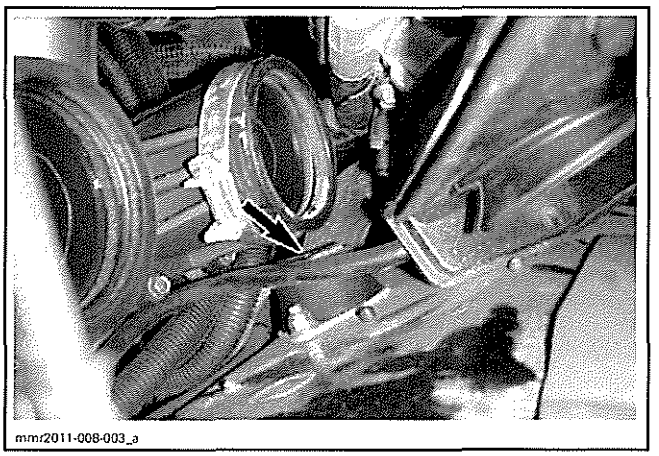


22. Disconnect coolant temperature sensor (CTS) connector.

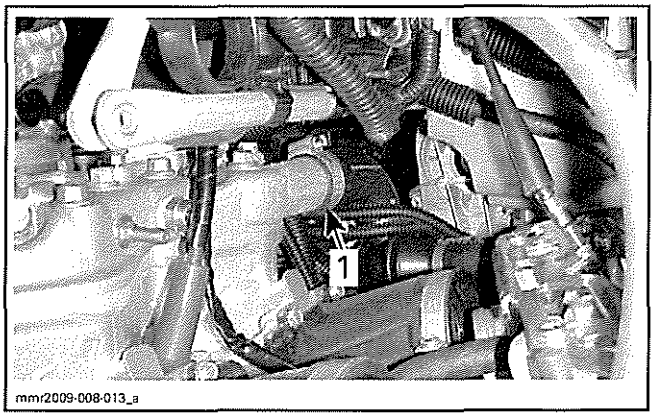


1. CTS connector
2. MAG spark plug

23. Remove and discard screw securing rear MAG engine support to rear rubber mount.

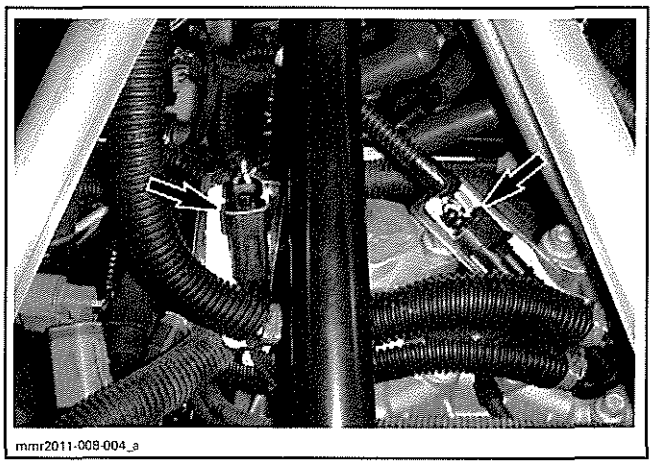


24. Disconnect coolant hose from cylinder head.

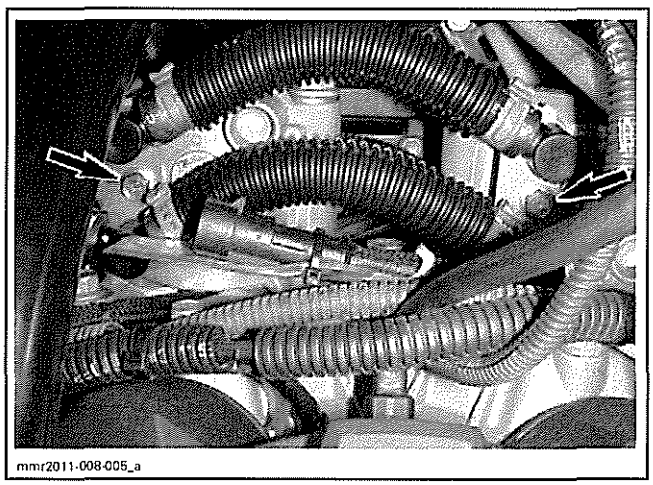


1. Coolant hose

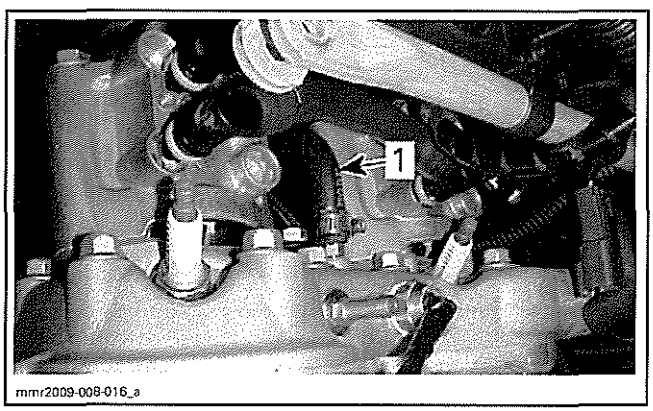
25. Disconnect fuel injector connectors.


mmr2011-008-004_a

26. Remove screws that attach fuel injector hose retainers to fuel injectors.


mmr2011-008-005_a

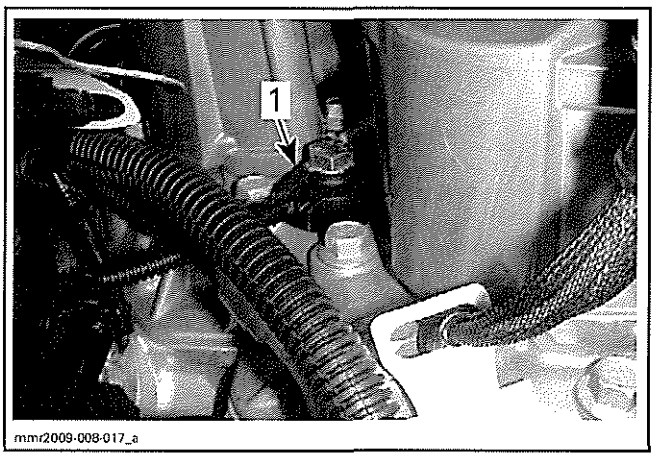
27. Place a rag at the bottom of fuel injectors and unplug fuel hoses from fuel injectors.
28. Disconnect coolant hose on the top of cylinder head.



mmr2009-008-016_a

1. Coolant hose from coolant reservoir

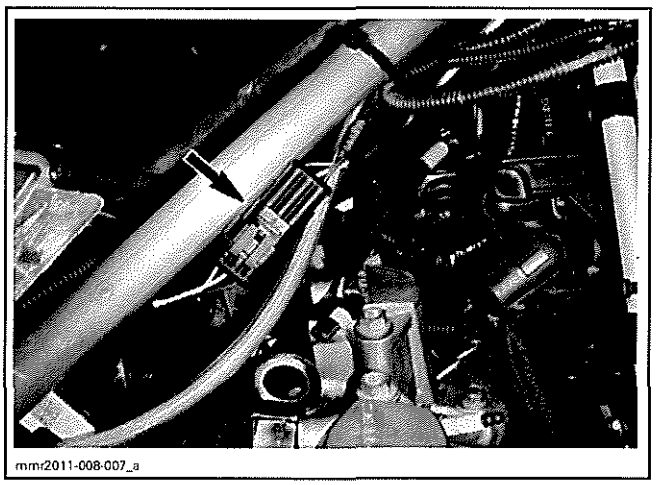
29. Remove knock sensor from cylinder head.



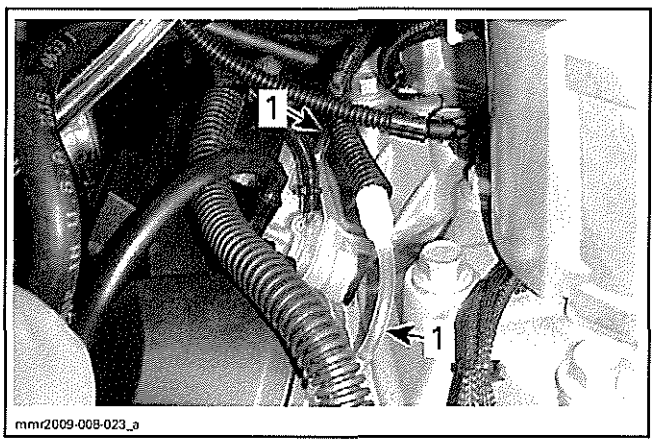
mmr2009-008-017_a

1. Knock sensor

30. Disconnect 3D RAVE connector.


mmr2011-008-007_a

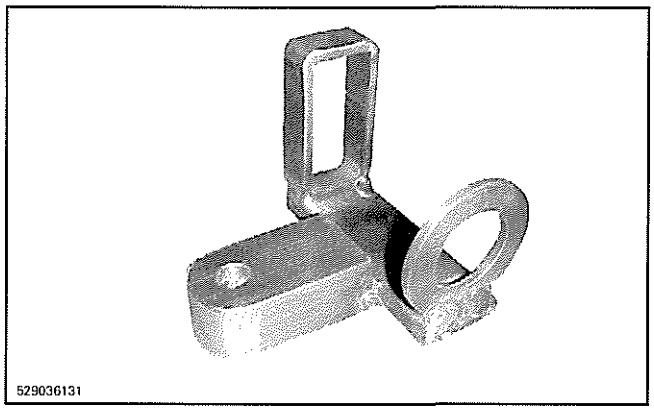
31. Disconnect oil hoses from 3D RAVE valves.

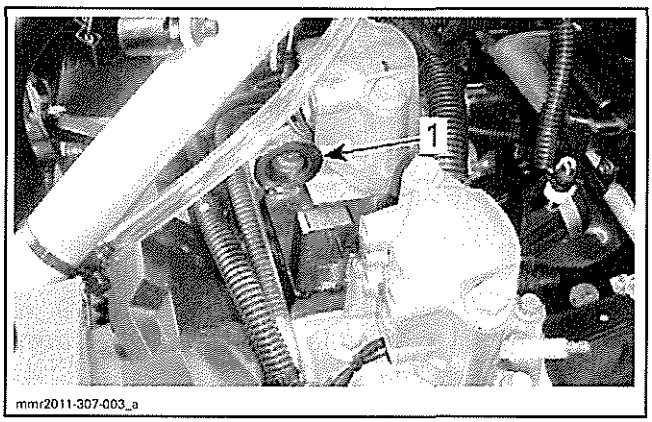


mmr2009-008-023_a

TYPICAL
1. 3D RAVE valve oil hoses

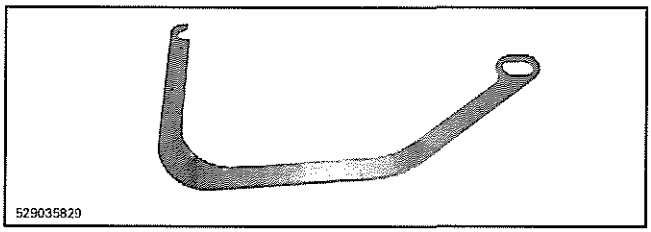
32. Secure the ENGINE LIFTING TOOL (P/N 529 036 131) instead of knock sensor using the knock sensor screw.

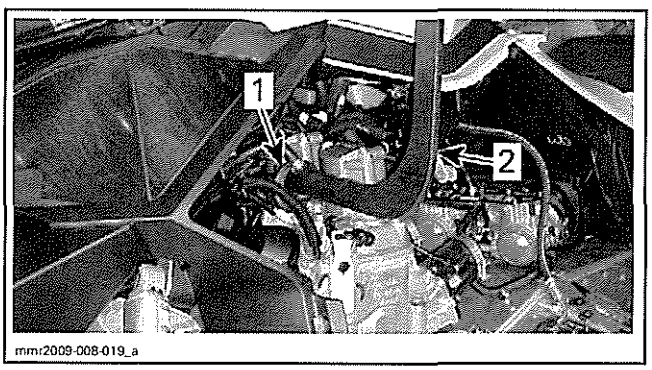




1. Engine lifting tool

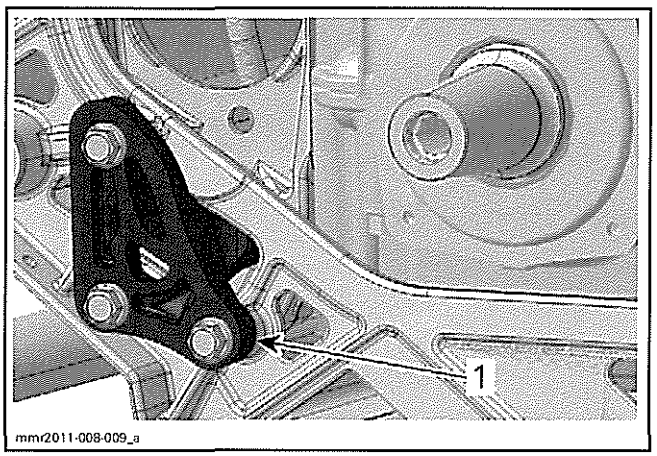
33. Place the ENGINE LIFTING HOOK (P/N 529 035 829) into engine lifting tool rings.





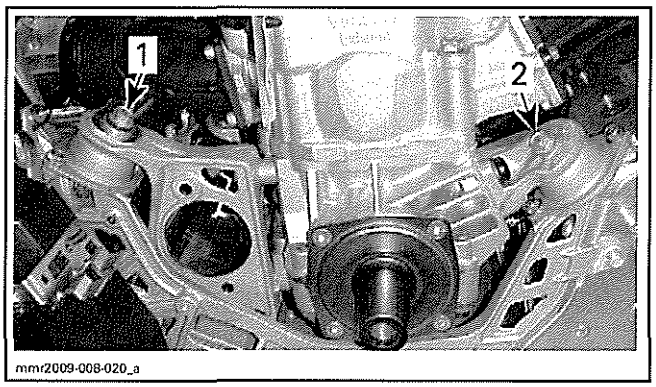
TYPICAL
1. Engine lifting tool
2. Engine removal hook

34. Remove engine stopper. Discard screws.



1. Engine stopper

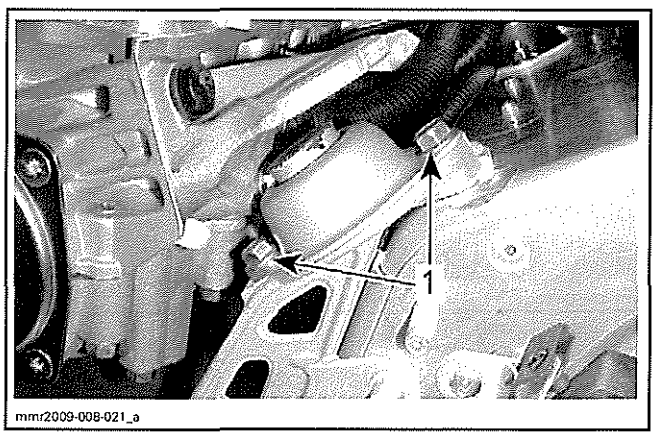
35. Remove and discard screws securing PTO engine supports to front and rear rubber mounts.



1. Front engine support screw
2. Rear engine support screw

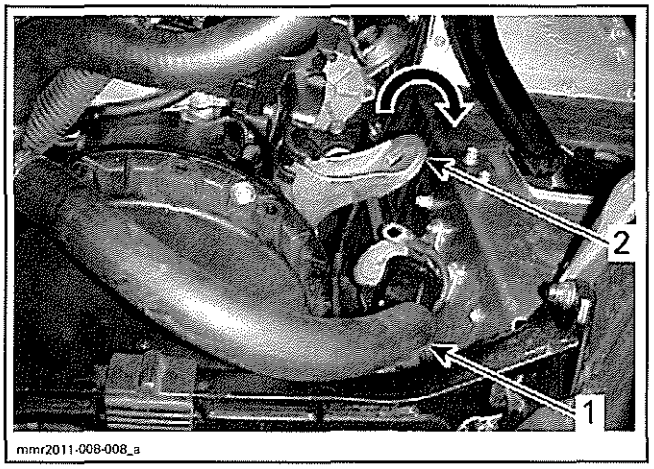
36. Slightly lift the engine.

37. Remove PTO rear rubber mount.



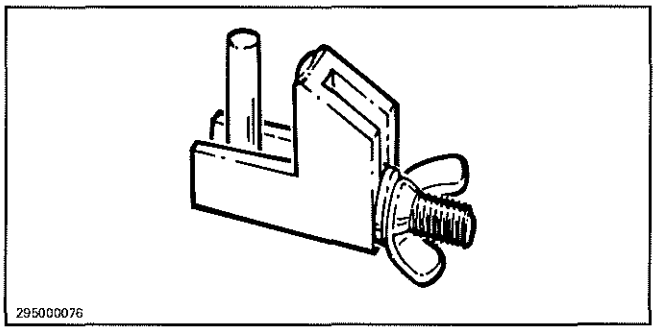
1. Rubber mount screws

38. Clear coolant hose from MAG front engine support.

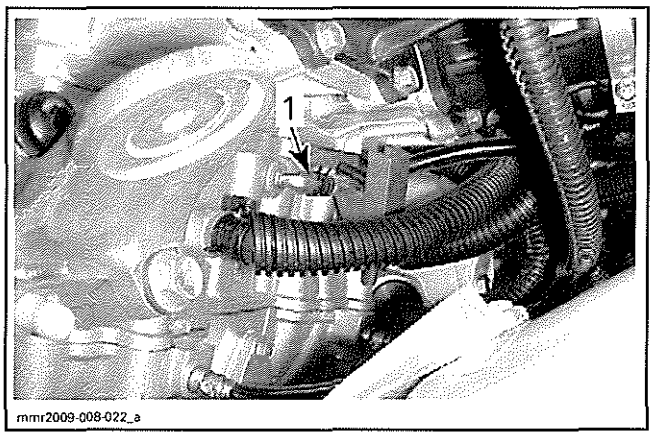


1. Coolant hose
2. Front MAG engine support

39. Install a SMALL HOSE PINCHER (P/N 295 000 076) on the oil return hose.

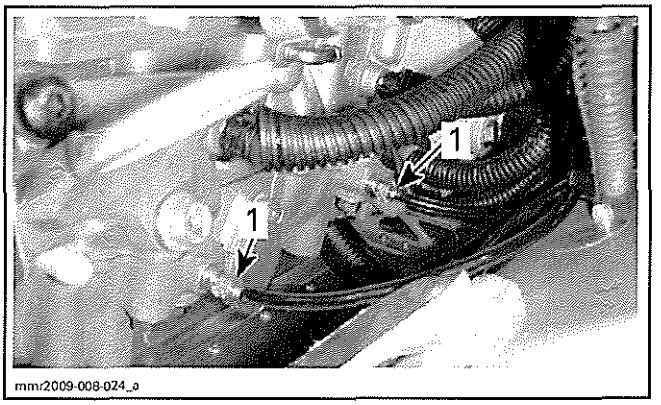


40. Disconnect oil return hose.



1. Oil return hose

41. Disconnect oil inlet hoses from crankcase. Discard Oetiker clamps.



1. Inlet hoses

42. Lift engine and slide it out of vehicle.

NOTICE **Pay attention not to damage fuel hoses or adapters.**

Engine Installation

To install engine, reverse the removal procedure. However, pay attention to the following.

- Install NEW self-locking screws where required, refer to exploded view at the beginning of this subsection.
- Install NEW Oetiker clamps when installing oil inlet hoses.
- Install and tighten engine support screws. Refer to *ENGINE SUPPORT INSTALLATION* in this subsection.
- Install and adjust engine stopper. Refer to *ENGINE STOPPER ADJUSTMENT* in this subsection.
- Oil hoses must be routed correctly to avoid lubrication problems. To route hoses correctly, refer to *OIL INJECTION PUMP HOSES CONNECTION* in *LUBRICATION SYSTEM* subsection.
- When engine installation is completed, bleed oil system. Refer to *LUBRICATION SYSTEM* subsection.
- If a new engine is installed or the engine was repaired, restart the break-in procedure in B.U.D.S.

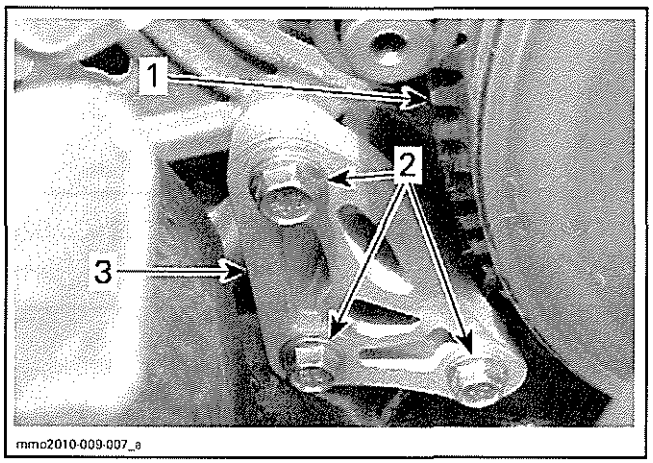
ENGINE STOPPER

Engine Stopper Adjustment

The engine stopper is located on the LH front engine support, in front of the drive pulley.

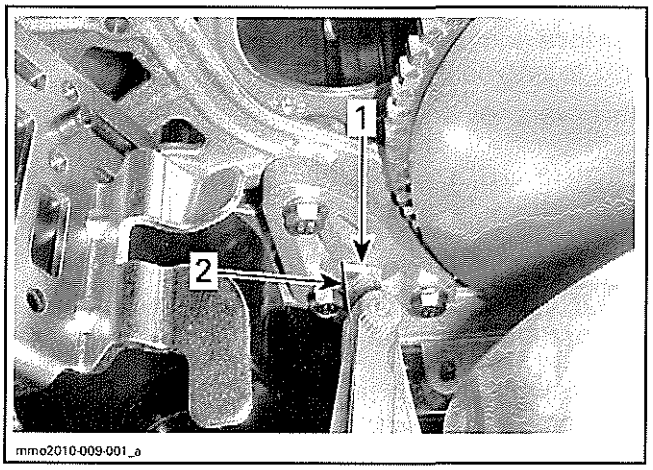
1. Remove tether cord from the engine cut-off switch.
2. Remove LH side panels, refer to *BODY* subsection.

3. Remove drive belt guard, refer to *DRIVE BELT* subsection.
4. Loosen the three screws retaining engine stopper to engine support just enough to allow a vertical play (1/2 to one turn).



1. Drive pulley
2. Engine stopper screws
3. Engine stopper

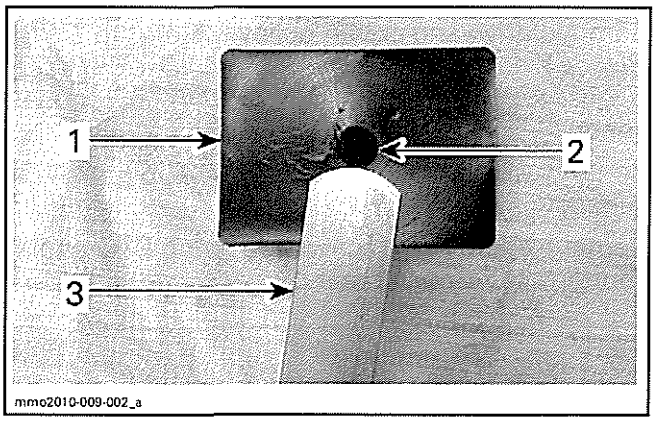
5. Insert a 0.5 mm (.02 in) feeler gauge in the engine stopper opening (see illustration).



1. Opening
2. Feeler gauge

6. Place feeler gauge between engine stopper and rubber stop block (on engine).

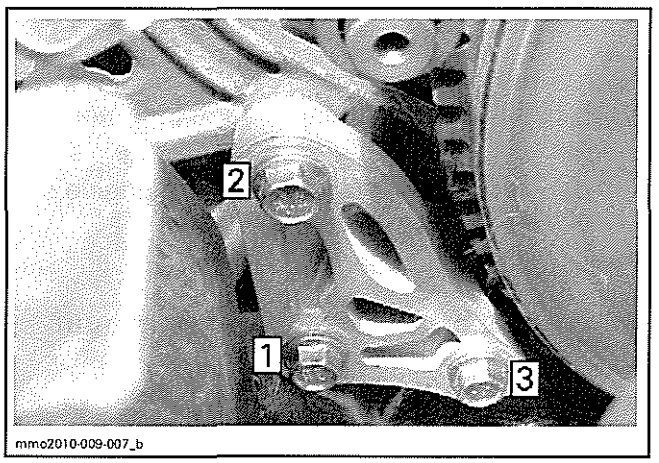
NOTE: Do not insert the feeler gauge too deep, as it will pass over the bump at the surface of the rubber stop block and alter adjustment. See illustration.



TYPICAL
1. Rubber stop block
2. Bump
3. Feeler gauge

7. Tighten engine stopper screws to specification following the illustrated sequence.

ENGINE STOPPER SCREWS TORQUE
10 N•m (89 lbf•**in**)



TIGHTENING SEQUENCE

NOTE: Take care not to pinch the feeler gauge.

NOTICE Serious pulley damage can occur if the engine stopper and its screws are not properly installed.

ENGINE SUPPORT

Engine Support Inspection

Check if engine supports are cracked, bent or damaged. Replace if necessary.

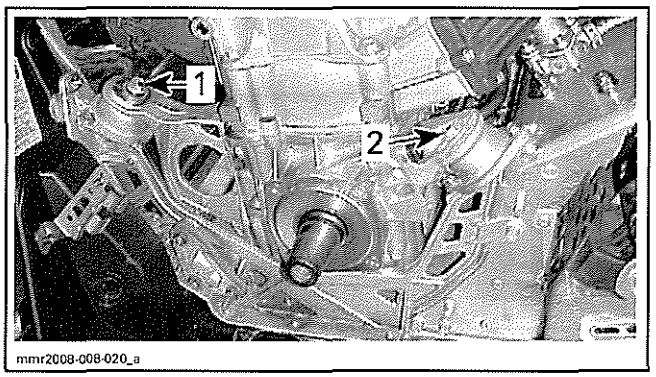
PTO Side Engine Support Removal (Engine not Removed)

Remove the electric starter. Refer to *STARTING SYSTEM* subsection.

Remove drive and driven pulleys. Refer to *DRIVE PULLEY* and *DRIVEN PULLEY AND COUNTERSHAFT (600 HO E-TEC AND 1200 4-TEC)* subsections.

Remove tuned pipe. Refer to *EXHAUST SYSTEM* subsection.

Remove and discard screws securing PTO engine supports to front and rear rubber mount adapters.



TYPICAL
1. *Front engine support screw*
2. *Rear engine support screw*

Insert a pry bar over the LH frame member and gently raise the engine just enough to remove engine weight from support.

Remove and discard screws retaining engine support to engine.

Remove engine support.

MAG Side Engine Support Removal (Engine not Removed)

Remove muffler and tuned pipe. Refer to *EXHAUST SYSTEM* subsection.

Remove driven pulley. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 HO E-TEC AND 1200 4-TEC)* subsection.

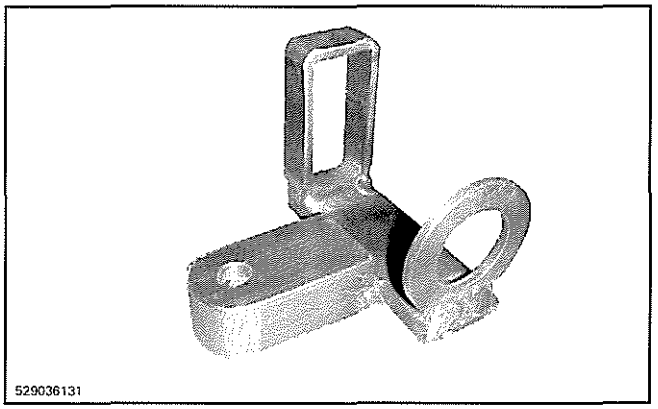
Remove primary air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.

Unscrew clamps retaining throttle body to intake adapters.

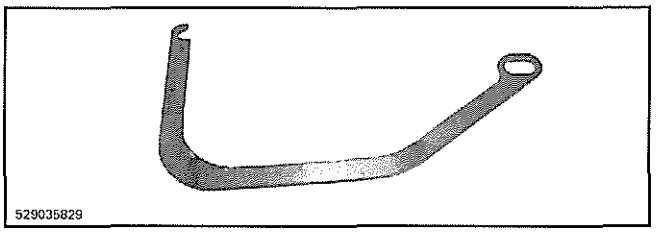
Move and attach throttle body aside.

Remove knock sensor.

Secure the ENGINE LIFTING TOOL (P/N 529 036 131) instead of knock sensor using the knock sensor screw.



Place the ENGINE LIFTING HOOK (P/N 529 035 829) into engine lifting tool rings.



Remove and discard screws securing engine supports to rubber mount adapters.

Lift engine.

Remove and discard screws retaining engine support to engine.

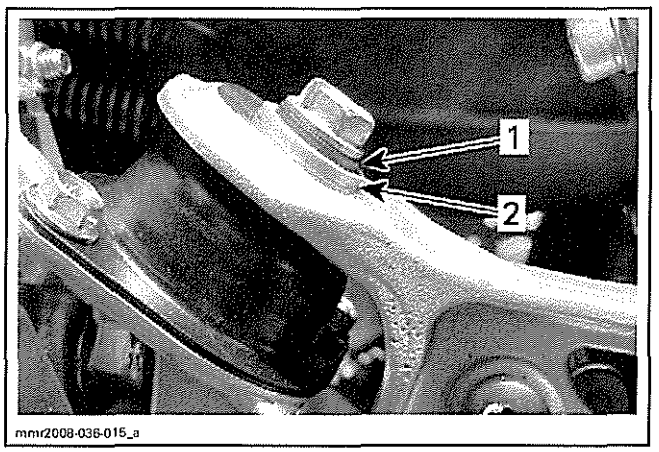
Remove engine support.

Engine Support Installation

The installation is the reverse of the removal procedure, however pay attention to the following.

NOTICE **Engine stopper must be adjusted after installing engine support.**

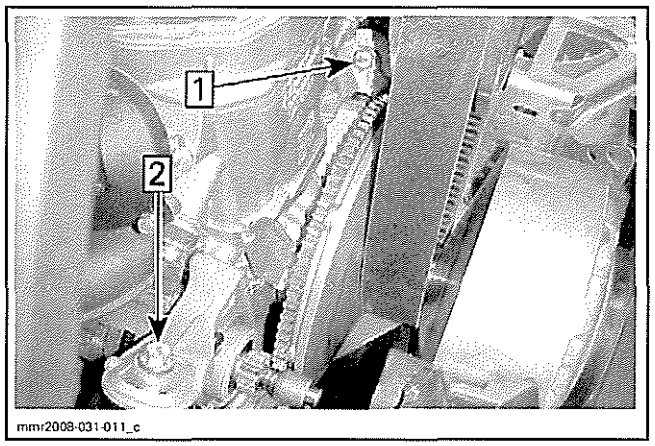
Front engine supports (PTO and MAG sides) are secured using a conical washer and a flat washer.



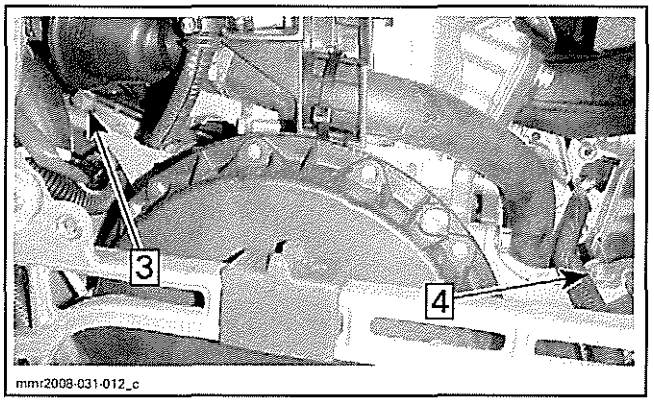
TYPICAL - FRONT ENGINE MOUNT (PTO SIDE)
1. *Conical washer*
2. *Flat washer*

Tighten engine supports bolts to specification as per the following sequence.

ENGINE SUPPORT BOLTS		
TORQUE	25 N•m (18 lbf•ft)	
SEQUENCE	1	Rear engine support (PTO side)
	2	Front engine support (PTO side)
	3	Rear engine support (MAG side)
	4	Front engine support (MAG side)



TIGHTENING SEQUENCE — PTO SIDE



TIGHTENING SEQUENCE — MAG SIDE

Adjust engine stopper, refer to *ENGINE STOPPER ADJUSTMENT* in this subsection.

ENGINE RUBBER MOUNT

Engine Rubber Mount Inspection

Check engine rubber mounts. Replace them if brittle, cracked or damaged.

Engine Rubber Mount Removal

Remove muffler and tuned pipe. Refer to *EXHAUST SYSTEM* subsection.

Remove driven pulley. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 HO E-TEC AND 1200 4-TEC)* subsection.

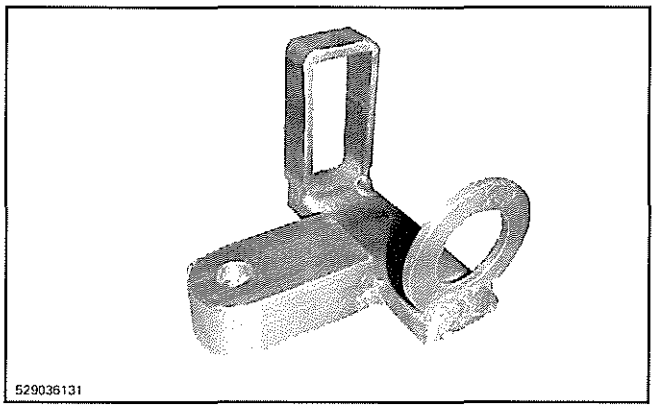
Remove primary air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.

Unscrew clamps retaining throttle body to intake adapters.

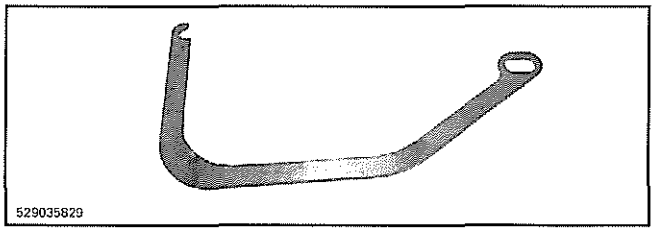
Move and attach throttle body aside.

Remove knock sensor.

Secure the ENGINE LIFTING TOOL (P/N 529 036 131) instead of knock sensor using the knock sensor screw.



Place the ENGINE LIFTING HOOK (P/N 529 035 829) into engine lifting tool rings.



Remove and discard screws securing engine supports to rubber mount adapters.

Lift engine.

Unscrew bolts or nuts securing engine rubber mounts to frame.

Engine Rubber Mount Installation

The installation is the reverse of the removal procedure.

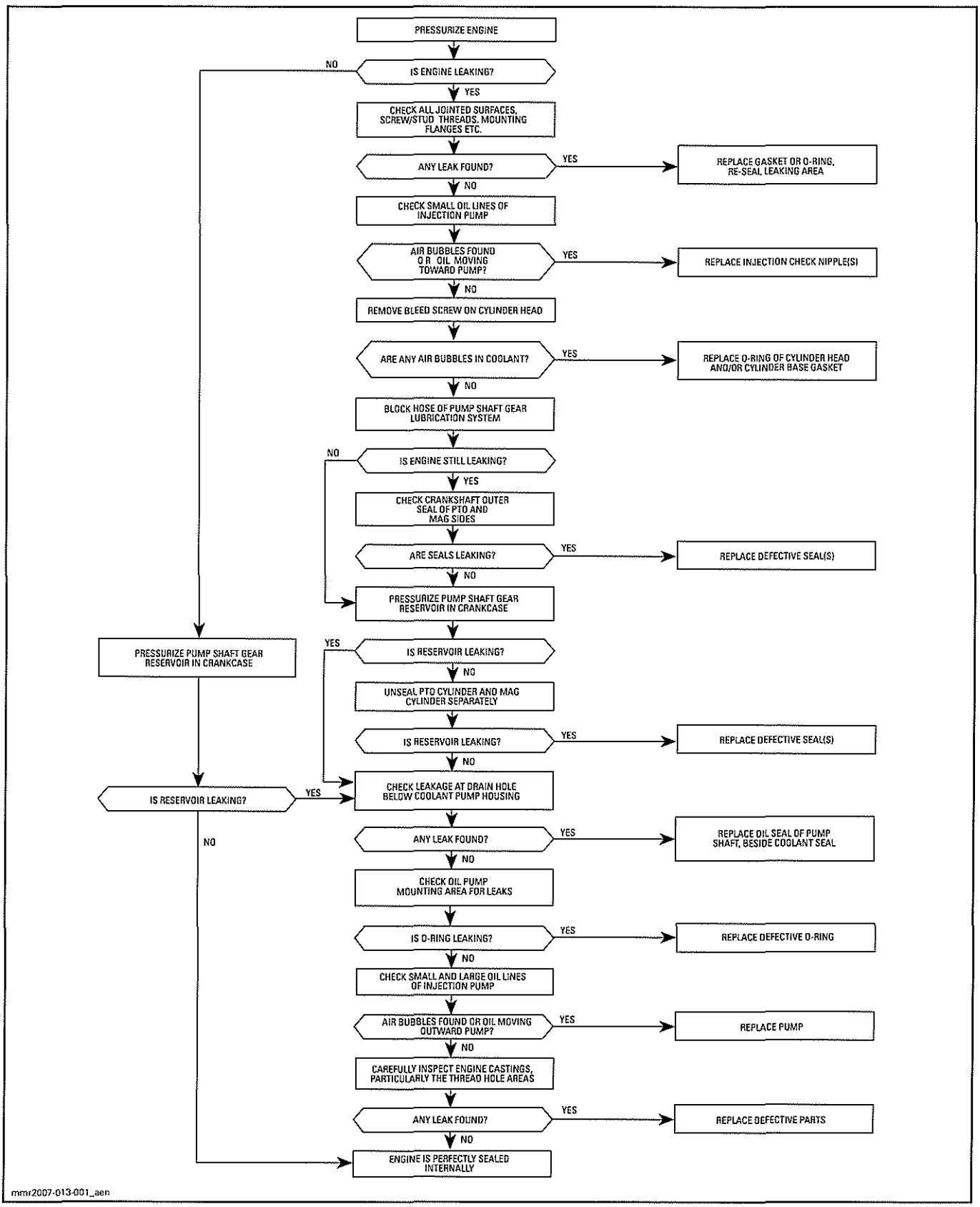
ENGINE LEAK TEST

SERVICE TOOLS

Description	Part Number	Page
INTAKE PLUG	529 036 203	57
MANIFOLD PLUG 63 MM (2-1/2")	529 035 961	57
SMALL HOSE PINCHER	295 000 076	57
VACUUM/PRESSURE PUMP	529 021 800	57

TROUBLESHOOTING

NOTE: This flow chart must be used as a visual reference during the engine leak test procedure.

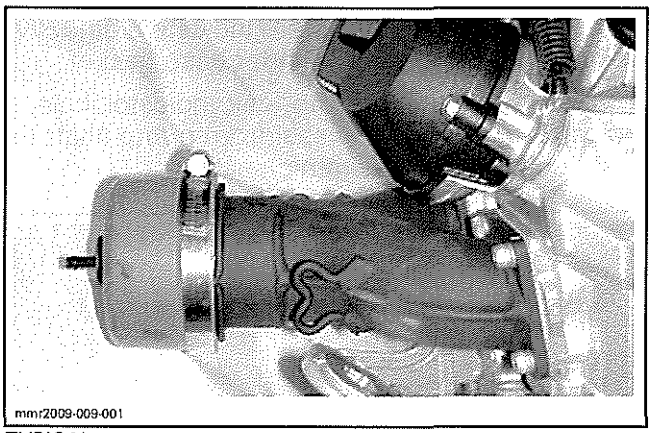


PROCEDURES

ENGINE

Prior to take apart an engine, it is important to proceed with a leak test to diagnose engine problems. Whenever the engine is disassembled, a leak test should be performed after reassembly.

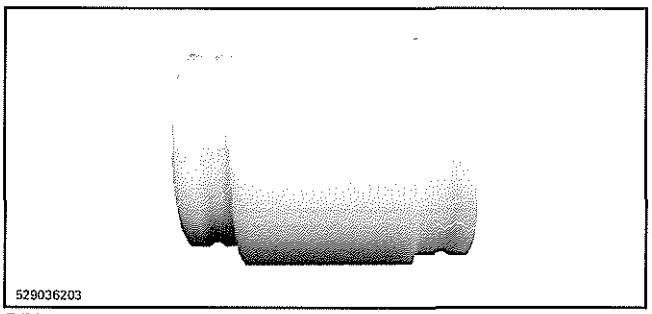
1. Remove engine. Do not remove the exhaust manifold. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
2. Install MANIFOLD PLUG 63 MM (2-1/2") (P/N 529 035 961) over exhaust manifold and secure with a clamp.



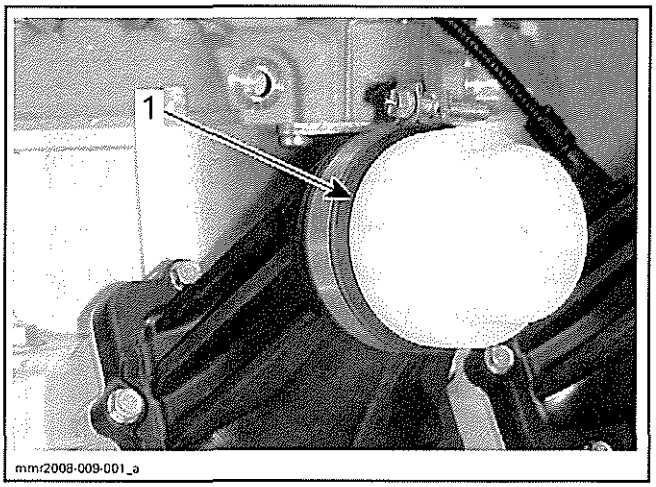
TYPICAL

3. Insert an intake plug in each intake adapters. Refer to the following table.
4. Tighten with existing clamps.

INTAKE PLUG	
600 HO E-TEC	INTAKE PLUG (P/N 529 036 203)

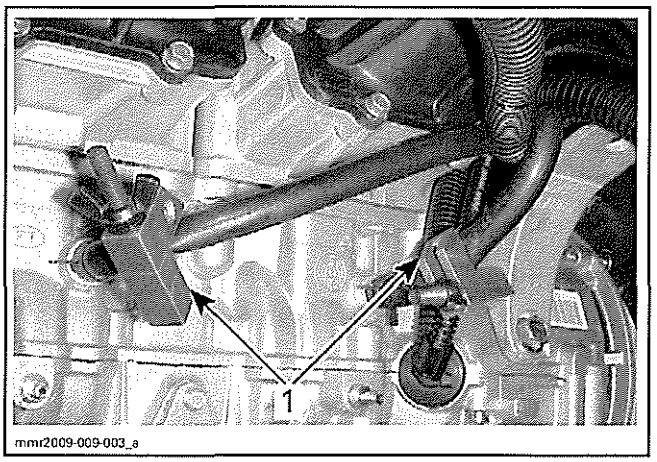


P/N 529 036 203



TYPICAL
1. Intake plug

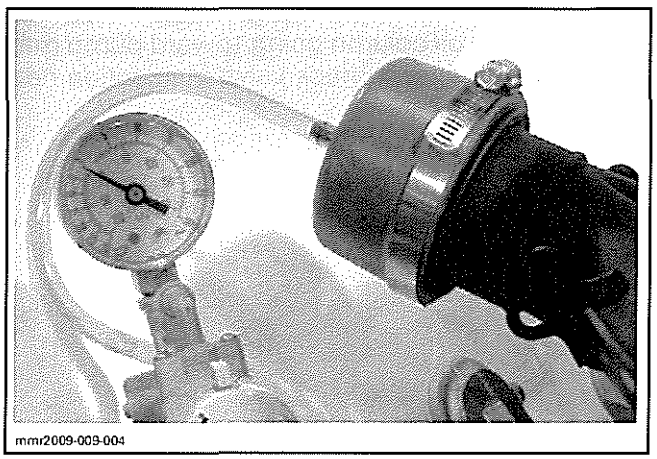
5. Using a SMALL HOSE PINCHER (P/N 295 000 076), block each impulse hose as applicable.



1. Small hose pinchers

NOTICE Pay attention not to squeeze hose nipples.

6. Install VACUUM/PRESSURE PUMP (P/N 529 021 800) on manifold plug.



TYPICAL

7. Activate pump and pressurize engine.

ENGINE LEAK TEST	
PRESSURE	TIME (Without pressure drop)
34 kPa (5 PSI)	3 minutes

NOTICE Do not exceed the specified pressure.

8. If pressure drops before 3 minutes, spray a soapy solution on tester kit (manifold and intake plugs, vacuum/pressure pump and its hose).
   - 8.1 If tester kit (manifold and intake plugs, hoses and pump) is leaking, bubbles will indicate where leak comes from.
   - 8.2 If tester kit is not leaking, check engine, see *ENGINE COMPONENTS TO BE VERIFIED.*

Engine Components to be Verified

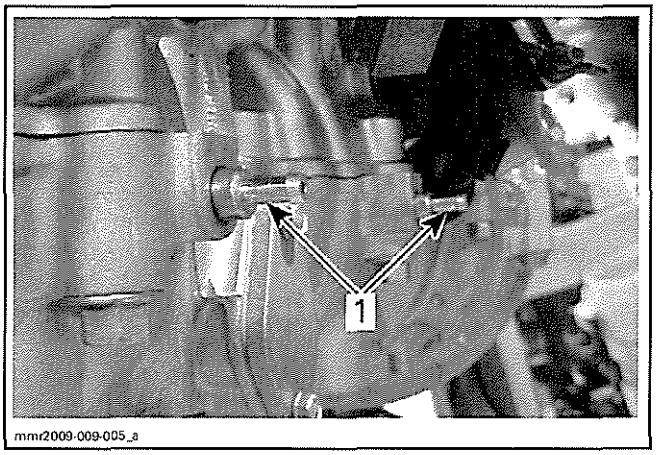
Leak indicator hole below coolant pump housing.

All jointed surfaces and screw or stud threads of engine:
- Spark plug base, insulator
- Cylinder head
- RAVE valve bellows, piston and housing
- Cylinder
- Crankcase halves (joint)
- Crankshaft outer seals (PTO and MAG)
- Coolant pump housing.

Verify also the small injection oil lines coming from oil pump.
- Coolant bleed nipples on cylinder head
- Fuel injector gaskets.

Troubleshooting Tips

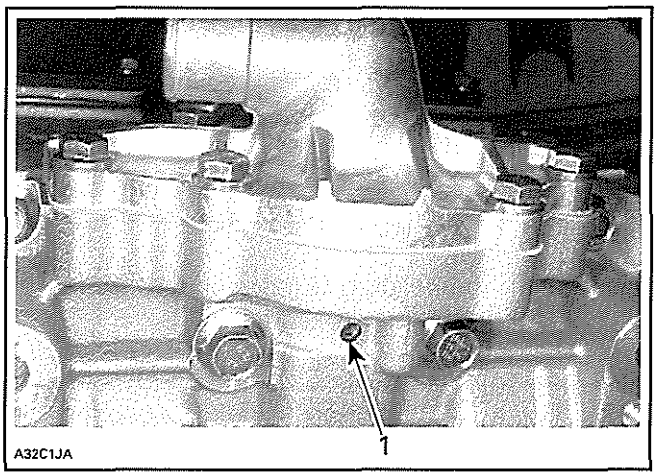
Air bubbles or oil column going toward pump may indicates a defective check valve in injection nozzle.



600 HO E-TEC ENGINE SHOWN
1. Injection nipples

Air bubbles in cooling system indicate a defective cylinder head O-ring or cylinder base gasket.

If there is a leak from the leak indicator hole, it indicates a defective oil seal from pump shaft (oil seal behind coolant ceramic seal).



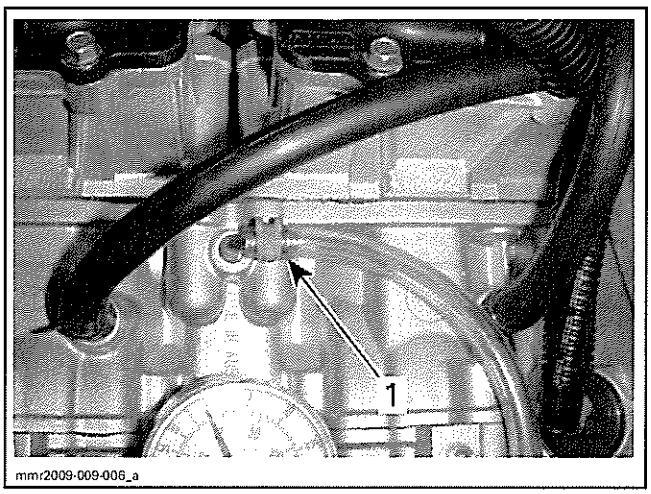
1. Leak indicator hole

PUMP SHAFT OIL GEAR RESERVOIR

Install air pump on reservoir fitting and pressurize engine.

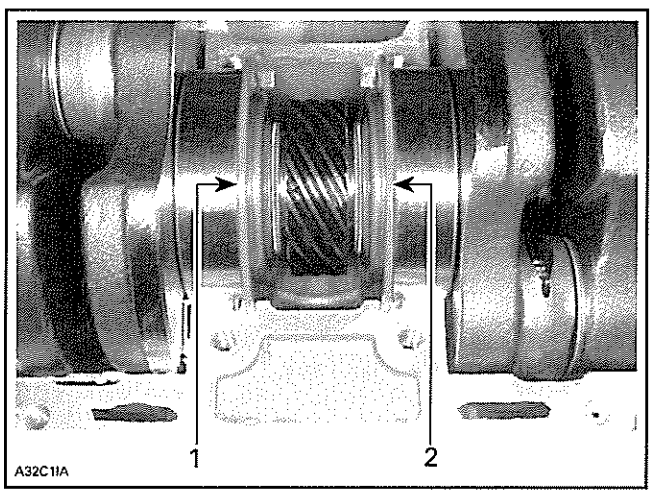
PUMP SHAFT OIL GEAR RESERVOIR LEAK TEST	
PRESSURE	TIME (Without pressure drop)
34 kPa (5 PSI)	3 minutes

NOTICE Do not exceed the specified pressure.

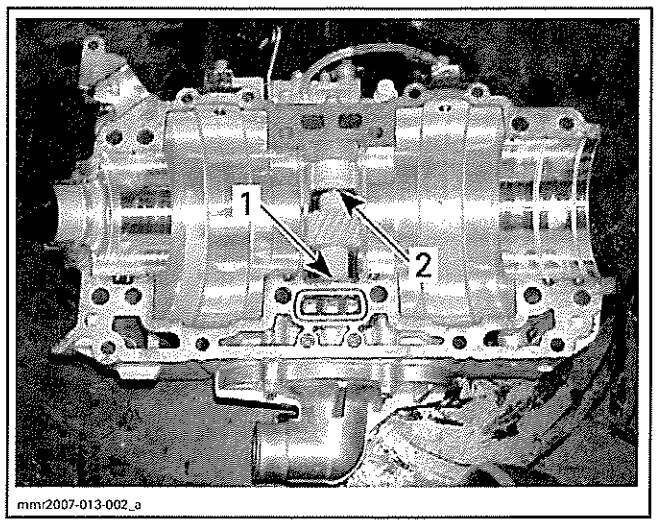


TYPICAL
1. Air pump hose on fitting

If pressure drops, it indicates a defective crankshaft inner seal or a defective oil seal either on water pump side or oil pump side.



TYPICAL — CRANKCASE INSIDE VIEW
1. Leakage through inner seal on PTO side
2. Leakage through inner seal on MAG side



TYPICAL — CRANKCASE INSIDE VIEW
1. Leakage through water pump seal (reservoir side)
2. Leakage on oil pump side (seal or O-ring)

ENGINE MEASUREMENT

SERVICE TOOLS

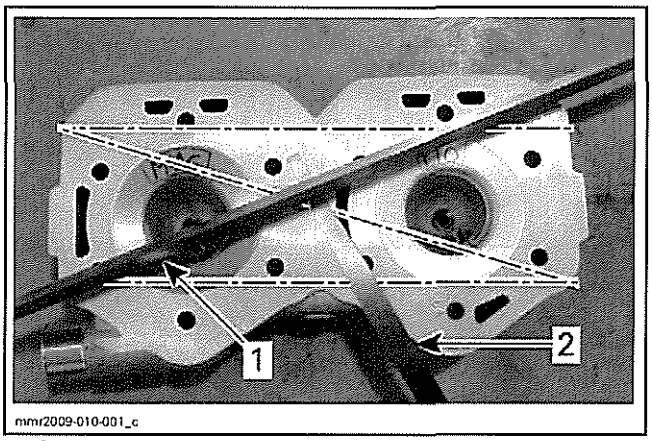
Description	Part Number	Page
DEGREE WHEEL	529 035 607	65
PISTON PROJECTION	529 036 215	66
TDC DIAL INDICATOR	295 000 143	66

PROCEDURES

NOTE: This subsection explains the procedures to correctly measure engine components. For the engine technical specifications, refer to *INSPECTION* in the appropriate *ENGINE* subsection.

CYLINDER HEAD WARPAGE

1. Check gasket mating surface of the cylinder head with a straight edge and a feeler gauge. Make sure part is within the given specification.
2. If cylinder head is out of specification, replace it.

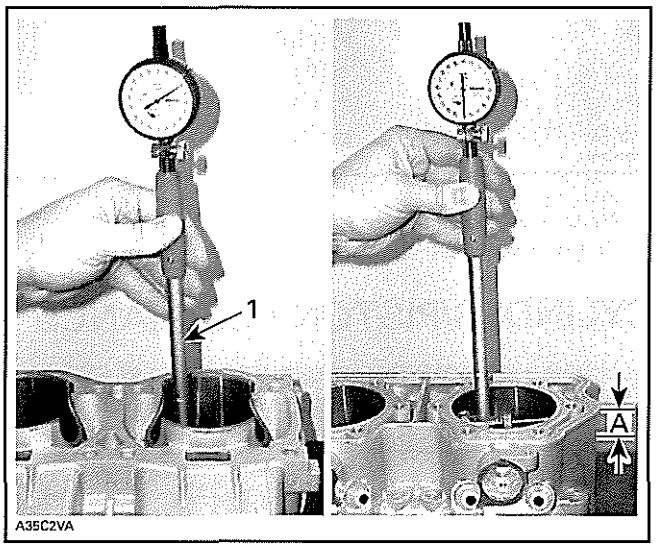


1. Straight edge
2. Feeler gauge

CYLINDER TAPER

1. Measure cylinder diameter in the following locations:
   - Above exhaust port
   - Below intake port.
2. Compare cylinder diameters.
3. If the difference exceeds the specified dimension, the cylinder should be rebored and honed or should be replaced. Nikasil cylinder can be honed using diamond hone but can not be rebored.

NOTE: Be sure to restore the chamfer around all cylinder sleeve port openings.

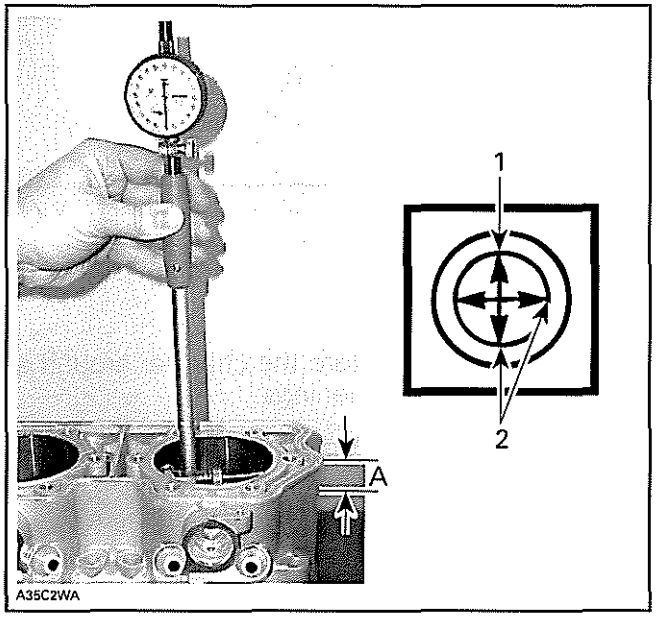


1. Below the intake port
A. Above exhaust port

CYLINDER OUT OF ROUND

1. Measuring above exhaust port with a cylinder gauge, check if the cylinder out of round is more than the specified dimension.
2. If larger, cylinder should be rebored and honed or should be replaced. Nikasil cylinder can be honed using diamond hone but cannot be rebored.

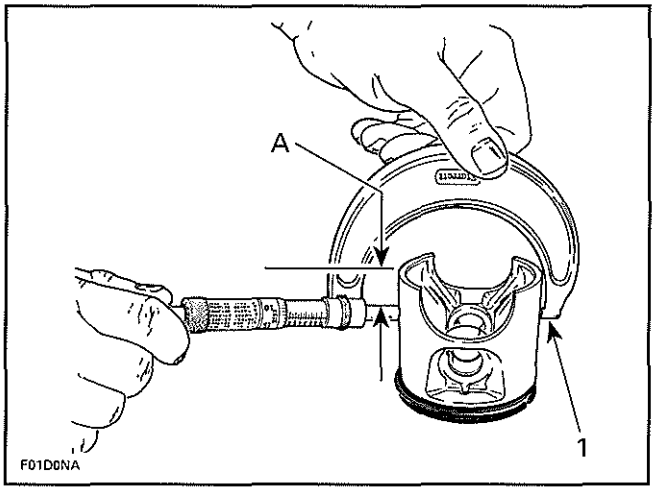
NOTE: Be sure to restore the chamfer around all cylinder sleeve port openings.



1. Piston pin position
2. Measures to be compared
A. Above exhaust port

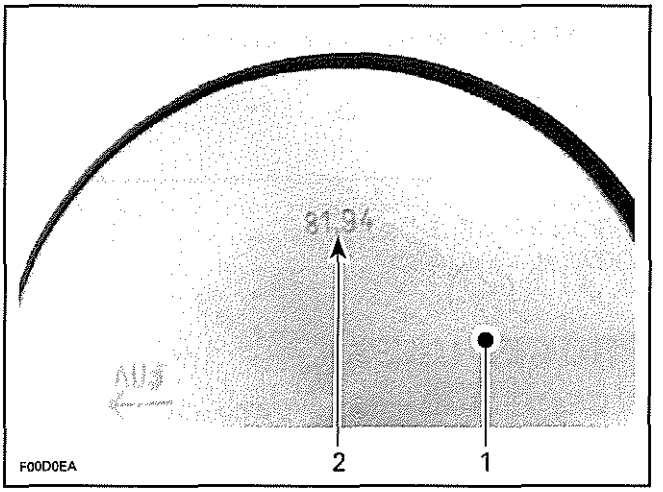
CYLINDER/PISTON CLEARANCE

1. Using a micrometer, measure piston at "A" perpendicularly (90°) to piston pin.



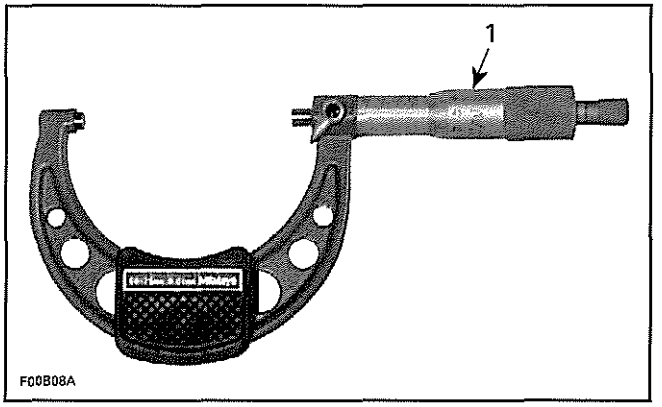
TYPICAL
1. Measuring perpendicularly (90°) to piston pin axis
A. 15 mm (.591 in)

2. The measured dimension must not be less than 0.15 mm (.006 in) of the one scribed on piston dome. Otherwise, install a new piston.



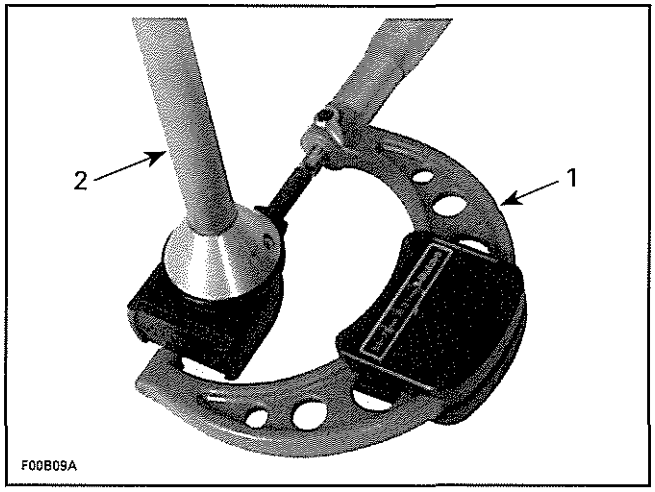
TYPICAL
1. Piston dome
2. Piston measurement

3. If piston is within tolerance, adjust and lock a micrometer to the piston dimension.

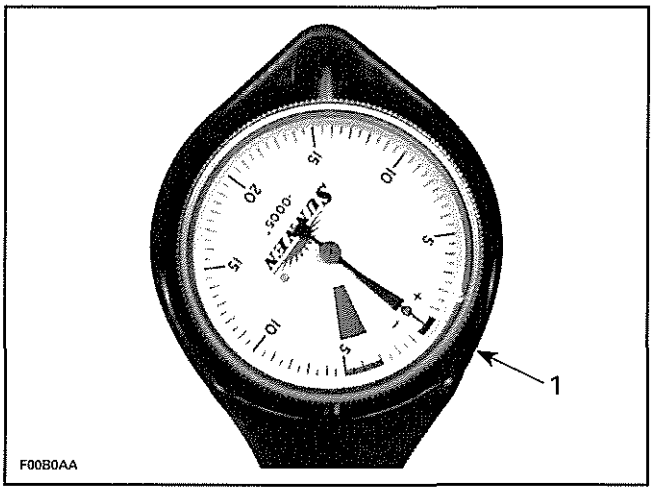


1. Micrometer set to the piston dimension

4. Refer to *PROCEDURE CONTINUATION WITH A NEW OR USED PISTON* further.
5. With the micrometer set to the piston dimension, adjust a cylinder bore gauge to the micrometer dimension and set the indicator to 0.



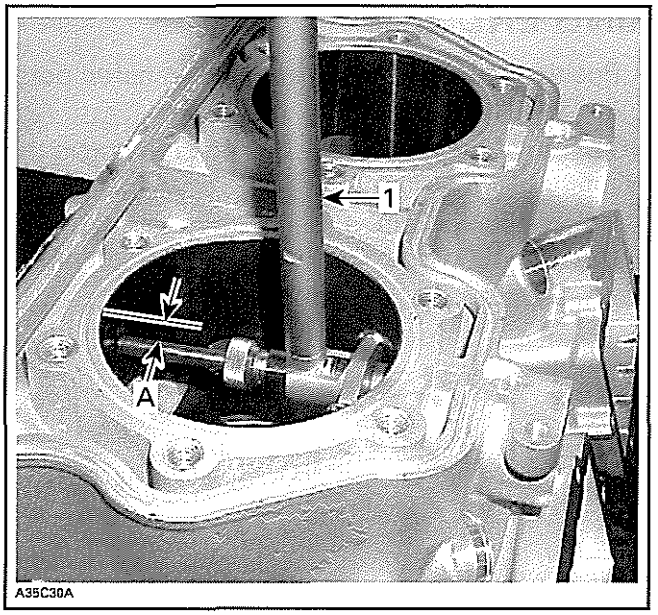
1. Use the micrometer to set the cylinder bore gauge
2. Dial bore gauge



1. Indicator set to 0 (zero)

NOTE: Make sure the cylinder bore gauge indicator is set exactly at the same position as with the micrometer, otherwise the reading will be false.

6. Position the dial bore gauge above the exhaust port.
7. IMPORTANT: Always remove cylinder-block from crankcase before measuring.



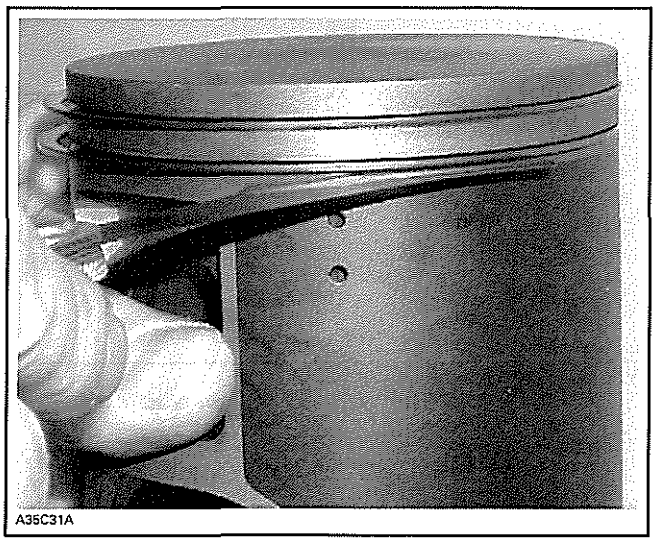
1. Measuring perpendicularly (90°) to piston pin axis
A. Above exhaust port

8. Read the measurement on the cylinder bore gauge. The result is the exact piston/cylinder wall clearance. If clearance exceeds specified tolerance, replace cylinder and piston.

NOTE: Oversize pistons are available for the 593 engine only.

RING/PISTON GROOVE CLEARANCE

1. Using a feeler gauge check clearance between rectangular ring and groove.
2. Replace piston if clearance exceeds specified tolerance.

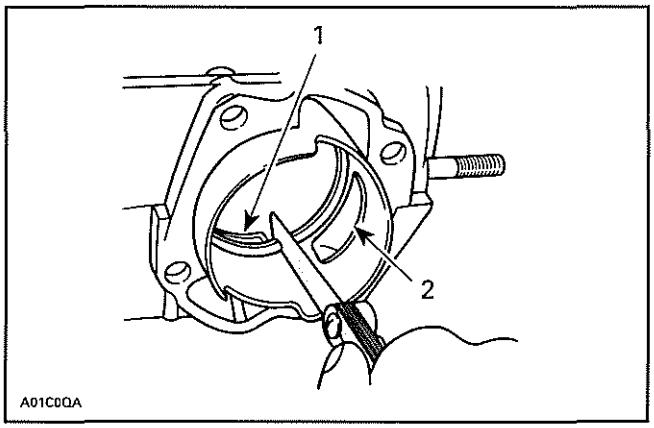


RING END GAP

1. Position ring halfway between transfer ports and intake port.

NOTE: In order to correctly position the ring in the cylinder, use piston as a pusher.

2. Using a feeler gauge, check ring end gap. Replace ring if gap exceeds specified tolerance.

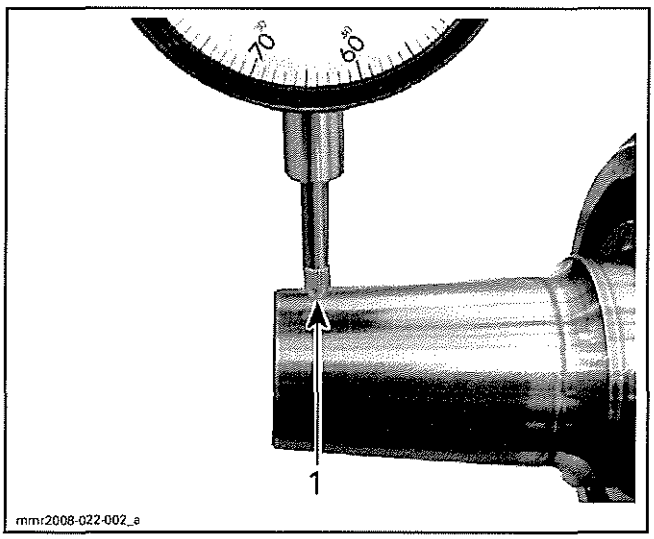


TYPICAL
1. *Transfer port*
2. *Intake port*

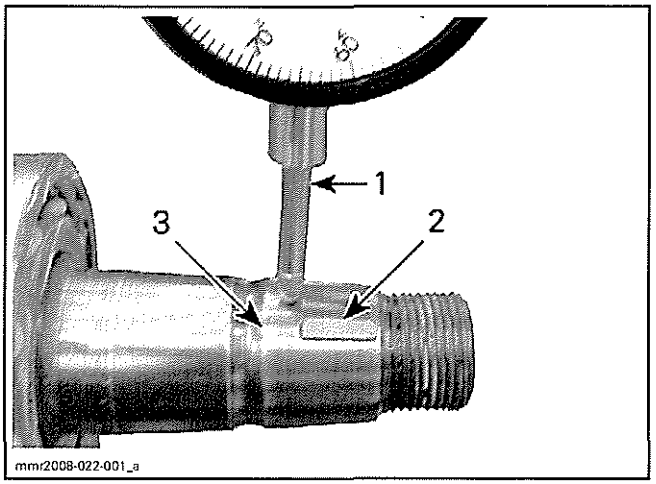
CRANKSHAFT DEFLECTION

Measuring in Crankcase

1. Using a dial indicator, check deflection with crankshaft in crankcase.



TYPICAL — PTO SIDE
1. *Measure deflection 3 mm (1/8 in) from crankshaft end*

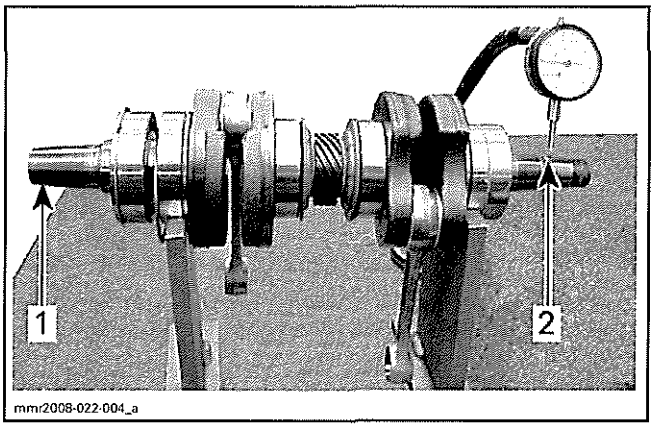


TYPICAL — MAG SIDE
1. *Measure deflection at mid point between key and groove*
2. *Key*
3. *Groove*

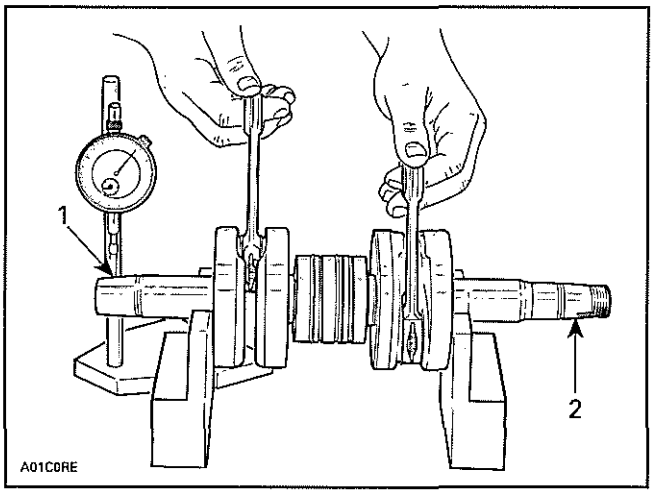
2. If deflection exceeds the specified tolerance, recheck deflection using V-shaped blocks to determine the defective part(s). See *MEASURING ON BENCH*.

Measuring on Bench

1. Once engine is disassembled, check crankshaft deflection on V-shaped blocks.



TYPICAL — V-SHAPED BLOCKS POSITION WITH BEARINGS
1. *Measure deflection 3 mm (1/8 in) from crankshaft end*
2. *Measure deflection at mid point between key and groove*



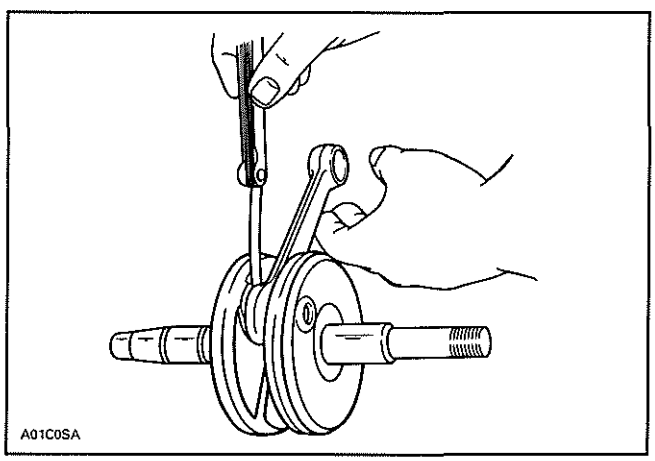
TYPICAL — V-SHAPED BLOCKS POSITION WITHOUT BEARINGS
1. Measure deflection 3 mm (1/8 in) from crankshaft end
2. Measure deflection at mid point between key and groove

NOTE: Crankshaft deflection cannot be correctly measured between centers of a lathe.

2. If deflection exceeds the specified tolerance, it can be worn bearings or a bent crankshaft.
3. Remove crankshaft bearings and check deflection again on V-shaped blocks to determine the defective part(s).
4. If the deflection exceeds the specified tolerance, crankshaft should be repaired or replaced.

CONNECTING ROD BIG END AXIAL PLAY

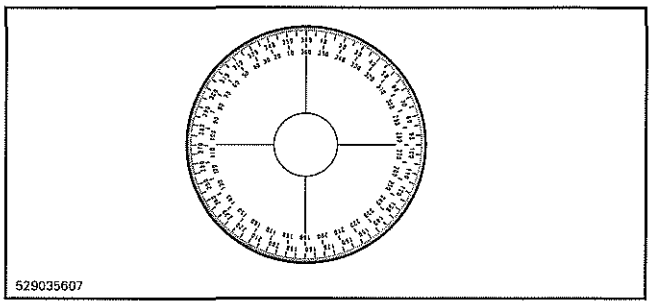
1. Using a feeler gauge, measure distance between thrust washer and crankshaft counterweight.
2. If the distance exceeds specified tolerance, repair or replace the crankshaft.

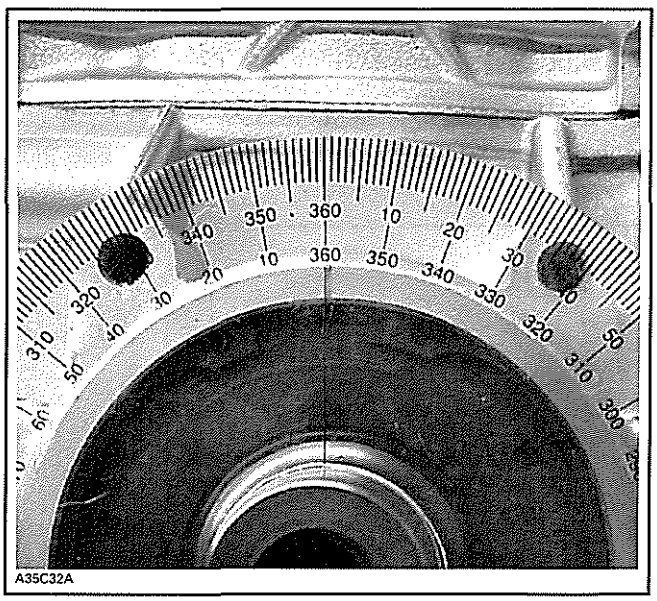


TYPICAL

CRANKSHAFT ALIGNMENT

1. Remove injectors. Refer to *E-TEC DIRECT FUEL INJECTION* subsection.
2. Bring MAG piston at top dead center. Refer to *IGNITION SYSTEM* subsection.
3. Scribe a mark on crankcase.
4. Install the DEGREE WHEEL (P/N 529 035 607) on crankshaft end so that 360° mark aligns with the mark on crankcase. Do not rotate crankshaft.





5. Remove dial indicator and install it in spark plug hole on PTO side.
6. Bring PTO piston to top dead center. Degree wheel must rotate with crankshaft.
7. Interval between cylinders must be 180° ± 0.5.
8. Any other reading indicates a misaligned (twisted) crankshaft.

PISTON PROJECTION MEASUREMENT

NOTE: The piston projection measurement is used to determine the correct cylinder base gasket thickness when engine components are replaced.

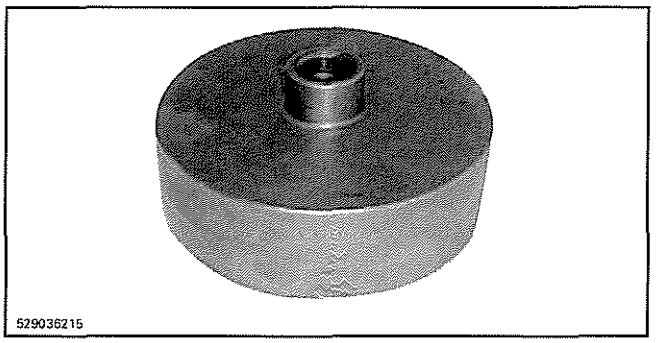
Engine Preparation

NOTE: As a troubleshooting step, It is possible to measure piston projection without removing engine from vehicle.

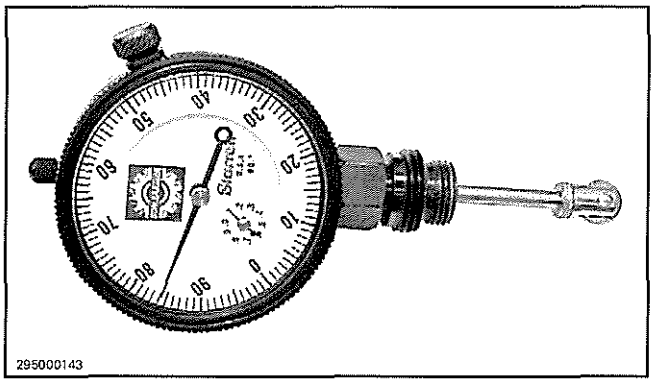
1. Bring PTO piston to TDC using the TDC DIAL INDICATOR (P/N 295 000 143).
2. Remove cylinder head from engine. Refer to *TOP END* subsection.
3. Remove O-rings from cylinder block.
4. Clean top surface of cylinder block.
5. Ensure piston dome is clean and free of any carbon deposits.
6. Ensure cylinder block screws are properly tighten.

Measurement

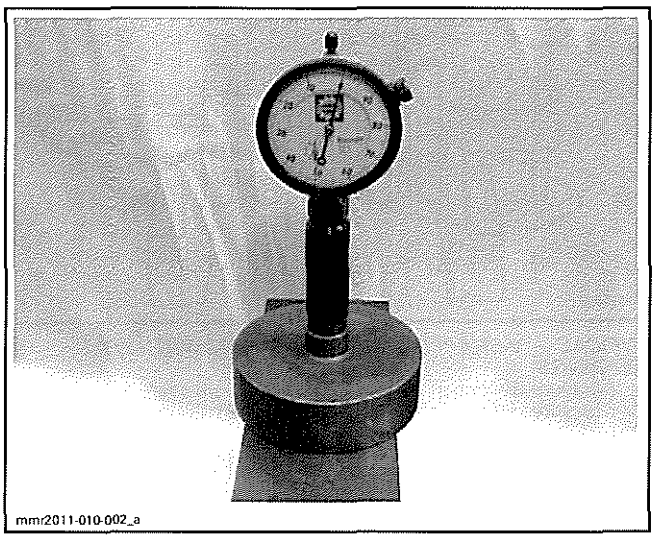
1. Use the PISTON PROJECTION (P/N 529 036 215) tool.



2. Install the TDC DIAL INDICATOR (P/N 295 000 143) on the piston projection tool.

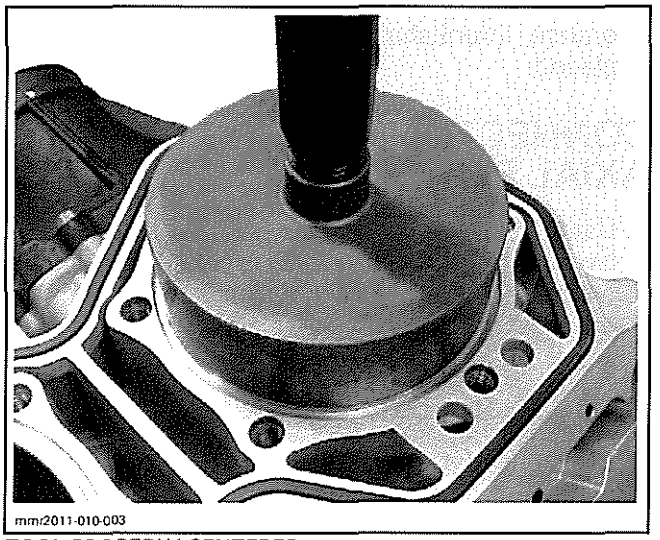


3. Place piston projection tool on a flat steel surface.
4. Rotate dial indicator face to position the **0** in line with needle.



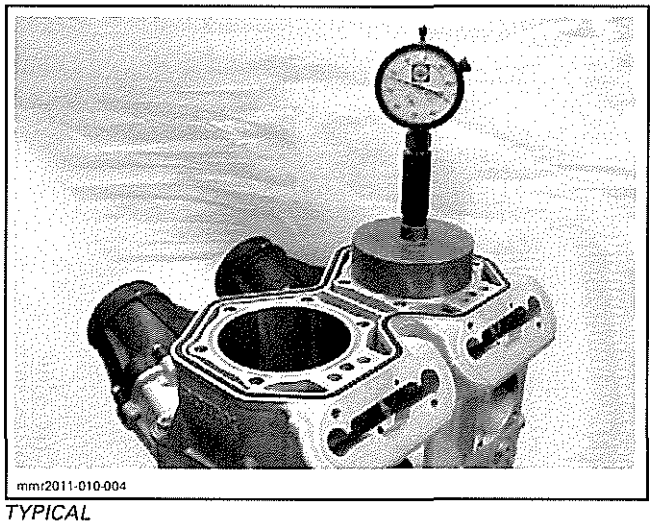
SETTING THE ZERO

5. Install tool on PTO cylinder.
6. Center tool with cylinder to ensure that dial indicator reads piston dome.



TOOL PROPERLY CENTERED

7. Ensure that PTO piston is set to TDC.
8. Read dial indicator then note measurement.



TYPICAL

NOTE: Convert dial indicator measurement to millimeter.

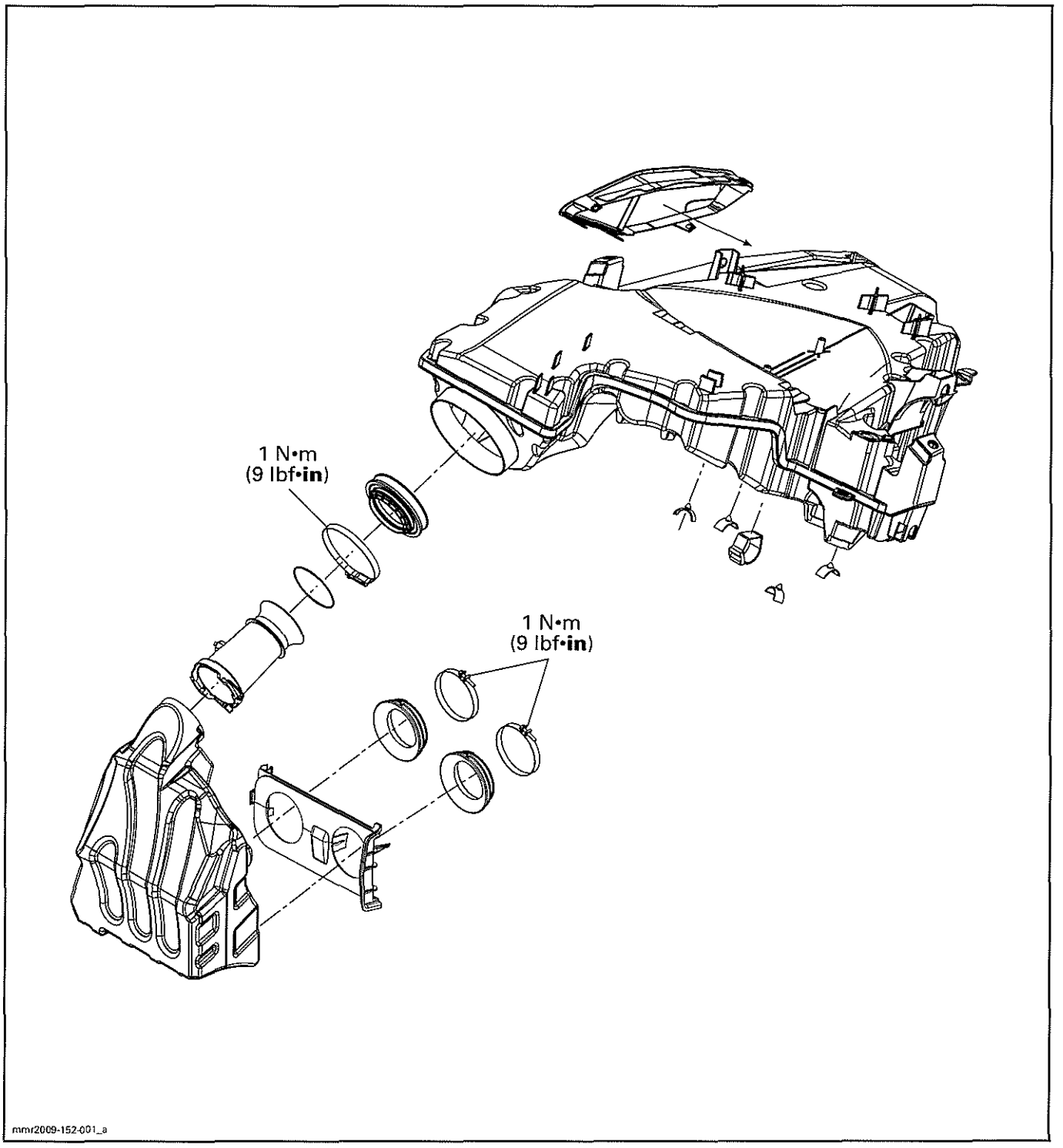
9. Check if piston projection is according to specification. Refer to *TOP END* subsection.

NOTICE Take care to use the proper specification according to the type of engine and the model of vehicle.

10. Repeat procedure for MAG cylinder.
11. If piston projection is out of specification, replace base gasket.

NOTE: A thicker base gasket will lower the piston projection measurement.

AIR INTAKE SYSTEM



GENERAL

During assembly/installation, use the torque values and service products as in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices (e.g.: locking tabs, elastic stop nuts, cotter pins, etc.) must be replaced with a new ones.

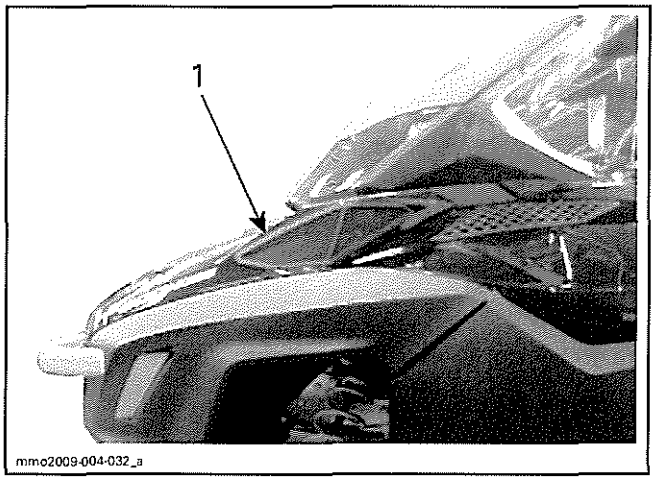
NOTICE Hoses, cables or locking ties removed during a procedure must be reinstalled as per factory standards.

PROCEDURES

AIR FILTER

Air Filter Removal

1. Pull the air filter out using the tab near LH headlight.



TYPICAL
1. Air filter

Air Filter Cleaning

Clean with fresh water and mild soap.

Replace air filter as required.

NOTE: If the filter is very dirty, clean the interior of secondary air intake silencer at the same time.

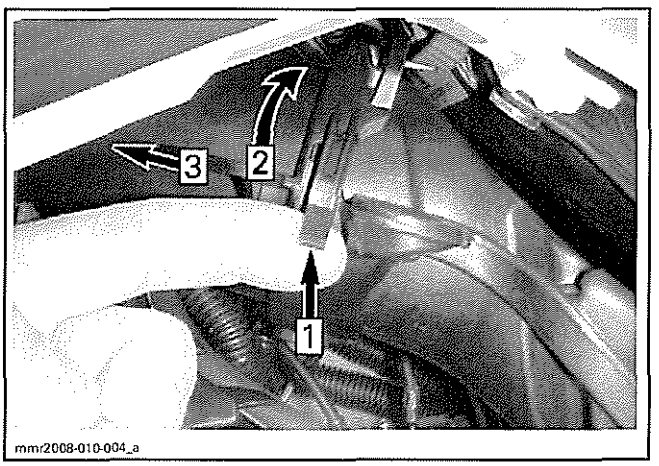
Air Filter Installation

The installation is the reverse of the removal procedure.

PRIMARY AIR INTAKE SILENCER

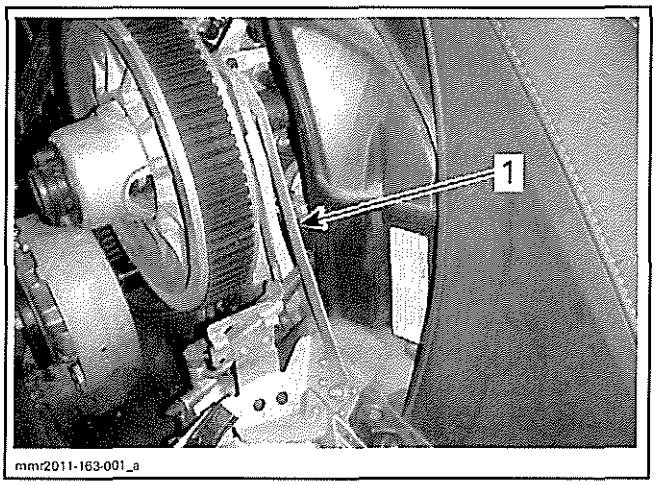
Primary Air Intake Silencer Removal

1. Remove LH side panels.
2. Remove drive belt guard, refer to *DRIVE BELT* subsection.
3. Unlock connector tube as follows:
   3.1 Lift tab on rear section of connector tube.
   3.2 Twist tube counterclockwise and pull slightly forward.



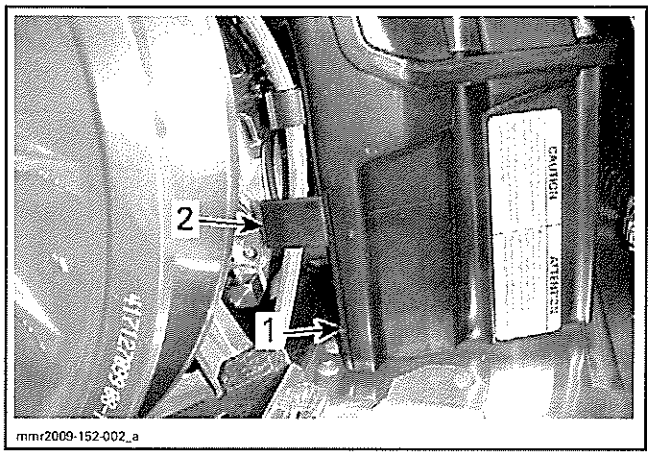
Step 1: Lift tab
Step 2: Twist tube
Step 3: Pull forward

4. Remove side bar from vehicle.



1. Side bar

5. Push securing tab of primary air intake silencer and pull silencer out of adapter plate.



TYPICAL
1. *Primary air intake silencer*
2. *Securing tab*

Primary Air Intake Silencer Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

Guide primary air intake silencer into the adapter plate groove.

Ensure primary air silencer is pushed to the end of adapter plate.

Ensure securing tab is fully engaged.

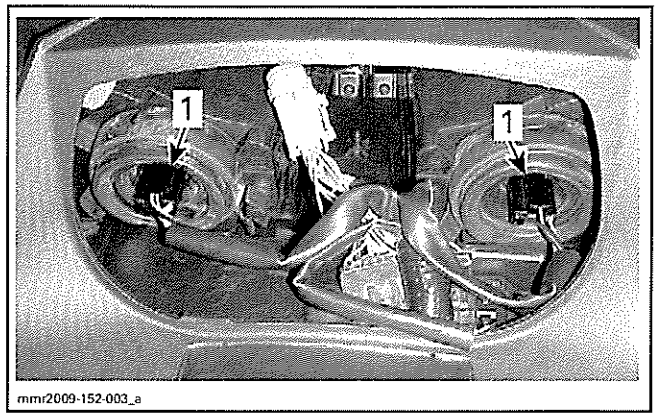
NOTICE Be careful not to damage foam during installation.

SECONDARY AIR INTAKE SILENCER

Secondary Air Intake Silencer Removal

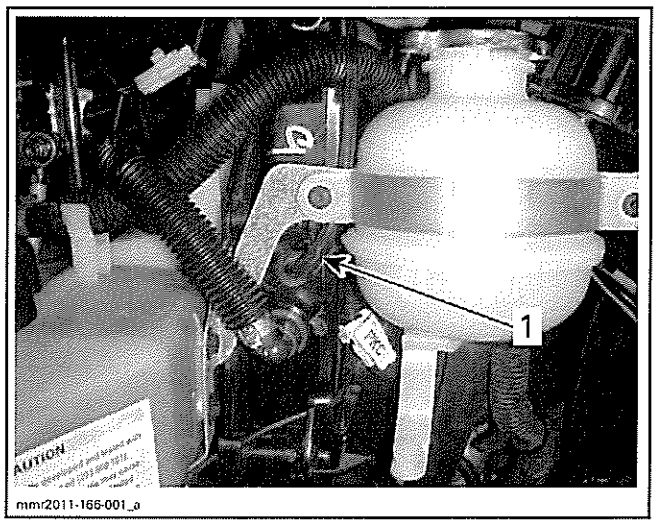
NOTE: The secondary air intake silencer is removed as a unit with gauge support.

1. Refer to *BODY* subsection and remove the following parts:
   - Hood
   - Side panels
   - Windshield.
2. Remove the multifunction gauge. Refer to *LIGHTS, GAUGE AND ACCESSORIES* subsection.
3. Unplug headlight connectors.



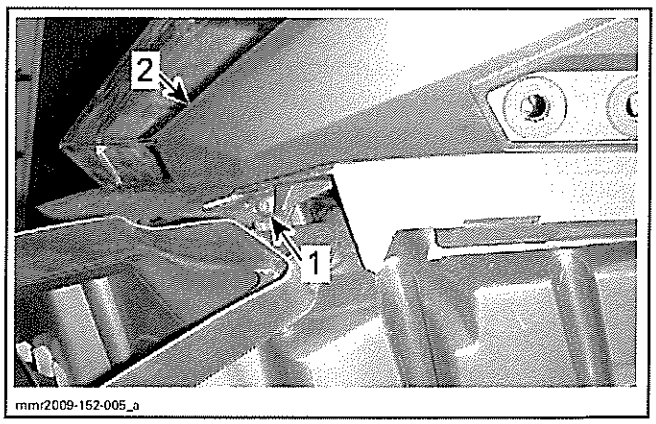
1. *Headlight connectors*

4. Disconnect APS hose from ECM.



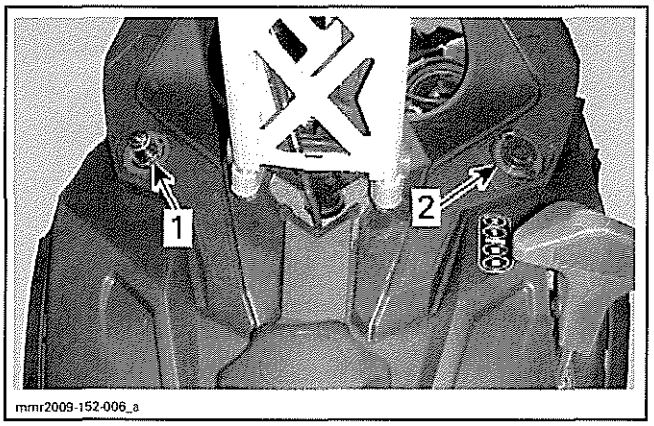
1. *APS hose*

5. Remove screws securing console to gauge support.



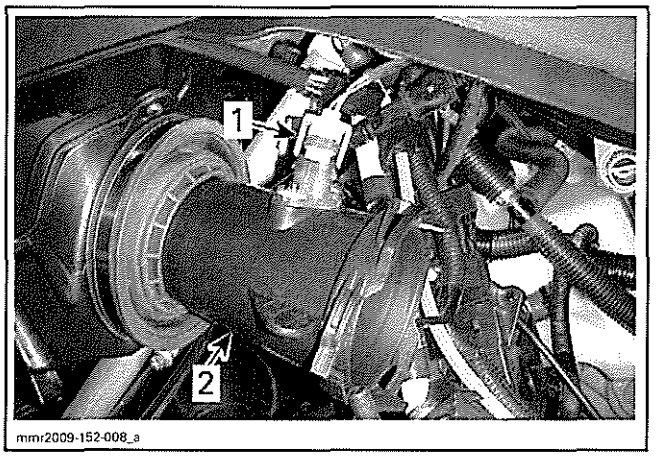
LH SIDE SHOWN
1. *Retaining screw*
2. *Gauge support*

6. Unplug the D.E.S.S. post and the 12-volt power outlet.



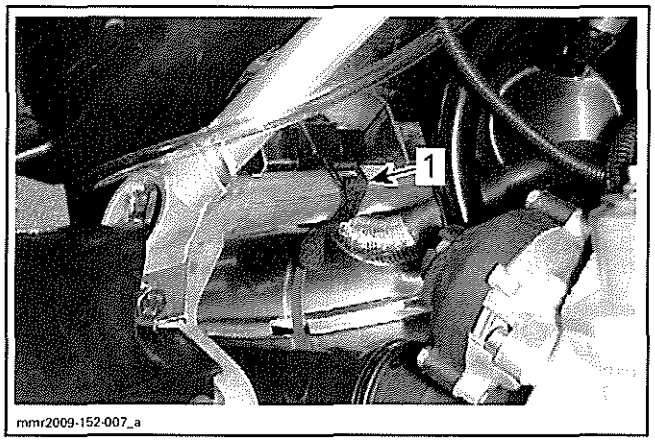
TYPICAL
1. *D.E.S.S. post*
2. *12-volt power outlet*

7. Unlock connector tube as described in *PRIMARY AIR INTAKE SILENCER REMOVAL.*
8. Disconnect air temperature sensor (ATS) located on top of connector tube.



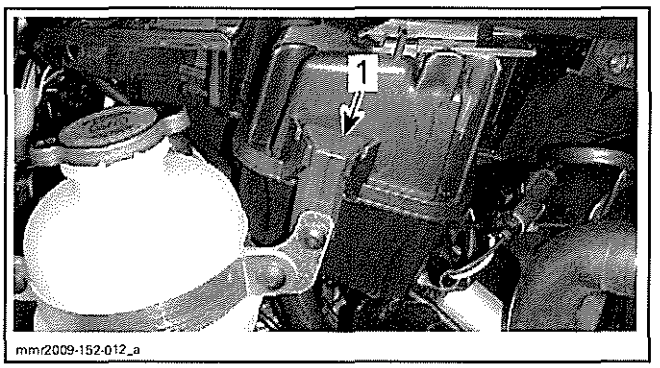
TYPICAL
1. *ATS sensor connector*
2. *Connector tube*

9. Pull off the hook-and-loop fastener located on the front lower portion of the secondary air intake silencer.



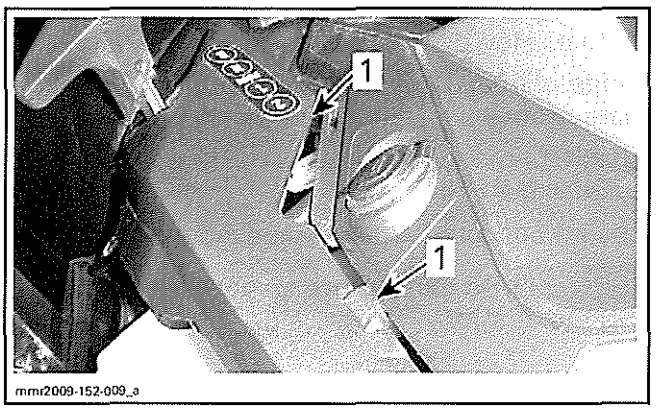
TYPICAL
1. *Hook-and-loop fastener*

10. Detach rubber attachment from secondary air intake silencer.



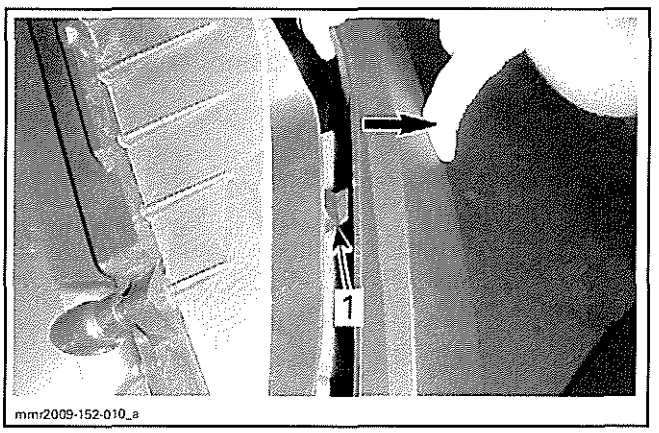
1. *Rubber attachment*

11. Detach console ends from gauge support (2 tabs on each side).



1. *Retaining tabs*

12. Move the LH bottom pan aside to free the retaining pin of secondary air intake silencer.



1. *Retaining pin*

13. Remove secondary air intake silencer and gauge support from vehicle.

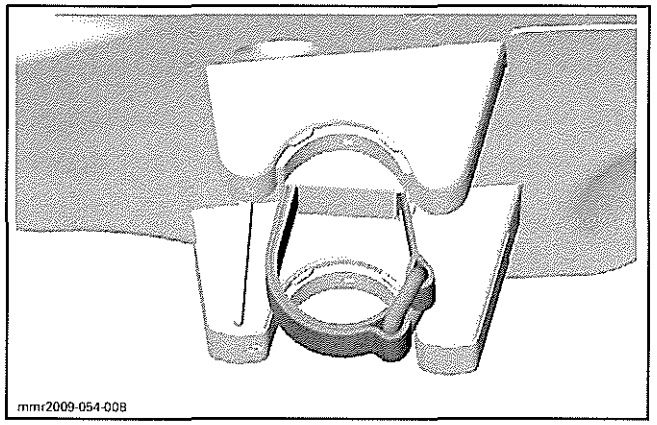
Secondary Air Intake Silencer Removal from Gauge Support

To separate secondary air intake silencer from gauge support, refer to *GAUGE SUPPORT* in *BODY* subsection.

Secondary Air Intake Silencer Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

Make sure to route hook-and-loop fastener correctly.

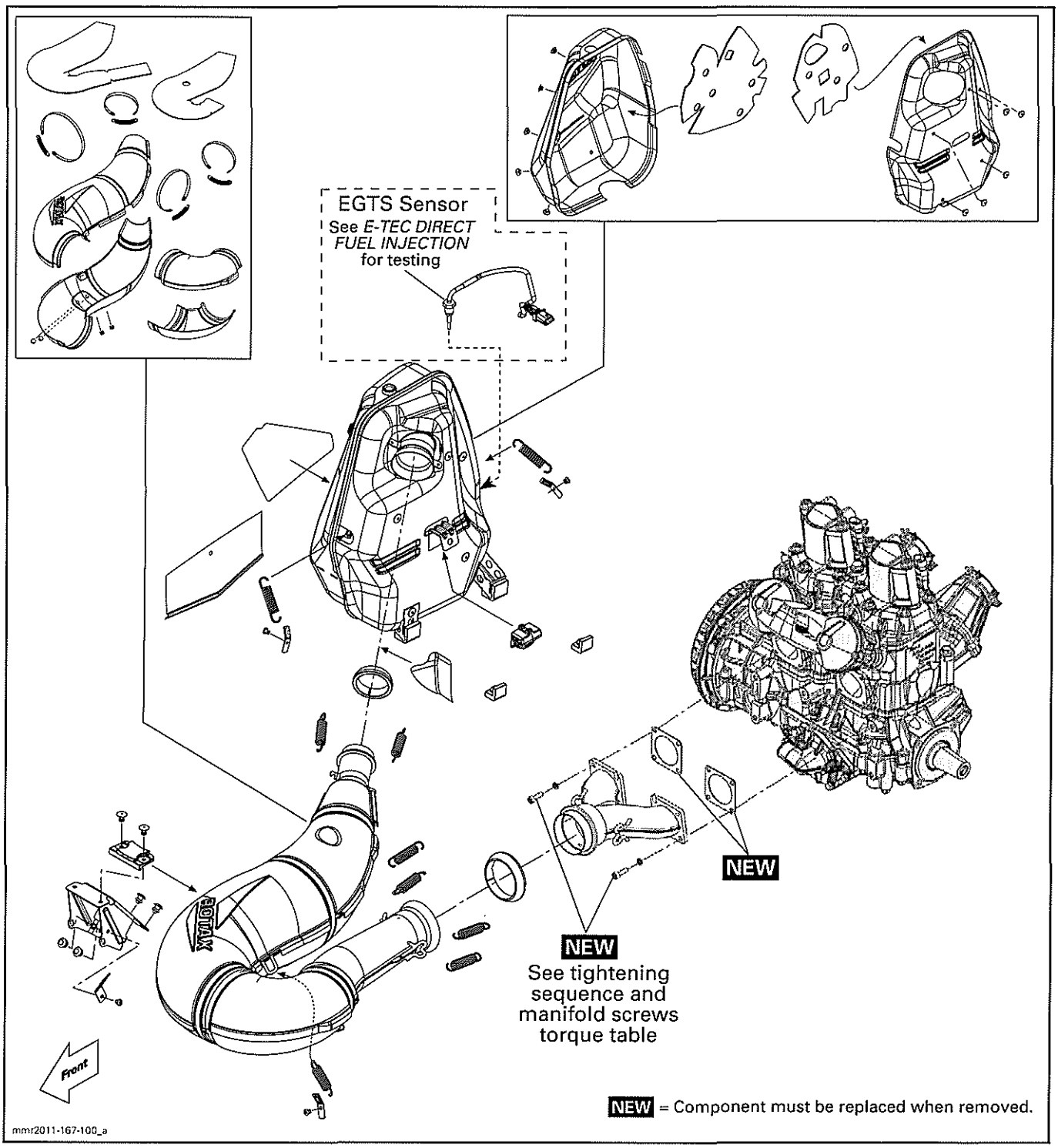


Make sure to reconnect the APS hose and the ATS sensor.

EXHAUST SYSTEM

SERVICE TOOLS

Description	Part Number	Page
SPRING INSTALLER/REMOVER	529 035 983	76–77



GENERAL

⚠ WARNING

To avoid potential burns, never touch exhaust system components immediately after the engine has been running because these components are very hot. Let engine and exhaust system cool down before performing any servicing.

During assembly/installation, use the torque value and service products as shown in the exploded view.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, self-locking fasteners, cotter pins, etc.) must be replaced with new ones.

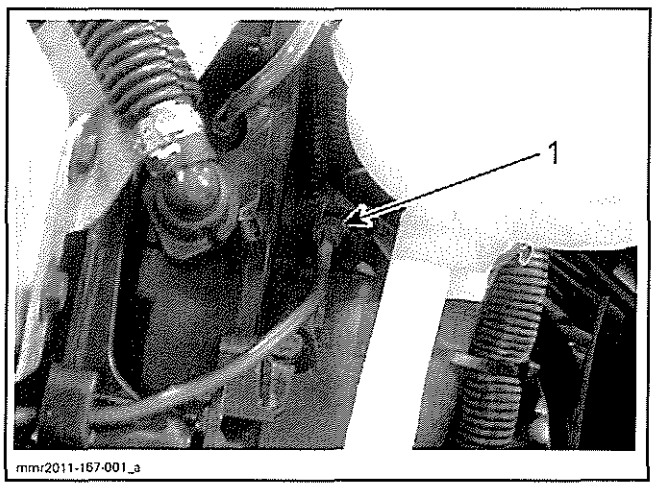
NOTICE Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.

PROCEDURES

MUFFLER

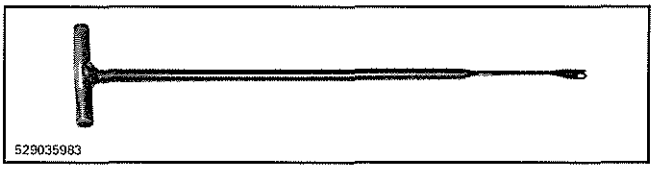
Muffler Removal

1. Remove RH side panels.
2. Detach EGTS sensor connector from support.
3. Disconnect EGTS sensor connector.



IN FRONT OF ECM SUPPORT
1. EGTS sensor connector

4. Use SPRING INSTALLER/REMOVER (P/N 529 035 983).



5. Remove muffler by detaching springs.

Muffler Inspection

Check muffler for cracks or other damages.

Muffler Installation

For installation, reverse the removal procedure.

EGTS SENSOR

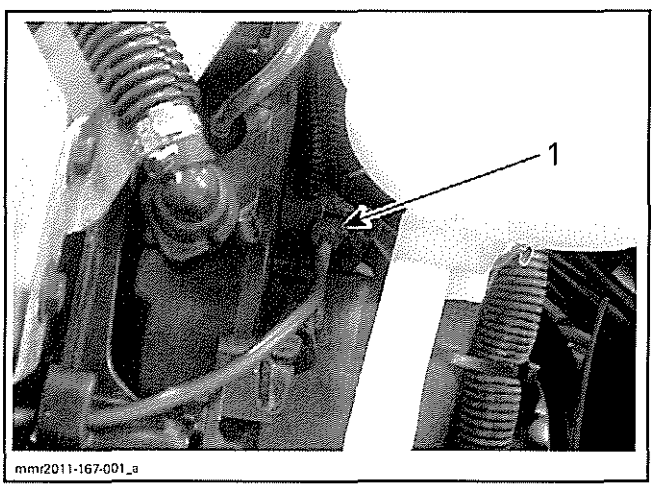
EGTS Sensor Test

Refer to *E-TEC DIRECT FUEL INJECTION* subsection for EGTS sensor (Exhaust Gas Temperature Sensor) testing.

EGTS Sensor Replacement

NOTE: New EGTS sensors have paraffin wax on their tip to protect the sensor during shipping. Paraffin will melt at first engine operation.

1. Remove RH side panels.
2. Detach EGTS sensor connector from support.
3. Disconnect EGTS sensor connector.

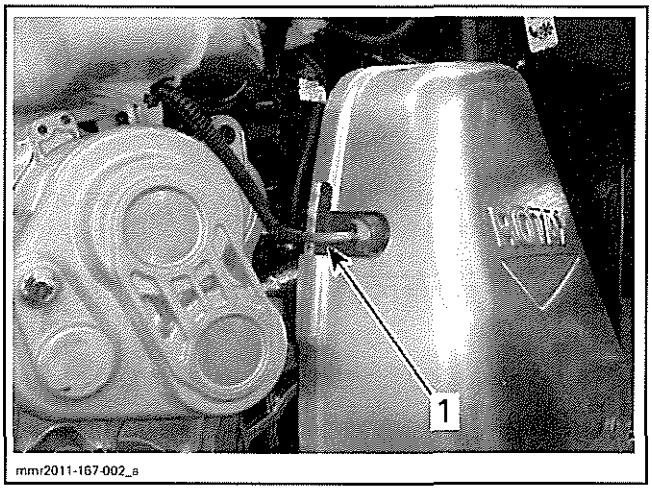


IN FRONT OF ECM SUPPORT
1. EGTS sensor connector

4. Remove *MUFFLER*. See procedure in this subsection.
5. Remove EGTS sensor from muffler.
6. Install NEW EGTS sensor in the following specific position for optimum efficiency.

NOTE: Do not use a sensor if it was dropped.

NOTICE Do not use an impact wrench for installation.



TYPICAL
1. EGTS sensor positioned horizontally

7. Tighten EGTS sensor to specification while holding sensor to prevent turning.

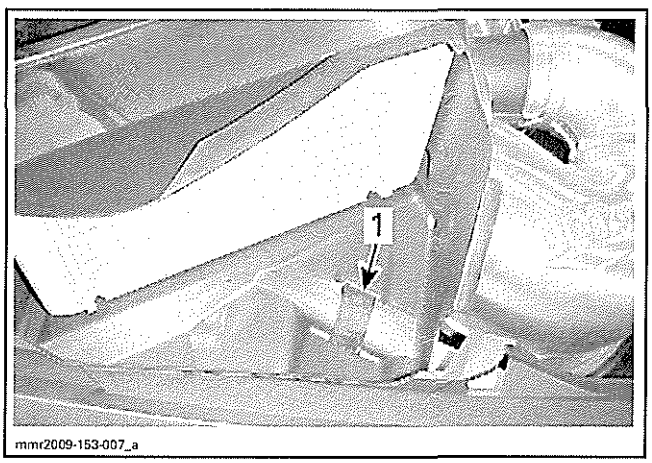
EGTS SENSOR TORQUE
45 N•m (33 lbf•ft)

8. Install muffler as the reverse of removal.
9. Connect EGTS sensor connector.
10. Attach EGTS sensor connector on support.
11. Install RH side panels.

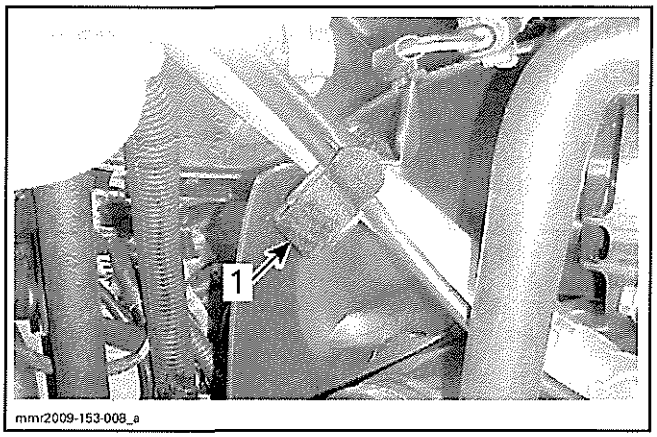
TUNED PIPE

Tuned Pipe Removal

1. Refer to *BODY* subsection and remove:
   - Side panels
   - Hood.
2. Remove muffler. Refer to *MUFFLER REMOVAL* in this subsection.
3. Detach hook-and-loop fasteners from front radiator.

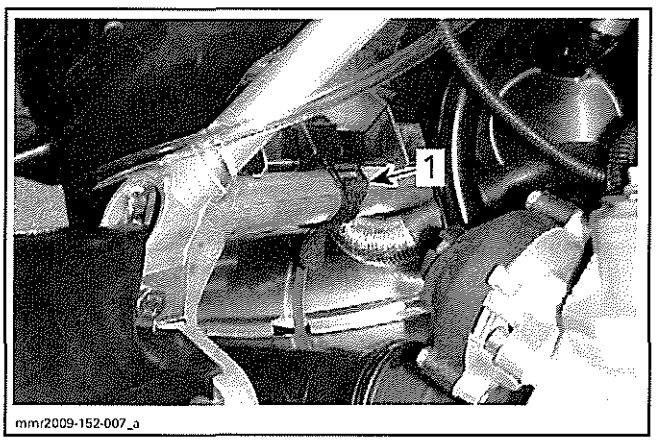


1. Hook-and-loop fastener



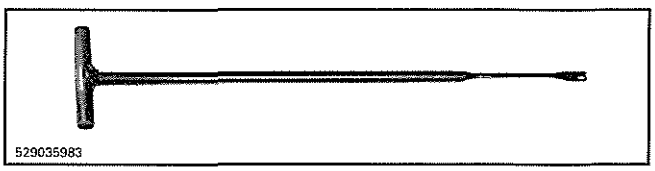
BEHIND RADIATOR
1. Hook-and-loop fastener

4. Detach hook-and-loop fastener from secondary air intake silencer.



TYPICAL
1. Hook-and-loop fastener

5. Slightly lift front radiator and secondary air intake silencer.
6. Use SPRING INSTALLER/REMOVER (P/N 529 035 983).



7. Detach tuned pipe retaining springs.
8. Remove tuned pipe.
9. Remove doughnut shaped exhaust gaskets.

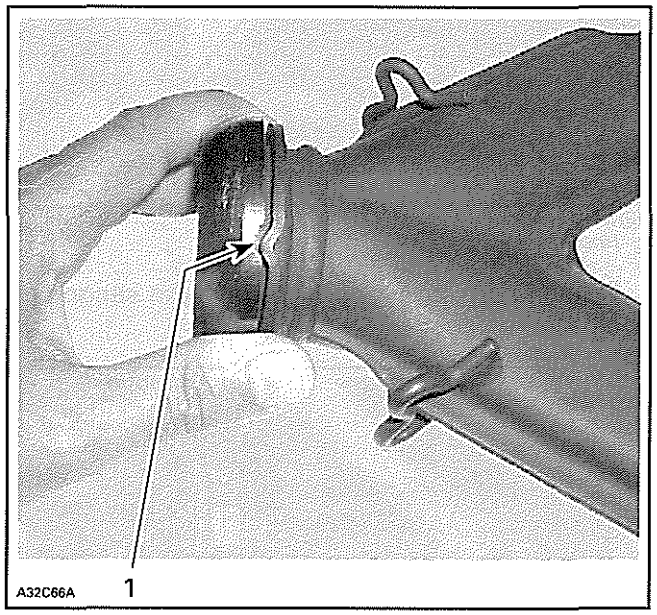
Tuned Pipe Inspection

1. Check tuned pipe and shields for:
   - Damages
   - Cracks.
2. Inspect gaskets condition. Replace if required.

Tuned Pipe Installation

The installation is the reverse of removal procedure. However, pay attention to the following.

Install doughnut shaped exhaust gasket with both of its notches aligned with Y-manifold protrusions.

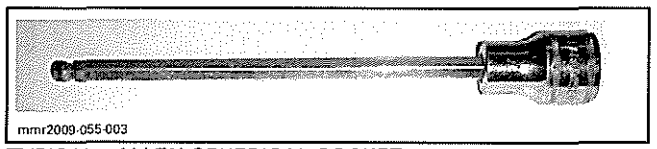


TYPICAL
1. Align notches

MANIFOLD

Manifold Removal

1. Remove secondary air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.
2. Remove tuned pipe. Refer to *TUNED PIPE REMOVAL* in this subsection.
3. Remove and discard manifold screws using an appropriate ALLEN SPHERICAL SOCKET.



TYPICAL - ALLEN SPHERICAL SOCKET

NOTICE Heat screws for 30 seconds before loosening to prevent screw breakage.

4. Remove manifold.
5. Remove gaskets.

Manifold Inspection

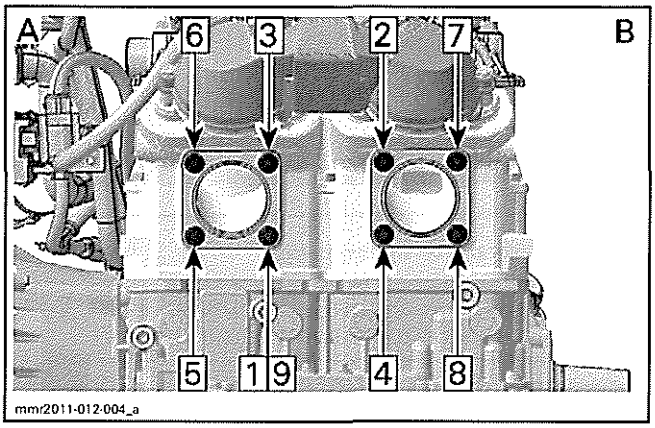
Check if manifold is cracked or damaged. Replace if necessary.

Manifold Installation

The installation is the reverse of removal procedure. However, pay attention to the following.

Install manifold with NEW gaskets.

Tighten NEW manifold screws to specification using the following sequence.



TIGHTENING SEQUENCE
A. MAG side
B. PTO side

ENGINE	MANUAL TORQUE
600 HO E-TEC	17 N•m (150 lbf•**in**)

NOTICE Do not use an impact wrench to tighten manifold screws.

LUBRICATION SYSTEM

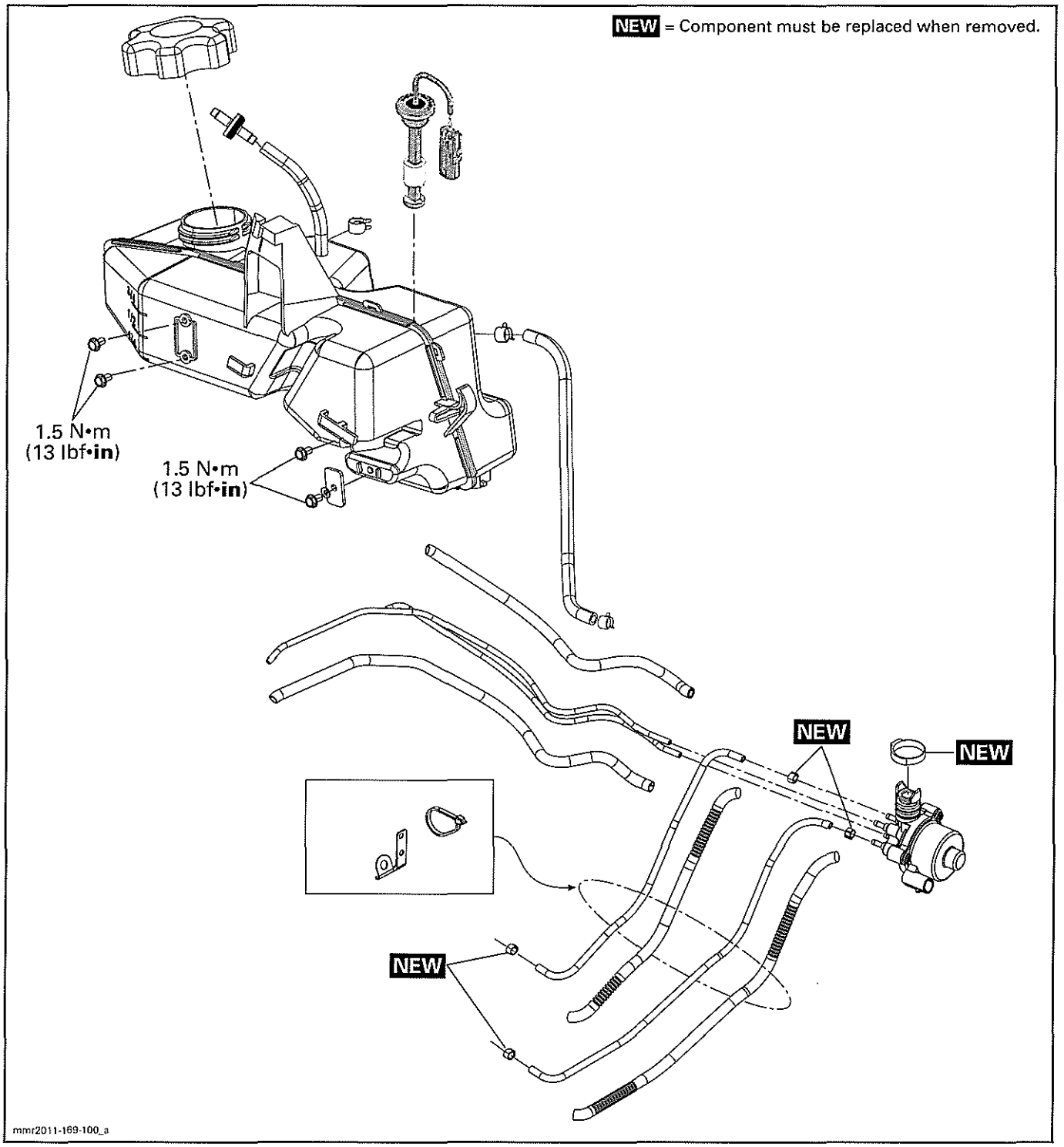
SERVICE TOOLS

Description	Part Number	Page
FLUKE 115 MULTIMETER	529 035 868	90
LEAK TEST KIT	529 033 100	82
SMALL HOSE PINCHER	295 000 076	82
SUCTION PUMP	529 035 880	86
VACUUM/PRESSURE PUMP	529 021 800	82–83, 90

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 648 (GREEN)	413 711 400	91
PULLEY FLANGE CLEANER	413 711 809	91
XPS INJECTION OIL	293 600 117	82
XPS SYNTHETIC 2-STROKE OIL	293 600 132	82
XPS SYNTHETIC BLEND 2-STROKE OIL	293 600 100	82

OIL INJECTION TANK AND OIL PUMP



GENERAL

During assembly/installation, use the torque values and service products as shown in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, self-locking fasteners, etc.) must be replaced with new ones.

⚠ WARNING

Wipe off any oil spills. Oil is highly flammable.

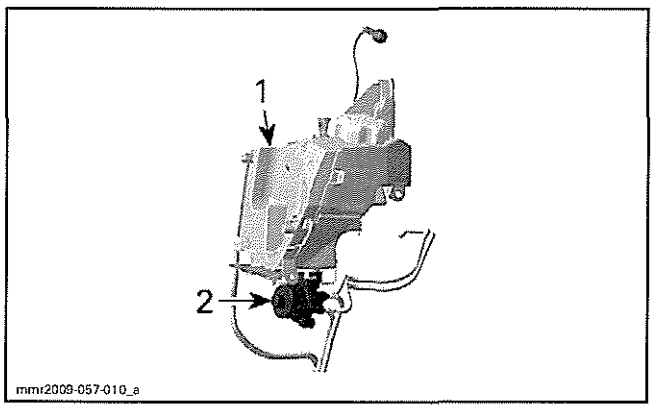
NOTICE Do not use a hose pincher on outlet hose. This would damage the spring inside hose.

NOTICE Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.

SYSTEM DESCRIPTION

An electronic oil injection pump with a mechanical positive displacement type is used. An electronic pump is more accurate and injection rate can be changed according to engine requirements. This results in a greatly reduced oil consumption.

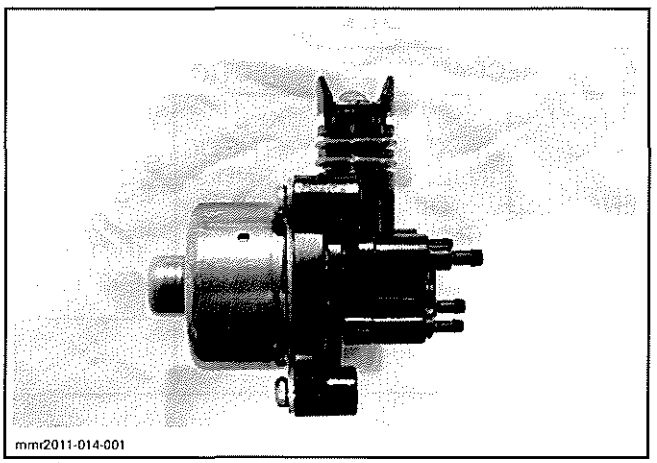
The electronic oil injection pump is directly attached under oil injection tank.



1. *Oil injection tank*
2. *Electronic oil injection pump*

The pump features a total of 4 outlets:
- 2 large outlets to the crankcase to lubricate engine internal parts.
- 2 small outlets to the 3D RAVE valves to lubricate valves to prevent carbon deposits.

The 4 plungers in the pump work synchronized. They pump all at the same time.



TYPICAL

The ECM controls the pump to inject a variable amount of oil through the entire engine operating range and conditions.

Oil Pump Operation

For the first 6 hours of engine break-in period, oil delivery is increased.

Oil/fuel ratio can go up to approximately 70:1 after the break-in period.

At idle, pump works at approximately less than 1 pulse per minute. A very low quantity of oil is injected to reduce engine smoke and to reduce engine emissions.

As engine speed increases, oil flow increases but not proportionally. It varies according to the specific engine requirements.

At 8000 RPM, pump works at approximately 120 pulses per minute.

When operating vehicle in high altitude area, oil flow is reduced proportionally as altitude increases.

When engine temperature is low, more electrical power is sent to pump to warm it up to improve oil flow.

Automated Engine Oil Fogging

An automated engine oil fogging has been implemented to automatically inject the required oil to protect the engine during vehicle storage.

Engine speed will be increased to approximately 2000 RPM and excess oil will be injected for approximately 30 seconds then, the engine will automatically be stopped.

The storage mode can be activated either by using B.U.D.S. or the multifunction gauge on the vehicle. Refer to *STORAGE PROCEDURE* subsection.

RECOMMENDED INJECTION OIL

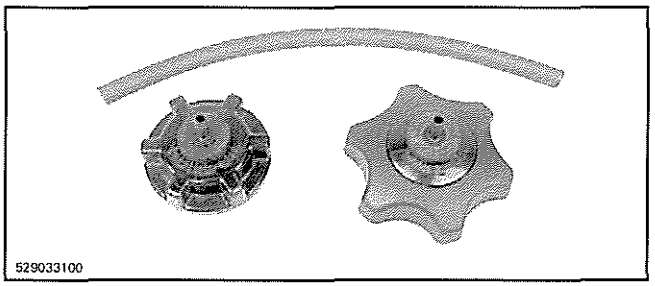
RECOMMENDED INJECTION OIL			
ENGINES	XPS INJECTION OIL (P/N 293 600 117)	XPS SYNTHETIC BLEND 2-STROKE OIL (P/N 293 600 100)	XPS SYNTHETIC 2-STROKE OIL (P/N 293 600 132)
600 HO E-TEC		✓	✓

NOTICE These engines have been developed and validated using the XPS™ 2-stroke oils. BRP strongly recommends the use of the applicable XPS 2-stroke oils at all times. Damages caused by oil which is not suitable for the engine will not be covered by the BRP limited warranty.

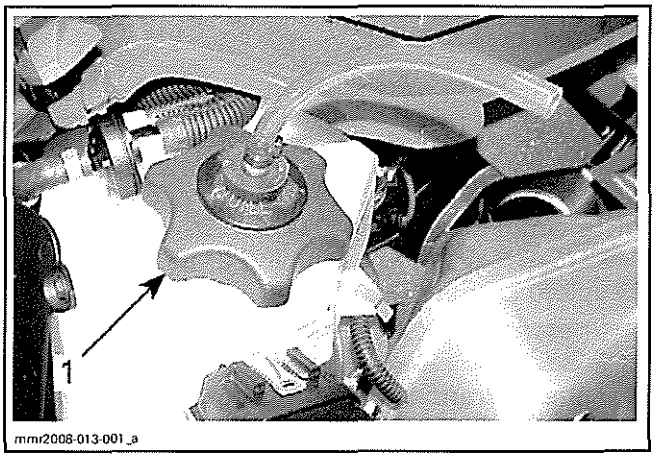
INSPECTION

OIL SYSTEM LEAK TEST

1. Use the LEAK TEST KIT (P/N 529 033 100).

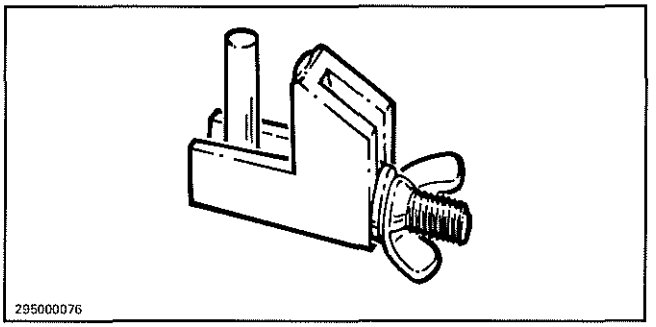


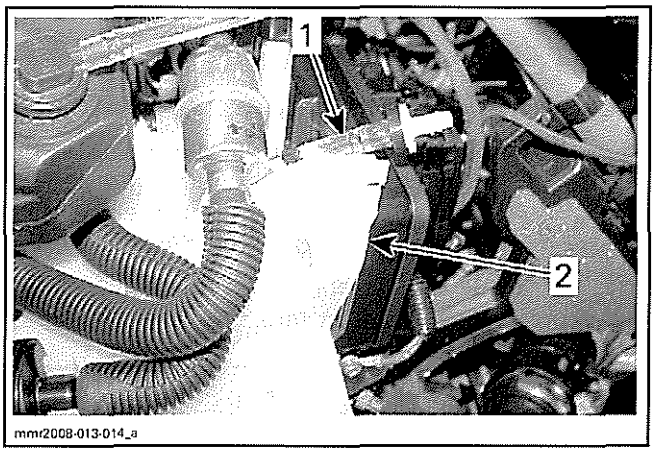
2. Install the test cap on oil tank.



TYPICAL
1. Test cap on tank

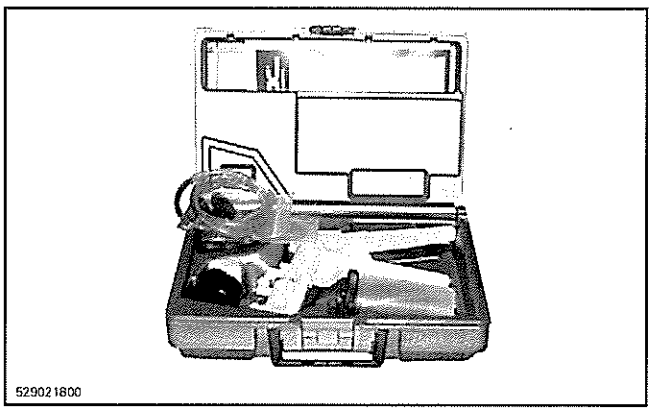
3. Install a SMALL HOSE PINCHER (P/N 295 000 076) on check valve outlet hose.





TYPICAL
1. Check valve outlet hose
2. Oil tank

4. Connect the VACUUM/PRESSURE PUMP (P/N 529 021 800) to test cap.



5. Pressurize oil system as follows.

PRESSURE	TIME TO HOLD PRESSURE
18 kPa (2.6 PSI)	3 minutes

If pressure drops, locate leak(s) and repair or replace leaking component(s).

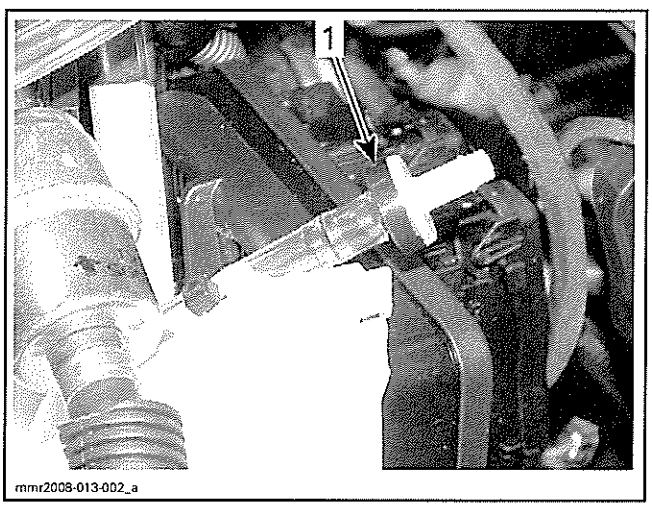
Check Valve Test

1. Use VACUUM/PRESSURE PUMP (P/N 529 021 800).
2. Pressurize check valve as follows.

CHECK VALVE TEST	
Air toward oil tank	Valve must let air to enter
Air toward outside	Valve must stop air to exit

NOTICE If check valve does not allow air to enter, serious engine damage will occur.

NOTE: When replacing one-way check valve, ensure that black side is positioned toward oil tank.



TYPICAL
1. Black side here

TROUBLESHOOTING

SYMPTOM	CAUSE	ACTION
	Damaged or disconnected oil pump.	Check oil pump wires and connectors on oil pump.
	Circuit wires, connectors or ECM output pins.	Check WHITE/RED wire on oil pump connector for 55/60 volts.
		Check system circuit J1B-23.
		Repair or replace defective part(s).
Engine seizure (PTO or MAG side)	Damaged, kinked or obstructed inlet hose.	Repair or replace hose and test oil pump (oil outflow).
	Damaged oil pump inner piston.	Replace oil pump.
	Mechanical engine problem.	Repair or replace engine defective part(s).

PROCEDURES

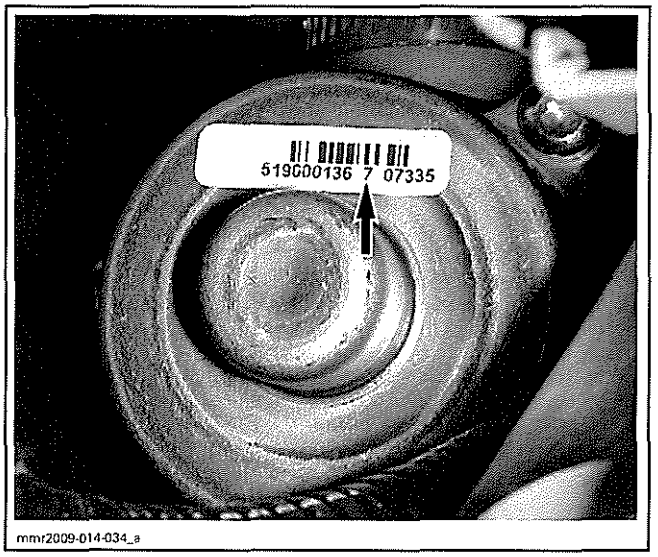
OIL PUMP

Oil Pump Identification

Every pump is bench tested. Its electrical and flow characteristics are registered throughout all its operating range and are associated to a compensation number.

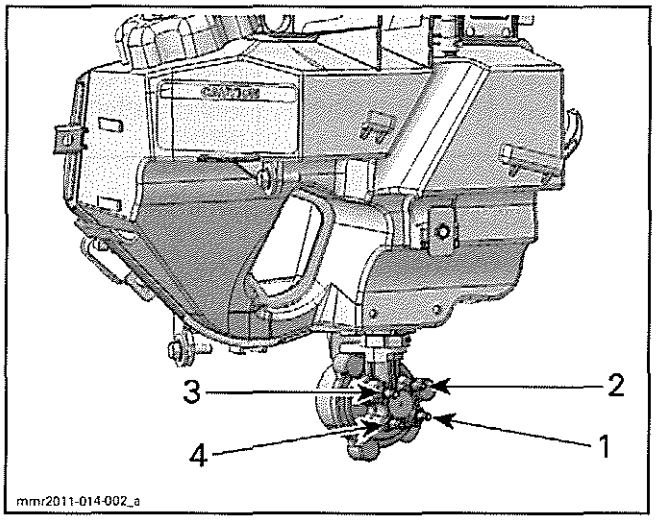
When a pump is replaced, the compensation number must be entered in B.U.D.S. so that the ECM properly controls the pump according to its optimized characteristics.

The compensation number is located on a label on the pump as shown.

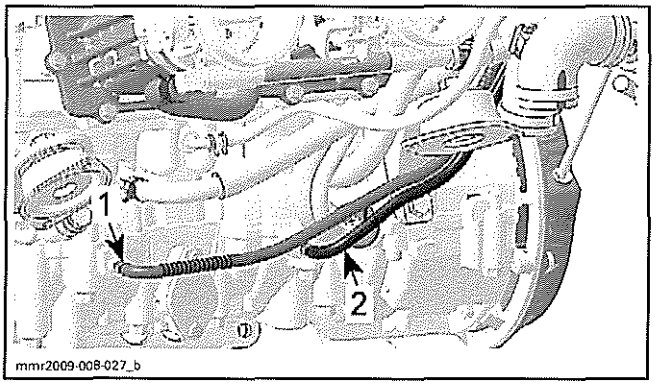


Oil pump bleeding is done with B.U.D.S. Refer to *OIL PUMP BLEEDING* in this subsection.

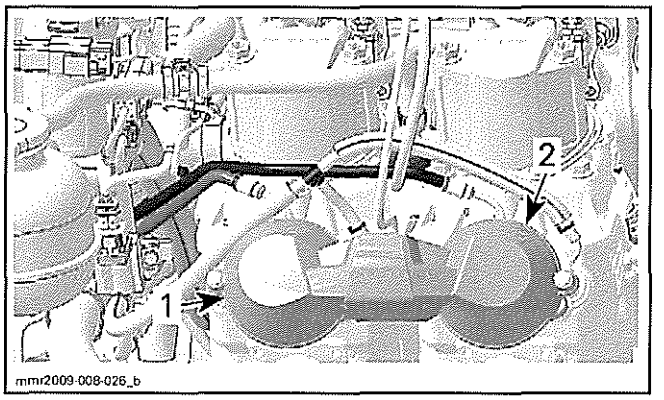
Oil Pump Hoses Connection



TYPICAL
1. *To engine PTO side*
2. *To 3D RAVE valve PTO side*
3. *To engine MAG side*
4. *To 3D RAVE valve MAG side*



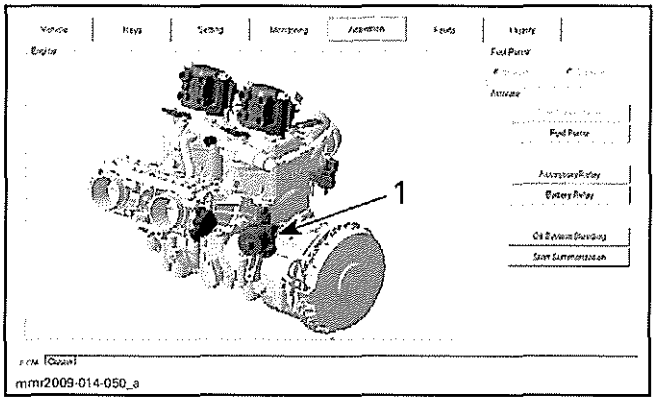
TYPICAL
1. *Oil inlet hose (PTO side)*
2. *Oil inlet hose (MAG side)*



TYPICAL
1. *MAG 3D RAVE valve*
2. *PTO 3D RAVE valve*

Oil Pump Test with B.U.D.S.

1. Connect B.U.D.S. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. In B.U.D.S., press **Read Data**.
3. Select **Activation** folder then the **ECM** page.
4. Press on oil pump.

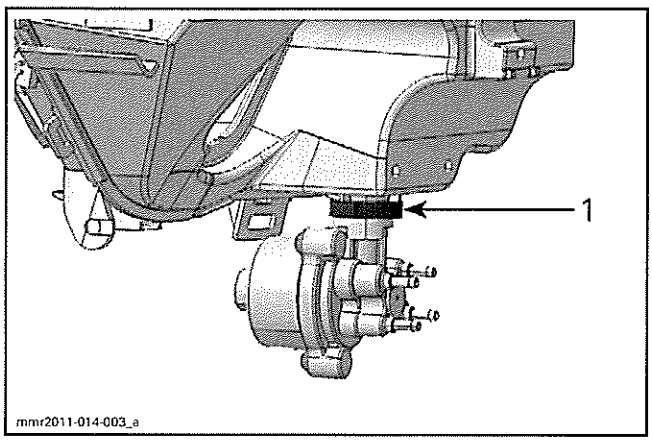


1. *Press here to activate oil pump*

5. Listen if oil pump is activated.
6. If test fails, check wires and connector.

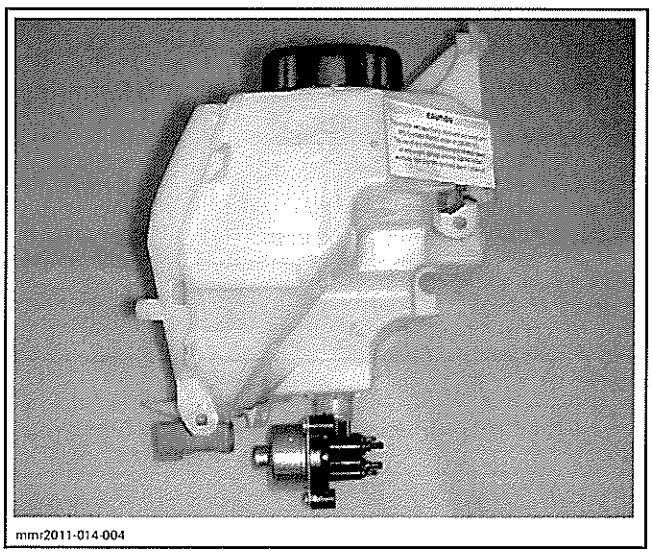
Oil Pump Removal

1. Remove oil tank from vehicle. Refer to *OIL TANK* in this subsection.
2. Remove and discard Oetiker clamp securing oil pump to oil tank.

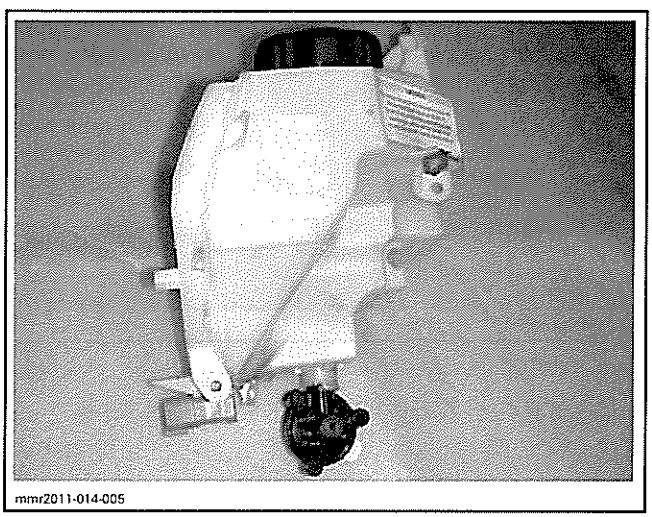


1. Oetiker clamp

3. Rotate oil pump from 90 degrees as illustrated.



TYPICAL - PUMP LOCKED INTO OIL TANK

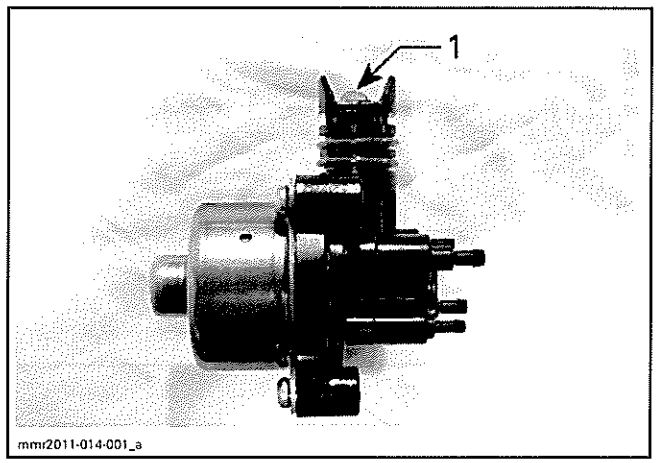


TYPICAL - PUMP RELEASED FROM OIL TANK

4. Move oil pump downward to remove it from oil tank.

Oil Pump Inspection

Check the strainer on the top of oil pump. Replace oil pump if the strainer is clogged.



1. Oil pump strainer

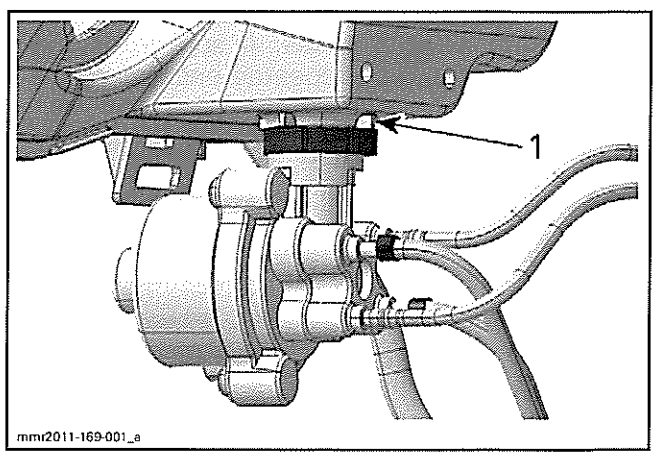
NOTE: Do not replace oil pump needlessly. If strainer is slightly dented, oil pump is still functional.

Oil Pump Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

Install NEW Oetiker clamp to secure oil injection pump.

Ensure Oetiker clamp makes contact with oil tank ribs.



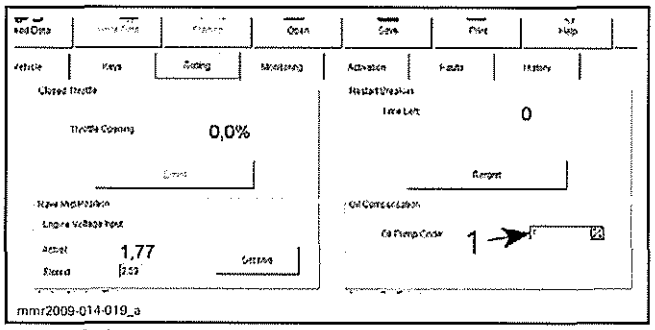
1. Oil tank rib

Refer to *OIL TANK INSTALLATION* to properly reinstall oil tank.

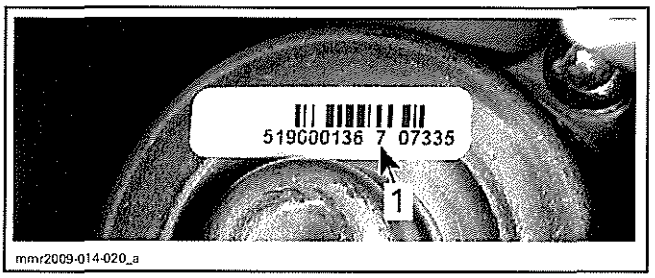
Oil Pump Bleeding

1. Connect B.U.D.S. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. Start vehicle.

3. In B.U.D.S., press Read Data.
4. Select Setting folder then the ECM page.
5. Compare oil pump codes in B.U.D.S. and on oil pump sticker.



1. B.U.D.S. oil pump code



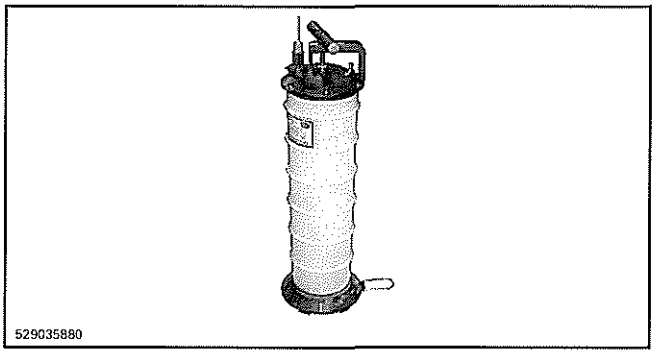
BACK OF OIL PUMP
1. Oil pump code (0 to 9)

6. Correct oil pump code in B.U.D.S. if required.
7. Select Activation folder then ECM page.
8. Press Oil System Bleeding button.
9. Wait until engine returns to idle RPM.
10. Check for air into hoses. If so, the bleeding procedure must be repeated once more.

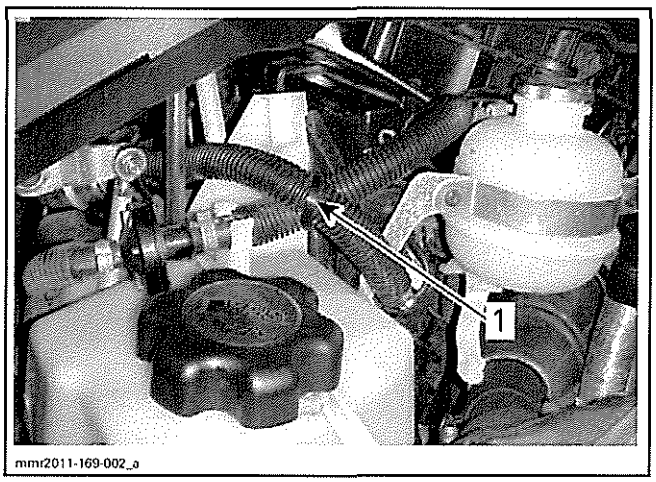
OIL TANK

Oil Tank Removal

1. Refer to *BODY* subsection and remove:
   - Hood
   - Side panels.
2. Refer to *AIR INTAKE SYSTEM* subsection and remove:
   - Primary air intake silencer
   - Secondary air intake silencer as a unit with gauge support.
3. Drain oil tank using the SUCTION PUMP (P/N 529 035 880).

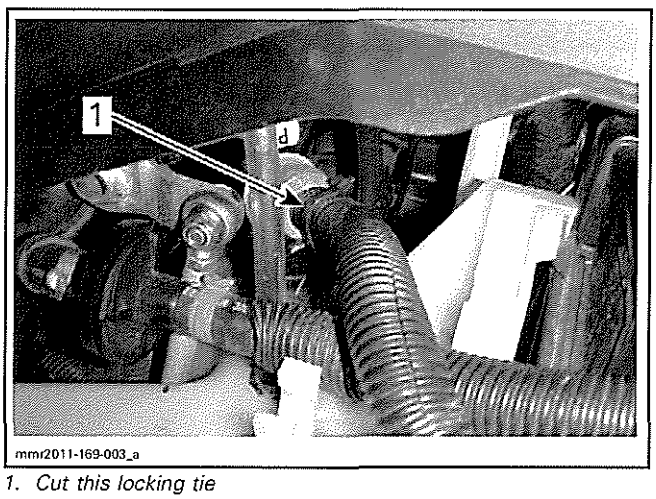


4. Cut locking tie securing fuel hoses together.



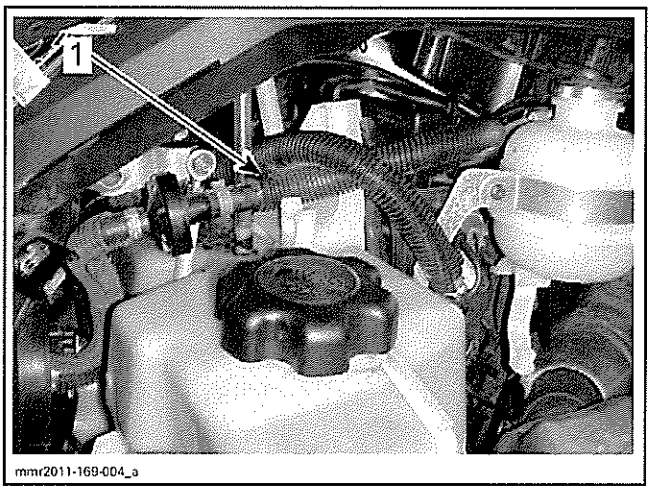
1. Cut this locking tie

5. Cut locking tie securing fuel hose to oil tank.



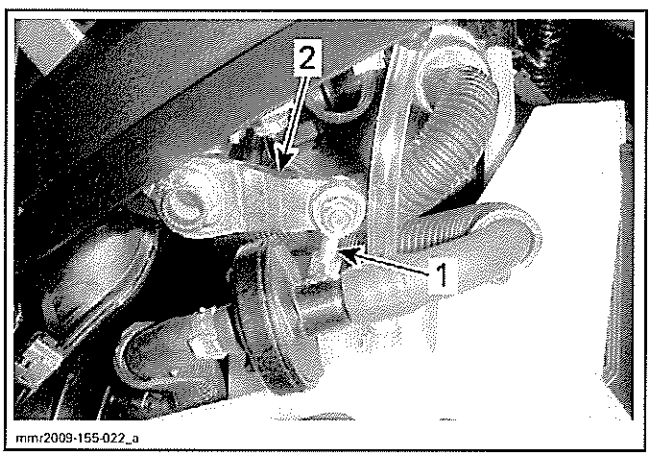
1. Cut this locking tie

6. Detach fuel hose from the top of oil tank.



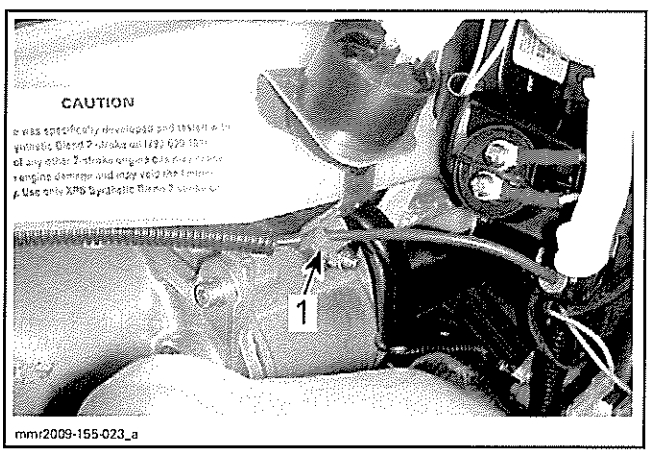
1. *Fuel hose*

7. Unscrew the shift linkage from gearshift lever.



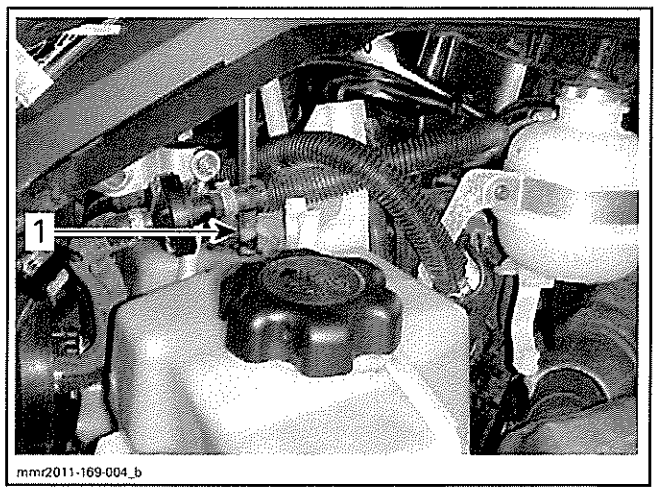
1. *Shift linkage*
2. *Gearshift lever*

8. Detach the EGTS sensor wire from retaining clip.



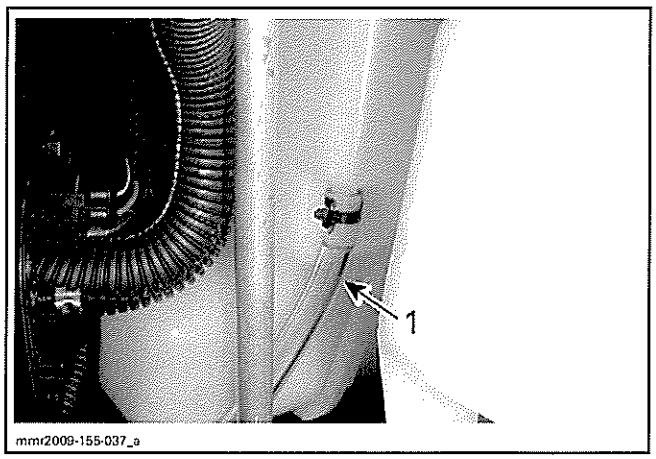
TYPICAL
1. *Retaining clip*

9. Disconnect oil tank vent hose from oil tank.



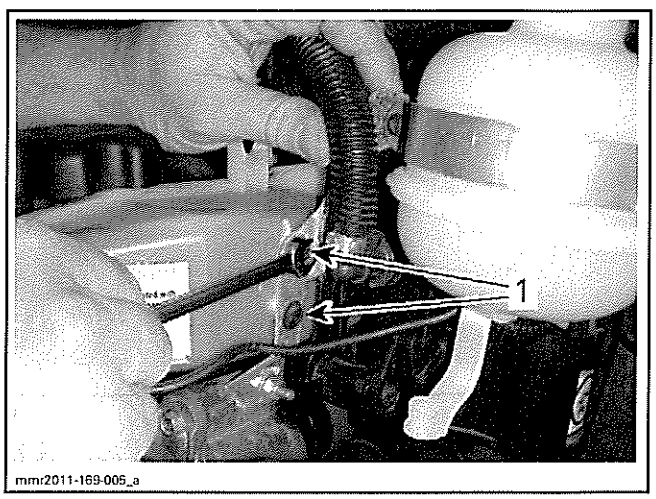
1. *Oil tank vent hose*

10. Disconnect crankcase vent hose from oil tank.



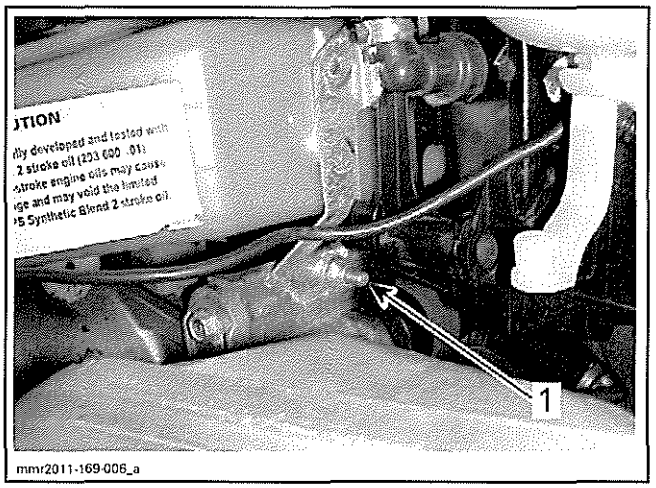
1. *Crankcase vent hose*

11. Remove screws securing oil tank to coolant tank support.



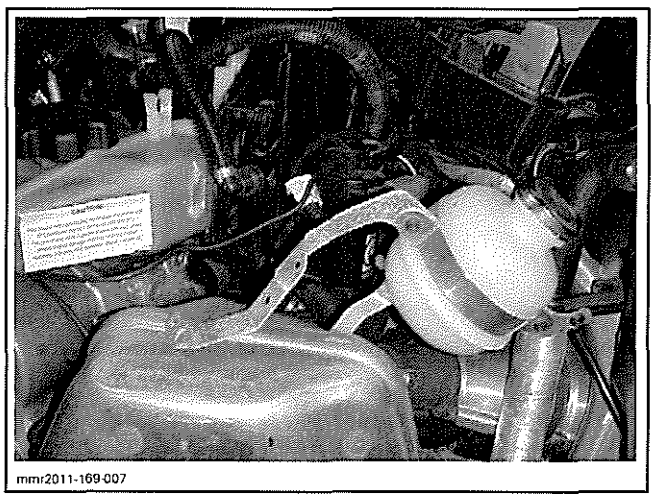
1. *Oil tank screws*

12. Remove bolt securing coolant tank support to gearbox.

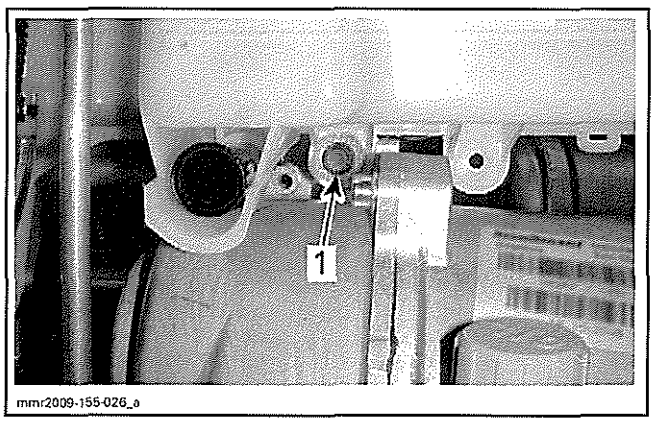


1. Coolant tank support bolt

13. Move coolant tank support aside.

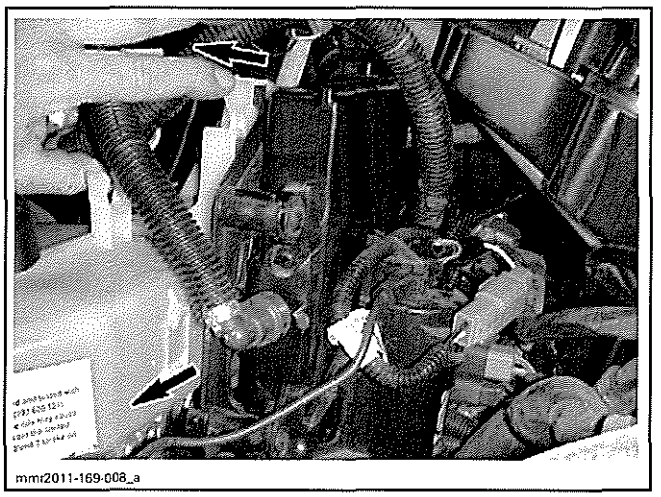


14. Remove screw securing oil tank to gearbox.

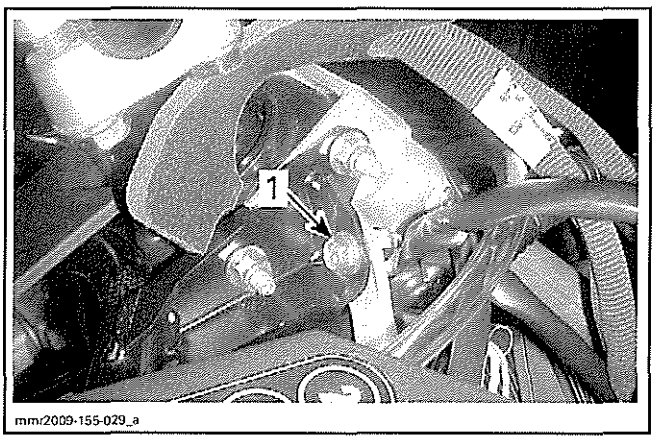


1. Oil tank retaining screw

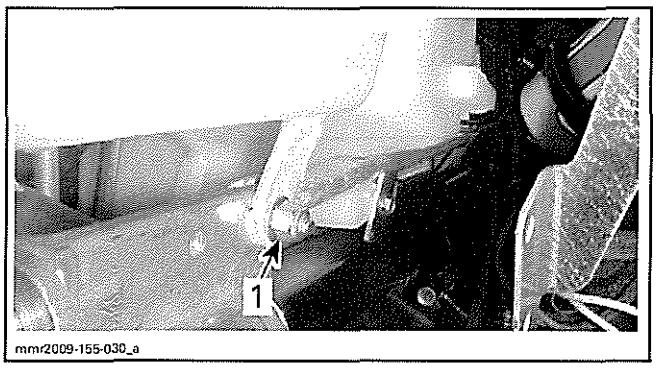
15. Detach the ECM from oil tank by pressing the upper tab and sliding the support outwards.



16. Remove the RH side frame member.

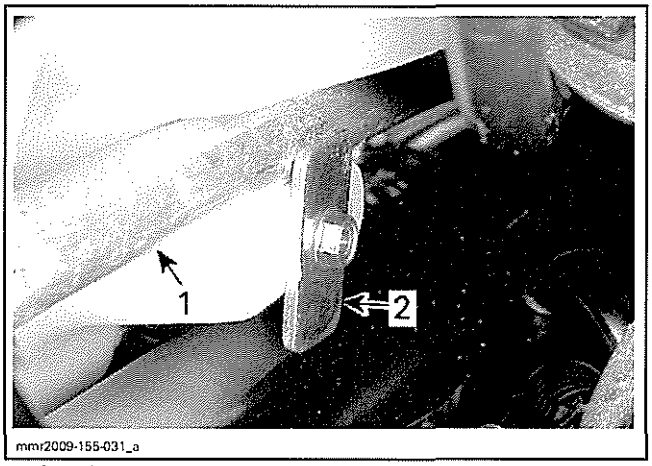


RH SIDE
1. Side frame member upper bolt



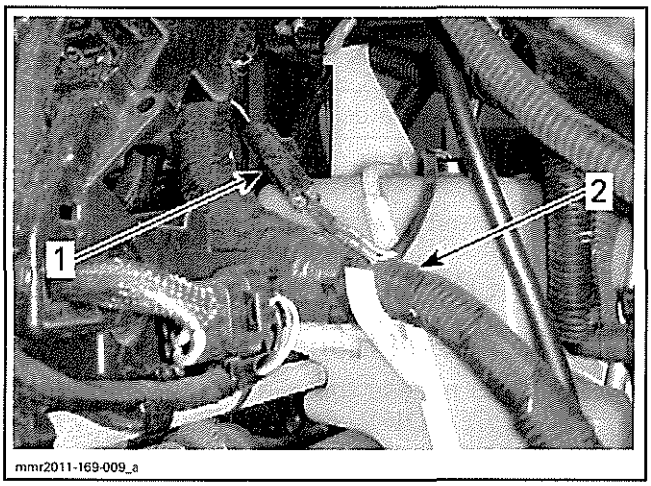
RH SIDE
1. Side frame member lower bolt

17. Remove holder securing oil tank to side frame member brace.



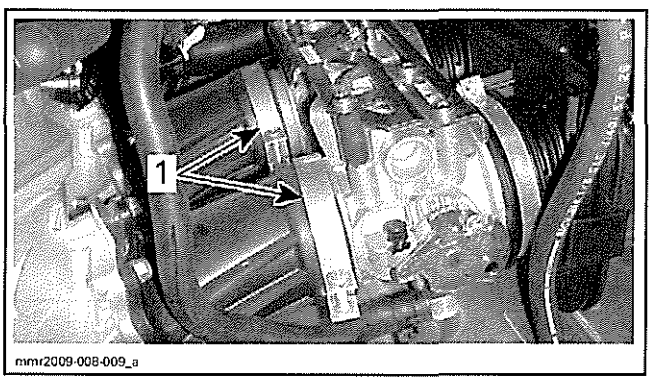
1. Side frame member brace
2. Oil tank holder

18. From LH side of vehicle:
    - Disconnect oil level sensor connector
    - Detach harness from oil tank.



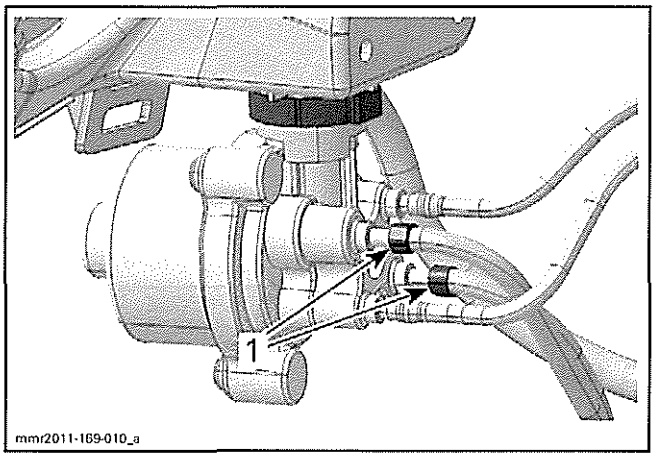
1. Oil level sensor connector
2. Harness

19. Unscrew clamps securing throttle body to intake adapters.



TYPICAL
1. Throttle body clamps

20. Move throttle body aside.
21. Place a rag under oil pump to catch oil spillage.
22. From LH side of vehicle, proceed as follows:
    22.1 Remove and discard Oetiker clamps securing oil hoses to oil pump fittings.

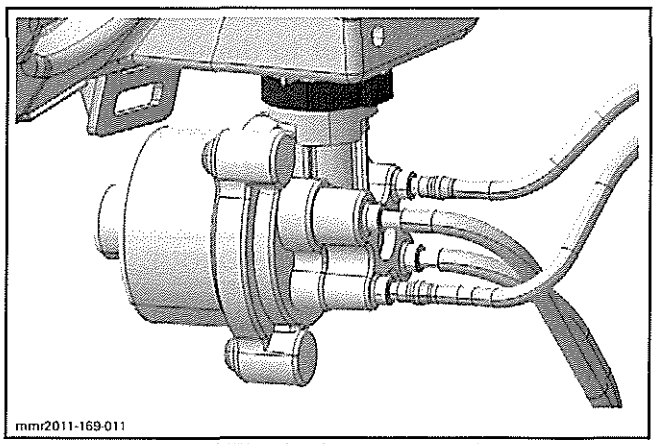


SOME PARTS REMOVED FOR CLARITY PURPOSE
1. Oetiker clamps (2x)

NOTE: Use metal scissors to cut clamps.

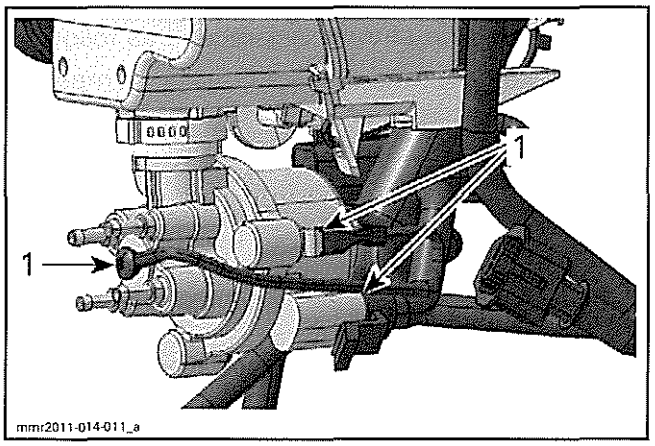
22.2 Carefully disconnect hoses from oil pump using a small screwdriver.

NOTICE Be careful not to damage oil pump fittings.



SOME PARTS REMOVED FOR CLARITY PURPOSE

22.3 Disconnect oil pump connectors.



SOME PARTS REMOVED FOR CLARITY PURPOSE
1. Oil pump connectors

23. Remove oil tank from vehicle.
24. Remove oil pump from oil tank. Refer to *OIL PUMP REMOVAL* in this subsection.
25. Remove oil level sensor from oil tank.

Oil Tank Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

Properly route and connect oil hoses into oil pump. Refer to *OIL PUMP HOSES CONNECTION* in this subsection.

NOTICE Be careful not to damage oil pump fittings.

Install NEW Oetiker clamp to secure hose routed towards PTO and MAG oil inlet.

Tighten oil tank screws to specification.

OIL TANK SCREWS TORQUE
1.5 N•m (13 lbf•**in**)

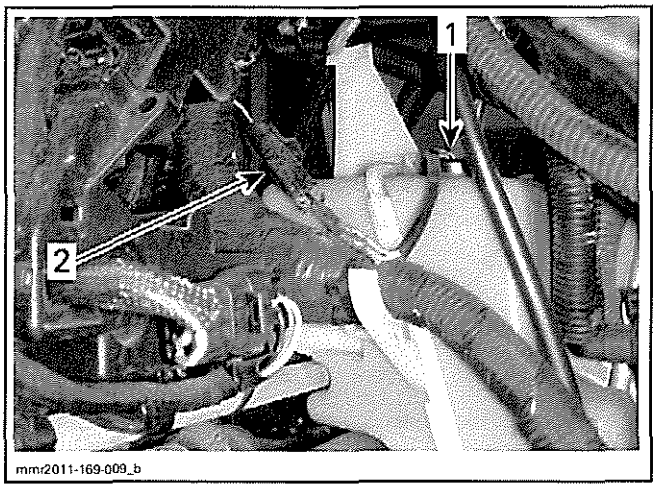
Fill up oil tank using recommended oil. See *RECOMMENDED INJECTION OIL* in this subsection.

Bleed oil injection system. Refer to *OIL PUMP BLEEDING* in this subsection.

OIL LEVEL SENSOR

Oil Level Sensor Location

The oil level sensor is located on the top of oil tank.



VIEW FROM LH SIDE OF VEHICLE
1. Oil level sensor
2. Oil level sensor connector

Oil Level Sensor Test

Measure resistance of the oil level sensor using a FLUKE 115 MULTIMETER (P/N 529 035 868).

SENSOR POSITION	RESISTANCE
Sensor float downwards	High value or infinite (OL)
Sensor float upwards	0.2 Ω (closed)

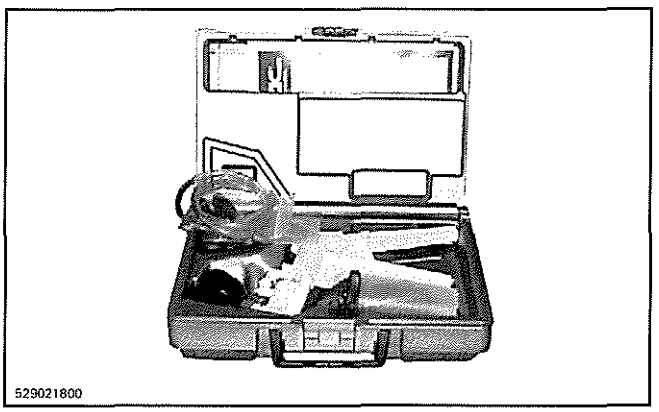
If resistance test fails, replace sensor.

INJECTION NOZZLE

Injection Nozzle Inspection

Lift engine to access the injector nozzles. Refer to *ENGINE REMOVAL AND INSTALLATION.*

Use the VACUUM/PRESSURE PUMP (P/N 529 021 800).



Test check valve of injection nozzle as follows.

PUMP SETTING	Set to VACUUM	Set to PRESSURE
TO DO	Activate pump several times	Slowly activate pump and listen to check valve
RESULT	Air must not flow through check valve	You should hear it release pressure at approximately 20.7 kPa (3 PSI)
ACTION	Success: Perform next test	Success: Check valve is good
	Failed: Replace injection nozzle	Failed: Replace injection nozzle

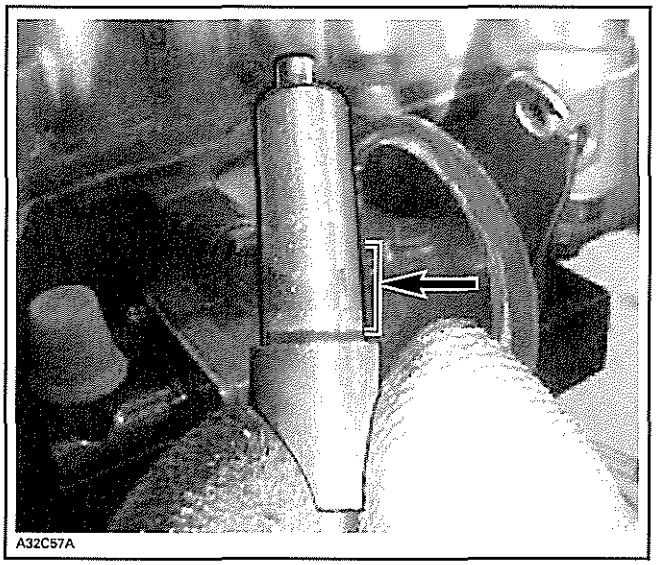
Injection Nozzle Removal

NOTICE Do not remove injection nozzle needlessly. It is likely to be damaged.

1. To gain access to the injector nozzles, engine must be lifted. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
2. Clean injection nozzle area to remove oil or dirt.
3. Heat injection nozzle then pull it out of crankcase.

Injection Nozzle Installation

1. Prior to coating it with Loctite, make sure check valve body is clean and dry. If necessary, clean from dirt or oil, with PULLEY FLANGE CLEANER (P/N 413 711 809).
2. Apply LOCTITE 648 (GREEN) (P/N 413 711 400) on the outer diameter of the check valve (machined section). Take care that Loctite is ONLY in this area.


A32C57A

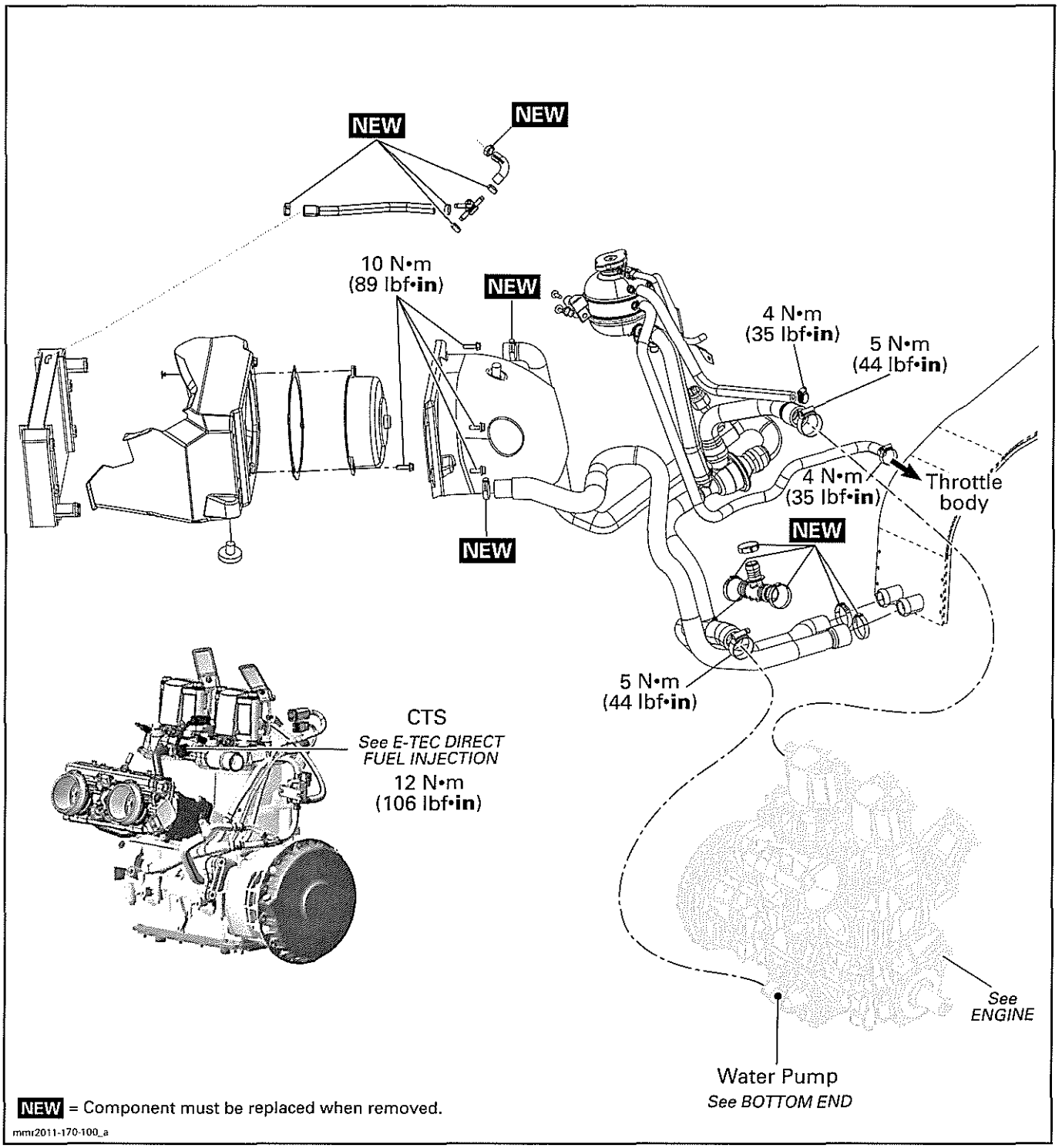
APPLY LOCTITE ON THIS AREA ONLY

3. Punch in the injection nozzle carefully with a plastic hammer.
4. Clean crankcase from surplus of Loctite 648 with a rag.
5. Reinstall engine into vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.

COOLING SYSTEM

SERVICE TOOLS

Description	Part Number	Page
LARGE HOSE PINCHER	529 032 500	98
TEST CAP	529 035 991	95
VACUUM/PRESSURE PUMP	529 021 800	95


NEW
NEW
10 N•m
(89 lbf•in)
NEW
NEW
4 N•m
(35 lbf•in)
5 N•m
(44 lbf•in)
4 N•m
(35 lbf•in)
Throttle body
NEW
5 N•m
(44 lbf•in)
CTS
See E-TEC DIRECT FUEL INJECTION
12 N•m
(106 lbf•in)
See ENGINE
Water Pump
See BOTTOM END
NEW = Component must be replaced when removed.
mmr2011-170-100_a

GENERAL

NOTE: It is a good practice to check for fault codes using B.U.D.S. software as a first troubleshooting step. Refer to the *DIAGNOSTIC AND FAULT CODES* subsection.

During assembly/installation, use torque values and service products as shown in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

To avoid potential burns, do not remove the coolant tank cap or loosen the cooling drain plug if the engine is hot.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, self-locking fasteners, cotter pins, etc.) must be replaced with new ones.

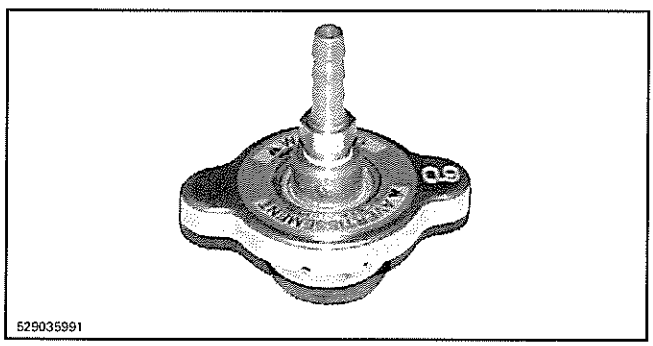
NOTICE Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.

INSPECTION

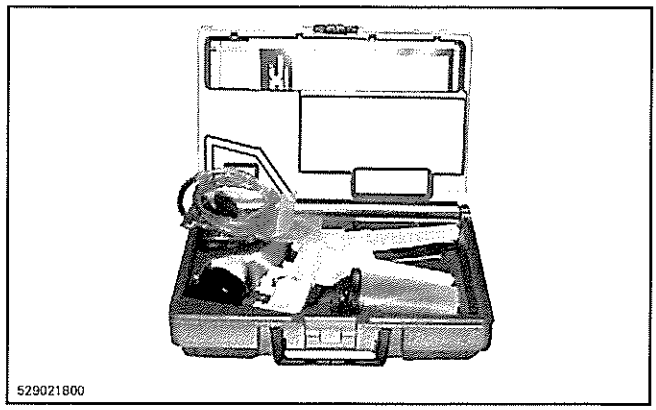
COOLING SYSTEM LEAK TEST

NOTE: This test confirms if there is a leak in the cooling system, including the engine.

Install the TEST CAP (P/N 529 035 991) on coolant tank.

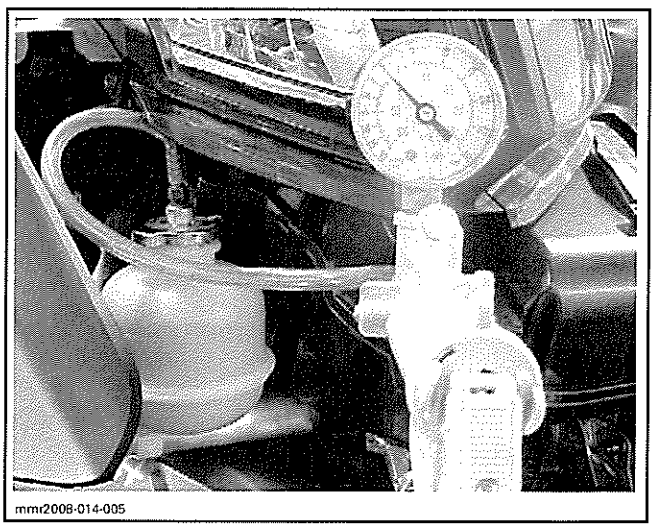


Connect the VACUUM/PRESSURE PUMP (P/N 529 021 800) on the test cap nipple.



Pressurize system through coolant tank.

TEST PRESSURE
100 kPa (15 PSI)



TYPICAL

If pressure drops, check all hoses and engine for coolant leaks. Spray a soap/water solution and look for air bubbles.

TROUBLESHOOTING

The following is provided to help in diagnosing the probable source of troubles. It is a guideline and should not be assumed to show all causes for all problems.

Always check for fault codes. If a fault code is detected, service the fault code first.

ENGINE OVERHEATING

1. Low coolant level.
   - *Refill and check for leaks (hoses or clamps missing or defective, or cylinder head gaskets leaks). Repair or replace.*
2. Air in cooling system.
   - *Refill and bleed cooling system.*

3. Defective thermostat (does not open when engine is warm up).
   - *Replace thermostat.*
4. Defective water pump.
   - *Inspect and replace defective components.*
5. Coolant temperature sensor defective.
   - *Check and replace.*
6. Dirty front radiator or heat exchanger.
   - *Clean front radiator or heat exchanger.*
7. Defective coolant reservoir cap.
   - *Replace cap.*
8. Wrong coolant density.
   - *Check and adjust coolant density according to BRP's recommendations or replace coolant.*
9. Defective cooling fan.
   - *Check cooling fan motor operation.*
   - *Check fuse and relay of cooling fan motor.*
   - *Check wiring harness of cooling fan motor.*

PROCEDURES

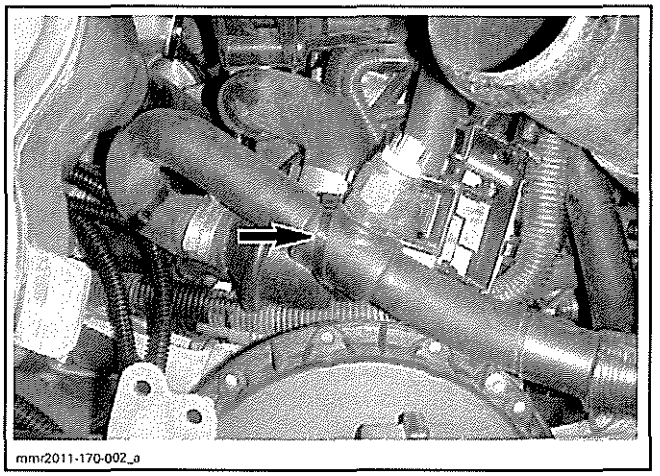
WATER PUMP

Refer to *BOTTOM END* subsection.

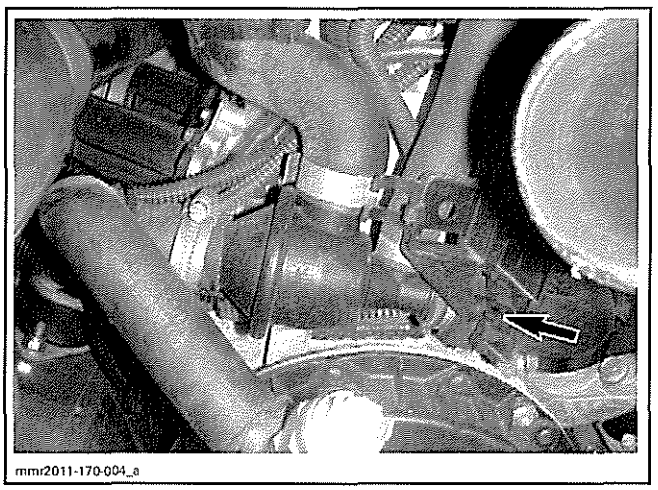
THERMOSTAT

Thermostat Removal

1. Remove RH side panels. Refer to *BODY* subsection.
2. Remove muffler. Refer to *EXHAUST SYSTEM* subsection.
3. Drain cooling system. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.
4. Cut locking ties securing coolant hoses to support.

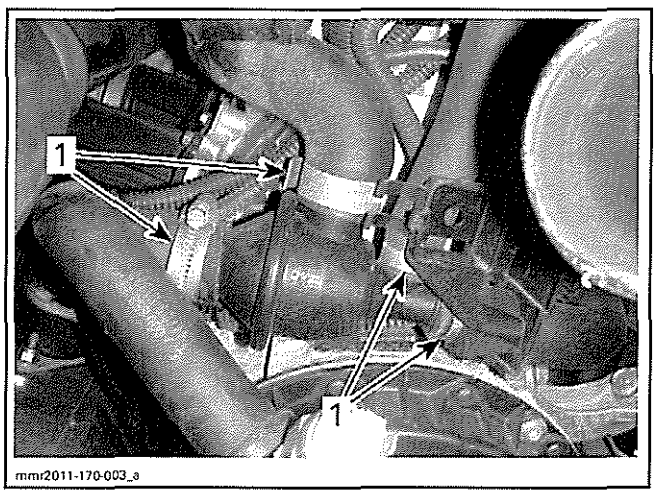


LOCKING TIE TO REMOVE



LOCKING TIE TO REMOVE

5. Disconnect all coolant hoses from thermostat.



1. Clamps

6. Remove thermostat from vehicle.

Thermostat Test

To check thermostat, put in water and heat water.

THERMOSTAT TEMPERATURE	
Starts to open	37°C (99°F)
Fully open	55°C (131°F)

Thermostat Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

Properly refill and bleed cooling system as described in *PERIODIC MAINTENANCE PROCEDURES* subsection.

COOLANT TANK CAP

Using a pressure cap tester, check the relief pressure of coolant tank cap.

If the test failed, install a new cap.

CAP OPENING PRESSURE
90 kPa (13 PSI)

NOTICE Do not install a tank cap exceeding the recommended pressure.

HEAT EXCHANGER

Heat Exchanger Cleaning and Inspection

Remove all debris between heat exchanger fins.

Check if heat exchanger fins are damaged. Replace heat exchanger if necessary.

NOTE: A heat exchanger with many broken fins does not work properly.

Heat Exchanger Removal

1. Remove fuel tank. Refer to *FUEL TANK AND FUEL PUMP* subsection.
2. Remove engine from vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
3. Remove rear suspension. Refer to *REAR SUSPENSION (SC-5U)* subsection.
4. Disconnect coolant hoses from heat exchanger.
5. Drill or grind all rivets retaining the heat exchanger to tunnel. Refer to *FRAME* subsection for drilling procedure.

NOTE: When pushing the rivets out, support the frame around the rivet with a socket on the opposite side to avoid warpage.

6. Remove heat exchanger from vehicle.

Heat Exchanger Installation

Installation is the reverse of removal procedure. However pay attention to the following.

Refill and bleed cooling system as described in *PERIODIC MAINTENANCE PROCEDURES* subsection.

COOLANT TANK

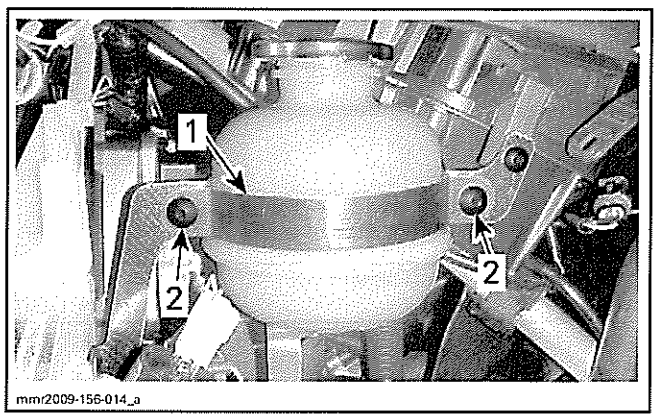
Coolant Tank Removal

Remove hood and RH side panel, refer to *BODY* subsection.

Siphon coolant tank.

Remove all hoses from coolant tank.

Remove retaining screws to disengage coolant tank from holder.



1. Coolant tank holder
2. Retaining screws

Coolant Tank Inspection

Check if the tank is cracked or melted. Replace if necessary.

Coolant Tank Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

Properly refill cooling system. Refer to *COOLING SYSTEM REFILL AND BLEEDING* in *PERIODIC MAINTENANCE PROCEDURES* subsection.

COOLANT TEMPERATURE SENSOR (CTS)

To test and replace the CTS, refer to *E-TEC DIRECT FUEL INJECTION* subsection.

FRONT RADIATOR

Front Radiator Cleaning and Inspection

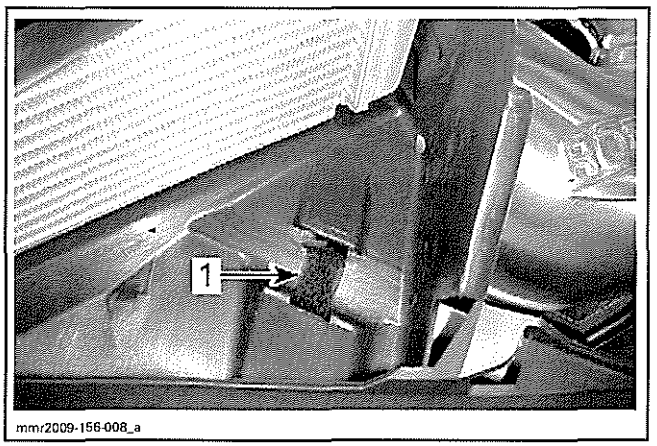
Remove all debris between radiator fins.

Check if the radiator fins are damaged. Replace the front radiator if necessary.

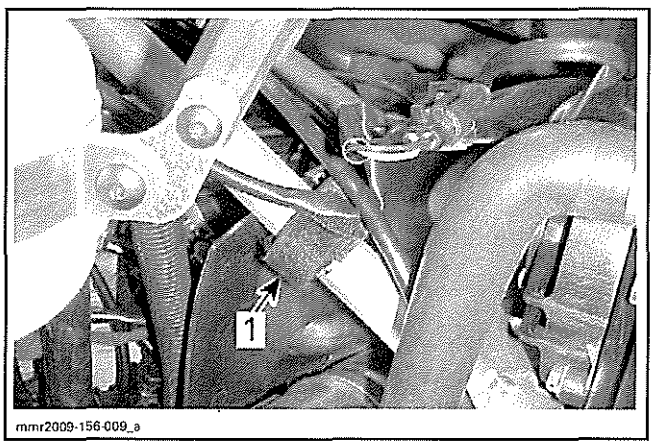
NOTE: A radiator with many broken fins does not work properly.

Front Radiator Removal

1. Remove hood. Refer to *BODY* subsection.
2. Remove secondary air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.
3. Detach hook-and-loop fasteners and lift radiator over the bottom pan side.

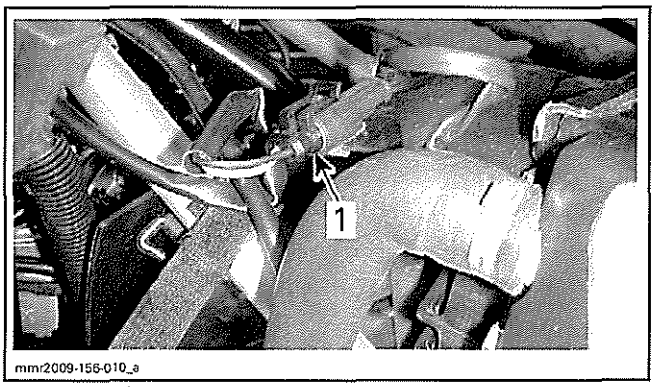


1. Front hook-and-loop fastener



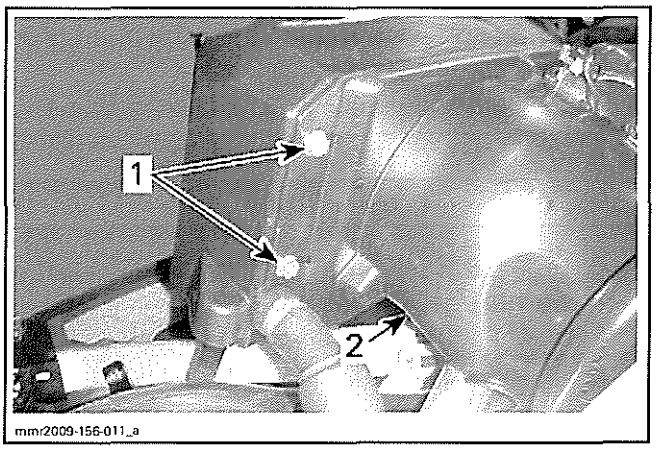
1. Rear hook-and-loop fastener

4. Unplug radiator fan connector.



1. Radiator fan connector

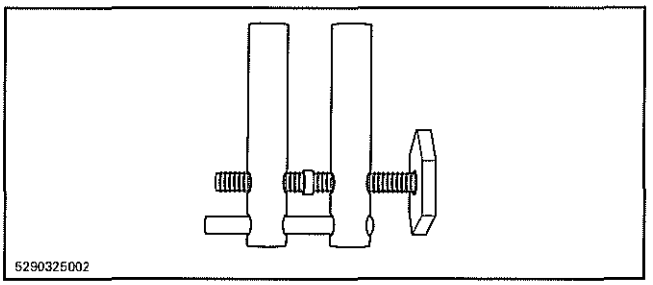
5. Remove radiator air deflector.

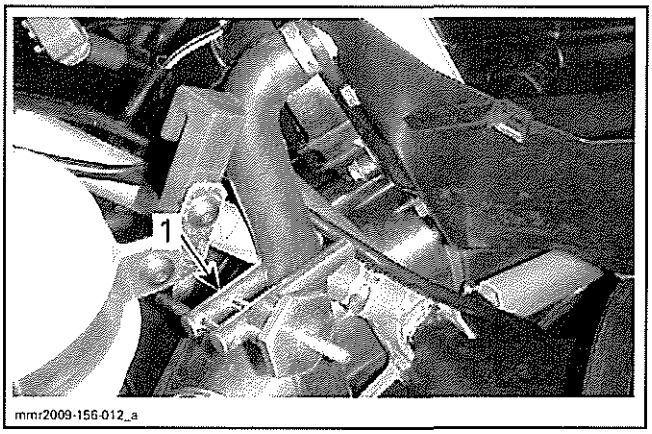


1. Retaining screws
2. Radiator air deflector

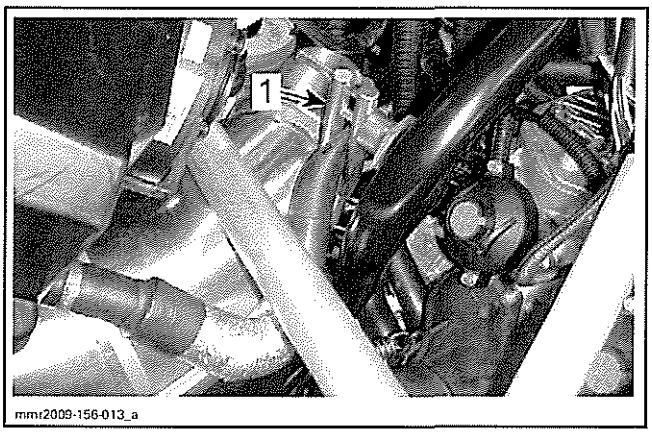
6. Install a LARGE HOSE PINCHER (P/N 529 032 500) on each radiator hoses.

NOTICE Never squeeze the aluminum section of radiator hoses with hands or hose pincher. These sections can be deformed and cause cooling system problems.





RADIATOR INLET HOSE
1. Large hose pincher



RADIATOR OUTLET HOSE
1. Large hose pincher

7. Place a drain pan under the radiator outlet hose.
8. Cut Oetiker clamps securing both hoses to radiator.
9. Disconnect radiator outlet hose.
10. Disconnect radiator inlet hose.
11. Remove radiator from vehicle.

Front Radiator Installation

For installation, reverse the removal procedure. However, pay attention to the following.

Install **new** Oetiker clamps to secure coolant hoses.

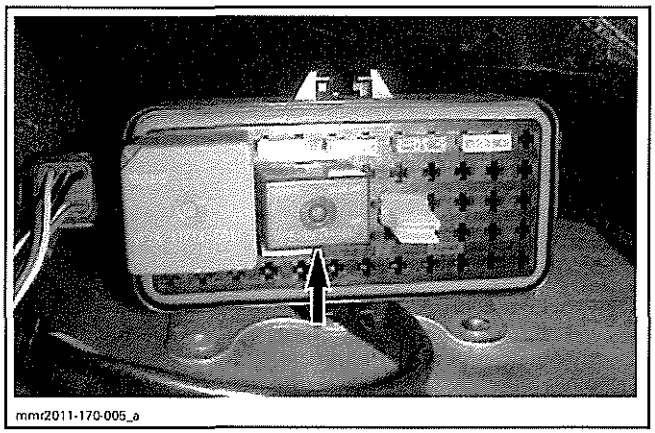
COOLING FAN

Cooling Fan Operating Condition

RADIATOR COOLING FAN		
ENGINE TEMPERATURE	COOLING FAN RELAY	COOLING FAN OPERATION
> 50°C (122°F)	Close	Starts
< 45°C (113°F)	Open	Stops

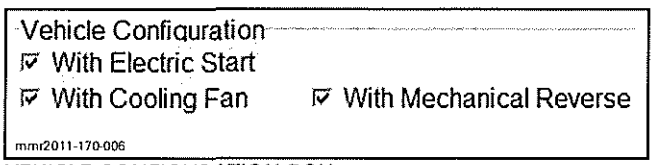
Cooling Fan Relay Location

The cooling fan relay is located in the fuses box.



Cooling Fan Configuration in B.U.D.S.

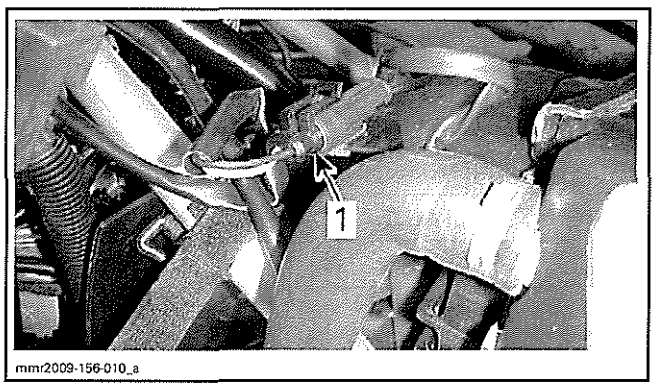
1. Connect vehicle to B.U.D.S., refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. In B.U.D.S., select the following:
   - **Read Data** button
   - **Setting** tab
   - ECM page.
3. Ensure that **With Cooling Fan** box is properly checked.



VEHICLE CONFIGURATION BOX

Cooling Fan Motor Operation Test

1. Disconnect front radiator cooling fan connector.



1. Radiator fan connector

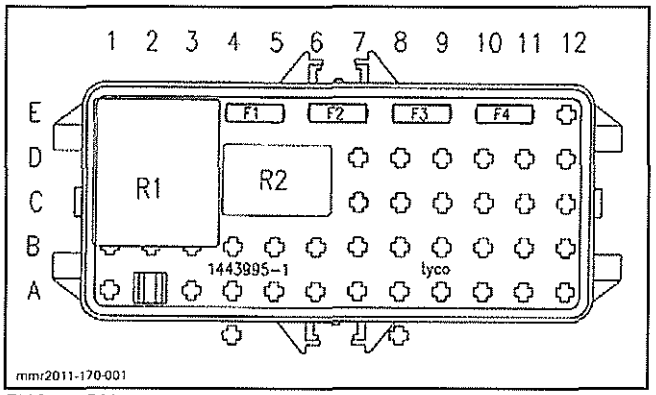
2. Connect cooling fan connector pin B (BLUE wire) to a 20 A suitable fuse jumper and then directly to the positive battery post.

3. Connect cooling fan connector pin A (BLACK wire) directly to the negative battery post.
4. Check if motor works properly.
5. If motor does not work, replace it.

Cooling Fan Testing Sequence

If B.U.D.S. is properly configured and cooling fan does not work, follow this testing sequence to diagnose problem.

1. Check cooling fan connector and terminal condition.
2. Check cooling fan fuse (F4).
3. Check cooling fan relay (R2).



FUSE BOX

4. Check cooling fan motor operation.
   - Refer to *COOLING FAN MOTOR OPERATION TEST.*
5. Check input voltage at cooling fan motor.

NOTE: Engine must be started and engine temperature must be > 50°C (122°F).

INPUT VOLTAGE AT COOLING FAN MOTOR	
TEST PROBES	VOLTAGE
GY/GN	Battery voltage (±12 Vdc)
BK	

6. Check input voltage at cooling fan relay.

INPUT VOLTAGE AT COOLING FAN RELAY	
TEST PROBES	VOLTAGE
Fuse box pin 6C	Battery voltage (±12 Vdc)
Battery negative (-) post	

INPUT VOLTAGE AT COOLING FAN RELAY	
TEST PROBES	VOLTAGE
Fuse box pin 4C	Battery voltage (±12 Vdc)
Battery negative (-) post	

7. Check ECM ground continuity test (relay).

ECM GROUND CONTINUITY TEST (RELAY)	
TEST PROBES	VOLTAGE
ECM-J1B pin 18	Close to 0 Ω
Fuse box pin 4D	

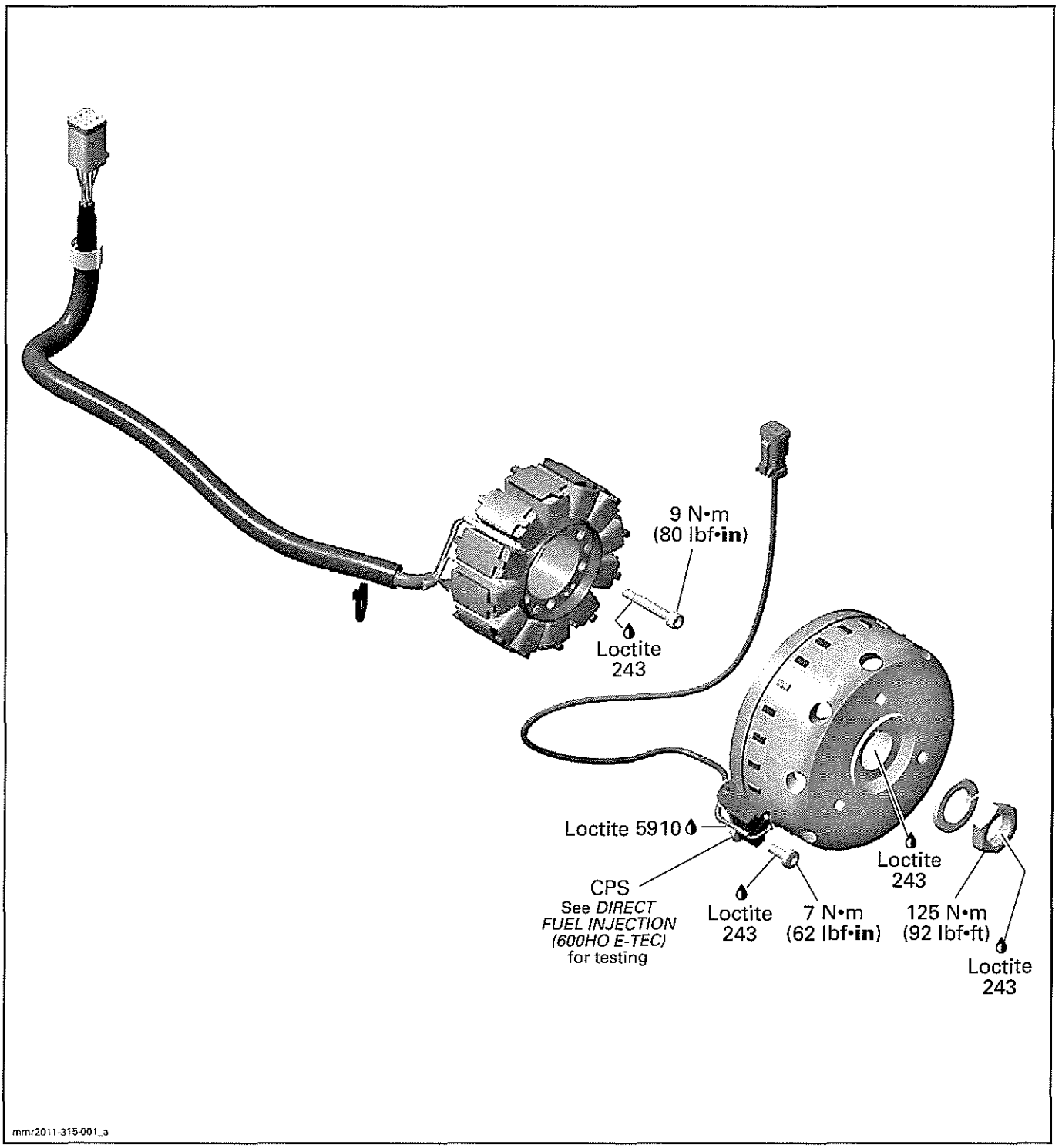
MAGNETO SYSTEM

SERVICE TOOLS

Description	Part Number	Page
CRANKSHAFT PROTECTOR (MAG)	420 876 557	104
FLUKE 115 MULTIMETER	529 035 868	105–106
MAGNETO PULLER RING	420 876 081	103
MAGNETO PULLER	529 035 547	104

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 243 (BLUE)	293 800 060	104–105, 107–108
LOCTITE 5910	293 800 081	108


9 N•m
(80 lbf•in)
Loctite
243
Loctite 5910
CPS
See DIRECT
FUEL INJECTION
(600HO E-TEC)
for testing
Loctite
243
7 N•m
(62 lbf•in)
Loctite
243
125 N•m
(92 lbf•ft)
Loctite
243
mmr2011-315-001_a

GENERAL

During assembly/installation, use the torque values and service products as shown in the exploded view.

Clean threads before applying a threadlocker. Refer to the *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* sections at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, self-locking fasteners, etc.) must be replaced with new ones.

NOTICE Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.

PROCEDURES

MAGNETO FLYWHEEL

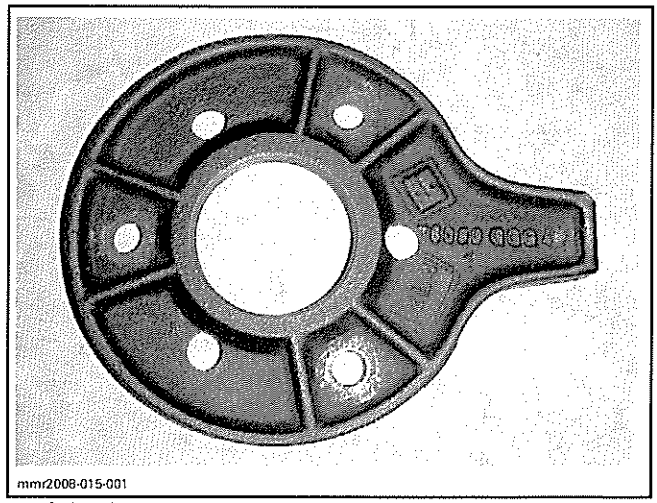
Magneto Flywheel Access

1. Remove RH side panels.
2. Remove muffler, refer to *EXHAUST SYSTEM* subsection.

Magneto Flywheel Removal

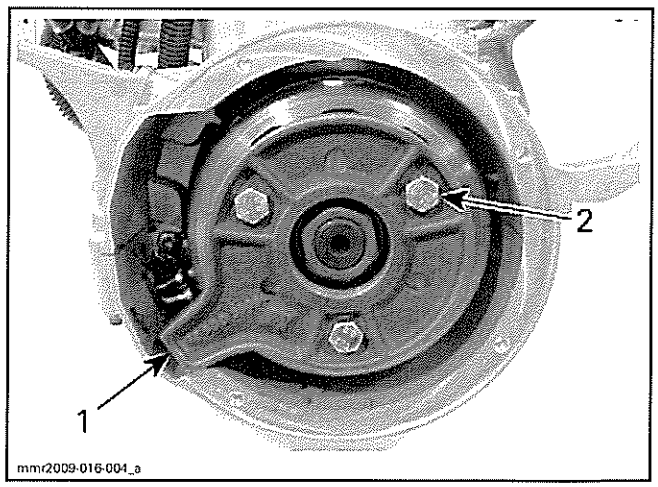
⚠ CAUTION Ensure tether cord is removed from engine cut-off switch and emergency engine stop switch is in the OFF position.

1. Remove magneto housing cover.
2. Install the MAGNETO PULLER RING (P/N 420 876 081) on magneto flywheel using three M8 x 25 hexagonal screws.



MAGNETO PULLER RING (P/N 420 876 081)

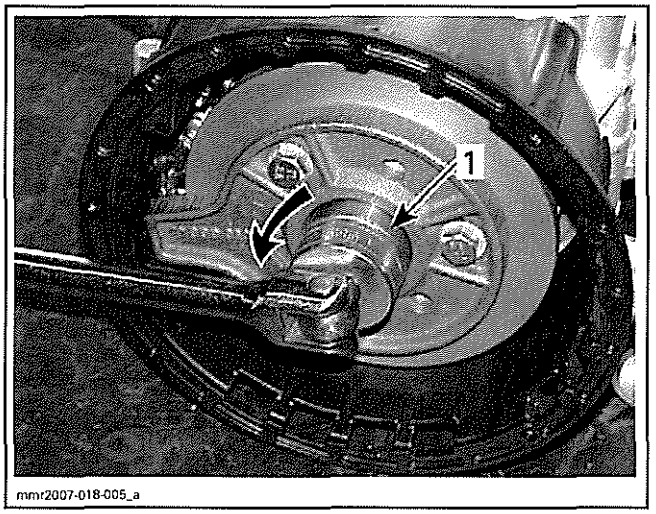
NOTICE Use only the recommended screw lengths to fasten puller ring to magneto flywheel. If other screw lengths are used, the stator behind the magneto flywheel may be damaged.



1. Tab in magneto housing opening
2. M8 screws of appropriate length

3. Remove magneto flywheel retaining nut, using an appropriate socket.

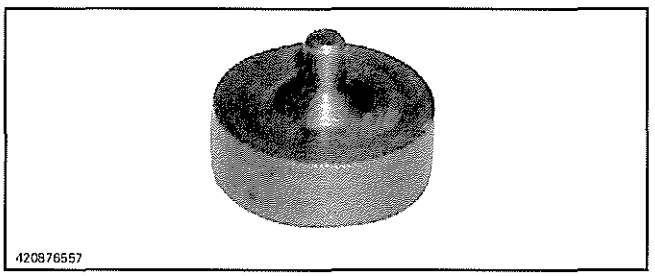
MAGNETO FLYWHEEL REMOVAL
30 mm socket with the outside diameter machined to 40 mm (1.580 in)



TYPICAL
1. Machined 30 mm socket

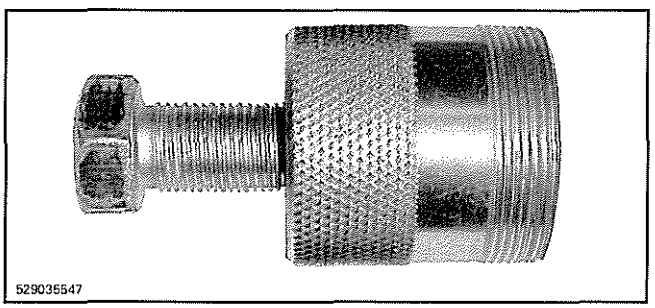
NOTE: To correctly remove a threadlocked fastener, first tap on the fastener to break threadlocker bond. This will prevent the thread from breaking.

4. Install the CRANKSHAFT PROTECTOR (MAG) (P/N 420 876 557) on crankshaft end.

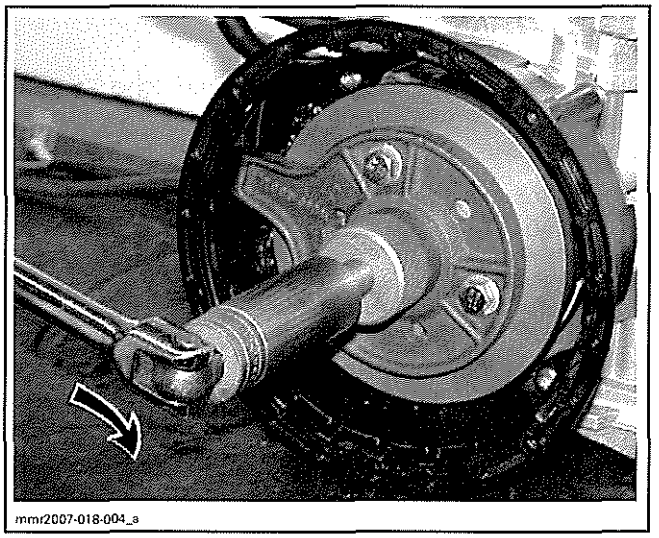


NOTE: Apply a small amount of grease on the end of the crankshaft to hold crankshaft protector in place.

5. Install the MAGNETO PULLER (P/N 529 035 547) into the magneto puller ring.



6. Tighten puller bolt, while tapping on puller bolt head with a hammer to release magneto flywheel from crankshaft.



TYPICAL

Magneto Flywheel Cleaning

Use a clean dry rag only without any solvent or similar product.

Magneto Flywheel Inspection

Inspect magneto flywheel for abnormal coloration (brown or blue) that would indicate overheating condition.

If overheating condition is suspected, carry out the following:

- Check flywheel magnetic field using a piece of metal. If magnetic field is not felt or weak, replace flywheel.
- Inspect flywheel for cracks, pay particular attention to the inside circumference (magnets), and the tapered center portion.
- Check if magneto housing ventilation holes are clean.
- Check stator for signs of overheating.
- Test stator, see procedures further in this subsection.

Magneto Flywheel Installation

1. Clean crankshaft extension (taper) and apply LOCTITE 243 (BLUE) (P/N 293 800 060) on tapered surface.
2. Position Woodruff key, magneto flywheel and lock washer on crankshaft.
3. Clean threads in magneto flywheel nut and apply LOCTITE 243 (BLUE) (P/N 293 800 060).
4. Install nut on crankshaft and tighten.

MAGNETO FLYWHEEL NUT TORQUE
125 N•m (92 lbf•ft)

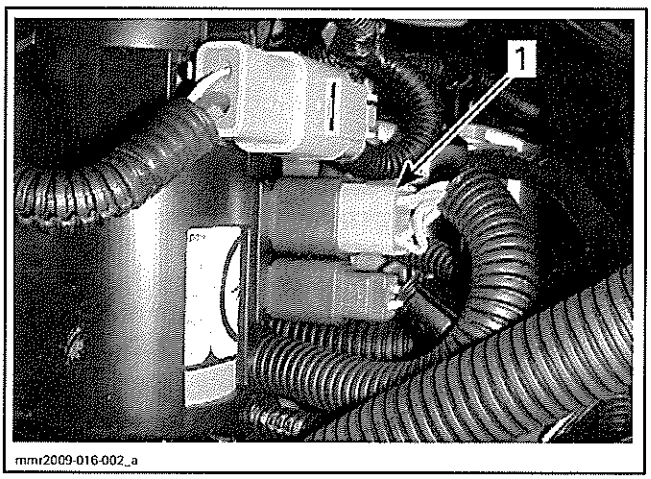
5. Install magneto cover.

MAGNETO COVER SCREWS TORQUE
7 N•m (62 lbf•**in**) + LOCTITE 243 (BLUE) (P/N 293 800 060)

STATOR

Stator Connector Access

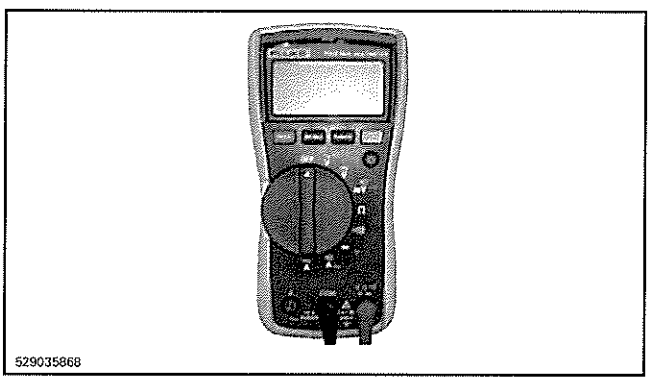
Remove the following components to access to stator connector:
- LH side panels
- Drive belt guard.



TYPICAL
1. Stator connector

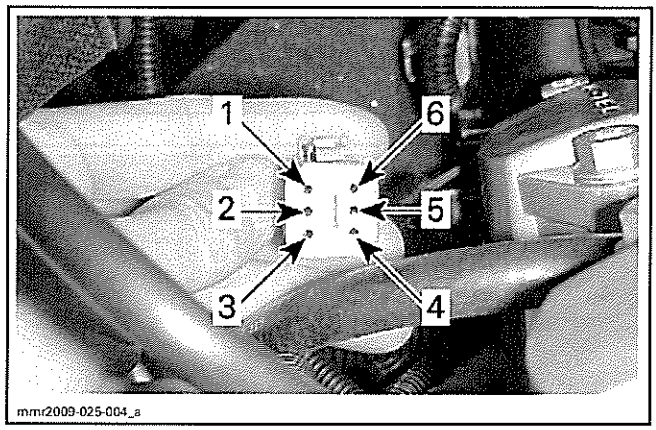
Stator Continuity Test

1. Disconnect stator connector.
2. Set FLUKE 115 MULTIMETER (P/N 529 035 868) to Ω.



3. Measure resistance of each stator coil as follows.

STATOR CONTINUITY TEST		
TEST PROBES		RESISTANCE @ 20°C (68°F)
Pin 1	Pin 6	0.63 ± 0.03 Ω
Pin 2	Pin 5	
Pin 3	Pin 4	



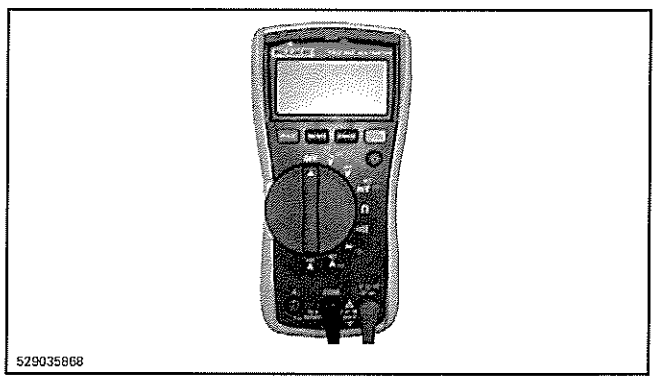
STATOR CONNECTOR PIN-OUT

NOTE: The stator resistance values mentioned in the table are manufacturers specifications under ideal conditions. If stator coil resistance is less than 1 Ω, consider stator to be in good working condition.

If resistance is out of specification, replace stator.

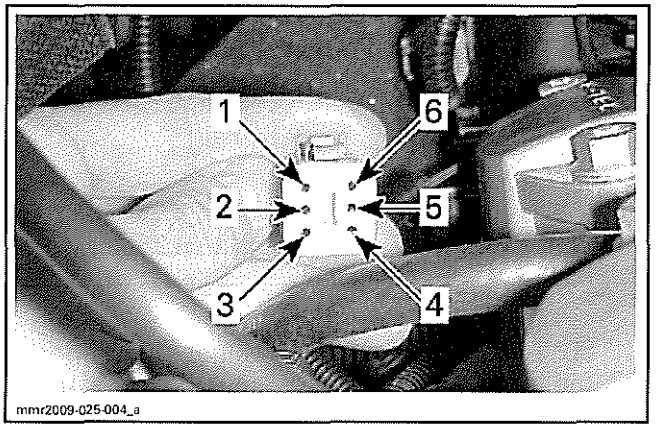
Stator Insulation Test

1. Disconnect stator connector.
2. Set FLUKE 115 MULTIMETER (P/N 529 035 868) to Ω.



3. Measure resistance as follows.

STATOR INSULATION TEST		
TEST PROBES		RESISTANCE @ 20°C (68°F)
Pin 1	Engine ground	OL (open circuit)
Pin 2		
Pin 3		
Pin 1	Pin 4	
Pin 1	Pin 5	
Pin 2	Pin 4	

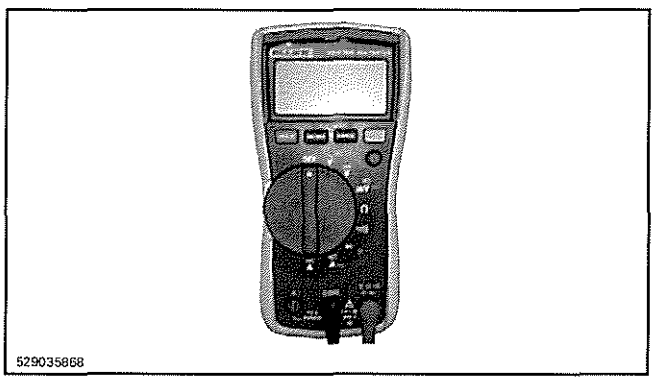


STATOR CONNECTOR PIN-OUT

If results are out of specification, the stator and/or the wiring need to be repaired/replaced.

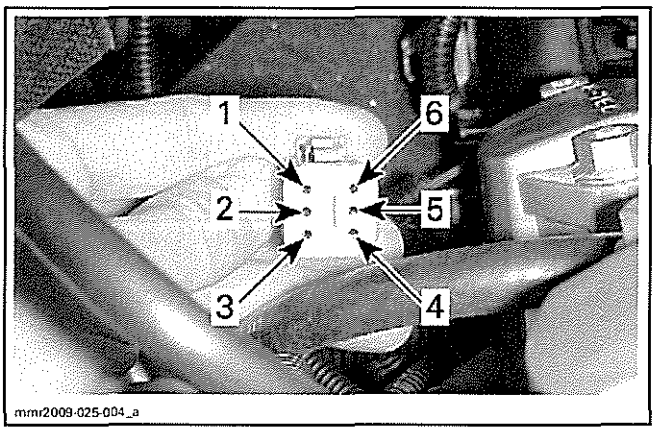
Stator Voltage Output Test

1. Disconnect stator connector.
2. Set FLUKE 115 MULTIMETER (P/N 529 035 868) to Vac and **manually set a scale** capable of reading at least 20 Vac.



3. Manually crank engine and read voltage from each winding as follows.
4. Repeat the test 3 times for each winding.

STATOR OUTPUT VOLTAGE TEST		
TEST PROBES		VOLTAGE
Pin 1	Pin 6	Approximately 15 - 20 Vac
Pin 2	Pin 5	
Pin 3	Pin 4	

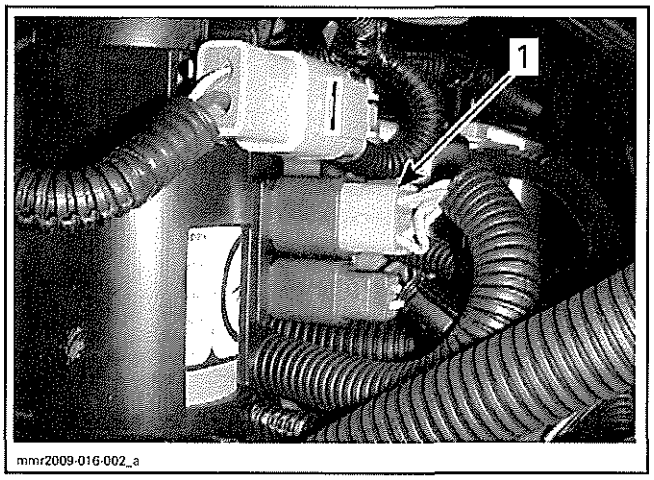


STATOR CONNECTOR PIN-OUT

5. If voltage is lower than specification, remove and inspect magneto flywheel and stator. Refer to *MAGNETO FLYWHEEL* in this subsection.
6. Replace magneto flywheel and/or stator if applicable.

Stator Removal

1. Lift engine to gain access to stator harness. Refer to *ENGINE REMOVAL AND INSTALLATION (E-TEC)* subsection.
2. Remove *MAGNETO FLYWHEEL*, see procedure in this subsection.
3. Remove Allen socket screws retaining stator to magneto housing.
4. Remove grommet from crankcase where the crankshaft position sensor (CPS) sensor and stator wires exit magneto housing.
5. Disconnect the CPS connector.
6. Disconnect stator connector located on the capacitor support.



TYPICAL
1. Stator connector

NOTE: To ease harness routing at installation, tie a string on each connector and let the strings follow through as you pull on the harnesses. Pass the CPS sensor connector through the grommet first.

7. Remove stator and carefully pull wires through the grommet.

NOTE: It will be necessary to break the silicone sealant behind the left side of the stator. Proceed carefully to avoid wire damage.

Stator Cleaning

Use a clean dry rag only without any solvent or similar product.

Stator Installation

NOTE: It is important to remove the old silicon sealant behind the LH side of the stator then apply new silicon at stator installation.

1. Insert stator connector through the crankcase and grommet, followed by the CPS sensor connector.
2. Install grommet on crankcase.

NOTE: During installation, ensure stator harness is located on the left side.

3. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on threads of stator screws then tighten them to specification.

STATOR RETAINING SCREWS TORQUE
9 N•m (80 lbf•**in**)

4. Tie the strings on the connectors used during removal of the stator and CPS sensor connectors, then pull on them to route the harnesses up to their original locations.
5. Reconnect the stator connector.

NOTICE Do not apply dielectric grease or any other similar product on Deutsch waterproof housings as housing seal may be damaged.

6. Reinstall all other removed parts.

CRANKSHAFT POSITION SENSOR (CPS)

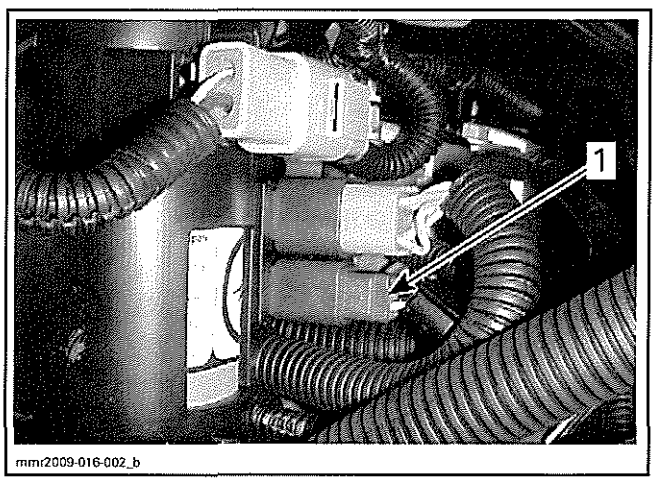
CPS Sensor Test

Refer to *E-TEC DIRECT FUEL INJECTION* subsection.

CPS Sensor Removal

⚠ CAUTION Ensure tether cord is removed from engine cut-off switch and emergency engine stop switch is in the OFF position.

1. Remove engine from vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION (E-TEC)* subsection.
2. Remove *MAGNETO FLYWHEEL*, see procedure in this subsection.
3. Remove CPS sensor retaining screws.
4. Remove grommet from crankcase where CPS sensor harness exits magneto housing.
5. Disconnect CPS sensor connector located on the capacitor support.



1. CPS sensor connector

NOTE: To ease harness routing at installation, tie a string to the CPS sensor connector and guide it through as you pull on the CPS sensor harness.

6. Remove CPS sensor and carefully pull harness through from crankcase.

CPS sensor Installation

The installation is the reverse of the removal procedure, however pay attention to the following.

Tie the rope used during removal on the CPS sensor connector, then pull on it to route the harness to its original location.

Apply threadlocker on CPS sensor screws.

CPS SENSOR RETAINING SCREWS THREADLOCKER
LOCTITE 243 (BLUE) (P/N 293 800 060)

Tighten CPS sensor screws to specification.

CPS SENSOR RETAINING SCREWS TORQUE
7 N•m (62 lbf•**in**)

NOTE: It is important to remove the old silicon at CPS sensor location then apply new silicon. Secure CPS sensor then stick the CPS sensor harness using LOCTITE 5910 (P/N 293 800 081).

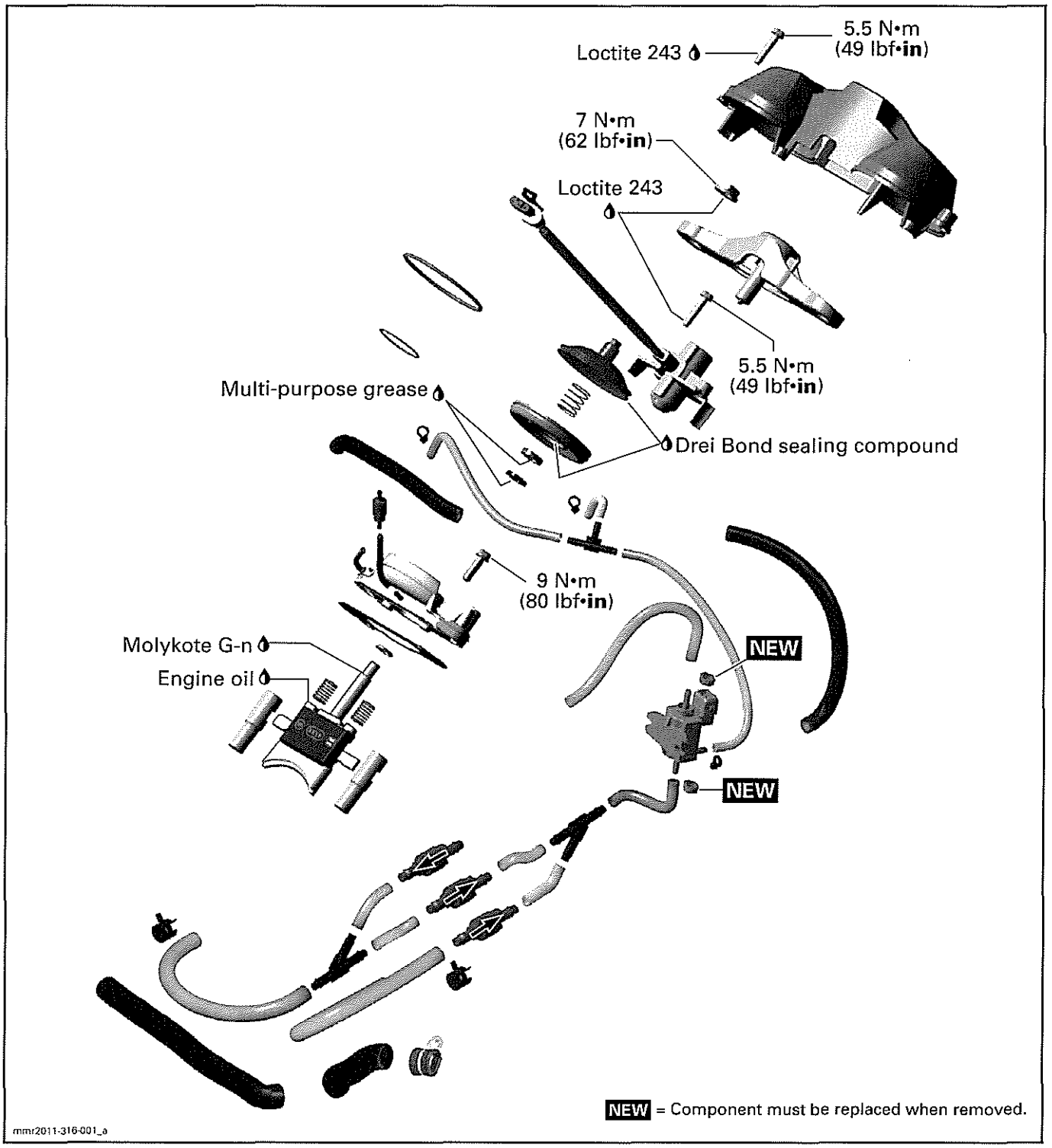
RAVE

SERVICE TOOLS

Description	Part Number	Page
T-HARNESS	529 035 869	124
VACUUM/PRESSURE PUMP	529 021 800	113, 116–117, 123–125

SERVICE PRODUCTS

Description	Part Number	Page
DREI BOND SEALING COMPOUND	420 297 906	121
LOCTITE 243 (BLUE)	293 800 060	114, 122
MOLYKOTE G-N	420 297 433	120


5.5 N•m
(49 lbf•in)
Loctite 243
7 N•m
(62 lbf•in)
Loctite 243
5.5 N•m
(49 lbf•in)
Multi-purpose grease
Drei Bond sealing compound
9 N•m
(80 lbf•in)
Molykote G-n
Engine oil
NEW
NEW
NEW = Component must be replaced when removed.
mmr2011-316-001_a

GENERAL

During assembly/installation, use torque values and service products as shown in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS PROCEDURE* and *LOCTITE APPLICATION PROCEDURE* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, self-locking fasteners, cotter pins, etc.) must be replaced with new ones.

NOTICE **Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.**

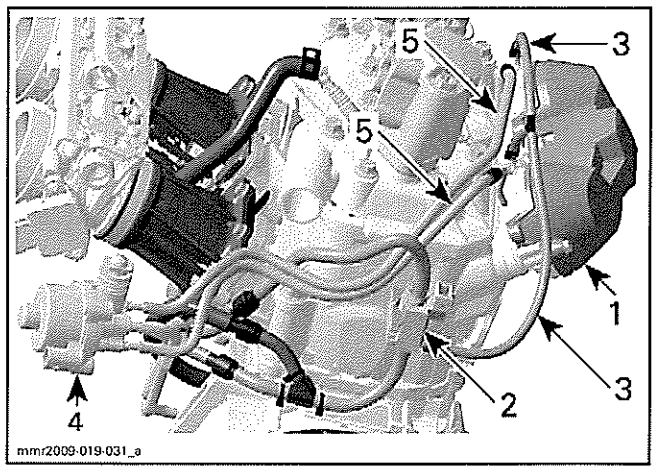
SYSTEM DESCRIPTION

Here are the main features of the E-TEC 3D RAVE valves.

- RAVE valves are lubricated by the electronic oil injection pump.
- RAVE valve position feedback to ECM. A hall-effect position sensor is used (RPS; RAVE position sensor).
- Only one solenoid is used to activate the RAVE valves.
- RAVE valves movement is synchronized and monitored with a link bar.

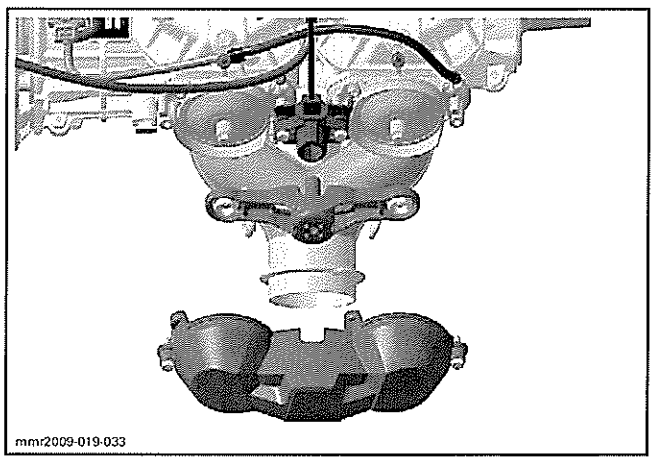
The ECM mappings use the following parameters to control the 3D RAVE valves:

- Engine RPM's
- Crankshaft rate of acceleration (CPS)
- Atmospheric pressure (APS)
- Intake temperature (ATS)
- Engine temperature (CTS)
- Throttle position (TPS)
- Engine detonation (KS).



1. *Linked RAVE valves*
2. *RAVE solenoid*
3. *Inlet hoses (Vacuum and pressure to RAVE valves)*
4. *Electronic oil injection pump*
5. *Oil lines to RAVE valves*

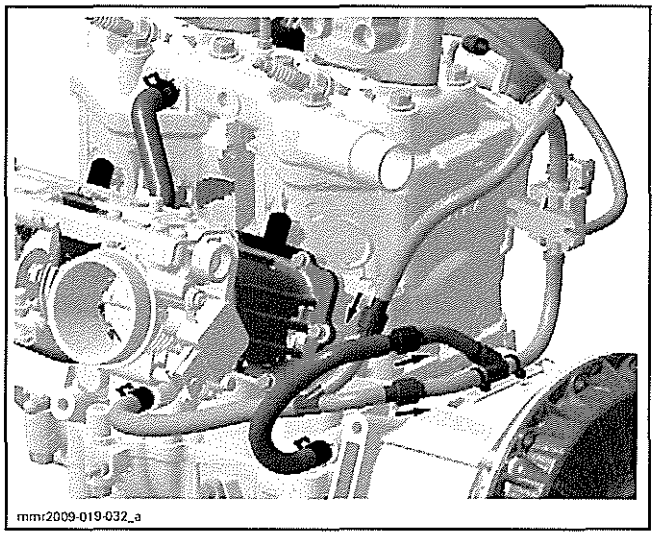
A link bar is used to keep RAVE valves opening and closing synchronized one with each other. This provides a more consistent engine operation.



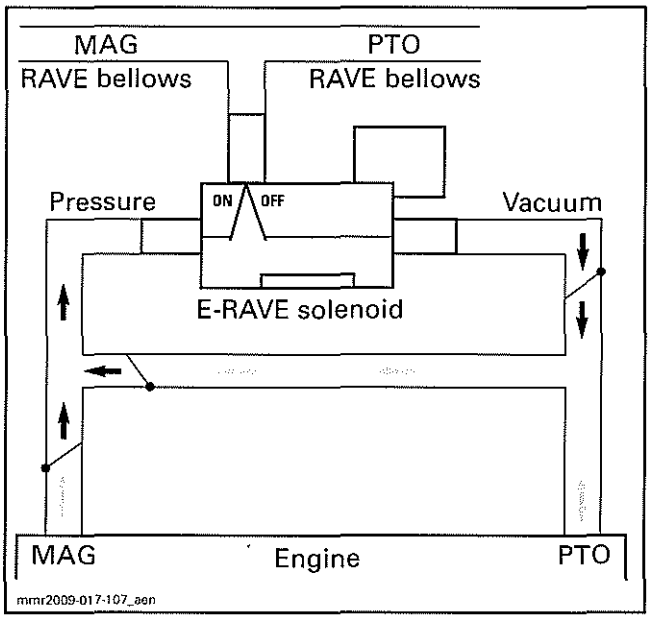
If link bar is removed, a particular adjustment is required at the assembly. Also, B.U.D.S. needs to be used to set the RAVE positions.

The RAVE position sensor (RPS) provides the ECM its actual position. Either closed, mid-position or open. This informs the ECM that the RAVE valves are really at the expected position so that the proper amount of fuel is injected as well as other required operating parameters are applied.

The 3D RAVE arrangement uses only one solenoid to move the RAVE valves to the desired position.



CRANKCASE HOSES, CHECK VALVES AND Y-CONNECTORS ARRANGEMENT TO SOLENOID



SOLENOID VACUUM/PRESSURE SEPARATION

The ECM controls the solenoid as follows.

RAVE VALVES POSITION	SOLENOID STATE	SOLENOID VALVE OPERATION
FULLY OPENED	ON	Pressure
MIDDLE	Switched between ON and OFF repeatedly by the ECM (pulse width modulation with a variable DC) (duty cycle from 10 to near 50%).	Near atmospheric pressure (floating position). A constant switching between pressure and vacuum to keep the RAVE in the mid position as set in the ECM.
CLOSED	OFF	Vacuum

TROUBLESHOOTING

DIAGNOSTIC TIPS

As a first troubleshooting step, perform the following procedures to ensure RAVE system is properly adjusted.

1. *3D RAVE VALVE SYNCHRONIZATION*
2. *3D RAVE VALVES POSITION SENSOR SETTING*
3. *3D RAVE VALVES POSITION VALIDATION.*

TROUBLESHOOTING GUIDELINES

RAVE Valves Position Sensor Fault Code

The ECM may generate a **position sensor fault code** if the RAVE valve is not reaching the desired position.

If a position sensor fault code is generated by the ECM, check the following:

Defective Position Sensor

- Test position sensor operation.
- Check position sensor wiring.

Excessive Carbon Build-up in RAVE Valves

- Use the recommended oil quality, refer to *LUBRICATION.*
- Check for damaged, kinked or obstructed inlet hoses (vacuum and pressure).
- Check for proper oil pump code in B.U.D.S., refer to *LUBRICATION.*

NOTE: Insufficient oil delivery to RAVE valves may result in a carbon build-up.

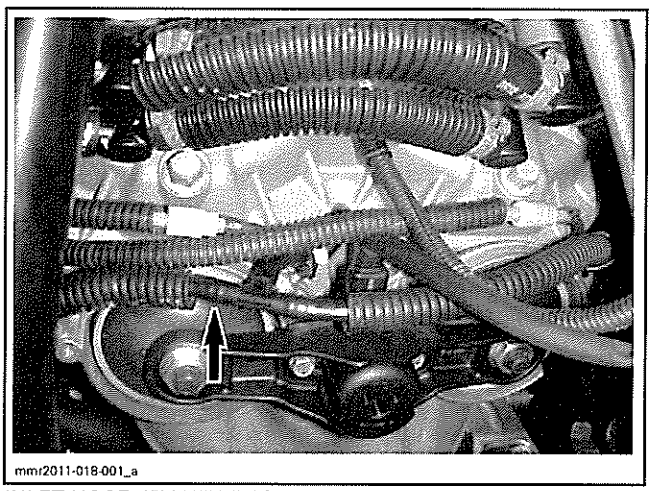
RAVE System Leaking
- Perform a *3D RAVE VALVE LEAK TEST*.
- Check for damaged or loose Oetiker clamp.
- Check for damaged hose or fitting.
- Check for a faulty check valve, refer to *CHECK VALVES*.
- Check for a faulty solenoid, refer to *SOLENOID*.

PROCEDURES

3D RAVE VALVES POSITION SENSOR

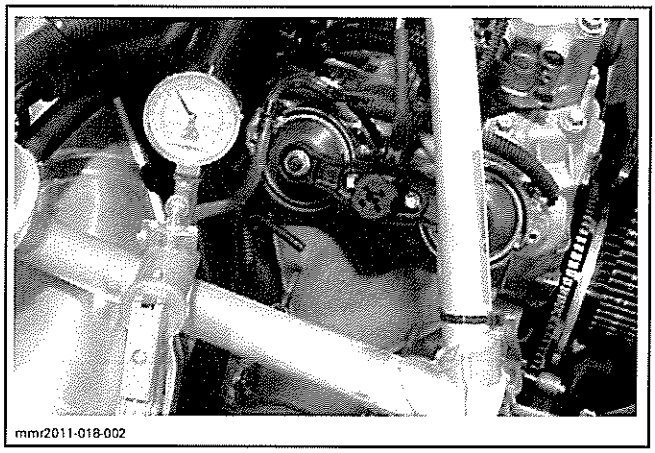
3D RAVE Valves Position Sensor Setting

1. Ensure RAVE valve are properly synchronized as per *3D RAVE VALVE SYNCHRONIZATION* procedure.
2. Remove body parts as required to access to position sensor.
3. Disconnect inlet hoses (vacuum/pressure) at the Y-fitting.

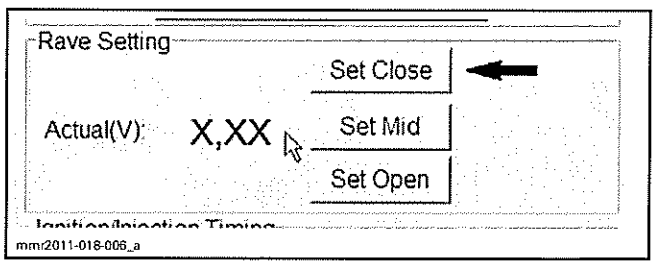


INLET HOSE AT Y-FITTING

4. Connect VACUUM/PRESSURE PUMP (P/N 529 021 800) onto Y-fitting.

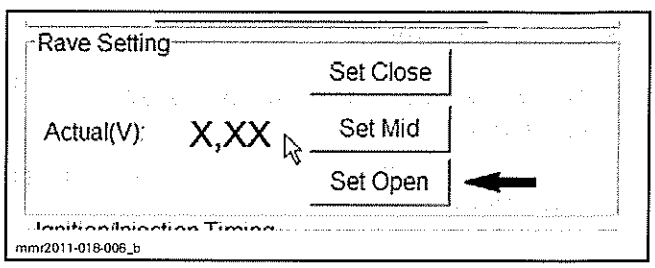


5. Connect vehicle to B.U.D.S., Refer to *COMMUNICATION TOOLS AND B.U.D.S. SOFTWARE* subsection.
6. In B.U.D.S., select **Setting** tab.
7. Apply -34kPa (10 inHg) of vacuum.
   - 7.1 Press **Set Close** button in **Rave Setting** area.
   - 7.2 Confirm that **Actual (V)** is within B.U.D.S. specification.



TYPICAL

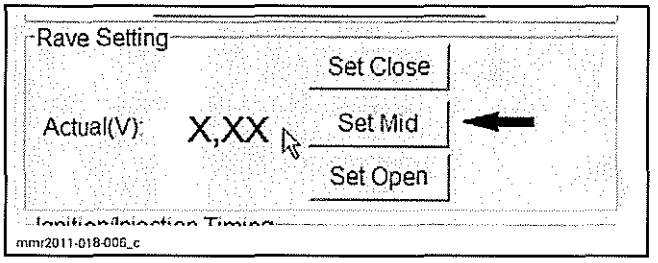
8. Apply 69 kPa (10 PSI) of pressure.
   - 8.1 Press **Set Open** button in **Rave Setting** area.
   - 8.2 Confirm that **Actual (V)** is within B.U.D.S. specification.



TYPICAL

9. Disconnect vacuum/pressure pump from Y-fitting.
   - 9.1 Press **Set Mid** button in **Rave Setting** area.

9.2 Confirm that **Actual (V)** is within B.U.D.S. specification.

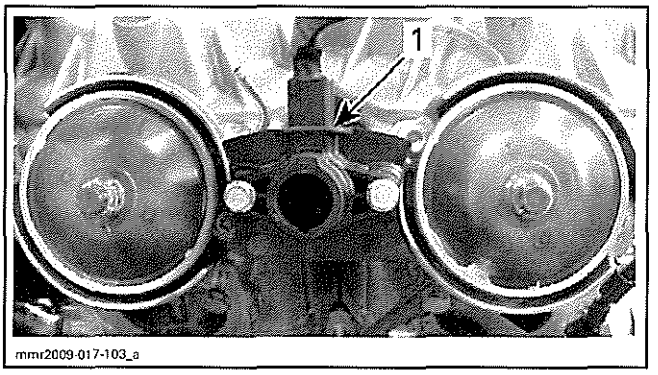


TYPICAL

10. Validate that position sensor is properly set. Refer to *3D RAVE VALVES POSITION VALIDATION* in this subsection.

3D Rave Valves Position Sensor Removal

1. Remove body parts as required to access to position sensor.
2. Disconnect position sensor connector.
3. Remove RAVE valves cover and link bar, see *3D RAVE VALVES REMOVAL* in this subsection.
4. Remove RAVE valves position sensor.



1. Position sensor

NOTICE It is very important to perform *3D RAVE VALVES SYNCHRONIZATION* whenever link bar is removed.

3D Rave Valves Position Sensor Installation

1. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on screws threads.
2. Install position sensor with wiring upwards.
3. Install connector.
4. Position link bar on RAVE valve pistons.
5. Install nuts on piston threads but do not tighten yet.
6. Perform *3D RAVE VALVE SYNCHRONIZATION* procedure in this subsection to complete link bar installation.

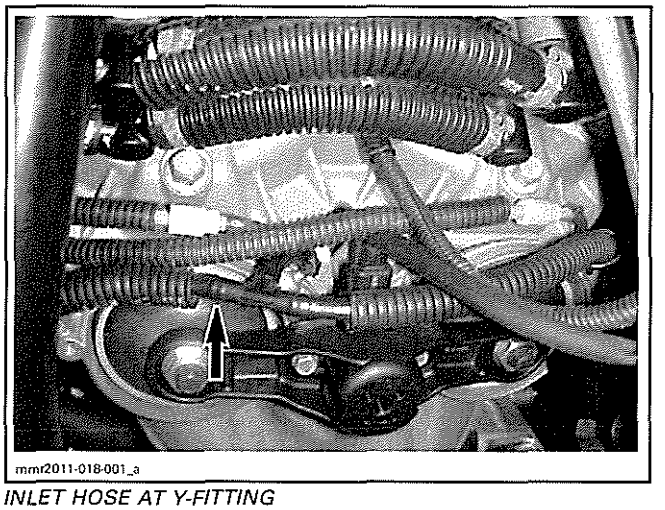
NOTICE It is very important to perform *3D RAVE VALVES SYNCHRONIZATION* whenever link bar is removed.

3D RAVE VALVES

3D RAVE Valve Synchronization

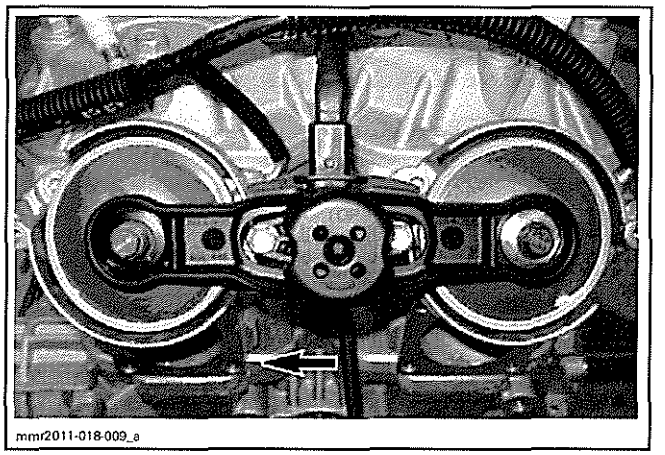
Adjustment Procedure

1. Disconnect inlet hose (vacuum/ pressure) at the Y-fitting.

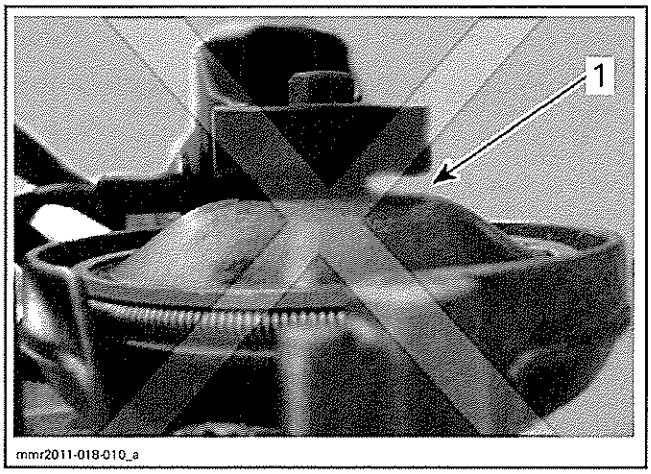


INLET HOSE AT Y-FITTING

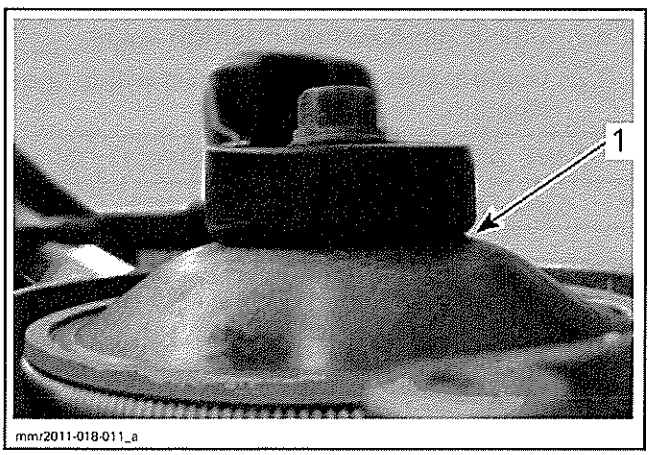
2. Ensure that retaining nuts are loosened.
3. Move link bar toward MAG side.
4. Tighten PTO nut by hand.



5. Check if a gap is visible between MAG valve piston and link bar.

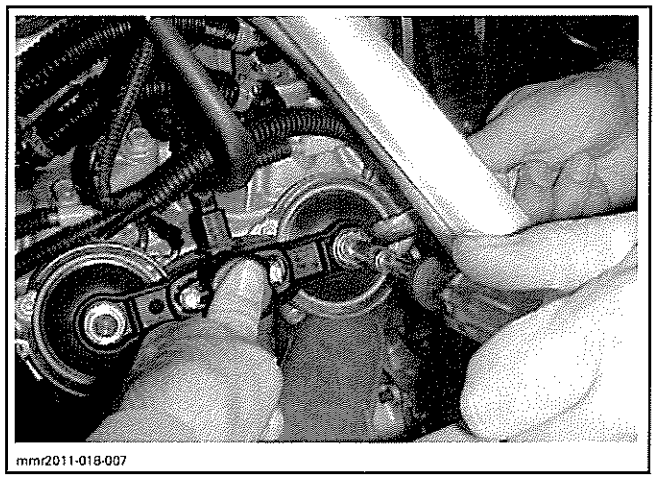


WRONG ADJUSTMENT
1. Gap



CORRECT ADJUSTMENT
1. No gap

6. If a gap is visible:
   - 6.1 Unscrew PTO nut then slightly move link bar toward PTO side.
   - 6.2 Tighten PTO nut by hand and recheck gap.
   - 6.3 Repeat above sequence until no gap is visible.
7. Push the center of link bar downwards in order to seat both RAVE valves on their fully closed position.
8. Firmly hold link bar downwards.
9. Tighten both retaining nuts while holding RAVE valve pistons with a wrench.



NOTICE To prevent RAVE valve piston breakage, proceed with care and make sure piston does not turn.

10. Adjust position sensor using B.U.D.S. Refer to *3D RAVE VALVES POSITION SENSOR SETTING*.

Validation Procedure

1. Push and pull link bar to force RAVE valves to pass through their 3 positions.
   - 1.1 Ensure that only **one** step is felt at mid position.
   - 1.2 If out of specification, repeat the *ADJUSTMENT PROCEDURE*.
2. With B.U.D.S., check position sensor voltage as follows:
   - 2.1 Difference from fully opened to mid position.
   - 2.2 Difference from closed to mid position.
   - 2.3 Confirm that voltage is within **0.15 volts**.
   - 2.4 If out of specification, repeat the *ADJUSTMENT PROCEDURE*.
3. Start engine and check RAVE valves operation.
   - Pistons should move freely.
   - If not, look for excessive friction due to torsion force applied on the piston rods during installation.

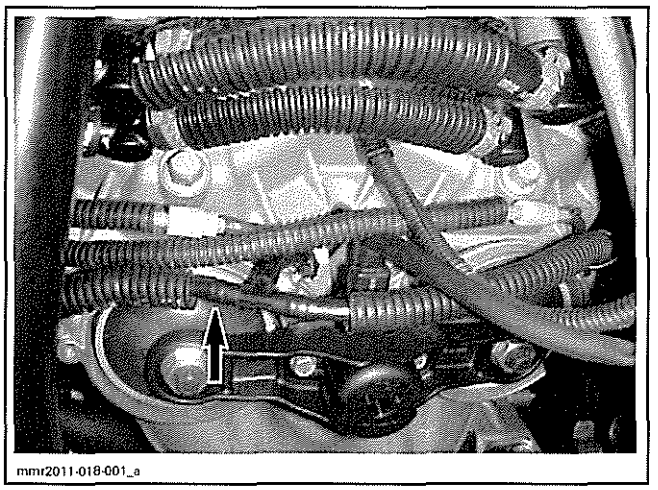
⚠ WARNING

Prior to starting engine, ensure vehicle is properly lifted with the track off the ground.

3D RAVE Valves Position Validation

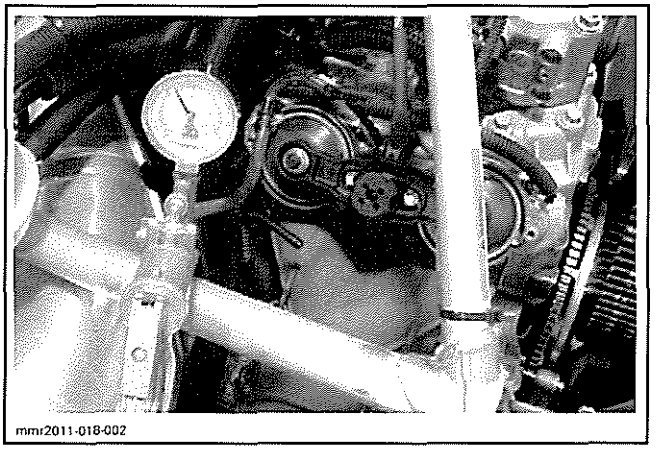
1. Ensure RAVE valves are properly synchronized as per *3D RAVE VALVE SYNCHRONIZATION*.
2. Ensure position sensor is properly set as per *3D RAVE VALVES POSITION SENSOR SETTING*.

3. Remove body parts as required to access to RAVE valves.
4. Disconnect inlet hoses (vacuum/pressure) at the Y-fitting.



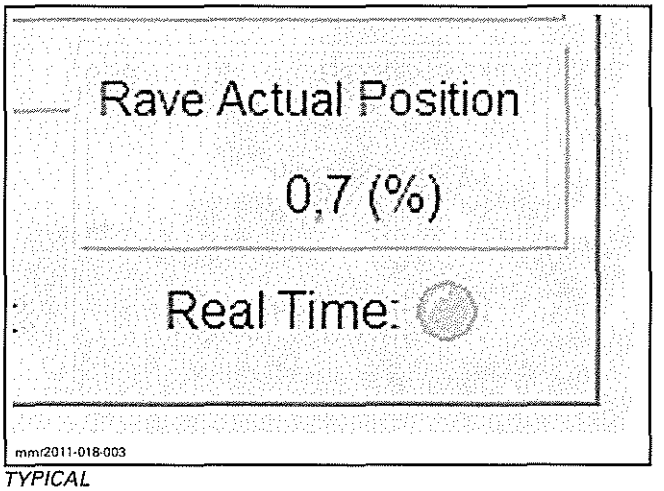
INLET HOSE AT Y-FITTING

5. Connect VACUUM/PRESSURE PUMP (P/N 529 021 800) onto Y-fitting.



6. Connect vehicle to B.U.D.S., Refer to *COMMUNICATION TOOLS AND B.U.D.S. SOFTWARE* subsection.
7. In B.U.D.S., select **Monitoring** tab.
8. Apply -34kPa (10 inHg) of vacuum.
   8.1 Check **Rave Actual Position** value.
   8.2 Confirm that actual position is within specification.

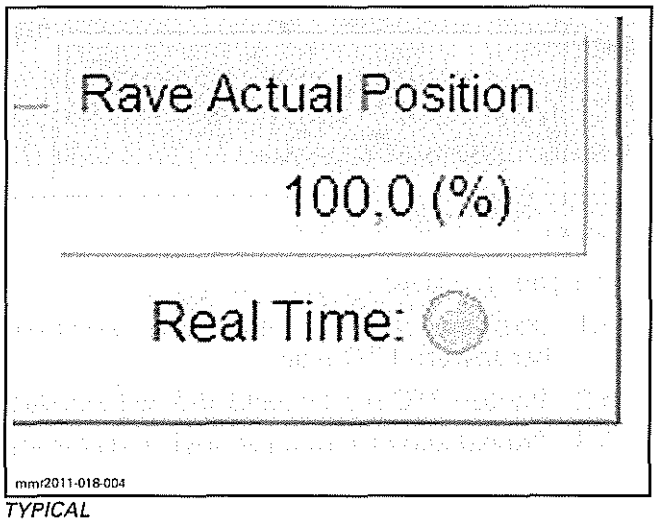
RAVE ACTUAL POSITION SPECIFICATION	
Closed	< 2%



TYPICAL

9. Apply 69 kPa (10 PSI) of pressure.
   9.1 Check **Rave Actual Position** value.
   9.2 Confirm that actual position is within specification.

RAVE ACTUAL POSITION SPECIFICATION	
Fully Opened	> 98%



TYPICAL

10. Disconnect vacuum/pressure pump from Y-fitting.
11. Manually locate rave valves at the middle position to overcome friction.
    11.1 Check **Rave Actual Position** value.
    11.2 Confirm that actual position is within specification.

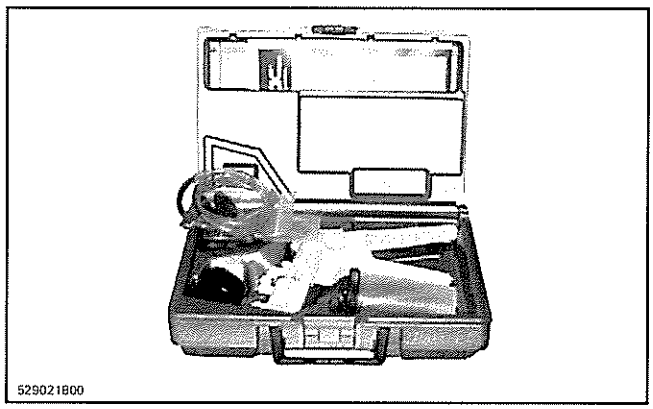
RAVE ACTUAL POSITION SPECIFICATION		
600 HO E-TEC	Middle	48 ± 2 %

If RAVE valves actual position are out of specification, check the following:
- RAVE valves cleanliness
- RAVE valves for leaks. Refer to *3D RAVE VALVE LEAK TEST* in this subsection.

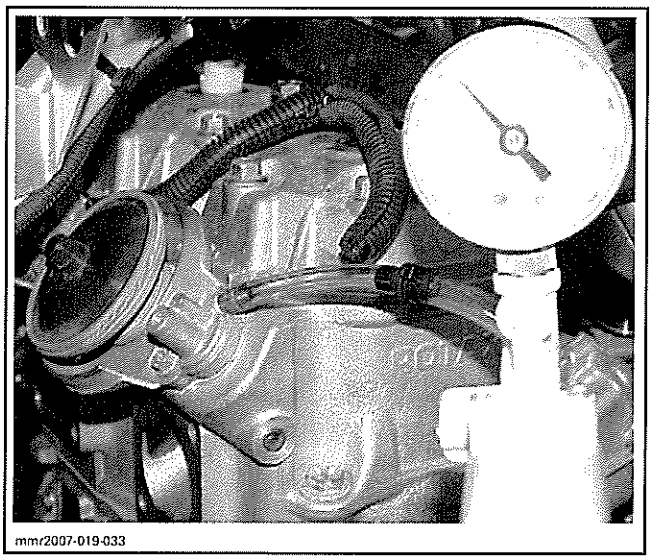
3D RAVE Valve Leak Test

NOTE: Test each RAVE individually.

Use the VACUUM/PRESSURE PUMP (P/N 529 021 800).

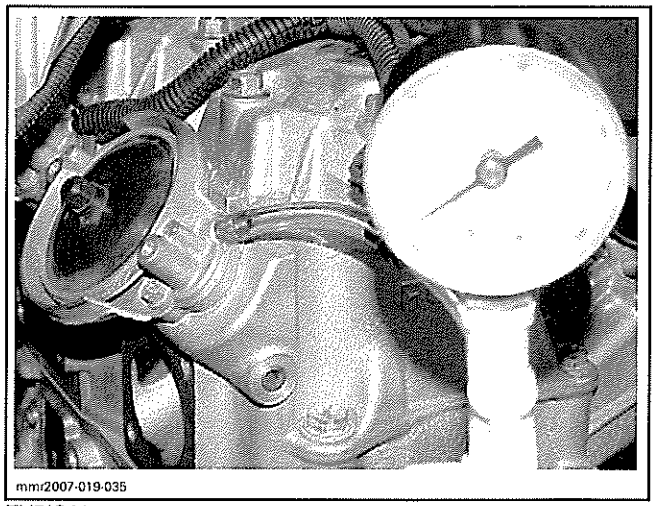


1. Remove RAVE valves cover and link bar, see *3D RAVE VALVES REMOVAL* in this subsection.
2. Disconnect RAVE inlet hose (vacuum/pressure).
3. Install test pump on nipple and apply pressure.
4. Check if piston fully rises.



TYPICAL

5. Apply vacuum.
6. Check if piston fully lowers.



TYPICAL

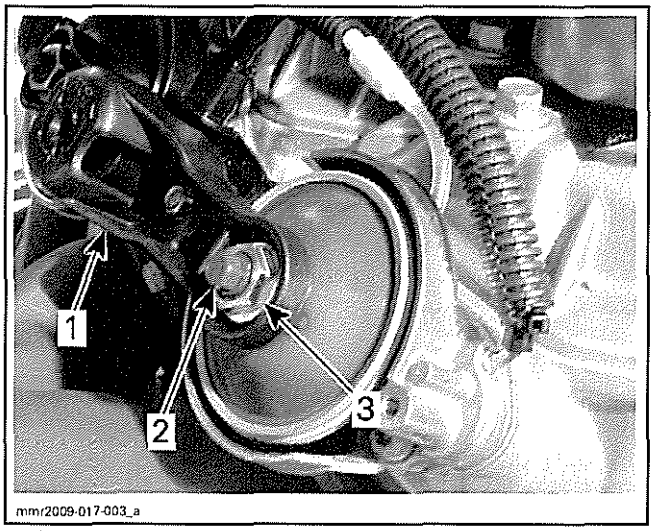
7. If a leak is detected, check the following:
   - Cracked or damaged bellows
   - Damaged seal inside RAVE valve.
8. Install RAVE valve link bar and cover.

NOTICE To prevent RAVE valve piston breakage, proceed with care and make sure piston does not turn.

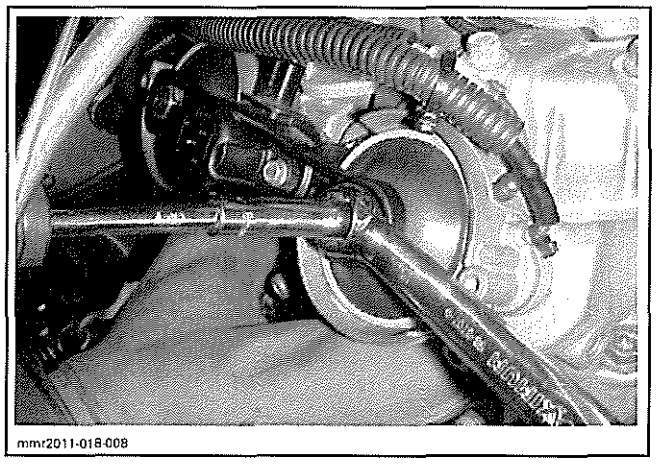
NOTICE It is very important to perform *3D RAVE VALVES SYNCHRONIZATION* whenever link bar is removed. See procedure in this subsection.

3D RAVE Valves Removal

1. Remove LH side panel.
2. Remove tool kit support located on drive belt guard.
3. Remove RAVE valves cover.
4. Remove RAVE valves link bar as follows.
   4.1 Hold RAVE valve pistons with a wrench then remove the retaining nuts.

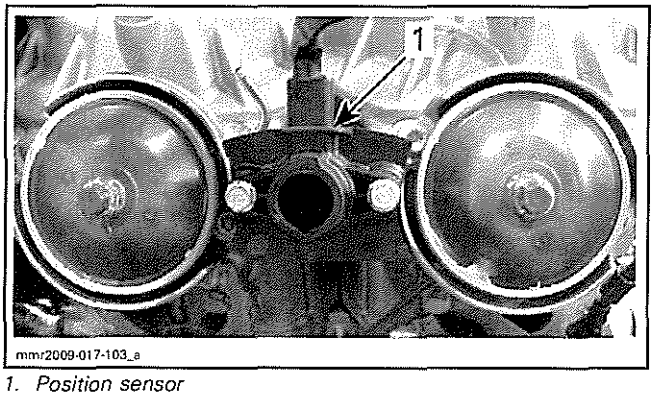


1. *Link bar*
2. *RAVE valve piston*
3. *Retaining nut*



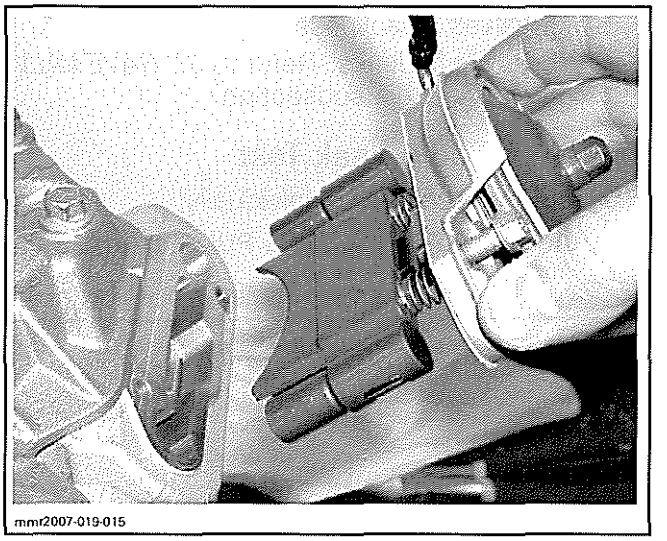
NOTICE To prevent RAVE valve piston breakage, proceed with care and make sure piston does not turn.

5. Remove RAVE valves position sensor.



1. *Position sensor*

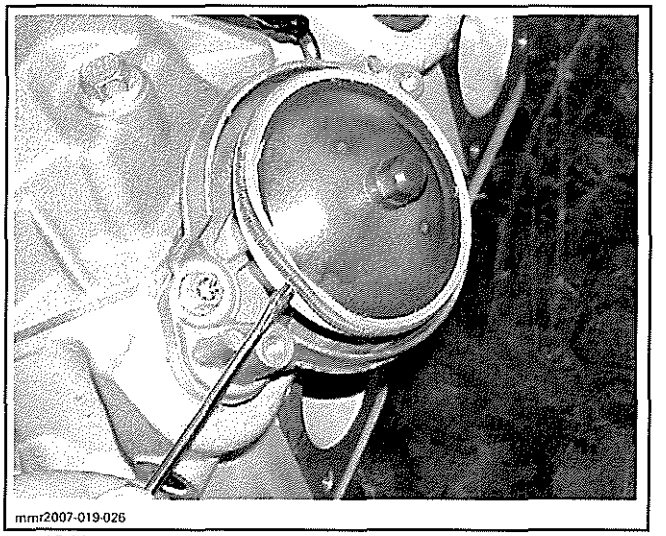
6. Disconnect RAVE valve oil lines and inlet hoses (vacuum/pressure).
7. Remove screws retaining RAVE valve housing to the cylinder.
8. Pull RAVE valve assembly out.



NOTE: Be careful not to loose springs underneath housing.

3D RAVE Valve Disassembly

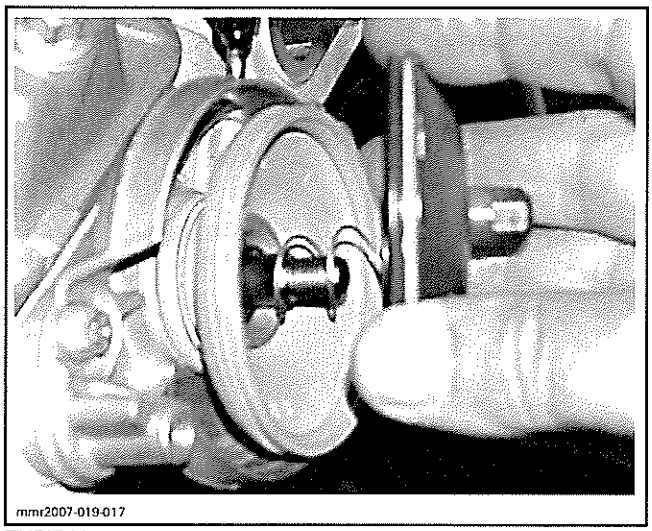
1. Carefully remove spring retaining bellow to RAVE valve piston.



TYPICAL

2. Free bellow from RAVE valve piston.
3. Carefully unscrew RAVE valve piston then remove compression spring.

⚠ CAUTION Firmly hold RAVE valve piston. The compression spring inside the valve applies pressure against the piston.

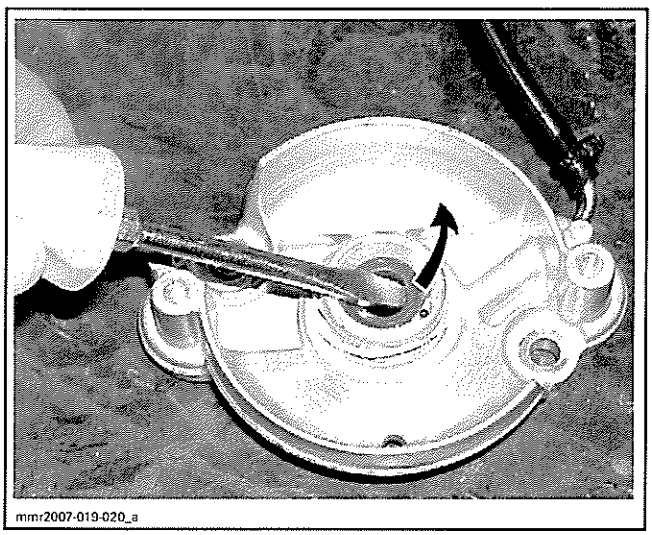


TYPICAL

4. Carefully remove bellow from RAVE valve housing.

NOTE: If oil is found in housing area, replace seals.

5. Extract RAVE valve from housing.
6. Take note of seals orientation and carefully pry them out.



TYPICAL

3D RAVE Valve Cleaning

The RAVE valves should be cleaned every 3 years or 10 000 km (6000 mi) whichever comes first. Clean carbon deposits as required.

Thoroughly clean all RAVE VALVES components and cylinder slots.

No special solvents or cleaners are required when cleaning the valve.

RAVE Valves Frequently Gummed

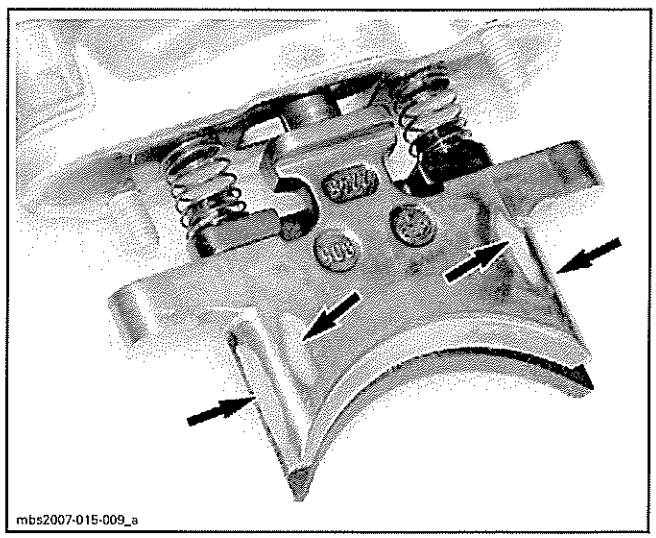
If the valves are getting gummed more frequently than usual, do the following:

- Check if XPS synthetic blend injection oil is used.
- Check lubrication hoses for restriction.
- Check lubrication hoses for presence of air. Bleed system if needed.
- Check lubrication check valves as explained in this section.

3D RAVE Valve Inspection

Check valves for breakage.

Check valves for wear at sliding points and straightness.



SIGNS OF WEAR

Check spring condition and straightness.

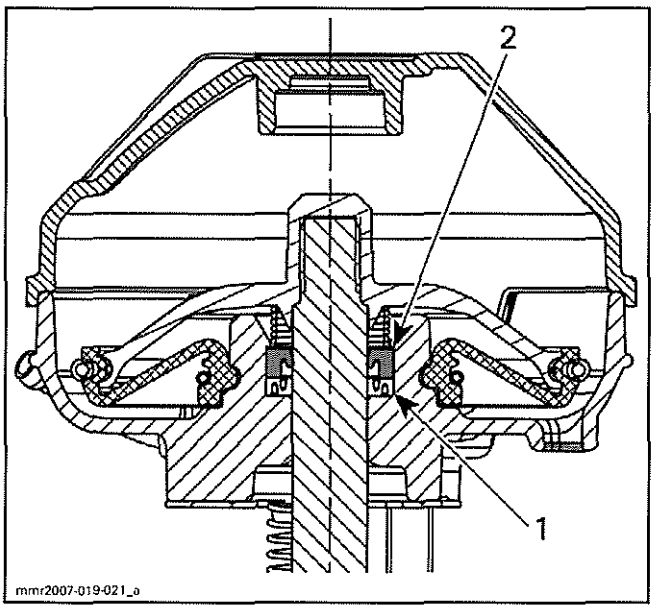
NOTE: Oil dripping from draining hole indicates a defective seal and a loosen retaining spring or damaged bellows.

Check for cracked, dried or perforated bellows.

NOTE: Make sure hoses are not leaking, kinked or damaged.

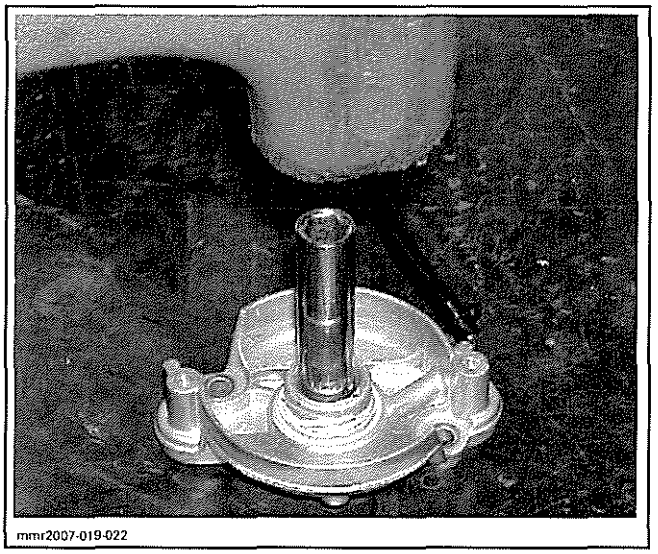
3D RAVE Valve Assembly

1. Position parts as per illustrations.



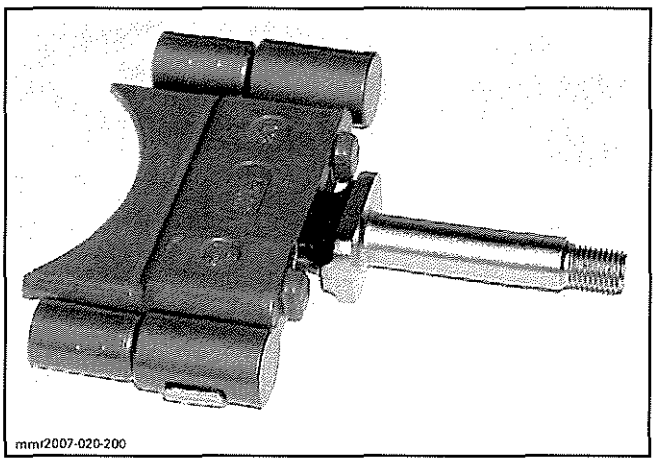
1. Oil seal
2. Gasket ring

2. Use an appropriate pusher to reinstall seals.

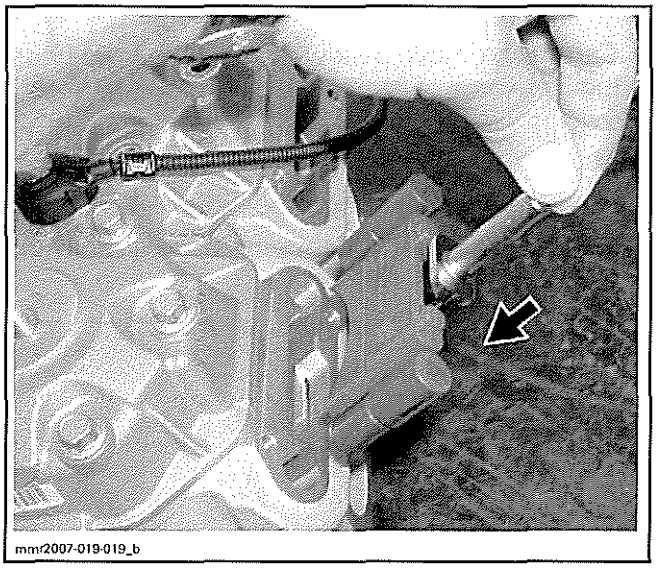


TYPICAL

3. Assemble together the main and side valves.

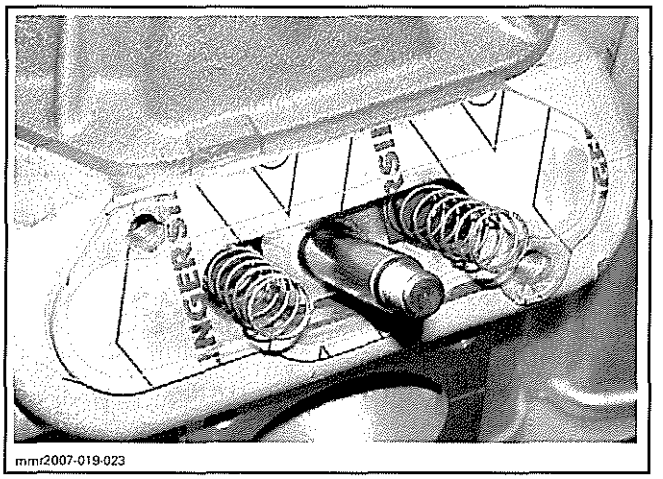


4. Insert valves together in cylinder. Install gasket.

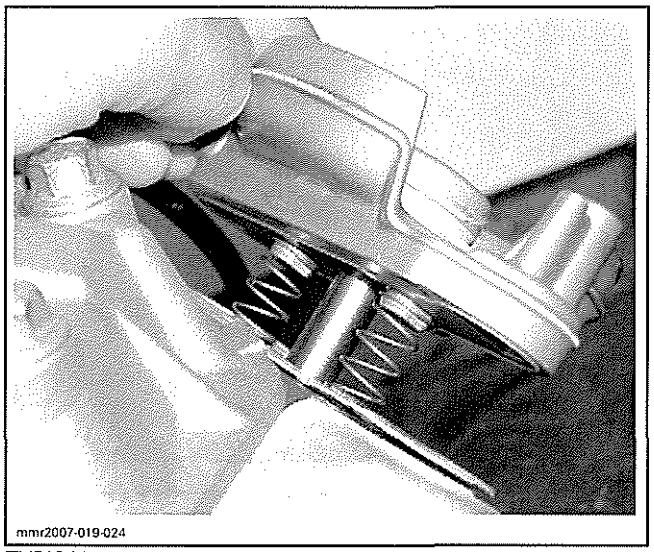


TYPICAL

5. Align springs on stud ends of valves.

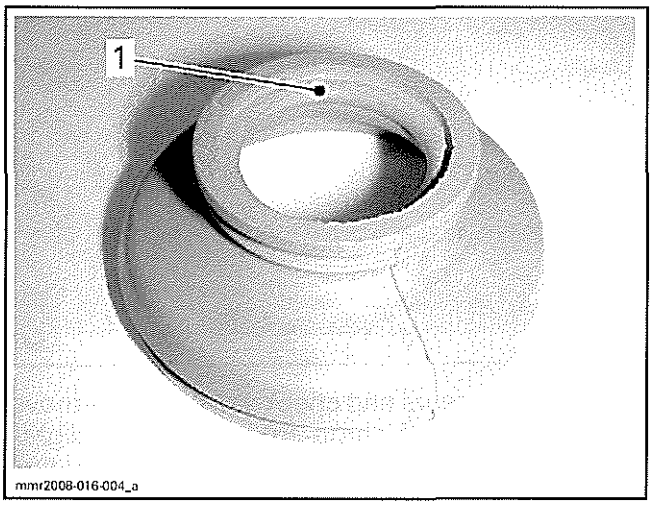


6. Apply MOLYKOTE G-N (P/N 420 297 433) to valve shaft and on seals in housing.
7. Install housing and carefully align springs on stud ends of housing.



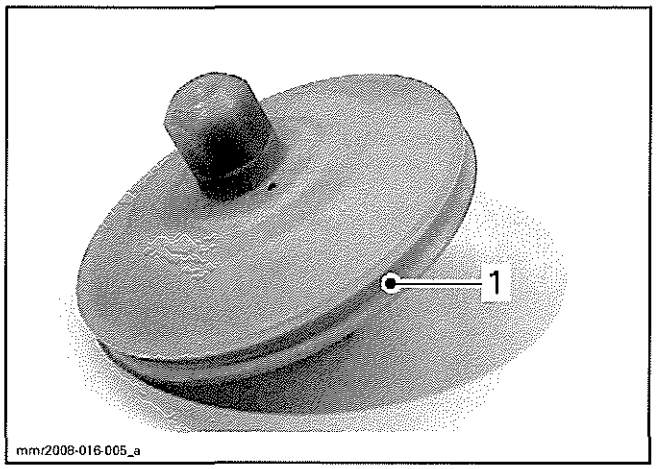
TYPICAL

8. Install lower spring on bellow.
9. Apply DREI BOND SEALING COMPOUND (P/N 420 297 906) on bellow lower rib, then install bellow and spring.



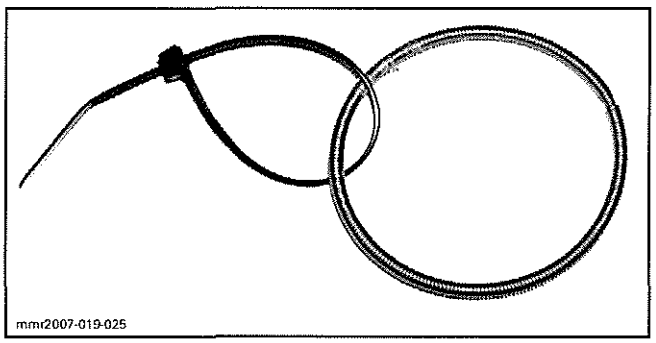
1. Apply Drei Bond here

10. Install compression spring then tighten valve piston.
11. Apply DREI BOND SEALING COMPOUND (P/N 420 297 906) on valve piston groove.

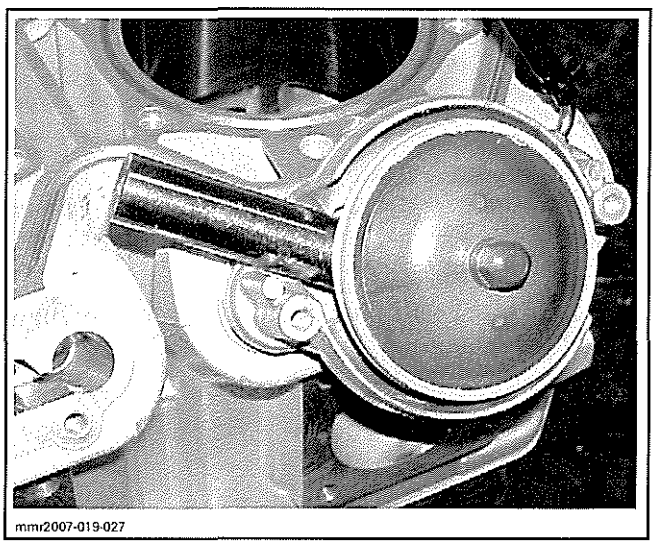


1. Apply Drei Bond here

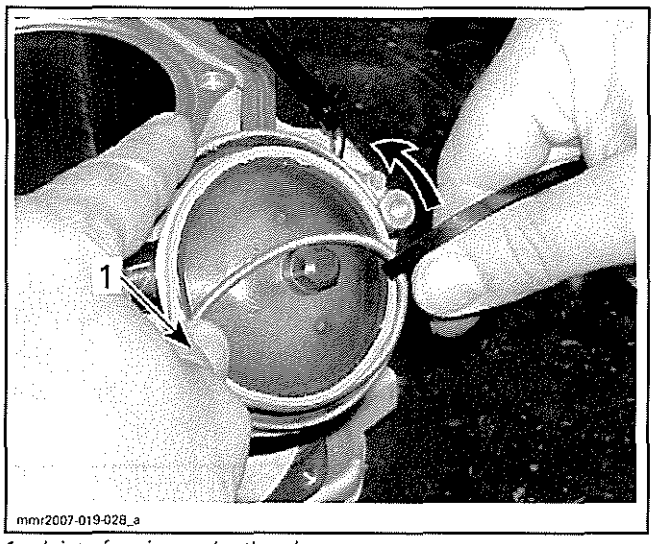
12. Position bellow on valve piston then secure top retaining spring as follows.
13. Attach a locking tie to spring.



14. Block valve piston in the open position with a suitable socket.

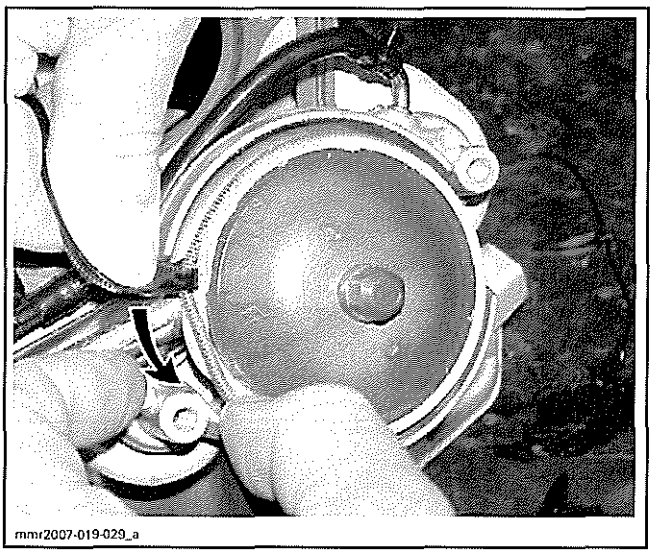


15. Position joint of spring under your thumb.
16. Hold spring with your thumb while sliding spring on the other side using the locking tie.



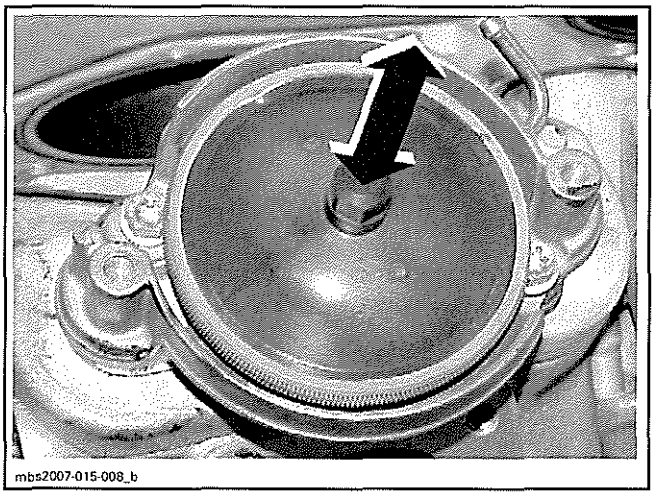
1. Joint of spring under thumb

17. Continue sliding locking tie all around the edge of valve piston.

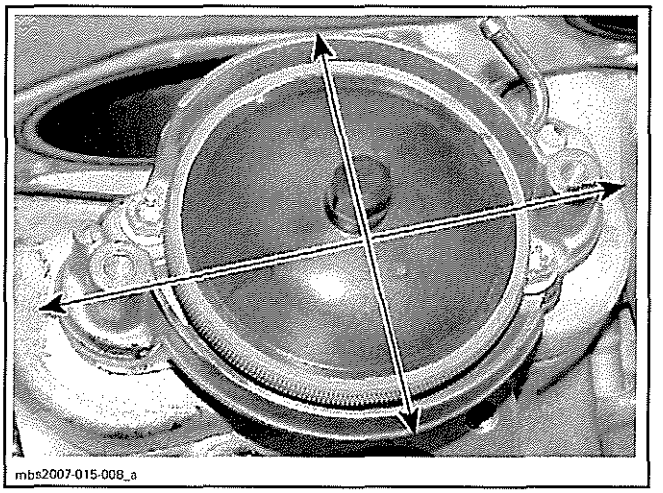


NOTE: Take care there is no strain in the bellow that could apply some bending force or torsion to the 3D RAVE valve. That may contribute to a RAVE valve jam.

18. Push and pull valve piston to make sure it moves freely.



19. When installing valve assembly in its housing, center valve horizontally and longitudinally then hand tighten screws.



20. Tighten screws and check valve for free movement again. If some friction is felt, slightly loosen screws and readjust housing then retighten screws.
21. Repeat the process until a free movement is obtained.
22. Install position sensor.
23. Position link bar on valve pistons.
24. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on valve piston threads.
25. Install retaining nuts but do not tighten yet.
26. Install lubrication and inlet hoses (vacuum/pressure).
27. Perform *3D RAVE VALVE SYNCHRONIZATION.* See procedure in this subsection.

NOTICE It is very important to perform *3D RAVE VALVES SYNCHRONIZATION* whenever link bar is removed.

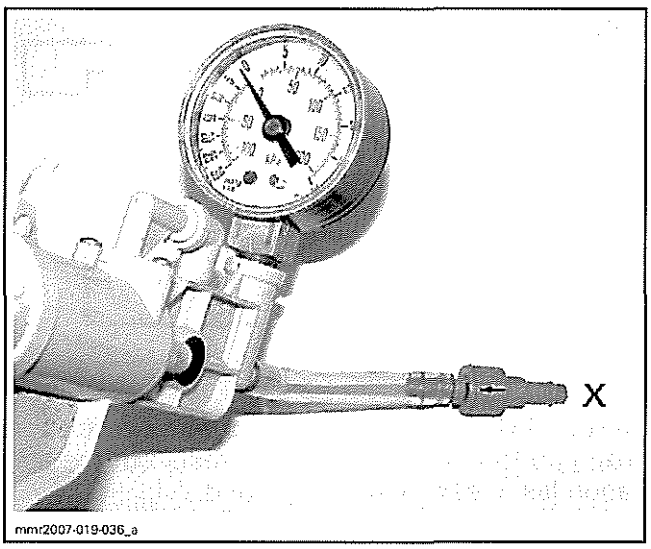
28. Bleed oil lines. Refer to *OIL PUMP (600 HO E-TEC)* in the *LUBRICATION SYSTEM* subsection.

CHECK VALVES (ACTUATOR CIRCUIT)

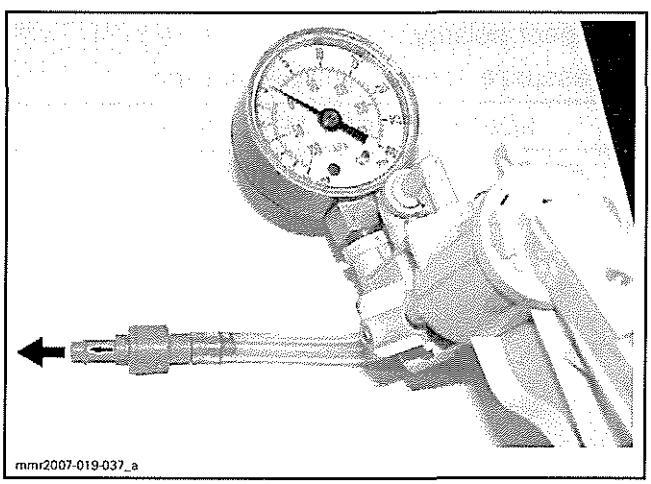
Check Valve Leak Test (Actuator Circuit)

1. Disconnect check valve.
2. Install VACUUM/PRESSURE PUMP (P/N 529 021 800) as shown.
3. Pressurize check valve to specification.

CHECK VALVE LEAK TEST (ACTUATOR CIRCUIT)	
34 kPa (5 PSI)	Valve must stand pressure



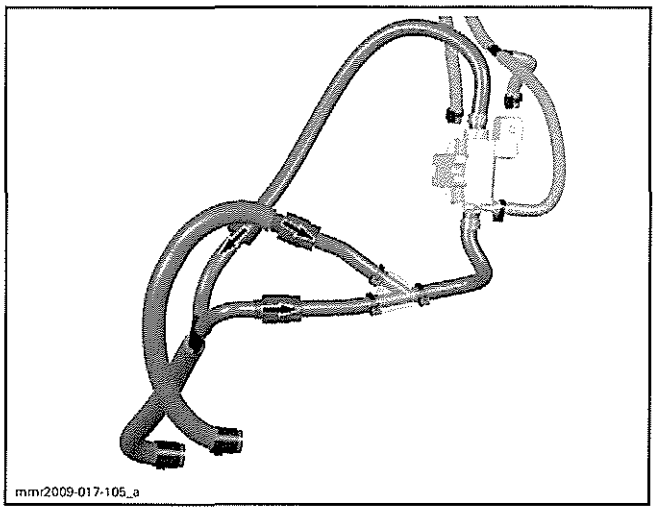
4. Install test pump on the opposite side.
5. Pressurize check valve.
6. Check that air flows freely.



Replace valve if any test failed.

Check Valve Installation (Actuator Circuit)

Ensure to reinstall all check valves in the proper direction.



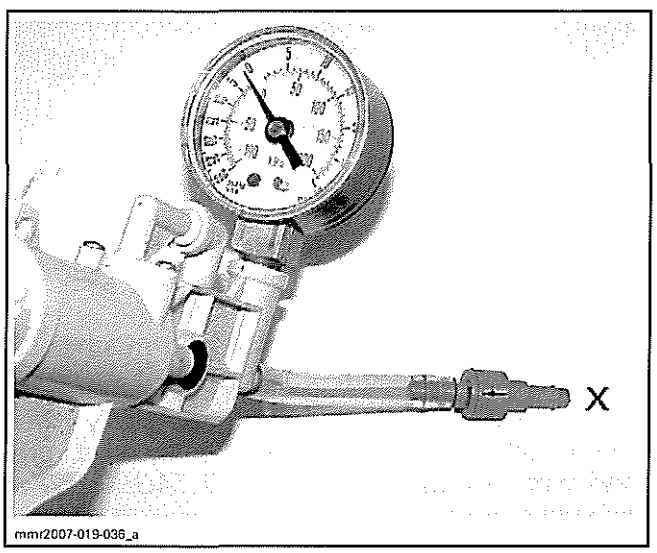
CHECK VALVE ORIENTATION

CHECK VALVES (LUBRICATION CIRCUIT)

Check Valve Test (Lubrication Circuit)

1. Disconnect check valve.
2. Install VACUUM/PRESSURE PUMP (P/N 529 021 800) as shown.
3. Pressurize check valve to specification.

CHECK VALVE LEAK TEST (LUBRICATION CIRCUIT)	
10 kPa (1.5 PSI)	Valve must stand pressure



TYPICAL

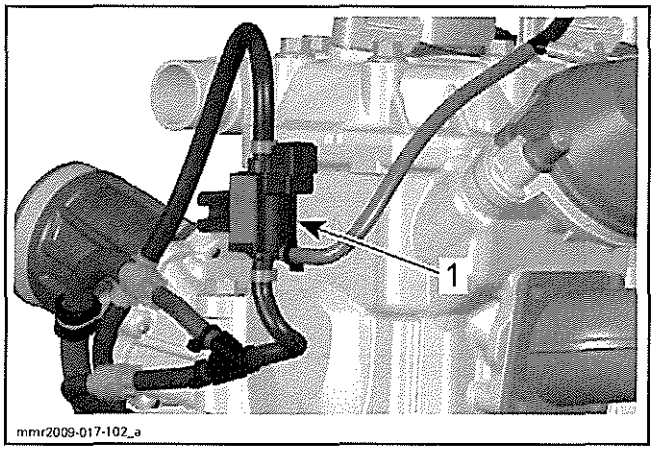
4. Install test pump on the opposite side.
5. Check that air starts to flow between 14 kPa and 24 kPa (2 PSI and 3 PSI).

Replace valve if any test failed.

SOLENOID

Solenoid Location

The solenoid is located on the RH side of the vehicle.

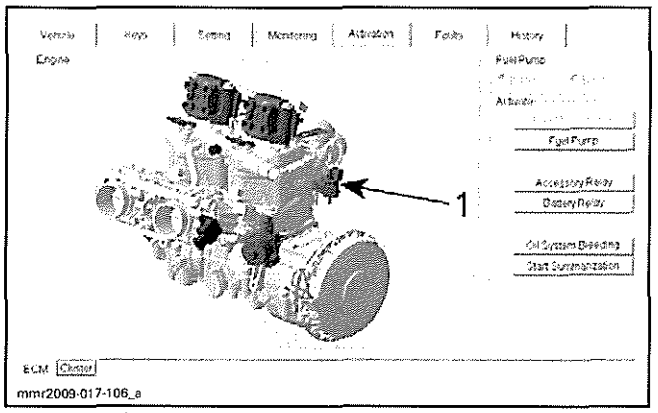


1. RAVE solenoid

Solenoid Test with B.U.D.S.

Refer to *COMMUNICATION TOOLS AND B.U.D.S. SOFTWARE* subsection for proper connection to vehicle.

Using B.U.D.S. software (E-TEC version), energize RAVE solenoid from **Activation** tab.

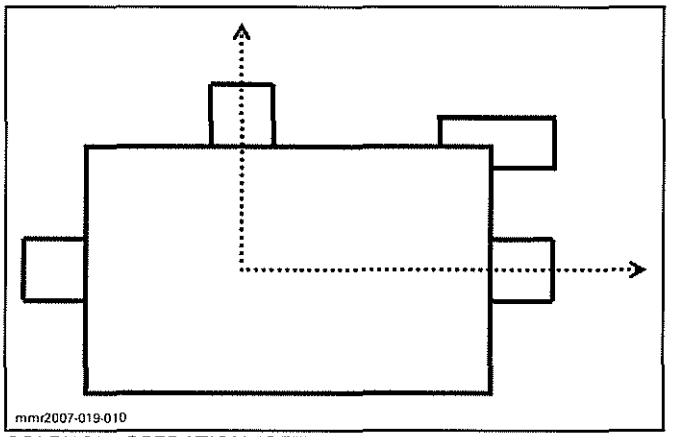


1. Activate here

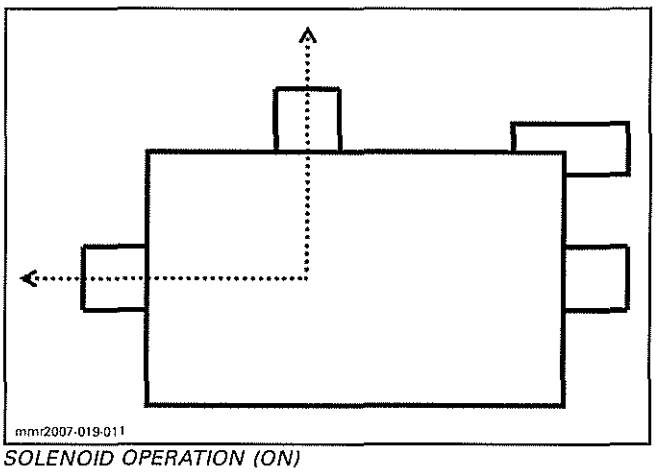
This will validate the RAVE solenoid mechanical and electrical operation.

If the solenoid does not work or works only when T-HARNESS (P/N 529 035 869) is connected, proceed with *SOLENOID INPUT VOLTAGE TEST* in this subsection.

Solenoid Leak Test



SOLENOID OPERATION (OFF)



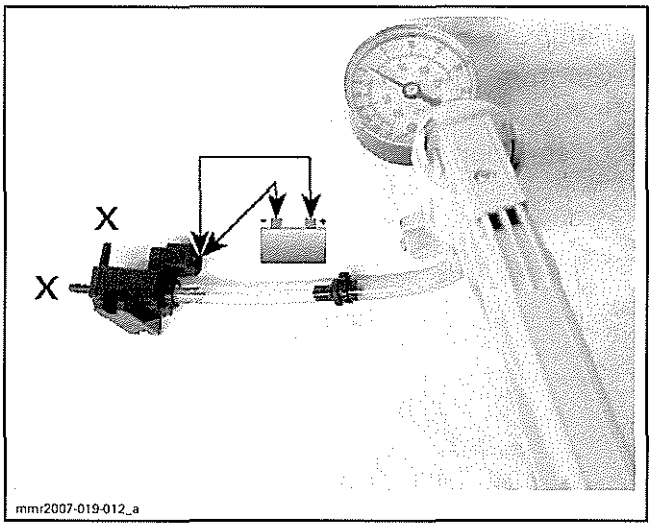
SOLENOID OPERATION (ON)

NOTE: B.U.D.S. may be used to activate solenoid when performing the following tests but the activation lasts less than one second.

Supply Hose

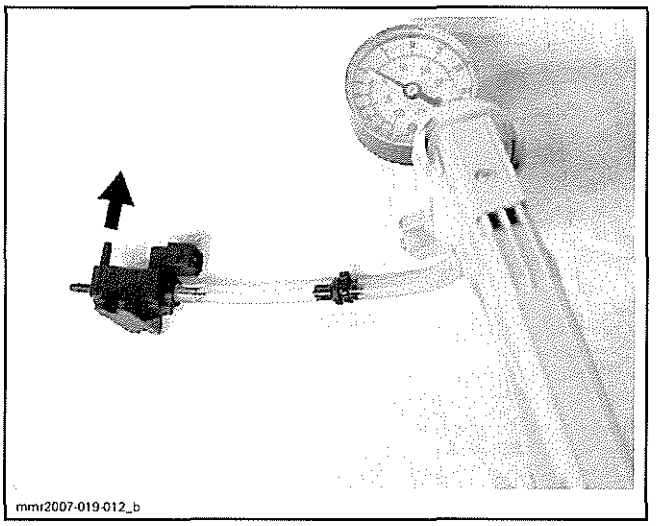
1. Disconnect supply hose from solenoid.
2. Install the VACUUM/PRESSURE PUMP (P/N 529 021 800) on solenoid nipple.
3. Supply 12 Vdc to solenoid terminals. Ensure to respect polarity.
4. Pressurize solenoid to specification.

SOLENOID LEAK TEST (SUPPLY)	
69 kPa - 103 kPa (10 PSI - 15 PSI)	Solenoid must stand pressure



SUPPLY HOSE TESTING

5. Disconnect 12 Vdc supply from solenoid.
6. Check that solenoid evacuates pressure.



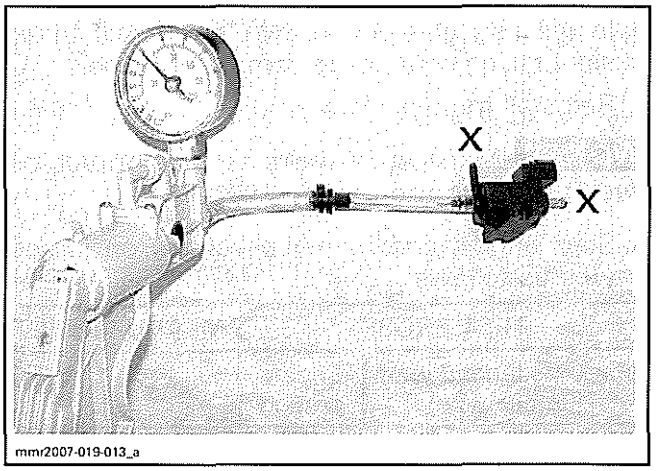
SUPPLY HOSE TESTING

If any test failed, replace solenoid.

Outlet Hose

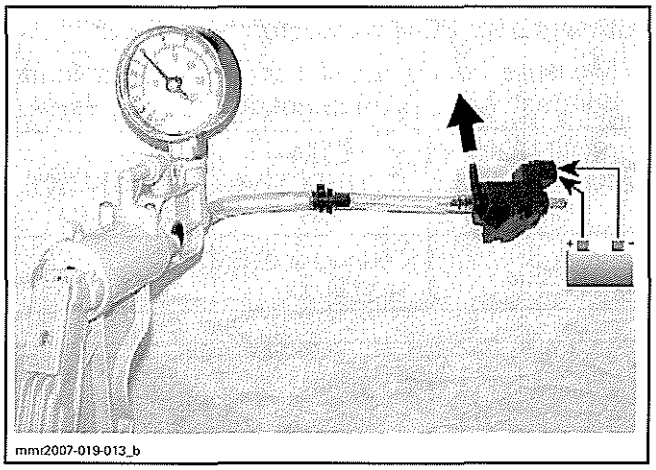
1. Disconnect outlet hose from solenoid.
2. Install the VACUUM/PRESSURE PUMP (P/N 529 021 800) on solenoid nipple.
3. Pressurize solenoid to specification.

SOLENOID LEAK TEST (OUTLET)	
69 kPa - 103 kPa (10 PSI - 15 PSI)	Solenoid must stand pressure



OUTLET HOSE TESTING

4. Supply 12 Vdc to solenoid terminals. Ensure to respect polarity.
5. Check that solenoid evacuates pressure.

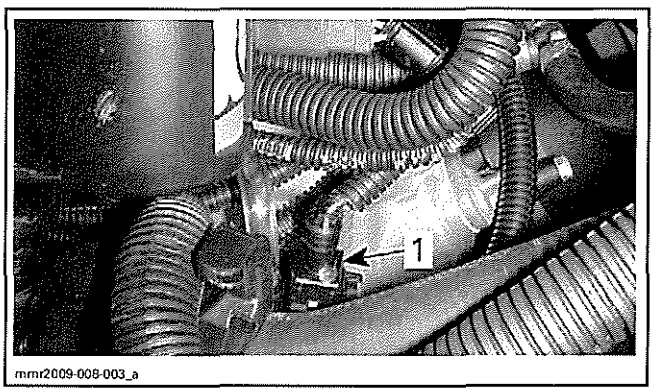


OUTLET HOSE TESTING

If any test failed, replace solenoid.

Solenoid Input Voltage Test

1. Remove muffler. Refer to *EXHAUST SYSTEM.* subsection.
2. Disconnect the connector from the solenoid.



1. Solenoid connector

3. Install a suitable jumper wire on pin 2 (harness side) taking care not to damage terminal.
4. Reinstall muffler.

NOTICE Make sure there is no contact between muffler and jumper wire.

5. Start engine and measure voltage on jumper wire as follows.

TEST PROBE		MEASUREMENT
Pin 2 (extended with jumper wire)	Engine ground	Battery voltage

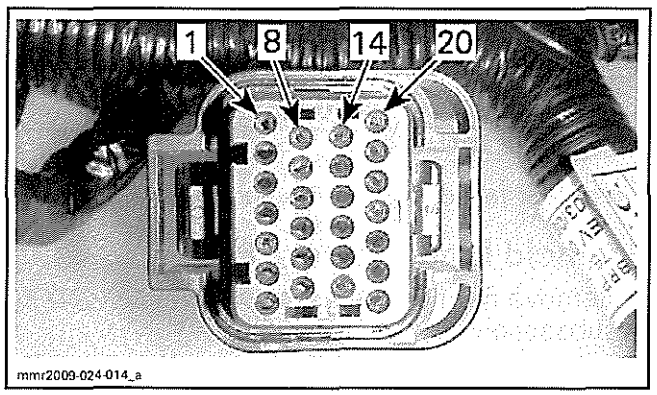
If reading is not as per specification repair/replace wiring/connector.

If solenoid does not work but the voltage supply is good, perform *SOLENOID CIRCUIT TEST.*

Solenoid Circuit Test

1. Disconnect ECM connector.
2. Measure wiring resistance between solenoid connector and ECM connector as follows.

SOLENOID CONNECTOR PIN	ECM CONNECTOR PIN	RESISTANCE
1	Connector J1B pin 22	Close to 0 Ω



ECM J1B CONNECTOR PIN OUT

If the solenoid circuit test failed, repair/replace wiring/connector.

Solenoid Replacement

1. Remove muffler. Refer to *EXHAUST SYSTEM.* subsection.

NOTE: Mark hose locations of RAVE solenoid for reinstallation.

2. Disconnect solenoid.
3. Cut the locking ties retaining the coolant hoses to the plastic bracket.
4. Remove solenoid screws.
5. Cut the small Oetiker clamps securing the hoses to the solenoid.

For installation, reverse the removal procedure.

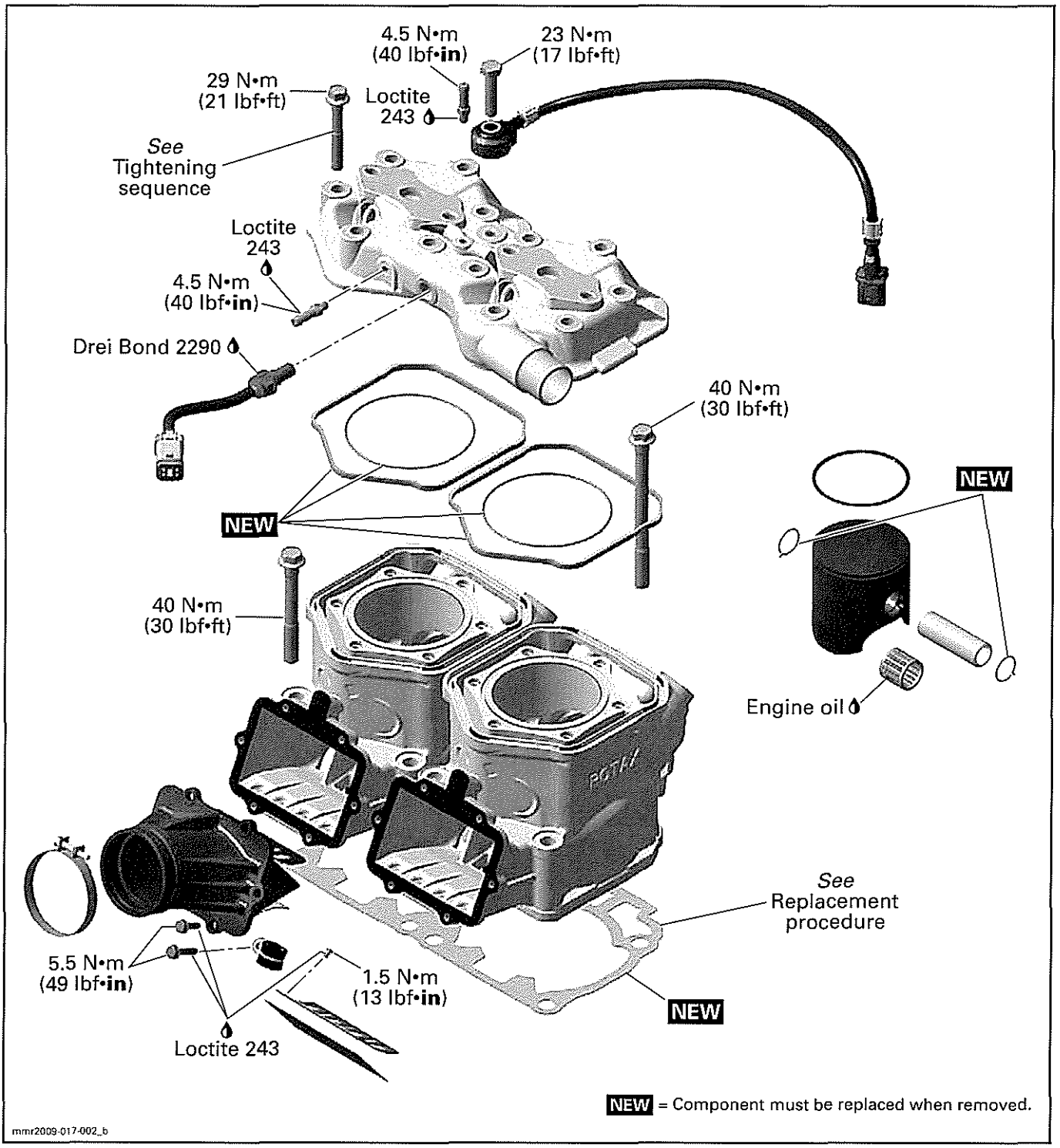
TOP END

SERVICE TOOLS

Description	Part Number	Page
PISTON CIRCLIP INSTALLER	529 035 686	133
RUBBER PAD PROTECTOR	529 023 400	132

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE CHISEL (GASKET REMOVER)	413 708 500	130–131


4.5 N•m
(40 lbf•in)
23 N•m
(17 lbf•ft)
29 N•m
(21 lbf•ft)
Loctite
243
See
Tightening
sequence
Loctite
243
4.5 N•m
(40 lbf•in)
Drei Bond 2290
40 N•m
(30 lbf•ft)
NEW
NEW
40 N•m
(30 lbf•ft)
Engine oil
See
Replacement
procedure
5.5 N•m
(49 lbf•in)
1.5 N•m
(13 lbf•in)
NEW
Loctite 243
NEW = Component must be replaced when removed.
mmr2009-017-002_b

GENERAL

Before completely disassembling the engine, check airtightness. Refer to *ENGINE LEAK TEST* subsection.

To measure internal parts, refer to *ENGINE MEASUREMENT* subsection.

During assembly or installation:

- Use torque values and service products as shown in the exploded view.
- Clean threads before applying a threadlocker. Refer to the *INTRODUCTION* subsection.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, self-locking fasteners, cotter pins, etc.) must be replaced with new ones.

NOTICE Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.

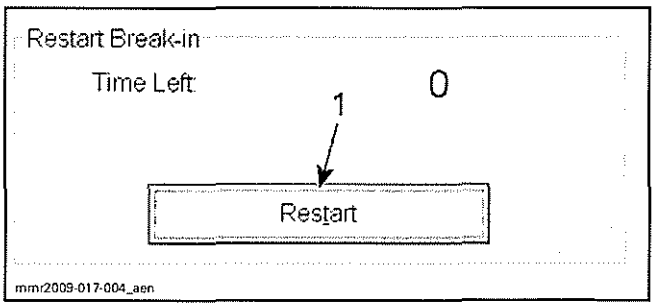
⚠ WARNING

Always disconnect the magneto connector prior to:
- Disconnecting any fuel hose.
- Removing a fuel injector.
- Removing a spark plug cable or spark plug.

Otherwise, if the engine is cranked, fuel vapors may ignite in presence of a spark creating a fire hazard.

ENGINE BREAK-IN

1. Follow *OPERATOR'S GUIDE* recommendation relating to break-in.
2. Restart break-in period in B.U.D.S. as follows:
   - 2.1 Ensure to use the latest B.U.D.S. software.
   - 2.2 Select **Setting** tab.
   - 2.3 Click on **Restart** button in **Restart Break-in** box.



1. Click on Restart

INSPECTION

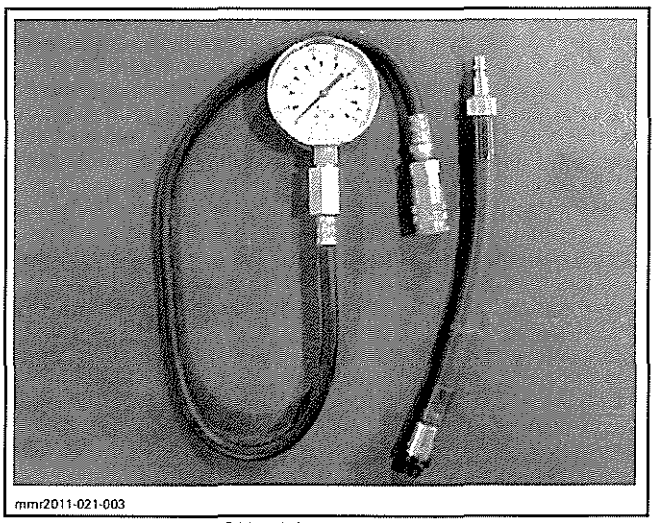
ENGINE COMPRESSION TEST

1. Remove body parts as required to access to the spark plugs.
2. Lift rear of vehicle to clear track from the ground. Support it with a wide base stand.

⚠ WARNING

Prior to measuring engine compression, ensure vehicle is properly lifted with the track off the ground.

3. Safely warm up engine.
4. Remove a spark plug.
5. Disconnect RAVE inlet hoses.
6. Install an appropriate ENGINE COMPRESSION TOOL on engine.



ENGINE COMPRESSION TOOL

Depress throttle lever to wide open position.

Press start button for a few seconds.

Check if engine compression is according to specification.

ENGINE COMPRESSION SPECIFICATION	
SERVICE LIMIT	758 kPa (110 PSI)

PROCEDURES

REED VALVES

Reed Valve Removal

1. Remove throttle body, refer to *E-TEC DIRECT FUEL INJECTION* subsection.
2. Remove screws retaining intake adapters.
3. Remove reed valves.

Reed Valve Inspection

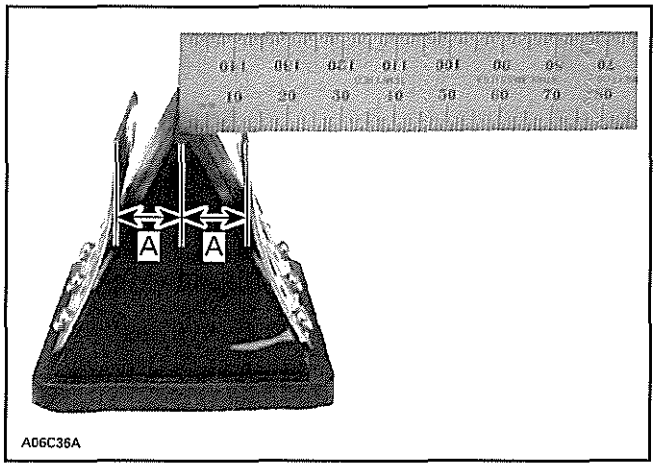
Check reed valve for proper tightness.

There must not be any play between blade and valve body when exerting finger pressure on blade at blade stopper location.

If there is play, turn blade upside down and recheck.

If there is still a play, replace blade and/or valve body.

Check distance from blade stopper outer edge to center of reed valve block.



TYPICAL
A. Blade stopper distance

BLADE STOPPER DISTANCE
17.5 mm to 18.25 mm (.689 in to .719 in)

NOTE: Bend the blade stopper as required to obtain the proper distance.

Reed Valve Installation

The installation is the reverse of the removal procedure. However, pay attention to the following

Blades have a curved shape. Install with their curve facing reed block.

NOTE: Blade stoppers may slightly interfere with cylinder during installation. Adjusted distance will be reduced automatically upon installation.

CYLINDER HEAD

Cylinder Head Removal

1. Release fuel pressure using B.U.D.S. software. Refer to *ELECTRIC FUEL PUMP (E-TEC)* in *FUEL TANK AND FUEL PUMP* subsection.
2. Remove LH side panels.
3. Remove drive belt guard. refer to *DRIVE BELT* subsection.
4. Remove primary and secondary air intake silencers, refer to *AIR INTAKE SYSTEM* subsection.
5. Drain coolant, refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.
6. Disconnect fuel lines. Refer to *FUEL SYSTEM* subsection.
7. Disconnect injectors electrical connectors.
8. Remove spark plugs.
9. Remove knock sensor.
10. Disconnect temperature sensor connector.
11. Disconnect coolant hoses at cylinder head.
12. Disconnect throttle body heater inlet hose at cylinder head.
13. Remove cylinder head screws.
14. Remove cylinder head from cylinders.

Cylinder Head Inspection

Check cylinder head for cracks, warp or other damages. Replace if necessary.

NOTE: Refer to *ENGINE MEASUREMENT* for the measurement procedures.

Cylinder Head Warpage

CYLINDER HEAD WARPAGE SPECIFICATION	
SERVICE LIMIT	0.5 mm (.02 in) for total length of cylinder head

Cylinder Head Cleaning

Scrape off any carbon deposits from cylinder head.

Use LOCTITE CHISEL (GASKET REMOVER) (P/N 413 708 500).

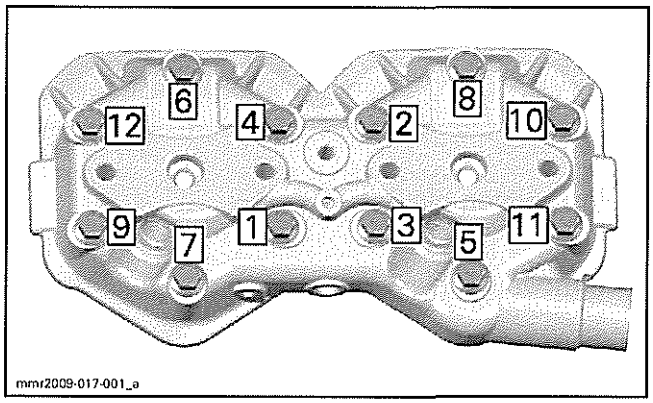
Cylinder Head Installation

The installation is the reverse of removal procedure, however pay attention to the following.

Install NEW rubber ring and round O-rings on each cylinder.

Tighten cylinder head screws to specification following the illustrated sequence.

CYLINDER HEAD SCREWS TORQUE	
FIRST STEP	15 N•m (133 lbf•**in**)
SECOND STEP	29 N•m (21 lbf•ft)



TIGHTENING SEQUENCE

Refill cooling system, refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

Tighten knock sensor retaining screw to specification.

KNOCK SENSOR SCREW TORQUE
23 N•m (17 lbf•ft)

CYLINDERS

Cylinder Removal

1. Refer to *EXHAUST SYSTEM* subsection and remove:
   - Muffler
   - Tune pipe
   - Exhaust manifold.
2. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 HO E-TEC AND 1200 4-TEC)* subsection and remove:
   - Driven pulley
   - Countershaft bearing support.
3. Disconnect throttle bodies from intake adapters and set aside.
4. Refer to *RAVE* subsection and remove:
   - RAVE valves cover
   - RAVE valves link bar.
5. Disconnect RAVE valves oil lines and vacuum/pressure hoses.
6. Remove *CYLINDER HEAD* as explained in this subsection.
7. Remove cylinder screws.
8. Remove cylinders from crankcase.

Cylinder Inspection

Check cylinders for cracks and scoring on the top and bottom of cylinders. Replace if necessary.

NOTE: Refer to *ENGINE MEASUREMENT* for the measurement procedures.

Cylinder Taper

SERVICE LIMIT
0.10 mm (.004 in)

Cylinder Out of Round

SERVICE LIMIT
0.08 mm (.003 in)

Cylinder Cleaning

Using LOCTITE CHISEL (GASKET REMOVER) (P/N 413 708 500), scrape off any carbon deposits from cylinder exhaust port.

Cylinder Installation

The installation is the reverse of removal procedure, however pay attention to the following.

Install a NEW base gasket of the same thickness as the old one. Refer to *CYLINDER BASE GASKET*.

Lubricate cylinder wall with new injection oil or equivalent.

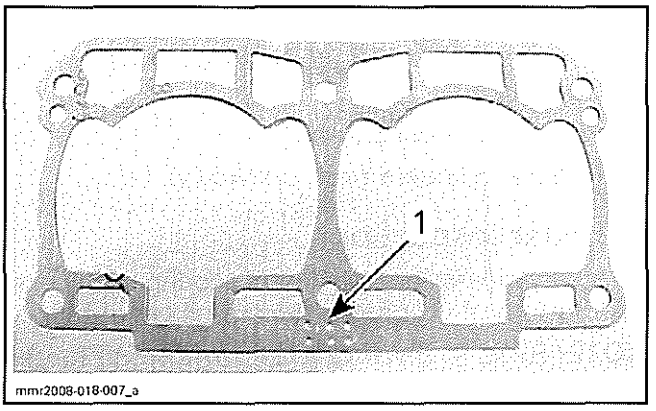
CYLINDER BASE GASKET

Cylinder Base Gasket Replacement

NOTICE **Always install a gasket of the proper thickness. Failure to do so may cause detonation and severe engine damage.**

1. Ensure top surface of crankcase is clean.
2. Install a NEW cylinder base gasket of the same thickness as the one that was installed at factory.

NOTE: The number of dots corresponds to the thickness in tenth of millimeter. A 5 dots gasket has a thickness of 0.5 mm (.02 in). Note that the 1.0 mm (.039 in) gasket has no dots.



TYPICAL
1. Gasket thickness identification dots

NOTE: If thickness of the factory installed gasket is unknown, install a 7 dots gasket (0.7 mm (.028 in)) as a base line.

3. Install cylinders.
4. Carefully clean cylinder screws, specifically under screw head.
5. Tighten cylinder screws to specification in a crisscross sequence.

CYLINDER SCREWS TORQUE	
M8	29 N•m (21 lbf•ft)
M10	40 N•m (30 lbf•ft)

6. Measure piston projection as described in *ENGINE MEASUREMENT* subsection.

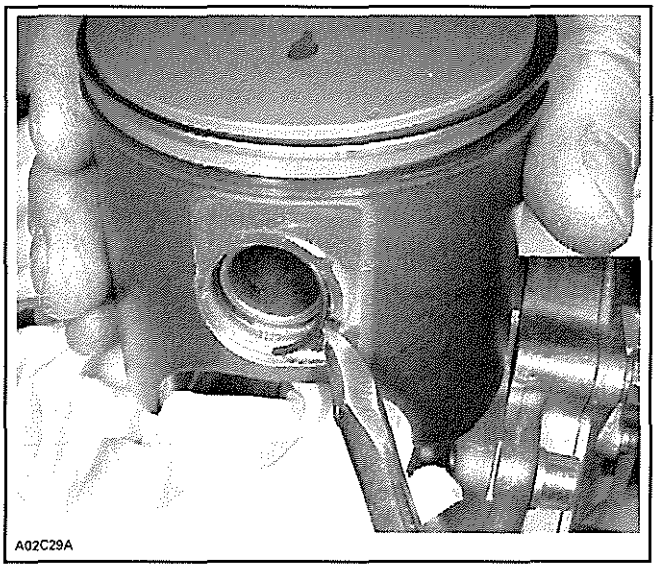
Piston Projection Measurement

PISTON PROJECTION SPECIFICATION	
SERVICE LIMIT	0.90 mm to 1.10 mm (.035 in to .043 in)

PISTONS

Piston Removal

1. Remove *CYLINDERS*, as explained in this subsection.
2. Place a clean cloth or RUBBER PAD PROTECTOR (P/N 529 023 400) over crankcase.
3. Using a pointed tool inserted in piston notch, remove both circlips from piston.
4. Discard circlips.



TYPICAL

5. Push piston pin out of piston.
6. Remove piston.
7. Remove bearing.

Piston Inspection

Inspect piston for scoring, cracking or other damage.

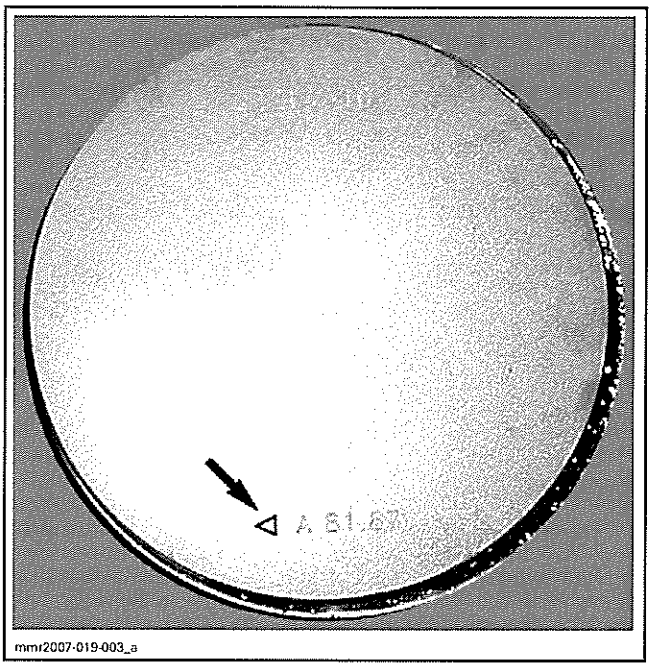
NOTE: Refer to *ENGINE MEASUREMENT* for the measurement procedures.

MEASUREMENT	MAXIMUM
Ring/piston groove clearance	0.20 mm (.0079 in)
Ring end gap	1.0 mm (.039 in)
Piston/cylinder clearance	0.20 mm (.008 in)

Piston Cleaning

Scrape off any carbon deposits from piston dome.

NOTE: The arrow on the piston dome must be visible after cleaning.

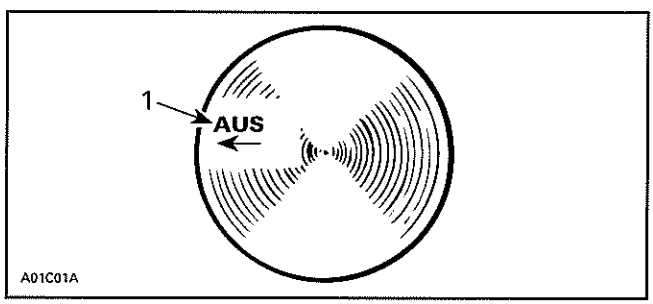


EXHAUST DIRECTION INDICATION

Clean the piston ring groove with a groove cleaner tool or with a piece of broken ring.

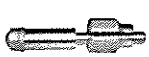
Piston Installation

1. Lubricate needle bearing with injection oil.
2. Insert bearing into connecting rod.
3. Place piston over connecting rod with the letters "AUS" (over an arrow on the piston dome) facing down to exhaust port.



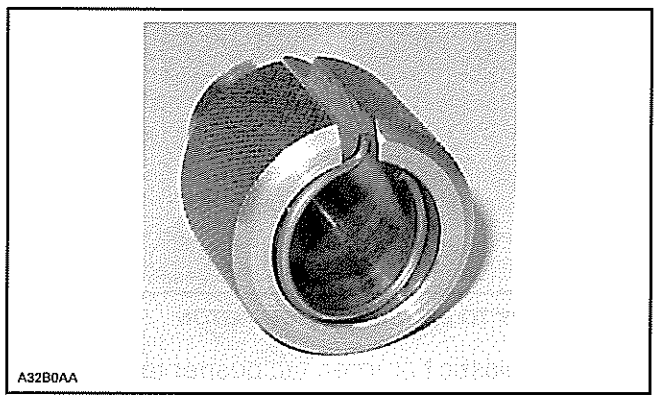
1. Exhaust

4. Push piston pin trough piston.
5. Use appropriate piston circlip installer to install NEW mono-hook circlips.

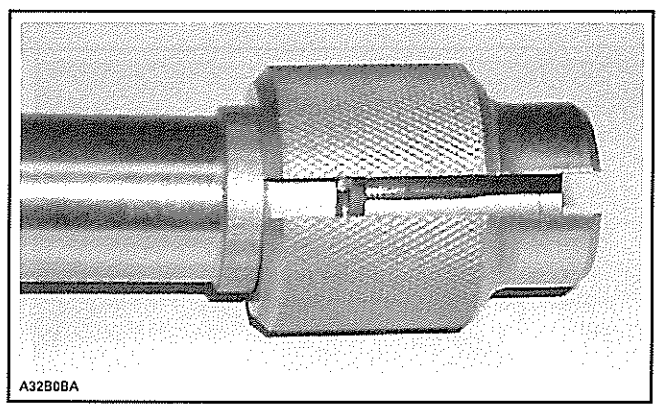
TOOL	
PISTON CIRCLIP INSTALLER (P/N 529 035 686)	

NOTICE Always install NEW mono-hook circlip(s). If circlip installation fails at the first attempt, always retry with a new one.

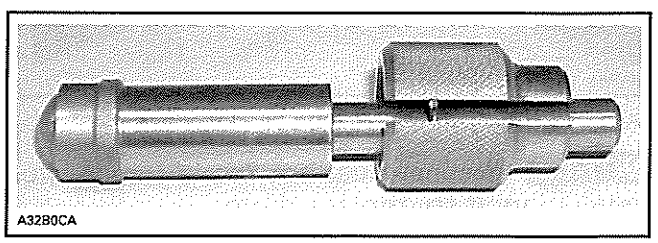
6. Insert circlip into support so that, when installed in piston groove, the gap will be below the tab.

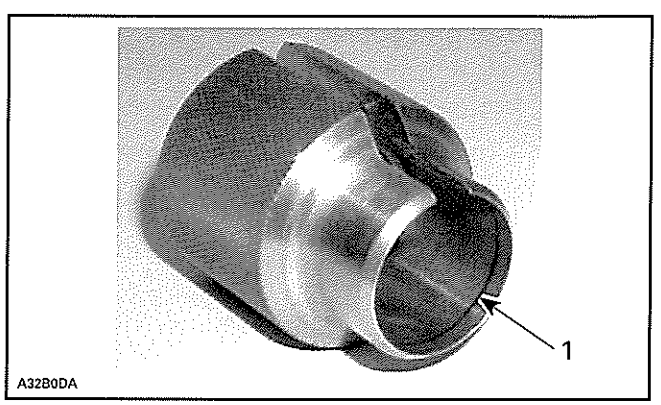


7. With round end of pusher, position circlip perpendicular to the support axis.

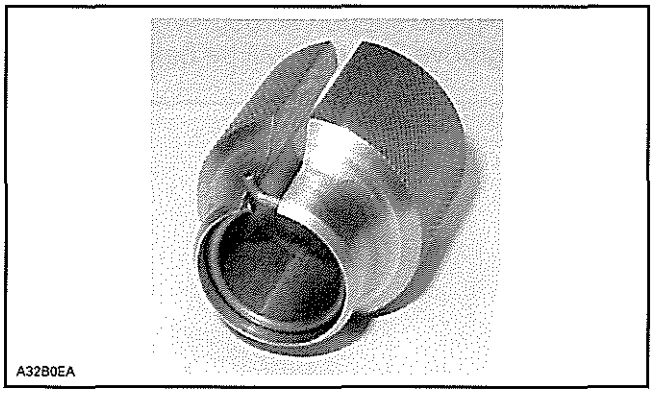


8. With the other end of the pusher, push circlip into the support groove.





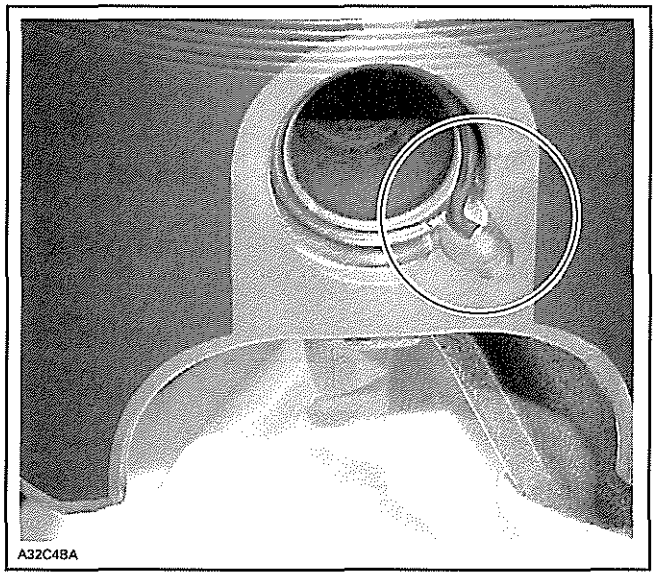
1. Groove



CIRCLIP READY TO BE INSTALLED ON PISTON

9. Using a plastic hammer, tap pusher to put circlip in place.

NOTE: Make sure to install NEW circlips with the gap below the tab exactly as shown on the following photo.



GAP BELOW THE TAB

NOTICE Circlips must not move freely after installation; if so, replace them.

10. Install all other removed parts as the reverse of removal procedure.

BOTTOM END

SERVICE TOOLS

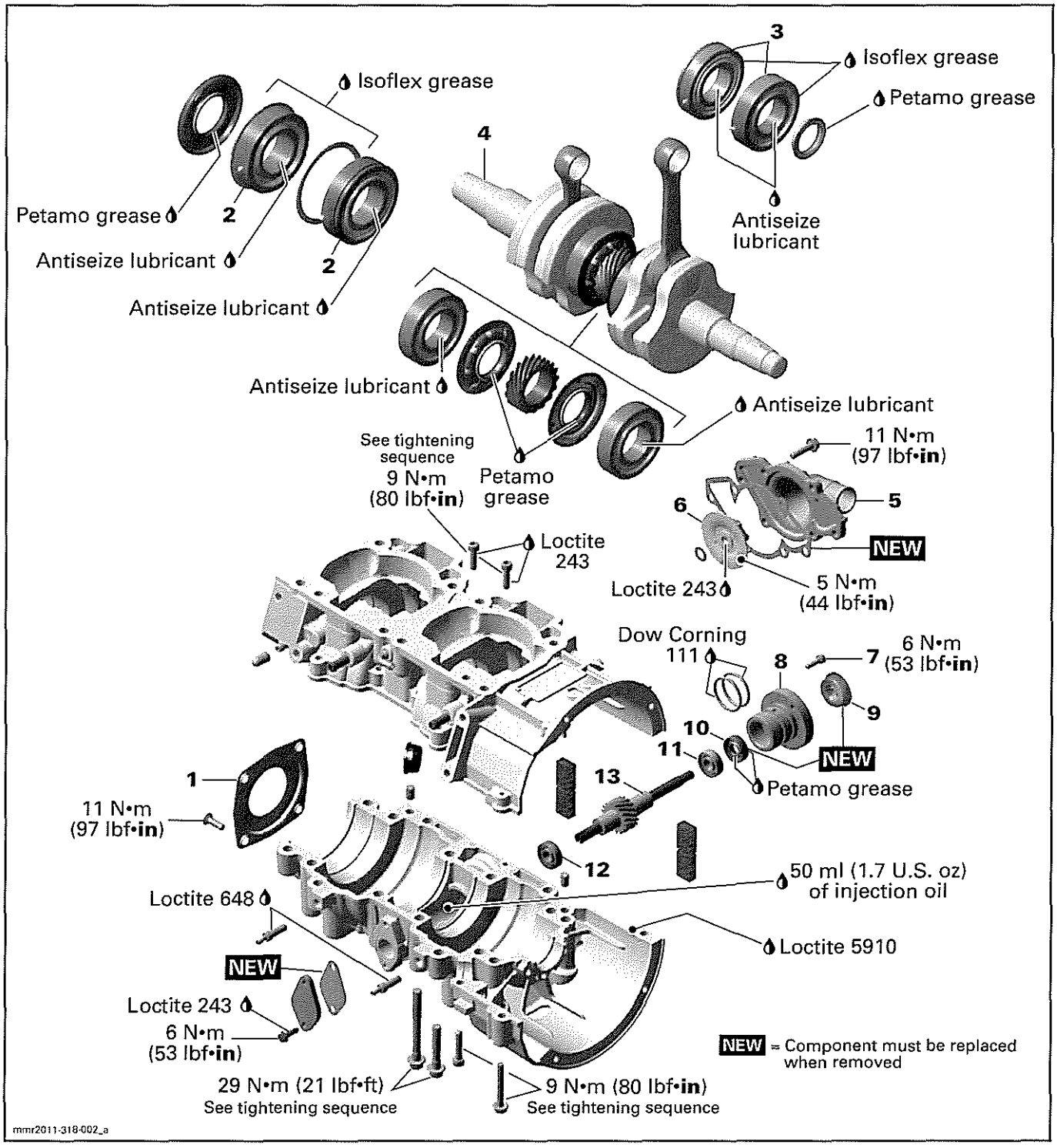
Description	Part Number	Page
BEARING HEATER	529 035 969	146
BEARING INSTALLER (PTO)	529 035 990	147
CERAMIC SEAL INSTALLER	529 036 014	141
CRANKSHAFT BEARING INSTALLER (MAG)	529 035 980	147
CRANKSHAFT BEARING PULLER	529 036 004	144
CRANKSHAFT DISTANCE GAUGE	529 035 968	147
CRANKSHAFT PROTECTOR (MAG)	420 876 557	144
CRANKSHAFT PROTECTOR (PTO)	420 876 552	144
HALF-RINGS	420 977 479	144
OIL SEAL GUIDE	529 035 822	141
OIL SEAL PUSHER	529 035 757	140
PULLER RING	420 977 494	144
SUPPORT PLATE	529 035 976	147
TEMPERATURE INDICATOR STICK	529 035 970	146

SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
SNAP-ON BEARING SEPARATOR	CJ 951	145
SNAP-ON MANUAL IMPACT DRIVER	PIT120	142
SPX/OTC BEARING SEPARATOR	1124	145

SERVICE PRODUCTS

Description	Part Number	Page
ISOFLEX GREASE TOPAS NB 52	293 550 021	148
LOCTITE 5910	293 800 081	142
LOCTITE 767 (ANTISEIZE LUBRICANT)	293 800 070	145
LOCTITE CHISEL (GASKET REMOVER)	413 708 500	142
PULLEY FLANGE CLEANER	413 711 809	145
XPS LUBE	293 600 016	145


3
Isoflex grease
Petamo grease
Isoflex grease
4
Petamo grease
2
Antiseize lubricant
2
Antiseize lubricant
Antiseize lubricant
Antiseize lubricant
Antiseize lubricant
See tightening sequence
9 N•m (80 lbf•in)
Petamo grease
11 N•m (97 lbf•in)
6
5
NEW
Loctite 243
Loctite 243
5 N•m (44 lbf•in)
Dow Corning 111
8
7
6 N•m (53 lbf•in)
9
10
11
NEW
Petamo grease
1
11 N•m (97 lbf•in)
13
12
50 ml (1.7 U.S. oz) of injection oil
Loctite 648
Loctite 5910
NEW
Loctite 243
6 N•m (53 lbf•in)
NEW = Component must be replaced when removed
29 N•m (21 lbf•ft)
See tightening sequence
9 N•m (80 lbf•in)
See tightening sequence
mmr2011-318-002_a

GENERAL

Engine removal is required to repair bottom end except for the water pump impeller.

All oil seals and gaskets must be discarded and replaced with new ones when crankcase is split.

Clean all metal components in a non-ferrous metal cleaner.

To measure internal parts, refer to *ENGINE MEASUREMENT* subsection.

During assembly or installation:
- Use torque values and service products as shown in the exploded view.
- Clean threads before applying a threadlocker. Refer to the *INTRODUCTION* subsection.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, self-locking fasteners, cotter pins, etc.) must be replaced with new ones.

NOTICE Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.

⚠ WARNING

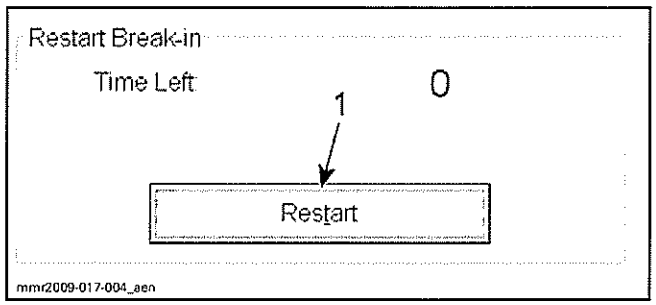
Always disconnect the magneto connector prior to:
- Disconnecting any fuel hose.
- Removing a fuel injector.
- Removing a spark plug cable or spark plug.

Otherwise, if the engine is cranked, fuel vapors may ignite in presence of a spark creating a fire hazard.

ENGINE BREAK-IN

NOTICE After a repair involving major parts replacement, a break-in period must be observed.

1. Follow *OPERATOR'S GUIDE* recommendation relating to break-in.
2. Restart break-in period in B.U.D.S. as follows:
   - 2.1 Ensure to use the latest B.U.D.S. software.
   - 2.2 Select **Setting** tab.
   - 2.3 Click on **Restart** button in **Restart Break-in** box.



1. Click on Restart

PROCEDURES

WATER PUMP

Water Pump Removal

Engine In Vehicle

Refer to *BODY* subsection and remove:
- Hood
- RH side panel.

Refer to *EXHAUST SYSTEM* subsection and remove:
- Tuned pipe
- Muffler.

Remove starter. Refer to *STARTING SYSTEM* subsection.

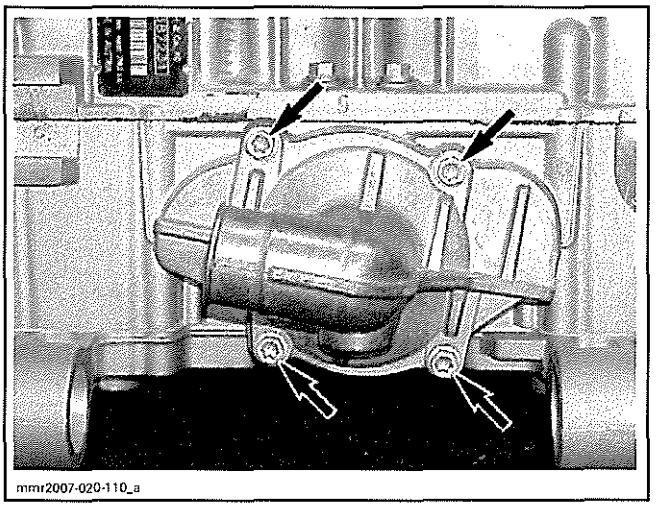
Put a large drain pan under vehicle bottom pan.

Unplug the coolant hose from the water pump cover.

Refer to *ENGINE OUT OF VEHICLE* to complete procedure.

Engine Out of Vehicle

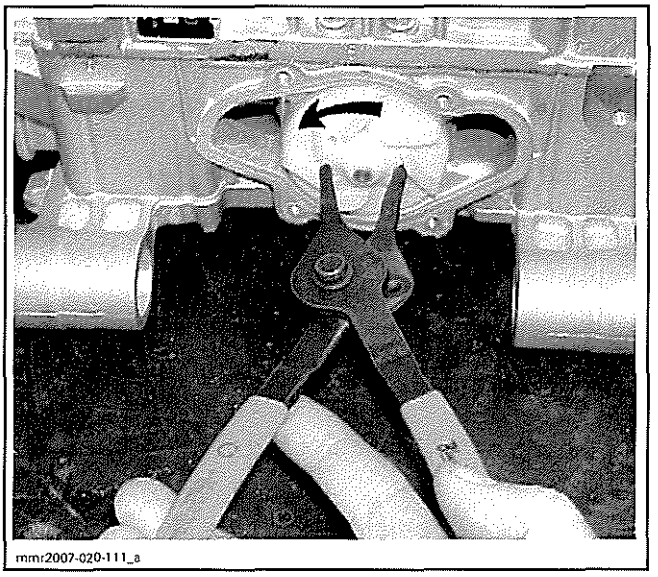
Remove water pump cover **no. 5**.



TYPICAL

Remove impeller no. 6 by turning it counterclockwise.

NOTICE Be careful not to damage impeller fins.



TYPICAL

Clean gasket surfaces of water pump cover and crankcase.

Water Pump Installation

The installation is the reverse of removal procedure. However, pay attention to the following details.

Install a NEW gasket.

Tighten screws of water pump cover to specification in a crisscross sequence.

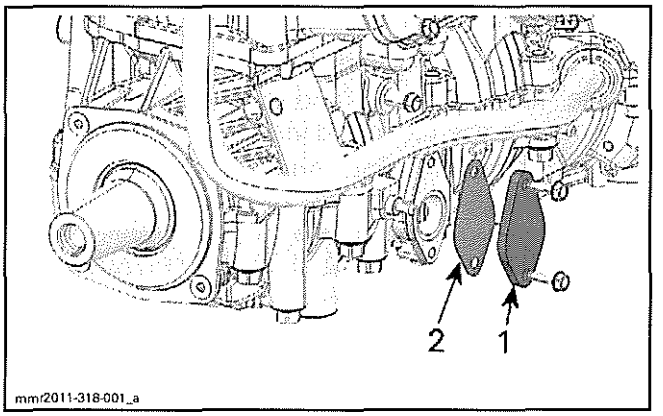
WATER PUMP COVER SCREWS TORQUE
11 N•m (97 lbf•**in**)

BEARING CARRIER AND PUMP SHAFT

Bearing Carrier and Pump Shaft Removal

Remove the cover plate located at the back of engine.

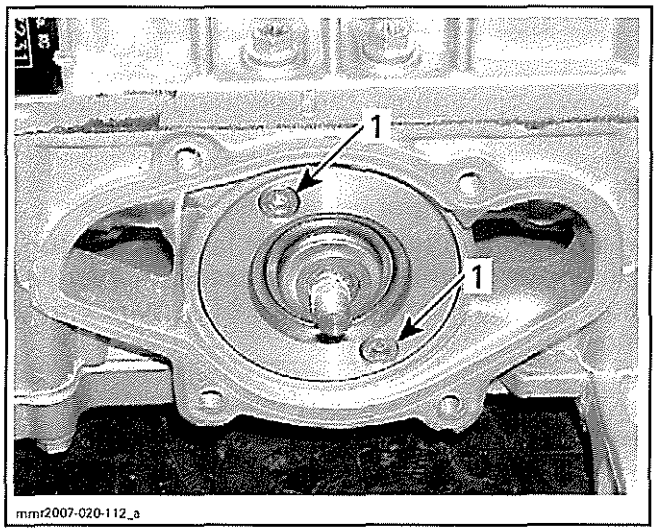
Discard cover plate gasket.



1. *Cover plate*
2. *Cover plate gasket*

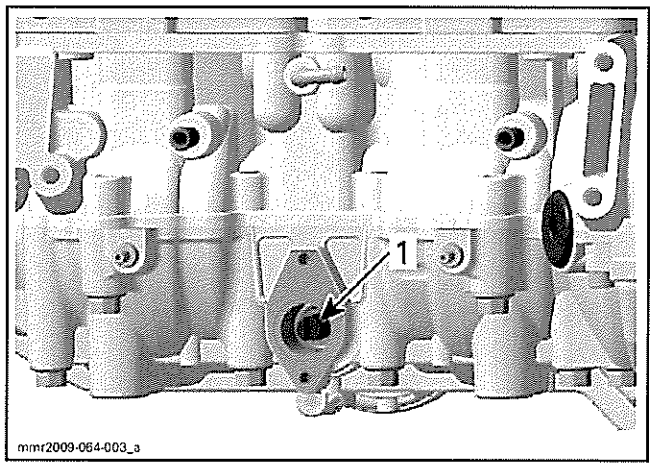
Remove *WATER PUMP*. See procedure in this subsection.

Remove bearing carrier retaining screws no. 7.



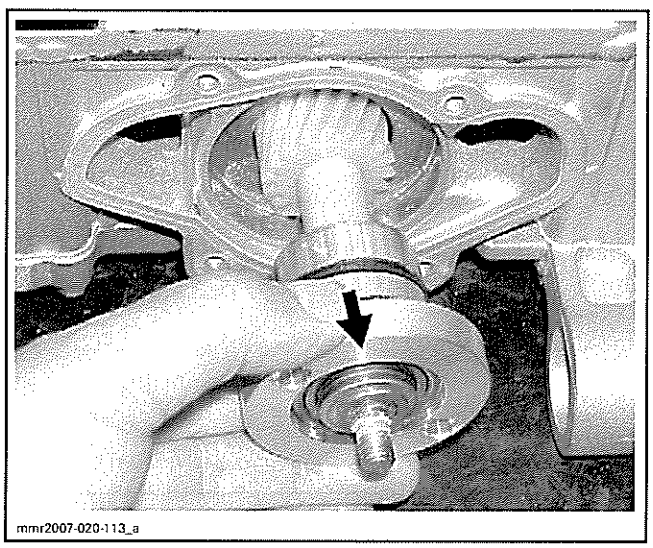
TYPICAL
1. *Bearing carrier retaining screws*

Push pump shaft out while turning shaft to release it from crankshaft worm gear.



TYPICAL
1. Push out shaft here

Extract bearing carrier and pump shaft.



TYPICAL

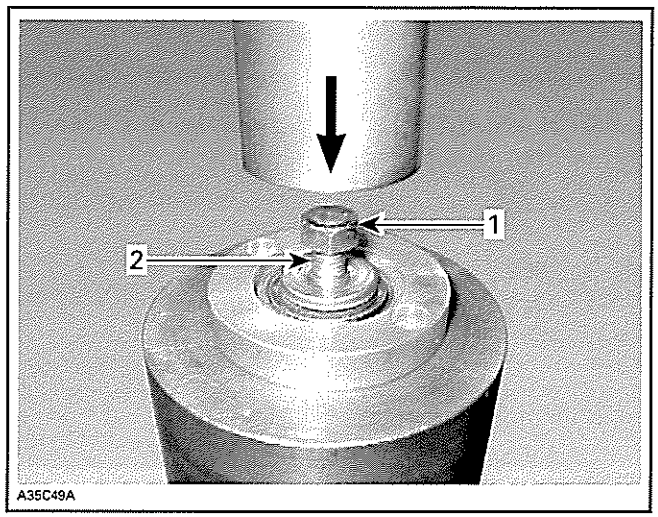
Bearing Carrier and Pump Shaft Disassembly

NOTE: The pump shaft cannot be disassemble without damaging the ceramic seal and oil seal.

Protect the threads of shaft with a suitable M8 nut.

Properly support bearing carrier.

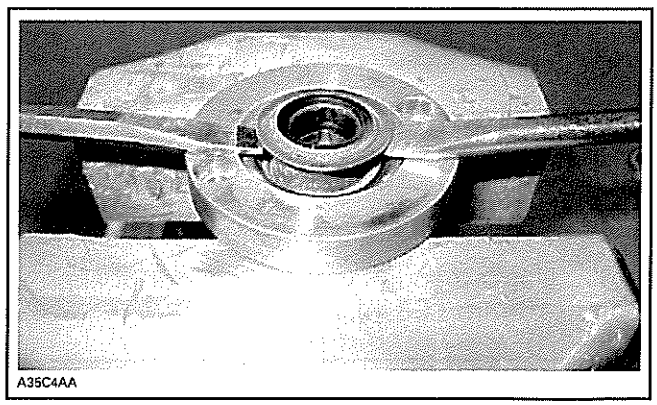
Push pump shaft out using a press.



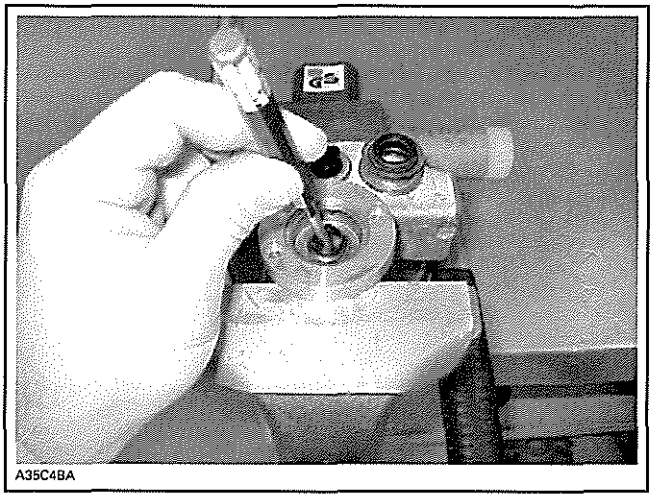
TYPICAL
1. M8 nut
2. Shaft

NOTICE Pay attention not to damage the bearing carrier during disassembly. Marks or other damages will lead to coolant or oil leakage.

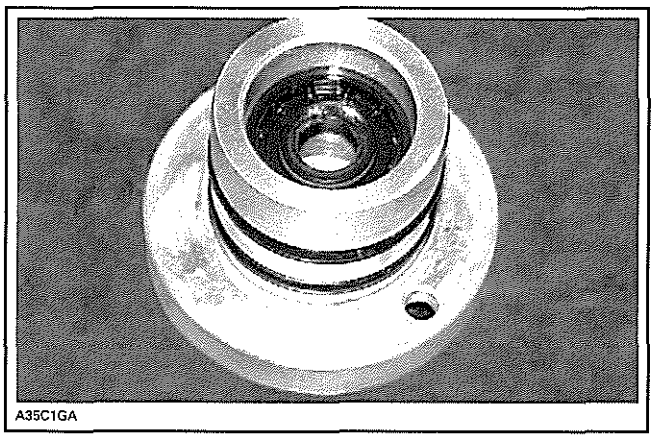
Pry inner part of ceramic seal no. 9 out.



Push out bearing no. 11 from the bearing carrier using an appropriate pusher.

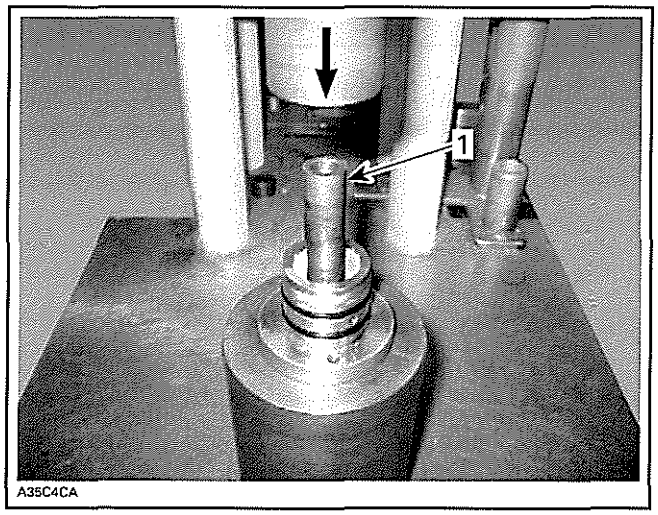

A35C4BA

Push oil seal **no. 10** out.


A35C1GA

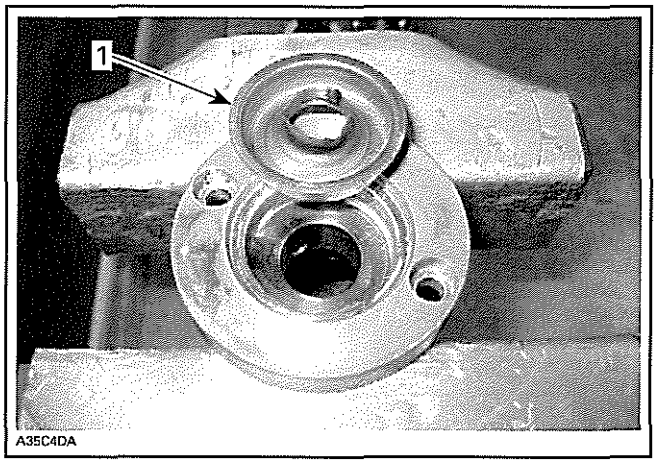
Carefully press the outer part of ceramic seal out.

NOTE: Use a mandrel with a diameter of approximately 16 mm (.63 in).



A35C4CA

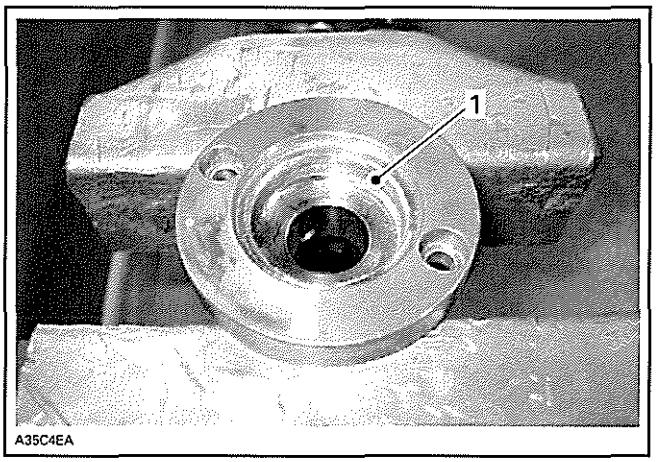
1. 16 mm (.63 in) mandrel



A35C4DA

1. Outer part of ceramic seal

Remove sealant from bearing carrier with sand paper no. 180.



A35C4EA

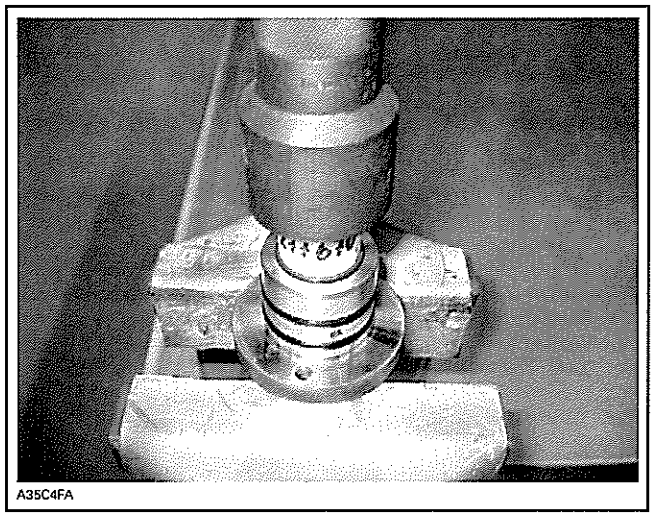
1. Remove sealant

Bearing Carrier and Pump Shaft Reassembly

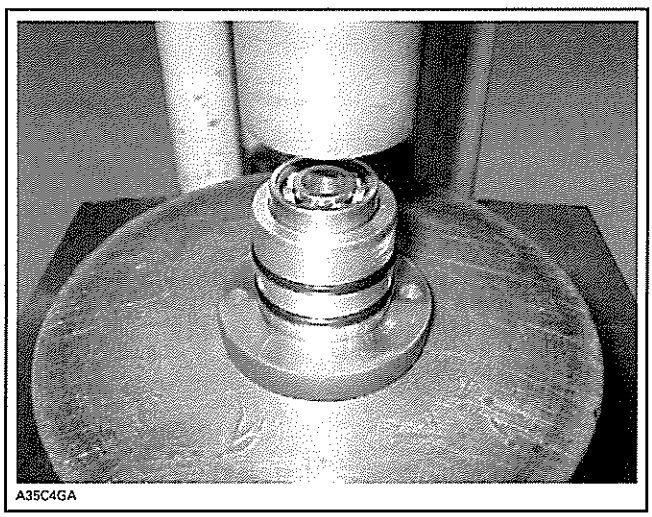
Reverse disassembly procedure and pay attention to the following.

NOTE: Never put oil in the press fit area of the oil seal and ceramic seal.

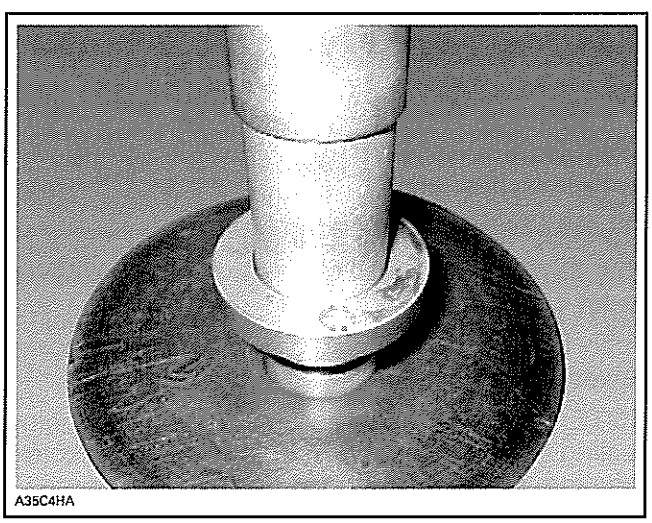
Push the **NEW** oil seal **no. 10** in bearing carrier using the OIL SEAL PUSHER (P/N 529 035 757).


A35C4FA

Press bearing no. 11 into bearing carrier no. 8.

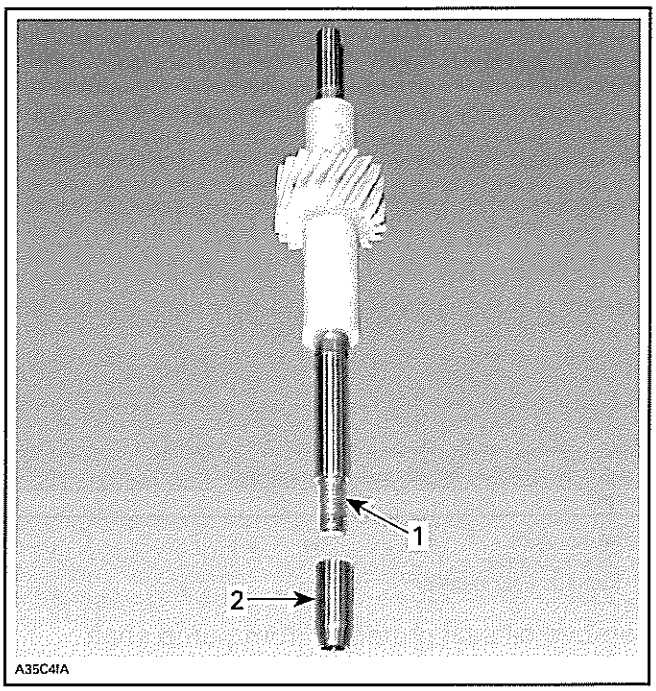

A35C4GA

Push the NEW ceramic seal no. 9 in bearing carrier no. 8 using the CERAMIC SEAL INSTALLER (P/N 529 036 014).


A35C4HA

NOTICE Never use a hammer for the ceramic seal installation. Only use a press to avoid damaging the ceramic component.

Put OIL SEAL GUIDE (P/N 529 035 822) on pump shaft no. 13.



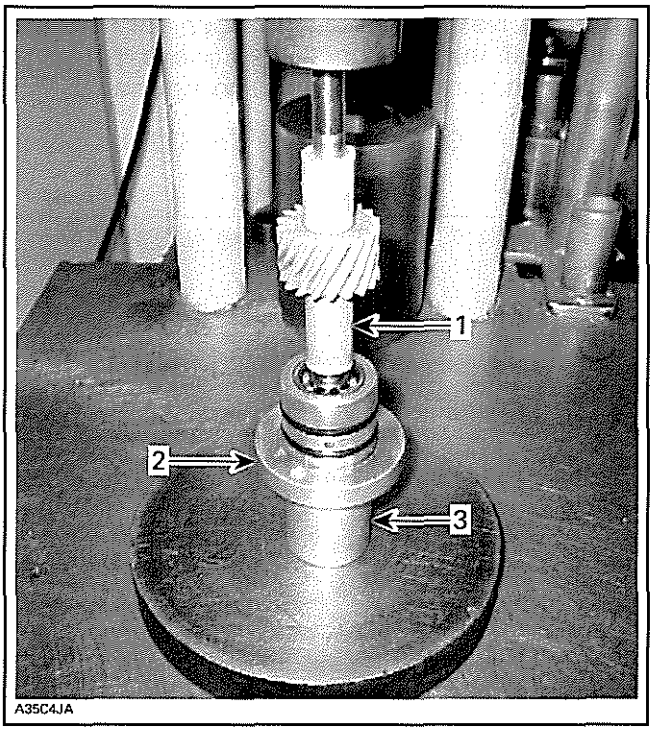
A35C4IA

1. *Pump shaft*
2. *Oil seal protector*

Press pump shaft no. 13 into the bearing carrier no. 8 with appropriate force.

NOTICE Inadequate force will damage the oil seal and bearing.

NOTE: During installation support the ceramic seal using the CERAMIC SEAL INSTALLER (P/N 529 036 014) as shown on the following illustration.



1. Pump shaft
2. Bearing carrier
3. Ceramic seal installer

Remove oil seal protector from pump shaft.

Bearing Carrier and Pump Shaft Installation

The installation is the reverse of removal procedure, however pay attention to the following.

Pour 50 ml (1.7 U.S. oz) of injection oil in the cavity under crankshaft worm gear.

Install pump shaft and bearing carrier in crankcase while turning shaft to mesh gears.

Tighten bearing carrier retaining screws no. 7 to specification.

BEARING CARRIER SCREWS TORQUE
6 N•m (53 lbf•in)

CRANKCASE

Crankcase Disassembly

Remove engine from vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.

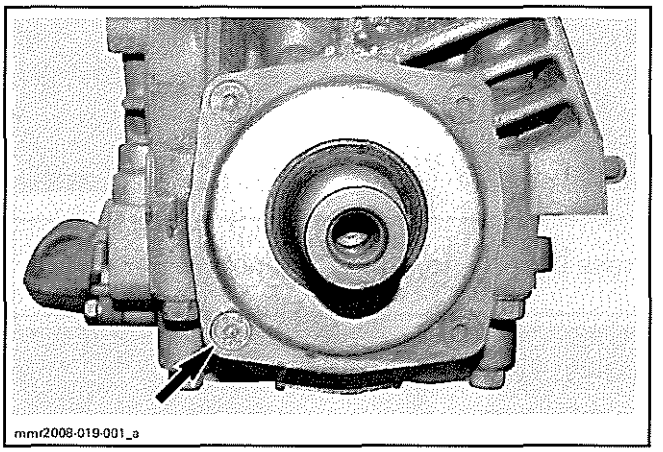
Remove cylinder head and cylinders. Refer to *TOP END* subsection.

Refer to *MAGNETO SYSTEM* subsection and remove:
- Magneto cover
- Crankshaft position sensor
- Magneto flywheel
- Stator.

Remove front engine supports.

Remove PTO oil seal cover no. 1.

NOTE: Tap screw heads to break the Loctite bond or use a SNAP-ON MANUAL IMPACT DRIVER (P/N PIT120).



TYPICAL

Remove all screws that retain crankcase halves together.

Split crankcase and remove crankshaft.

Crankcase Cleaning

Clean all metal components in a non-ferrous metal cleaner.

Use LOCTITE CHISEL (GASKET REMOVER) (P/N 413 708 500) accordingly.

NOTICE Never use a sharp object to remove sealant as score marks incurred are harmful to crankcase sealing.

Crankcase Inspection

Check crankcase for cracks or other damages. Replace if necessary.

Crankcase Assembly

Install crankshaft in lower crankcase. See *CRANKSHAFT* for procedure.

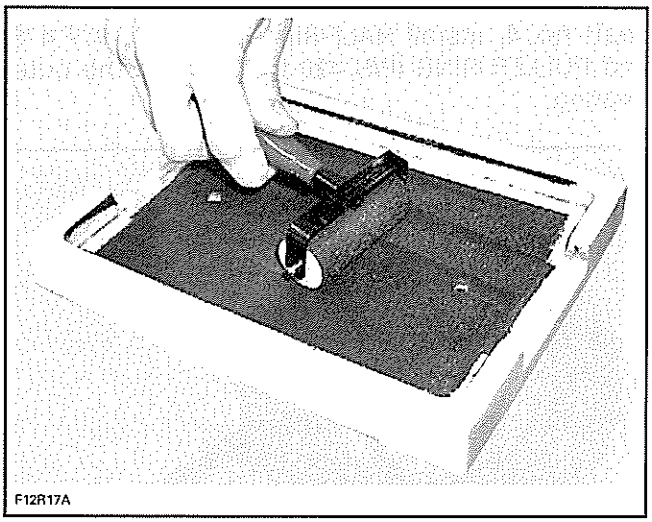
Pour 50 ml (1.7 U.S. oz) of injection oil in the cavity under crankshaft worm gear.

Apply LOCTITE 5910 (P/N 293 800 081) on crankcase halves. Proceed as follows.

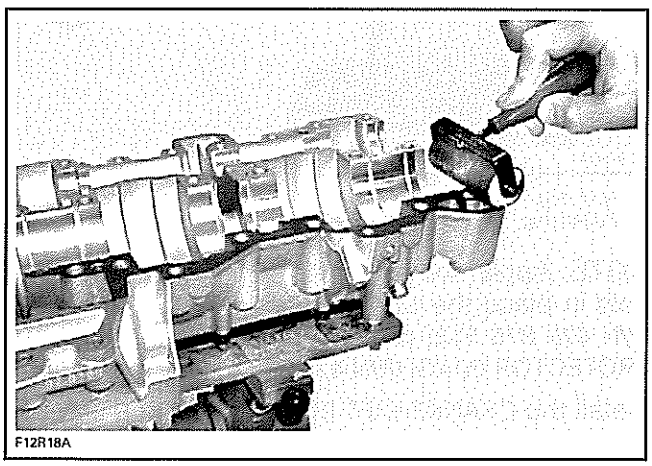
NOTE: The total assembly sequence, including sealing compound application and crankcase torquing, must be performed within 10 minutes.

Use a plexiglass plate and apply some sealant on it. Use a 50 - 75 mm (2 - 3 in) soft rubber roller and spread the sealant to get a thin uniform coat on the plate (spread as necessary).

When ready, apply the sealant on crankcase mating surfaces.



TYPICAL



TYPICAL

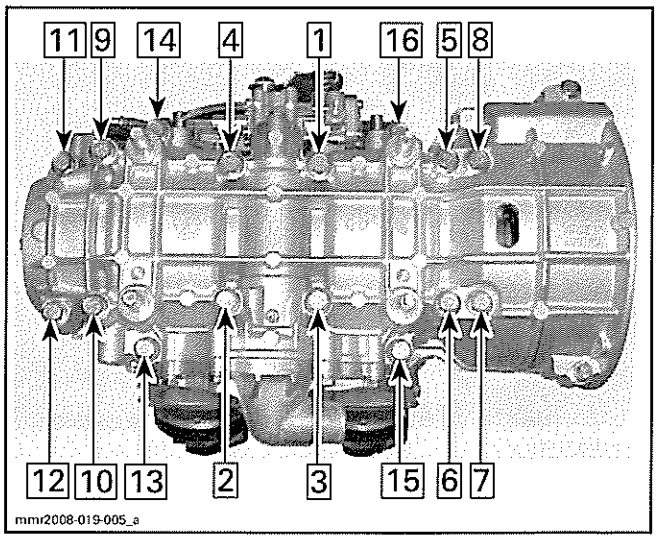
NOTE: If you do not use the roller method, you may use your finger to uniformly distribute the sealant.

Assemble both crankcase halves.

Install M8 screws (16x) in crankcase.

Tighten M8 screws to specification as per illustrated sequence.

CRANKCASE M8 SCREWS TORQUE	
FIRST STEP	18 N•m (159 lbf•**in**)
FINAL STEP	29 N•m (21 lbf•ft)

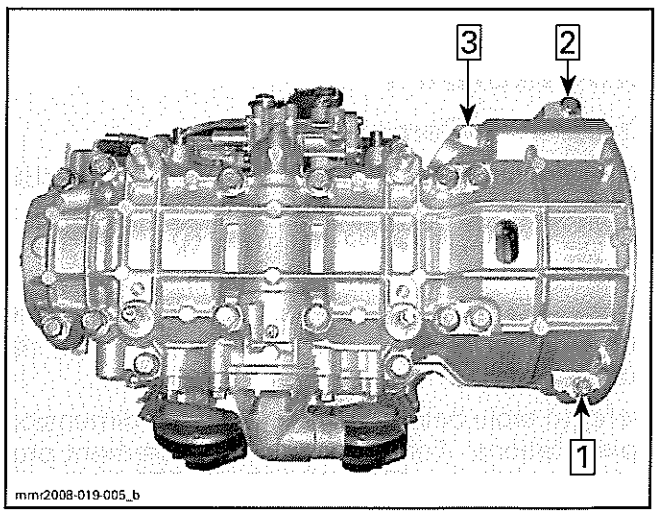


TIGHTENING SEQUENCE - M8 SCREWS

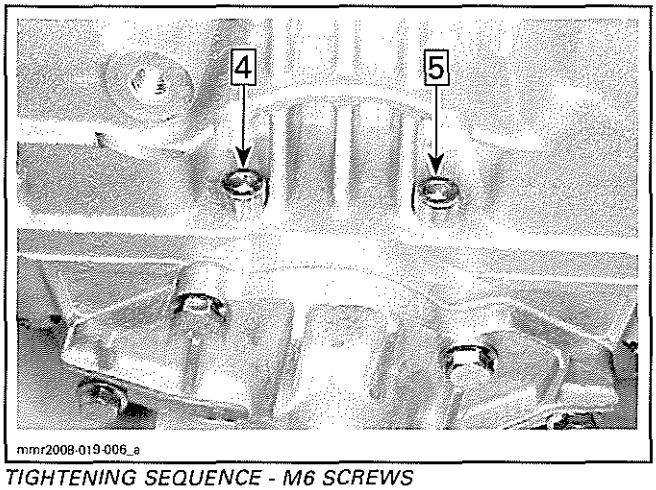
Install M6 screws (5x) in crankcase.

Tighten M6 screws to specification as per illustrated sequence.

CRANKCASE M6 SCREWS TORQUE
9 N•m (80 lbf•**in**)



TIGHTENING SEQUENCE - M6 SCREWS



TIGHTENING SEQUENCE - M6 SCREWS

Install PTO oil seal cover no. 1.

Tighten oil seal cover to specification.

OIL SEAL COVER SCREWS TORQUE
11 N•m (97 lbf•**in**)

NOTE: It is recommended to test engine cooling system for leaks after engine assembly, before installation in vehicle. Refer to *COOLING SYSTEM* subsection.

CRANKSHAFT

Crankshaft Removal

To remove crankshaft, use crankcase disassembly procedure.

Crankshaft Inspection

Check crankshaft bearings. They must turn smoothly and without noise. Replace as required.

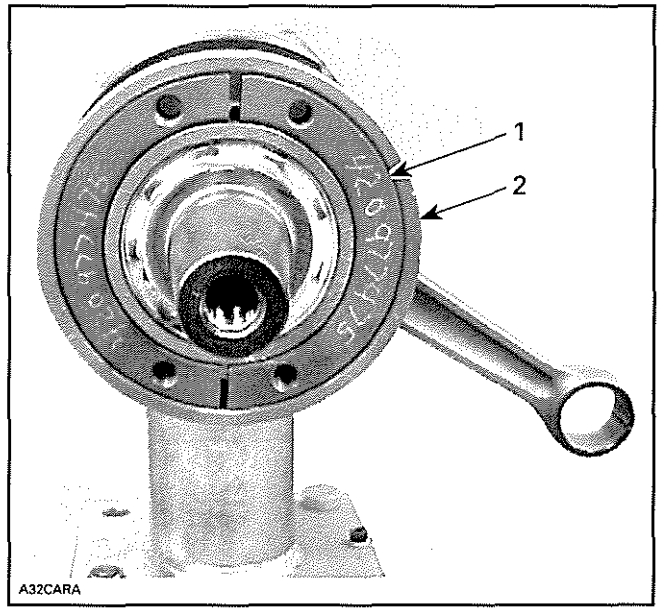
Refer to table below to find crankshaft dimension specifications. For dimension measurement procedures, refer to *ENGINE MEASUREMENT* subsection.

ENGINE MEASUREMENT	TOLERANCES		
	NEW PARTS (min.)	(max.)	WEAR LIMIT
Crankshaft deflection on PTO side	N.A.	0.06 mm (.0024 in)	N.A.
Crankshaft deflection on MAG side	N.A.	0.05 mm (.002 in)	N.A.
Crankshaft deflection in center of crankshaft	N.A.	0.08 mm (.003 in)	N.A.
Connecting rod big end axial play	0.28 mm (.011 in)	0.68 mm (.027 in)	1.20 mm (.047 in)
Crankshaft end-play	0.10 mm (.004 in)	0.30 mm (.012 in)	N.A.

Crankshaft Bearing Removal

NOTE: Normally it takes approximately 10 minutes to heat up a bearing so in the event of replacing bearing, it's recommended to start the bearing heating process prior to removal operation. See procedure further.

To remove bearings no. 2 and no. 3 from crankshaft no. 4, install HALF-RINGS (P/N 420 977 479) and PULLER RING (P/N 420 977 494) on the outer bearing.

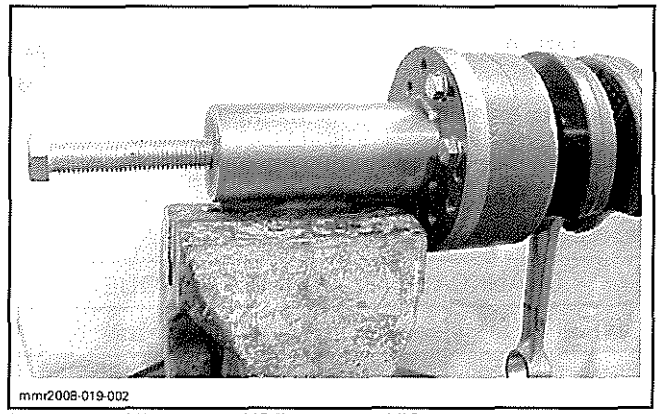


1. Half ring
2. Puller ring

NOTE: Apply some grease on crankshaft end to hold in place the CRANKSHAFT PROTECTOR (PTO) (P/N 420 876 552) on PTO side and CRANKSHAFT PROTECTOR (MAG) (P/N 420 876 557) on MAG side.

Install the CRANKSHAFT BEARING PULLER (P/N 529 036 004) on the half rings.

Secure the bearing puller in a vise by one of its rib.



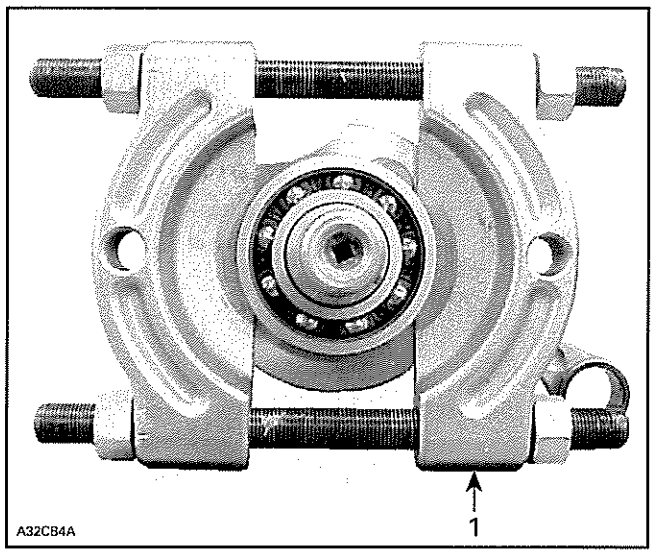
BEARING PULLER SECURED IN THE VISE

NOTICE Never use any air impact tool for tightening the puller bolt. Lubricate the bolt with XPS LUBE (P/N 293 600 016) to avoid damaging the threads.

Screw in the puller bolt until the bearing comes out.

Follow the same procedure for the inner bearing.

NOTE: In the case of damaged bearing or less clearance between crankshaft counterbalance and the bearing or on the MAG side bearing, use SNAP-ON BEARING SEPARATOR (P/N CJ 951) or SPX/OTC BEARING SEPARATOR (P/N 1124) to facilitate the removal.

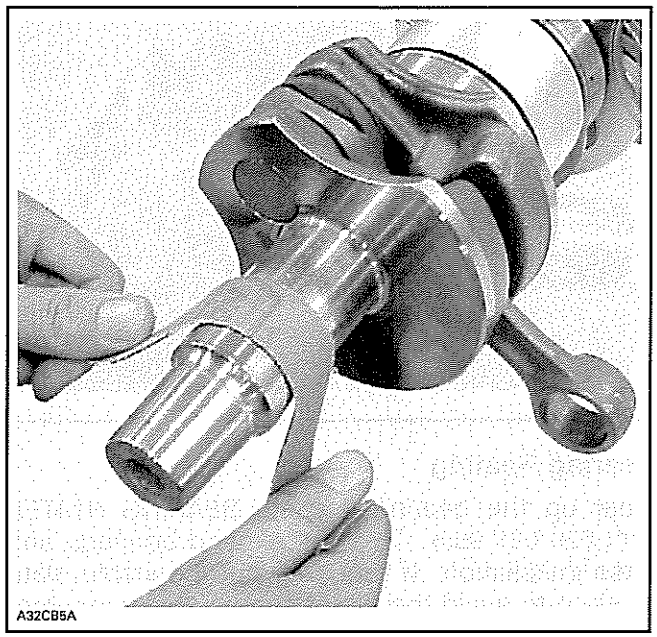


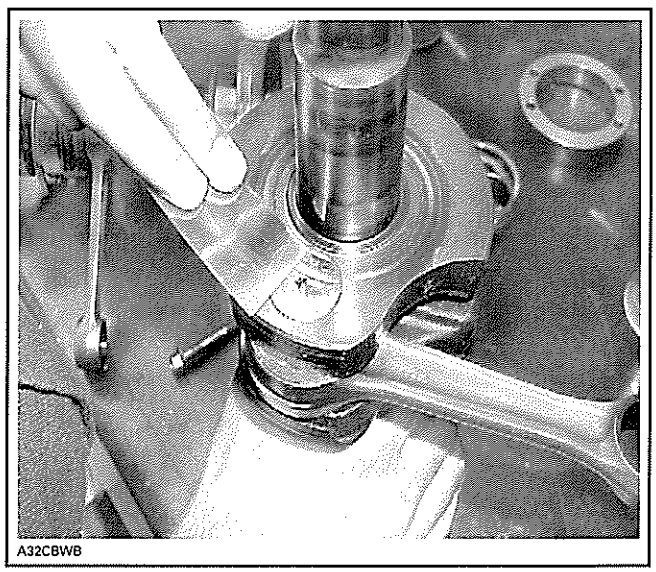
1. Bearing separator

Crankshaft Bearing Installation

Inspect crankshaft ends for damage.

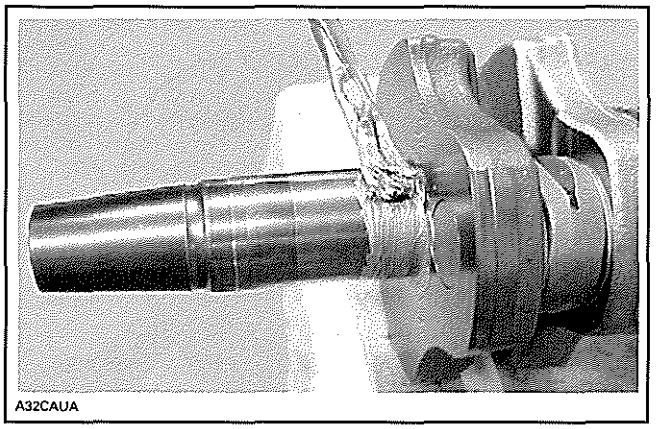
Clean crankshaft ends with sand paper no. 180 to remove possible seal marks and debris.





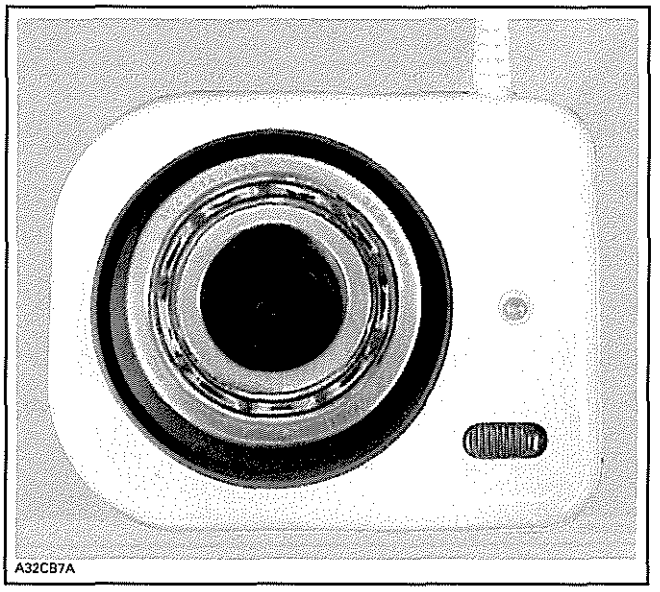
Remove all residue using PULLEY FLANGE CLEANER (P/N 413 711 809).

Apply LOCTITE 767 (ANTISEIZE LUBRICANT) (P/N 293 800 070) on crankshaft bearing mounting area.


A32CAUA

Bearing Heating

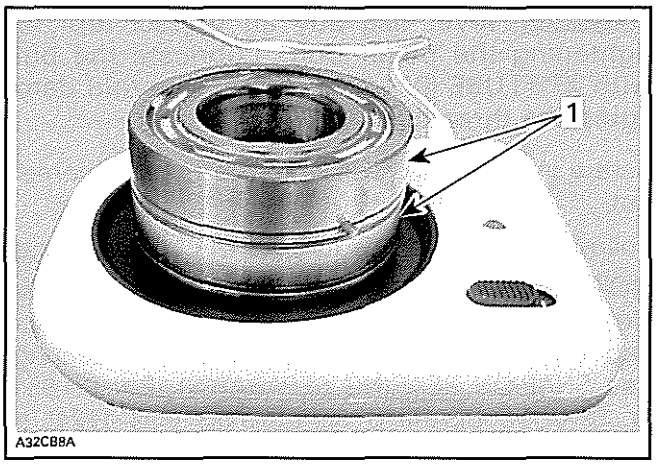
Heat up the bearing(s) using BEARING HEATER (P/N 529 035 969). This will expand bearings and ease installation. If required, put a suitable plate or shim to avoid the direct contact between integrated seal with the heating surface.


A32CB7A

NOTICE Bearing(s) should not be heated to more than 80°C (176°F). Do not heat bearing(s) with direct flame, or with a heat gun or soaked in a heated oil bath. Inappropriate bearing(s) heating may result in inner seals or cage failure.

For even heat distribution, turn bearing several times during heating process.

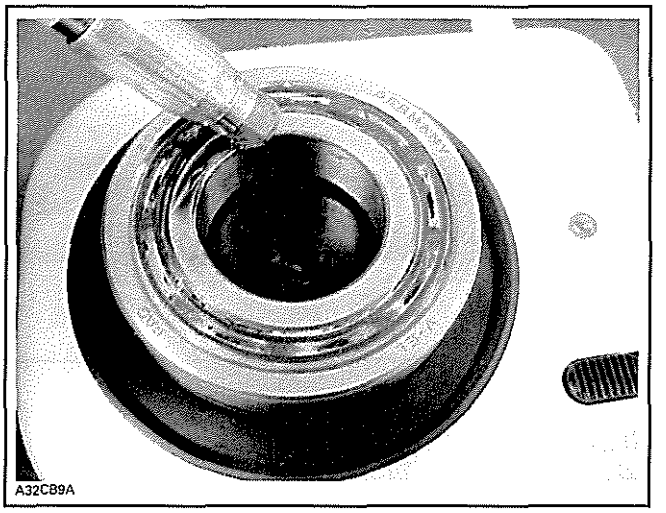
NOTE: Two bearings can be heated at the same time on one bearing heater.



A32CB8A

1. Bearings

Probe the side of the inner race of the bearing with the temperature TEMPERATURE INDICATOR STICK (P/N 529 035 970). Stick will liquefy when the bearing reach the proper temperature.


A32CB9A

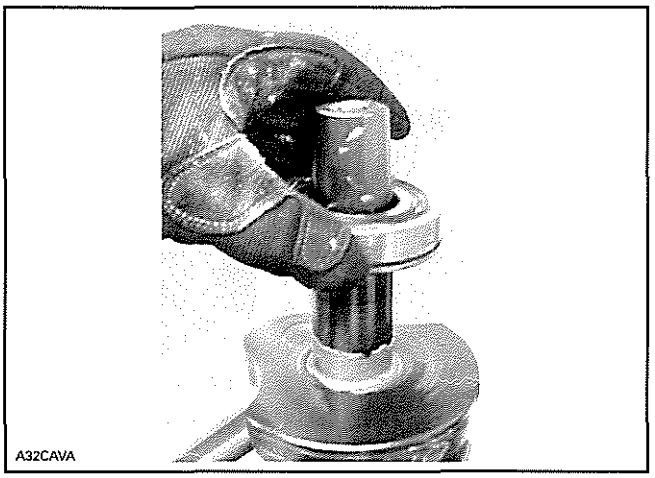
⚠ WARNING

Do not touch heated bearing with bare hands. Always wear heat resisting gloves before handling the heated bearing(s).

NOTICE Never reinstall a bearing that has been removed.

PTO Side Bearings

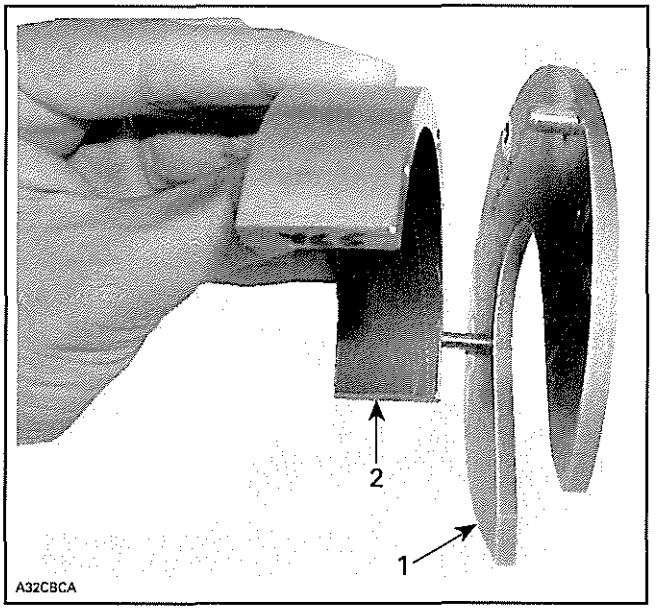
Slide in the inner PTO bearing with the integrated seal facing crankshaft. Push bearing to end position.



NOTE: Heated bearing should slide easily onto the crankshaft. If required, push with a BEARING INSTALLER (PTO) (P/N 529 035 990) on the inner ring of the bearing. **Pay special attention to correct positioning of the locating pins and/or retaining discs.**

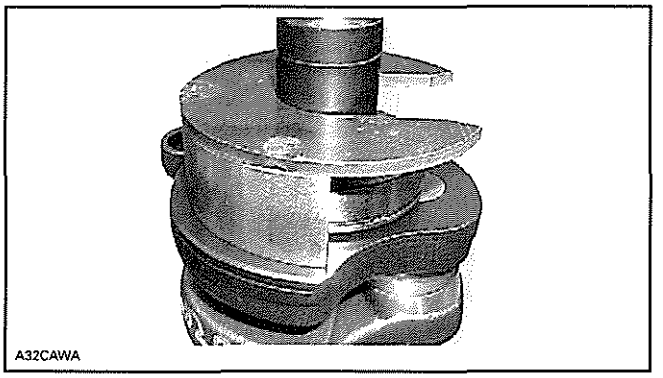
Install retaining discs.

Install the SUPPORT PLATE (P/N 529 035 976) with the CRANKSHAFT DISTANCE GAUGE (P/N 529 035 968).



1. Support plate
2. Distance gauge

Install bearing locator tool.

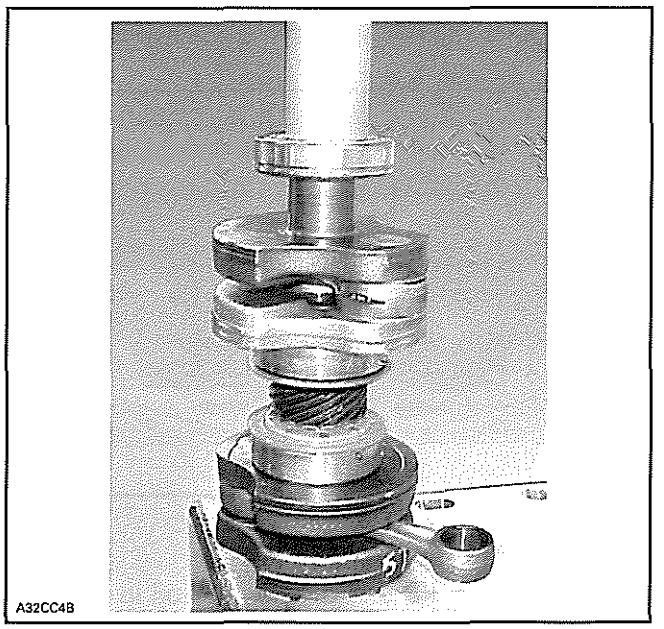


Slide the heated outer PTO bearing onto the crankshaft until it contacts the distance gauge.

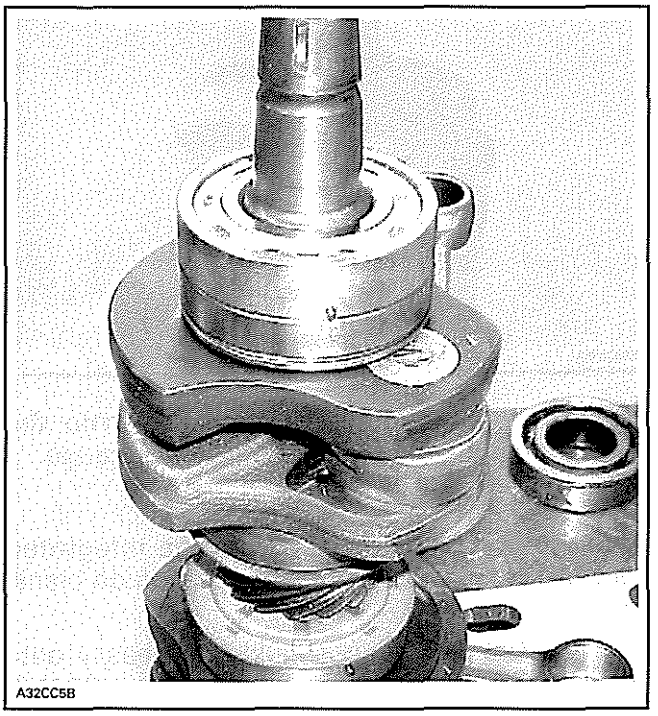
MAG Side Bearings

Slide the first MAG bearing **with the integrated seal facing crankshaft** until it bottoms on crankshaft shoulder.

NOTE: Heated bearing should slide easily onto the crankshaft. If required, push with a CRANKSHAFT BEARING INSTALLER (MAG) (P/N 529 035 980) on the inner ring of the bearing.

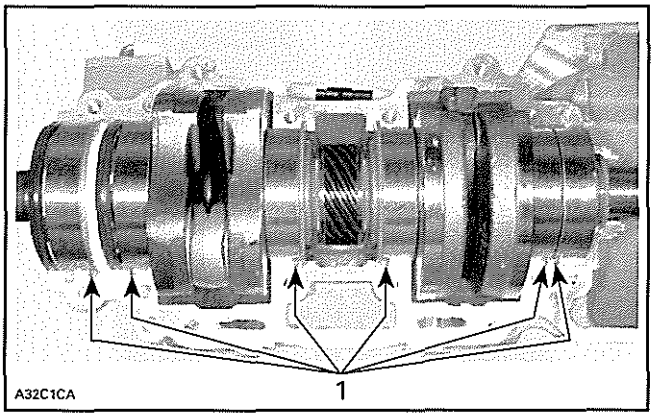


Slide-in the second bearing until it contacts the first one.



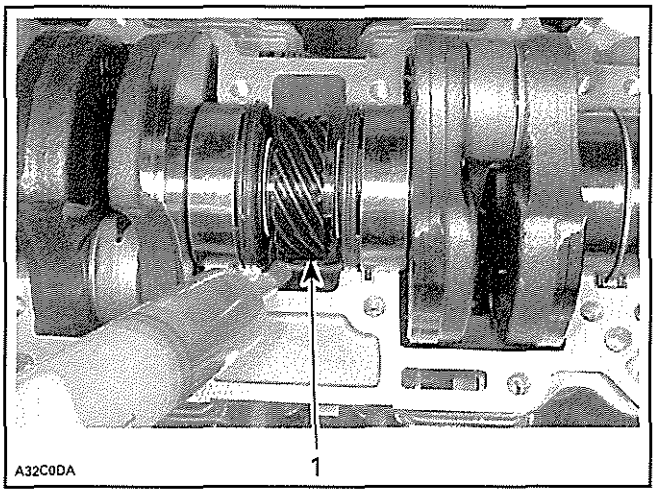
Crankshaft Installation

At crankshaft installation, position locating pins as illustrated.



TYPICAL
1. Position pins

Pour 50 ml (1.7 U.S. oz) of injection oil in the pan under worm gear to lubricate worm gear as per photo.



1. Oil bath

Apply ISOFLEX GREASE TOPAS NB 52 (P/N 293 550 021) as per following procedure:

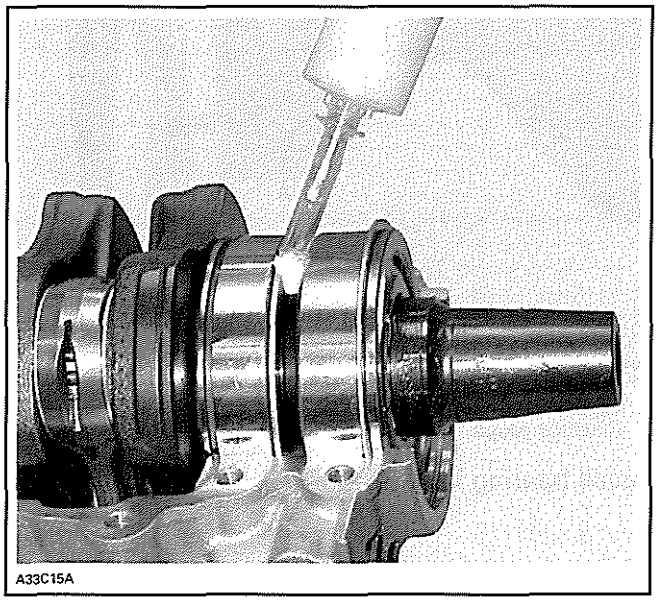
NOTICE Use only the recommended grease. Make sure not to push grease between the outside bearing race and the crankcase half.

Put 30 ml ± 5 ml (1 U.S. oz ± .2 U.S. oz) of grease in a syringe.

NOTE: The 50 g tube corresponds to 50 ml of grease.

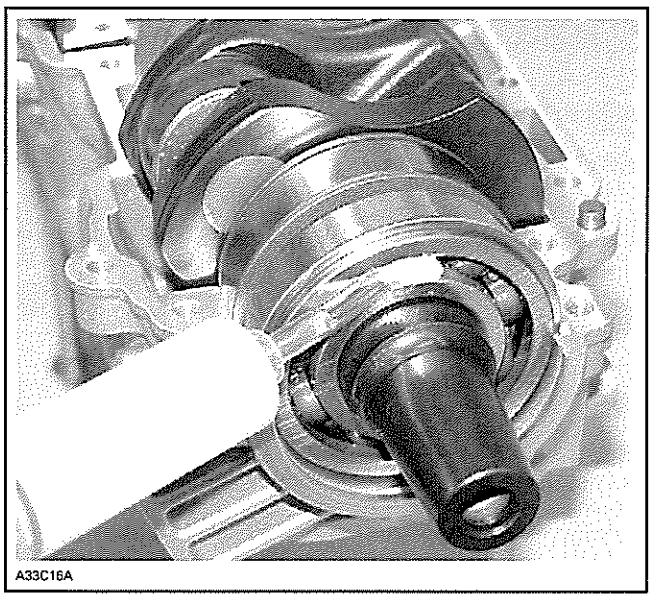
NOTICE Do not exceed the recommended amount of grease.

Fill inner side of PTO side bearing with grease (about 10 ml (.3 U.S. oz)).

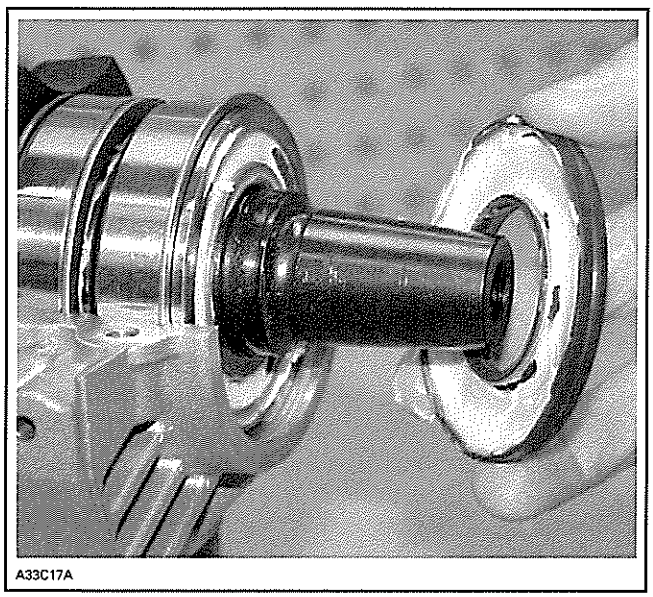


PTO SIDE BEARING FILLED WITH GREASE

With the syringe, fill the outer ball bearing and inner side of outer seal with the remaining of grease.



BALLS COATED WITH A SEAM OF GREASE



TYPICAL — FILL WITH GREASE AND SET IN PLACE

Apply 6 ml (.2 U.S. oz) of grease to MAG side outer bearing.

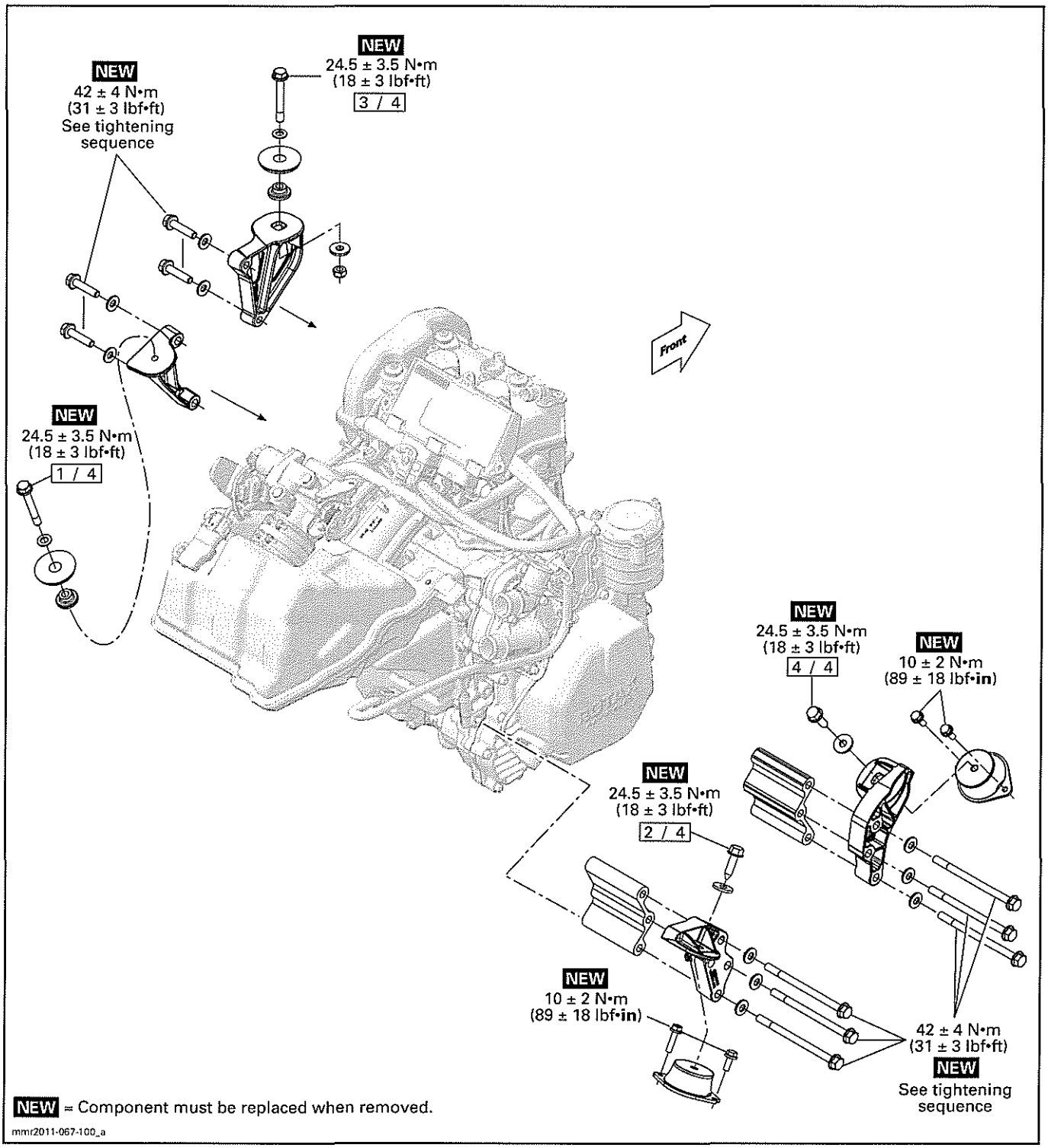
NOTE: If replaced with new bearing, do not apply grease as new bearings come with grease already applied.

Proceed with crankcase assembly. Refer to *CRANKCASE* subsection.

ENGINE REMOVAL AND INSTALLATION

SERVICE TOOLS

Description	Part Number	Page
ENGINE LIFTING TOOL	529 036 217	155



GENERAL

During assembly/installation, use the torque values and service products as in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, cotter pin, etc.) must be replaced with new ones.

NOTICE Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.

PROCEDURES

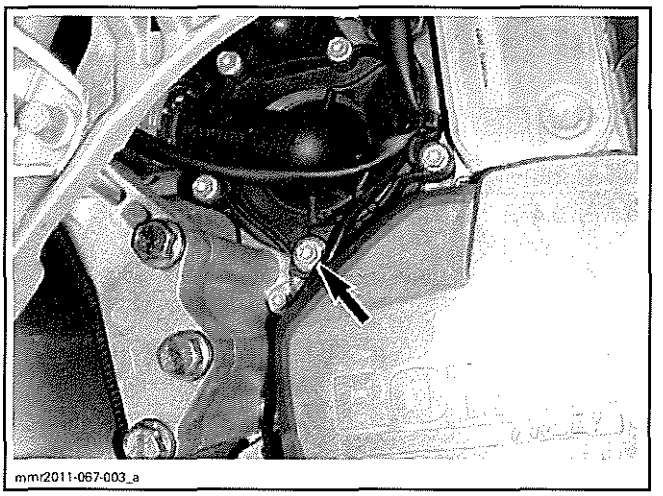
ENGINE

Engine Removal

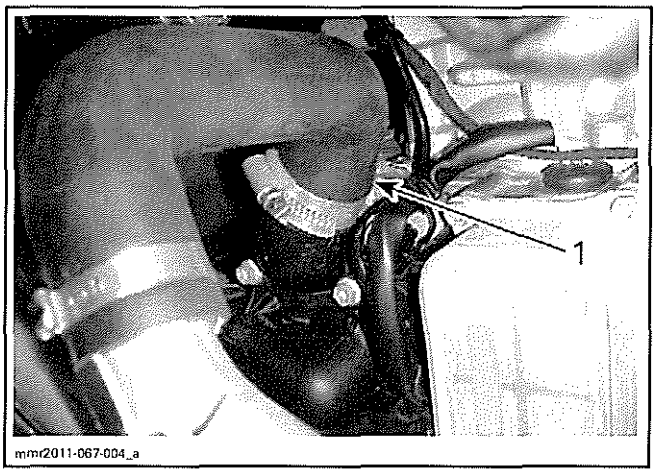
1. Place vehicle on a workstation equipped with an engine-lifting hoist.
2. Release fuel pressure using B.U.D.S. software. Refer to *ELECTRIC FUEL PUMP* in *FUEL TANK AND FUEL PUMP* subsection.
3. Refer to *BODY* subsection and remove:
   - Side panels
   - Hood
   - Upper bottom pans.
4. Remove air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.
5. Move fuel tank rearward without removing it. Refer to *FUEL TANK AND FUEL PUMP* subsection.
6. Disconnect negative (–) cable from battery.

MAG Side Operations

1. Remove breather hose from coolant reservoir.
2. Discard Oetiker clamp.
3. Refer to *EXHAUST SYSTEM* subsection and remove:
   - Muffler
   - Exhaust pipes
   - Exhaust flanges.
4. Drain engine coolant by unscrewing lower screw of water pump.

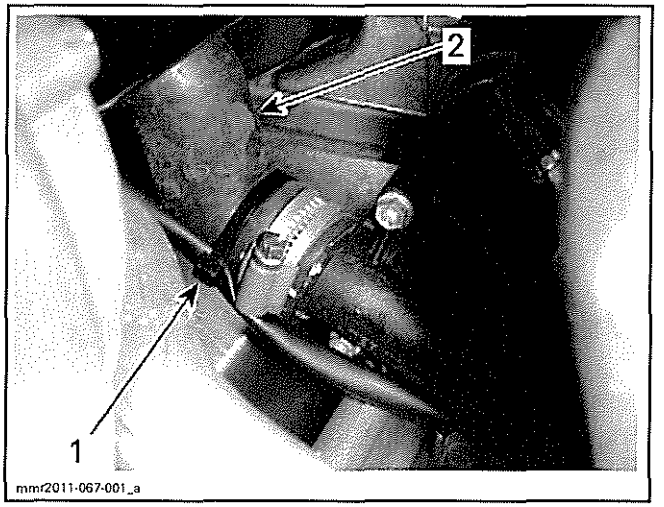


5. Disconnect outlet hose from thermostat housing.



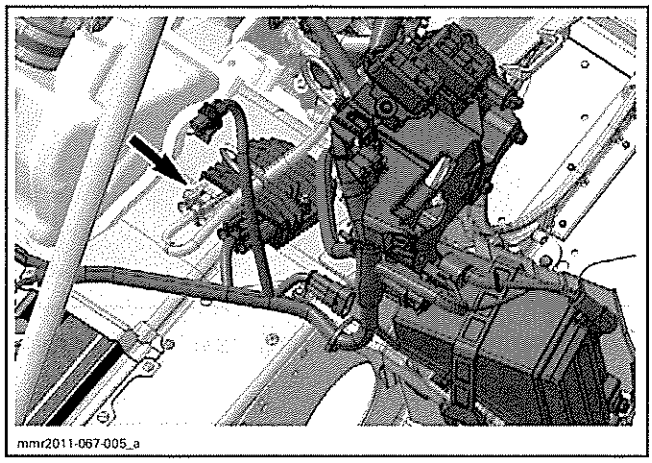
TYPICAL
1. Thermostat housing outlet hose.

6. Remove locking tie on water pump inlet hose.
7. Disconnect coolant inlet hose from water pump.



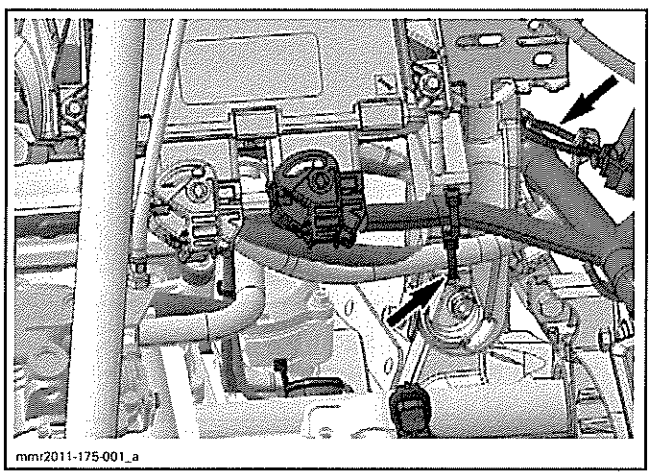
1. Locking tie
2. Water pump inlet hose

8. Remove locking tie securing magneto connector wires.
9. Disconnect magneto connector from voltage regulator.



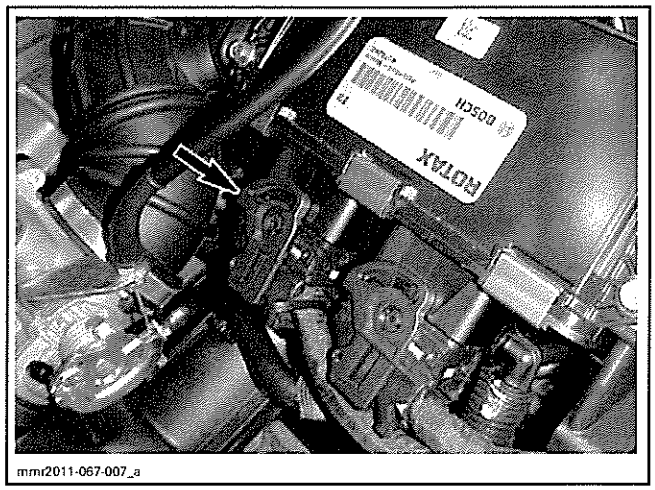
SOME PARTS REMOVED FOR CLARITY PURPOSE

10. Remove locking ties securing harness of ECM connector A to ECM support.

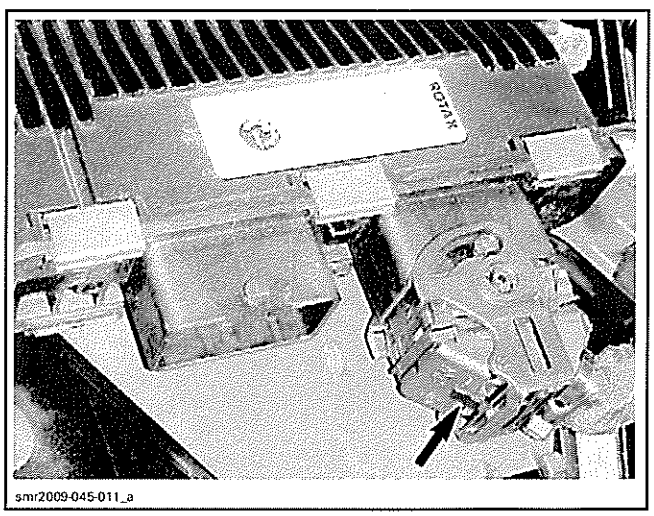


TYPICAL - SOME PARTS REMOVED FOR CLARITY PURPOSE

11. Disconnect ECM connector A (engine harness) from ECM.

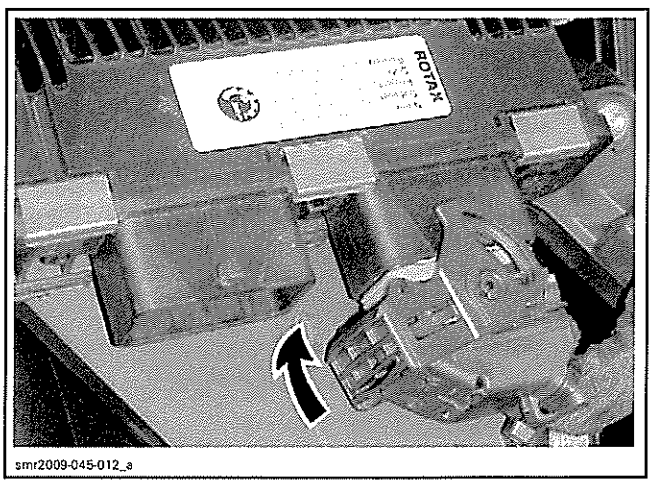


11.1 Push **and hold** the locking tab of the desired connector.



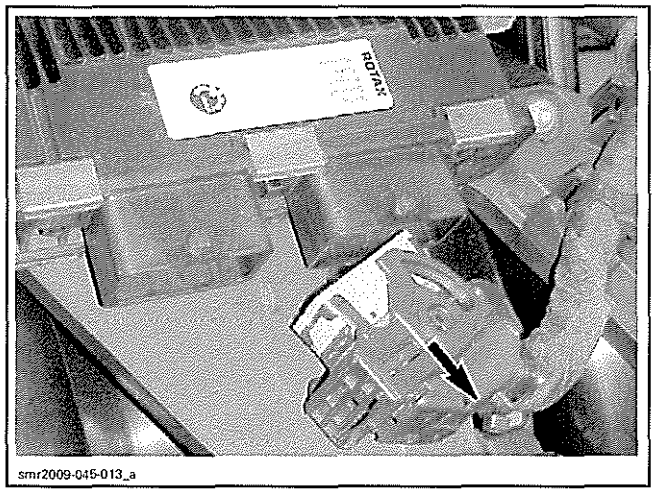
TYPICAL

11.2 Rotate connector lock until it stops.



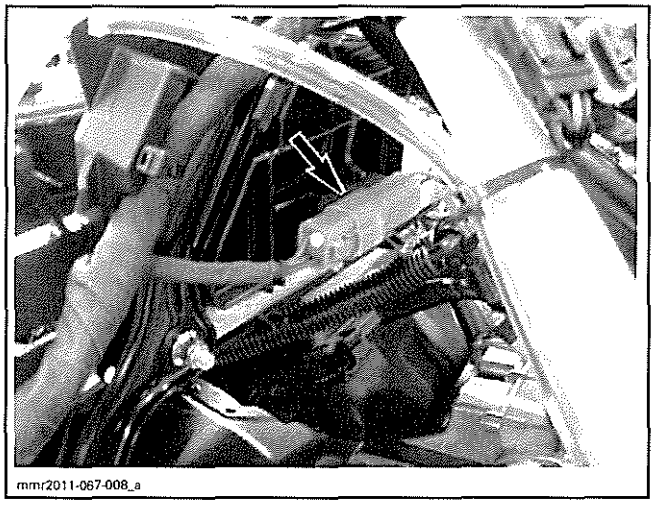
TYPICAL

11.3 Pull out connector.

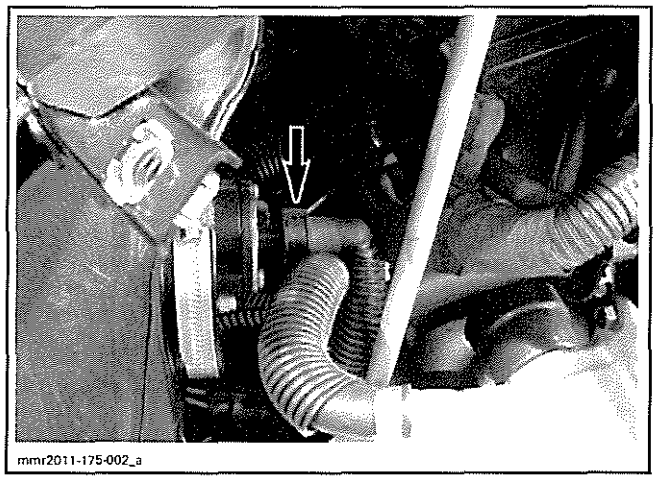


TYPICAL

12. Disconnect engine harness connector located in front of ECM support.

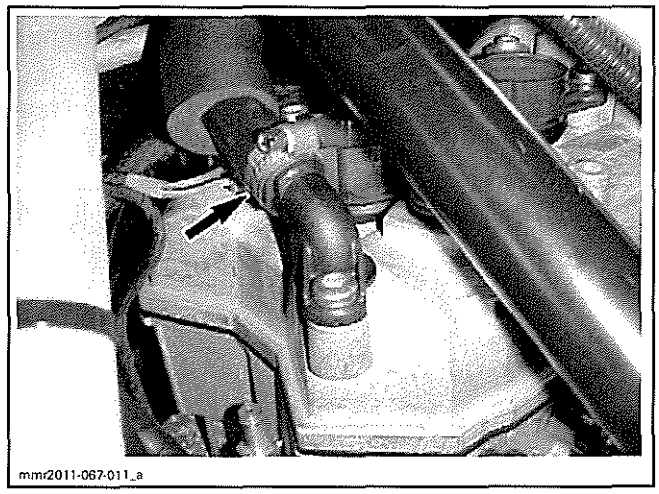


13. Disconnect fuel hose from fuel tank.

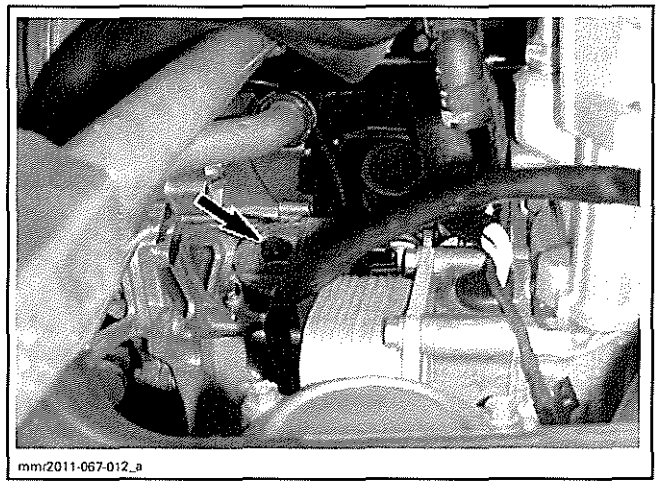


NOTE: Wrap a rag around fuel hose end to catch leakage.

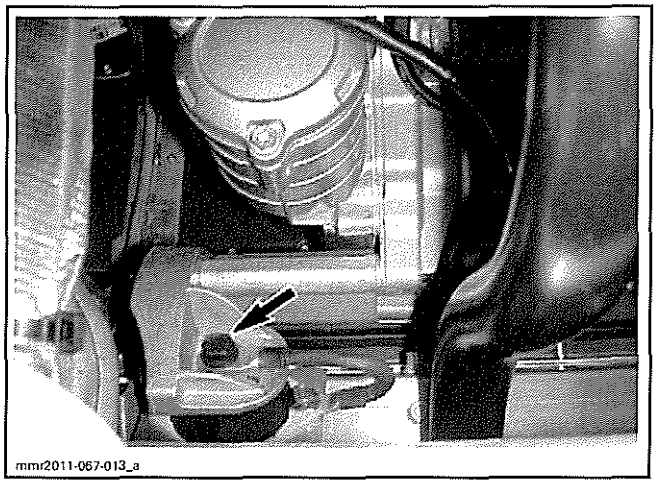
14. Disconnect blow by hose from valve cover.



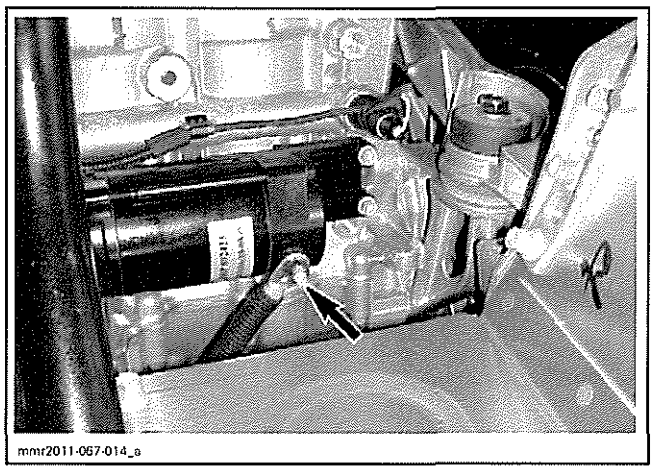
15. Remove screw securing rear MAG rubber mount to engine support.



16. Remove screw securing front MAG rubber mount to engine support.

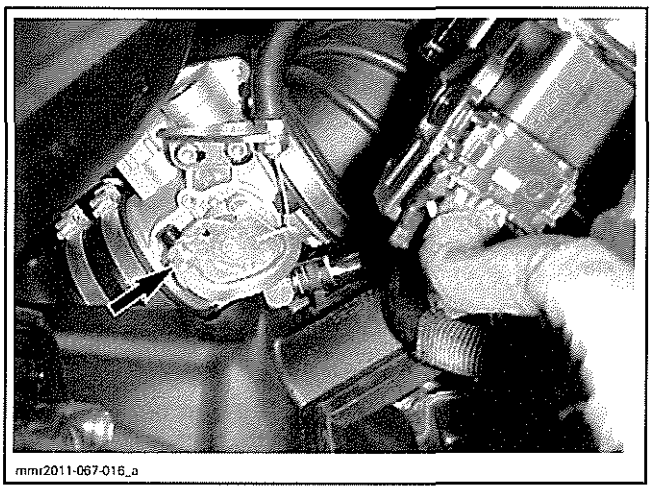


17. Disconnect positive (+) cable from starter.

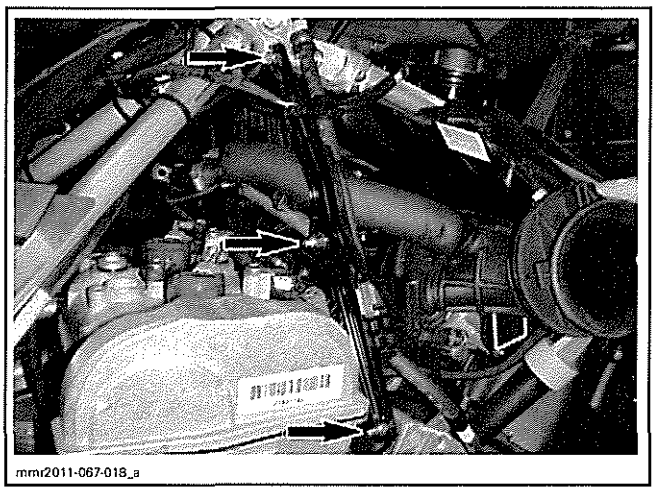

mmr2011-067-014_a

PTO Side Operations

1. Remove drive pulley. Refer to *DRIVE PULLEY (e-Drive)* subsection.
2. Refer to *DRIVEN PULLEY AND COUNTER-SHAFT (600 ACE)* subsection and remove:
   - Driven pulley
   - Countershaft.
3. Detach throttle cable from throttle body.

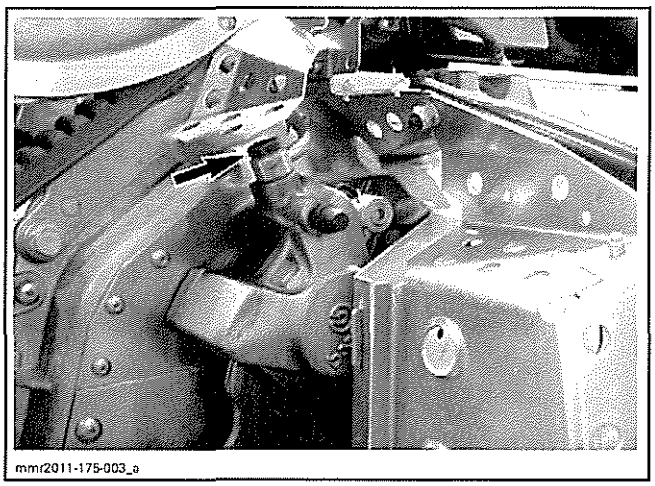

mmr2011-067-016_a

4. Remove LH side frame member.

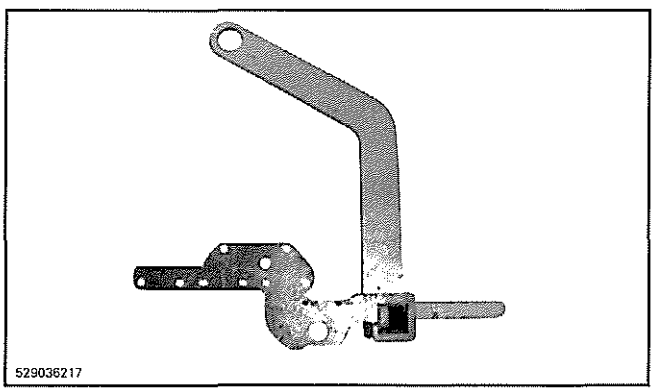

mmr2011-067-018_a

RETAINING SCREWS

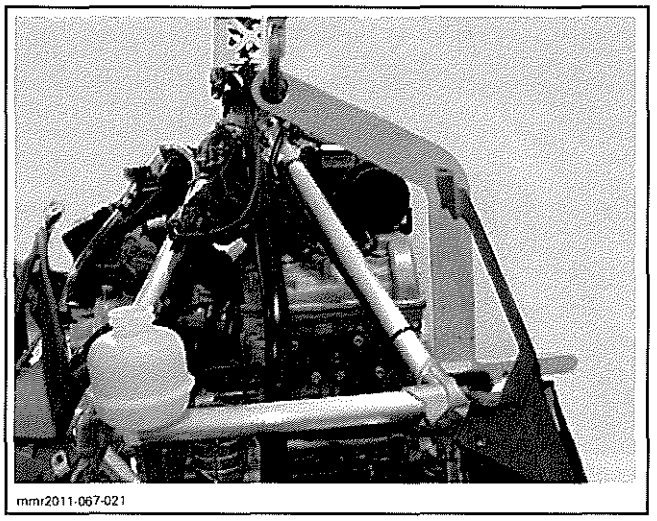
5. Remove Banjo fitting from brake caliper.


mmr2011-175-003_a

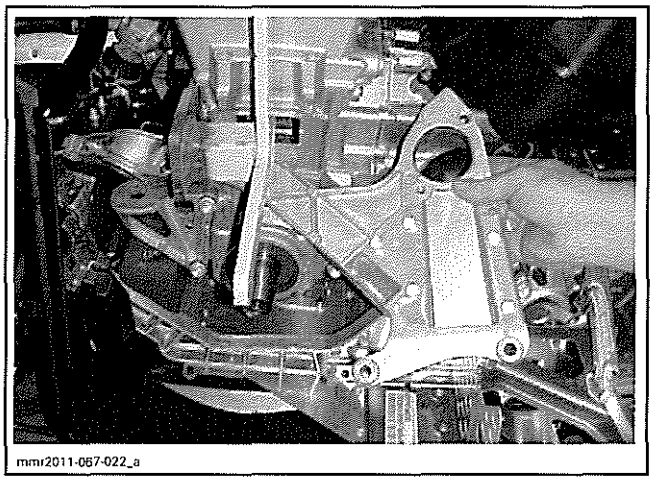
6. Install the ENGINE LIFTING TOOL (P/N 529 036 217) instead of exhaust flanges.



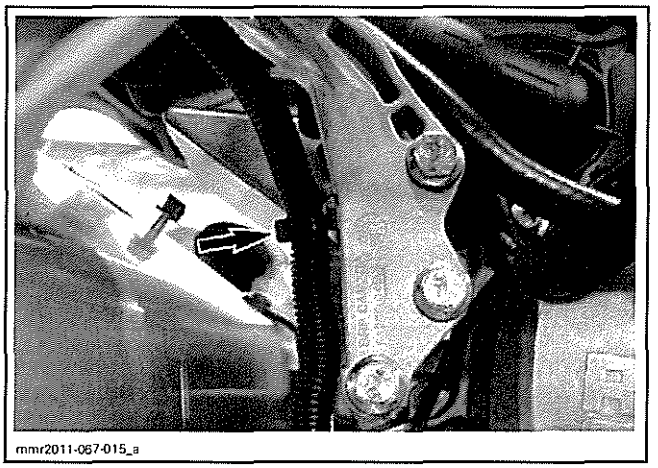
7. Secure lifting tool using exhaust flange screws.
8. **Slightly** lift engine using engine-lifting hoist.


mmr2011-067-021

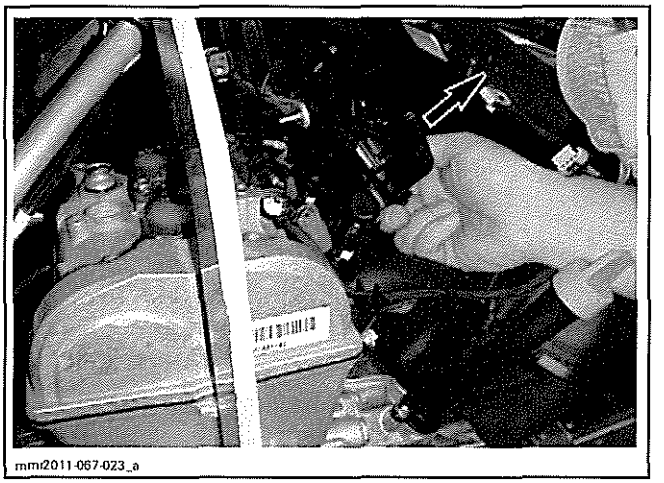
9. Remove countershaft bearing support. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 ACE)*.


mmr2011-067-022_a

10. Remove locking tie of starter positive (+) cable located on rear MAG engine support.


mmr2011-067-015_a
ENGINE MAG SIDE

NOTICE Move ECM support rearward to avoid to damage fuel rail during engine removal.


mmr2011-067-023_a
MOVE ECM SUPPORT REARWARD

11. Lift engine then slide it out of vehicle.

Engine Installation

The installation is the reverse of removal procedure, however pay attention to the following.

Install NEW self-locking screws where required, refer to exploded view at the beginning of this subsection.

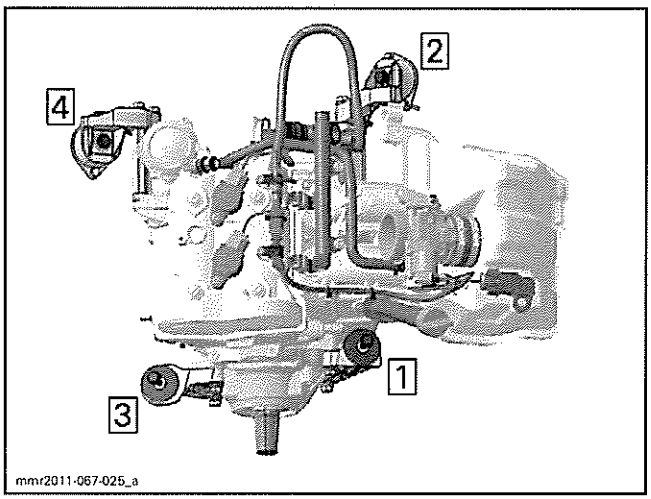
Refill and bleed brake system. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

Tighten Banjo fitting on brake caliper with NEW sealing washers. Refer to *BRAKE* subsection for tightening torque.

Properly tighten countershaft bearing support. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 ACE)* subsection for tightening sequence.

Tighten engine rubber mount screws to specification as per the following sequence.

ENGINE RUBBER MOUNT SCREWS TORQUE (M8)
24.5 N•m ± 3.5 N•m (18 lbf•ft ± 3 lbf•ft)



TIGHTENING SEQUENCE

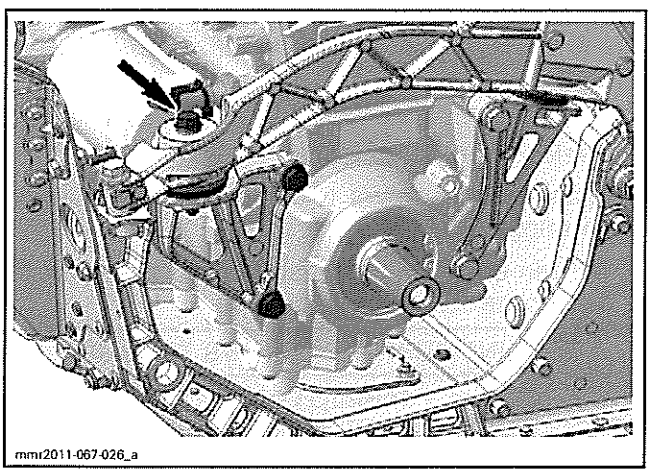
ENGINE SUPPORTS

Engine Support Inspection

Check if engine supports are cracked, bent or damaged. Replace if necessary.

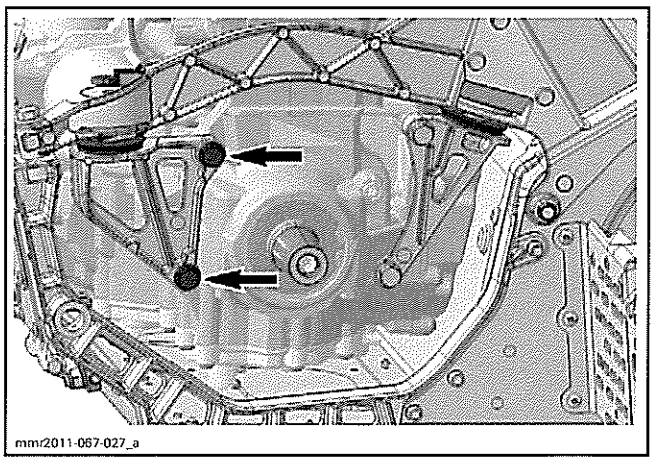
Front Engine Support Replacement (PTO Side)

1. Remove body parts and components as required to access to the engine support.
2. Remove bolt securing rubber mount to engine support.



SOME PARTS REMOVED FOR CLARITY PURPOSE

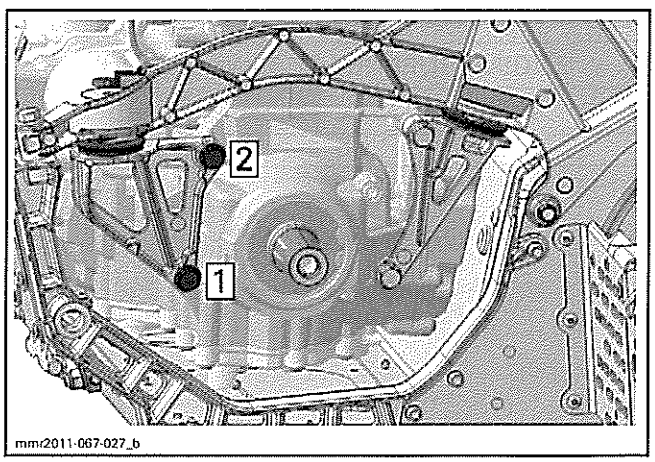
3. Remove screws securing engine to engine support.



SOME PARTS REMOVED FOR CLARITY PURPOSE

4. Replace engine support.
5. Install NEW screws to secure engine support on engine.
6. Tighten engine support screws to specification as per the following sequence.

ENGINE SUPPORT SCREWS TORQUE
42 N•m ± 4 N•m (31 lbf•ft ± 3 lbf•ft)

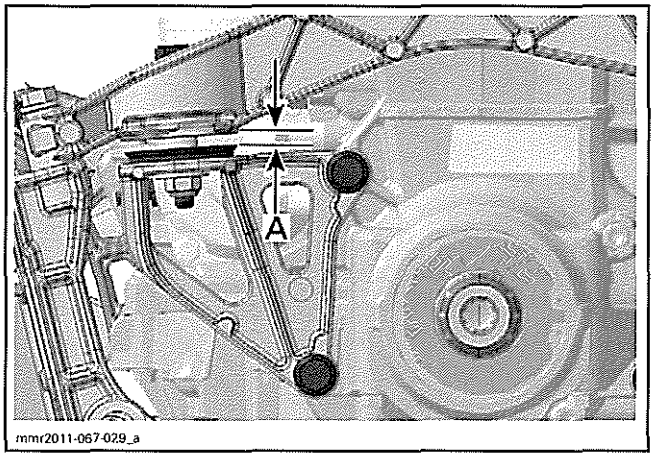


TIGHTENING SEQUENCE

7. Install NEW bolt to secure engine rubber mount on engine support.
8. Tighten engine rubber mount screw to specification.

ENGINE RUBBER MOUNT SCREWS TORQUE (M8)
24.5 N•m ± 3.5 N•m (18 lbf•ft ± 3 lbf•ft)

NOTE: It is normal that a gap (5 mm (3/16 in)) is visible between engine stopper and countershaft bearing support. This gap will allow engine to move and reduce vibration.



A. Normal gap

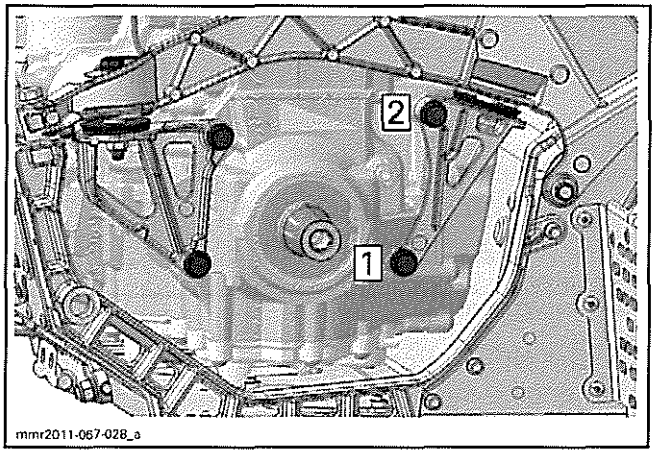
9. Install body parts and components as the reverse of removal procedure.

Rear Engine Support Replacement (PTO Side)

To replace rear engine support, refer to *FRONT ENGINE SUPPORT REPLACEMENT (PTO SIDE)*. However pay attention to the following.

Tighten engine support screws to specification as per the following sequence.

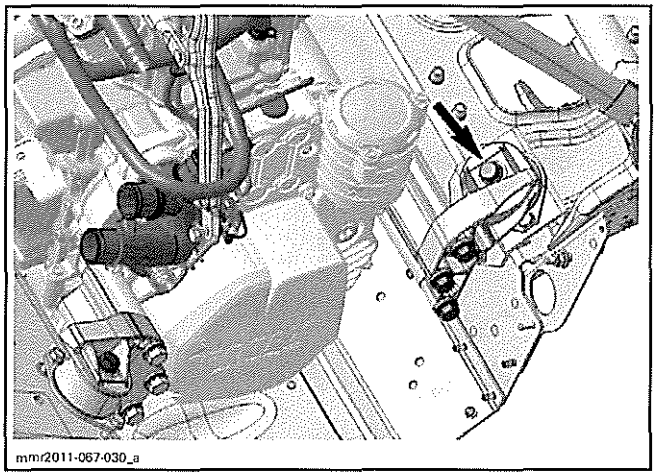
ENGINE SUPPORT SCREWS TORQUE
42 N•m ± 4 N•m (31 lbf•ft ± 3 lbf•ft)



TIGHTENING SEQUENCE

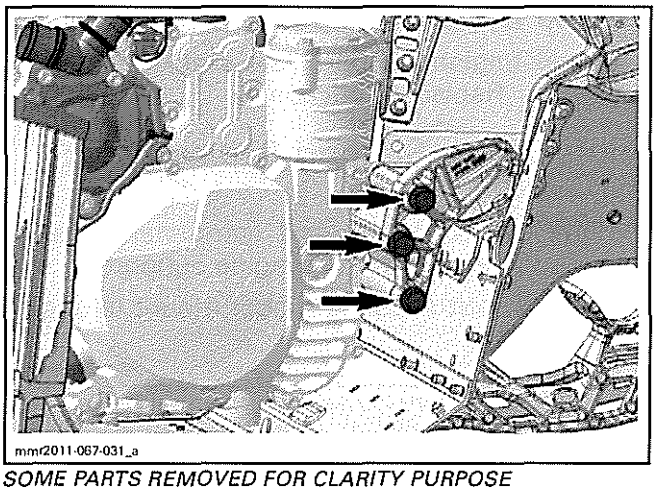
Front Engine Support Replacement (MAG Side)

1. Remove body parts and components as required to access to the engine support.
2. Remove screw securing rubber mount to engine support.



SOME PARTS REMOVED FOR CLARITY PURPOSE

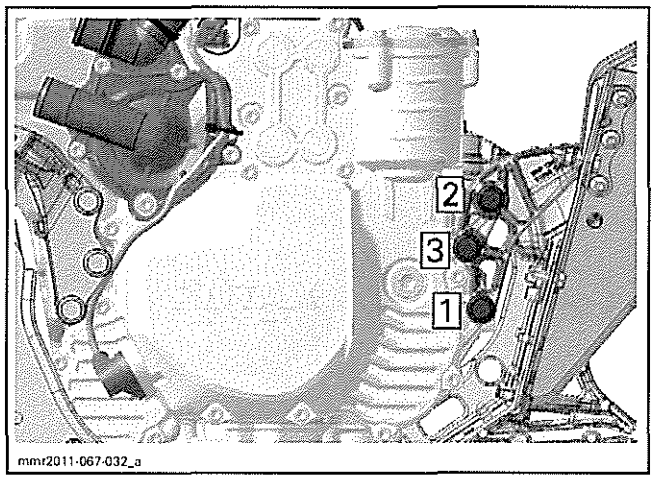
3. Remove screws securing engine to engine support.



SOME PARTS REMOVED FOR CLARITY PURPOSE

4. Replace engine support.
5. Install NEW screws to secure engine support on engine.
6. Tighten engine support screws to specification as per the following sequence.

ENGINE SUPPORT SCREWS TORQUE
42 N•m ± 4 N•m (31 lbf•ft ± 3 lbf•ft)



TIGHTENING SEQUENCE

7. Install NEW screw to secure engine rubber mount on engine support.
8. Tighten engine rubber mount screw to specification.

ENGINE RUBBER MOUNT SCREWS TORQUE (M8)
24.5 N•m ± 3.5 N•m (18 lbf•ft ± 3 lbf•ft)

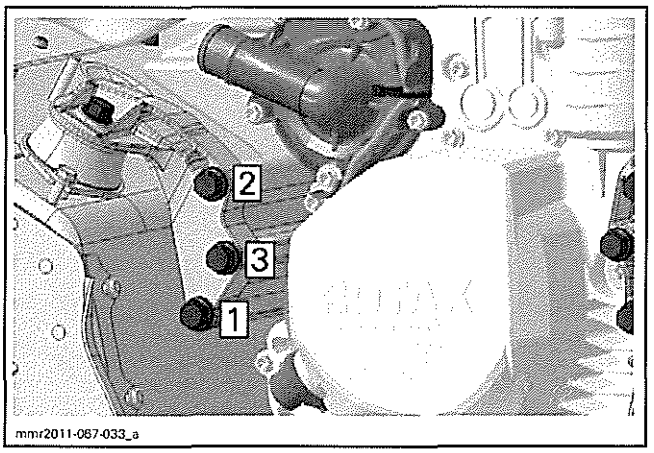
9. Install body parts and components as the reverse of removal procedure.

Rear Engine Support Replacement (MAG Side)

To replace rear engine support, refer to *FRONT ENGINE SUPPORT REPLACEMENT (MAG SIDE).* However pay attention to the following.

Tighten engine support screws to specification as per the following sequence.

ENGINE SUPPORT SCREWS TORQUE
42 N•m ± 4 N•m (31 lbf•ft ± 3 lbf•ft)



TIGHTENING SEQUENCE

ENGINE RUBBER MOUNTS

Engine Rubber Mount Inspection

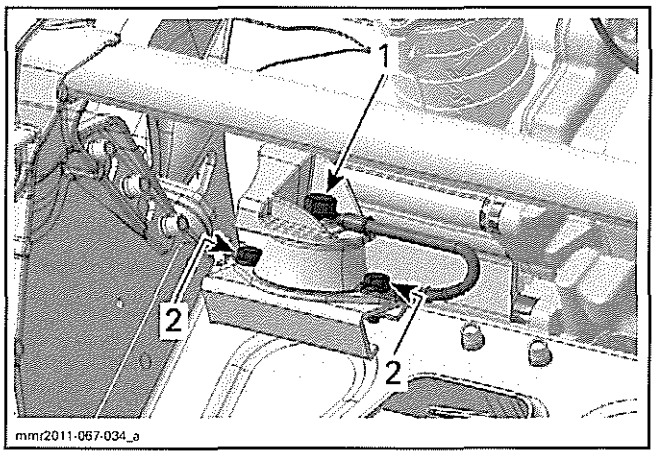
Check rubber mounts. Replace them if brittle, cracked or damaged.

Front and Rear Engine Rubber Mount Replacement (PTO Side)

1. Remove countershaft bearing support. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 ACE)* subsection.
2. Replace engine rubber mount.
3. Install countershaft bearing support. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 ACE)* subsection.

Front and Rear Engine Rubber Mount Replacement (MAG Side)

1. Remove body parts and components as required to access to the engine rubber mount.
2. Remove screw securing rubber mount to engine support.
3. Remove screws securing rubber mount to frame.



TYPICAL - FRONT ENGINE RUBBER MOUNT SHOWN
1. Screw securing rubber mount to engine support (M8)
2. Screws securing rubber mount to frame (M6)

4. Replace engine rubber mount.
5. Install NEW screws to secure engine rubber mount.
6. Tighten engine rubber mount screws to specification.

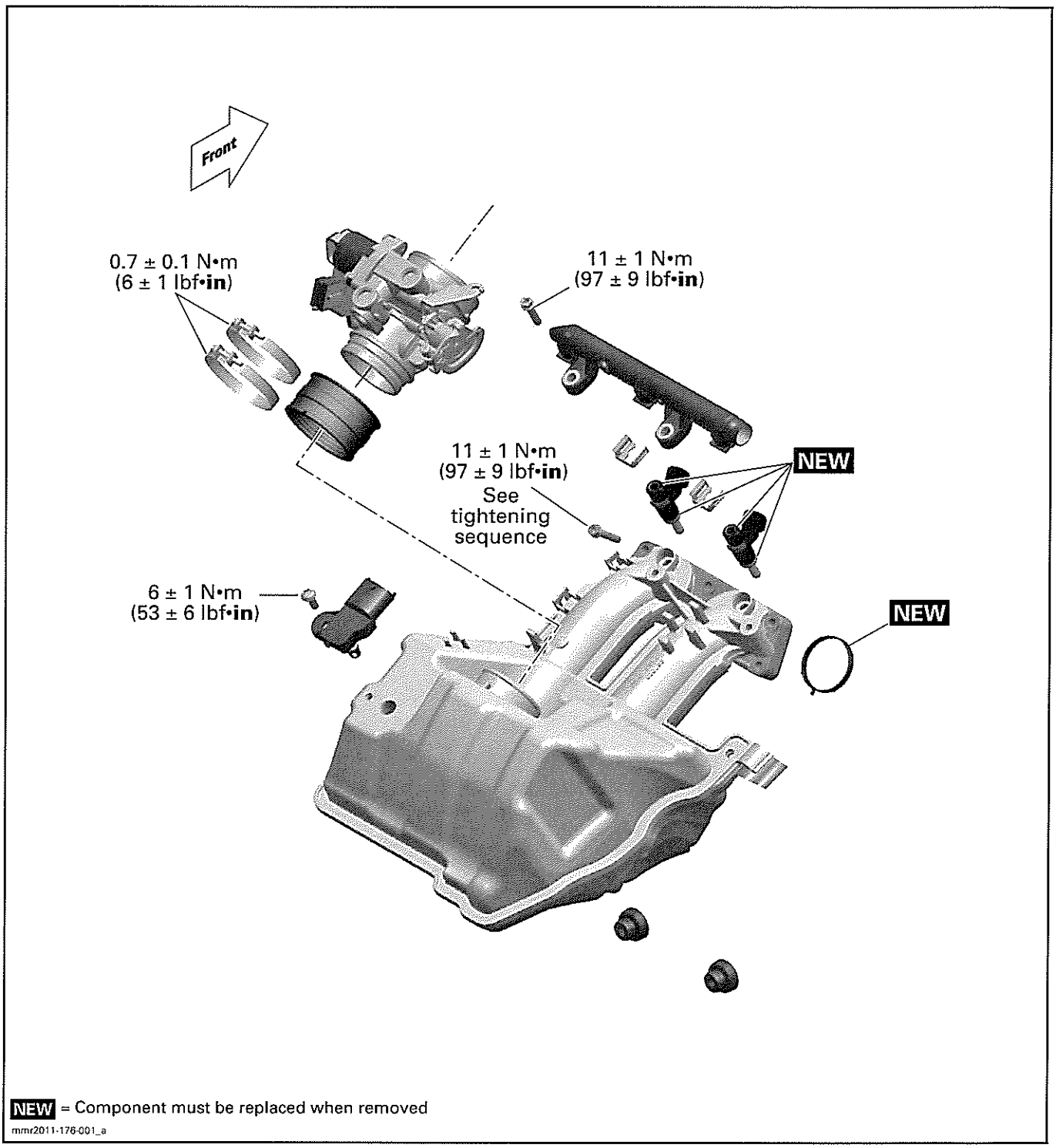
ENGINE RUBBER MOUNT SCREWS TORQUE (M8)
24.5 N•m ± 3.5 N•m (18 lbf•ft ± 3 lbf•ft)

ENGINE RUBBER MOUNT SCREWS TORQUE (M6)
10 N•m ± 2 N•m (89 lbf•**in** ± 18 lbf•**in**)

7. Install body parts and components as the reverse of removal procedure.

AIR INTAKE SYSTEM

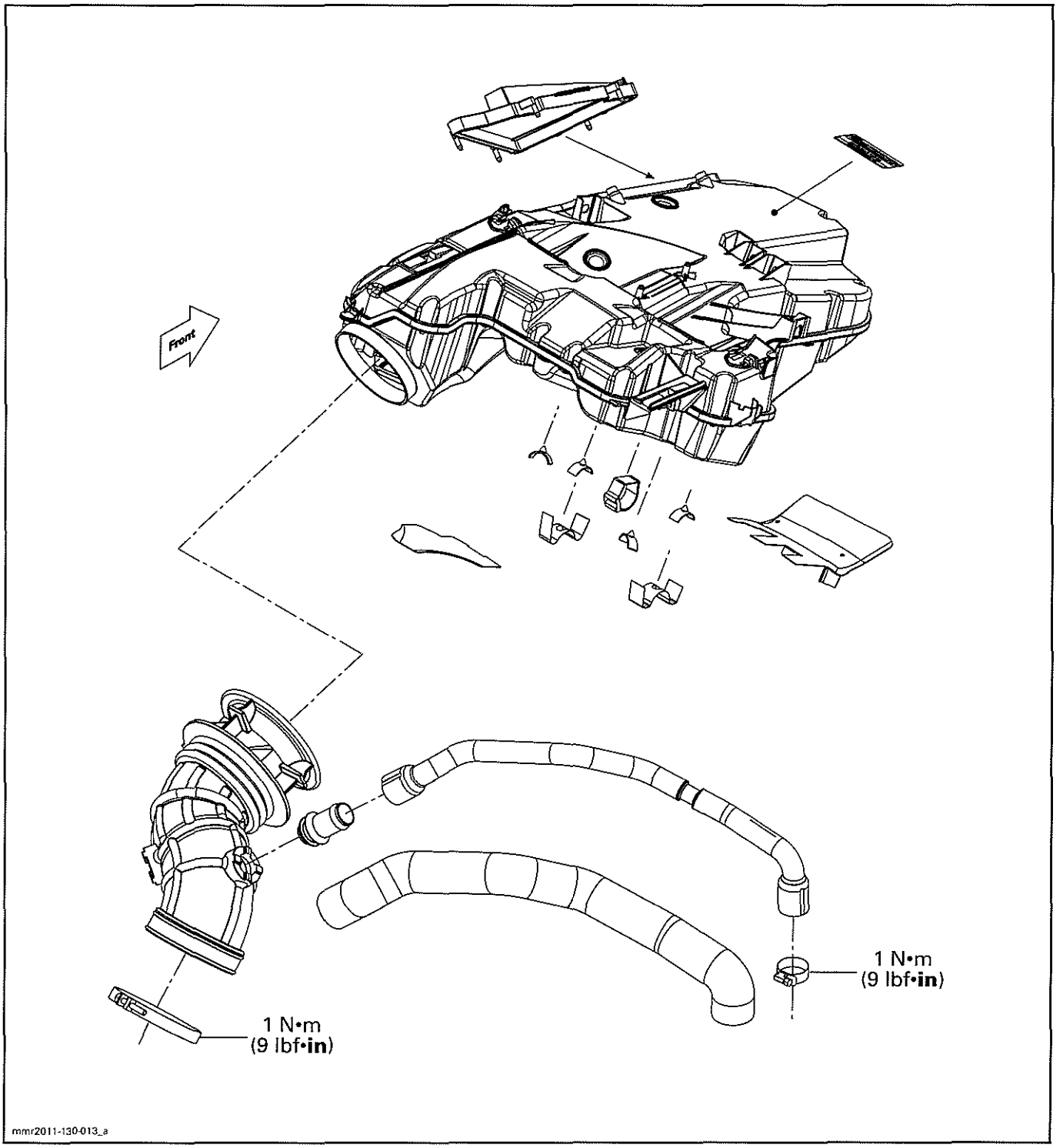
INTAKE MANIFOLD



NEW = Component must be replaced when removed

mmr2011-176-001_a

AIR INTAKE SILENCER



GENERAL

During assembly/installation, use the torque values and service products as shown in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

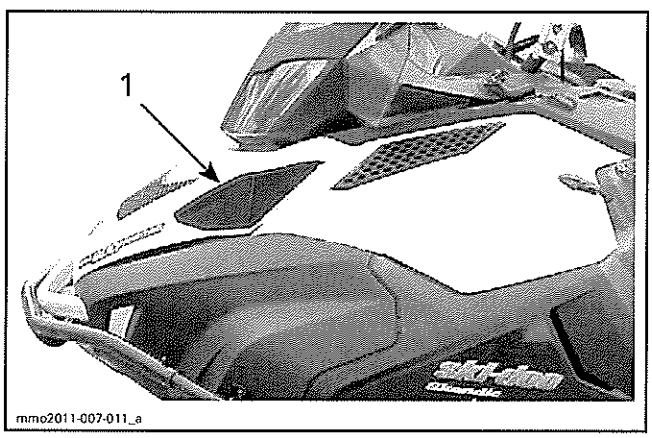
Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, cotter pins, etc.) must be replaced with a new ones.

NOTICE Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.

PROCEDURES

AIR FILTER

Air Filter Removal



1. Air filter

To remove filter, simply pull it out.

Air Filter Cleaning

Clean with fresh water and mild soap.

Replace air filter as required.

NOTE: If the filter is very dirty, clean the interior of air intake silencer at the same time.

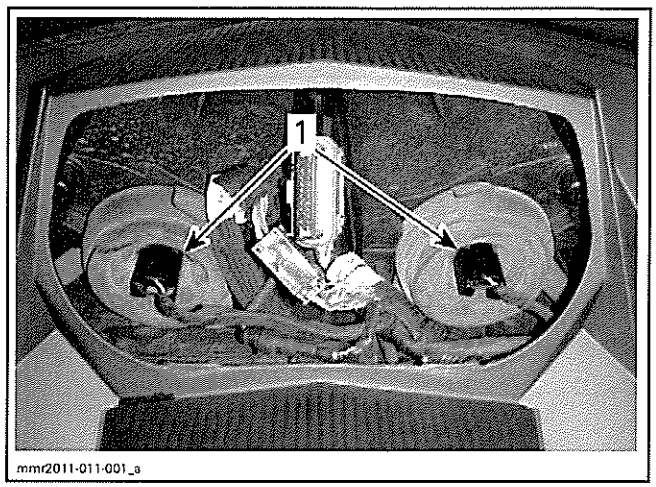
Air Filter Installation

To install filter, push it back in place making sure it is properly secured.

AIR INTAKE SILENCER

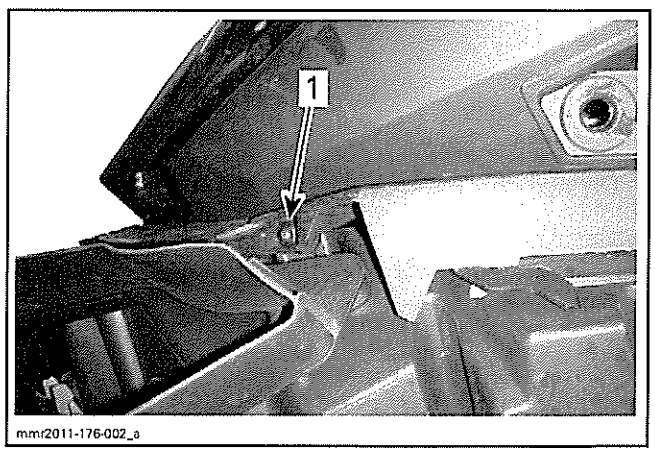
Air Intake Silencer Removal as a Unit with Gauge Support

1. Remove multifunction gauge. Refer to *LIGHTS, GAUGE AND ACCESSORIES* subsection.
2. Disconnect headlight connectors.



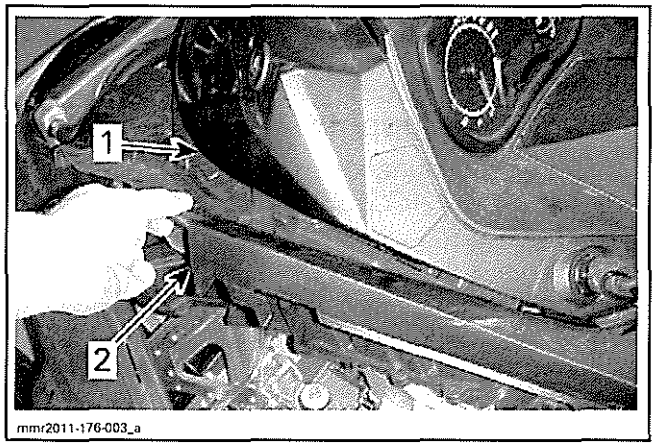
TYPICAL
1. Headlight connectors

3. Refer to *BODY* subsection and remove:
   - Side panels
   - Hood.
4. Remove windshield.
5. Remove the front console screws on each side.



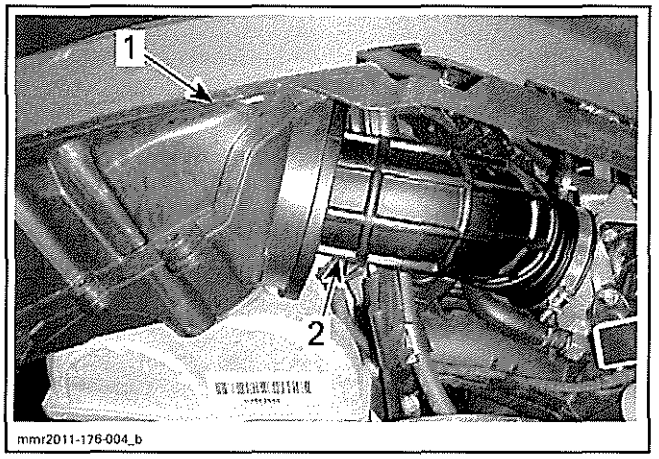
1. LH front console screw

6. Detach the front of console from the gauge support.



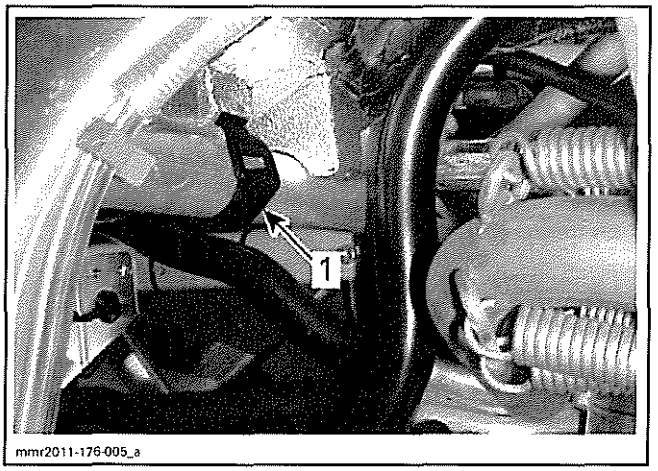
1. Gauge support
2. Console

7. Disconnect the 12-volt outlet and engine cut-off switch.
8. Disconnect the intake hose from air intake silencer.



RH SIDE OF ENGINE COMPARTMENT
1. Air intake silencer
2. Intake hose

9. Detach the hook-and-loop fastener.



RH SIDE OF ENGINE COMPARTMENT
1. Hook-and-loop fastener

10. Remove air intake silencer and gauge support from vehicle.

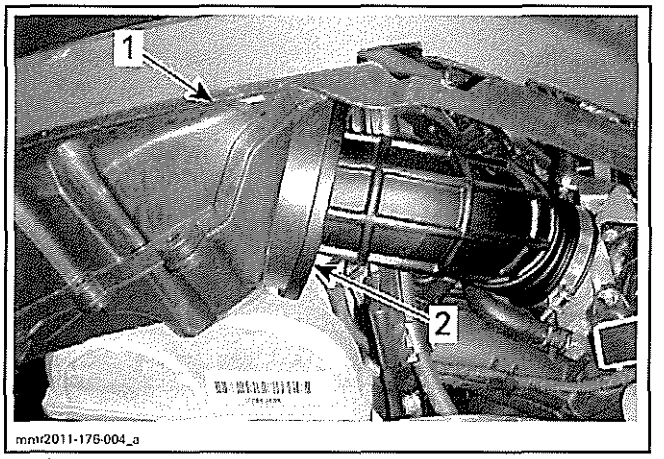
Air Intake Silencer Removal

1. Proceed with *AIR INTAKE SILENCER REMOVAL AS A UNIT WITH GAUGE SUPPORT.*
2. Separate air intake silencer from gauge support. Refer to *BODY* subsection.

Air Intake Silencer Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

The intake hose is completely inserted when its flange leans against the air intake silencer.

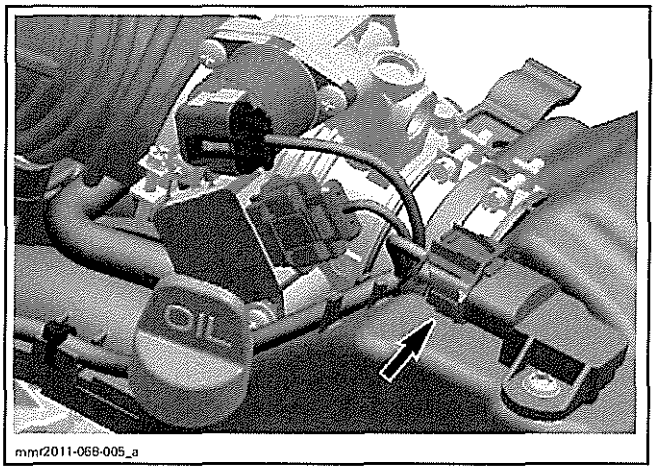


RH SIDE OF ENGINE COMPARTMENT
1. Air intake silencer
2. Intake hose flange

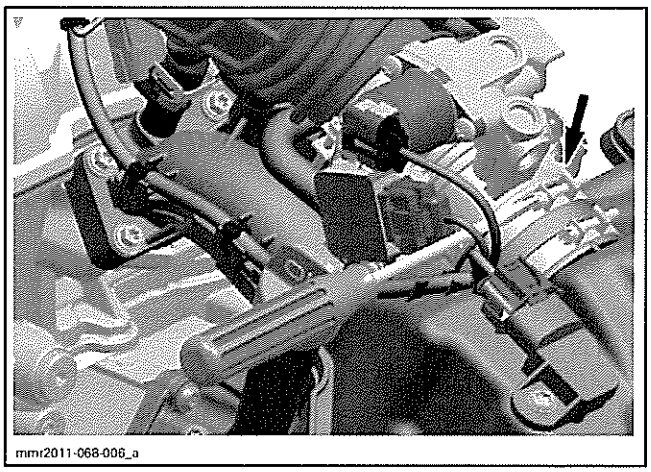
INTAKE MANIFOLD

Intake Manifold Removal

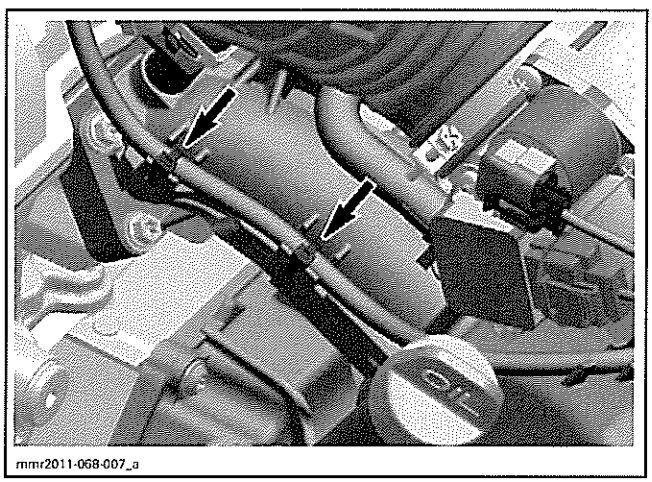
1. Remove the driven pulley, refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 ACE).*
2. Disconnect manifold absolute pressure and temperature sensor (MAPTS).



3. Loosen clamp securing throttle body to intake adapter.

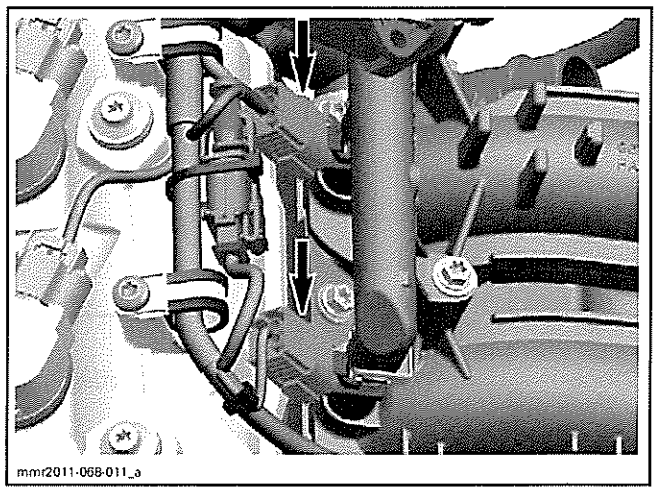


4. Cut locking ties securing TPS harness to fuel rail.



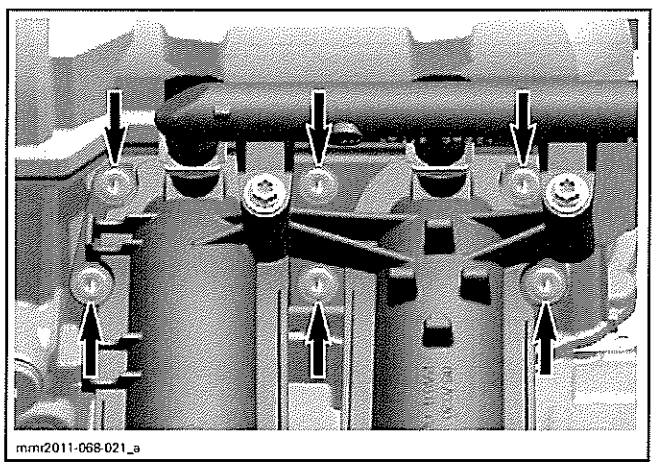
LOCKING TIES

5. Remove throttle body from intake adapter.
6. Move throttle body aside.
7. Disconnect fuel injector connectors.



INJECTOR CONNECTORS

8. Remove screws securing intake manifold to cylinder head.



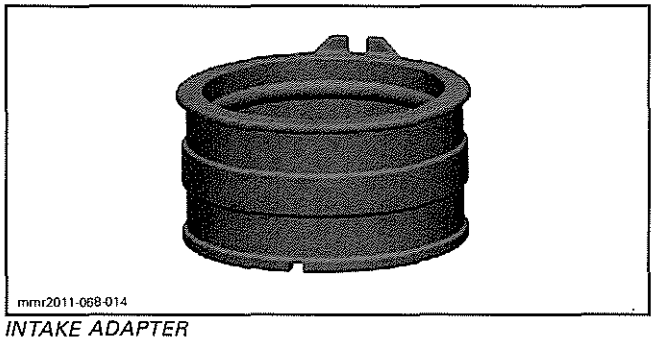
INTAKE MANIFOLD SCREWS

9. Remove intake manifold from engine.
10. Remove the following parts from intake manifold:
    - Intake adapter
    - MAPTS
    - Fuel rail with injectors. Refer to *ELECTRONIC FUEL INJECTION* subsection.

Intake Manifold Inspection

Check intake manifold for cracks, warping at flanges or any other visible damages. Replace if required.

Check if intake adapter is cracked, brittle or otherwise damaged.



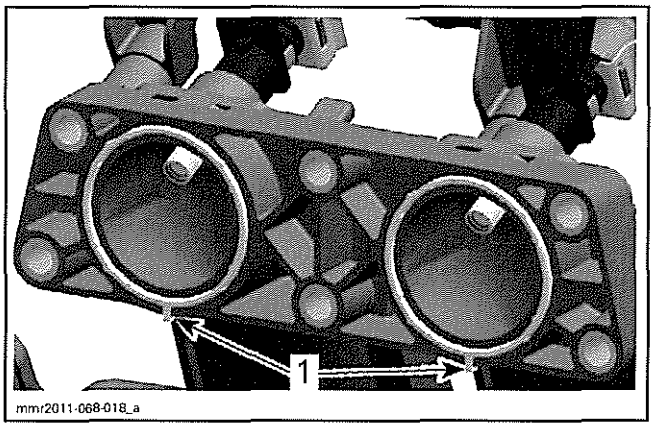
INTAKE ADAPTER

Check if intake manifold gaskets are brittle, hard or damaged. Replace if required.

Intake Manifold Installation

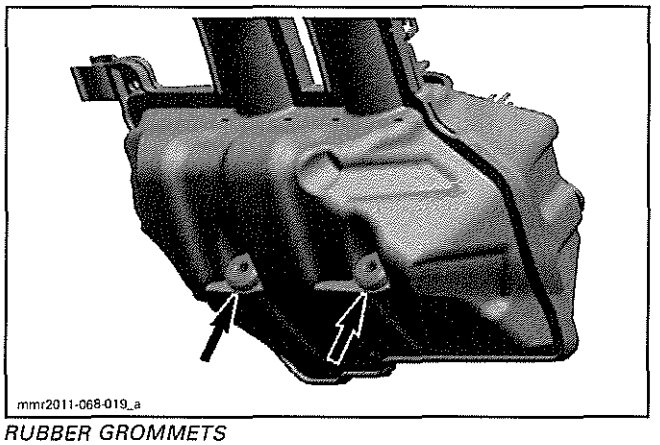
The installation is the reverse of the removal procedure. However, pay attention to the following.

Install NEW gaskets with tab properly inserted into notch.



1. Gaskets tab properly inserted

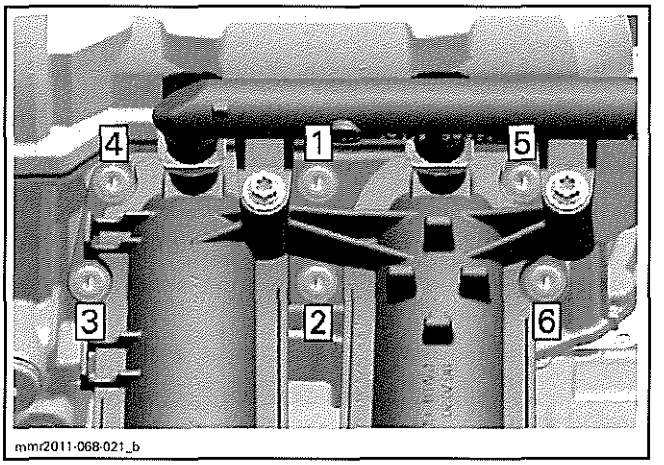
Ensure that rubber grommets are properly inserted.



RUBBER GROMMETS

Tighten intake manifold screws to specification as per the following sequence.

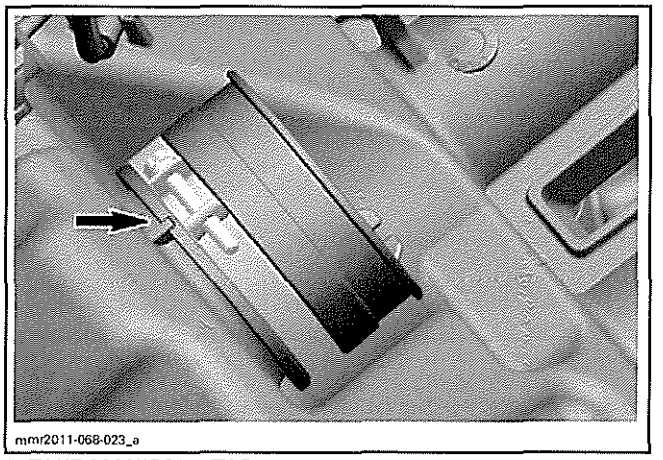
INTAKE MANIFOLD SCREWS TORQUE
11 N•m ± 1 N•m (97 lbf•**in** ± 9 lbf•**in**)



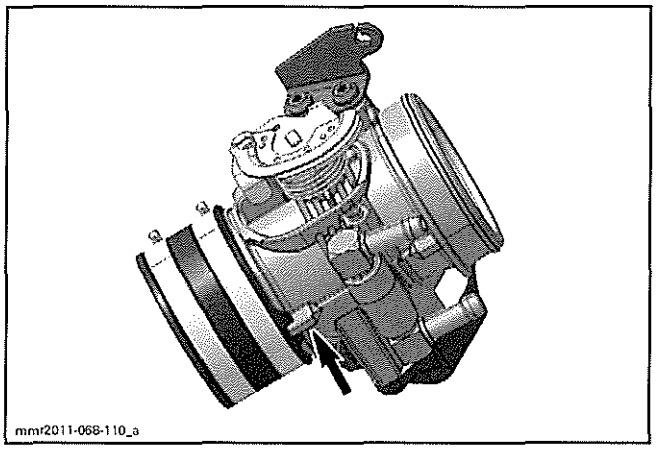
TIGHTENING SEQUENCE

Make sure to index intake adapter notches with the following components:

- Intake manifold tab
- Throttle body tab.



INTAKE MANIFOLD TAB

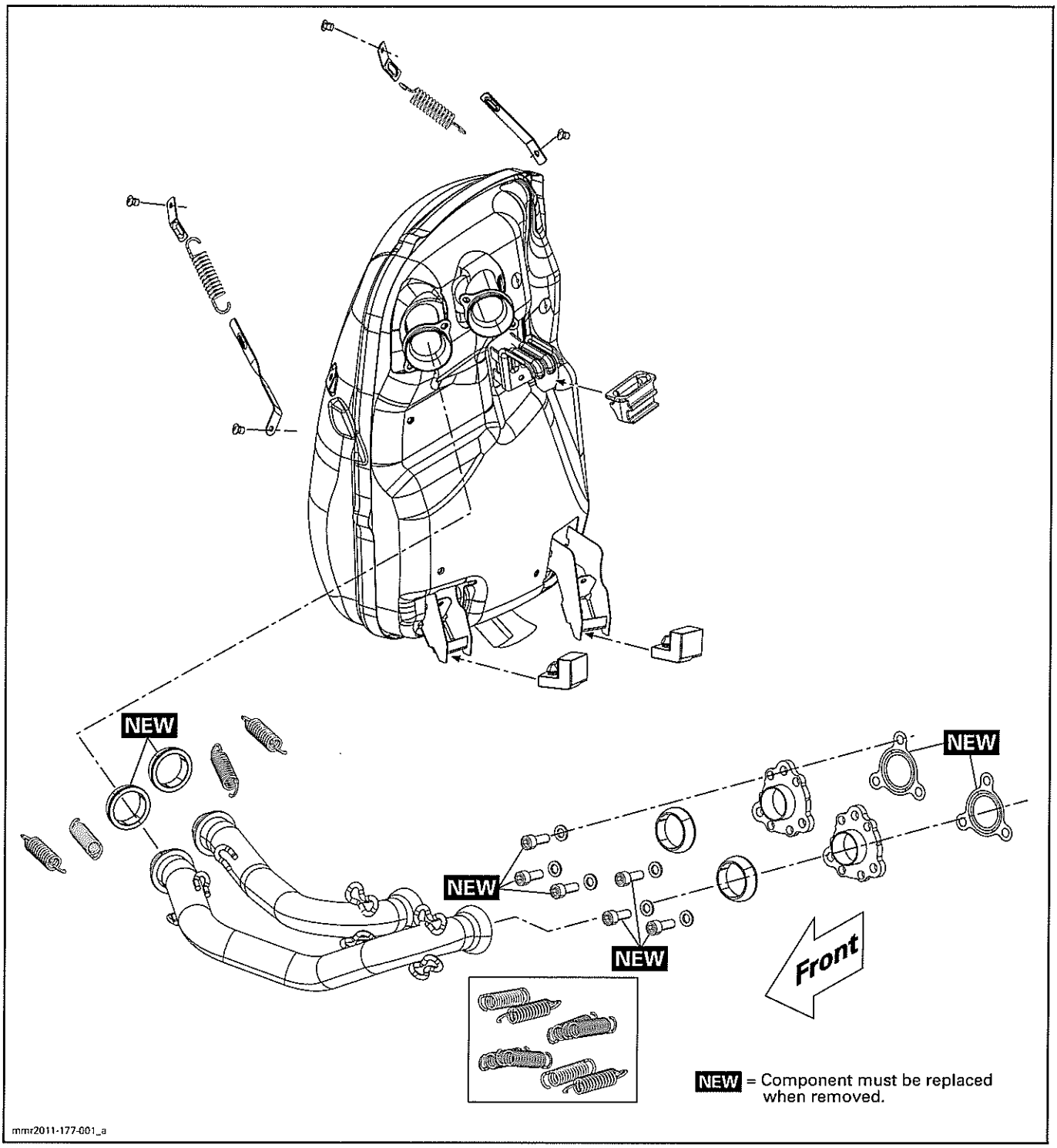


THROTTLE BODY TAB

EXHAUST SYSTEM

SERVICE TOOLS

Description	Part Number	Page
SPRING INSTALLER/REMOVER	529 035 983	168–169



GENERAL

⚠ WARNING

To avoid potential burns, never touch exhaust system components immediately after the engine has been running because these components are very hot. Let engine and exhaust system cool down before performing any servicing.

During assembly/installation, use the torque value and service products as in the exploded view.

⚠ WARNING

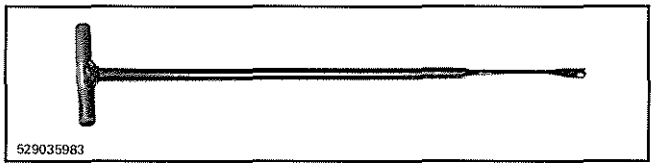
Torque wrench tightening specifications must be strictly adhered to.
Locking devices (e.g.: locking tabs, elastic stop nuts, self-locking fasteners, cotter pins, etc.) must be replaced with new ones.

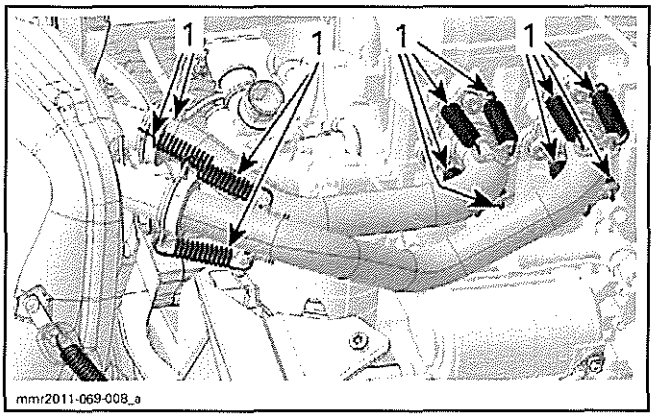
PROCEDURES

EXHAUST PIPES

Exhaust Pipe Removal

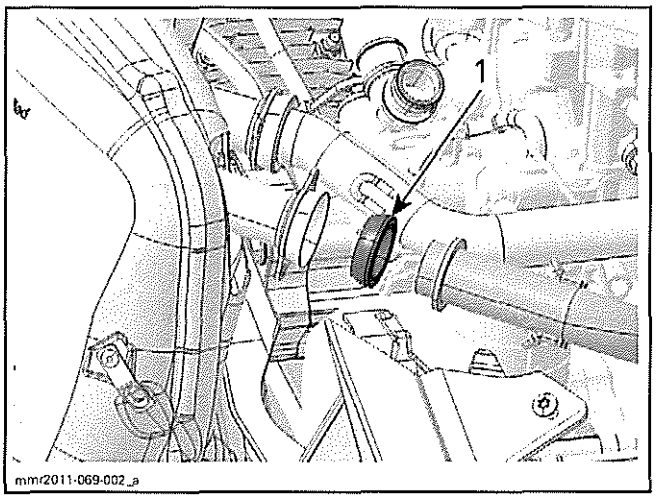
1. Refer to *BODY* subsection and remove:
   - LH and RH side panels
   - Hood.
2. Remove the belt guard. Refer to *DRIVE BELT* subsection.
3. Using the SPRING INSTALLER/REMOVER (P/N 529 035 983), remove all exhaust springs from exhaust pipes.



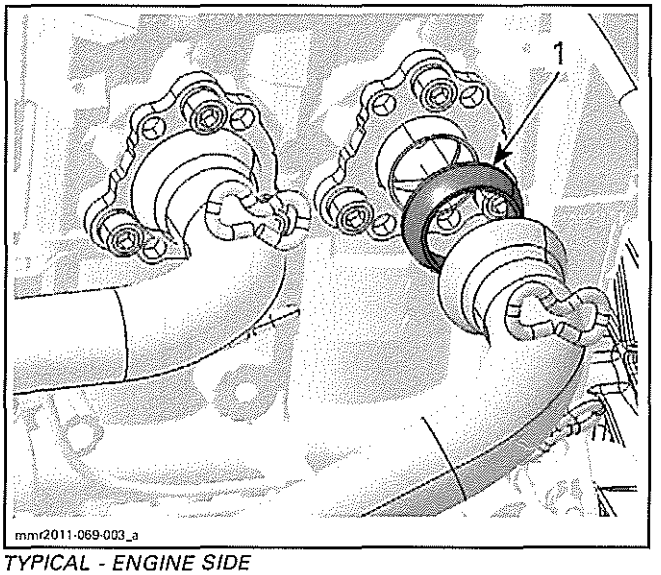


SEVERAL COMPONENTS REMOVED FOR CLARITY
1. Exhaust springs (4+8)

4. Pull out the exhaust pipes.
5. Remove exhaust gaskets at both ends.



TYPICAL - MUFFLER SIDE
1. Exhaust gasket



TYPICAL - ENGINE SIDE
1. Exhaust gasket

Exhaust Pipe Inspection

Check exhaust pipes for:
- Damages
- Cracks.

Inspect gaskets condition. Replace as required.

Exhaust Pipe Installation

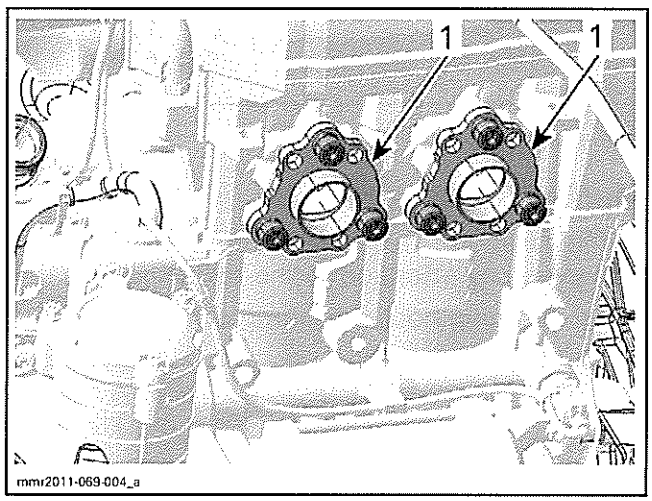
1. Install exhaust gaskets.
2. Position exhaust pipes into vehicle.
3. Align the muffler and exhaust pipe hooks together.
4. Install exhaust springs using the SPRING INSTALLER/REMOVER (P/N 529 035 983).

5. Ensure springs do not touch each other. Move apart if necessary.
6. Install all other removed parts.

EXHAUST FLANGE

Exhaust Flange Removal

1. Remove *EXHAUST PIPES*, see procedure in this subsection.
2. Remove the exhaust flanges.



1. Exhaust flanges

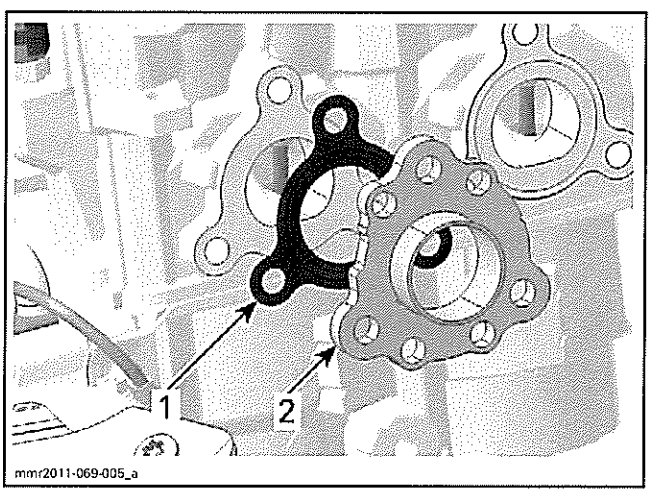
3. Remove and discard the exhaust flange gaskets.

Exhaust Flange Inspection

Check if the flanges are cracked or damaged. Replace if necessary.

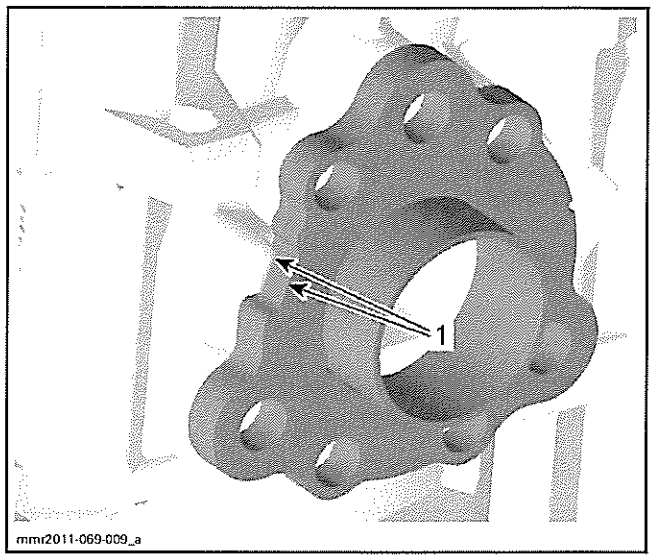
Exhaust Flange Installation

1. Install the exhaust flange with a **NEW** gasket.



SEVERAL COMPONENTS REMOVED FOR CLARITY
1. NEW gasket
2. Exhaust flange

2. Position exhaust flange on cylinder head. Align its notch with the cylinder tab.



1. Align notch with tab

3. Install screws.
4. Torque screws as per table.

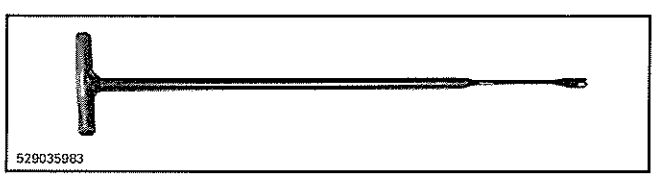
EXHAUST FLANGE SCREWS TIGHTENING TORQUE
24 N•m (18 lbf•ft)

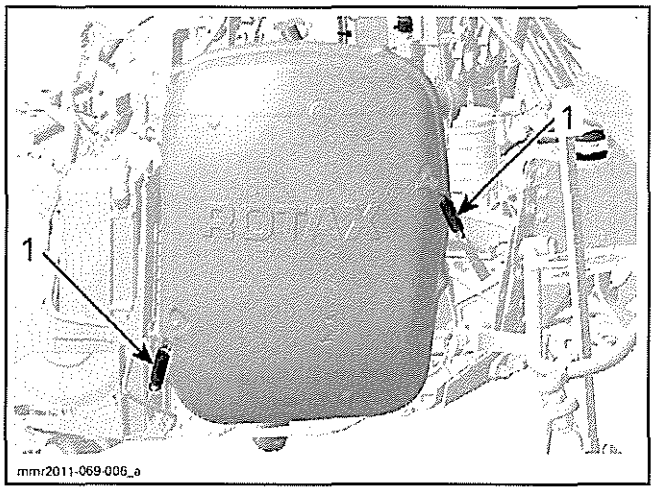
5. Install exhaust pipe.

MUFFLER

Muffler Removal

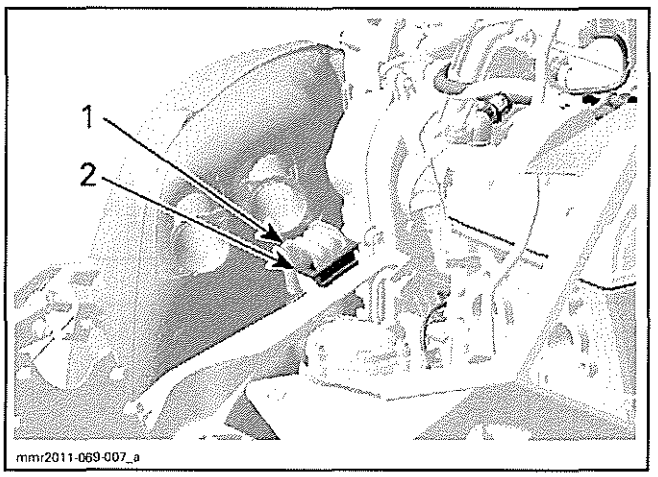
1. Remove the RH side panels.
2. Using the SPRING INSTALLER/REMOVER (P/N 529 035 983), remove:
   - The exhaust springs securing the muffler to the chassis.
   - The exhaust springs securing the muffler to the exhaust pipes.





TYPICAL - SEVERAL COMPONENTS REMOVED FOR CLARITY
1. Muffler retaining springs (2)

3. Lift up muffler to free the retaining hook.



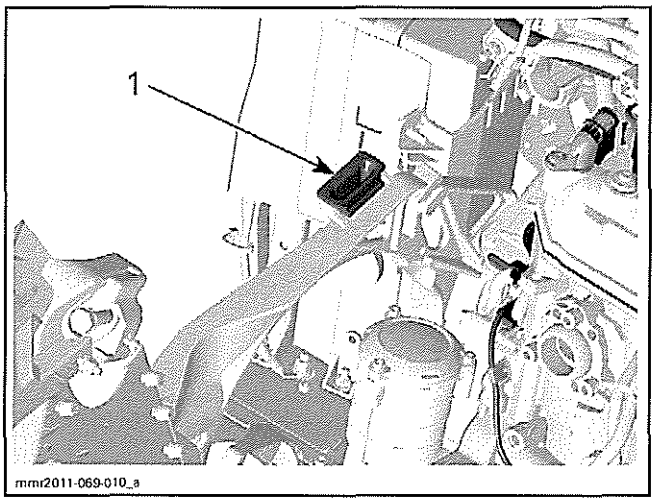
TYPICAL - SEVERAL COMPONENTS REMOVED FOR CLARITY
1. Retaining hook
2. Grommet

4. Remove the muffler.

Muffler Inspection

Check the muffler for cracks or other damage.

Check grommet condition.

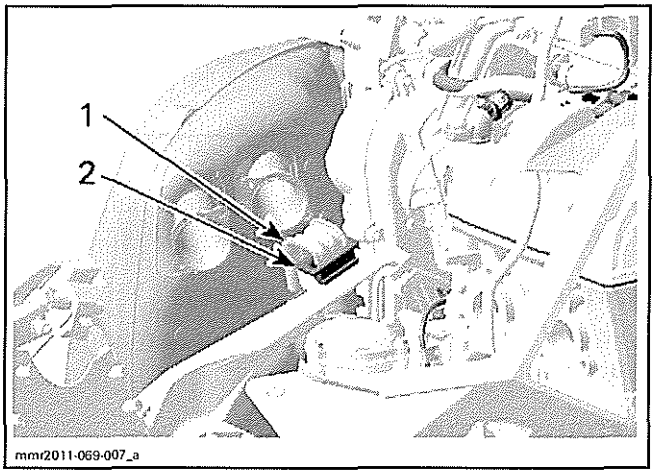


TYPICAL
1. Grommet

Muffler Installation

For installation, reverse the removal procedure. However, pay attention to the following.

Insert retaining hook into the grommet.



SEVERAL COMPONENTS REMOVED FOR CLARITY
1. Retaining hook
2. Grommet

Align the muffler and exhaust pipe hooks together.

Ensure springs do not touch each other. Move apart if necessary.

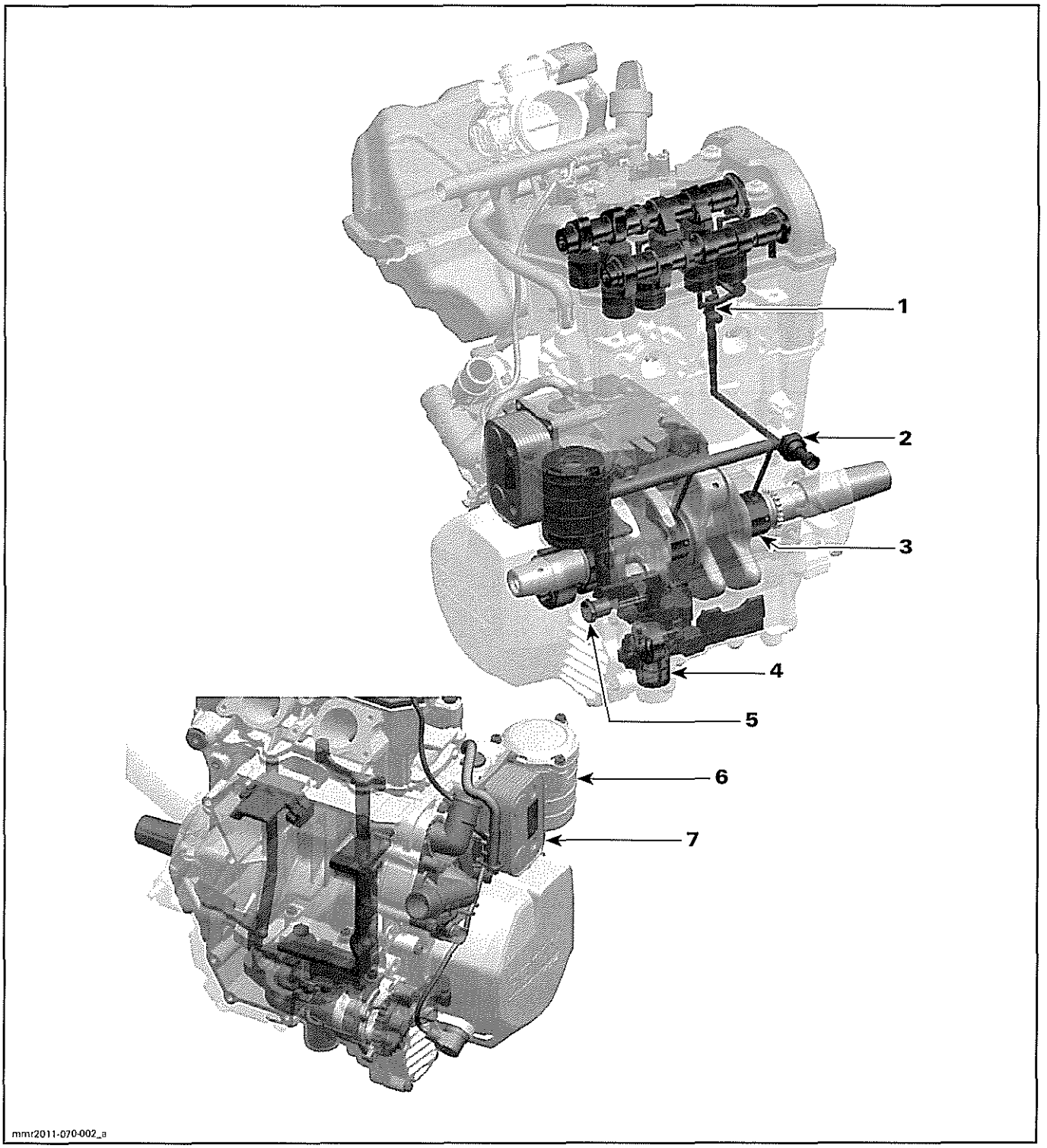
LUBRICATION SYSTEM

SERVICE TOOLS

Description	Part Number	Page
ADAPTER HOSE	529 035 652	174
ECM ADAPTER TOOL	529 036 166	176
FLUKE 115 MULTIMETER	529 035 868	176
OIL PRESSURE TEST CAP	529 036 158	174
PRESSURE GAUGE	529 035 709	174

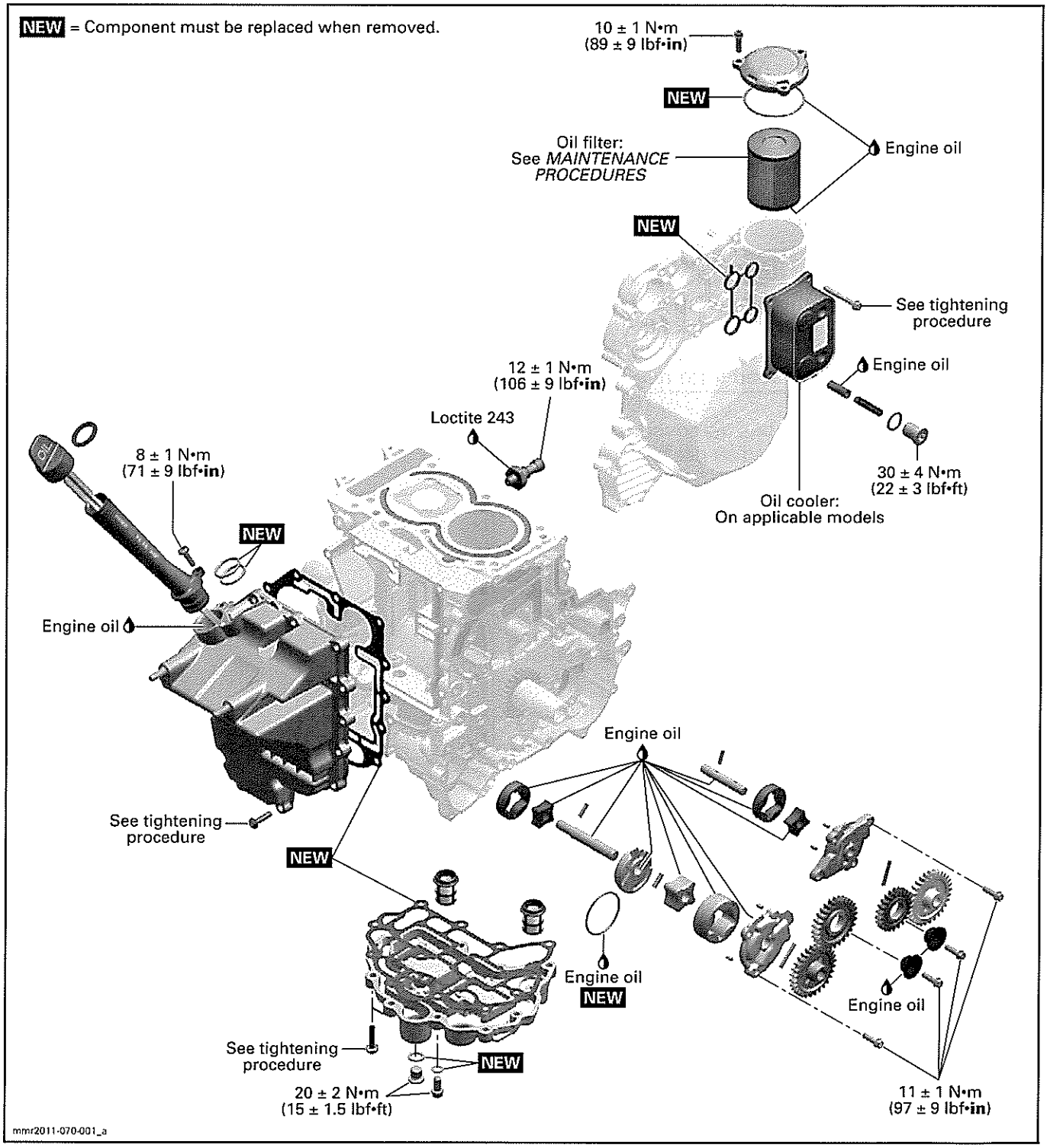
SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 243 (BLUE)	293 800 060	177



ENGINE LUBRICATION CIRCUIT

1. Oil channel to camshaft bearing
2. Oil Pressure Switch
3. Crankshaft main bearing
4. Oil strainer
5. Oil pressure regulator
6. Oil filter
7. Oil cooler


NEW = Component must be replaced when removed.
10 ± 1 N•m
(89 ± 9 lbf•in)
NEW
Oil filter:
See MAINTENANCE PROCEDURES
Engine oil
NEW
See tightening procedure
Engine oil
12 ± 1 N•m
(106 ± 9 lbf•in)
Loctite 243
30 ± 4 N•m
(22 ± 3 lbf•ft)
Oil cooler:
On applicable models
8 ± 1 N•m
(71 ± 9 lbf•in)
NEW
Engine oil
Engine oil
See tightening procedure
NEW
Engine oil
NEW
Engine oil
See tightening procedure
NEW
20 ± 2 N•m
(15 ± 1.5 lbf•ft)
11 ± 1 N•m
(97 ± 9 lbf•in)
mmr2011-070-001_a

GENERAL

During assembly/installation, use the torque values and service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to. Locking devices (e.g.: locking tabs, elastic stop nuts, cotter pins, etc.) must be replaced with new ones.

Hoses, cables or locking ties removed during a procedure must be reinstalled as per factory standards.

SYSTEM DESCRIPTION

This engine uses dry sump lubrication. The oil from the cylinder block, timing chain chamber and magneto cover is pumped by two suction pumps.

Both suction pumps are integrated into one module.

The 20 mm (.79 in) large oil suction pump returns the crankshaft and magneto chamber oil to the reservoir.

The 11 mm (.43 in) small oil suction pump returns the timing chain chamber oil to the oil reservoir.

An oil filter and one oil strainer are used to filter dirt and debris from the oil circuit.

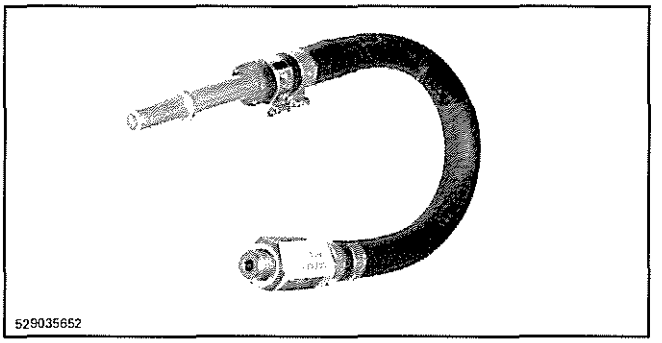
The oil strainer is located between oil sump cover and crankcase lower underneath the oil pressure pump.

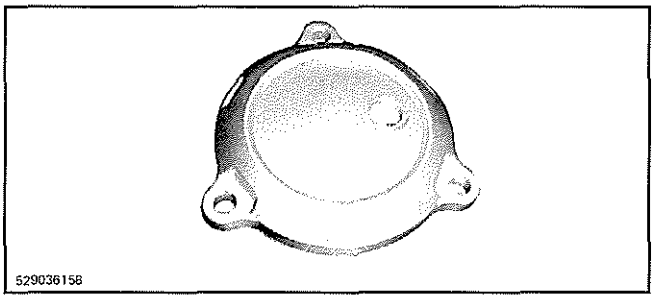
The oil pressure is provided by a pump and regulated by a spring loaded pressure regulator.

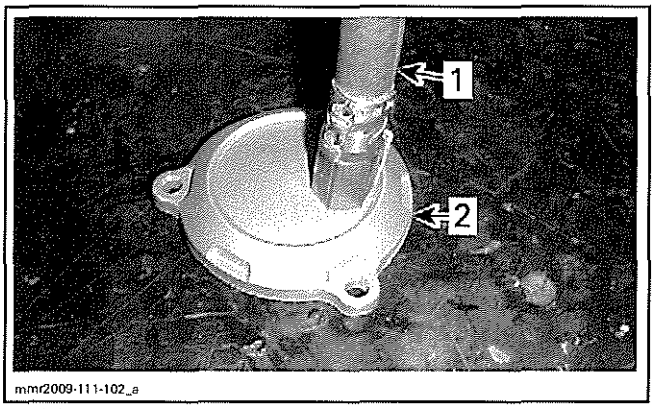
INSPECTION

ENGINE OIL PRESSURE

1. Remove the RH side panel.
2. Completely tighten the ADAPTER HOSE (P/N 529 035 652) on the OIL PRESSURE TEST CAP (P/N 529 036 158).

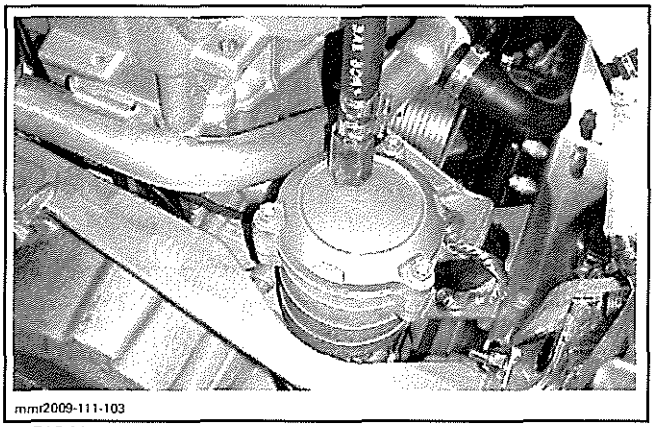






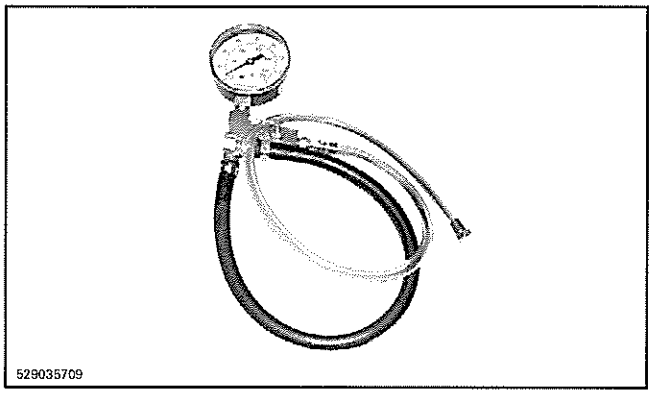
1. Adapter hose
2. Oil pressure test cap

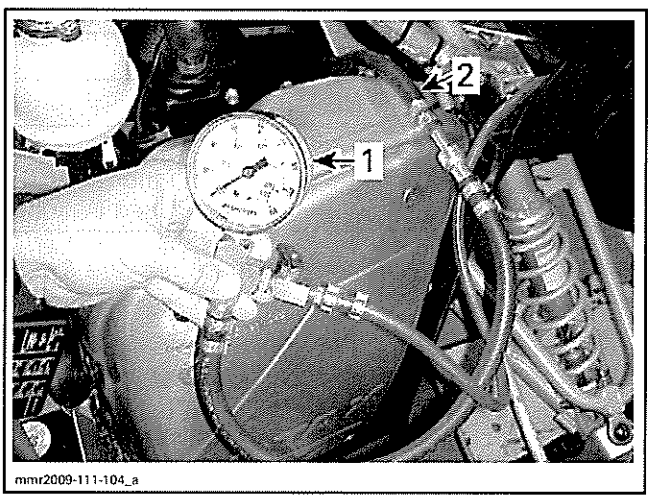
3. Install the oil pressure test cap on the oil filter reservoir. Position adapter hose near engine.



TYPICAL

4. Connect the PRESSURE GAUGE (P/N 529 035 709) to adapter hose.





TYPICAL
1. *Pressure gauge*
2. *Adapter hose*

5. Start engine and check the oil pressure.

ENGINE OIL PRESSURE @ 80°C (176°F)	
ENGINE SPEED	MINIMUM PRESSURE
Idle	60 kPa (8.7 PSI)
4000 RPM	400 kPa (58 PSI)

If the engine oil pressure is out of specification, refer to *TROUBLESHOOTING* in this subsection.

6. Remove engine oil pressure test tools.
7. Reinstall all removed parts.

TROUBLESHOOTING

Always check for fault codes. If a fault code is detected, service the fault code first.

LOW OR NO ENGINE OIL PRESSURE

1. Oil level is too low.
   - *Refill engine oil.*
   - *Check for high oil consumption. See below.*
   - *Check for oil leaks (oil leaking out of leak indicator hole, gaskets, oil seal or O-rings). Repair or replace.*
2. Defective or clogged oil filter.
   - *Replace engine oil and filter.*
3. Use of a bad grade oil.
   - *Replace engine oil with BRP recommended oil.*
4. Oil pressure regulator valve sticks open, or spring load is insufficient.
   - *Clean oil regulator piston and its bore. Replace if necessary.*
   - *Measure spring free length. Replace if out of specification.*
5. Oil pump(s) worn or damaged.
   - *Check if oil pump drive gears are damaged. Replace if necessary.*
   - *Check oil pump rotors and its bore for wear limits. Replace if out of specification.*
6. Engine oil strainer is clogged.
   - *Remove and clean engine oil strainer.*
7. Heavy wear on plain bearings.
   - *Check radial clearance of plain bearings. Replace if out of specification.*

HIGH OIL CONSUMPTION

1. Oil in breathing system.
   - *Check if breather V-ring is brittle, hard or damaged. Replace V-ring.*
   - *Check if oil separator cover is damaged or missing.*
2. Valve stem seals worn or damaged.
   - *Replace valve stem seals.*
3. Piston rings worn out (blue colored exhaust smoke).
   - *Replace piston rings.*

OIL CONTAMINATION (WHITE APPEARANCE)

1. Oil seal and rotary seal on water pump shaft leaking.
   - *Replace oil seal, rotary seal and water pump shaft. Change engine oil.*
2. Cylinder head gasket leaking.
   - *Replace cylinder head gasket. Change engine oil.*
3. Cylinder head screws not properly tightened.
   - *Retighten screws with recommended torque. Change engine oil.*
4. Oil cooler gasket leaking.
   - *Replace gasket. Change engine oil.*

PROCEDURES

OIL PRESSURE SWITCH (OPS)

OPS Activation

The oil pressure switch activates if engine oil pressure falls between 20 kPa and 40 kPa (2.9 PSI and 5.8 PSI).

OPS Access

1. Remove LH side panels.
2. Remove the drive belt guard. Refer to *DRIVE BELT* subsection.

OPS Inspection

First, ensure oil pressure is adequate. Refer to *ENGINE OIL PRESSURE.*

If the oil pressure is good, check the resistance of the oil pressure switch.

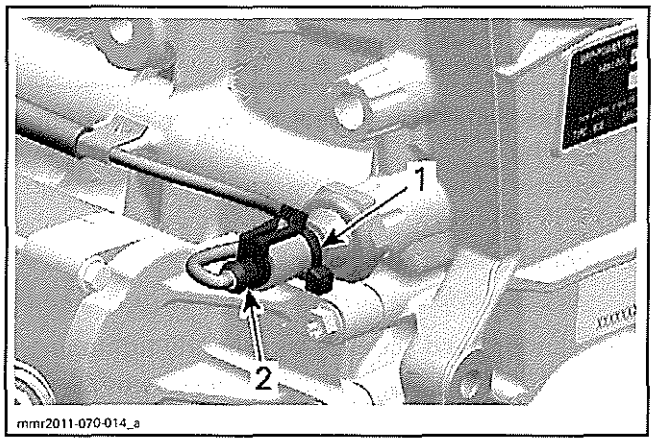
OPS Resistance Test

The engine must be warm to check the oil pressure switch properly.

⚠ WARNING

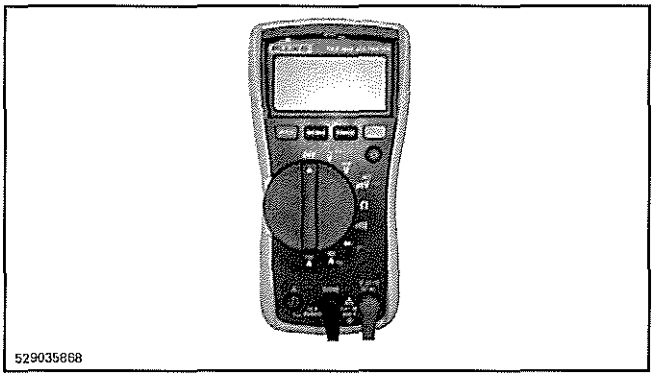
Be careful when working near hot part. To avoid potential burns, never touch exhaust system components immediately after the engine has been running as these components are very hot. Always use long sleeves and gloves.

1. Cut locking tie and disconnect the OPS connector.



1. Locking tie
2. OPS connector

2. Using the FLUKE 115 MULTIMETER (P/N 529 035 868), check the oil pressure switch resistance.



3. Read result and compare to table.

RESISTANCE (Ω)		
ENGINE NOT RUNNING		
OPS pin	Engine ground	Close to 0 Ω (normally closed switch)

If resistance is out of specification, replace the oil pressure switch.

If the resistance is correct, continue procedure. It will be necessary to use jumper wires.

4. Install drive belt guard.
5. Start engine.
6. Read result and compare to table.

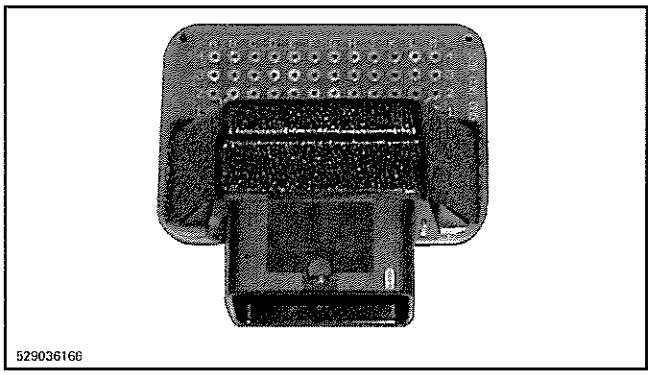
RESISTANCE (Ω)		
ENGINE RUNNING		
OPS pin	Engine ground	Infinitely high (OL)

If resistance is out of specification, replace the oil pressure switch.

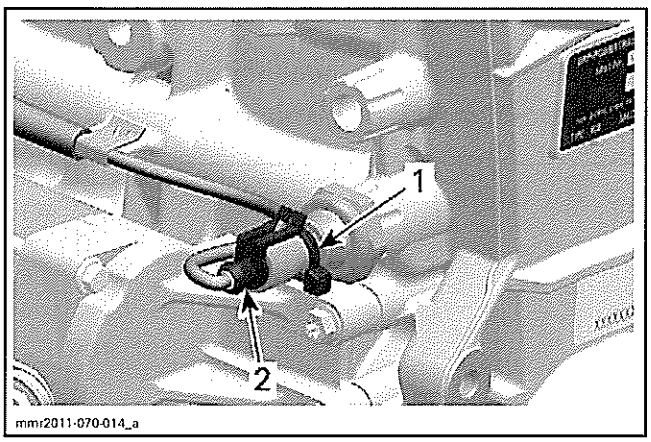
If the resistance is correct, check the oil pressure switch circuit continuity.

OPS Circuit Continuity Test

1. Disconnect ECM connector A. Refer to *ECM CONNECTOR ACCESS* in *ELECTRONIC FUEL INJECTION (600 ACE)* subsection.
2. Connect ECM connector A to the ECM ADAPTER TOOL (P/N 529 036 166).



3. Cut locking tie and disconnect the OPS connector.



1. Locking tie
2. OPS connector

4. Check continuity as follows.

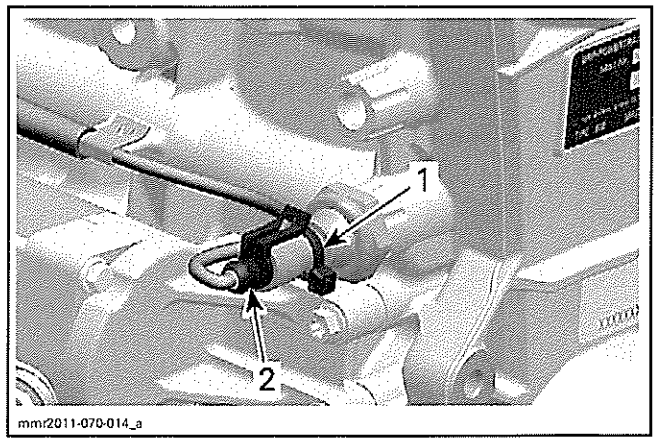
CIRCUIT CONTINUITY		
OPS connector	ECM A pin E3	Close to 0 Ω

If the continuity is good and all other tests, try a NEW ECM.

If the continuity is bad, repair or replace defective wire or connectors.

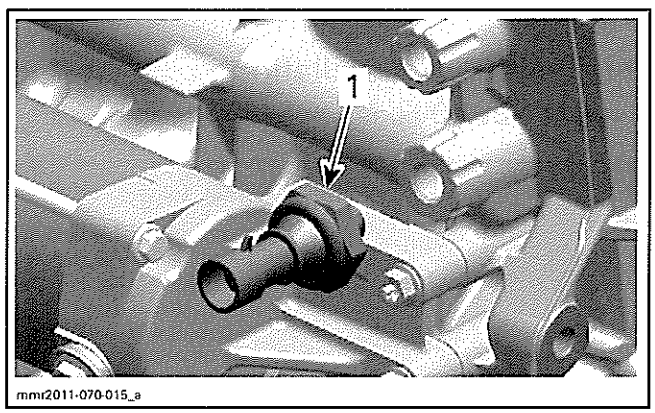
OPS Removal

1. Cut locking tie and unplug the OPS switch connector.



1. Locking tie
2. OPS connector

2. Unscrew and remove the OPS.



1. Oil pressure switch

OPS Installation

1. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on threads of oil pressure switch.
2. Tighten oil pressure switch to the specified torque.

OIL PRESSURE SWITCH TIGHTENING TORQUE
12 N•m ± 1 N•m (106 lbf•**in** ± 9 lbf•**in**)

3. Install all other removed parts.

NOTICE When installing the locking tie on the OPS connector, take care that the wires do not to make a sharp bend.

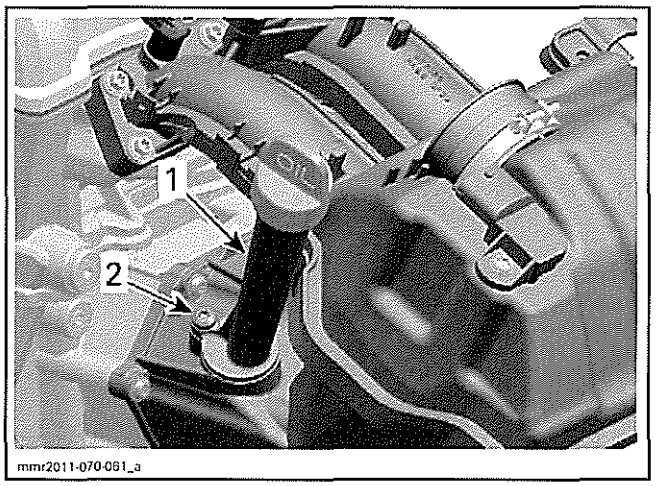
OIL FILLER TUBE

Oil Filler Tube Access

Remove drive belt guard, refer to *DRIVE BELT* subsection.

Oil Filler Tube Removal

1. Remove the oil filler tube retaining screw.

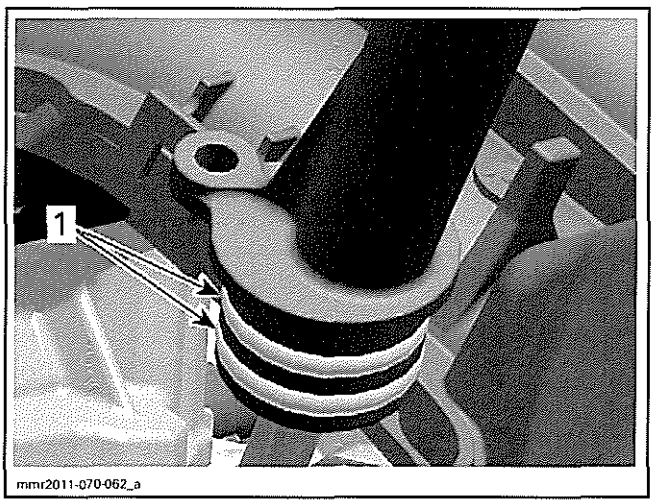


1. Oil filler tube
2. Retaining screw

2. Pull filler tube out of the oil tank cover.

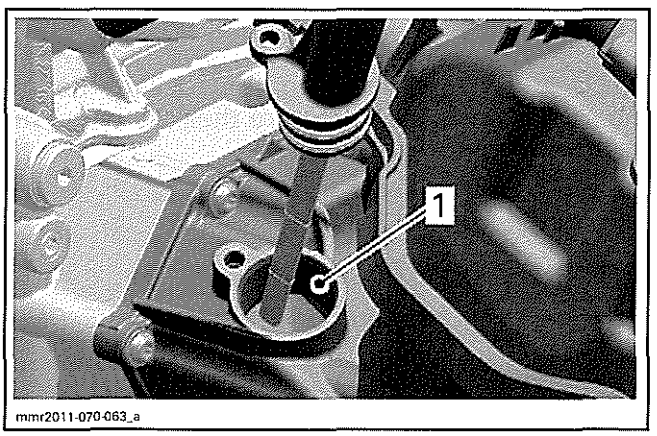
Oil Filler Tube Installation

1. Install NEW O-rings on the oil filler tube.



1. Oil filler tube O-rings

2. Lubricate the oil tank cover bore with engine oil.



1. Lubricate the oil tank cover bore

3. Install the oil filler tube.

4. Tighten retaining screw to the specified torque.

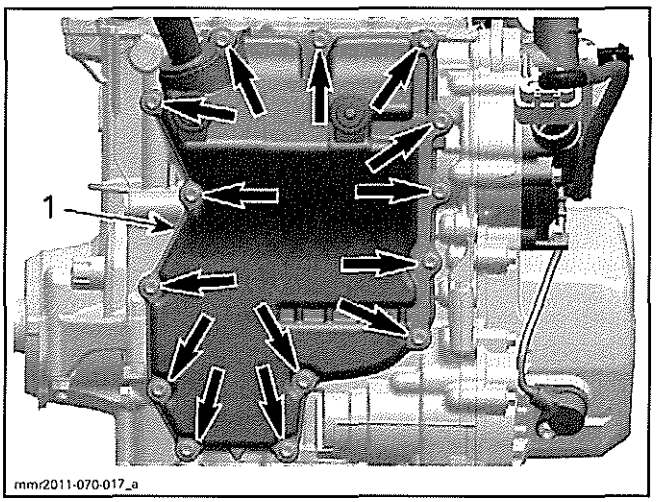
OIL FILLER TUBE SCREW TIGHTENING TORQUE
8 N•m ± 1 N•m (71 lbf•**in** ± 9 lbf•**in**)

5. Install all other removed parts.

OIL TANK

Oil Tank Cover Removal

1. Drain engine oil. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.
2. Remove the engine from vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
3. Place a drain pan underneath oil tank.
4. Unscrew oil tank cover retaining screws.



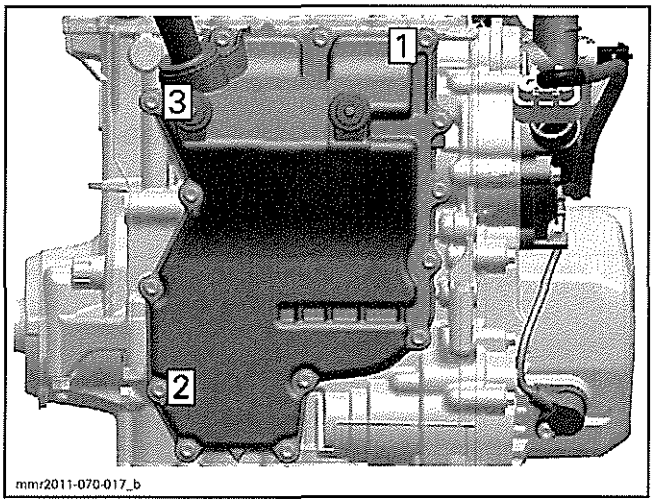
RETAINING SCREWS
1. Oil tank

5. Remove oil tank from the engine.

Oil Tank Cover Installation

1. Install NEW gasket.
2. Install the oil tank on the engine, then tighten screws in two steps as follows:
   2.1 Tighten the following screws to the specified torque and sequence.

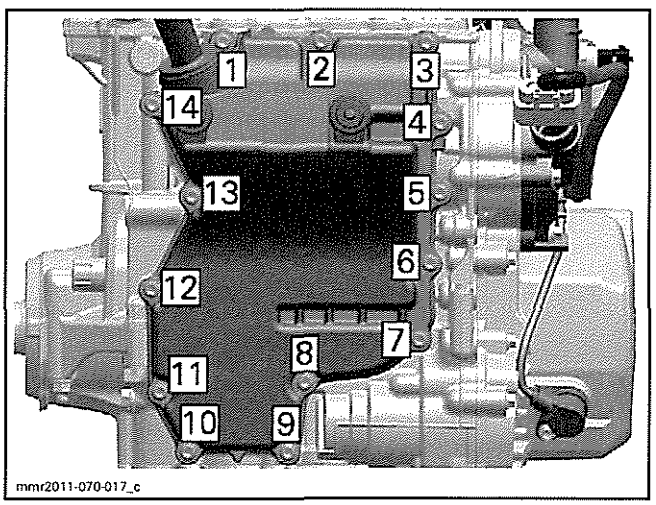
OIL TANK SCREWS TIGHTENING TORQUE (FOLLOW SEQUENCE)	
Step A	5 N•m ± 0.6 N•m (44 lbf•**in** ± 5 lbf•**in**)



TIGHTENING SEQUENCE STEP A

2.2 Tighten the following screws to the specified torque and sequence.

OIL TANK SCREWS TIGHTENING TORQUE (FOLLOW SEQUENCE)	
Step B	ORIGINAL CRANKCASE
	11 N•m ± 1 N•m (97 lbf•**in** ± 9 lbf•**in**)
Step B	NEW CRANKCASE
	14 N•m ± 2 N•m (124 lbf•**in** ± 18 lbf•**in**)



TIGHTENING SEQUENCE STEP B

3. Wipe off any oil spillage.
4. Install the engine in the vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
5. Fill up oil tank and check oil level. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

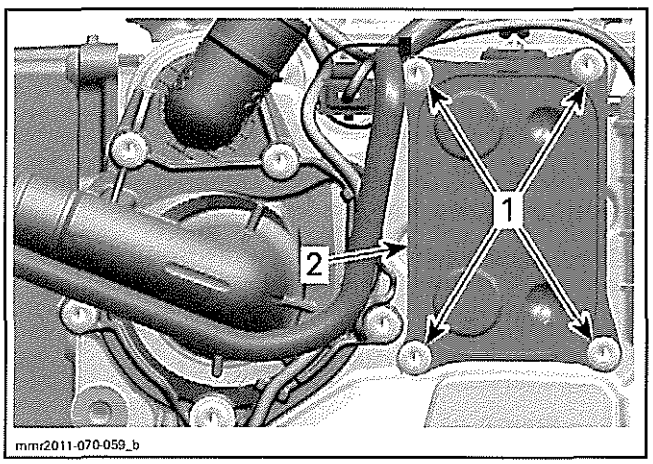
OIL COOLER

Oil Cooler Access

Remove muffler, refer to *EXHAUST SYSTEM* subsection.

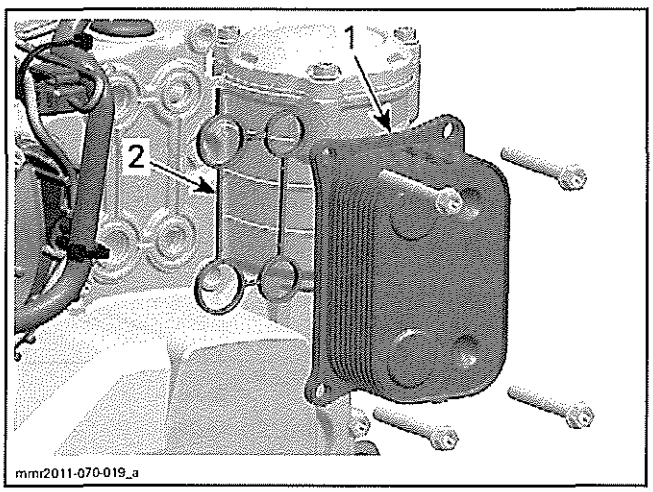
Oil Cooler Removal

1. Drain engine oil. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.
2. Drain cooling system. Refer to *COOLING SYSTEM* subsection.
3. Remove oil cooler retaining screws.



1. *Retaining screws*
2. *Oil cooler*

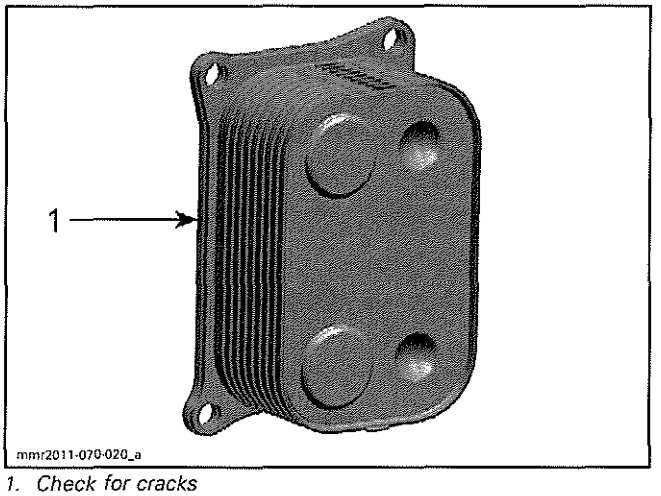
4. Place rags or towels under oil cooler to catch remaining oil and coolant.
5. Remove oil cooler and its gasket.



1. *Oil cooler*
2. *Gasket*

Oil Cooler Inspection

Check oil cooler for cracks and other damage.



1. Check for cracks

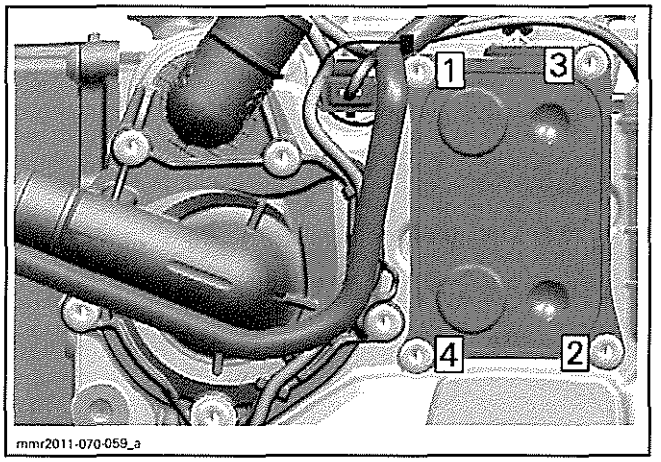
Replace parts as necessary.

Oil Cooler Installation

For installation, reverse the removal procedure. Pay attention to the following.

Tighten screws to the specified torque following the illustrated sequence.

OIL COOLER SCREWS TIGHTENING TORQUE (FOLLOW SEQUENCE)	
Step A	5 N•m ± 0.6 N•m (44 lbf•**in** ± 5 lbf•**in**)
Step B	10 N•m ± 1 N•m (89 lbf•**in** ± 9 lbf•**in**)



TIGHTENING SEQUENCE OIL-COOLER

Wipe off any oil and coolant spillage.

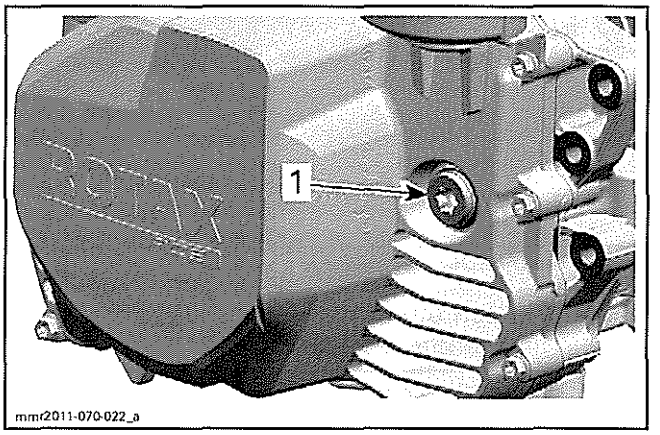
Fill up oil tank and check oil level. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

Refill and bleed cooling system. Refer to *COOLING SYSTEM* subsection.

ENGINE OIL PRESSURE REGULATOR

Oil Pressure Regulator Location

The engine oil pressure regulator is located inside the magneto cover.



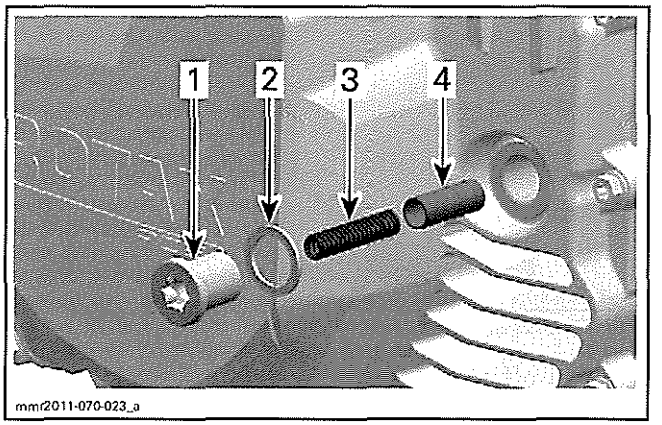
1. Engine oil pressure regulator

Oil Pressure Regulator Access

Remove muffler, refer to *EXHAUST SYSTEM* subsection.

Oil Pressure Regulator Removal

1. Drain engine oil. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.
2. Remove regulator plug and sealing washer. Discard sealing washer.
3. Pull oil pressure regulator parts out of the magneto cover.



1. Plug
2. Sealing washer
3. Regulator spring
4. Regulator piston

Oil Pressure Regulator Inspection

Clean bore and thread in the magneto cover from any contamination.

Inspect oil pressure regulator piston and its bore in cylinder block for scoring or other damages.

Check if piston moves easily in its bore.

Check compression spring for free length.

SPRING FREE LENGTH	
NEW NOMINAL	46 mm (1.811 in)
SERVICE LIMIT	45 mm (1.772 in)

Visually check compression spring for squareness.

Replace worn or damaged components.

Oil Pressure Regulator Installation

Install a NEW sealing washer on plug screw.

Tighten regulator plug to the specified torque.

OIL PRESSURE REGULATOR PLUG TIGHTENING TORQUE
30 N•m ± 4 N•m (22 lbf•ft ± 3 lbf•ft)

Wipe off any oil spillage.

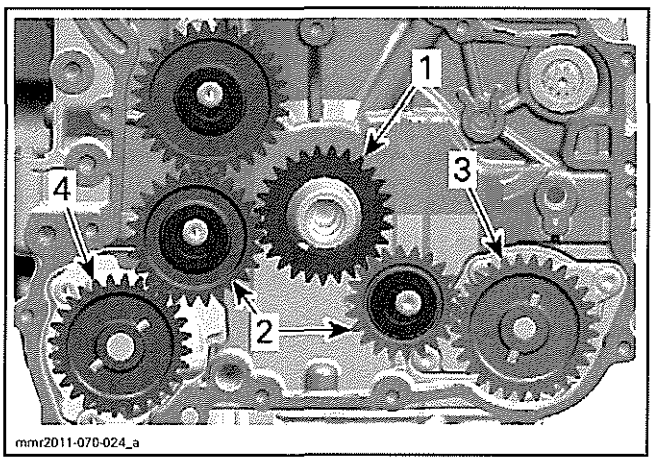
Fill up oil tank and check oil level. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

Install all other removed parts.

OIL PUMP DRIVE GEARS

Oil Pump Drive Gear Location

The oil pump gears are located on the MAG side, behind the magneto cover.



1. *Oil pump drive gear*
2. *Intermediate gears*
3. *Oil pressure pump gear*
4. *Oil suction pump gear*

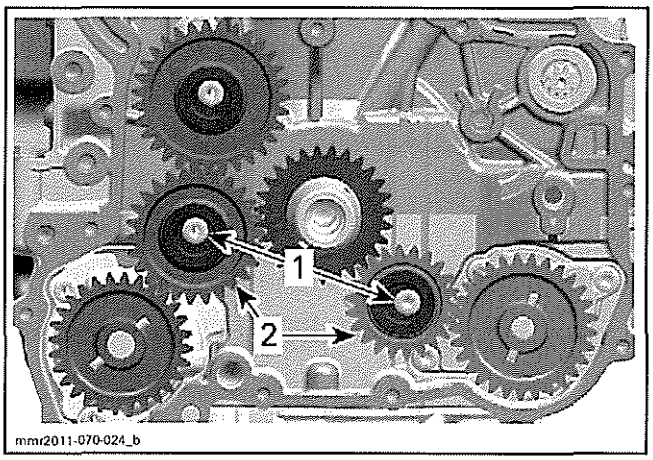
Oil Pump Drive Gear Access

Refer to *MAGNETO SYSTEM* subsection to remove:

- Magneto cover
- Rotor
- Sprag clutch gear.

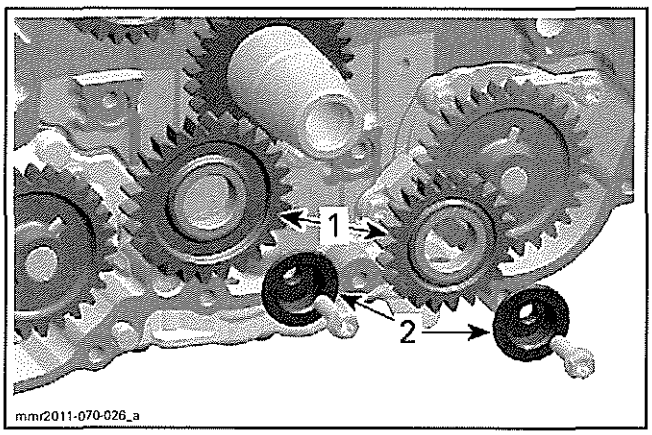
Oil Pump Drive Gear Removal

1. Drain engine oil, refer to *PERIODIC MAINTENANCE PROCEDURES*.
2. Unscrew oil pump intermediate gear screws.



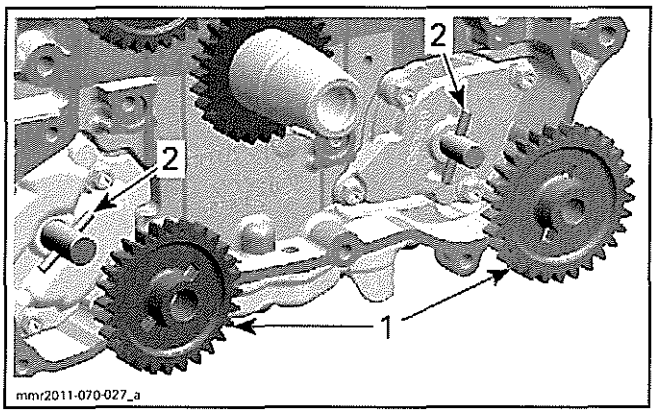
1. *Intermediate gears*
2. *Retaining screws*

3. Remove bearing sleeves and oil pump intermediate gears.



1. *Intermediate gears*
2. *Bearing Sleeves*

4. Remove oil pump gears and needle pins.



1. Oil pump gears
2. Needle pins

Oil Pump Drive Gear Inspection

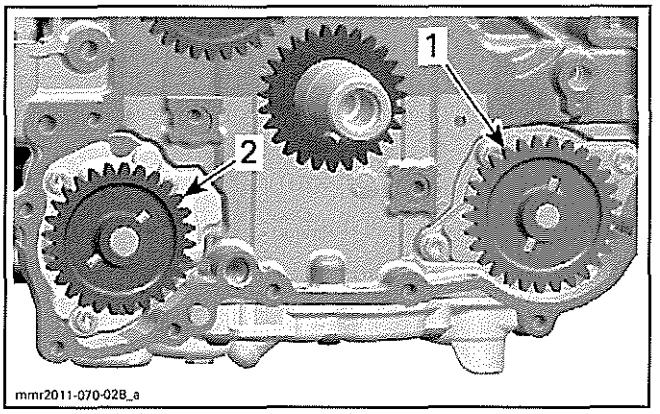
Inspect gears for wear, cracks or other damage.

Replace if damaged.

Oil Pump Drive Gear Installation

For installation, reverse the removal procedure, however, pay attention to the following.

1. Ensure not to mix up the oil pump gears, see next illustration.
   1.1 Install the BROWN oil pump gear (29 teeth) on oil pressure pump.
   1.2 Install the BLACK oil pump gear (28 teeth) on oil suction pump.



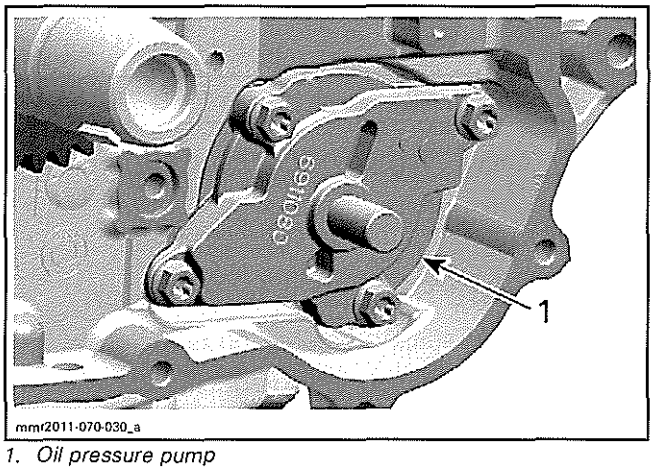
1. BROWN oil pump gear - 29 teeth
2. BLACK oil pump gear - 28 teeth

2. Lubricate intermediate gears bearing sleeves with engine oil, then install gears.
3. Install all other removed parts.
4. Fill up oil tank and check oil level. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

OIL PRESSURE PUMP

Oil Pressure Pump Location

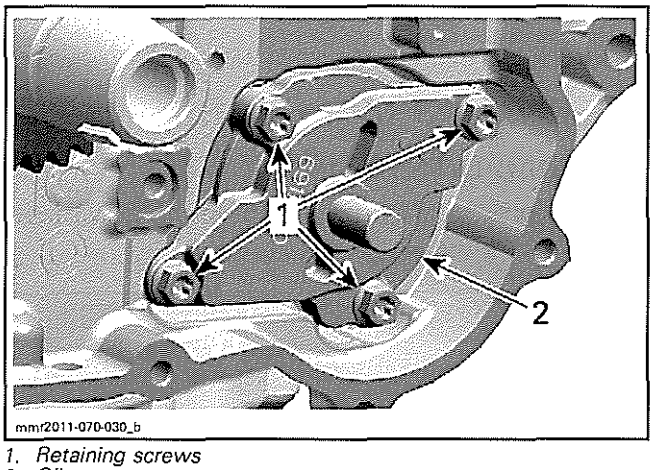
The oil pressure pump is located in the cylinder block, behind the magneto cover.



1. Oil pressure pump

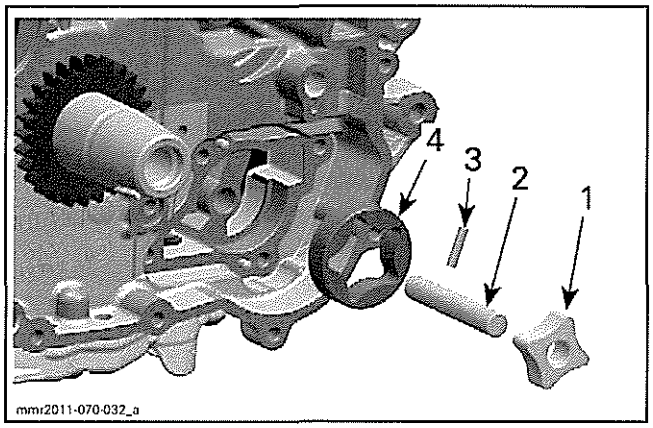
Oil Pressure Pump Removal

1. Remove *OIL PUMP DRIVE GEARS*, see procedure in this subsection.
2. Remove oil pump cover.



1. Retaining screws
2. Oil pump cover

3. Remove the following parts.



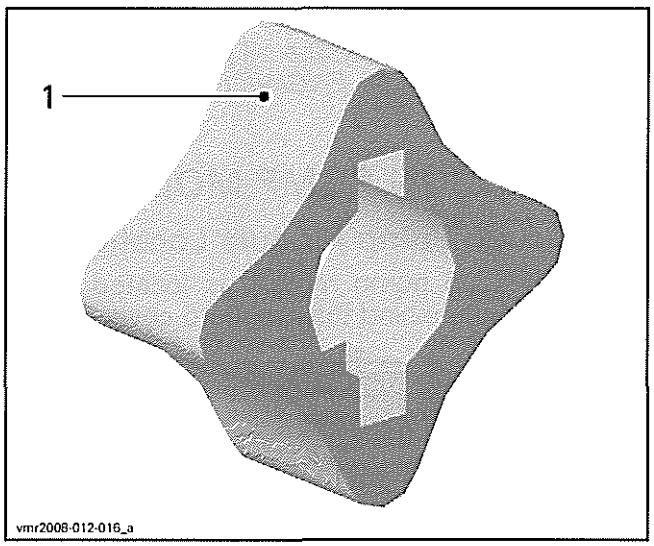
1. *Inner rotor*
2. *Oil pump shaft*
3. *Needle pin*
4. *Outer rotor*

Oil Pressure Pump Inspection

Inspect oil pump and oil pump cover bore for marks, scratches or other damage. Replace any damaged parts.

Check oil pump cover for damages and for surface straightness with a straight edge.

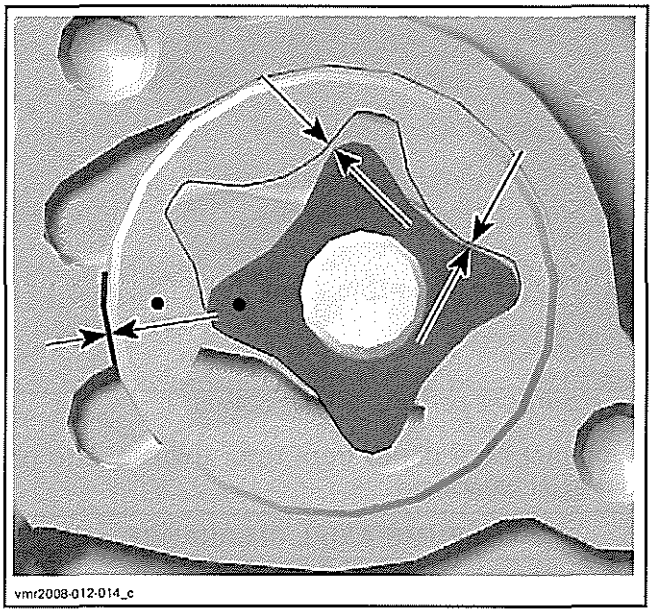
Check inner rotor for corrosion, worn pin slots or other damages. If so, replace inner and outer rotor at the same time.



1. *Pitting on the teeth*

Radial Clearance

Using a feeler gauge, measure the clearance of outer rotor and inner rotor where shown with the arrows.

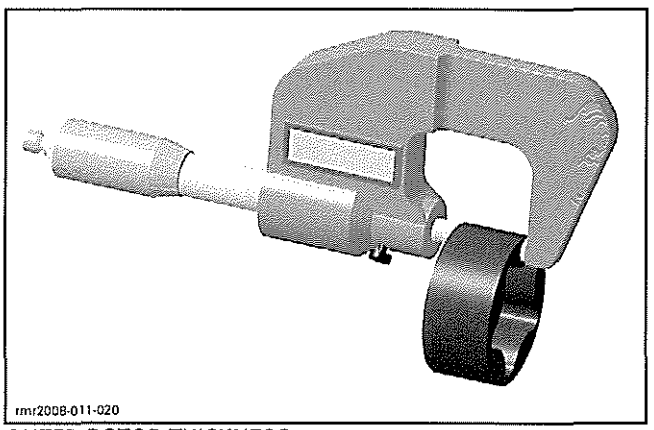


OIL PUMP RADIAL CLEARANCE	
SERVICE LIMIT	0.25 mm (.0098 in)

NOTE: If clearance of inner and outer rotors exceeds the tolerance, replace oil pump.

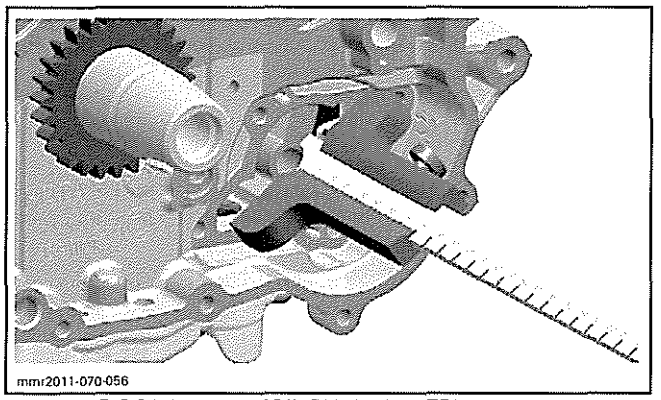
Axial Clearance

Measure outer rotor thickness with a micrometer.



OUTER ROTOR THICKNESS

Using a depth gauge, measure the depth of oil pump bore in the lower crankcase.



OIL PUMP BORE DEPTH (OIL PUMP COVER)

Substract bore depth from rotor thickness to obtain axial clearance.

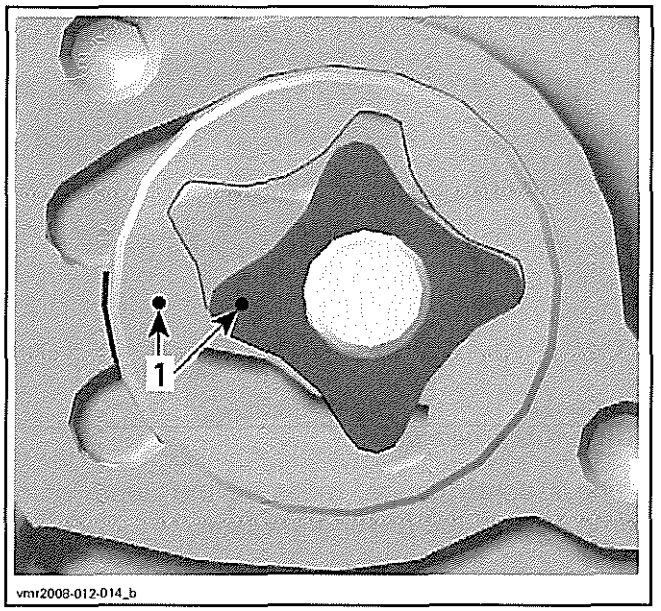
OIL PUMP AXIAL CLEARANCE	
SERVICE LIMIT	0.15 mm (.0059 in)

NOTE: When the axial clearance of the oil pump assembly increases, the oil pressure decreases.

Oil Pressure Pump Installation

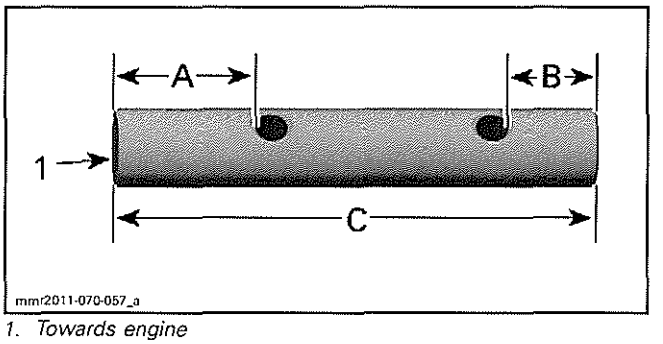
1. Lubricate inner and outer rotors with engine oil.

NOTICE Install rotors with the marks outwards and aligned together.



TYPICAL
1. Marks on inner and outer rotor

NOTICE The oil pump shaft is not symmetrical, the longer side must be installed inward.



1. Towards engine
A. 16.96 mm (.67 in)
B. 11.43 mm (.45 in)
C. 60.5 mm (2.38 in)

2. Place inner rotor onto the oil pump shaft. Lubricate parts with engine oil.
3. Insert the shaft and rotor assembly into the crankcase.
4. Lubricate the outer rotor with engine oil.
5. Install outer rotor onto the shaft with the mark aligned with the inner rotor mark.

After installation of the remaining parts, check for smooth operation of the oil pump assembly and axial play of the oil pump shaft.

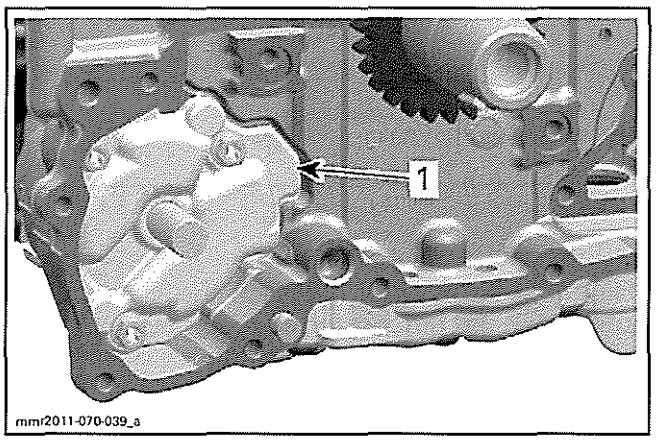
6. Fill up oil tank and check oil level. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

Start engine and make sure oil pressure is within specifications (refer to *ENGINE OIL PRESSURE* in this subsection).

OIL SUCTION PUMP MODULE

Oil Suction Pump Module Location

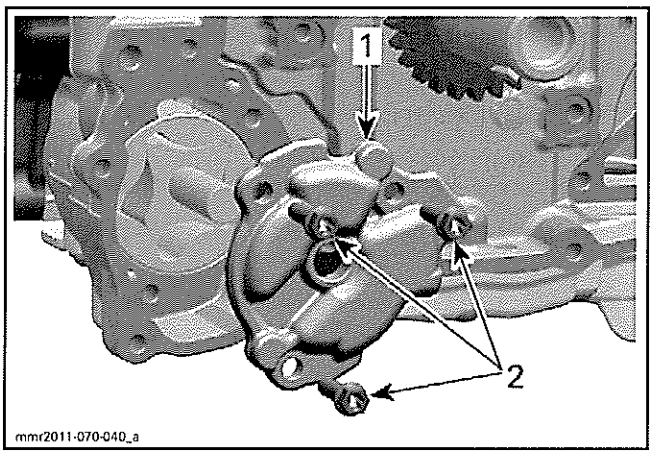
The oil suction pump module is located in the cylinder block, behind the magneto cover.



1. Oil suction pump module

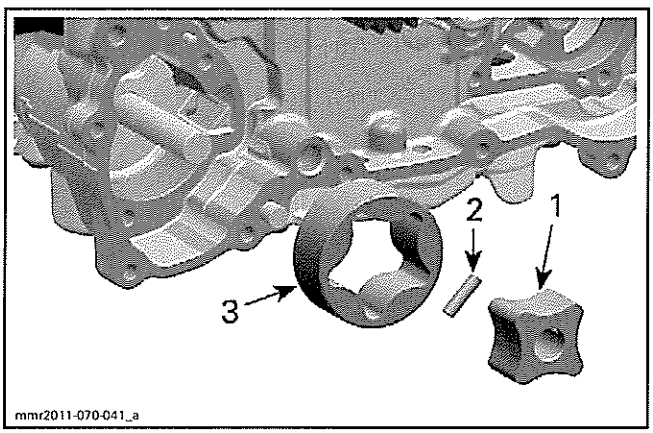
Oil Suction Pump Module Disassembly

1. Remove *OIL PUMP DRIVE GEARS*, see procedure in this subsection.
2. Remove oil pump module cover.



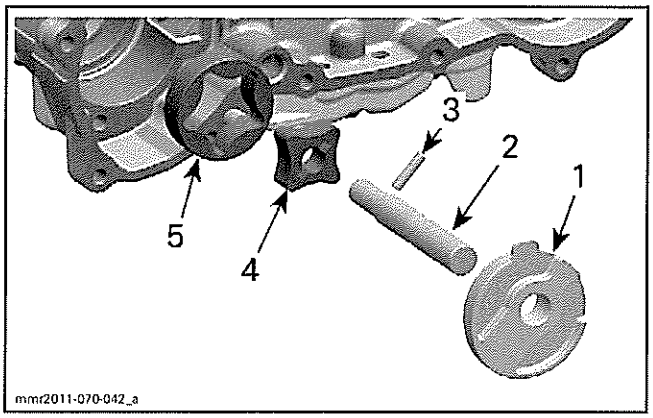
1. *Oil pump module cover*
2. *Retaining screws*

3. Disassemble the large oil suction pump as shown.



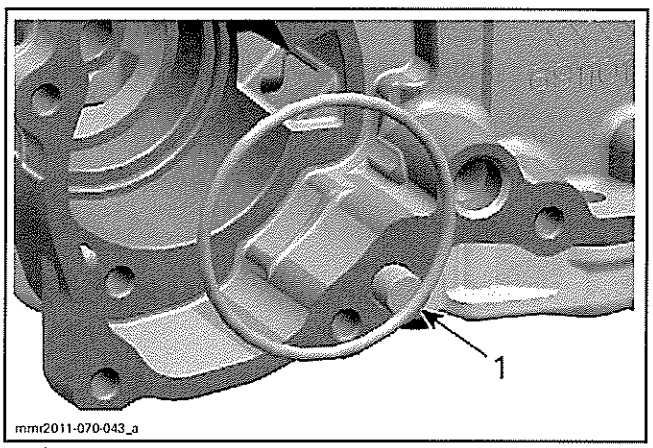
1. *Inner rotor*
2. *Needle pin*
3. *Outer rotor*

4. Disassemble the small oil suction pump as shown.



1. *Oil pump cover*
2. *Oil pump shaft*
3. *Needle pin*
4. *Inner rotor*
5. *Outer rotor*

5. Remove and discard the oil pump cover O-ring.



1. *Oil pump cover O-ring*

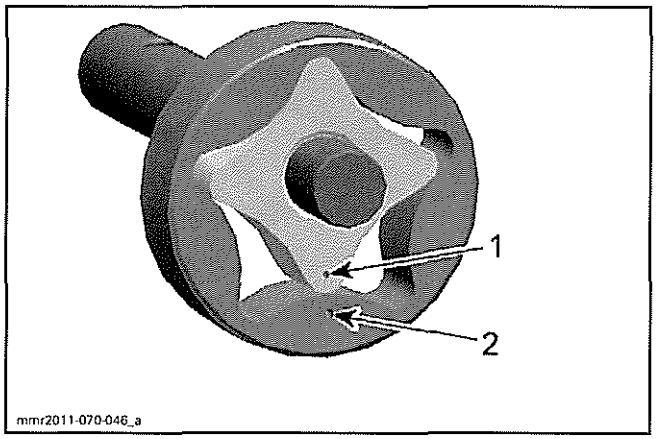
Oil Suction Pumps Inspection

The inspection of both oil suction pumps is the same as for the oil pressure pump. Refer to *OIL PRESSURE PUMP* in this subsection.

Oil Suction Pump Module Assembly

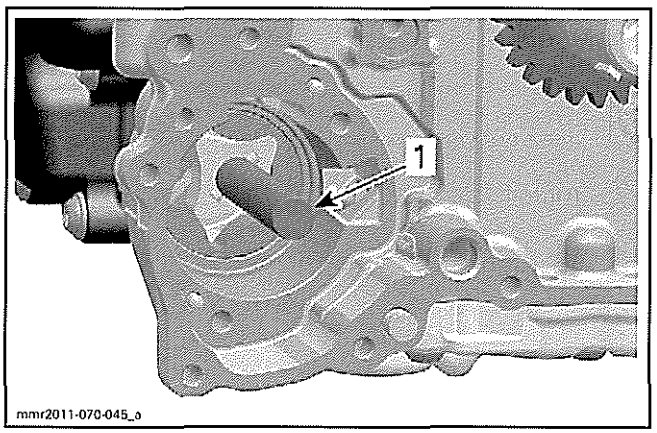
1. Lubricate inner and outer rotors with engine oil.

NOTICE When installing the oil pump rotors, make sure both marks are pointing toward the inside of the crankcase.



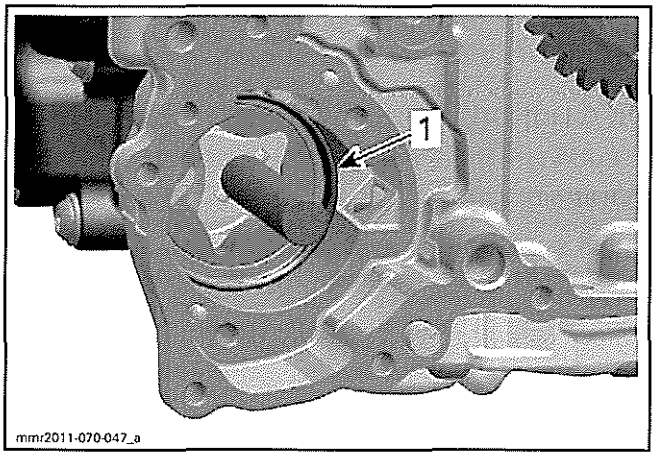
1. Mark on inner rotor
2. Mark on outer rotor

2. Install oil pump shaft along with the small oil suction pump inner rotor into the crankcase.
3. Install small oil suction pump outer rotor.



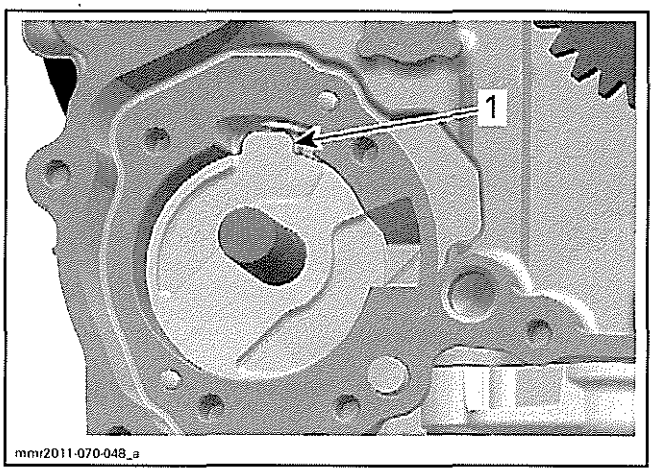
1. Oil pump shaft with small oil suction pump

Install a NEW oil pump cover O-ring.

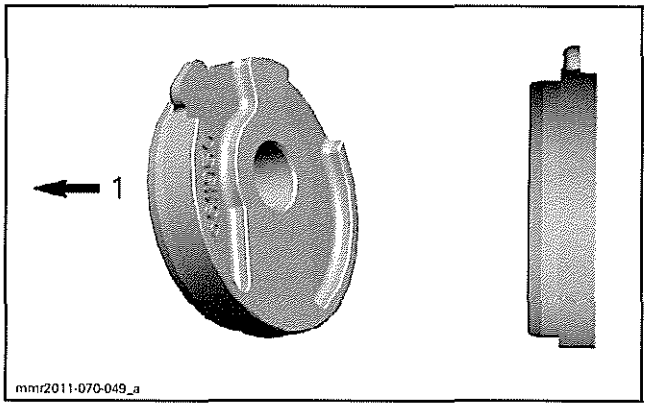


1. Oil pump cover O-ring

4. Lubricate both sides of the cover with engine oil.
5. Place the oil pump cover with the part number outwards and the tab aligned with the upper recess in the crankcase. Push cover in until a noise is heard, indicating the cover is properly installed.

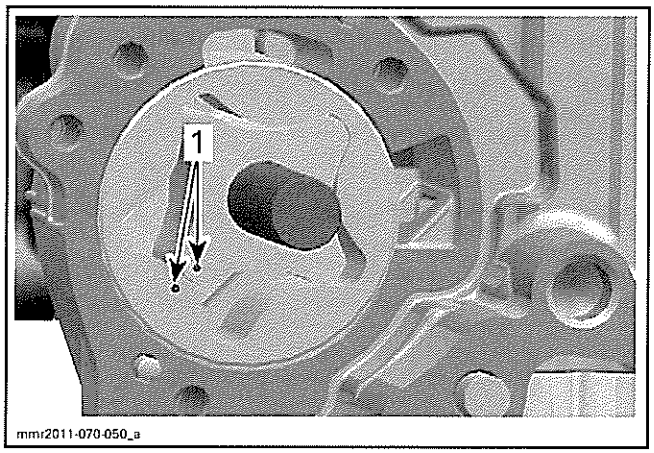


1. Oil pump cover tab properly positioned



COVER SHOWN IN TWO DIFFERENT ANGLES
1. Install inward

6. Lubricate large oil suction pump parts with engine oil.
7. Install large oil suction pump needle pin.
8. Install large oil suction pump inner rotor and outer rotor with the marks outwards and aligned together.



1. Marks on inner and outer rotor

9. Install other removed parts.

After installation is complete, check for smooth operation of the oil pump assembly and axial play of the oil pump shaft.

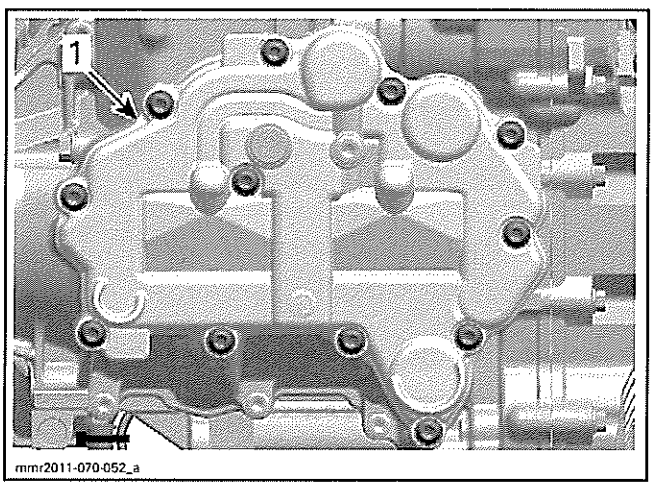
10. Fill up oil tank and check oil level. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

Start engine and make sure oil pressure is within specifications (refer to *ENGINE OIL PRESSURE* in this subsection).

OIL SUMP COVER

Oil Sump Cover Location

The oil sump cover is located on the engine bottom.



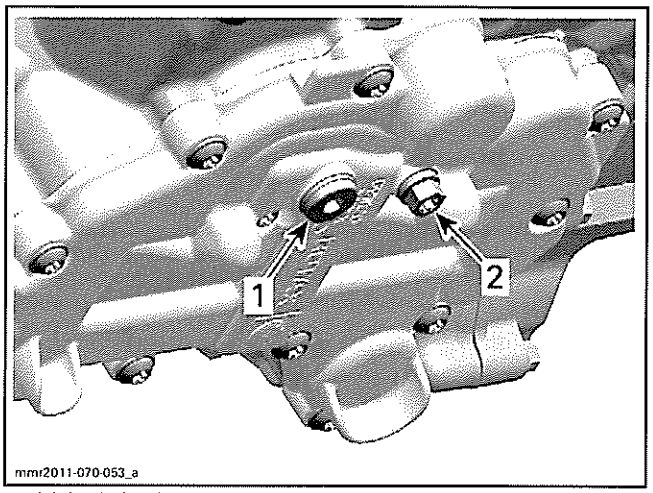
BOTTOM OF ENGINE
1. Oil sump cover

Oil Sump Cover Access

Remove engine from vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.

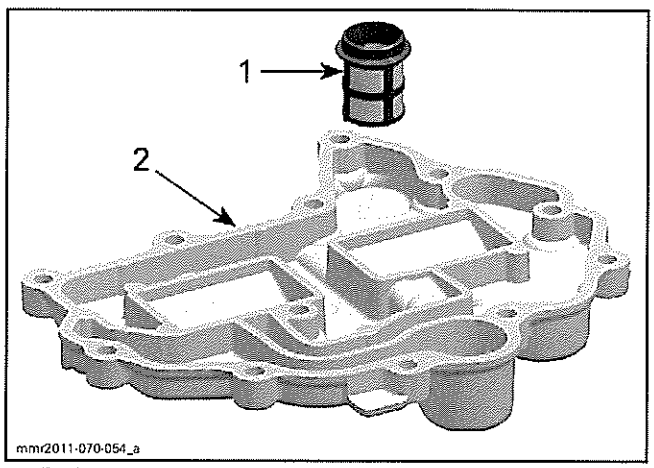
Oil Sump Cover Removal

1. Drain engine oil, refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.



1. Main drain plug
2. Secondary drain plug

2. Unscrew oil sump cover retaining screws.
3. Remove oil sump cover. Discard gasket.
4. Remove and clean engine oil strainer(s).

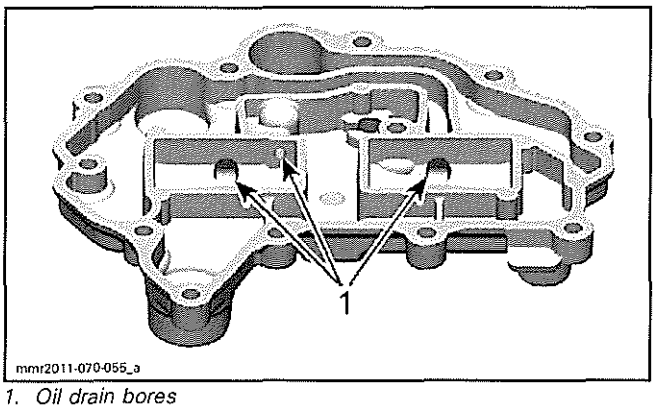


1. Engine oil strainer
2. Oil sump cover

Oil Sump Cover Inspection

Clean oil sump cover and engine oil strainer with a part cleaner, then use an air gun to dry it.

Blow out the oil orifices and check if they are not clogged.



1. Oil drain bores

Check oil sump cover for cracks or other damage.

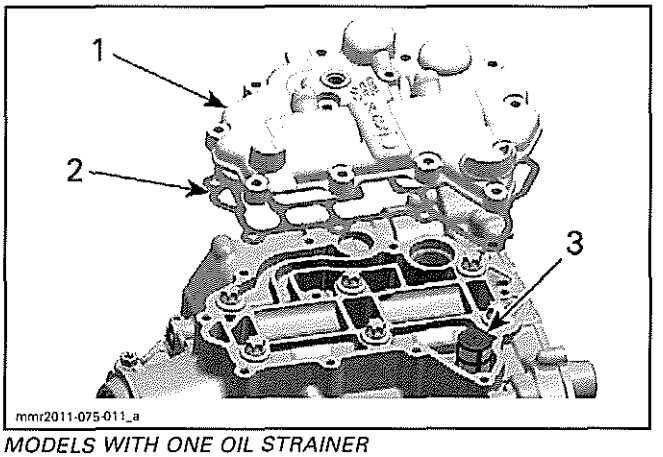
Check oil sump cover for flatness with straight edge.

Replace oil sump cover if necessary.

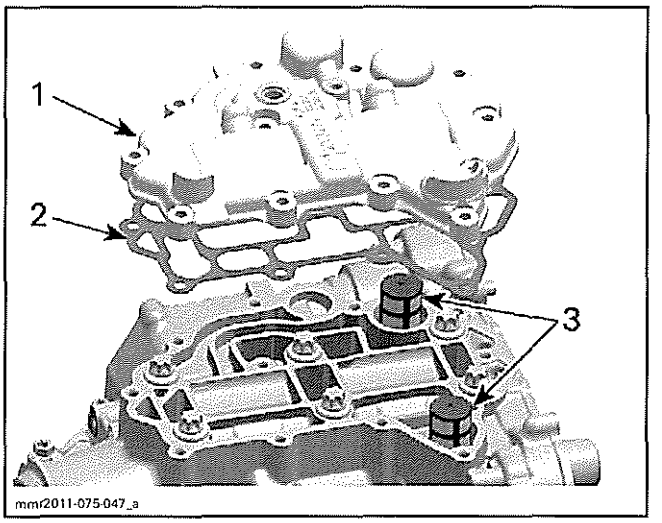
Check engine oil strainer for damage and change if necessary.

Oil Sump Cover Installation

1. Install a NEW oil sump cover gasket.
2. Install the strainer(s) as shown.



MODELS WITH ONE OIL STRAINER
1. Oil sump cover
2. Engine oil strainer
3. Gasket

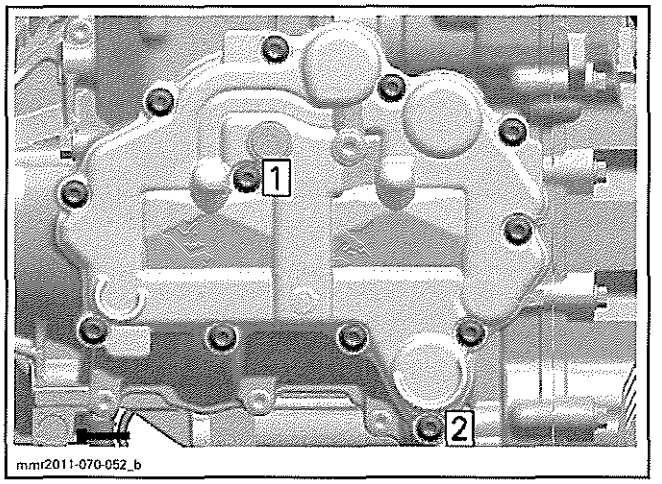


MODELS WITH TWO OIL STRAINERS
1. Oil sump cover
2. Engine oil strainers
3. Gasket

3. Install the oil sump cover on the engine, then tighten screws in two steps as follows:

   3.1 Tighten the following screws to the specified torque and sequence.

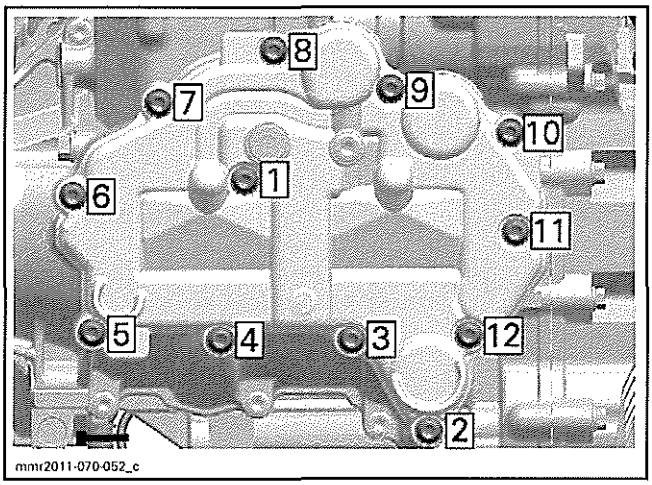
OIL SUMP COVER SCREWS TIGHTENING TORQUE (FOLLOW SEQUENCE)	
Step A	5 N•m ± 0.6 N•m (44 lbf•**in** ± 5 lbf•**in**)



TIGHTENING SEQUENCE STEP A

   3.2 Tighten the following screws to the specified torque and sequence.

OIL SUMP COVER SCREWS TIGHTENING TORQUE (FOLLOW SEQUENCE)	
Step B	11 N•m ± 1 N•m (97 lbf•**in** ± 9 lbf•**in**)



TIGHTENING SEQUENCE STEP B

4. Reinstall oil drain plugs using NEW sealing washers.
5. Install engine in vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
6. Fill up oil tank and check oil level. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

COOLING SYSTEM

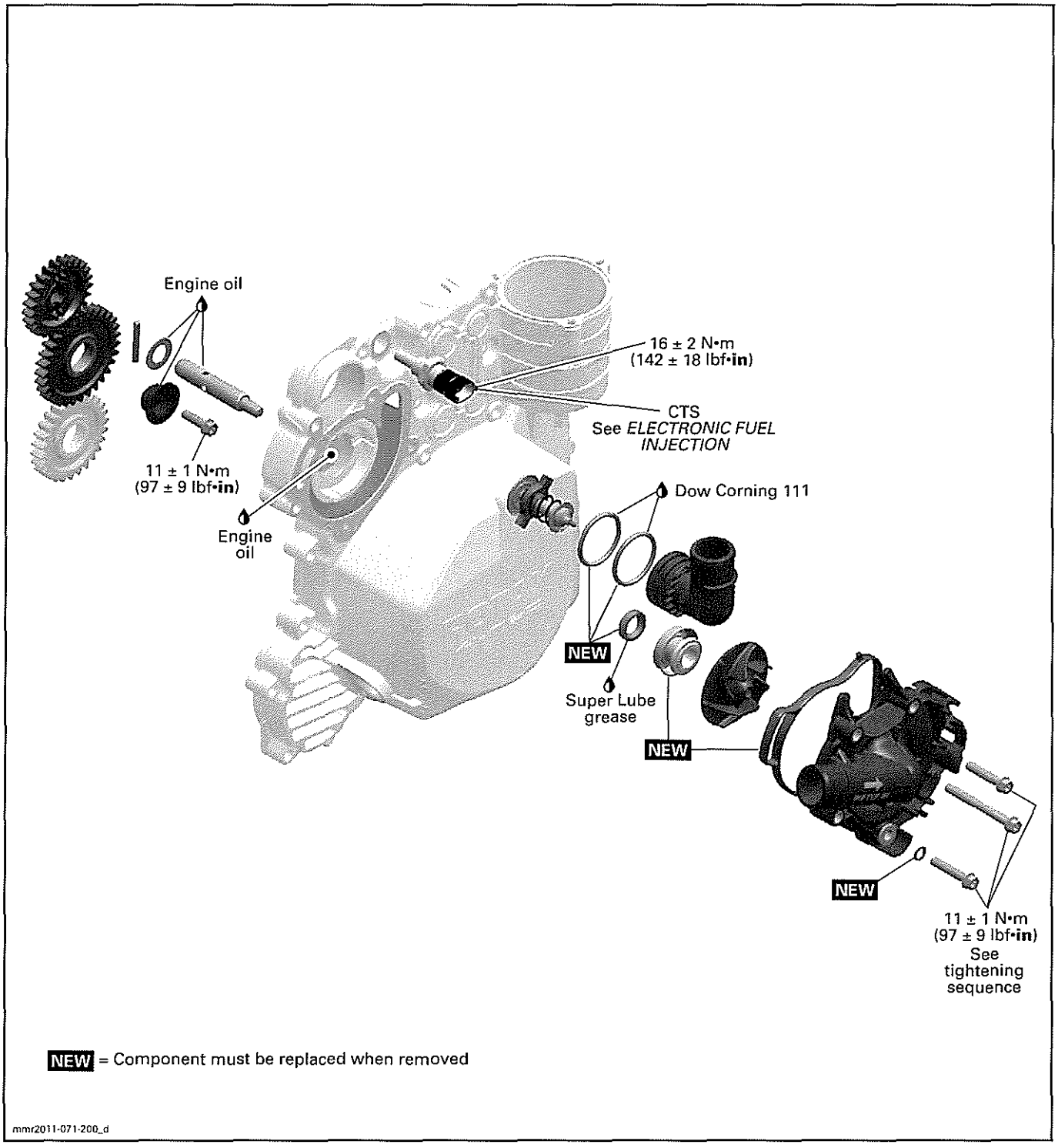
SERVICE TOOLS

Description	Part Number	Page
HANDLE	420 877 650	200
OIL SEAL PUSHER	529 036 210	200
ROTARY SEAL INSTALLER	529 036 211	200
TEST CAP	529 035 991	194
VACUUM/PRESSURE PUMP	529 021 800	194

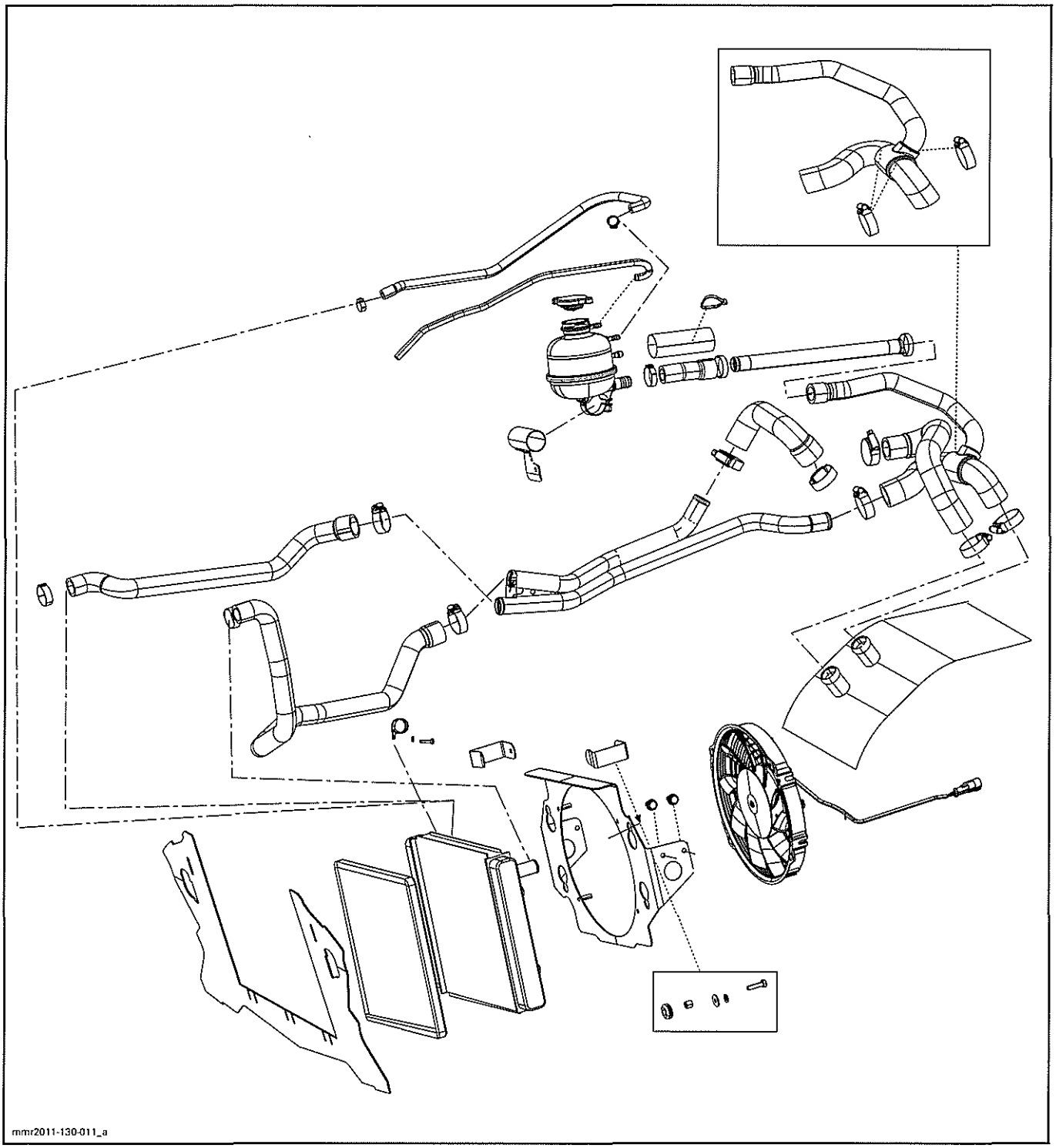
SERVICE PRODUCTS

Description	Part Number	Page
DOW CORNING 111	413 707 000	196
SUPER LUBE GREASE	293 550 030	200

ENGINE COMPONENTS



VEHICLE COMPONENTS



GENERAL

For a better understanding, some illustrations were taken with engine out of vehicle.

NOTE: It is a good practice to check for fault codes using B.U.D.S. software as a first troubleshooting step. Refer to the *DIAGNOSTIC AND FAULT CODES* subsection.

During assembly/installation, use the torque values and service products as shown in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

To avoid potential burns, do not remove the coolant tank cap or loosen the cooling drain plug if the engine is hot.

⚠ WARNING

Torque wrench tightening specifications must strictly be adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, cotter pin, etc.) must be replaced with new ones.

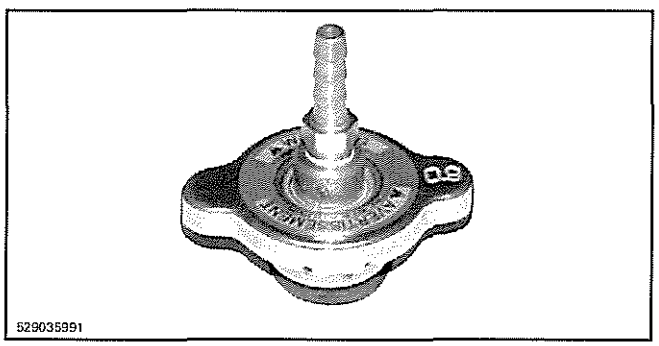
NOTICE Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.

INSPECTION

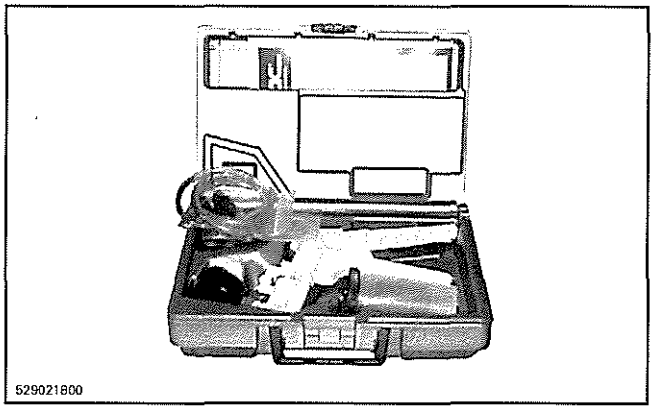
COOLING SYSTEM LEAK TEST

NOTE: This test confirms if there is a leak in the cooling system, including the engine.

Install the TEST CAP (P/N 529 035 991) on coolant reservoir.

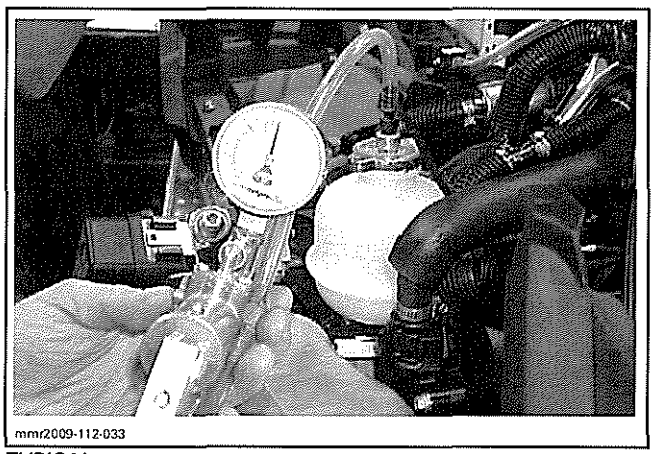


Connect the VACUUM/PRESSURE PUMP (P/N 529 021 800) to the test cap nipple.



Pressurize system through coolant reservoir.

COOLING SYSTEM LEAK TEST
100 kPa (15 PSI)

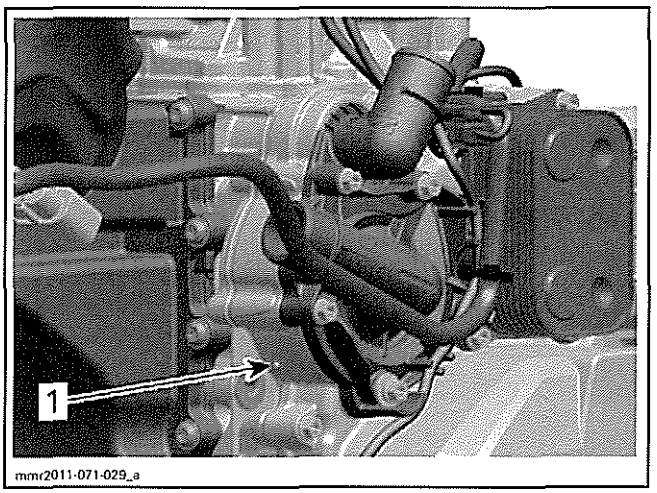


TYPICAL

If pressure drops, check all hoses and engine for coolant leaks. Spray a soap/water solution and look for air bubbles.

Check the leak indicator hole if there is oil or coolant leaking.

NOTE: In general leaking coolant indicates a damaged rotary seal. Leaking oil indicates a damaged oil seal. If either seal is leaking, both seals must be replaced at the same time. Refer to *WATER PUMP* in this subsection.



1. Leak indicator hole

TROUBLESHOOTING

The following is provided to help in diagnosing the probable source of troubles. It is a guideline and should not be assumed to show all causes for all problems.

Always check for fault codes. If a fault code is detected, service the fault code first.

ENGINE OVERHEATING

1. Low coolant level.
   - *Refill and check for leaks (coolant leaking out of leak indicator hole, hoses or clamps missing or defective, or cylinder head gaskets leaks). Repair or replace.*
2. Dirty heat exchanger.
   - *Clean heat exchanger fins. Replace heat exchanger as required.*
3. Air in cooling system.
   - *Refill and bleed cooling system.*
4. Defective thermostat (does not open when engine is warm up).
   - *Replace thermostat.*
5. Defective water pump.
   - *Inspect and replace defective components.*
6. Coolant temperature sensor defective.
   - *Check and replace.*
7. Wrong coolant concentration.
   - *Check and adjust coolant concentration according to BRP's recommendations or replace coolant.*
8. Defective coolant reservoir cap.
   - *Replace cap.*
9. Cooling fan.
   - *Refer to COOLING FAN DOES NOT OPERATE.*
10. Snow guard is too high.
    - *Check and adjust rear suspension.*

COOLING FAN DOES NOT OPERATE

1. Cooling fan fuse.
   - *Check cooling fan fuse, refer to POWER DISTRIBUTION (600ACE) subsection.*
2. Cooling fan configuration.
   - *Check cooling fan configuration in B.U.D.S., refer to COOLING FAN CONFIGURATION IN B.U.D.S. in this subsection.*
3. Defective cooling fan motor.
   - *Check cooling fan motor operation, refer to COOLING FAN MOTOR OPERATION TEST in this subsection.*
4. Cooling fan relay.
   - *Check cooling fan relay and circuits, see refer to COOLING FAN in this subsection.*

PROCEDURES

COOLANT RESERVOIR CAP

Coolant Reservoir Cap Test

Using a pressure cap tester, check the efficiency of coolant reservoir cap. If the cap does not meet specification, replace the cap.

CAP OPENING PRESSURE
110 kPa (16 PSI)

COOLANT RESERVOIR

Coolant Reservoir Removal

1. Siphon coolant from reservoir.
2. Disconnect coolant hoses from reservoir.
3. Remove coolant reservoir from vehicle.

Coolant Reservoir Installation

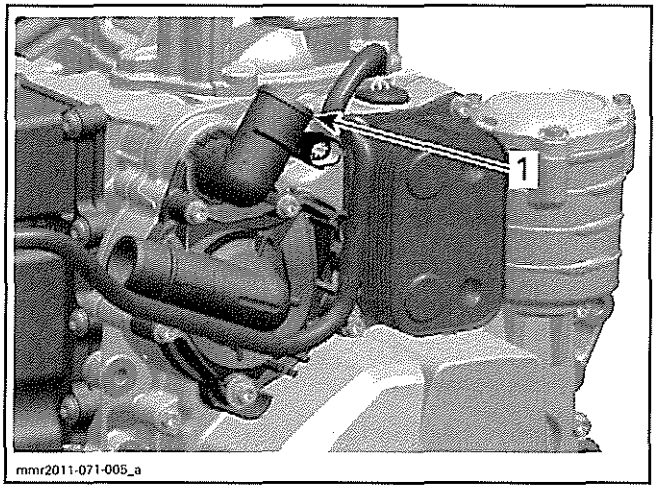
For installation, reverse the removal procedure. However, pay attention to the following.

Refill and bleed cooling system as described in *PERIODIC MAINTENANCE PROCEDURES* subsection.

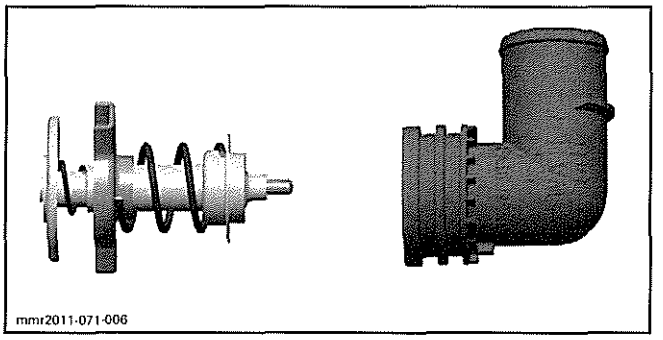
THERMOSTAT

Thermostat Location

The thermostat is located on engine MAG side.



1. Thermostat housing

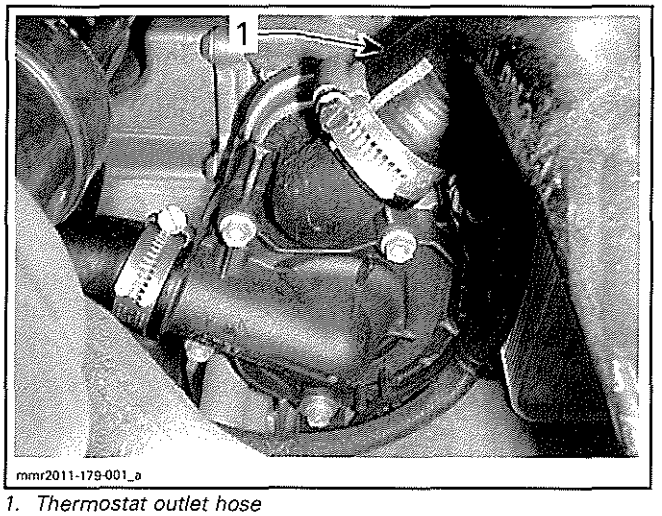


Thermostat Access

1. Remove upper RH side panel.

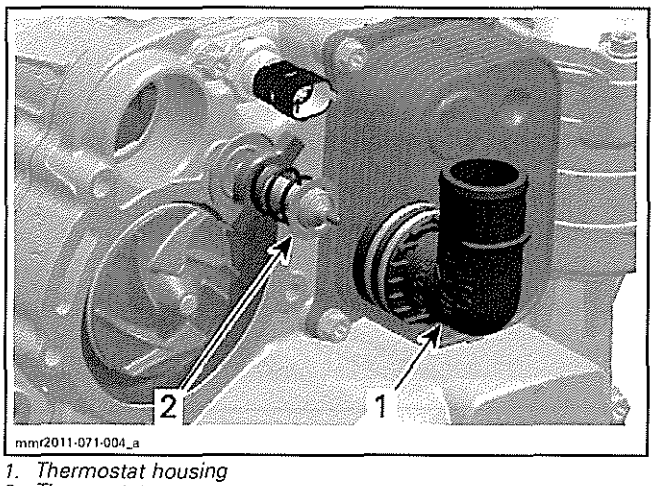
Thermostat Removal

1. Drain engine coolant. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.
2. Disconnect outlet hose from thermostat housing.



1. Thermostat outlet hose

3. Proceed with *WATER PUMP HOUSING REMOVAL*. See procedure in this subsection.
4. Remove thermostat housing then thermostat.



1. Thermostat housing
2. Thermostat

NOTE: Use shop rags to catch any spilled engine coolant.

Thermostat Test

To check thermostat, put it in water and heat water.

THERMOSTAT TEMPERATURE	
Starts to open	75°C (167°F)
Fully open	95°C (203°F)

Replace thermostat if out of specification.

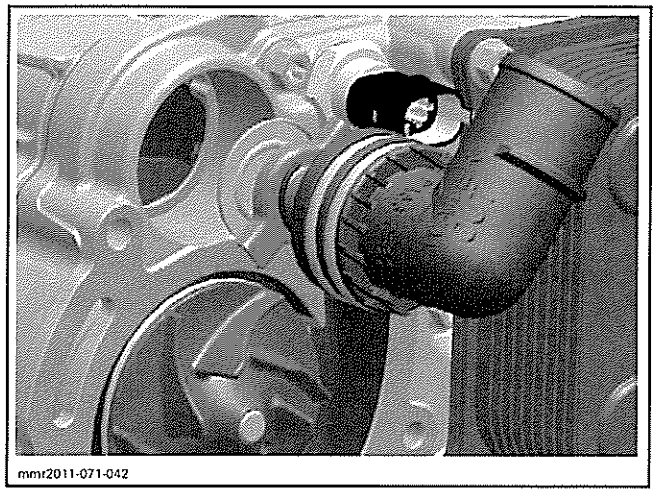
Thermostat Installation

The installation is the reverse of removal procedure, however pay attention to the following.

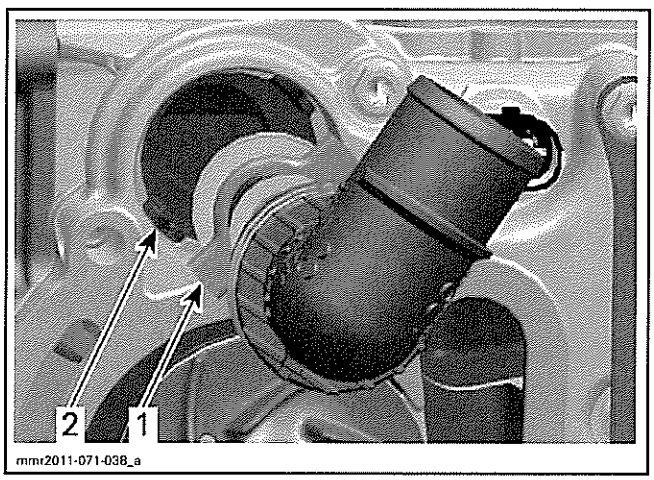
Install NEW O-rings on thermostat housing.

Apply DOW CORNING 111 (P/N 413 707 000) on O-rings.

Prior to installing thermostat, assemble thermostat and thermostat housing together.



Align both tabs of thermostat with magneto cover openings.



1. Thermostat tabs
2. Magneto cover openings

Install thermostat housing as follows:

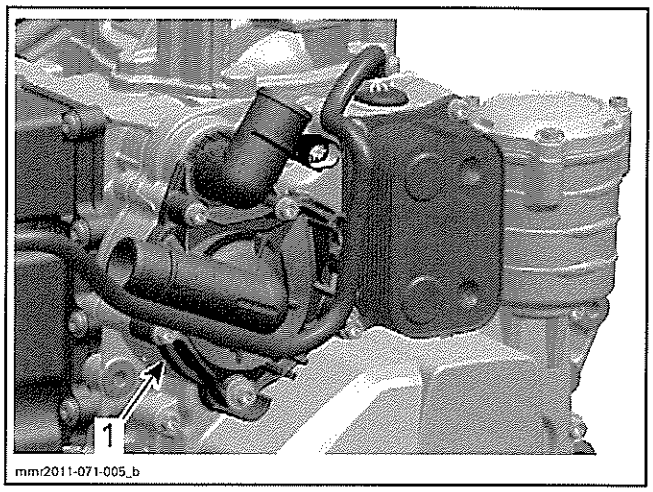
- Towards the front for vehicle equipped with a front radiator.
- Towards the rear for vehicle not equipped with a front radiator.

Refill and bleed cooling system. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

WATER PUMP

Water Pump Location

The water pump is located on engine MAG side.



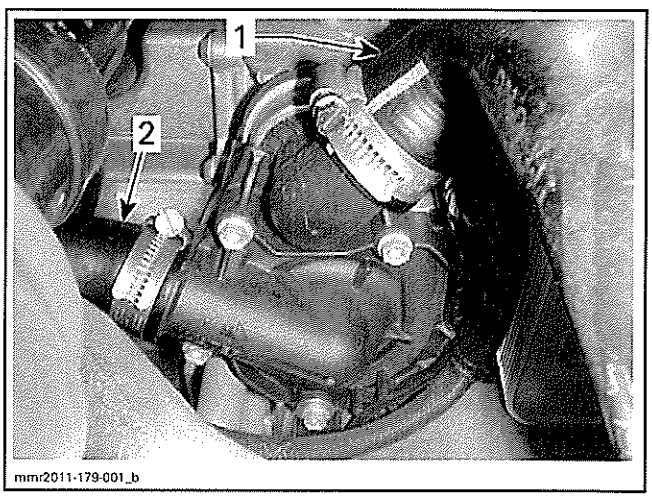
1. Water pump

Water Pump Access

1. Remove RH side panels.

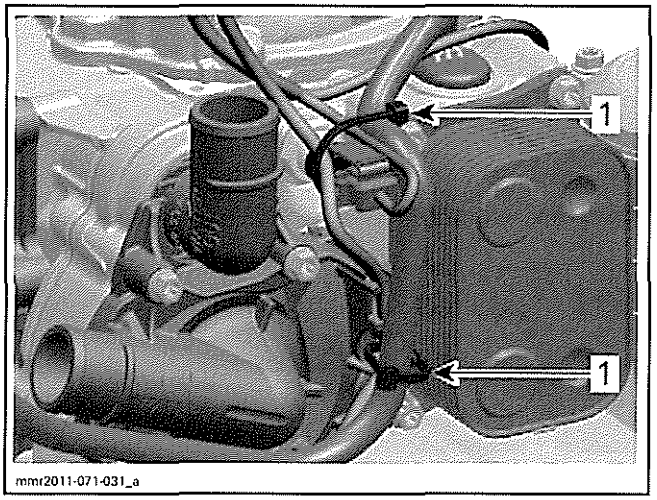
Water Pump Housing Removal

1. Drain engine coolant. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.
2. Disconnect outlet hose from thermostat housing.
3. Disconnect inlet hose from water pump housing.



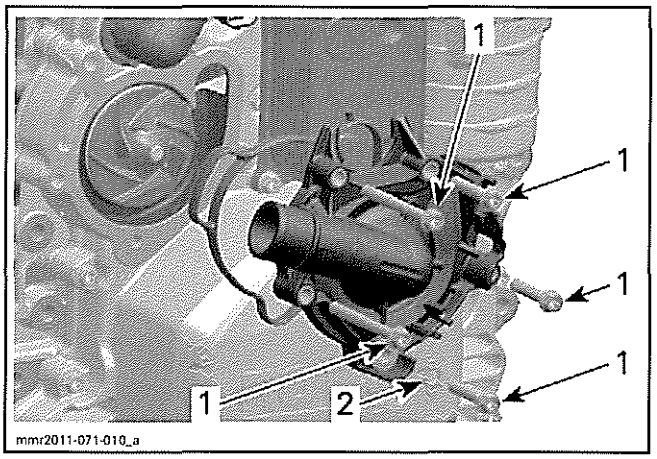
1. Thermostat outlet hose
2. Water pump inlet hose

4. Remove both locking ties securing magneto wires.



1. Locking ties

5. Remove retaining screws of water pump housing.
6. Discard sealing washer.
7. Remove water pump housing from magneto cover.

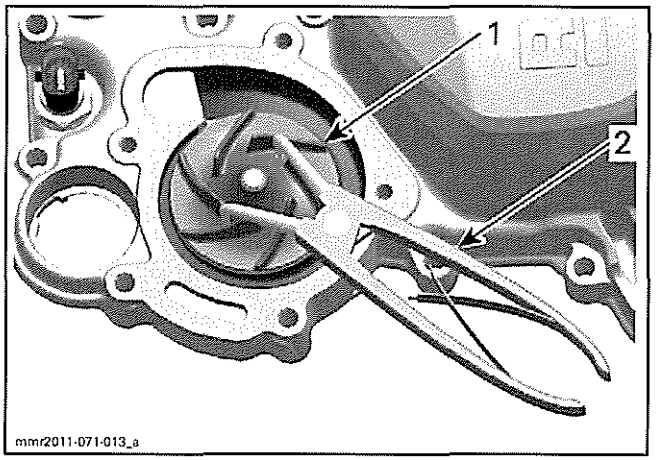


1. Retaining screws
2. Sealing washer

NOTE: Use shop rags to catch any spilled engine coolant.

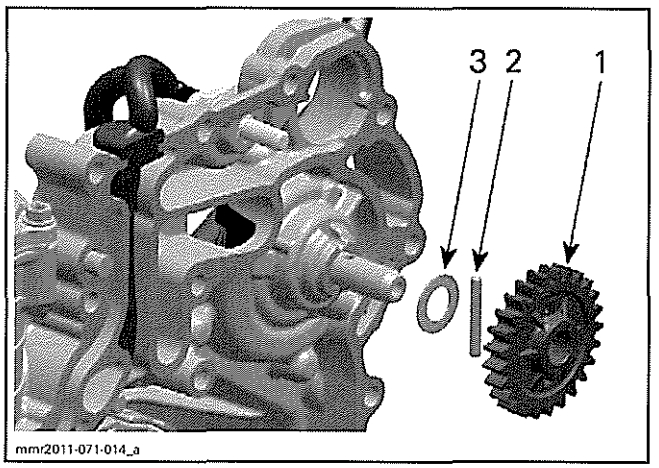
Water Pump Disassembly

1. Remove magneto cover. Refer to *MAGNETO AND STARTER* subsection.
2. Unscrew impeller counterclockwise using appropriate pliers.



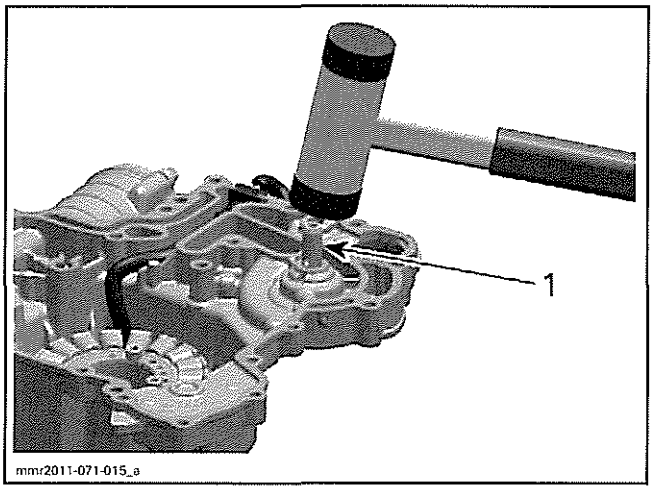
1. Impeller
2. Pliers

3. Remove the following components from magneto cover:
   - Water pump gear
   - Needle pin
   - Thrust washer.



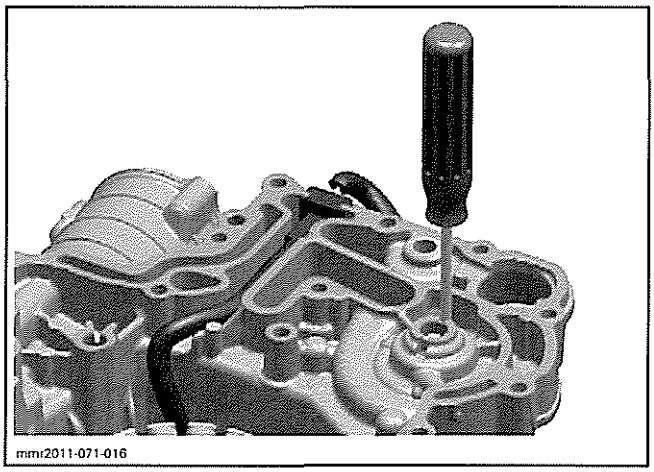
1. Water pump gear
2. Needle pin
3. Thrust washer

4. Remove water pump shaft using a plastic mallet.



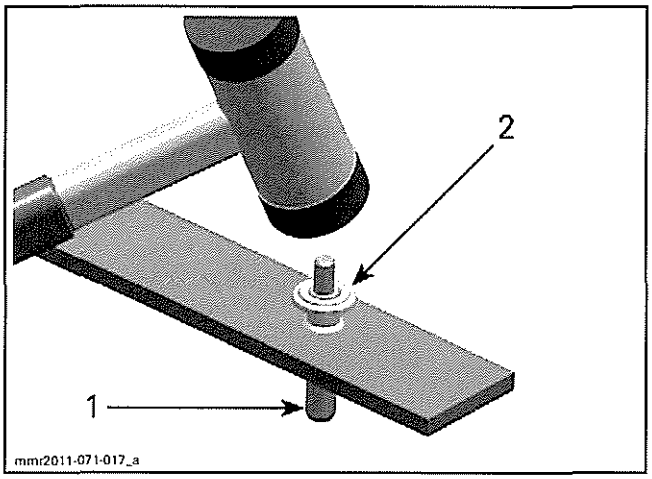
1. Water pump shaft

5. Remove the following components from magneto cover:
   - Oil seal
   - Remaining parts of rotary seal.



NOTICE Be careful not to damage the surface of the rotary seal bore in water pump housing.

6. Separate rotary seal from water pump shaft.



1. Water pump shaft.
2. Rotary seal

Water Pump Inspection

Check area of water pump housing for cracks or other visible damage.

Check water pump gear for wear or broken teeth.

Check if housing gasket is brittle, hard or damaged.

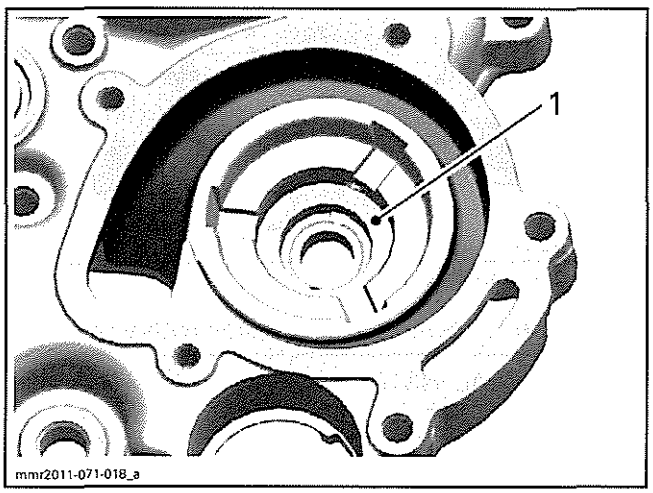
Check water pump shaft for visible damage.

Replace parts if necessary.

Water Pump Assembly

NOTE: Always replace oil seal and rotary seal together.

1. Clean rotary seal surface from old sealant.



1. Clean surface

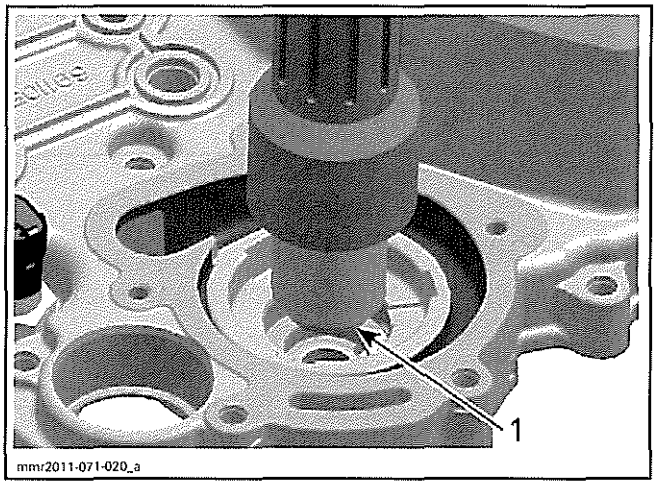
2. Apply engine oil on the press fit area of oil seal.

NOTICE Never use engine oil on the press fit area of the rotary seal.

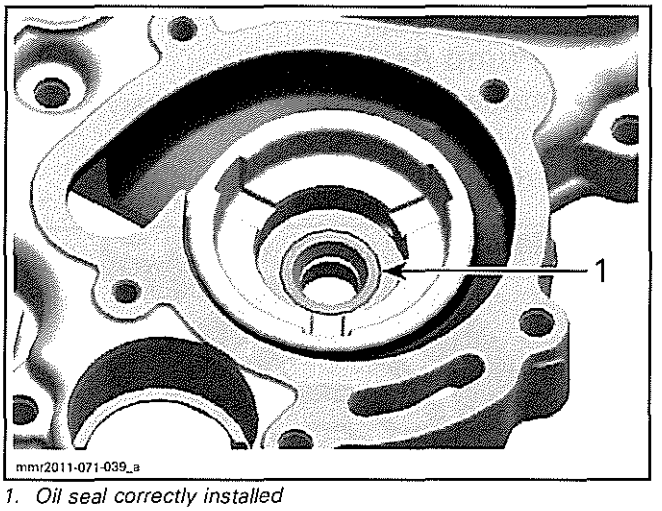
3. Use the following tools to install oil seal.

OIL SEAL PUSHER (P/N 529 036 210)	
HANDLE (P/N 420 877 650)	

4. Apply SUPER LUBE GREASE (P/N 293 550 030) on sealing lip of the oil seal.
5. Install NEW oil seal in magneto cover.



1. Oil seal



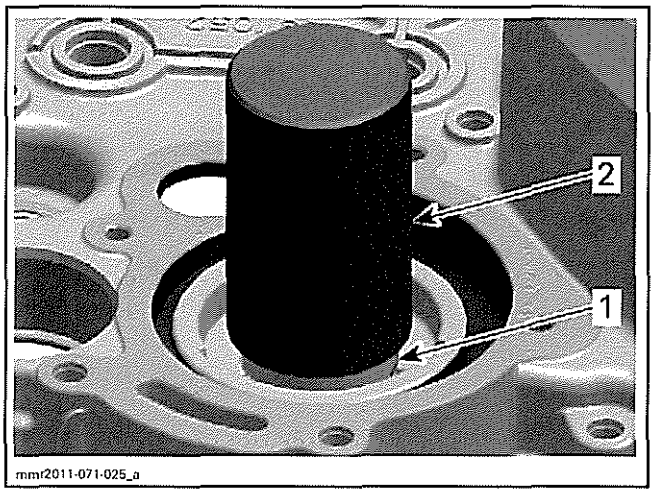
1. Oil seal correctly installed

6. Use the following tool to install rotary seal.

ROTARY SEAL INSTALLER (P/N 529 036 211)	

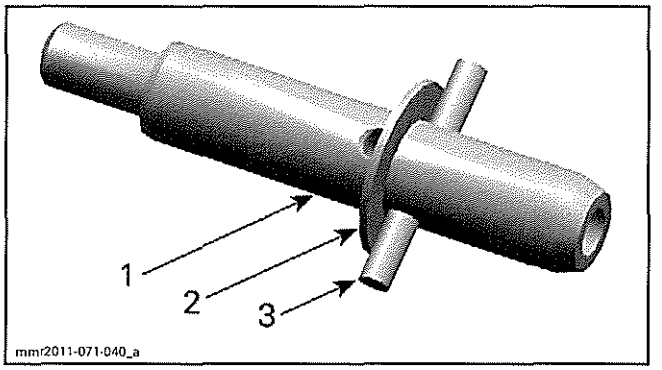
NOTE: Prior to installing, ensure that sealing lip of rotary seal is not damaged.

7. Install NEW rotary seal on magneto cover using a press.



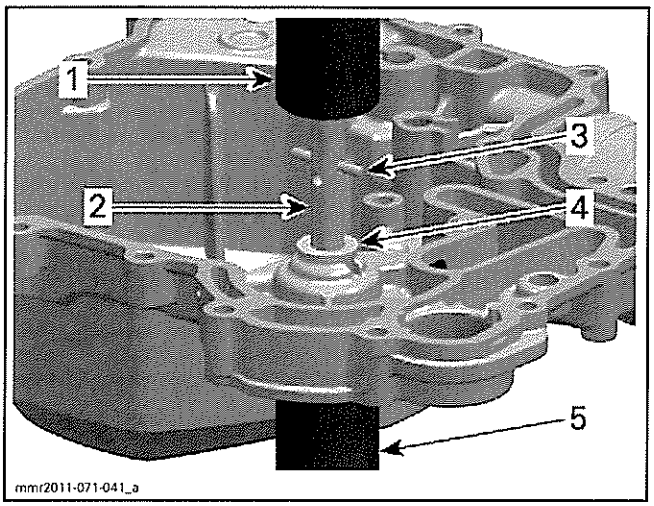
1. Rotary seal
2. Rotary seal installer

8. Assemble the following components onto water pump shaft.
   - Needle pin
   - Thrust washer.



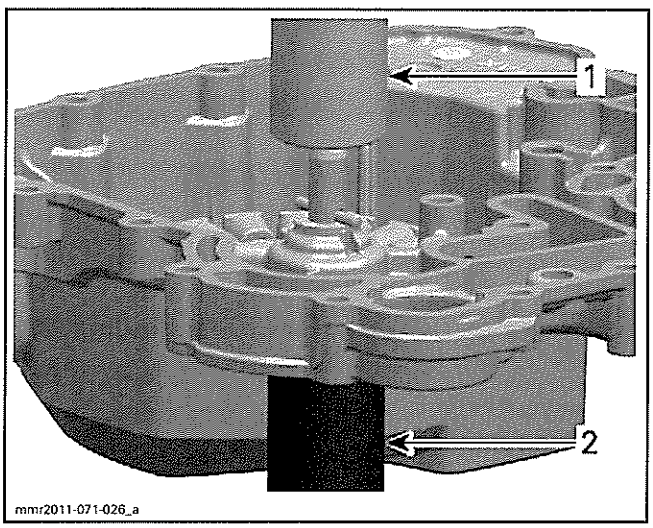
1. Water pump shaft
2. Thrust washer
3. Needle pin

9. Slide water pump shaft into rotary seal using a press.



1. *Press*
2. *Water pump shaft*
3. *Needle pin*
4. *Thrust washer*
5. *Rotary seal installer*

10. Carefully push water pump shaft until needle pin makes contact with thrust washer.



1. *Press*
2. *Rotary seal installer*

NOTICE Never use a hammer to install water pump shaft into rotary seal.

NOTE: After installation, water pump shaft must rotate freely.

11. Screw impeller clockwise using appropriate pliers.

NOTICE Be careful not to damage impeller wings during its installation.

12. Install magneto cover. Refer to *MAGNETO AND STARTER* subsection.

Water Pump Housing Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

NOTICE To prevent leaking, take care that the NEW gasket is exactly in groove when you reinstall the water pump housing.

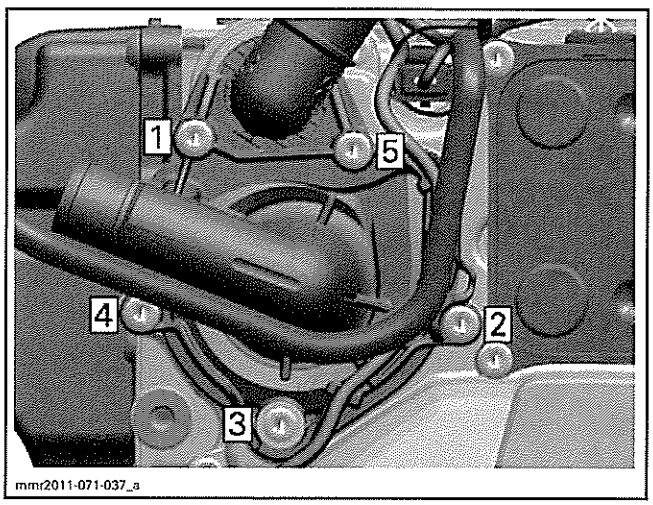
Install a NEW sealing washer on drain screw.

Install the following screws to secure water pump housing. Refer to the following illustration.

WATER PUMP HOUSING RETAINING SCREWS	
LOCATION	SCREW TYPE
1	M6 x 55
2	M6 x 30
3	M6 x 30
4	M6 x 55
5	M6 x 30

Tighten water pump housing retaining screws as follows.

WATER PUMP HOUSING SCREWS TIGHTENING TORQUE
11 N•m ± 1 N•m (97 lbf•**in** ± 9 lbf•**in**)



WATER PUMP HOUSING SCREWS TIGHTENING SEQUENCE

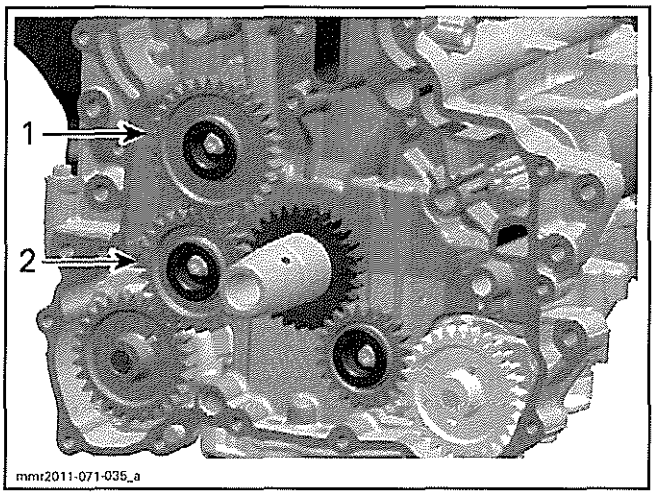
Tighten hose clamps to specification.

COOLANT HOSE CLAMPS TIGHTENING TORQUE
5.5 N•m ± 0.5 N•m (49 lbf•**in** ± 4 lbf•**in**)

WATER PUMP DRIVE GEARS

Water Pump Drive Gears Location

The water pump drive gears are located behind the magneto cover.



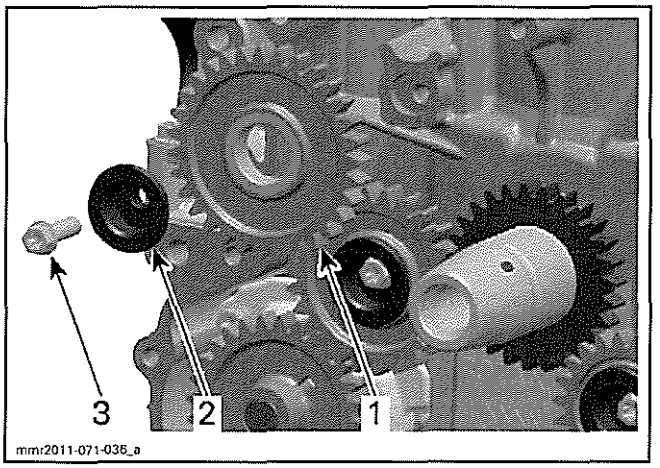
1. Water pump intermediate gear (31 teeth)
2. Suction pump intermediate gear, refer to LUBRICATION

Water Pump Drive Gears Access

Remove magneto cover. Refer to *MAGNETO AND STARTER* subsection.

Water Pump Drive Gears Removal

1. Remove screw securing water pump intermediate gear.
2. Remove bearing sleeve.
3. Slide off intermediate gear.



1. Water pump intermediate gear (31 teeth)
2. Bearing sleeve
3. M6 x 20 screw

Water Pump Drive Gears Inspection

Inspect gears for wear or other damage.

Replace gear(s) if necessary.

Water Pump Drive Gears Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

Apply engine oil on bearing sleeves.

Tighten water pump intermediate gear retaining screw to specification.

INTERMEDIATE GEAR RETAINING SCREWS TORQUE
11 N•m ± 1 N•m (97 lbf•**in** ± 9 lbf•**in**)

HEAT EXCHANGER

Heat Exchanger Cleaning and Inspection

Remove all debris between heat exchanger fins.

Check if heat exchanger fins are damaged. Replace if necessary.

NOTE: A heat exchanger with many broken fins does not work properly.

Heat Exchanger Removal

1. Drain cooling system, refer to *MAINTENANCE PROCEDURES* subsection.
2. Remove engine, refer to *ENGINE REMOVAL* subsection.
3. Remove fuel tank. Refer to *FUEL TANK AND FUEL PUMP* subsection.
4. Remove rear suspension. Refer to the *REAR SUSPENSION (SC-5U)* subsection.
5. Unplug coolant hoses from heat exchanger.
6. Drill or grind all rivets retaining the heat exchanger to the tunnel. Refer to *FRAME* subsection for drilling procedure.

NOTE: When pushing the rivets out, support the frame around the rivet with a socket on the opposite side to avoid warpage.

7. Remove heat exchanger from the vehicle.

Heat Exchanger Installation

Installation is the reverse of removal procedure.

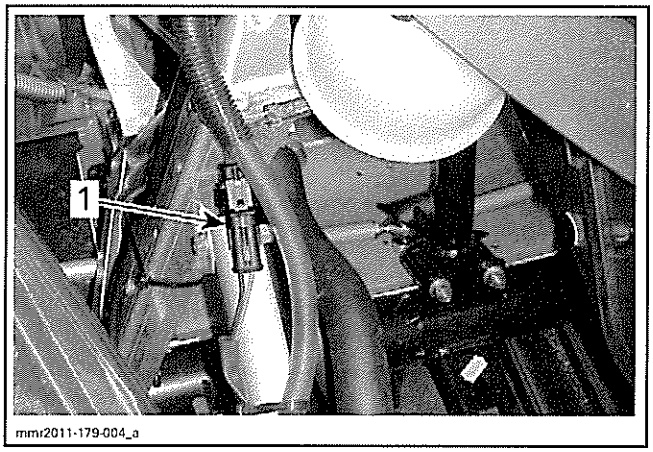
Refill cooling system as described in *PERIODIC MAINTENANCE PROCEDURES* subsection.

RADIATOR

Radiator Removal

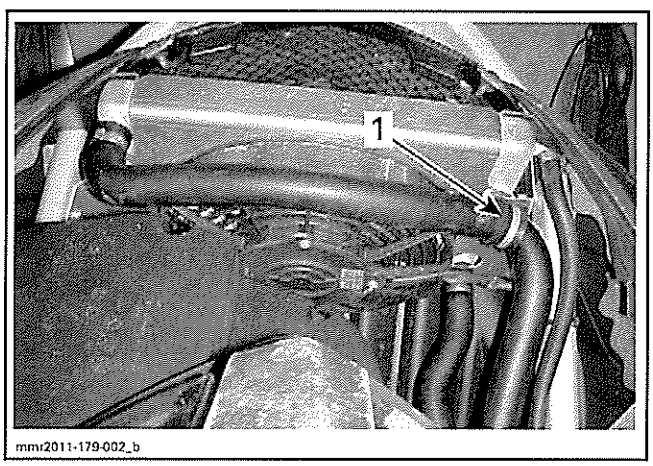
1. Drain cooling system, Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.
2. Remove hood.

3. Disconnect front radiator cooling fan connector.



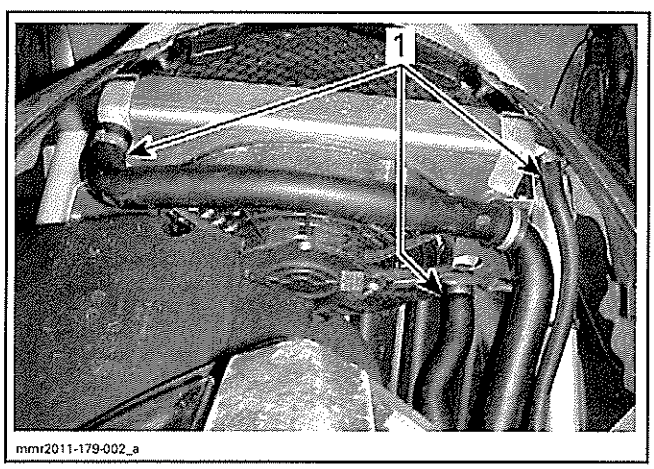
1. Radiator cooling fan connector

4. Cut the locking ties retaining the electrical harness to the front bumper.
5. Remove the hose upper hose retainer.



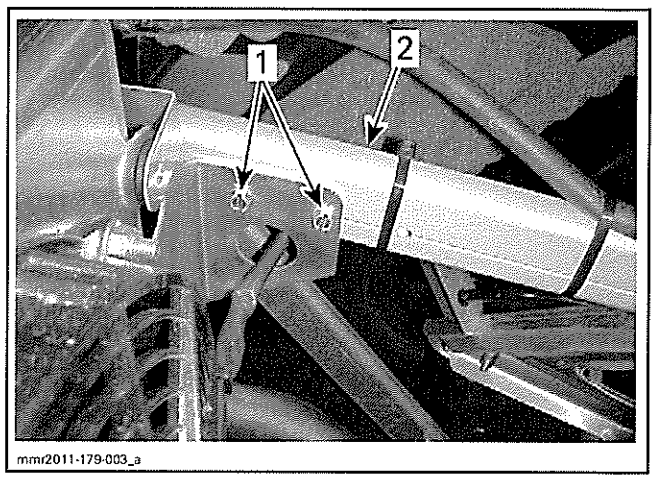
1. Upper hose retainer

6. Disconnect coolant hoses from front the radiator.



1. Coolant hoses

7. Remove screws retaining the radiator support to the front bumper on both sides.



1. Radiator support retaining screws
2. Front bumper

8. Remove front radiator from vehicle.

Front Radiator Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

Install NEW Oetiker clamps to secure coolant hoses.

COOLING FAN

Cooling Fan Operating Conditions

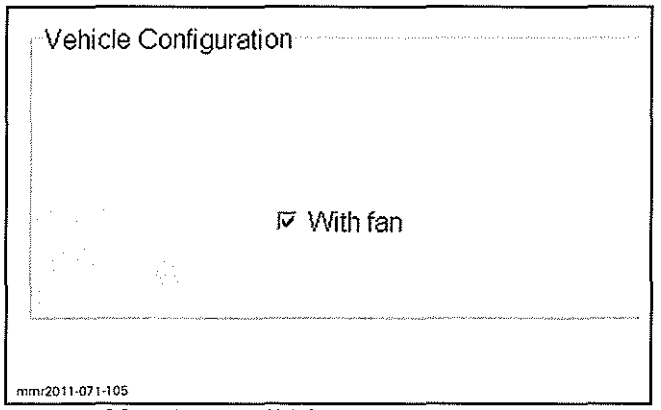
RADIATOR COOLING FAN		
ENGINE TEMPERATURE	COOLING FAN RELAY	COOLING FAN OPERATION
> 100°C (212°F)	Close	Starts
< 95°C (203°F)	Open	Stops

Cooling Fan Relay Location

The cooling fan relay is located in the fuse box. Refer to *POWER DISTRIBUTION (600 ACE).*

Cooling Fan Configuration in B.U.D.S.

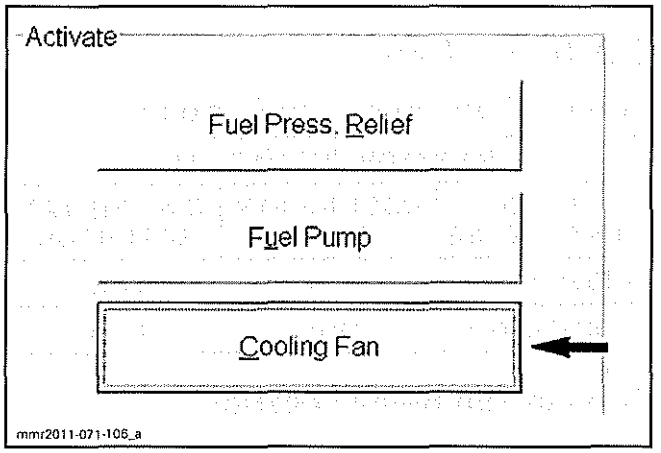
1. Connect vehicle to B.U.D.S., refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. In B.U.D.S., select the following:
   - **Read Data** button
   - **Setting** tab
   - **ECM** page.
3. Ensure that **With fan** box is properly checked.



VEHICLE CONFIGURATION BOX

Cooling Fan Test Using B.U.D.S.

1. Connect vehicle to B.U.D.S., refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. Depress the start button once to activate the ECM.
3. In B.U.D.S., select the following:
   - **Read Data** button
   - **Activation** tab
   - **ECM** page.
4. Press **Cooling Fan** button to activate cooling fan motor.



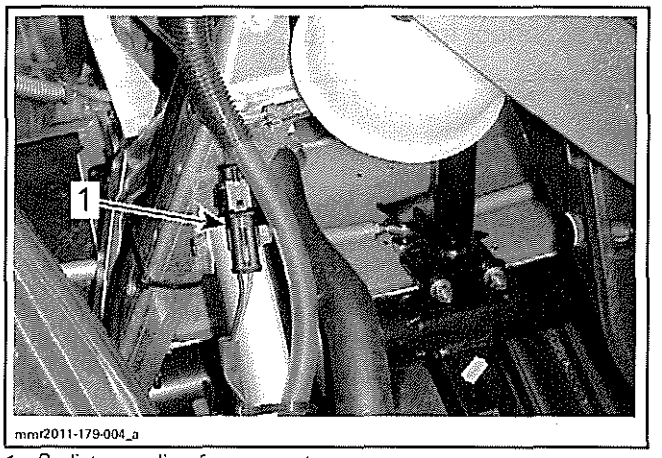
COOLING FAN ACTIVATION BUTTON

If cooling fan motor does not work, retest while touching the relay (R4).

- If a "click" is felt, carry out *COOLING FAN MOTOR OPERATION TEST* in this subsection.
- If a NO "click" is felt, see *COOLING FAN RELAY* under *TROUBLESHOOTING* in this subsection.

Cooling Fan Motor Operation Test

1. Disconnect radiator cooling fan connector.



1. Radiator cooling fan connector

2. Connect a 12 volts battery directly to fan motor connector.

If motor does not work, replace it.

If motor works, check fan motor wiring.

Cooling Fan Motor Input Voltage Test

Test conditions:

- Engine running with coolant temperature above 100°C (212°F)
- OR cooling fan activated using B.U.D.S. Refer to *COOLING FAN TEST USING B.U.D.S.*

COOLING FAN MOTOR INPUT VOLTAGE TEST	
TEST PROBES	VOLTAGE
GR/GN	Battery voltage (± 12 Vdc)
BK	

Cooling Fan Relay Input Voltage Test

RELAY INPUT VOLTAGE TEST (CONTACTS)	
TEST PROBES	VOLTAGE
Fuse box pin 10C	Battery voltage (± 12 Vdc)
Battery negative (-) post	

RELAY INPUT VOLTAGE TEST (WINDING)	
TEST PROBES	VOLTAGE
Fuse box pin 10D	Battery voltage (± 12 Vdc)
Battery negative (-) post	

Cooling Fan Relay Control Circuit Test

Test conditions:

- Engine running with coolant temperature above 100°C (212°F)
- OR cooling fan activated using B.U.D.S. Refer to *COOLING FAN TEST USING B.U.D.S.*

COOLING FAN RELAY CONTROL CIRCUIT TEST	
TEST PROBES	VOLTAGE
Fuse box pin 12C	Approximately battery voltage (± 12 Vdc)
Battery positive (+) post	

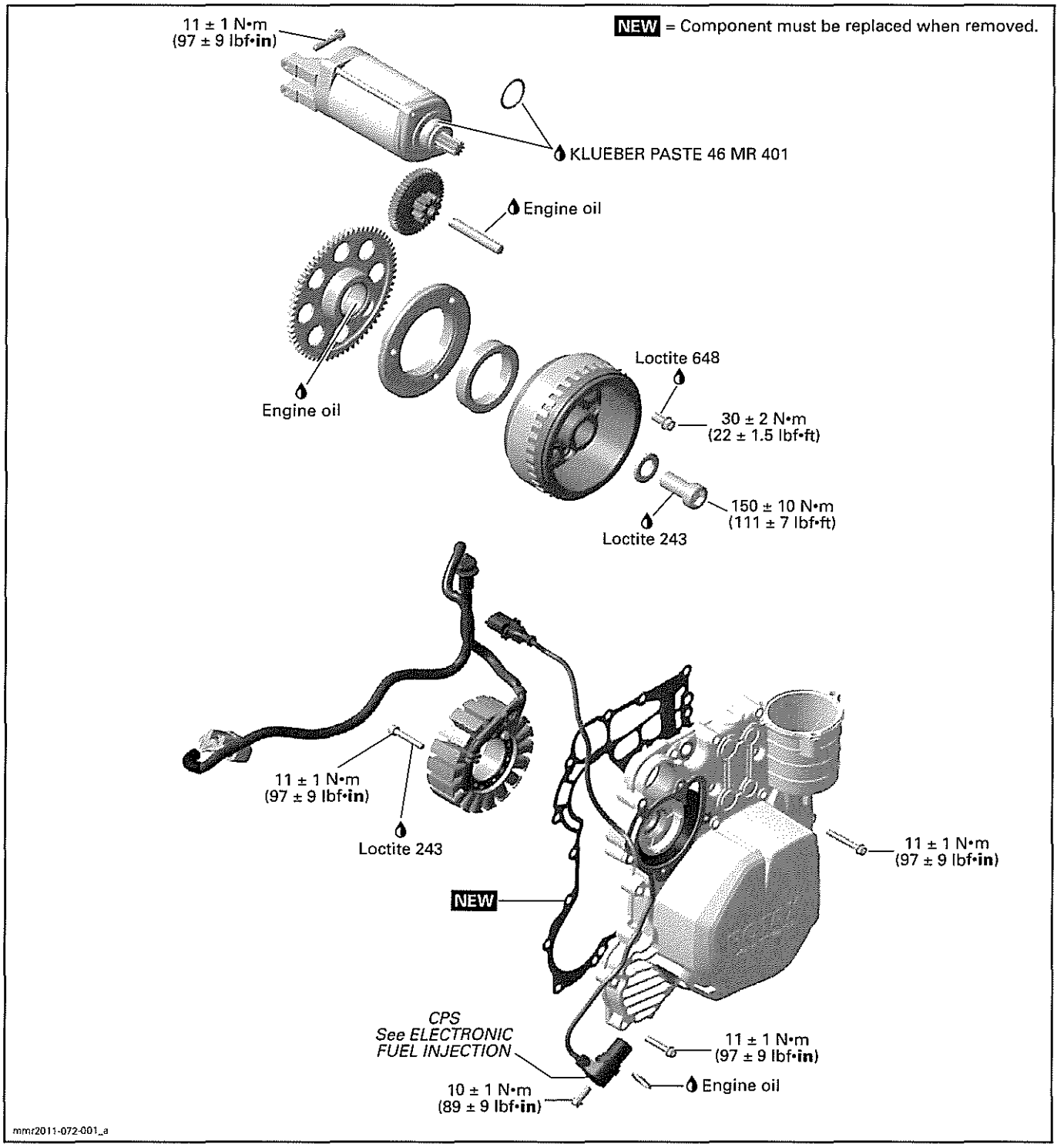
MAGNETO AND STARTER

SERVICE TOOLS

Description	Part Number	Page
CRANKSHAFT PROTECTOR	529 036 213	214
FLUKE 115 MULTIMETER	529 035 868	212, 218
FLYWHEEL PULLER	420 976 235	214

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 243 (BLUE)	293 800 060	213, 215
LOCTITE 648 (GREEN)	413 711 400	216
LOCTITE CHISEL (GASKET REMOVER)	413 708 500	210
PULLEY FLANGE CLEANER	413 711 809	214
SUPER LUBE GREASE	293 550 030	219


NEW = Component must be replaced when removed.
11 ± 1 N•m
(97 ± 9 lbf•in)
KLUEBER PASTE 46 MR 401
Engine oil
Engine oil
Loctite 648
30 ± 2 N•m
(22 ± 1.5 lbf•ft)
150 ± 10 N•m
(111 ± 7 lbf•ft)
Loctite 243
11 ± 1 N•m
(97 ± 9 lbf•in)
Loctite 243
11 ± 1 N•m
(97 ± 9 lbf•in)
NEW
CPS
See ELECTRONIC
FUEL INJECTION
11 ± 1 N•m
(97 ± 9 lbf•in)
Engine oil
10 ± 1 N•m
(89 ± 9 lbf•in)
mmr2011-072-001_a

GENERAL

⚠ WARNING

Always disconnect BLACK (-) cable first and reconnect last.

During assembly/installation, use the torque values and service products as in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must strictly be adhered to.
Locking devices when removed (ex: locking tabs, cotter pin, etc.) must be replaced.

NOTICE Hoses, cables or locking ties removed during a procedure must be reinstalled as per factory standards.

PROCEDURES

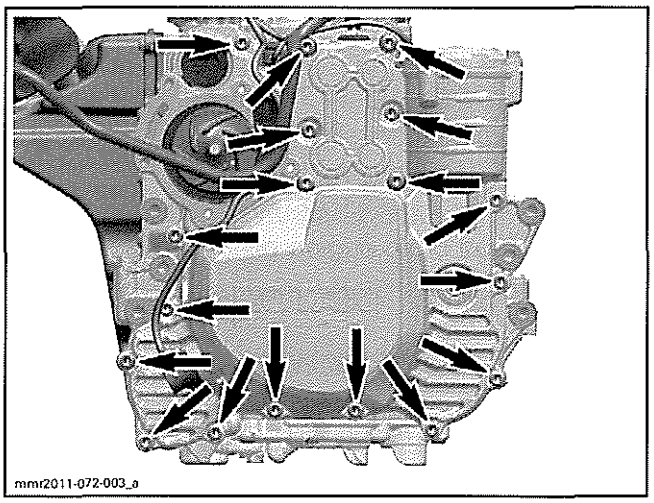
MAGNETO COVER

Magneto Cover Removal (Engine in Vehicle)

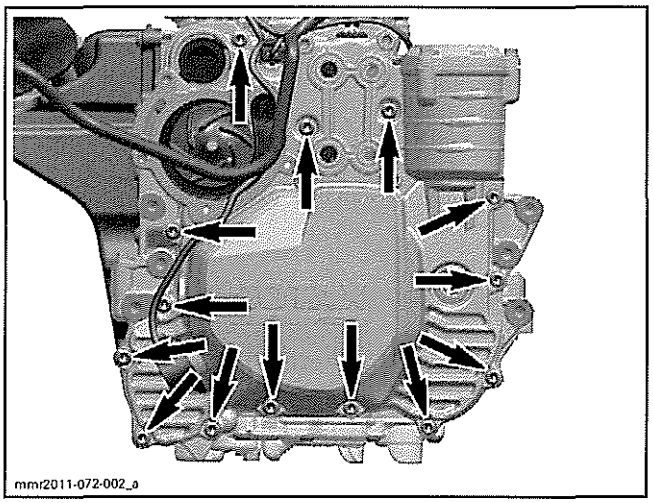
1. Refer to *BODY* subsection and remove:
   - Hood
   - LH side panels
   - RH side panels.
2. Refer to *AIR INTAKE SYSTEM* subsection and remove gauge support and air intake silencer as an assembly.
3. Refer to *EXHAUST SYSTEM* and remove:
   - Muffler
   - Exhaust pipes.
4. Refer to *PERIODIC MAINTENANCE PROCEDURES* and:
   - Drain coolant
   - Drain engine oil.
5. Cut the locking tie securing the stator wiring and disconnect stator connector.
6. Disconnect the CTS connector.
7. Refer to *COOLING SYSTEM* and remove:
   - Water pump housing
   - Thermostat housing.

NOTE: Do not remove coolant hose from thermostat housing.

8. Refer to *LUBRICATION SYSTEM* subsection and remove:
   - Oil pressure regulator
   - Oil cooler.
9. Detach the coolant tank from the frame.
10. Detach the radiator coolant pipes from the frame.
11. Place an oil pan under magneto area to catch remaining oil.
12. Remove magneto cover screws and slightly pull on magneto cover to ease CPS access.

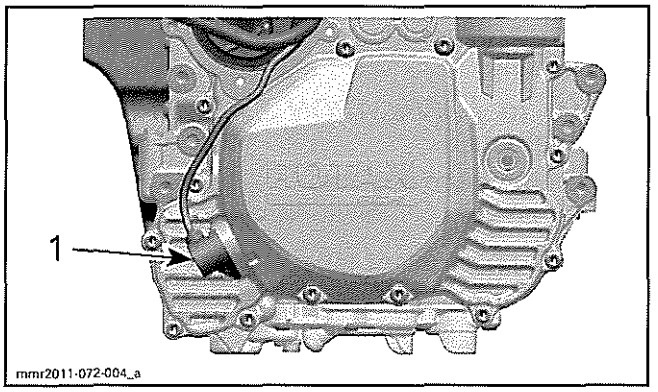


MAGNETO COVER SCREWS - MODELS WITHOUT OIL COOLER



MAGNETO COVER SCREWS - MODELS WITH OIL COOLER

13. Remove the CPS.

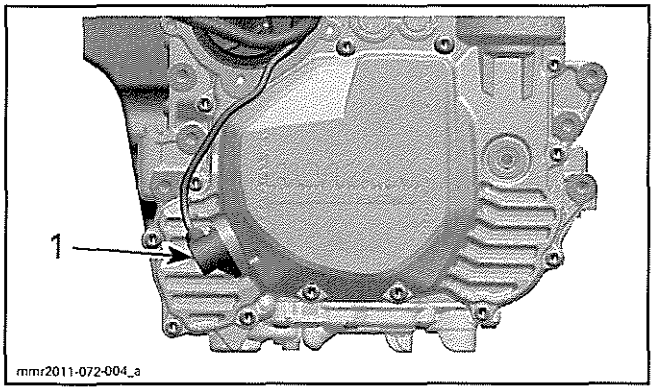


1. CPS

14. Pull magneto cover off, then carefully manoeuvre through the chassis to remove it.

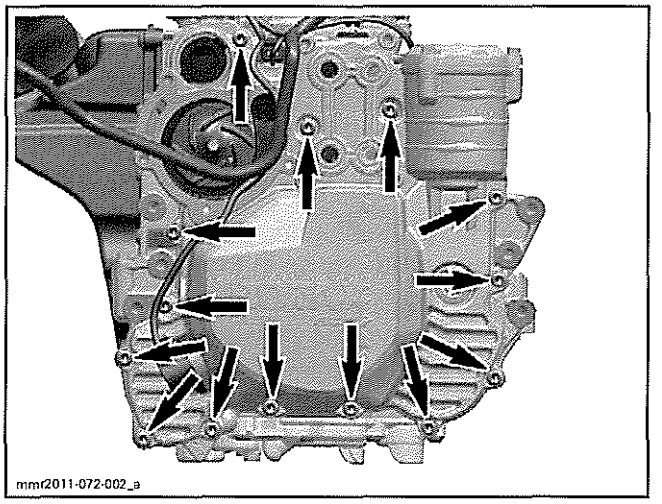
Magneto Cover Removal (Engine Removed)

1. Refer to *COOLING SYSTEM* and remove:
   - Water pump housing
   - Thermostat housing.
2. Refer to *PERIODIC MAINTENANCE PROCEDURES* and drain engine oil.
3. Place an oil pan under magneto area to catch remaining oil.
4. Refer to *LUBRICATION SYSTEM* subsection and remove:
   - Oil pressure regulator
   - Oil cooler (if equipped).
5. Remove the CPS.

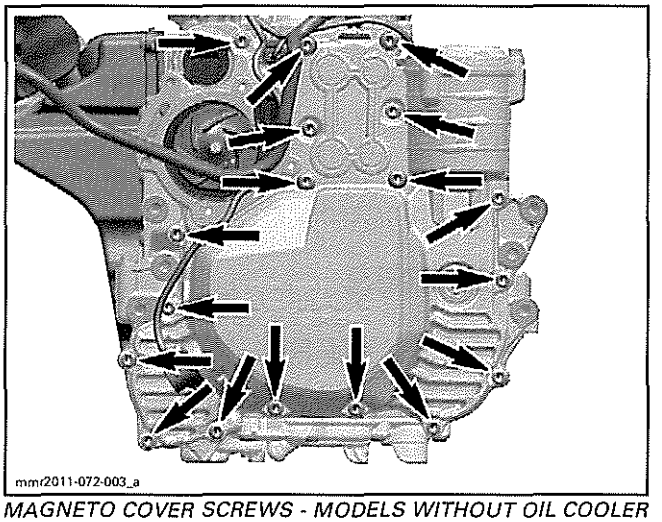


1. CPS

6. Remove magneto cover retaining screws.



MAGNETO COVER SCREWS - MODELS WITH OIL COOLER



MAGNETO COVER SCREWS - MODELS WITHOUT OIL COOLER

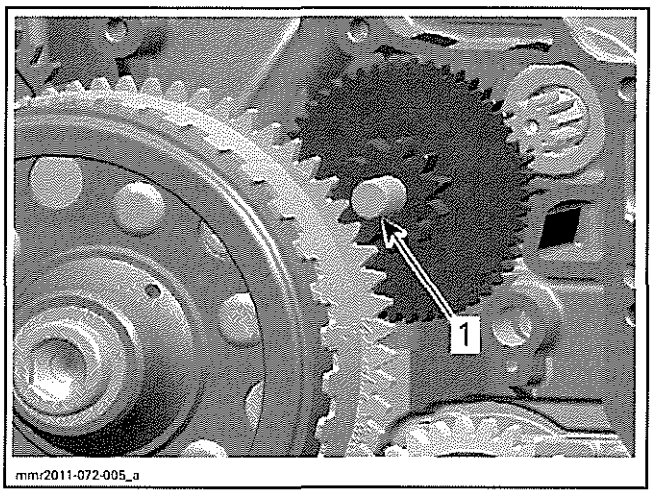
7. Pull magneto cover off.

Magneto Cover Inspection

Check magneto cover for cracks or other damage. Replace if necessary.

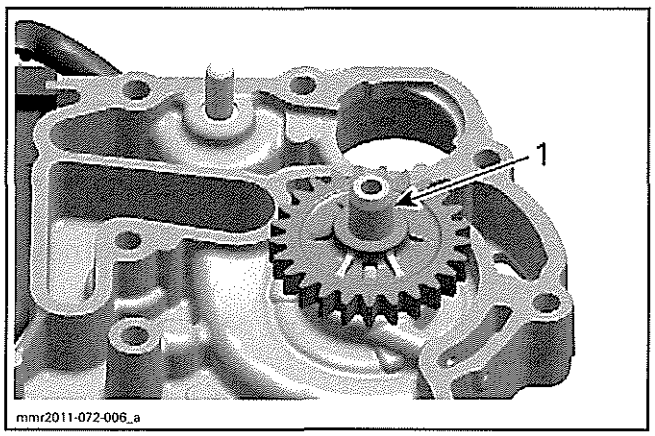
Magneto Cover Installation

1. To clean magneto cover use LOCTITE CHISEL LOCTITE CHISEL (GASKET REMOVER) (P/N 413 708 500).
2. Install a NEW magneto cover gasket.
3. Ensure that starter drive gear pin is in place.
4. Apply engine oil on starter drive gear pin.



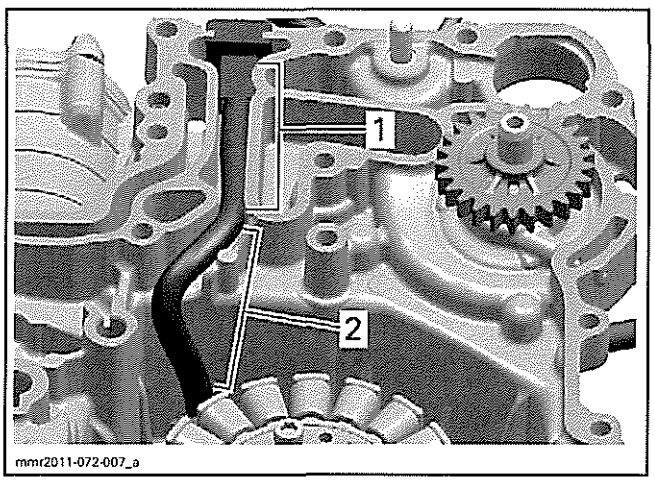
1. Starter drive gear pin

5. Apply engine oil on water pump shaft.



1. Water pump shaft - apply engine oil

NOTICE Make sure that the stator cable harness is embedded into the channel. The part of the harness that is out of the channel must be tight, otherwise it might chafe or jam.



1. Embedded in that area
2. Tight in this area

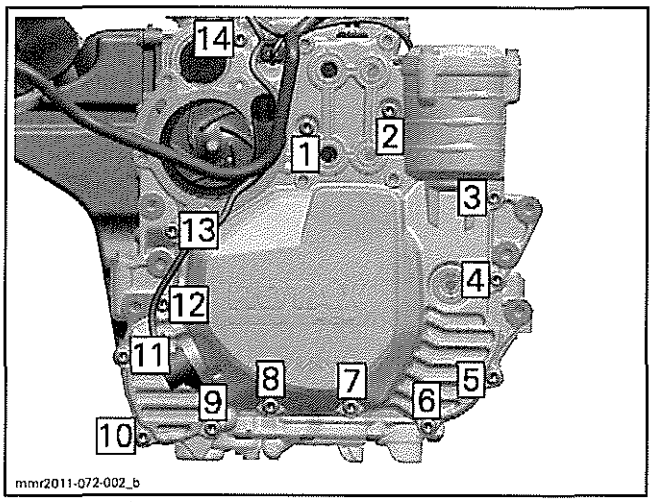
6. Carefully install magneto cover.

⚠ CAUTION Magnetic force between magneto flywheel and stator is very high. Avoid finger contusions.

7. Tighten magneto cover screws according to the following sequence.

MAGNETO COVER SCREWS TIGHTENING TORQUE (FOLLOW SEQUENCE)
11 N•m ± 1 N•m (97 lbf•**in** ± 5 lbf•**in**)

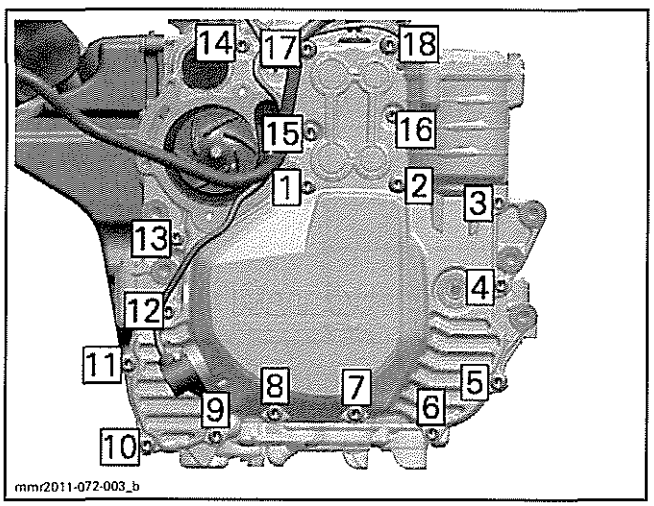
Models with Oil Cooler



TIGHTENING SEQUENCE - MODELS WITH OIL COOLER

Models without Oil Cooler

MAGNETO COVER SCREW LOCATION	
LOCATION	SCREW TYPE
1, 2, 17 and 18	M6 x 40
Other locations	M6 x 30

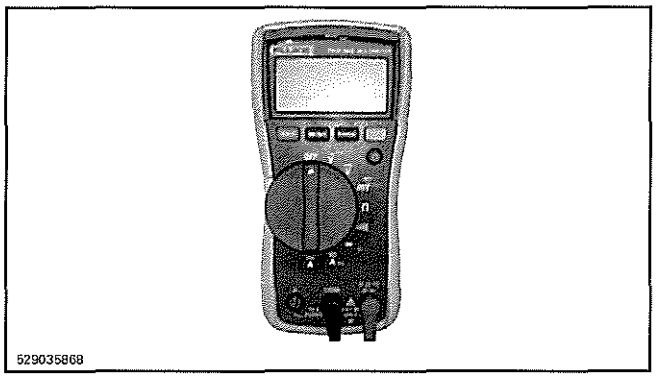


TIGHTENING SEQUENCE - MODELS WITHOUT OIL COOLER

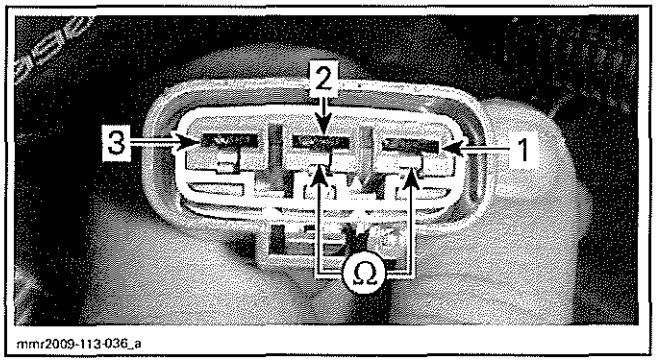
STATOR

Stator Continuity Test

1. Disconnect battery.
2. Disconnect the magneto connector from voltage regulator.
3. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Ω.



4. Connect multimeter probes between each pair of YELLOW wires.



1. Pin #1
2. Pin #2
3. Pin #3

5. Read resistance as per following table.

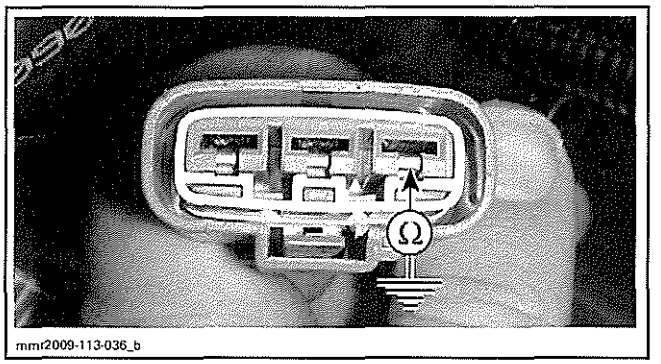
STATOR CONTINUITY TEST	
YELLOW WIRES (EACH PAIR)	RESISTANCE @ 20°C (68°F)
Pins 1 and 2	0.1 - 1 Ω
Pins 1 and 3	
Pins 2 and 3	

If any resistance reading is not as specified, the stator or the wiring (including connector) is open and needs to be repaired or replaced.

If resistance is good, perform the stator insulation test.

Stator Insulation Test

1. Connect multimeter between any YELLOW wire and chassis ground.



2. Read resistance.

STATOR INSULATION TEST	
PROBE POSITIONS	RESISTANCE @ 20°C (68°F)
Any YELLOW wire and chassis ground	Infinity (OL)

If any resistance reading is not as specified, the stator or the wiring is shorted to ground and needs to be repaired or replaced.

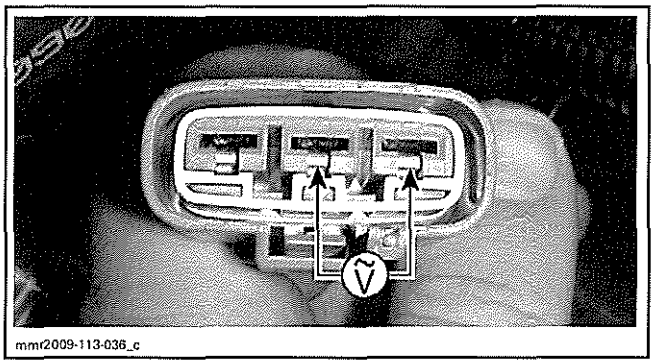
If the insulation test is good, perform the output voltage test.

Stator Output Voltage Test

1. Disconnect stator at voltage regulator.

NOTE: To ease access, move fuel tank back. Refer to *FUEL TANK AND FUEL PUMP.*

2. Start engine and let it reach its operating temperature.
3. Set multimeter to Vac scale.
4. With engine idling, connect multimeter between each pair of YELLOW wires.



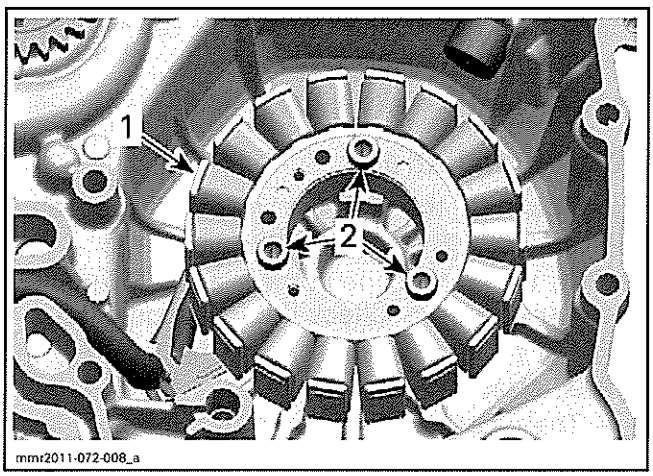
5. Read voltage.

STATOR OUTPUT VOLTAGE TEST		
TEST ENGINE SPEED	TERMINAL	VOLTAGE
Idle speed	1 and 2	± 25 Vac
	1 and 3	
	2 and 3	

If any voltage reading is significantly lower than specification, replace the stator.

Stator Removal

1. Remove the *MAGNETO COVER*, see procedure in this subsection.
2. Remove stator retaining screws.



1. Stator
2. Stator retaining screws

3. Pull stator out.

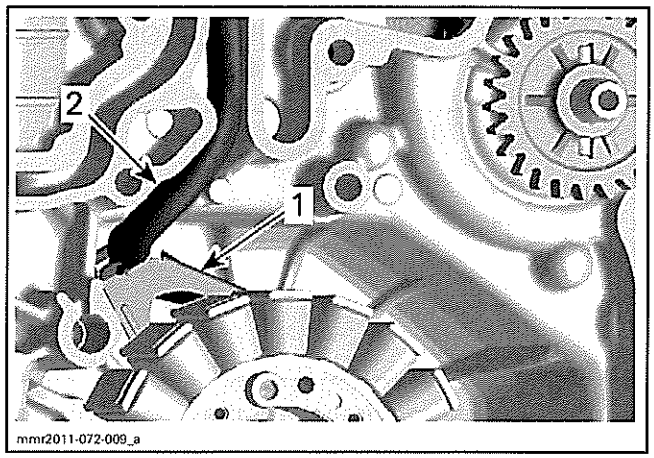
Stator Inspection

Check stator windings and insulation for cracks and other damages. If damaged replace it.

Check if stator wires are brittle, hard or otherwise damaged.

Stator Installation

1. Ensure that the stator cable is underneath the cable holder during installation of the stator.



1. Cable holder
2. Stator cable

2. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on threads of stator screws.
3. Install stator retaining screws and tighten to the specified torque.

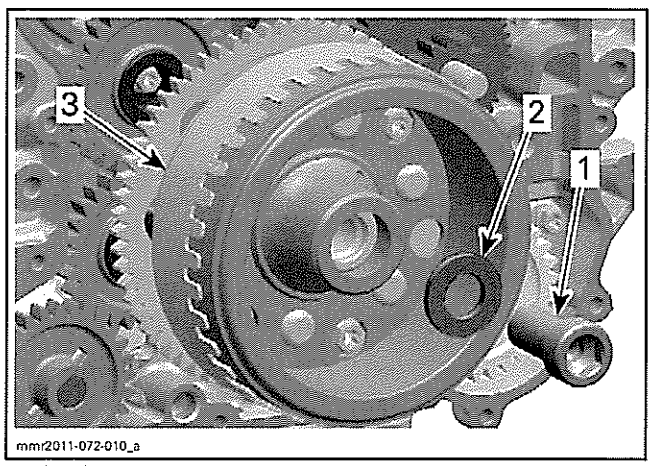
STATOR RETAINING SCREW TIGHTENING TORQUE
11 N•m ± 1 N•m (97 lbf•**in** ± 9 lbf•**in**)

4. Reinstall *MAGNETO COVER*, see procedure in this subsection.

ROTOR

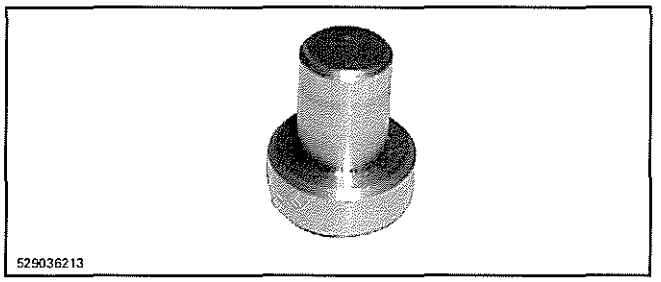
Rotor Removal

1. Remove the *MAGNETO COVER*, see procedure in this subsection.
2. Lock crankshaft. Refer to *CYLINDER BLOCK* subsection.
3. Remove rotor retaining screw and lock washer.



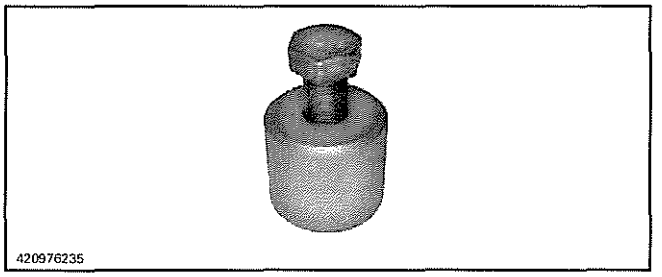
1. Retaining screw
2. Lock washer
3. Rotor

4. Install the CRANKSHAFT PROTECTOR (P/N 529 036 213) on the crankshaft end.

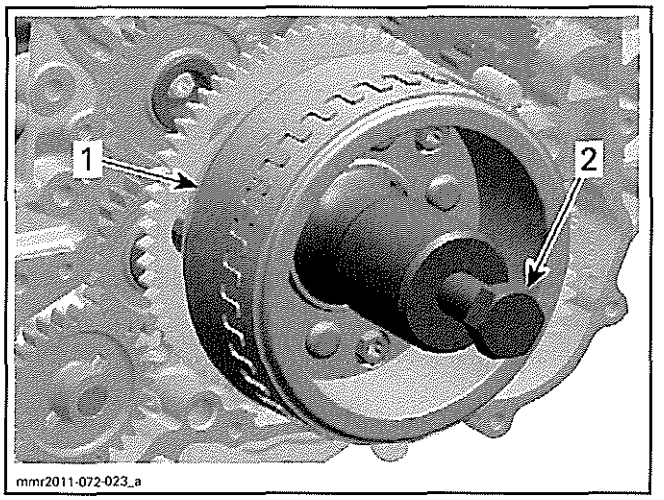


NOTE: Apply some grease on the crankshaft protector surface to ease puller operation.

5. Install the FLYWHEEL PULLER (P/N 420 976 235) on the rotor.



6. Pull rotor out by screwing the puller screw in.



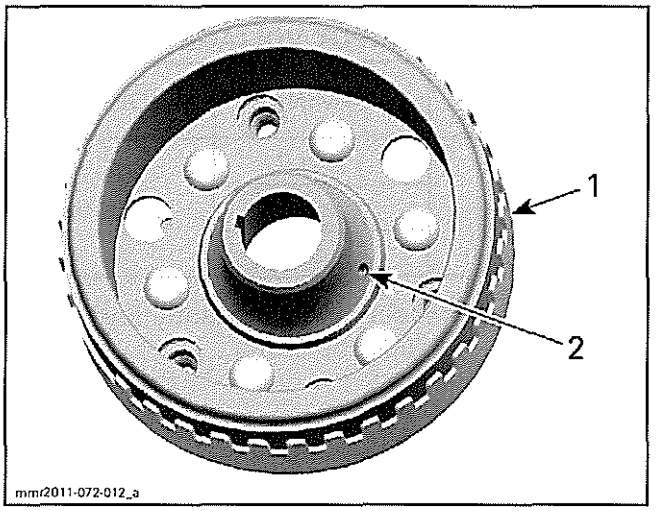
1. Rotor
2. Flywheel puller screw

Rotor Inspection

Check the inner side of the rotor for scratches or other damage.

Check woodruff key and keyway for wear or damages.

Check if trigger wheel teeth are bent or otherwise damaged.



1. Rotor with trigger wheel
2. Oil bore in magneto hub

Check woodruff key and keyway on the crankshaft for wear or damages.

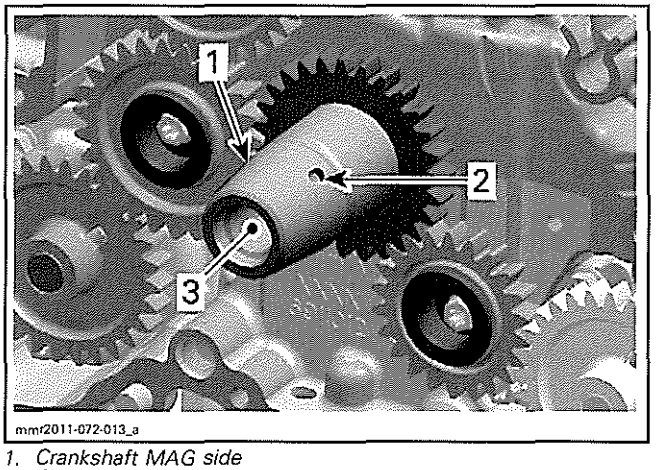
Replace parts as necessary.

Rotor Installation

Installation is the reverse removal procedure. However, pay attention to the following.

1. Blow the oil passage in the magneto hub using compressed air. Check if it is clogged.
2. Using PULLEY FLANGE CLEANER (P/N 413 711 809), clean:
   - The oil passage
   - The crankshaft threads
   - The crankshaft taper
   - The rotor taper.

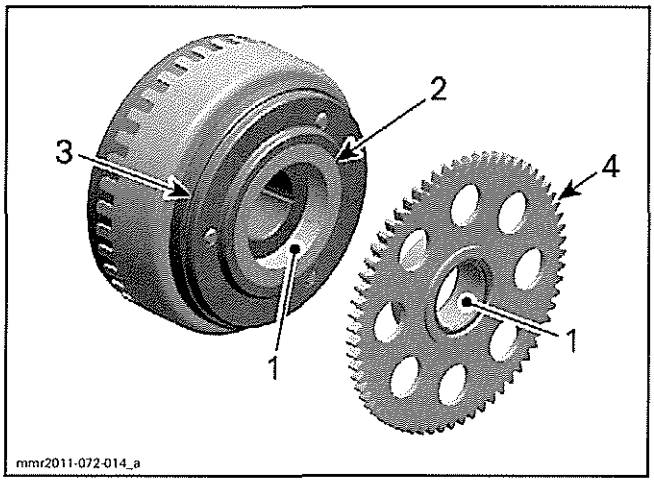
NOTICE Taper on crankshaft and rotor must be free of grease.



1. Crankshaft MAG side
2. Oil passage
3. Thread

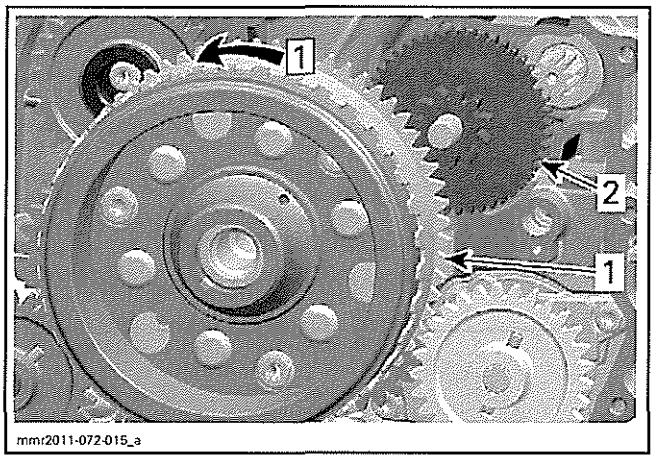
3. Apply oil on sprag clutch and needle bearing.

4. Install sprag clutch gear onto the rotor.



1. *Apply engine oil here*
2. *Sprag clutch*
3. *Sprag clutch housing*
4. *Sprag clutch gear*

5. Slide rotor along with the sprag clutch gear onto the crankshaft. The woodruff key and keyway must be aligned.
6. Rotate sprag clutch gear counterclockwise to align with starter double gear.



Step 1: Rotate to align teeth

1. *Sprag clutch gear*
2. *Starter double gear*

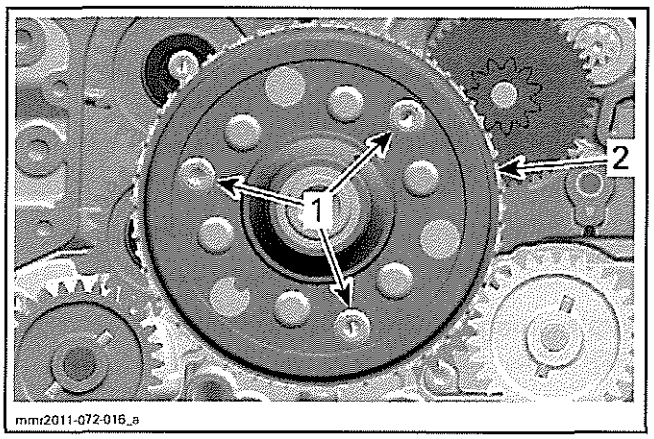
7. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on threads of rotor retaining screw.
8. Install washer and retaining screw.
9. Tighten to the specified torque.

ROTOR RETAINING SCREW TIGHTENING TORQUE
150 N•m ± 10 N•m (111 lbf•ft ± 7 lbf•ft)

SPRAG CLUTCH

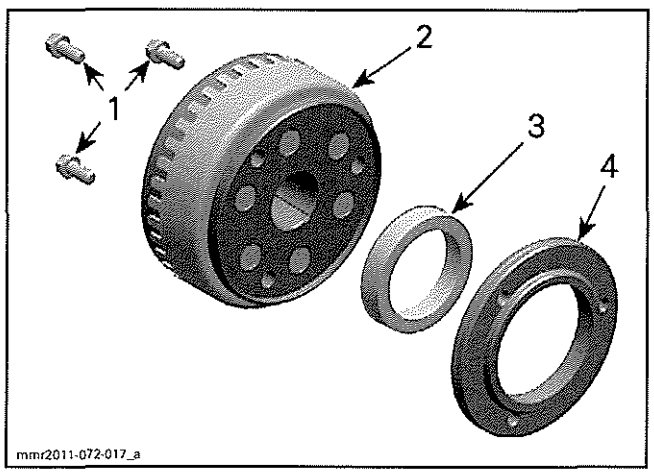
Sprag Clutch Removal

1. Remove the *MAGNETO COVER*, see procedure in this subsection.
2. Lock crankshaft. Refer to *CYLINDER BLOCK* subsection.
3. Loosen and remove sprag clutch housing screws.



1. *Sprag clutch housing screws*
2. *Rotor*

4. Remove *ROTOR*, see procedure in this subsection.
5. Remove sprag clutch housing.
6. Remove sprag clutch from sprag clutch housing.



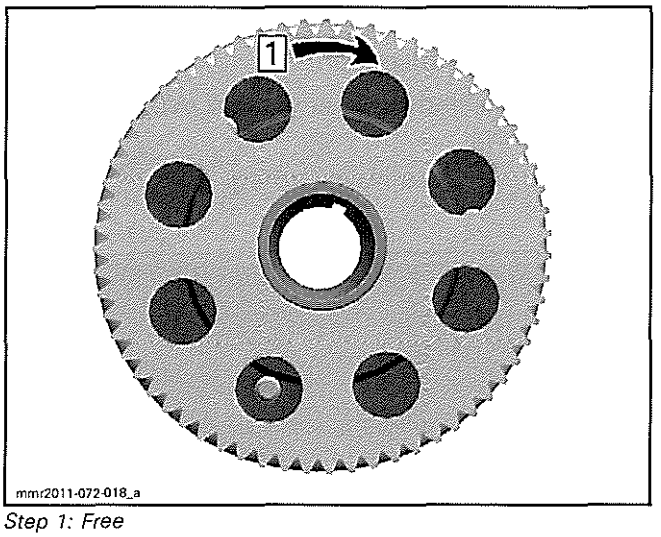
1. *Sprag clutch housing screws*
2. *Rotor*
3. *Sprag clutch*
4. *Sprag clutch housing*

Sprag Clutch Inspection

Inspect sprag clutch and sprag clutch housing for wear and damage.

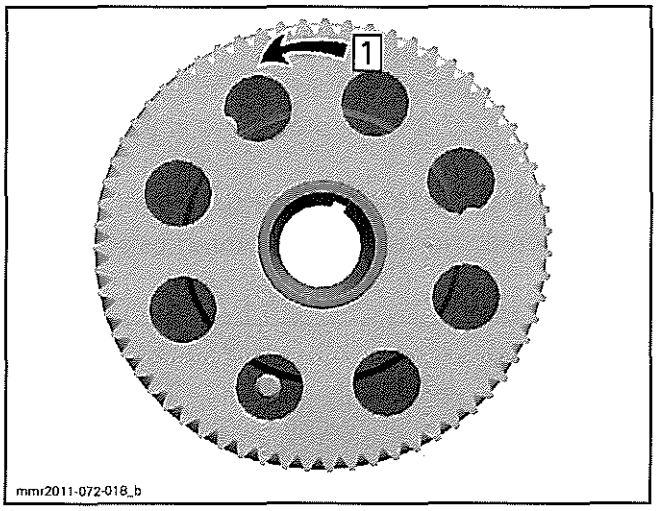
Check the collar of the sprag clutch gear, refer to *SPRAG CLUTCH GEAR*.

Rotate sprag clutch gear clockwise. Gear must rotate freely.



Step 1: Free

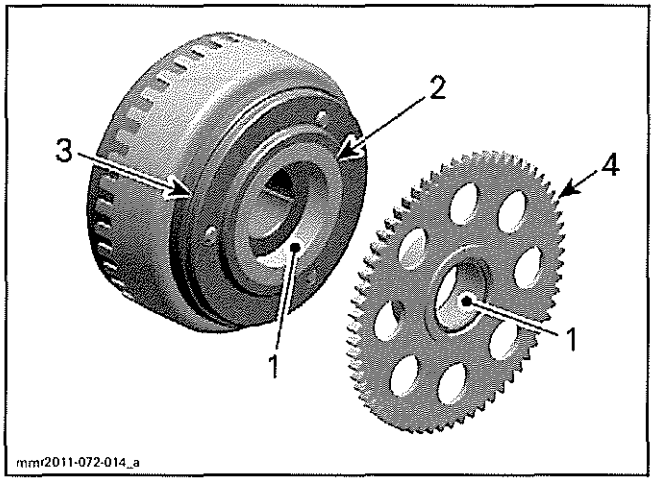
Rotate sprag clutch gear counterclockwise. Gear must lock.



Step 1: Lock

Sprag Clutch Installation

1. Apply LOCTITE 648 (GREEN) (P/N 413 711 400) on threads of sprag clutch housing screws.
2. Loosely install screws.
3. Apply engine oil on sprag clutch and sprag clutch gear needle bearing.



1. *Apply engine oil here*
2. *Sprag clutch*
3. *Sprag clutch housing*
4. *Sprag clutch gear*

4. Install *ROTOR*, see procedure in this subsection.
5. Tighten sprag clutch housing screws to the specified torque.

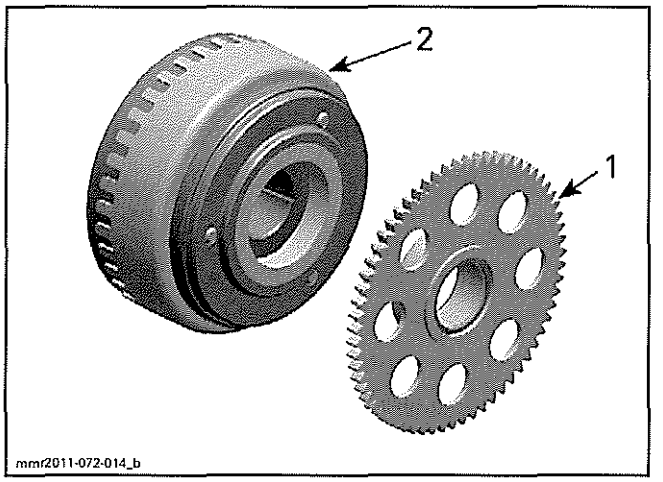
SPRAG CLUTCH HOUSING SCREWS TIGHTENING TORQUE
30 N•m ± 2 N•m (22 lbf•ft ± 1 lbf•ft)

6. Install all other removed parts.

SPRAG CLUTCH GEAR

Sprag Clutch Gear Removal

1. Remove rotor and sprag clutch gear together. Refer to *ROTOR* in this subsection.
2. Pull sprag clutch gear out of the rotor.

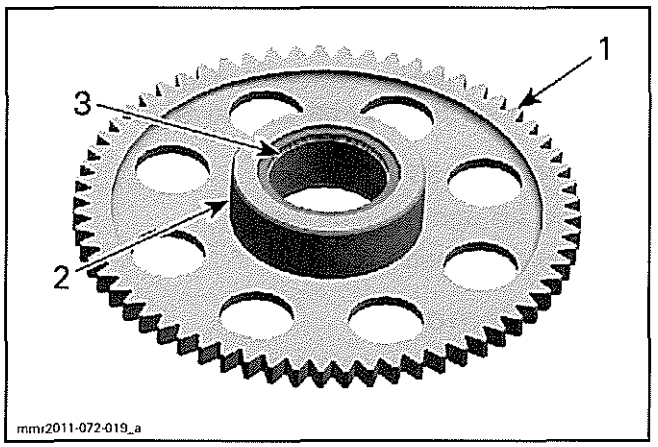


1. *Sprag clutch gear*
2. *Rotor*

Sprag Clutch Gear Inspection

Inspect gear, especially teeth and sprag clutch collar for wear and other damage.

Check needle bearing for wear and pittings.



1. *Teeth*
2. *Collar*
3. *Needle bearing*

Replace sprag clutch gear if necessary.

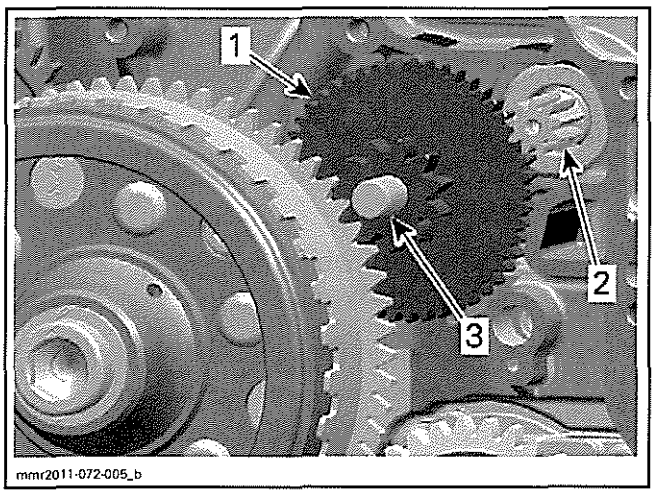
Sprag Clutch Gear Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

NOTE: Apply engine oil on needle bearing and collar of sprag clutch gear.

STARTER DRIVE GEARS

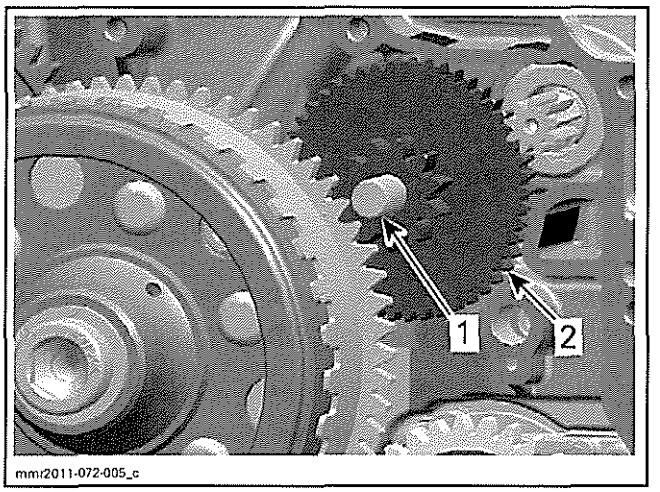
The starter drive gears are located on the engine MAG side behind the magneto cover.



1. *Starter double gear*
2. *Starter gear*
3. *Location pin*

Starter Drive Gear Removal

1. Remove *MAGNETO COVER*, see procedure in this subsection.
2. Remove location pin and starter double gear.



1. *Location pin*
2. *Starter double gear*

Starter Drive Gear Inspection

Inspect starter drive gears and location pin for wear and damage.

Replace parts if necessary.

Starter Drive Gear Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

1. Apply engine oil on the location pin.

STARTER

Starter Operation Test

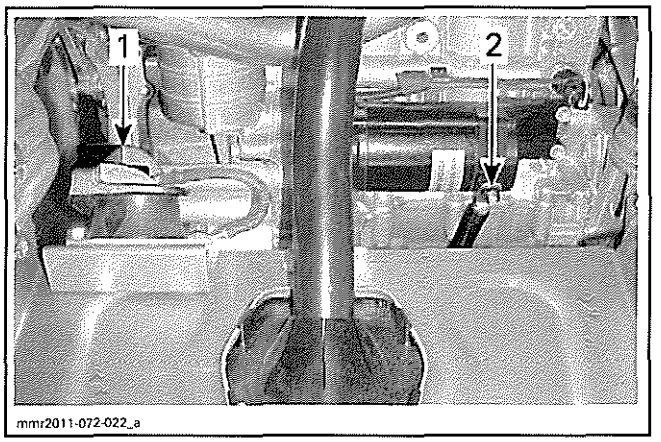
Before carrying out any starter test, make sure:

- Battery is fully charged and in good condition
- Cable connections at battery, starter and solenoid are tight.
- Cables are in good condition

1. Disconnect the negative battery cable.
2. Using booster cables and a fully charged battery or a power pack, carefully supply current directly to the starter.
   - 2.1 Connect the negative booster cable or power pack cable to a good ground such as an engine support.
   - 2.2 Temporarily touch the starter positive terminal.

⚠ WARNING

Sparks can occur when connecting jumper cables. To avoid fire hazard, be sure that no flammable liquids or fuel vapors are in the test area.



TYPICAL
1. *Engine support*
2. *Starter positive terminal*

If starter turns at normal speed, test the starting circuit. Refer to *STARTING SYSTEM* subsection.

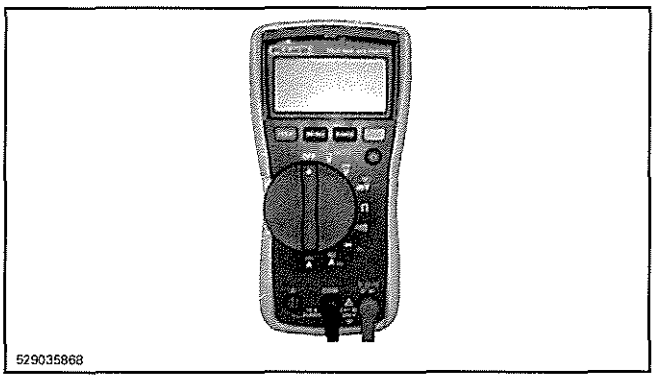
If starter turns slowly, carry out the *STARTER VOLTAGE DROP TEST (AT BATTERY).*

If starter does not turn, replace starter.

Starter Voltage Drop Test (at Battery)

NOTE: This test will confirm if starter draws too much current. Battery must be fully charged and in good condition.

1. To prevent engine from running, remove fuse F5.
2. Install the tether cord cap on the engine cut-off switch (D.E.S.S. post).
3. Turn the emergency engine stop switch ON.
4. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Vdc.



5. Probes the battery posts.
6. Crank engine and read voltage while cranking.

NOTE: Battery voltage will drop approximately 2 Vdc and fluctuate with starter cranking load.

If the result is close to battery voltage, the starter is in good condition.

If the result is below battery voltage (- 2 Vdc and more), the starter may be defective.

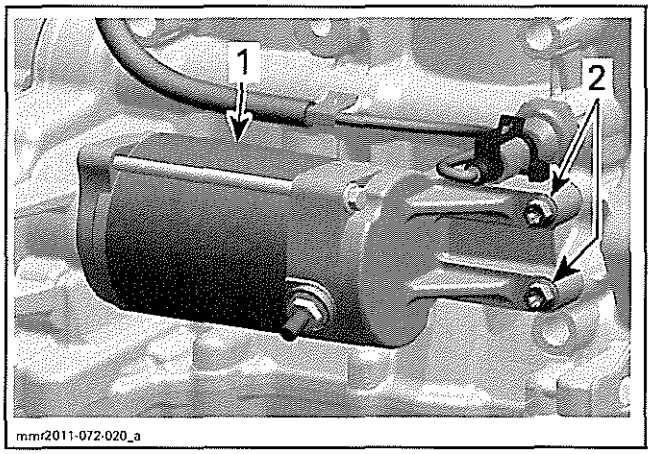
Starter Access

Remove LH and RH side panels.

Remove drive belt guard.

Starter Removal

1. Disconnect the negative battery cable.
2. Remove the starter cable from starter.
3. Remove starter retaining screws.



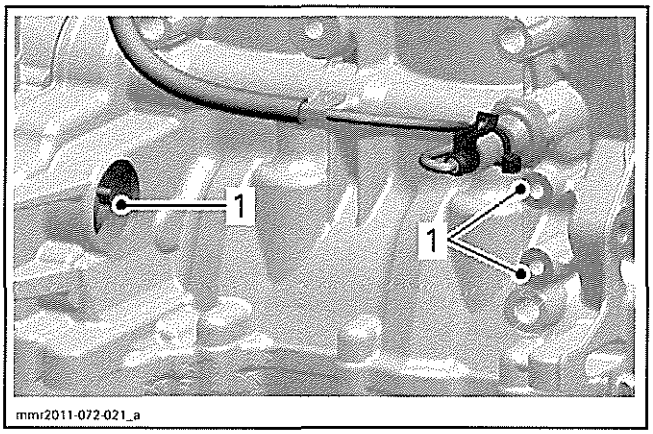
1. *Starter*
2. *Starter retaining screws*

4. Pull starter off the cylinder block.

Starter Installation

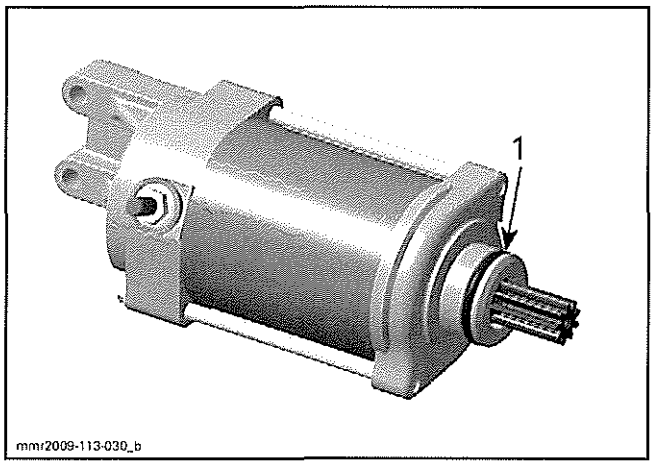
1. Ensure starter and engine mating surfaces are free of debris.

NOTICE Serious problems may arise if the starter is not properly aligned.



1. Clean mating surfaces

2. Apply SUPER LUBE GREASE (P/N 293 550 030) on the starter O-ring before installation.



1. Apply super lube grease

3. Install starter screws and tighten to the specified torque.
4. Connect the starter cable to the starter and tighten nut to the specified torque.

STARTER FASTENERS TIGHTENING TORQUE	
Starter retaining screws	11 N•m (97 lbf•**in**)
Starter cable nut	7 N•m (62 lbf•**in**)

5. Install all other removed parts.
6. Reconnect battery cables.

⚠ WARNING

Always connect the RED (+) starter cable first, then the BLACK (-) battery cable last. Whenever connecting the RED (+) cable to the starter motor, always make sure the BLACK (-) battery cable is disconnected to prevent electric shock.

7. Test for proper starter operation.

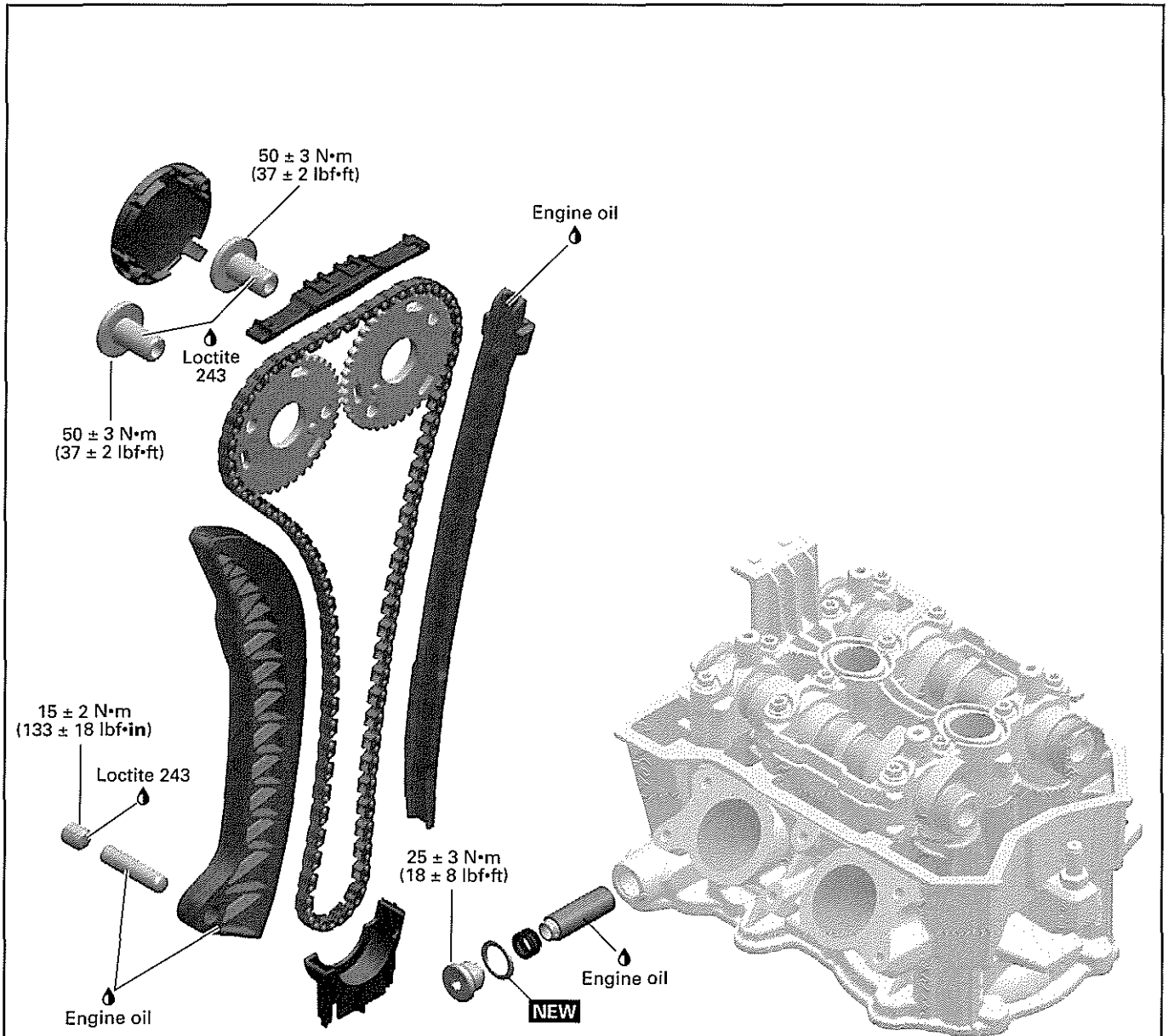
TIMING CHAIN

SERVICE TOOLS

Description	Part Number	Page
CAMSHAFT LOCKING TOOL	529 036 206	225–226

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 243 (BLUE)	293 800 060	227, 234
LOCTITE 767 (ANTISEIZE LUBRICANT)	293 800 070	231
SUPER LUBE GREASE	293 550 030	231



NEW = Component must be replaced when removed.

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GENERAL

Engine removal is necessary to work on the following components:
– Timing chain
– Timing chain guide (tensioner side).

Always disconnect BLACK (-) cable from the battery, then RED (+) cable before working on the engine.

⚠ WARNING

Always disconnect BLACK (-) cable first and reconnect last.

During assembly/installation, use torque values and service products as specified in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices (e.g.: locking tabs, elastic stop nuts, cotter pin, etc.) must be replaced.

Hoses, cables or locking ties removed during a procedure must be reinstalled as per factory standards.

When disassembling parts that are duplicated in the engine, (e.g.: valves, springs, etc.), it is strongly recommended to note their position and to keep the parts of the same assembly as a "group". If you find a defective component, it will be much easier to find the cause of the failure. Since parts were broken-in together during engine operation, they will maintain their matched fit when reassembled together within their "group".

TROUBLESHOOTING

The following is provided to help in diagnosing the probable source of troubles. It is a guideline and should not be assumed to provide solutions to every cause of all problems.

UNUSUAL ENGINE NOISE OR VIBRATIONS

1. Faulty chain tensioner.
   - *Replace chain tensioner.*
2. Chain guide(s) worn out.
   - *Replace chain guide(s).*
3. Stretched timing chain or worn sprockets.
   - *Replace timing chain and sprockets.*
4. Camshaft timing gear screws loose.
   - *Retighten screws to recommended torque.*
5. Incorrect camshaft timing adjustment.
   - *Replace damaged components and readjust camshaft timing.*

ENGINE LACKS ACCELERATION OR POWER

1. Incorrect camshaft timing adjustment.
   - *Replace damaged components and readjust camshaft timing.*

PROCEDURES

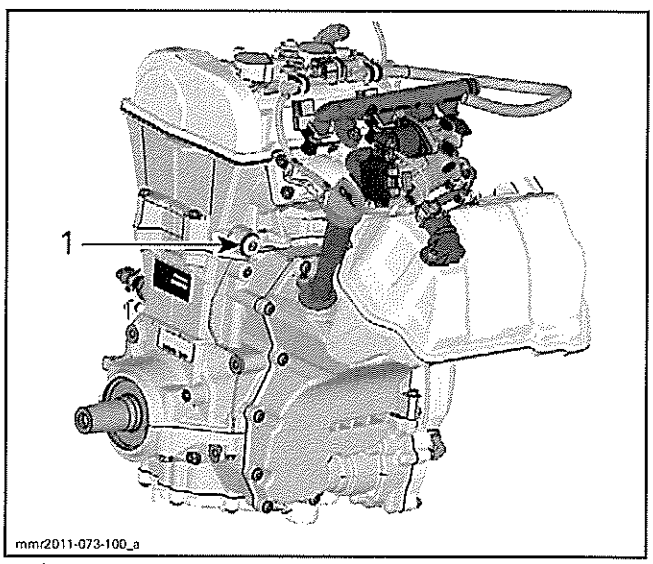
TIMING CHAIN TENSIONER

Timing Chain Tensioner Access

Remove driven pulley. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 ACE)* subsection.

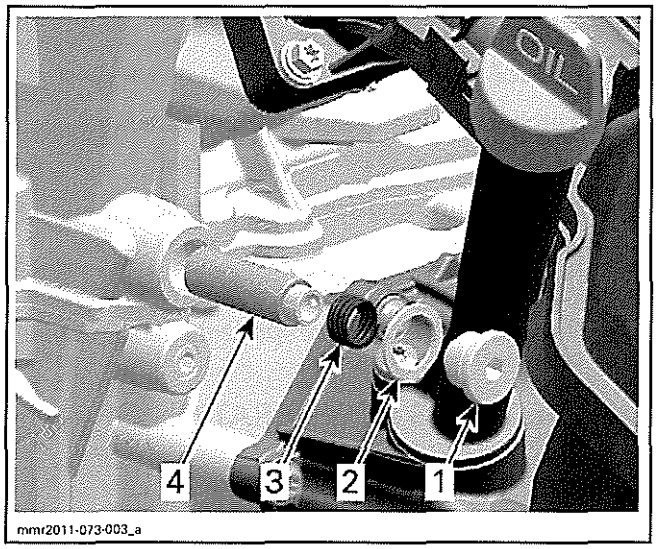
Timing Chain Tensioner Removal

1. Lock crankshaft, refer to *CYLINDER BLOCK* subsection.
2. Remove screw plug and discard the sealing washer.



1. Screw plug location, timing chain tensioner

3. Pull out spring and chain tensioner.



1. Screw plug
2. Sealing washer
3. Spring
4. Chain tensioner

Timing Chain Tensioner Inspection

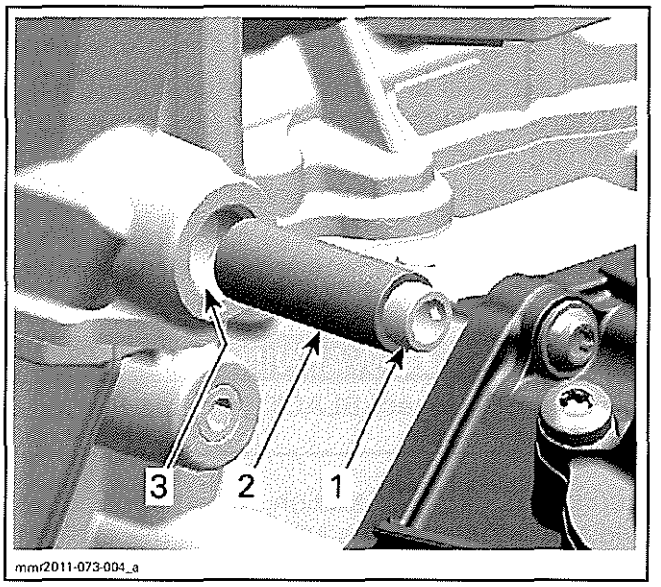
1. Check chain tensioner for scoring and freedom of movement in bore.
2. Compress chain tensioner and check for proper operation.

NOTE: The chain tensioner is difficult to compress when properly charged with oil, and easily compressed when it is not.

3. Check spring for straightness, corrosion and other visible damage.

Timing Chain Tensioner Installation

1. Apply engine oil on chain tensioner.
2. Insert chain tensioner in its bore with the plunger pointing outwards.



TIMING CHAIN TENSIONER INSTALLATION
1. Plunger
2. Chain tensioner
3. Tensioner bore in engine

3. Install spring on chain tensioner.
4. Install screw plug with a NEW sealing washer.
5. Tighten screw plug to specified torque.

SCREW PLUG TORQUE (TIMING CHAIN TENSIONER)
25 N•m ± 3 N•m (18 lbf•ft ± 2 lbf•ft)

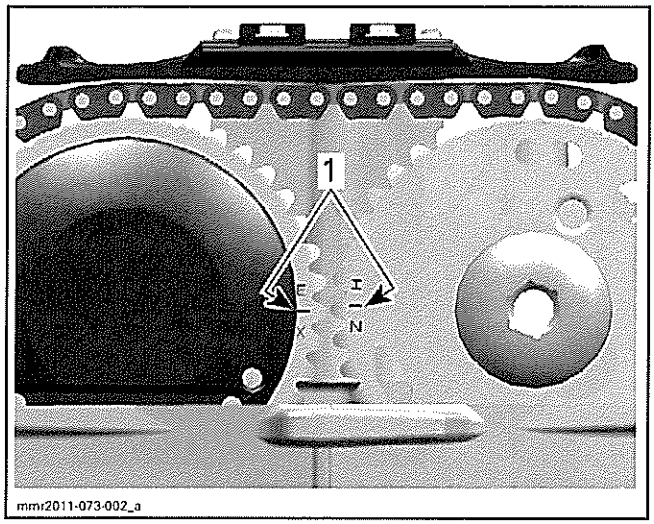
6. Install all other removed parts.

CAMSHAFT TIMING GEARS

Camshaft Timing Gear Removal

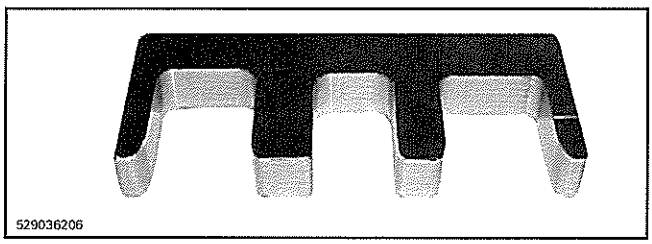
1. Remove *VALVE COVER*, see procedure in *CYLINDER HEAD* subsection.
2. Lock crankshaft, refer to procedure in *CYLINDER BLOCK* subsection.

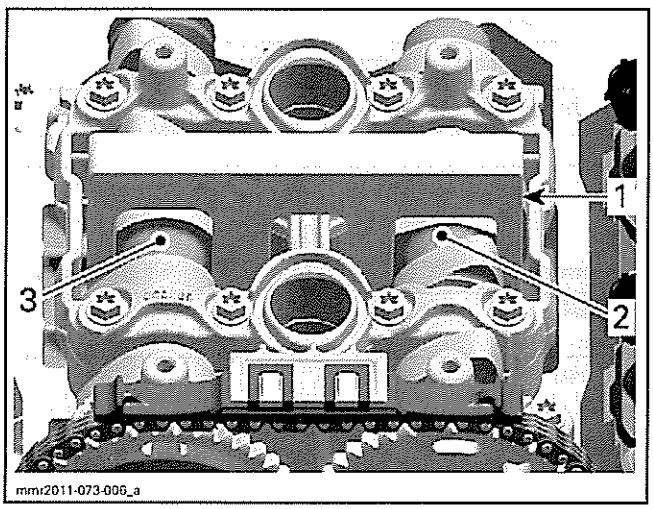
NOTE: When crankshaft is locked, the marks "IN" and "EX" on the camshaft timing gears must be aligned.



1. Marks on camshaft timing gears aligned

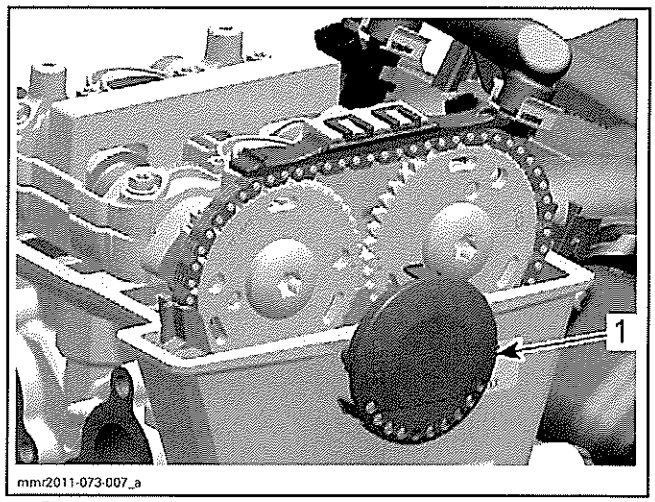
3. Lock camshaft using the CAMSHAFT LOCKING TOOL (P/N 529 036 206).





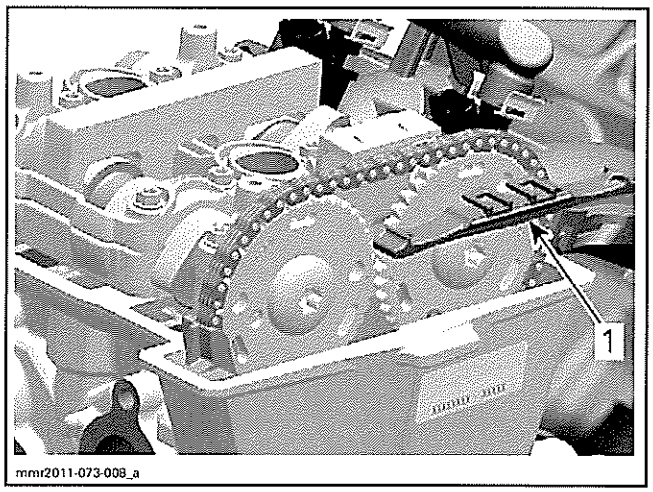
1. Camshaft locking tool
2. Intake camshaft
3. Exhaust camshaft

4. Remove *TIMING CHAIN TENSIONER*, see procedure in this subsection.
5. Remove breather cover.



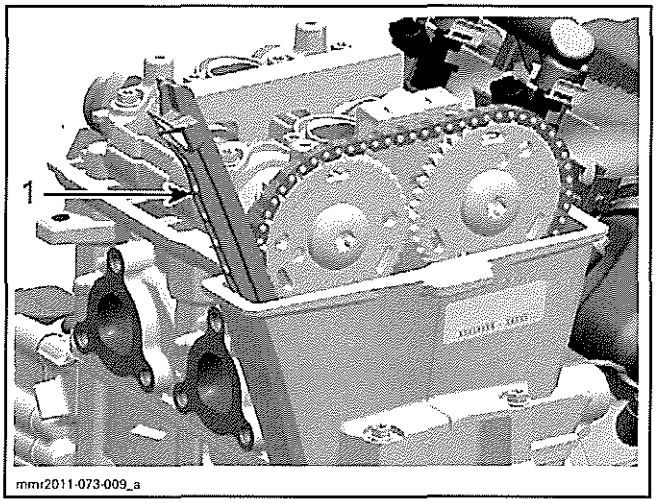
1. Breather cover

6. Remove upper timing chain guide from camshaft holder.



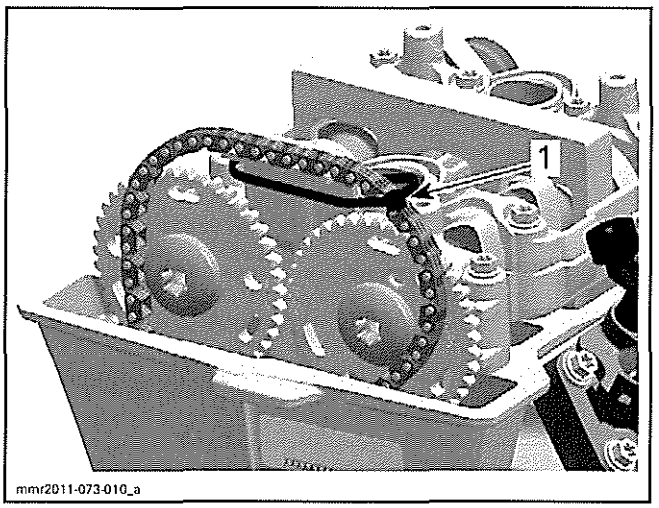
1. Upper timing chain guide

7. Inspect timing chain for radial play while still installed on camshaft timing gears. See *TIMING CHAIN INSPECTION* in this subsection.
8. Remove timing chain guide (exhaust side).



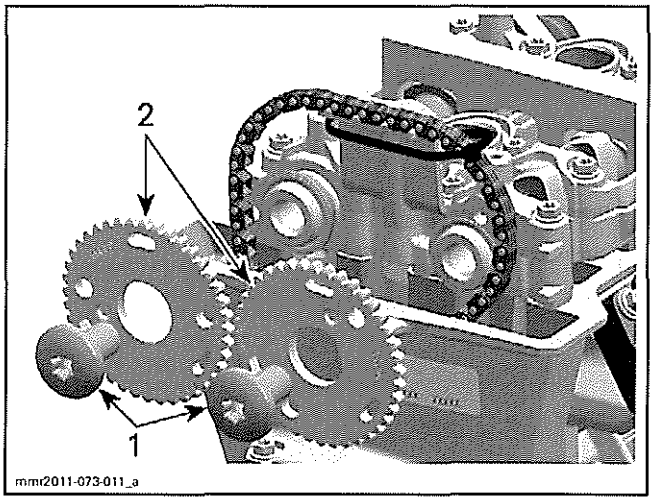
1. Timing chain guide (exhaust side)

9. Remove timing chain from camshaft timing gears and secure it to the camshaft holder using a locking tie.



1. Timing chain removed from gears and secured to camshaft holder

10. Unscrew and remove camshaft timing gear screws.
11. Remove camshaft timing gears.



1. Camshaft timing gear screws
2. Camshaft timing chain gears

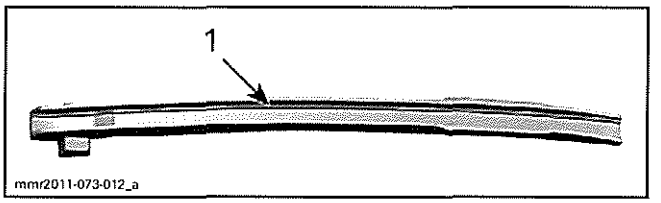
Camshaft Timing Gear Inspection

1. Check camshaft timing gears for wear or deterioration. If a gear is worn or damaged, replace camshaft timing gears and timing chain as a set.

NOTE: For crankshaft timing gear inspection, refer to *CYLINDER BLOCK* subsection.

2. Check timing chain guide for wear, cracks or deformation. Replace as required.
3. Replace timing chain guide if any groove caused by timing chain) exceeds service limit.

CHAIN GUIDE GROOVE DEPTH	
SERVICE LIMIT	1 mm (.039 in)



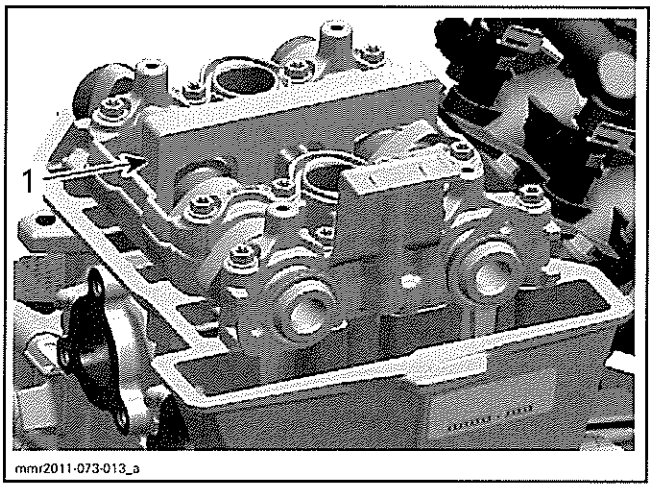
1. Timing chain guide

Camshaft Timing Gear Installation

Installation is the reverse of the removal procedure however, pay attention to the following details.

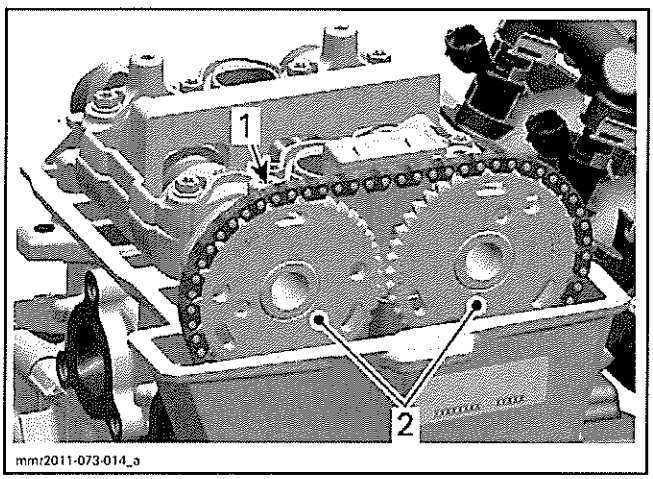
NOTICE Improper camshaft timing will damage engine components. Make sure camshafts and crankshaft are still locked. If not, lock them before beginning this procedure.

1. Ensure CAMSHAFT LOCKING TOOL (P/N 529 036 206) is properly installed on camshafts.



1. Camshaft locking tool properly installed

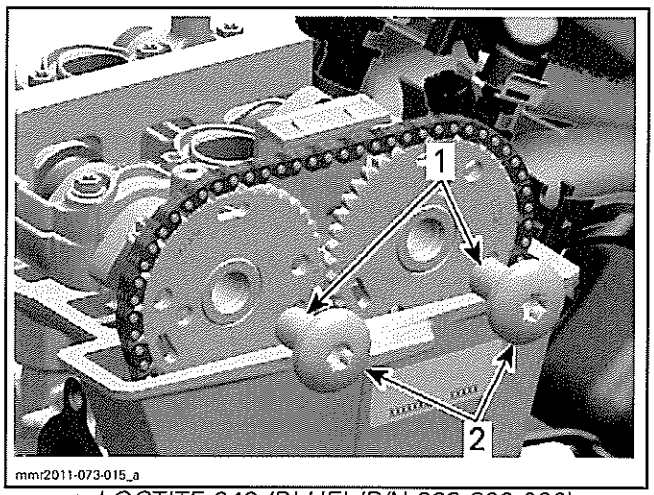
2. Install timing chain with camshaft timing gears.



1. Timing chain
2. Camshaft timing gears

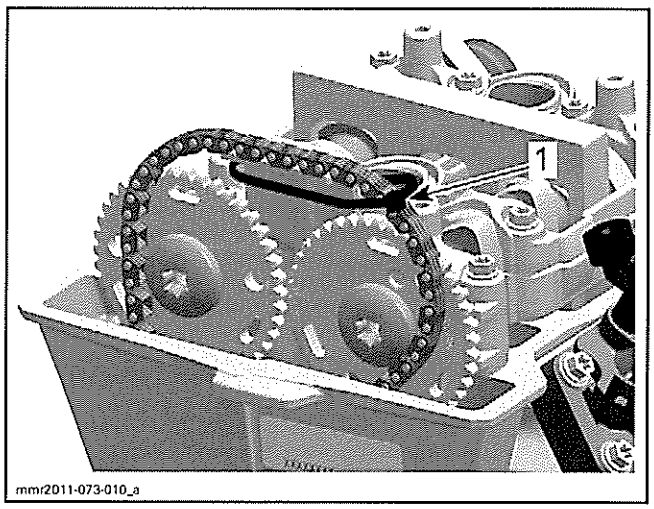
3. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on threads of camshaft timing gear screws.
4. Install camshaft timing gear screws hand tightened at this time.

NOTICE Do not torque timing gear screws at this time to avoid overstressing timing chain.



1. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) here
2. Screws to be hand tightened at this time

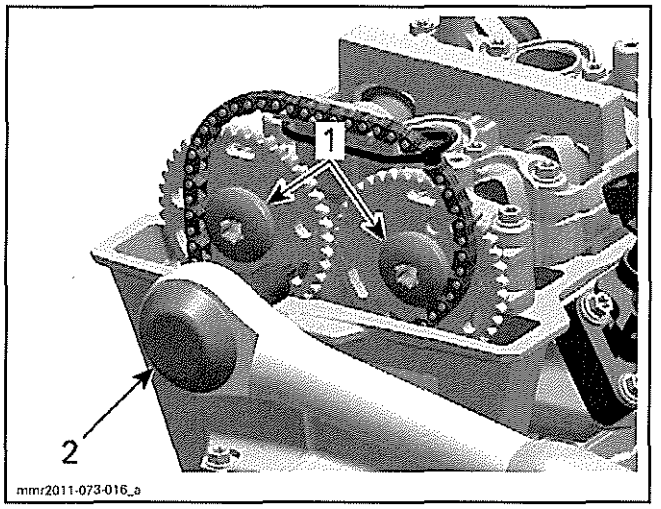
5. Remove timing chain from camshaft timing gears and secure it to the camshaft holder using a locking tie.



1. Timing chain removed from gears and secured to camshaft holder

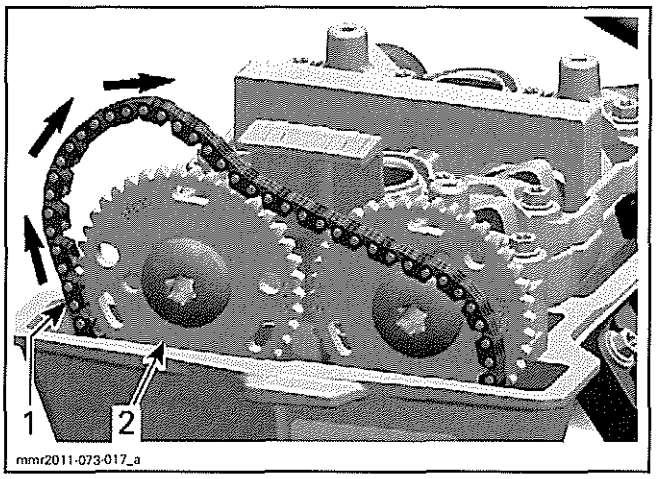
6. Torque both camshaft timing gear screws as specified.

CAMSHAFT TIMING GEAR SCREW TORQUE
50 N•m ± 3 N•m (37 lbf•ft ± 2 lbf•ft)



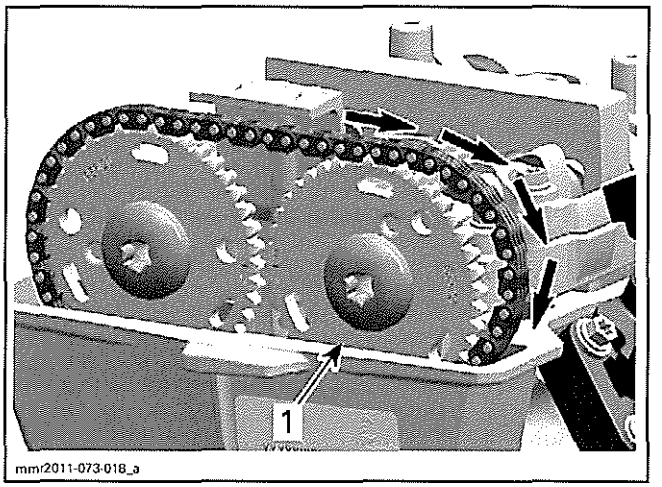
1. Timing gear screws
2. Torque wrench

7. Cut locking tie and pull timing chain up on exhaust side and install it on the exhaust camshaft timing gear.



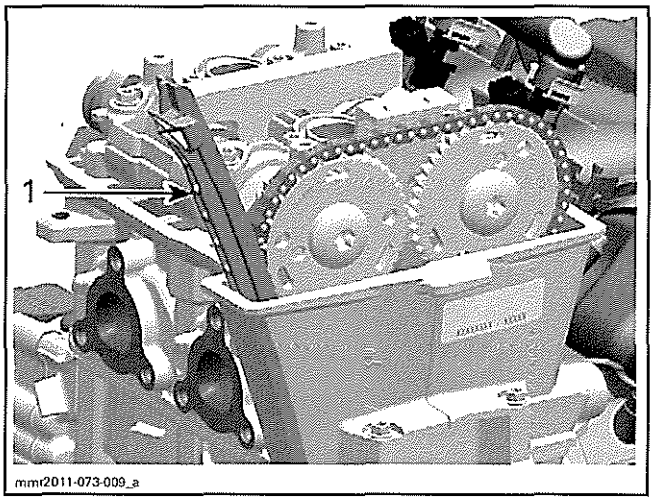
1. Timing chain
2. Exhaust camshaft timing gear

8. Pull timing chain towards intake side and install it on the intake camshaft timing gear.



1. Intake camshaft timing gear

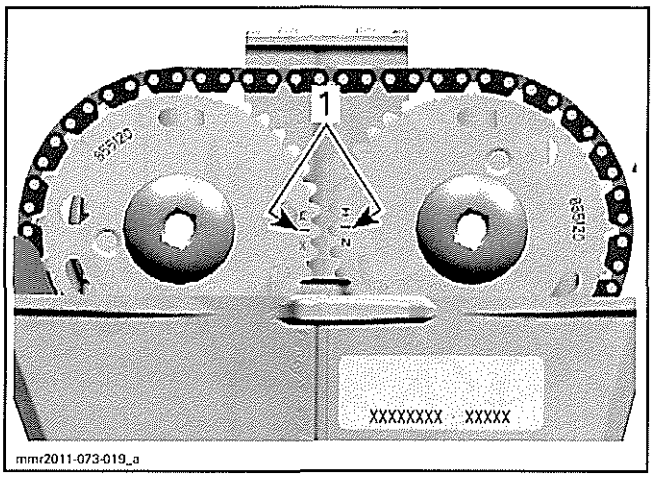
9. Install timing chain guide.



1. Timing chain guide

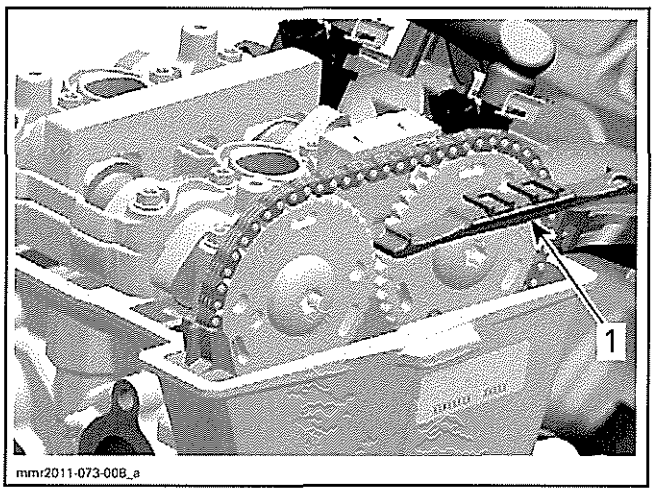
10. Install *TIMING CHAIN TENSIONER*, see procedure in this subsection.
11. Ensure marks on camshaft timing gears are still aligned. If not, repeat procedure.

NOTICE After installation of timing chain tensionner, the marks "IN" on intake and "EX" on exhaust camshafts must be aligned.



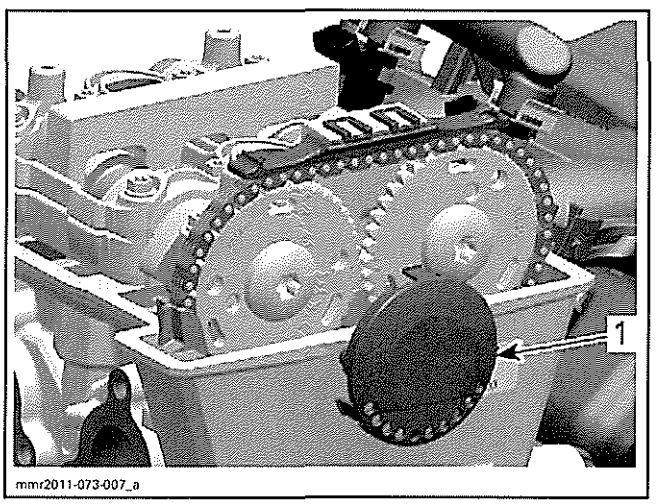
CAMSHAFT TIMING GEARS
1. Marks must be aligned

12. Install upper timing chain guide on camshaft holder.



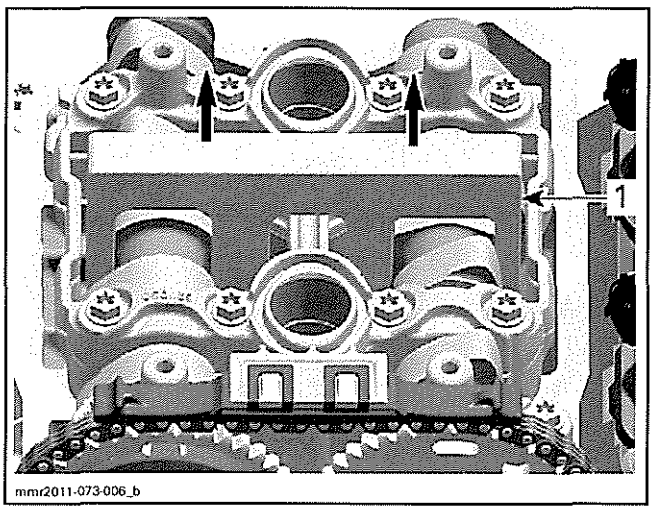
1. Upper timing chain guide

13. Install breather cover.



1. Breather cover

14. Remove camshaft locking tool.



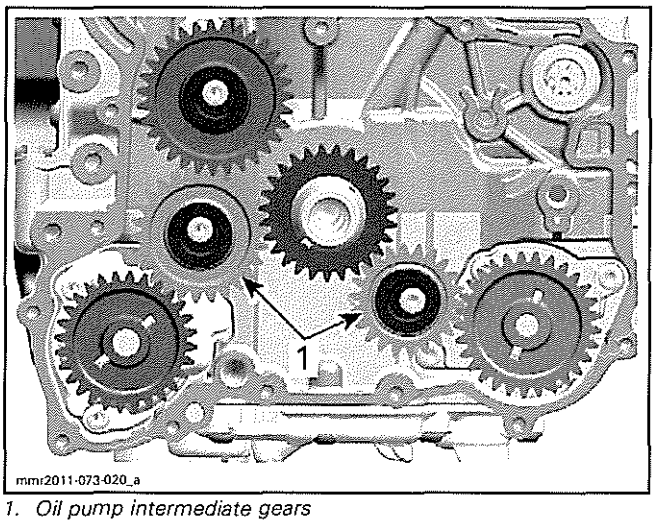
1. Camshaft locking tool removal

15. Remove crankshaft locking tool.
16. Install remaining parts.

TIMING CHAIN

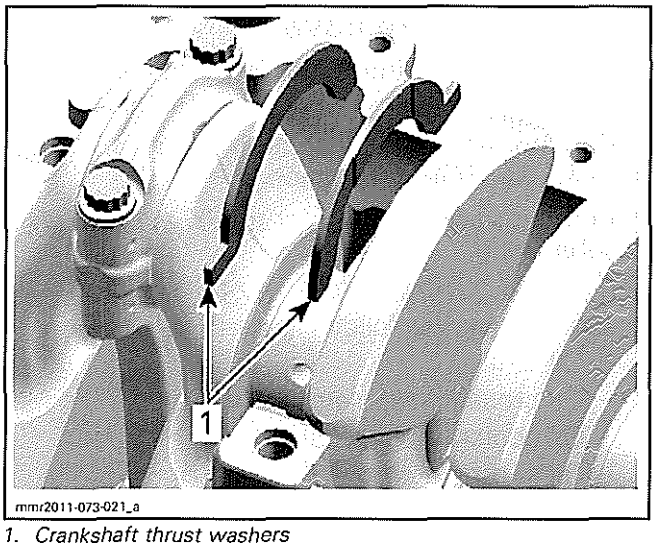
Timing Chain Removal

1. Remove engine from vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
2. Remove air intake manifold, refer to *AIR INTAKE SYSTEM* subsection.
3. Remove valve cover, refer to *CYLINDER HEAD* subsection.
4. Refer to *LUBRICATION SYSTEM* subsection and remove the following parts:
   - Oil tank
   - Oil pressure regulator valve
   - Oil cooler (if applicable)
   - Oil sump cover.
5. Refer to *COOLING SYSTEM* subsection and remove following parts:
   - Water pump housing
   - Thermostat.
6. Check timing chain for excessive radial play while still installed on timing gears. Refer to *TIMING CHAIN INSPECTION* in this subsection.
7. Remove the *CAMSHAFT TIMING GEARS*, see procedure in this subsection.
8. Refer to *MAGNETO AND STARTER* subsection and remove the following parts:
   - Magneto cover
   - Rotor
   - Starter drive gears.
9. Remove oil pump intermediate gears, refer to *LUBRICATION SYSTEM* subsection.



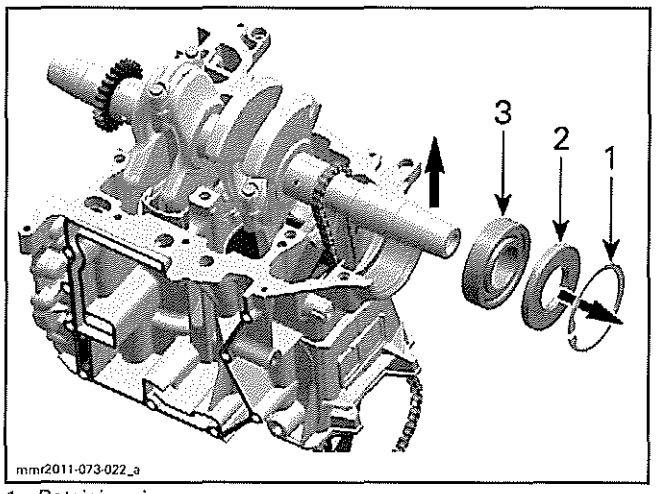
1. Oil pump intermediate gears

10. Remove crankshaft locking bolt.
11. Separate cylinder block, refer to *CYLINDER BLOCK* subsection.
12. Remove crankshaft thrust washers.



1. Crankshaft thrust washers

13. Remove retaining ring that secures the oil seal and PTO ball bearing.
14. Slightly lift the crankshaft and remove oil seal and PTO ball bearing.

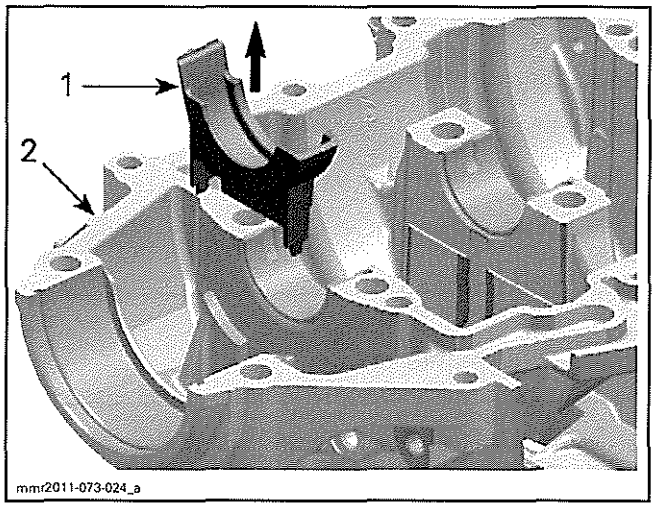


1. Retaining ring
2. Oil seal
3. Ball bearing

15. Remove timing chain.

NOTE: Make a mark on the timing chain to indicate the operating direction of the chain before removal.

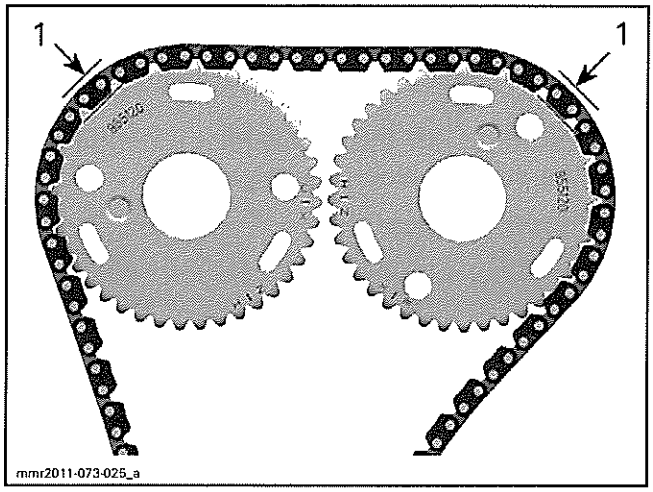
16. Remove lower timing chain guide from lower half of cylinder block.



1. Lower timing chain guide
2. Lower half of cylinder block

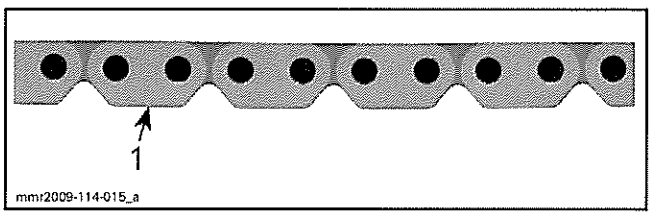
Timing Chain Inspection

1. Check timing chain on camshaft timing gears for excessive radial play while gears are still installed on camshafts.



1. Radial play

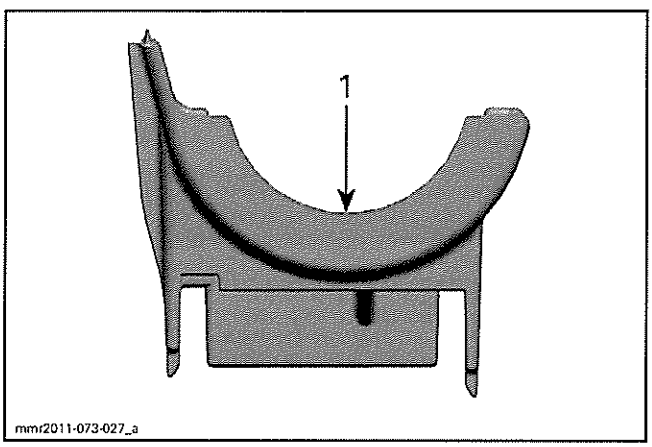
2. Check timing chain for wear and teeth condition.



1. Check teeth condition

NOTICE If timing chain is excessively worn or damaged, replace timing chain and camshaft timing gears as a set.

3. Check lower chain guide for wear, cracks or deformation. Replace as required.



1. Lower chain guide

4. Replace lower chain guide if timing chain wear grooves are visible.

CHAIN GUIDE GROOVE DEPTH	
SERVICE LIMIT	No timing chain wear groove allowed

NOTE: Also check the chain guide, tensioner side. Refer to *CHAIN GUIDE INSPECTION (TENSIONER SIDE)* further in this subsection.

Timing Chain Installation

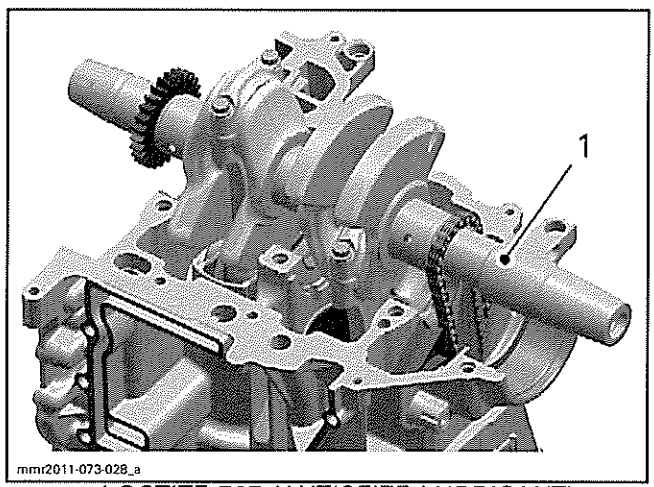
Installation is the reverse of the removal procedure however, pay attention to the following details.

NOTICE Improper camshaft timing will damage engine components, strictly follow this procedure.

1. Install timing chain.

NOTE: If the same timing chain is reinstalled, be sure to reinstall it in the same operating direction as marked during removal procedure.

2. Apply LOCTITE 767 (ANTISEIZE LUBRICANT) (P/N 293 800 070) on crankshaft at PTO-bearing surface area.



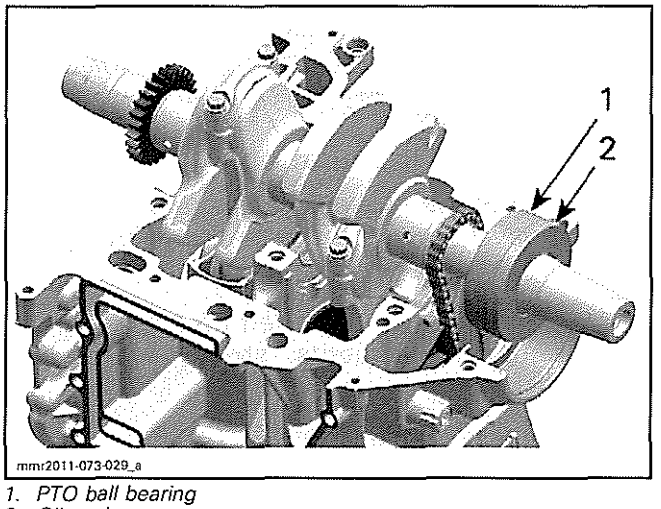
1. Apply LOCTITE 767 (ANTISEIZE LUBRICANT) (P/N 293 800 070) here

NOTE: After bearing installation, clean oil seal running surface on crankshaft.

3. Lubricate sealing lip of oil seal with SUPER LUBE GREASE (P/N 293 550 030).

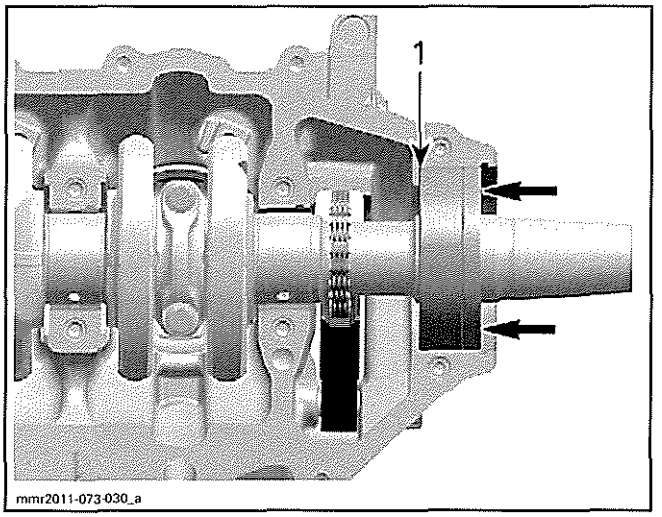
NOTICE Oil seal must be installed with sealing lip toward the engine.

4. Reinstall PTO ball bearing and oil seal on crankshaft.



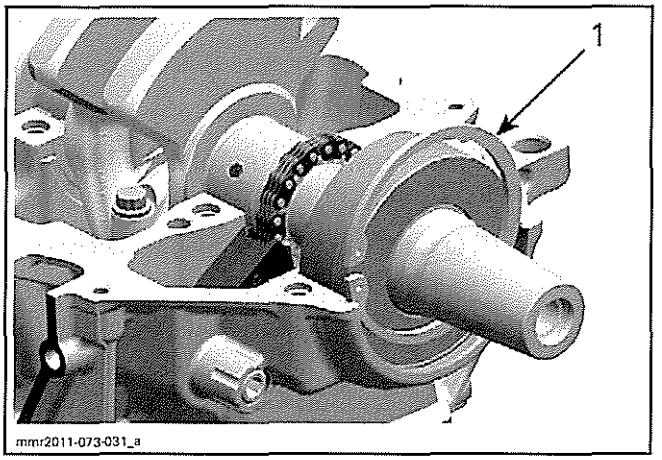
1. PTO ball bearing
2. Oil seal

5. Properly install crankshaft and push ball bearing and oil seal against axial stop.



1. PTO ball bearing against axial stop

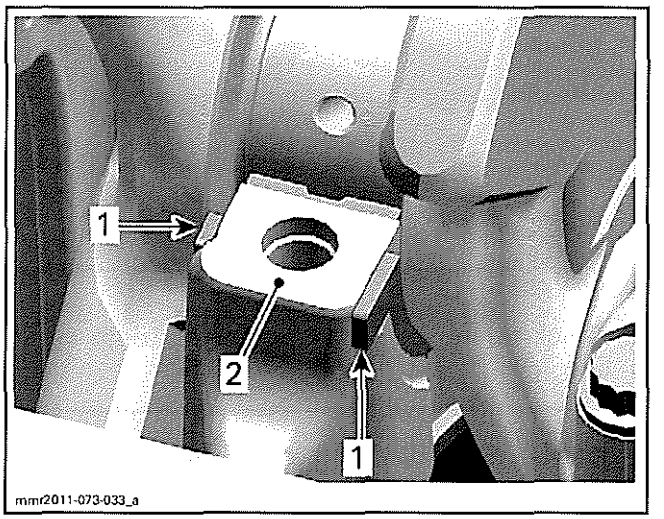
6. Install retaining ring.



1. Retaining ring

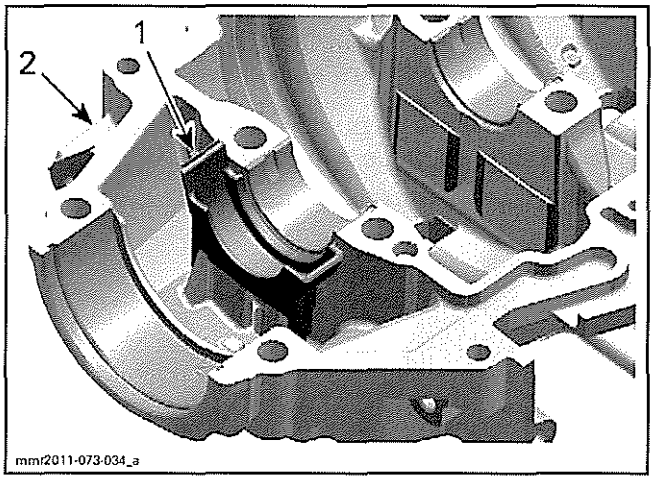
7. Properly install the crankshaft thrust washers with the slots facing against crankshaft counterweights.

NOTE: Crankshaft thrust washers must be flush with the cylinder block sealing surface.



1. Crankshaft thrust washers
2. Sealing surface

8. Reinstall lower chain guide in lower half of cylinder block.



1. Lower chain guide
2. Lower half of cylinder block

9. Reassemble cylinder block, refer to *CYLINDER BLOCK* subsection.
10. Lock crankshaft, refer to *CRANKSHAFT LOCKING PROCEDURE* in the *CYLINDER BLOCK* subsection.
11. Lock camshafts and install camshaft timing gears as per *CAMSHAFT TIMING GEAR INSTALLATION* in this subsection.
12. Install all other removed parts.

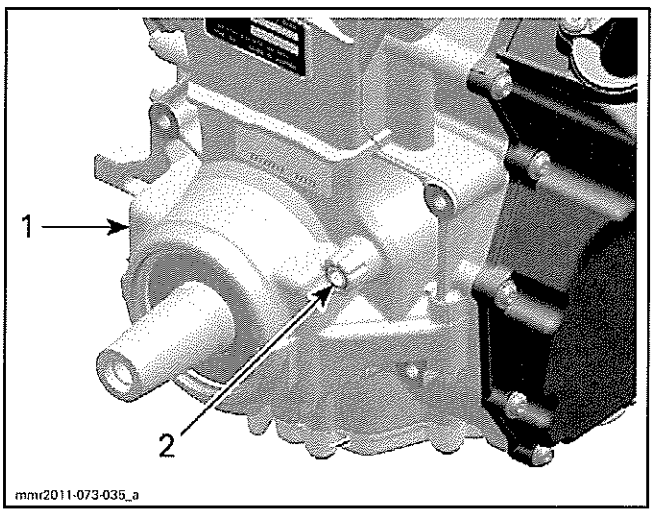
NOTE: Be sure to remove camshaft and crankshaft locking tools when timing chain is completely installed.

CHAIN GUIDE (TENSIONER SIDE)

Chain Guide Removal (Tensioner Side)

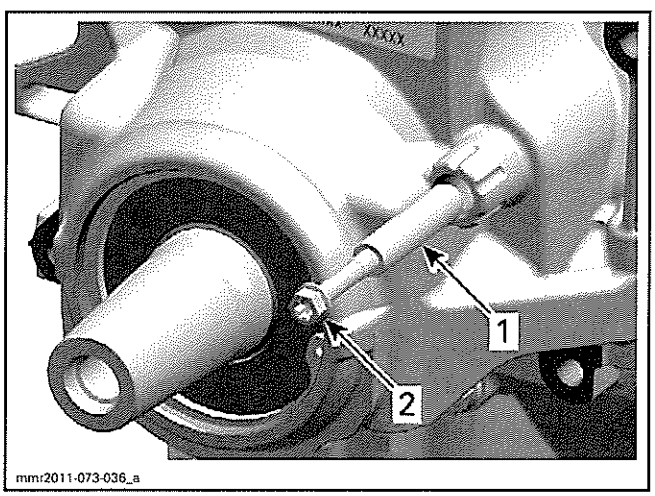
NOTE: Removal of chain guide is not recommended if there is no need for replacement.

1. Remove the *CAMSHAFT TIMING GEARS*, see procedure in this subsection.
2. Remove screw plug that covers the chain guide bearing pin.



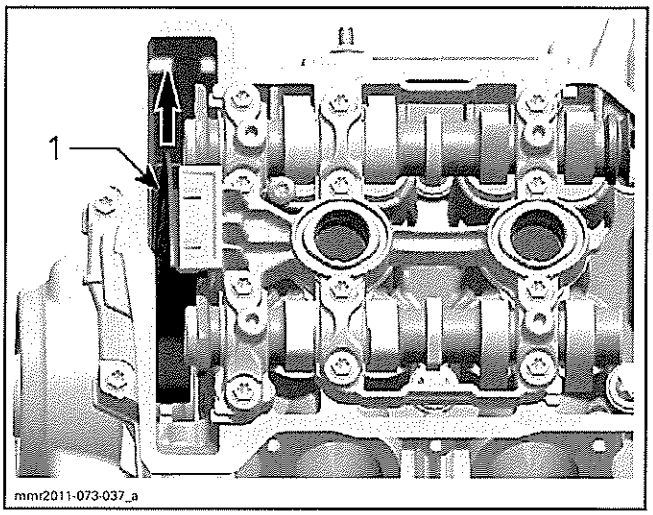
1. Cylinder block PTO side
2. Screw plug location

3. Use an M6 bolt to pull chain guide bearing pin out of cylinder block.



1. Chain guide bearing pin
2. M6 bolt

4. Push chain guide (tensioner side) to the exhaust camshaft side and remove it.



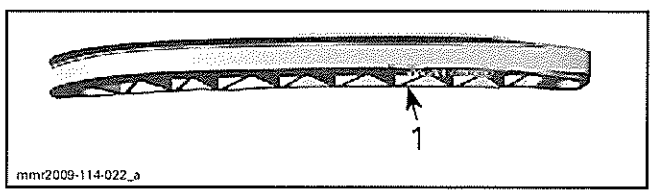
1. Chain guide (tensioner side)

Chain Guide Inspection (Tensioner Side)

Check chain guide for wear, cracks or deforming. Replace as required.

Replace chain guide if groove depth caused by timing chain exceeds service limit.

CHAIN GUIDE GROOVE DEPTH	
SERVICE LIMIT	1 mm (.039 in)



TYPICAL
1. Chain guide

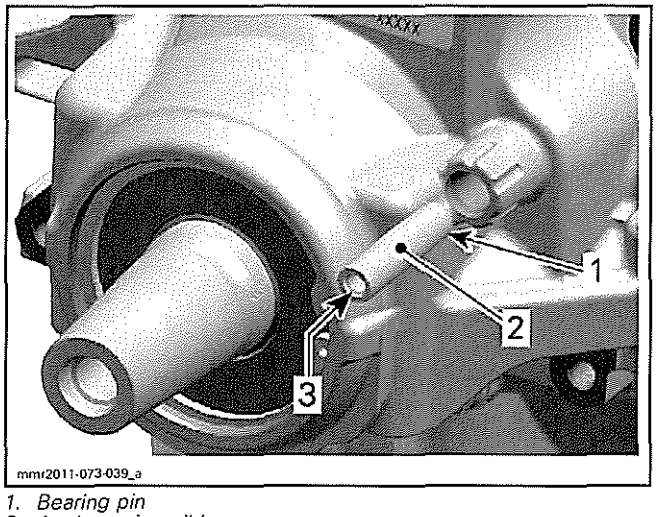
Chain Guide Installation (Tensioner Side)

Installation is the reverse of the removal procedure however, pay attention to the following details.

NOTICE Improper camshaft timing will damage engine components. Make sure camshafts and crankshaft are still locked. If not, lock them before beginning this procedure.

1. Insert chain guide.
2. Apply engine oil on bearing pin and install it with M6 threads facing outwards.

NOTICE Ensure chain guide bearing pin is properly inserted in the chain guide.



1. Bearing pin
2. Apply engine oil here
3. M6 threads facing outwards

3. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on screw plug of chain guide.
4. Tighten screw plug as specified.

SCREW PLUG TORQUE
15 N•m ± 2 N•m (133 lbf•**in** ± 18 lbf•**in**)

5. Properly reinstall camshaft timing gears. Refer to *CAMSHAFT TIMING GEARS* in this subsection.

CYLINDER HEAD

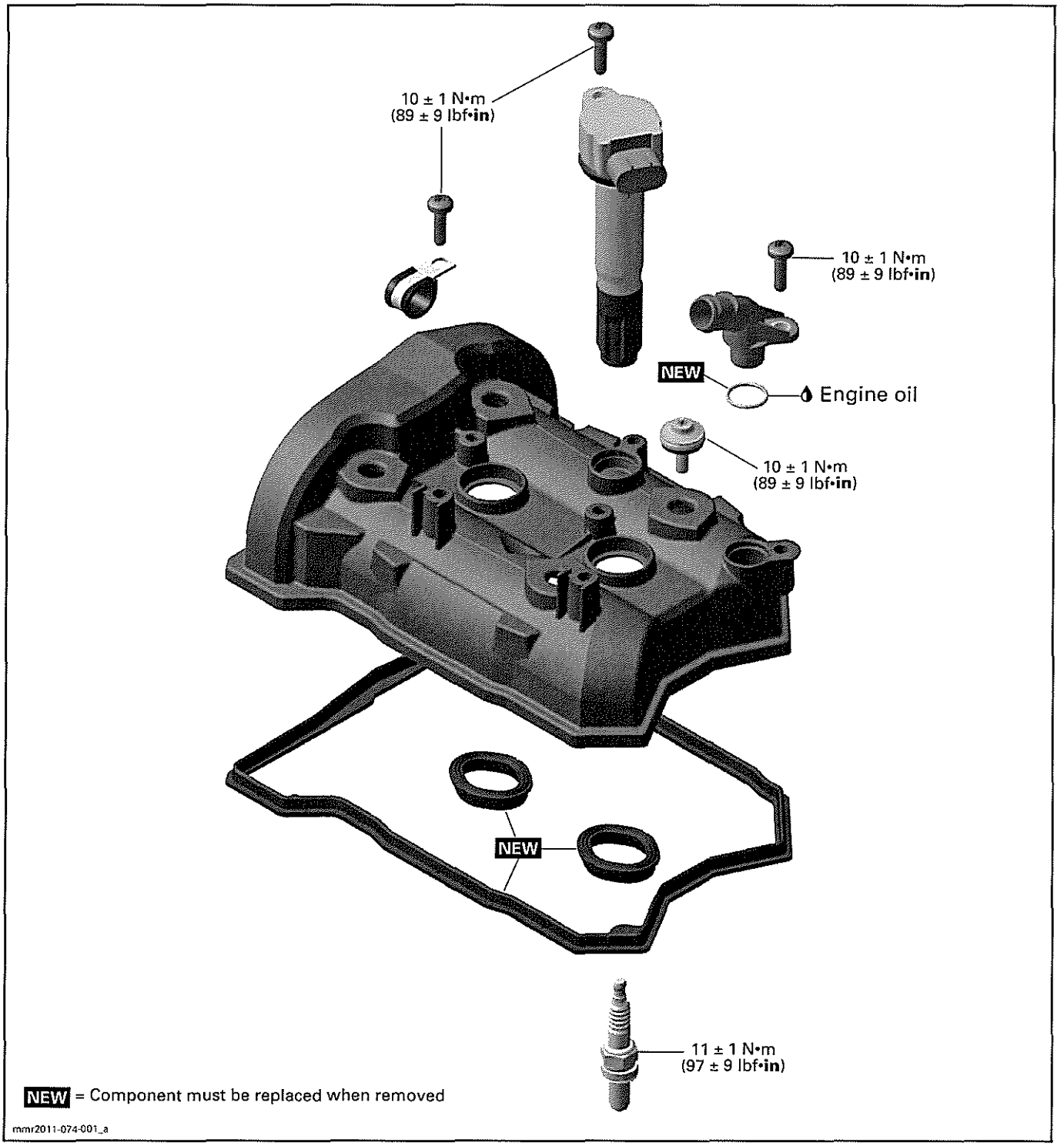
SERVICE TOOLS

Description	Part Number	Page
ENGINE LEAK DOWN TEST KIT	529 035 661	239
VALVE SPRING COMPRESSOR CUP	529 036 209	249
VALVE SPRING COMPRESSOR	529 035 724	249

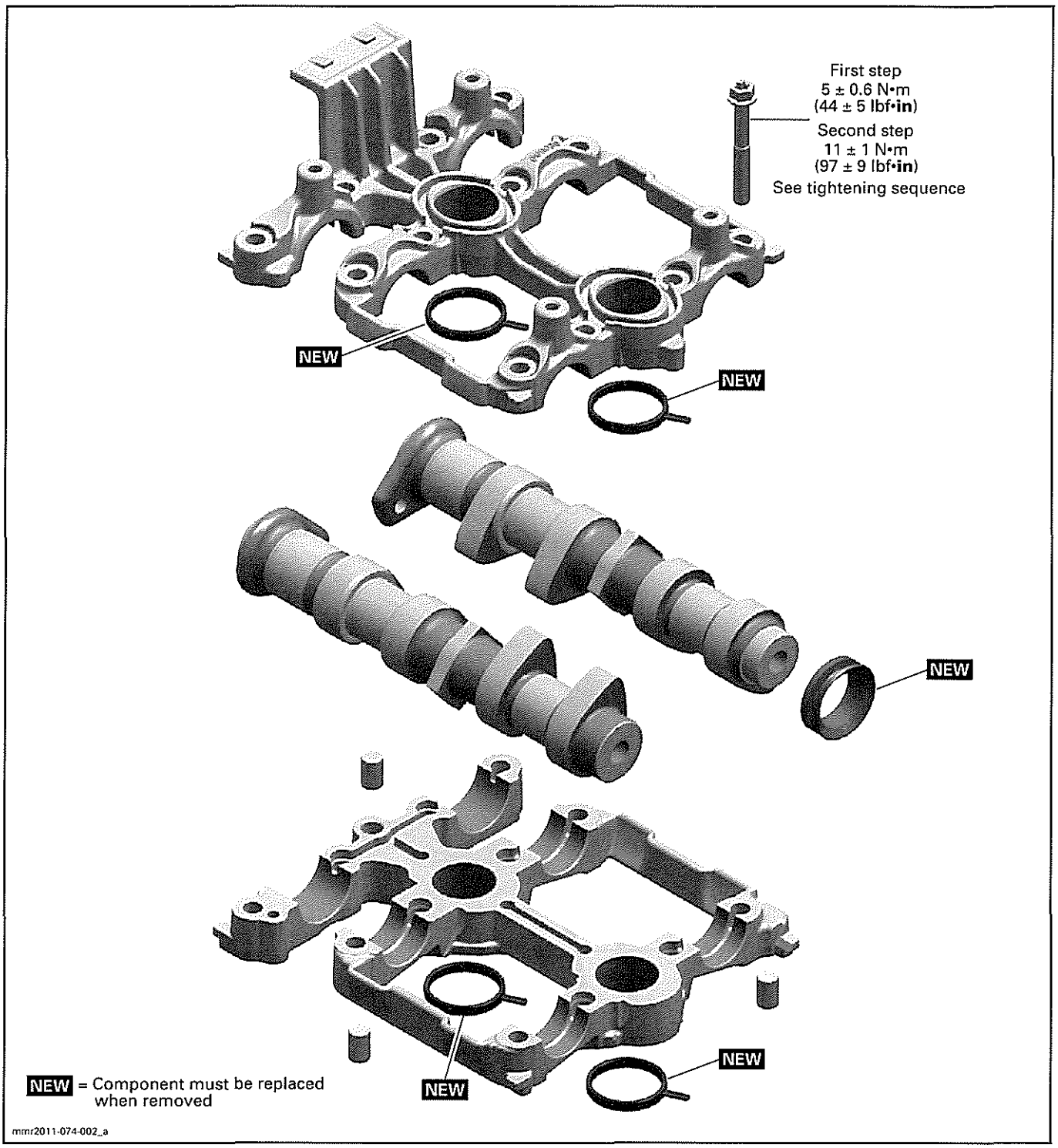
SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
SNAP-ON VALVE HOLDER	VL2	252
SNAP-ON VALVE STEM SEAL PLIERS	YA 8230	251

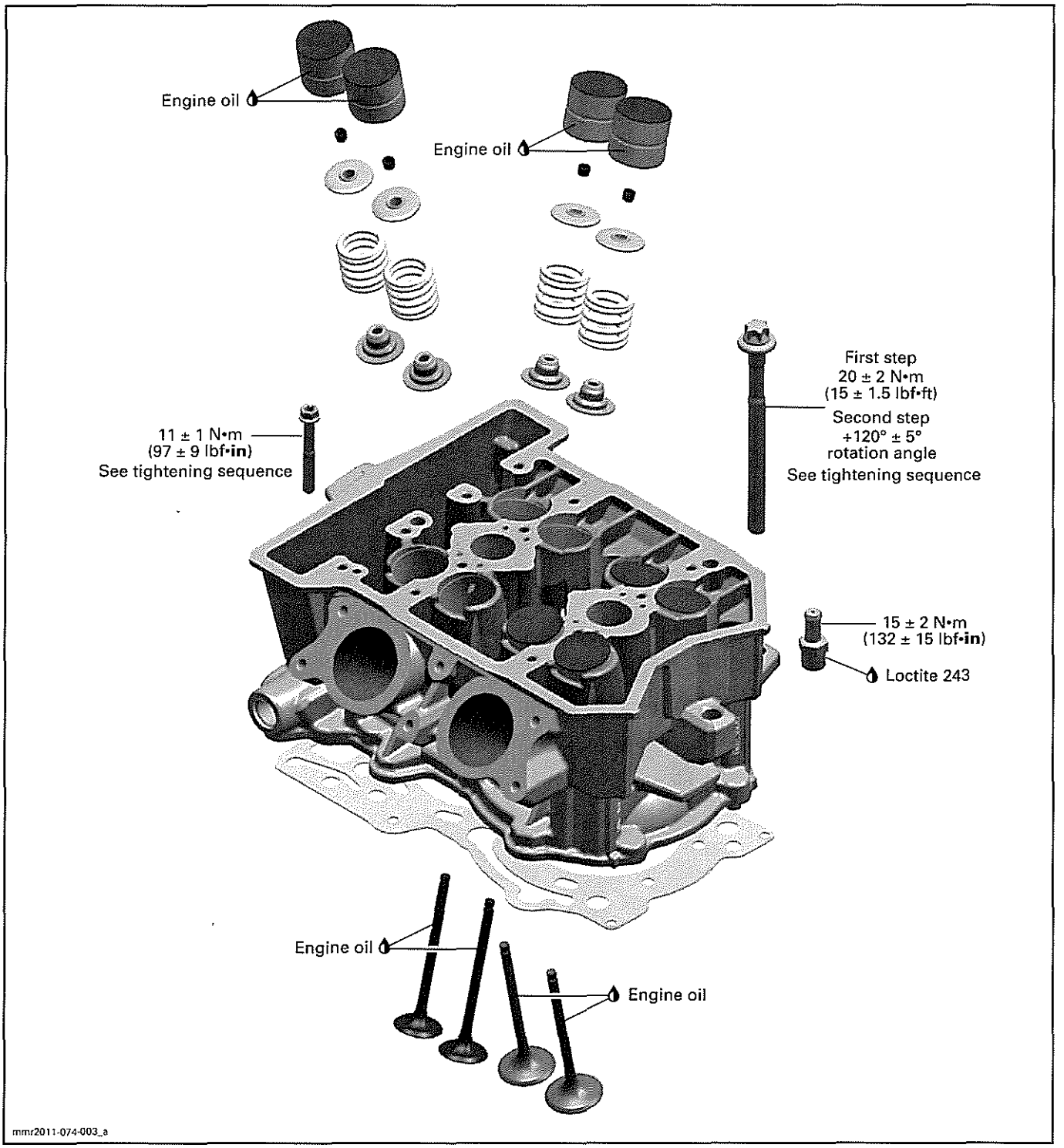
VALVE COVER


10 ± 1 N•m
(89 ± 9 lbf•in)
10 ± 1 N•m
(89 ± 9 lbf•in)
NEW
Engine oil
10 ± 1 N•m
(89 ± 9 lbf•in)
NEW
11 ± 1 N•m
(97 ± 9 lbf•in)
NEW = Component must be replaced when removed
mmr2011-074-001_a

CAMSHAFTS


First step
5 ± 0.6 N•m
(44 ± 5 lbf•in)
Second step
11 ± 1 N•m
(97 ± 9 lbf•in)
See tightening sequence
NEW
NEW
NEW
NEW
NEW
NEW = Component must be replaced when removed
mmr2011-074-002_a

CYLINDER HEAD



GENERAL

NOTE: For a better understanding, some illustrations are taken with engine out of the vehicle.

Always disconnect BLACK (-) cable from the battery, then RED (+) cable before working on the engine.

⚠ WARNING

Always disconnect BLACK (-) cable first and reconnect last.

During assembly/installation, use the torque values and service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices (e.g.: locking tabs, cotter pin, etc.) must be replaced.

Hoses, cables or locking ties removed during a procedure must be reinstalled as per factory standards.

When disassembling parts that are duplicated in the engine, (e.g.: valves, springs, etc.), it is strongly recommended to note their position and to keep the parts of the same assembly as a "group". If you find a defective component, it will be much easier to find the cause of the failure. Since parts were broke-in together during engine operation, they will maintain their matched fit when reassembled together within their "group".

INSPECTION

CYLINDER LEAK TEST

General

Before performing the cylinder leak test, verify the following:

- Clamp tightness
- Hoses condition.

NOTE: For best accuracy, the leak test should be done with the engine at normal operating temperature.

⚠ CAUTION Engine parts could be hot.

NOTE: The following steps are the same for each cylinder.

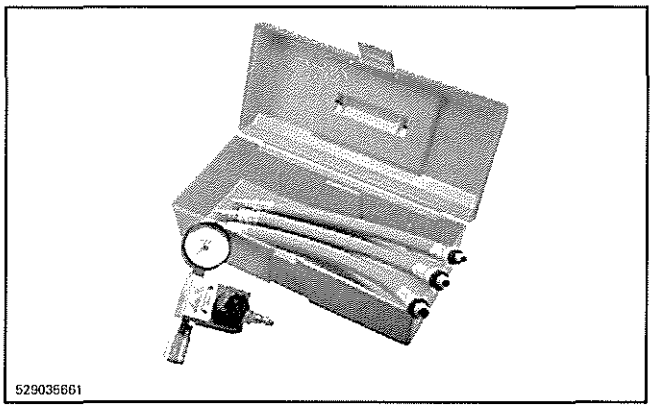
Preparation

1. Remove the *VALVE COVER*, see procedure in this subsection.
2. Remove spark plug.
3. Using the drive pulley, turn the engine counterclockwise to bring piston to TDC of compression stoke. Use a dial gauge or a suitable tool to position the piston to TDC.

NOTE: The piston must be set precisely to TDC of compression stroke. If not, the engine will continue to rotate when pressure builds up.

Leak Test

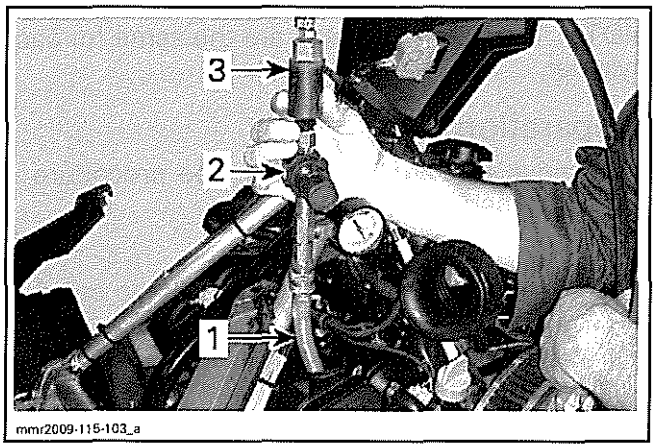
1. Install a gauge adaptor of the ENGINE LEAK DOWN TEST KIT (P/N 529 035 661) into spark plug hole.



2. Connect the leak down tester to an adequate air supply.
3. Set gauge needle to zero.

NOTE: All testers have specific instructions on gauge operation and required pressure. Refer to manufacturer's instructions.

4. Supply combustion chamber with air pressure.



TYPICAL
1. *Gauge adaptor*
2. *Leak tester*
3. *Air supply hose*

5. Note the amount or percentage of leakage (depending on tester).

LEAKAGE PERCENTAGE	ENGINE CONDITION
0% to 15%	Excellent condition
16% to 25%	Good condition
26% to 40%	Fair condition; reduced engine performance
41% and higher	Poor condition, diagnose and repair engine

Diagnosis

Listen for air leaks.
- Air escaping on intake port or throttle body means leaking intake valve(s).
- Air escaping on exhaust port means leaking exhaust valve(s).
- Air bubbles out of coolant tank means leaking cylinder head gasket.
- Air or coolant escaping from cylinder head means damaged gasket or loosened screws.
- Air escaping into crankcase area means excessively worn cylinder or broken piston rings.
- Air or oil escaping from crankcase means damaged gasket or loosened screws.

Repair Tips

Blue exhaust gas means damaged or worn piston rings or valve stem seals.

White exhaust gas means damaged cylinder head gasket.

Coolant tank cap opening without overheat means damaged cylinder head gasket.

Leaking valves can be caused by carbon deposits or burnt valve face.

Assembly

Reverse the preparation procedure.

TROUBLESHOOTING

Always check for fault codes. If a fault code is detected, service the fault code first. Refer to *DIAGNOSTIC AND FAULT CODES* subsection.

NOTE: When diagnosing an engine problem, always perform the cylinder leak test. This will help pinpoint a problem. Refer to *CYLINDER LEAK TEST* in this subsection.

UNUSUAL ENGINE NOISE OR VIBRATIONS

1. Discharged or defective valve lifters.
   - *Check engine oil pressure, refer to LUBRICATION SYSTEM.*
   - *Replace valve lifters.*
2. Camshaft(s) or camshaft holder(s) worn out.
   - *Check and replace damaged parts.*
3. Faulty chain tensioner.
   - *Replace chain tensioner. Refer to TIMING CHAIN subsection.*
4. Chain guide(s) worn out.
   - *Replace chain guide(s). Refer to TIMING CHAIN subsection.*
5. Stretched timing chain or worn out sprockets.
   - *Replace timing chain and sprockets. Refer to TIMING CHAIN subsection.*
6. Loose timing chain gear screws.
   - *Retighten screws with recommended torque.*
7. Incorrect camshaft timing.
   - *Replace damaged components and readjust camshaft timing.*

OIL LEAKAGE FROM CYLINDER HEAD

1. Leaking valve cover gasket.
   - *Replace valve cover gaskets and retighten valve cover with recommended torque.*
   - *Check valve cover for cracks or other damage.*
2. Leaking spark plug tube O-rings.
   - *Replace spark plug tube O-rings.*
   - *Clean spark plug area from oil spillage.*
3. Blow-by connector is leaking.
   - *Replace blow by connector O-ring.*

4. Leaking cylinder head gasket.
   - *Check cylinder head for damage.*
   - *Replace cylinder head gasket and retighten screws with recommended torquing procedure.*

ENGINE SUDDENLY TURNS OFF OR LACKS ACCELERATION OR POWER

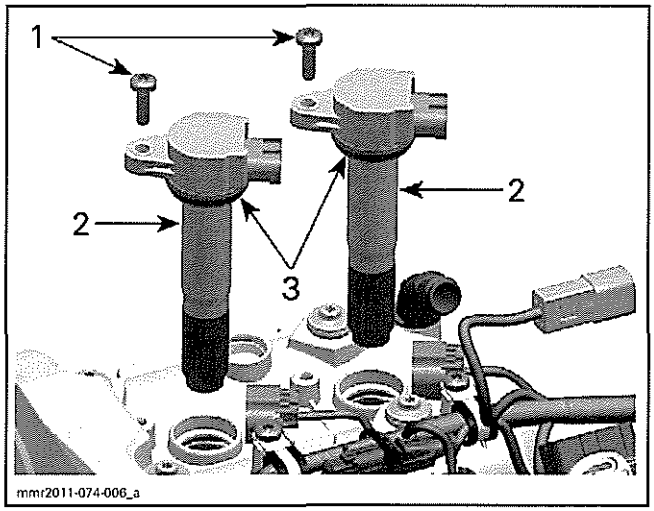
1. Incorrect camshaft timing.
   - *Replace damaged components and readjust camshaft timing.*
2. Leaking intake or exhaust valves.
   - *Perform a CYLINDER LEAK TEST. Repair or replace damaged components.*
3. Broken valve spring(s).
   - *Replace defective parts.*

PROCEDURES

VALVE COVER

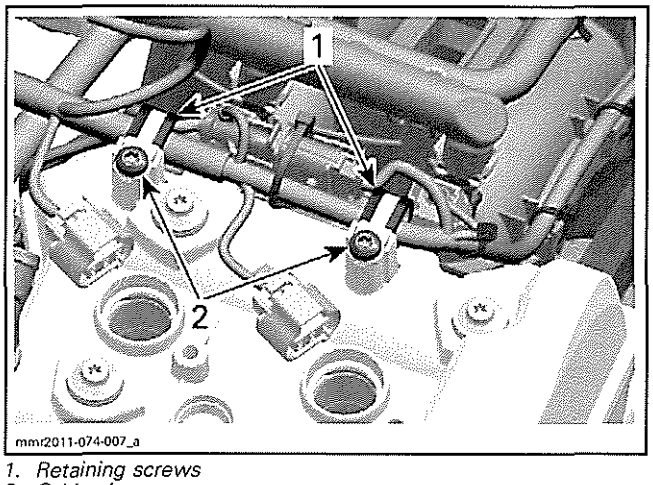
Valve Cover Removal (In Vehicle)

1. Remove the air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.
2. Unplug ignitions coils.
3. Remove ignition coils with gaskets.



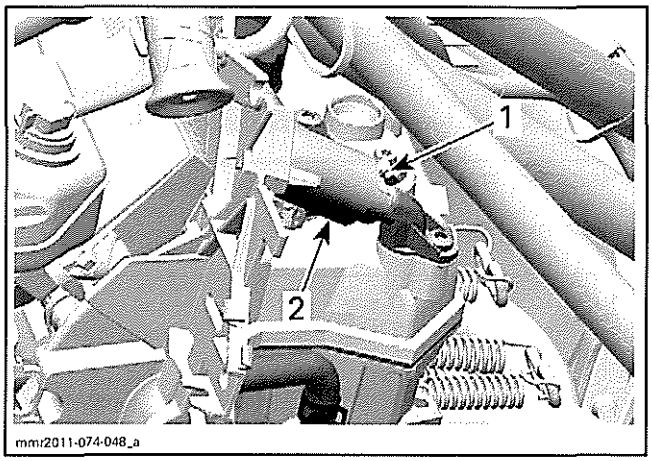
1. *Retaining screws*
2. *Ignition coils*
3. *Gaskets*

4. Remove screws securing the electrical harness to valve cover.



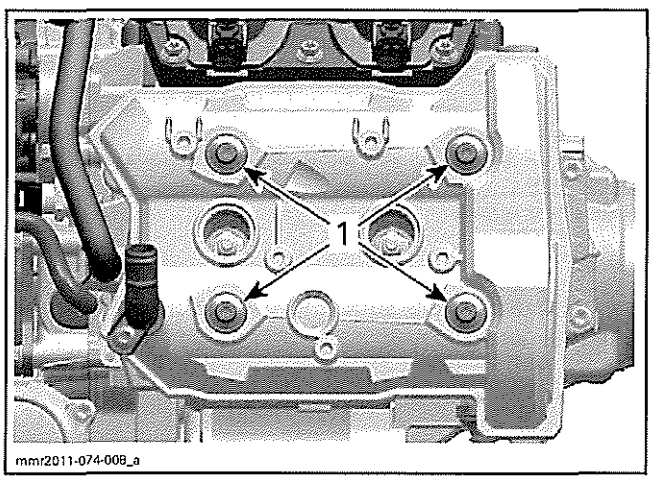
1. *Retaining screws*
2. *Cable clamps*

5. Unplug both fuel injectors.
6. Disconnect vent tube from the blow-by-connector.



1. *Clamp*
2. *Vent tube*

7. Remove valve cover retaining screws.

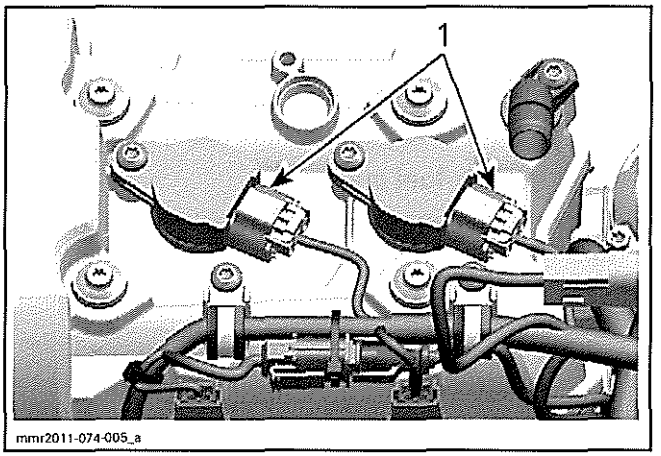


1. *Valve cover retaining screws*

8. Pull valve cover off the cylinder head.
9. Tilt the front of valve cover towards the exhaust manifold.
10. Remove valve cover by the LH side of the vehicle.

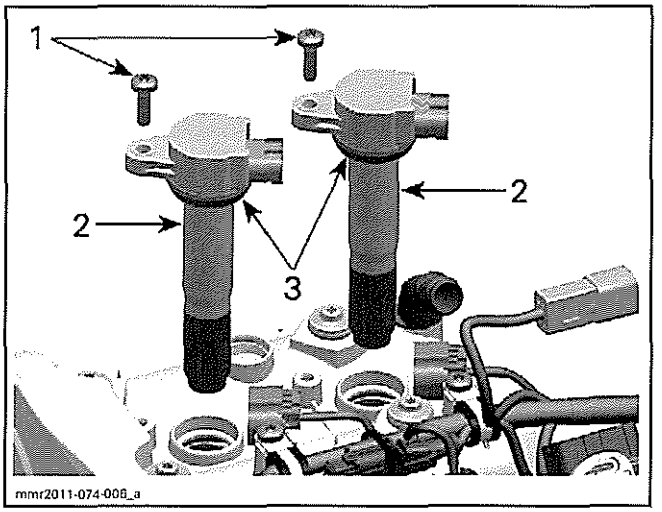
Valve Cover Removal (Engine Removed)

1. Unplug ignition coils.



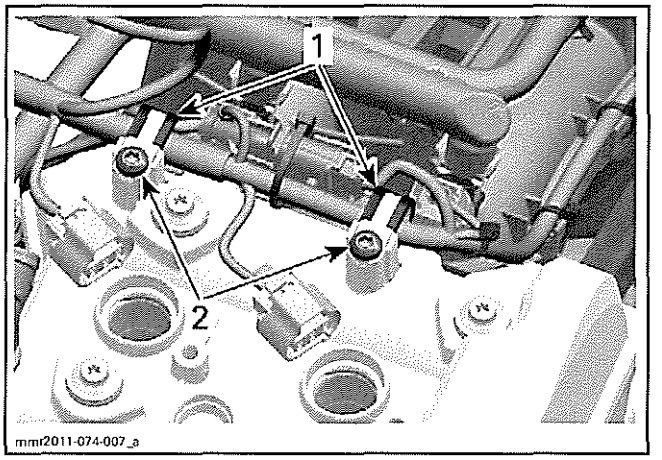
1. Ignition coil connectors

2. Remove ignition coils with gaskets.



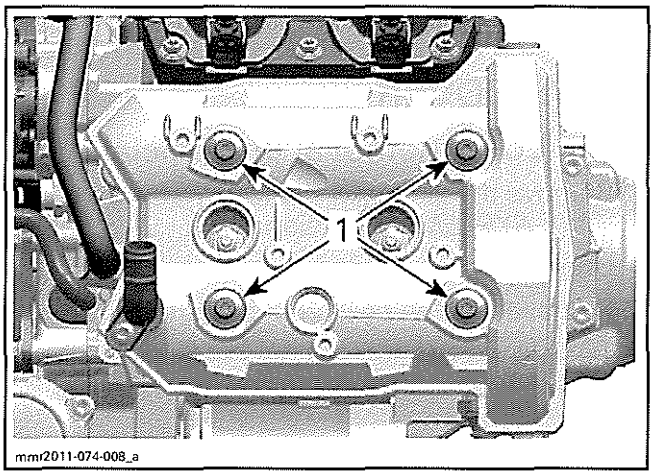
1. Retaining screws
2. Ignition coils
3. Gaskets

3. Remove screws securing the electrical harness to the valve cover.



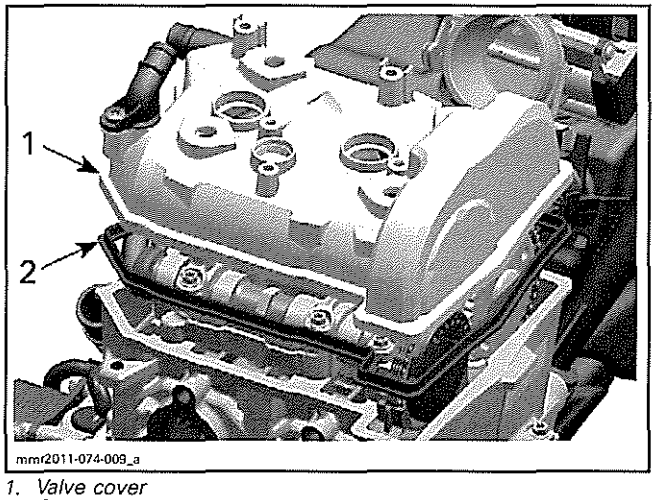
1. Retaining screws
2. Cable clamps

4. Remove valve cover retaining screws.



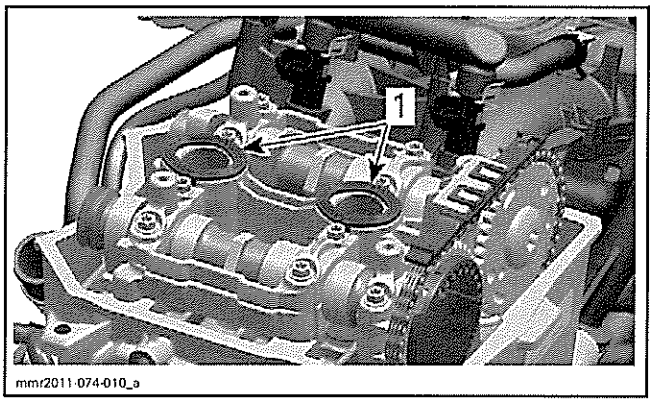
1. Valve cover screws

5. Remove the valve cover and its gasket.



1. Valve cover
2. Gasket

6. Remove valve cover small gaskets (spark plug tubes).



1. Small gaskets

Valve Cover Inspection

Check the valve cover for cracks or other damage.

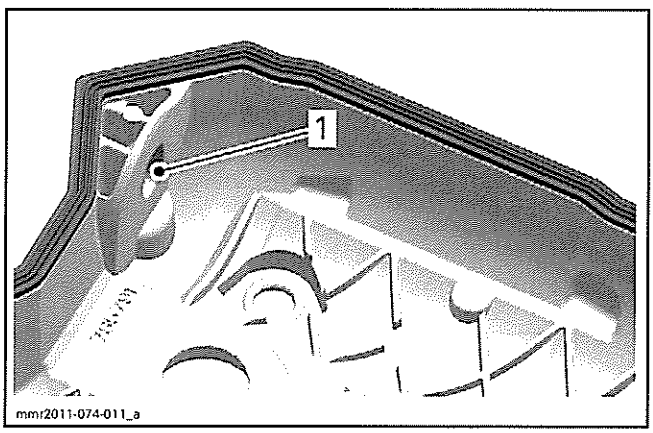
Check if the valve cover gaskets are brittle, hard or otherwise damaged.

Replace defective parts.

Valve Cover Installation

For installation reverse the removal procedure. However, pay attention to the following details.

1. Properly fit the small gaskets into the camshaft holder grooves.
2. Properly fit the large gasket into the valve cover groove.
3. Apply engine oil to the sealing surface of the V-ring.

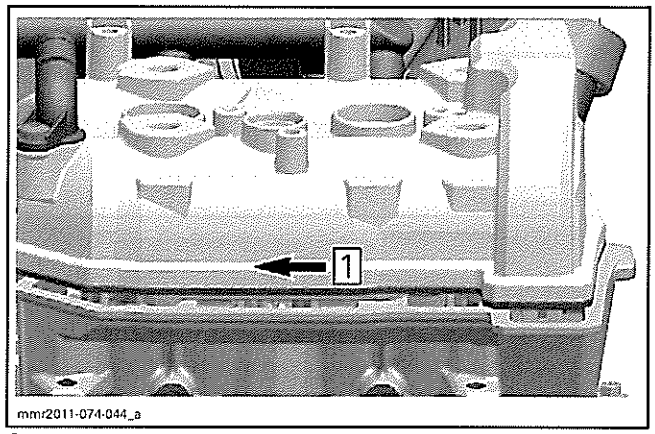


INSIDE VALVE COVER
1. Apply engine oil here

4. If engine is not in the vehicle, slide the valve cover inside engine compartment by the LH side of the vehicle.
5. Install valve cover.

NOTICE Adhere to the following procedure, otherwise damage to the V-ring will occur causing crankcase venting malfunction.

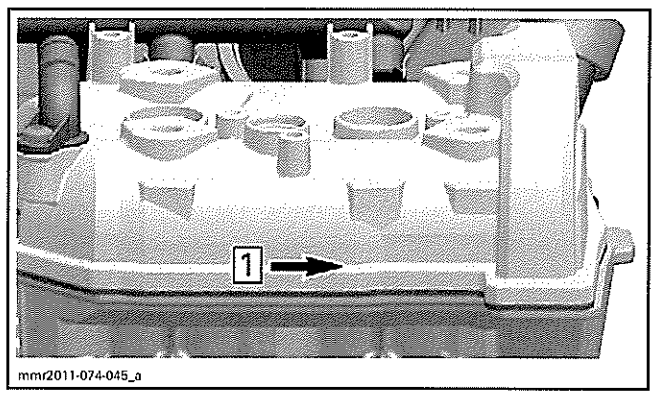
5.1 Move the valve cover towards the MAG side.



Step 1: Move valve cover towards MAG side

5.2 Put valve cover onto cylinder head.

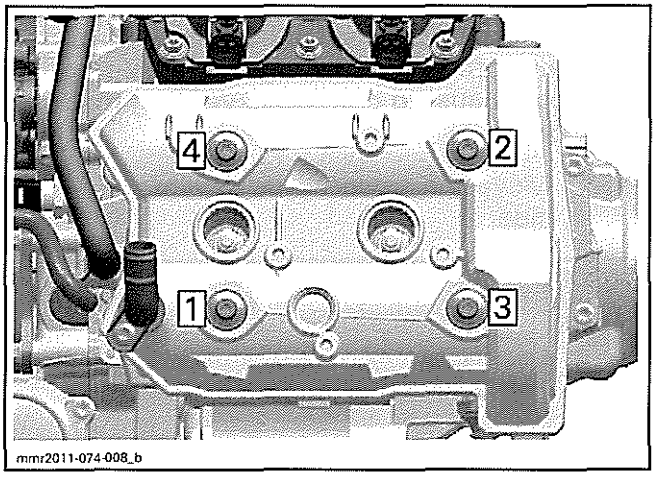
5.3 Push valve cover towards the PTO side to ensure that the V-ring properly seals on sealing surface inside the cover.



1. Push valve cover towards PTO side

6. Install valve cover screws and tighten as follows:

VALVE COVER SCREWS TIGHTENING TORQUE
10 N•m ± 1 N•m (89 lbf•**in** ± 9 lbf•**in**)



TIGHTENING SEQUENCE

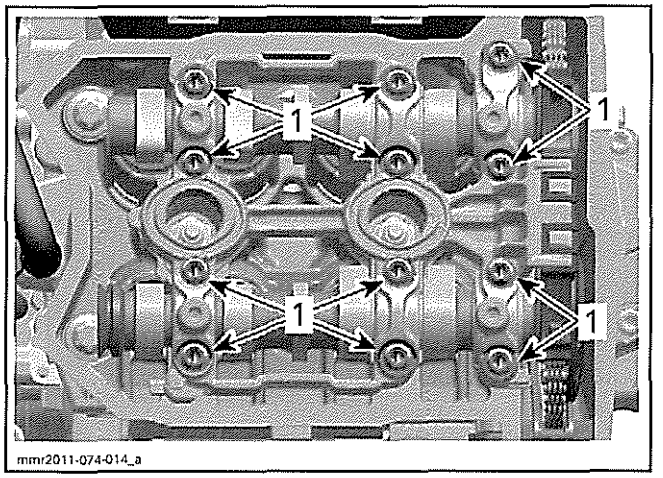
CAMSHAFTS

Camshaft Removal

1. Remove *VALVE COVER*, see procedure in this subsection.

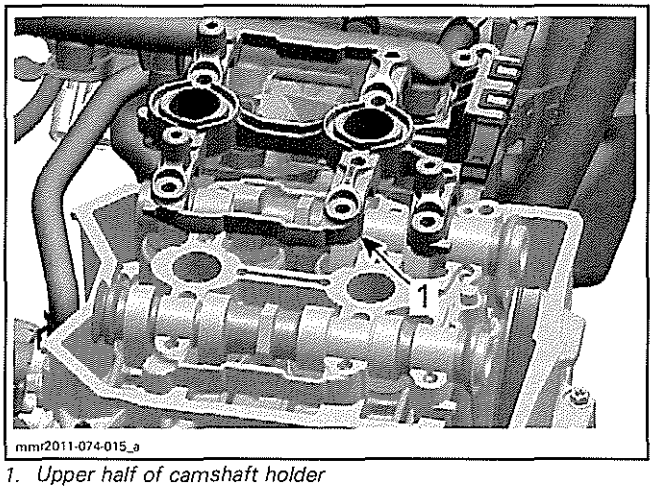
Refer to *TIMING CHAIN* subsection and remove:
- Timing chain tensioner
- Timing chain gears.

2. Remove camshaft holder retaining screws (12).



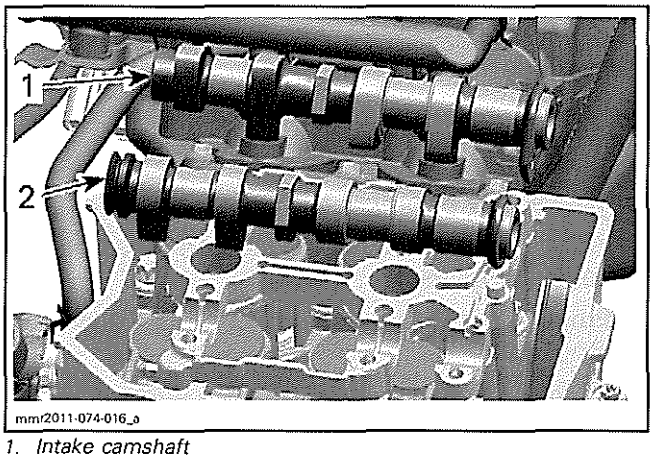
1. Camshaft holder retaining screws

3. Remove the camshaft holder upper half.



1. Upper half of camshaft holder

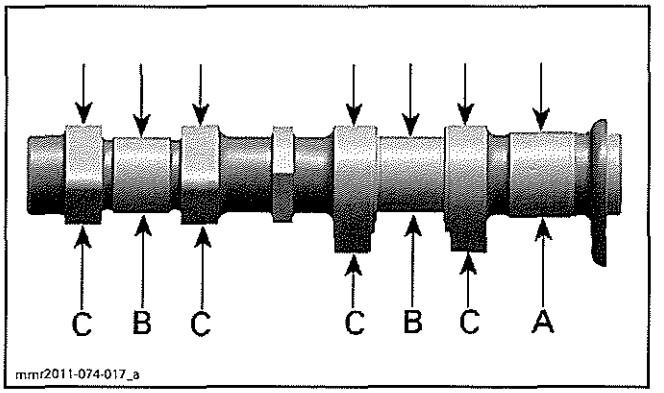
4. Remove camshafts.



1. Intake camshaft
2. Exhaust camshaft

Camshaft Inspection

1. Check each lobe and bearing journal for scoring, scuffing, cracks, or other signs of wear.
2. Check V-ring if it is brittle, hard or otherwise damaged.
3. Measure camshaft bearing journal diameter and lobe height, using a micrometer.



A. Camshaft journal (PTO)
B. Camshaft journal (center and MAG)
C. Camshaft lobes

CAMSHAFT JOURNAL DIAMETER	
PTO JOURNAL	
NEW	25.947 mm to 25.960 mm (1.0215 in to 1.022 in)
SERVICE LIMIT	25.92 mm (1.0205 in)
CENTER AND MAG JOURNAL	
NEW	22.947 mm to 22.960 mm (.9034 in to .9039 in)
SERVICE LIMIT	22.92 mm (.902 in)

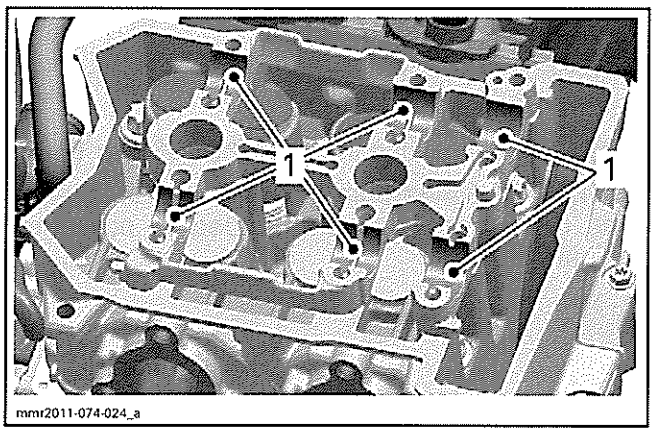
CAMSHAFT LOBE HEIGHT	
INTAKE CAMSHAFT	
NEW	38.70 mm to 38.90 mm (1.524 in to 1.531 in)
SERVICE LIMIT	38.67 mm (1.522 in)
EXHAUST CAMSHAFT	
NEW	39.40 mm to 39.60 mm (1.551 in to 1.559 in)
SERVICE LIMIT	39.38 mm (1.55 in)

Replace parts if necessary.

Camshaft Installation

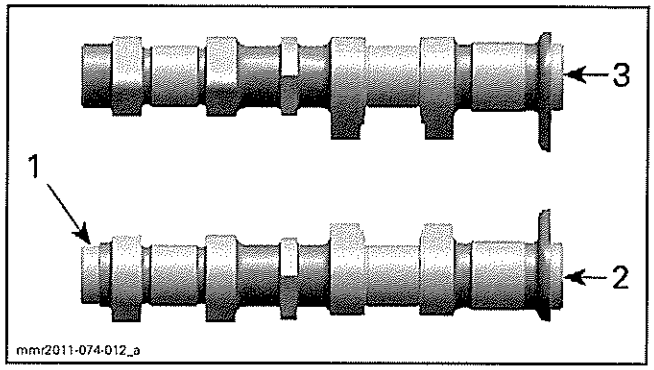
The assembly is the reverse of the removal procedure. However pay attention to the following details.

1. Before assembly of the camshafts apply engine oil on camshaft bearings.



1. Areas where to apply engine oil

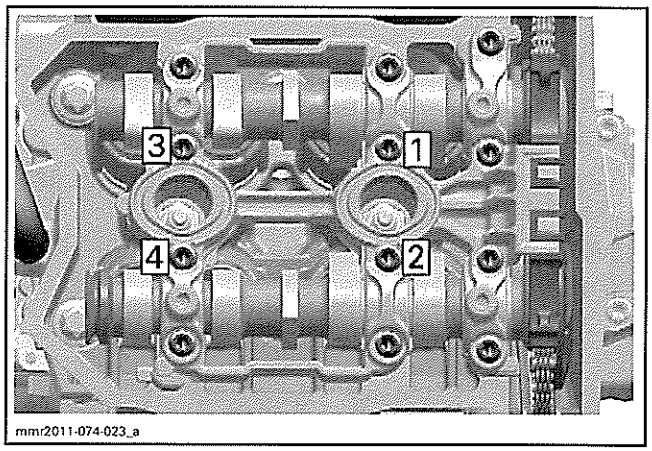
NOTE: The camshafts are not identical. Any mix-up of the components would lead to engine damage. The exhaust camshaft has a machined area on MAG side for the V-ring.



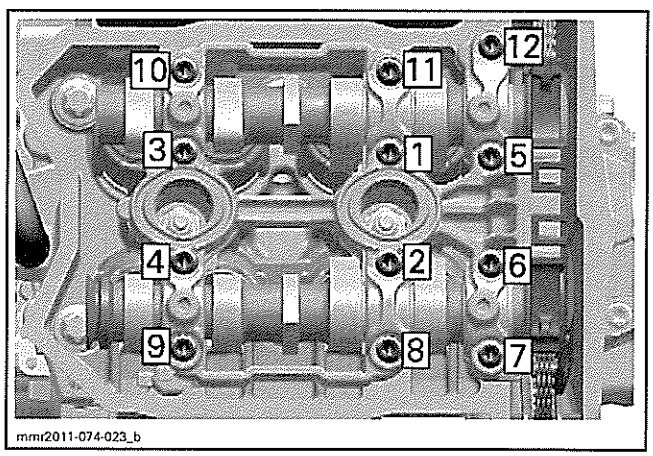
1. Machined area
2. Exhaust camshaft
3. Intake camshaft

2. Install the camshaft holder upper half, then tighten screws as follows:

CAMSHAFT HOLDER TIGHTENING TORQUE	
First Step	5 N•m ± 0.5 N•m (44 lbf•**in** ± 4 lbf•**in**)
Second Step	11 N•m ± 1 N•m (97 lbf•**in** ± 9 lbf•**in**)



CAMSHAFT HOLDER TIGHTENING SEQUENCE - FIRST STEP



CAMSHAFT HOLDER TIGHTENING SEQUENCE - SECOND STEP

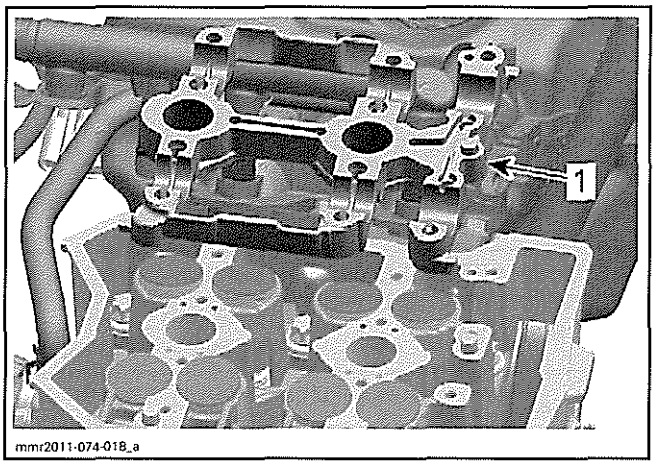
NOTE: After the reassembly of the camshafts is completed, check if camshafts can be turned.

CAMSHAFT HOLDER

Camshaft Holder Removal

Remove camshaft, see procedure in this subsection.

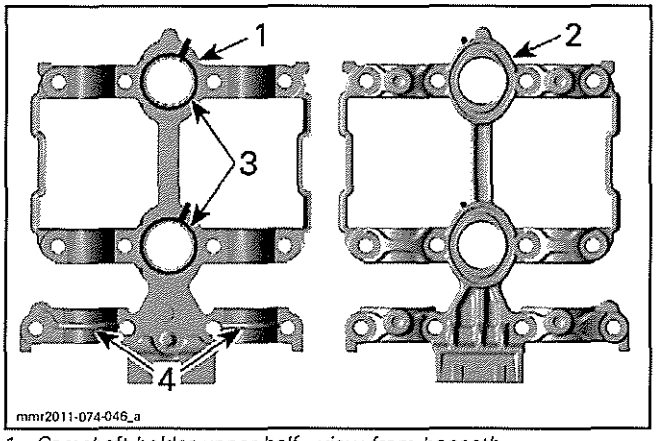
Remove the camshaft holder lower half and gaskets from cylinder head.



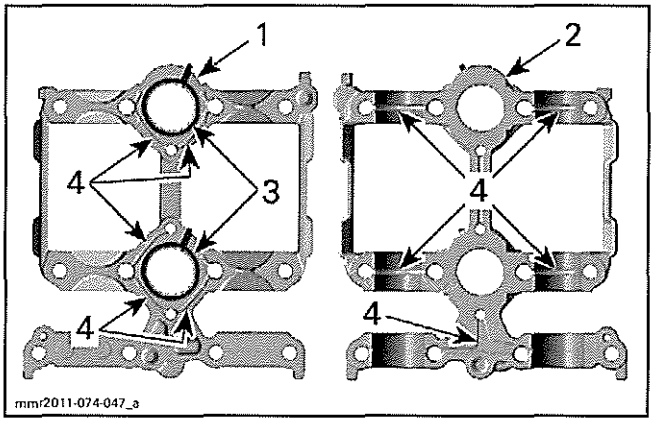
1. Lower camshaft holder

Camshaft Holder Inspection

1. Check camshaft holder for scoring, scuffing, cracks, or other signs of wear.
2. Check gasket if brittle hard or damaged. Replace if necessary
3. Make sure oil orifices are not clogged. Blow them with pressurized air.



1. Camshaft holder upper half - view from beneath
2. Camshaft holder upper half - view from above
3. Gaskets
4. Oil orifices



1. Camshaft holder lower half - view from beneath
2. Camshaft holder lower half - view from above
3. Gaskets
4. Oil orifices

Replace parts if necessary.

Camshaft Holder Installation

Install camshaft holder lower half.

Continue procedure as explained in *CAMSHAFT INSTALLATION* in this subsection.

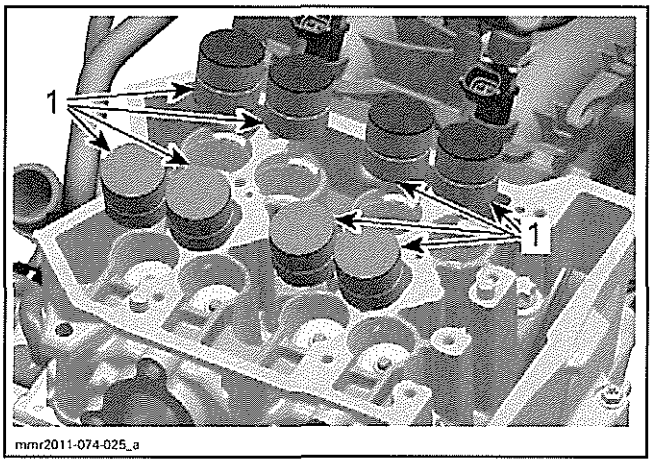
HYDRAULIC VALVE LIFTERS

Hydraulic Valve Lifter Removal

NOTE: Hydraulic valve lifter are maintenance free.

1. Remove valve cover, see procedure in this subsection.
2. Remove timing chain gears, refer to *TIMING CHAIN* subsection.
3. Remove camshafts, see procedure in this subsection.
4. Remove camshaft holder, see procedure in this subsection.
5. Pull hydraulic valve lifter off the cylinder head.

NOTE: When disassembling the hydraulic valve lifter, it is strongly recommended to note their original position.



1. Hydraulic valve lifter

Hydraulic Valve Lifter Inspection

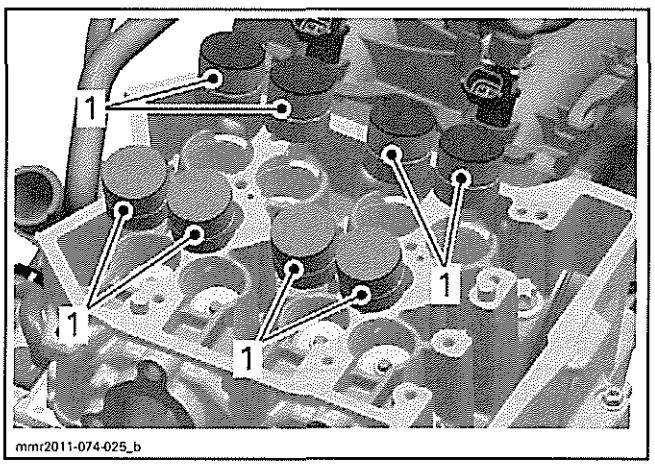
1. Check surface of hydraulic valve lifter for scoring or other damage.
2. Measure valve lifter diameter. Replace if out of specification.

HYDRAULIC VALVE LIFTER	
NEW	28.354 mm to 28.370 mm (1.1163 in to 1.1169 in)
SERVICE LIMIT	28.34 mm (1.1157 in)
HYDRAULIC VALVE LIFTER RADIAL CLEARANCE	
SERVICE LIMIT	0.100 mm (.0039 in)

Hydraulic Valve Lifter Installation

For installation reverse the removal procedure. However pay attention to the following details.

1. Apply engine oil on the outside diameter of the hydraulic valve lifter.

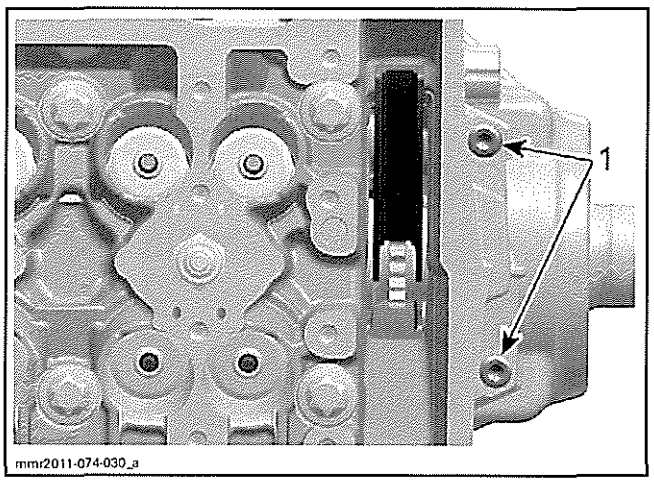


1. Apply engine oil on outer diameter

CYLINDER HEAD

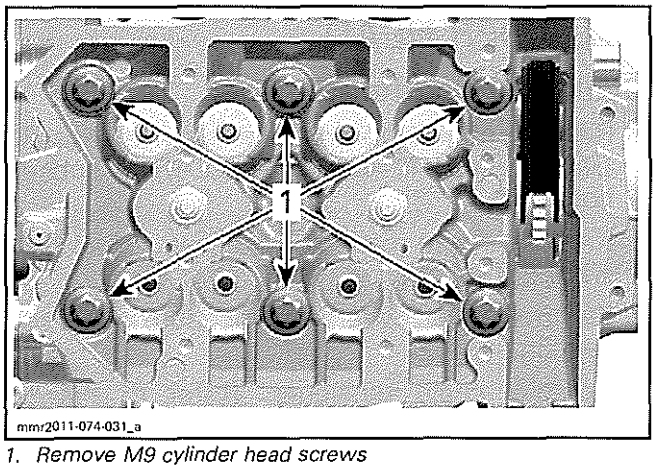
Cylinder Head Removal

1. Remove engine from the vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
2. Remove intake manifold. Refer to *AIR INTAKE SYSTEM* subsection.
3. Remove valve cover. See procedure in this subsection.
4. Remove chain tensioner. Refer to *TIMING CHAIN REMOVAL* subsection.
5. Remove the camshaft timing gears. Refer to *TIMING CHAIN* subsection.
6. Remove camshafts. See procedure in this subsection.
7. Remove camshaft holder. See procedure in this subsection.
8. Remove hydraulic valve lifters. See procedure in this subsection.
9. Remove M6 cylinder head screws.



1. Remove M6 cylinder head screws

10. Remove and discard M9 cylinder head screws.

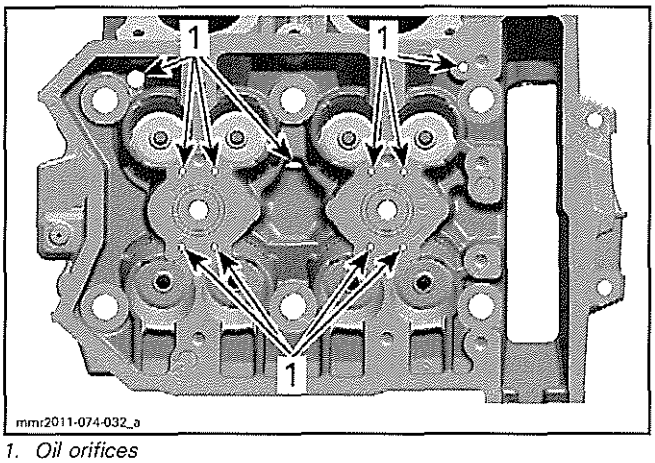


1. Remove M9 cylinder head screws

11. Pull cylinder head off the cylinder block.
12. Remove and discard cylinder head gasket.

Cylinder Head Cleaning

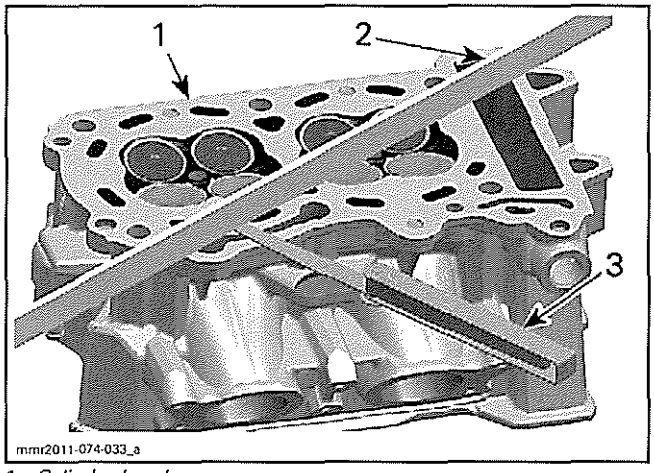
1. Remove carbon deposits from combustion chambers, exhaust ports and piston tops.
2. Clean cylinder head, especially cylinder head screw surface from oil spillage.
3. Blow the oil orifices pressurized air and make sure they are not clogged.



1. Oil orifices

Cylinder Head Inspection

1. Check for cracks between valve seats or other damage, if so, replace cylinder head.
2. Check cylinder head mating surface for flatness using a straight edge.
3. Check hydraulic valve lifter bores for scoring or other damage, if so, replace cylinder head.



1. Cylinder head
2. Straight edge
3. Feeler gauge

Check cylinder head warpage.

CYLINDER HEAD WARPAGE	
Maximum	0.15 mm (.0059 in)

If warpage exceeds specification, resurface the cylinder head as follows.

Use a 400 - 600 grit wet sandpaper on a surface plate and gently grind off the mating surface.

NOTE: To ensure an even surface, rotate cylinder head several times during resurfacing.

Replace cylinder head, if resurfacing fails.

Cylinder Head Installation

For installation, reverse the removal procedure. However, pay attention to the following details.

1. Install a NEW cylinder head gasket.

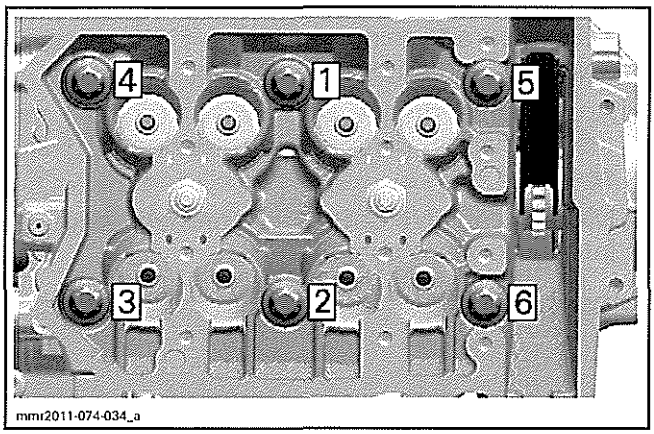
NOTICE **Each installation of the cylinder head requires a NEW cylinder head gasket. Using a gasket twice would cause engine damage.**

2. Install cylinder head on the cylinder block.
3. Install NEW M9 cylinder head screws.

NOTICE **This assembly uses stretch screws. Always use NEW screws and strictly adhere to the tightening procedure.**

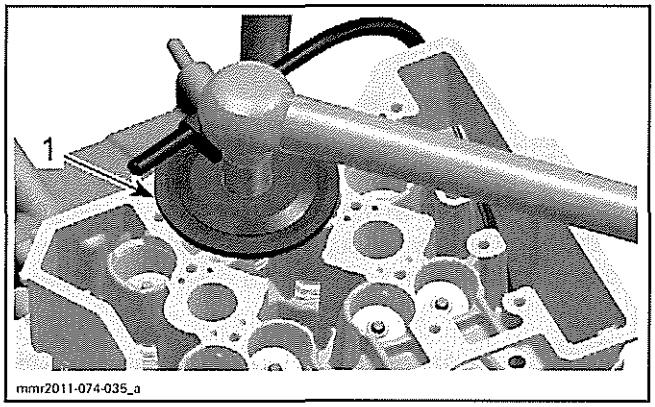
4. Tighten cylinder head screws as follows:

CYLINDER HEAD M9 SCREWS TIGHTENING TORQUE	
First step	20 N•m ± 2 N•m (15 lbf•ft ± 1 lbf•ft)
Second step	Additional 120° ± 5°



M9 SCREWS TIGHTENING SEQUENCE

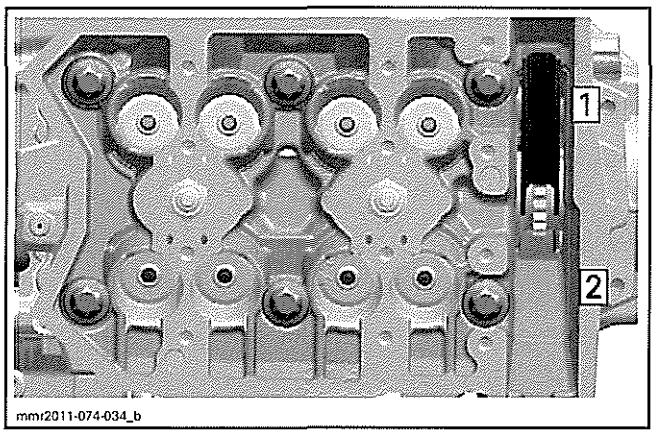
NOTE: Use a torque angle gauge to carry out the second step.



1. Torque angle gauge

5. Install M6 screws. Tighten as follows.

CYLINDER HEAD M6 SCREWS TIGHTENING TORQUE
11 N•m ± 1 N•m (97 lbf•**in** ± 9 lbf•**in**)

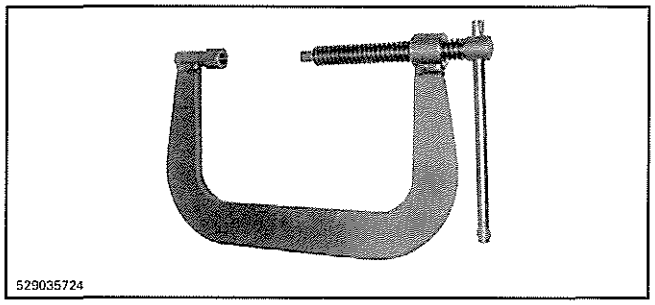


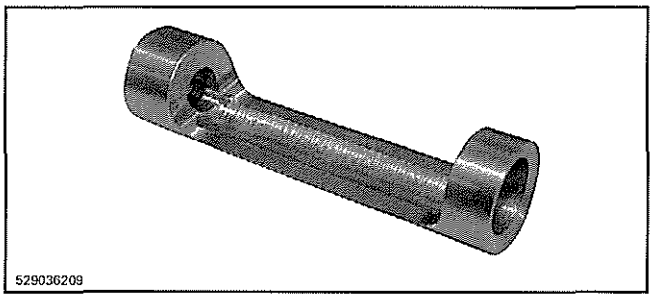
M6 SCREWS TIGHTENING SEQUENCE

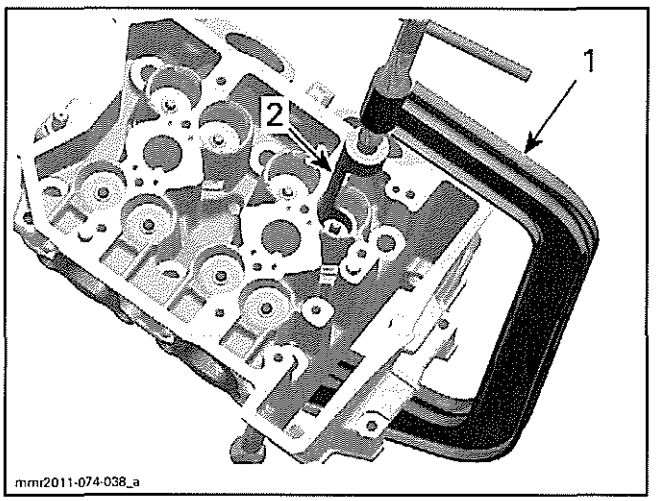
VALVE SPRINGS

Valve Spring Removal

1. Remove *CYLINDER HEAD*, see procedure in this subsection.
2. Compress valve spring, using the VALVE SPRING COMPRESSOR (P/N 529 035 724) and the VALVE SPRING COMPRESSOR CUP (P/N 529 036 209).

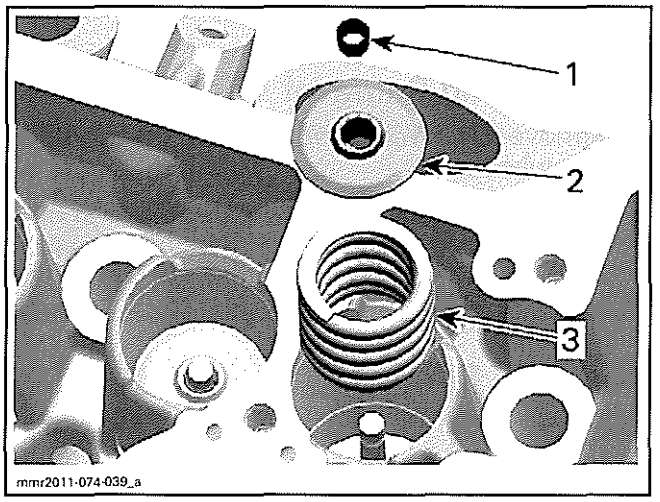






1. Valve spring compressor clamp
2. Valve spring compressor cup

3. Remove valve cotters.
4. Withdraw valve spring compressor tools.
5. Remove valve spring retainer and valve spring.

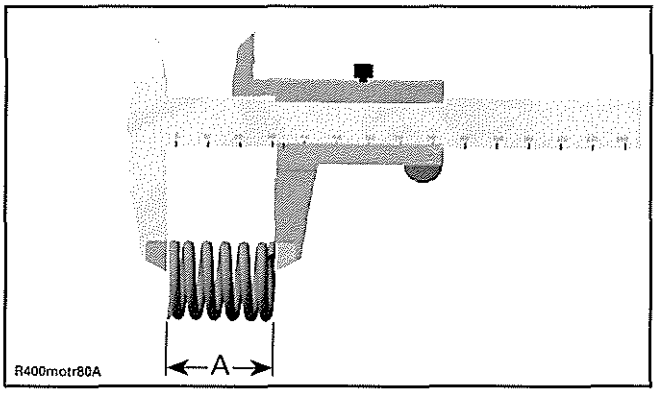


1. Valve cotters
2. Valve spring retainer
3. Valve spring

NOTE: Identify the position of each part very carefully, so it can be reinstalled in its original place.

Valve Spring Inspection

1. Check valve spring for rust, corrosion or other visible damage.
2. Check valve spring free length and straightness.



A. Spring free length

VALVE SPRING FREE LENGTH	
NEW	31.35 mm (1.2343 in)
SERVICE LIMIT	29.5 mm (1.1614 in)

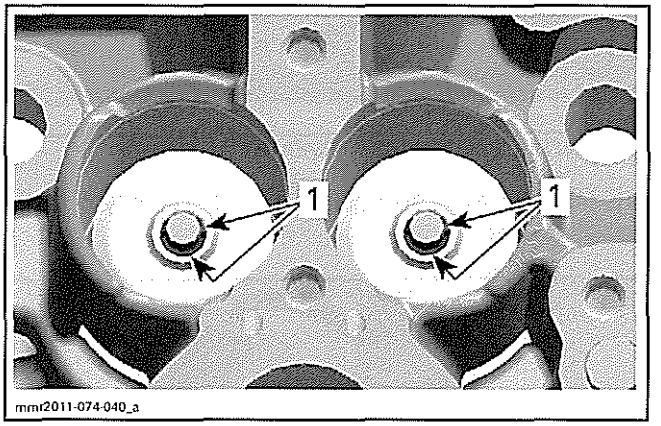
Replace valve spring, if out of specification.

Valve Spring Installation

For installation, reverse the removal procedure. Pay attention to the following details.

NOTE: Ensure to reinstall all parts in their original position as marked during removal.

1. Apply some grease on valve cotters, so that they remain in place while releasing the valve spring.
2. Make sure valve cotters are properly engaged into valve stem groove.



1. Valve cotters

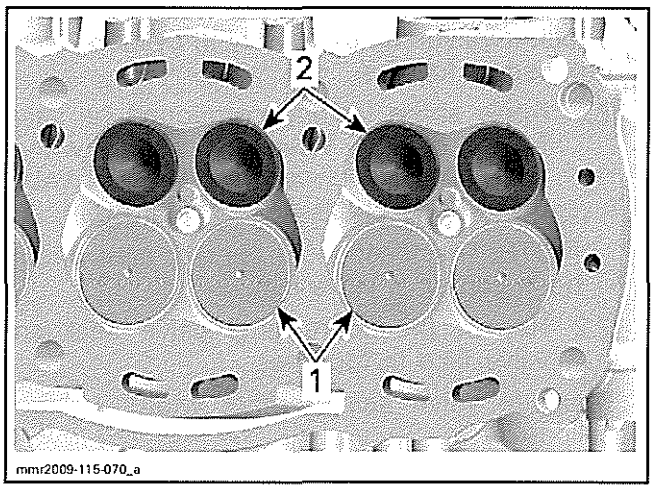
3. After spring is installed, ensure it is properly locked by lightly tapping on valve stem end with a soft hammer so that valve opens and closes a few times.

NOTICE Improperly locked valve spring will cause severe engine damage and hitting the valve stem end with excessive force could damage the valve.

VALVES

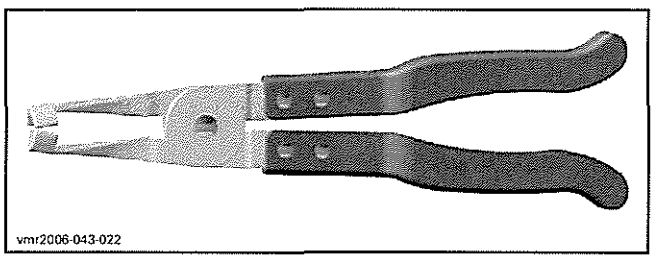
Valve Removal

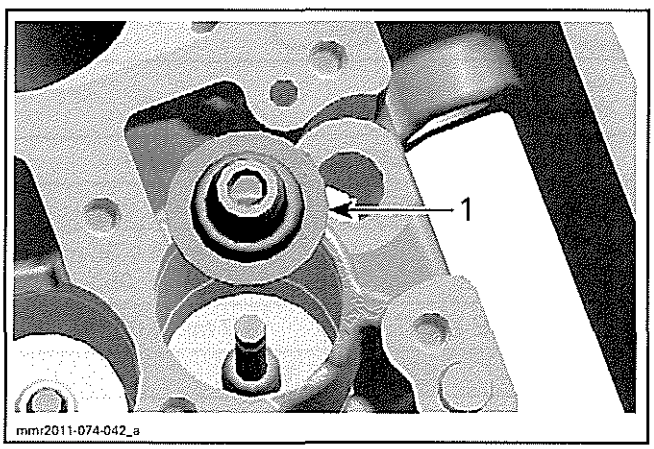
1. Remove *VALVE SPRING*, see procedure in this subsection.
2. Push on the valve stem, then pull valves out of cylinder head.



1. Intake valves 29 mm
2. Exhaust valves 25 mm

3. Remove and discard valve stem seal with special pliers such as the SNAP-ON VALVE STEM SEAL PLIERS (P/N YA 8230).



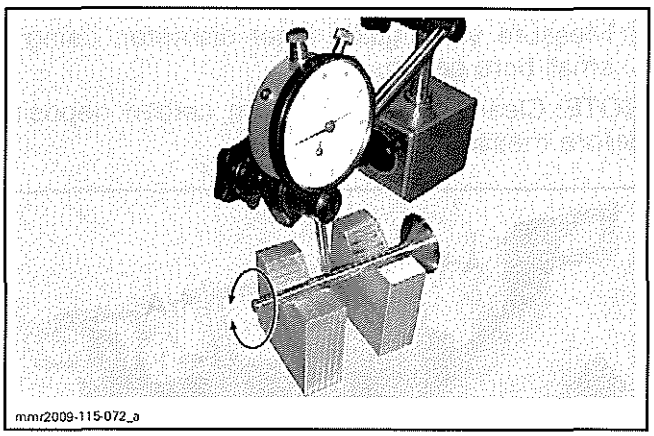


1. Valve stem seal

NOTE: Identify the position of each part very carefully, so it can be reinstalled in its original place.

Valve Inspection

Inspect valve surface, check for abnormal stem wear and bending.

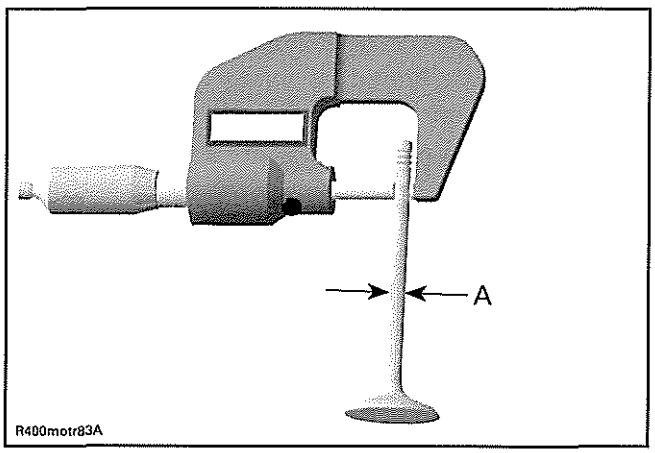


VALVE OUT OF ROUND INTAKE AND EXHAUST VALVE	
NEW	0.005 mm (.0002 in)
SERVICE LIMIT	0.06 mm (.0024 in)

Replace valve if out of specification.

Valve Stem and Valve Guide Clearance

1. Measure valve stem at three places, using a micrometer.



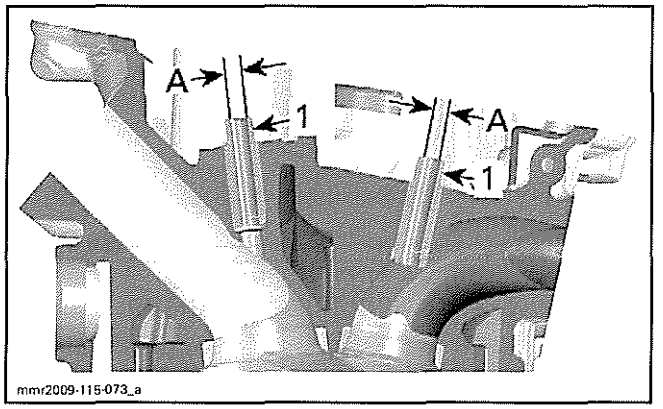
A. Valves stem diameter

VALVE STEM DIAMETER	
INTAKE VALVE	
NEW	4.958 mm to 4.972 mm (.1952 in to .1957 in)
SERVICE LIMIT	4.94 mm (.1945 in)
EXHAUST VALVE	
NEW	4.956 mm to 4.970 mm (.1951 in to .1957 in)
SERVICE LIMIT	4.94 mm (.1945 in)

Replace valve if stem is out of specification or if its surface is damaged or worn.

2. Measure valve guide inner diameter, using a small bore gauge.

NOTE: Clean valve guide from carbon deposits before measuring.

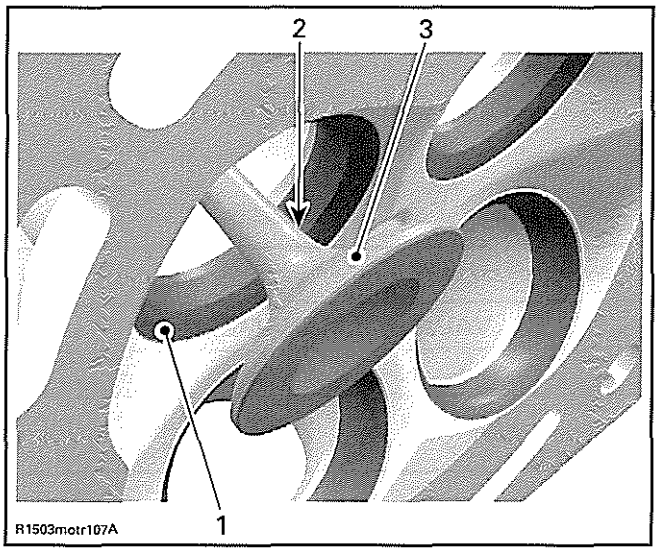


1. Valve guides
A. Valve guide inner diameter

VALVE GUIDE INNER DIAMETER	
NEW	5.000 mm to 5.012 mm (.1969 in to .1973 in)
SERVICE LIMIT	5.05 mm (.1988 in)

Replace cylinder head, if valve guide is out of specification.

Valve Face and Seat

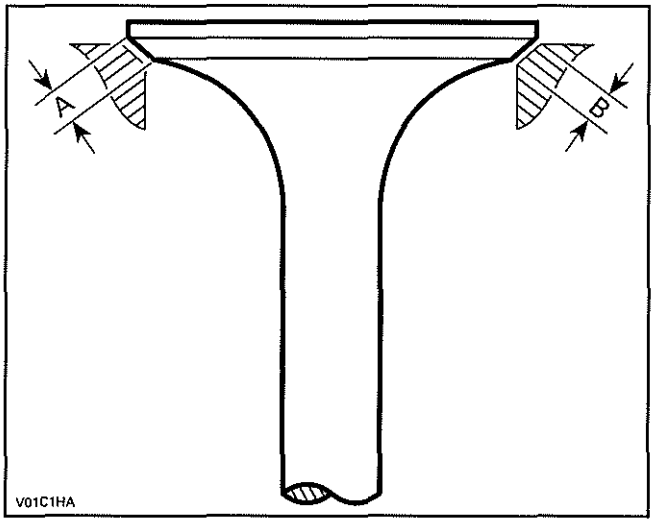


TYPICAL
1. Valve seat
2. Exhaust valve contaminated area
3. Valve face (contact surface to valve seat)

1. Check valve face and seat for burning, pitting and other signs of damage.
2. Check if valve seats properly in cylinder head. Proceed as follows.
   2.1 Apply some lapping compound on valve face and work valve on its seat with a lapping tool such as the SNAP-ON VALVE HOLDER (P/N VL2).

   NOTE: The location of contact area should be in center of valve face.

   2.2 Repeat procedure until valve seat and valve face fit together.
3. Measure valve seat contact width, using a caliper.



A. Valve face contact width
B. Valve seat contact width

VALVE SEAT CONTACT WIDTH	
INTAKE VALVE	
NEW	1.05 mm to 1.35 mm (.041 in to .053 in)
SERVICE LIMIT	1.7 mm (.067 in)
EXHAUST VALVE	
NEW	1.25 mm to 1.45 mm (.049 in to .057 in)
SERVICE LIMIT	1.8 mm (.0709 in)

Replace parts if out of specification.

Valve Installation

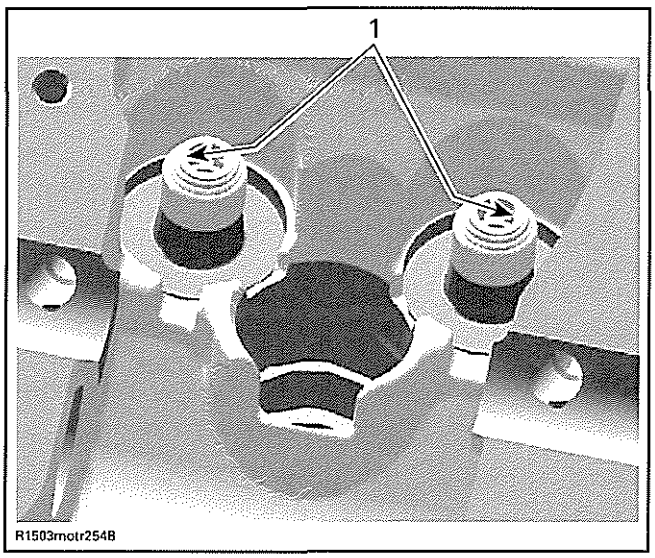
For installation reverse the removal procedure. Pay attention to the following details.

NOTE: Ensure to reinstall all parts in their original position as marked during removal.

1. Install a NEW valve stem seal whenever valve is removed.

2. Apply engine oil on valve stem and carefully slide through cylinder head and valve stem seal.

NOTICE Be careful when passing the valve stem through the sealing lip of the seal.



TYPICAL
1. Sealing lips of valve stem seal

3. Install *VALVE SPRING*. See procedure in this subsection.
4. Install all other removed parts.

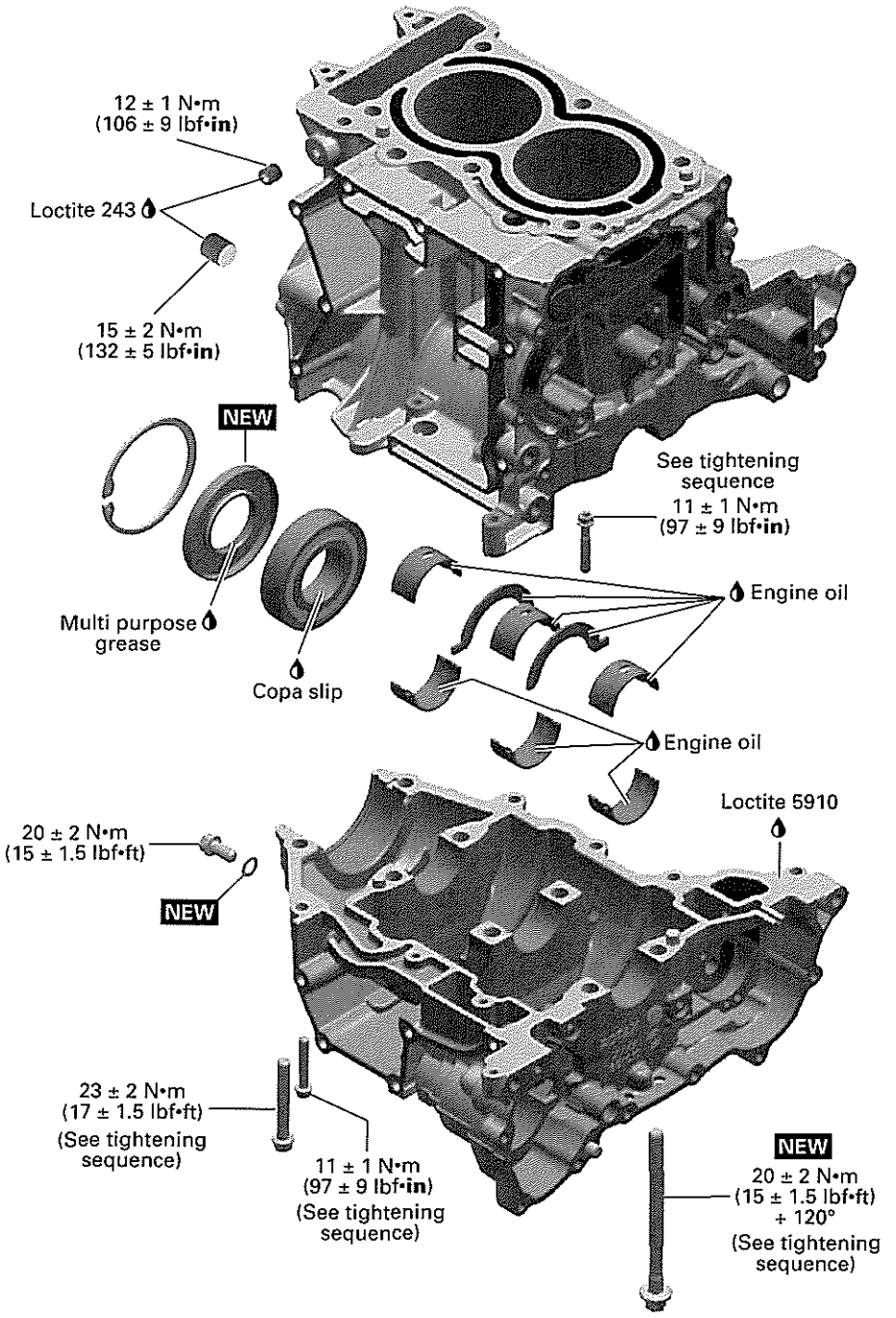
CYLINDER BLOCK

SERVICE TOOLS

Description	Part Number	Page
CRANKSHAFT LOCKING TOOL	529 036 205	267
CRANKSHAFT PROTECTOR (PTO)	420 876 552	258
PISTON CIRCLP INSTALLER	529 036 207	273
PISTON RING COMPRESSOR	529 036 208	275
PTO OIL SEAL INSTALLER	529 036 216	259–260

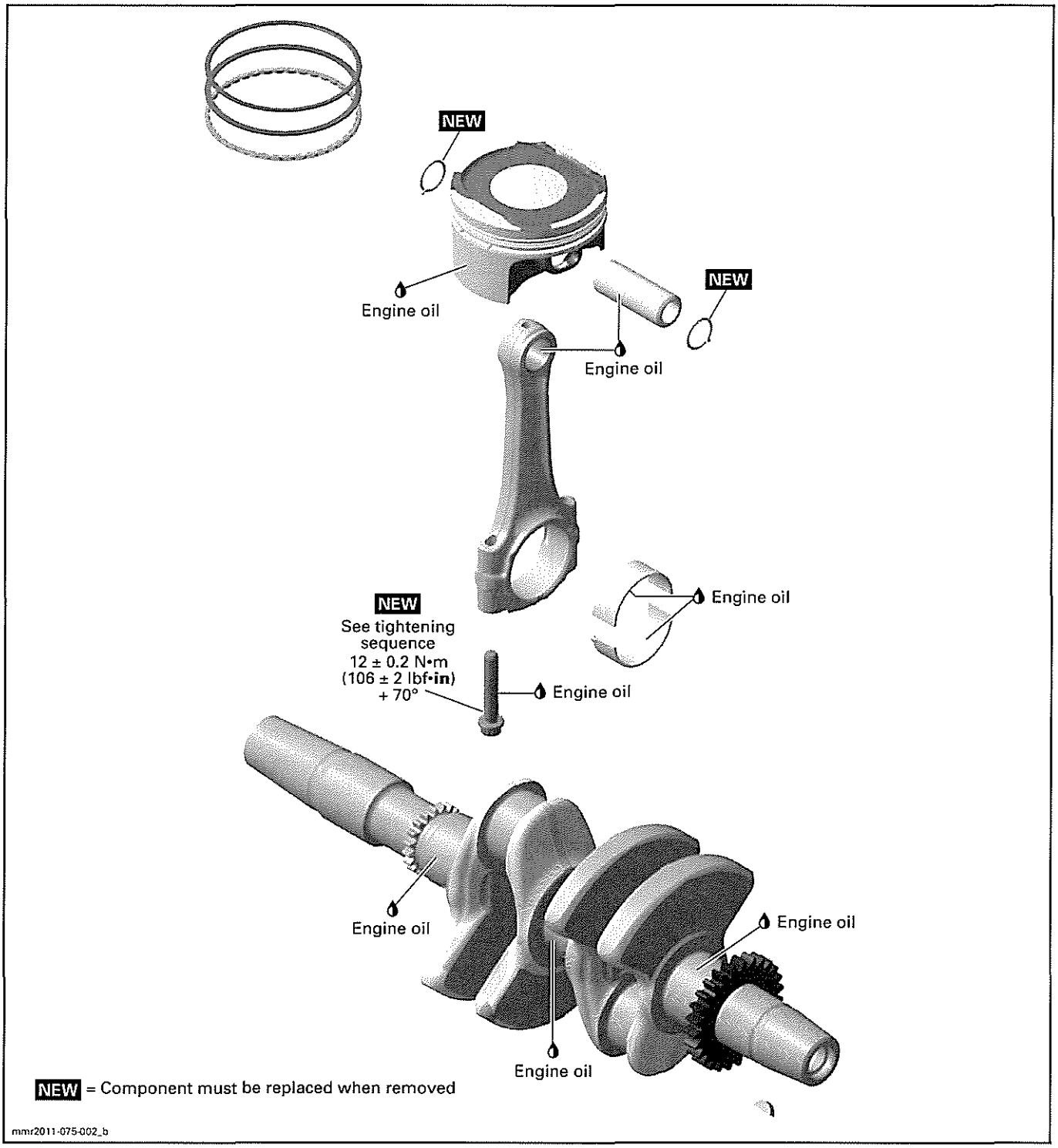
SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 5910	293 800 081	265
LOCTITE CHISEL (GASKET REMOVER)	413 708 500	263
SUPER LUBE GREASE	293 550 030	260



NEW = Component must be replaced when removed.

mmr2011-075-001_b


NEW
Engine oil
NEW
Engine oil
Engine oil
NEW
See tightening sequence
12 ± 0.2 N•m
(106 ± 2 lbf•in)
+ 70°
Engine oil
Engine oil
Engine oil
Engine oil
NEW = Component must be replaced when removed
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GENERAL

When disassembling parts that are duplicated in the engine, (e.g.: pistons, connecting rods etc.), it is strongly recommended to note their position and to keep the parts of the same assembly as a "group". If you find a defective component, it would be much easier to find the cause of the failure. Since parts were broken-in during engine operation, they will maintain their matched fit when reassembled together within their "group".

During assembly/installation, use torque values and service products as in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices, when removed (e.g.: locking tabs, elastic stop nuts, self-locking fasteners, cotter pins, etc.) must be replaced.

NOTICE Hoses, cables or locking ties removed during a procedure must be reinstalled as per factory standards.

TROUBLESHOOTING

Always check for fault codes. If a fault code is detected, service the fault code first. Refer to *DIAGNOSTIC AND FAULT CODES* subsection.

UNUSUAL ENGINE NOISE OR VIBRATIONS

1. Heavy wear on plain bearings.
   - *Check radial play of plain bearings. Replace if out of specification.*
2. Crankshaft axial play out of specification.
   - *Measure crankshaft axial play. If crankshaft axial play is out of specification, replace thrust washers.*
3. Connecting rod axial play out of specification.
   - *Measure connecting rod axial play on crankshaft. Replace connecting rod or crankshaft if out of specification.*
4. Connecting rod screws got loose.
   - *Replace damaged components and retighten screws with the recommended torque.*
5. Crankshaft PTO ball bearing is worn.
   - *Separate crankcase and check ball bearing for excessive play. Replace ball bearing if necessary.*

BLUE SMOKE IN THE EXHAUST

1. Oil scraper rings worn out.
   - *Replace piston rings.*

ENGINE SUDDENLY TURNS OFF (POOR IDLING)

1. Piston rings worn out.
   - *Replace piston rings.*
2. Piston/cylinder clearance out of specification.
   - *Check piston/cylinder clearance. Replace if out of specification.*
3. Melted or broken piston.
   - *Replace piston and cylinder block if necessary.*

PROCEDURES

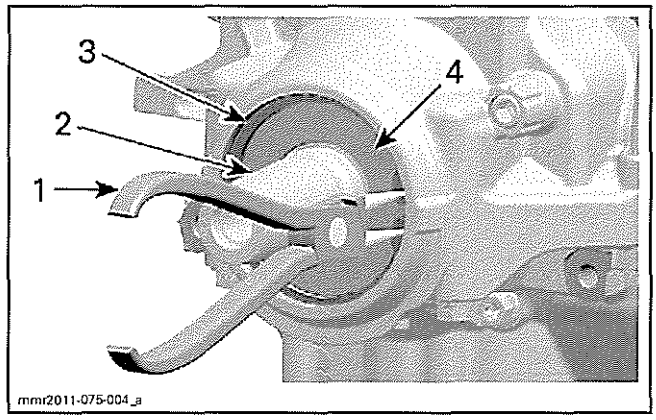
PTO OIL SEAL

PTO Oil Seal Replacement

NOTE: To replace the PTO oil seal, it is not necessary to remove engine from the vehicle.

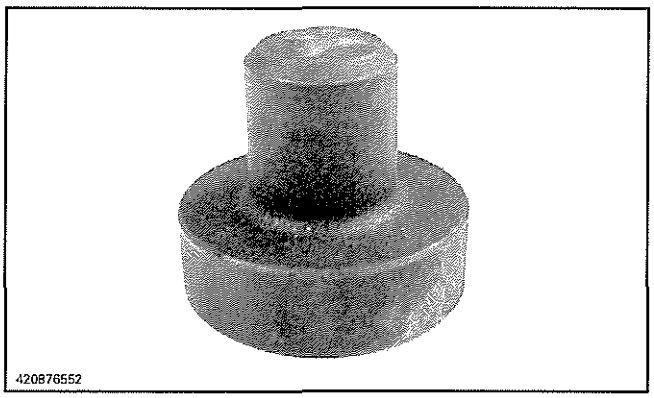
PTO Oil Seal Removal

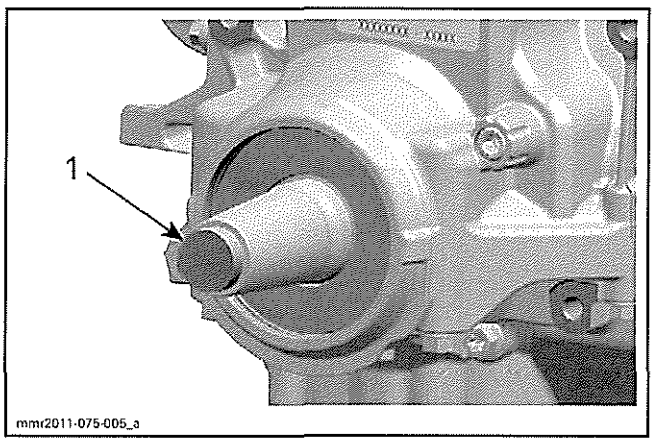
1. Remove drive pulley. Refer to *DRIVE PULLEY (eDRIVE)* subsection.
2. Use pliers to remove retaining ring.



1. *Pliers*
2. *Crankshaft PTO journal*
3. *Retaining ring*
4. *Oil seal*

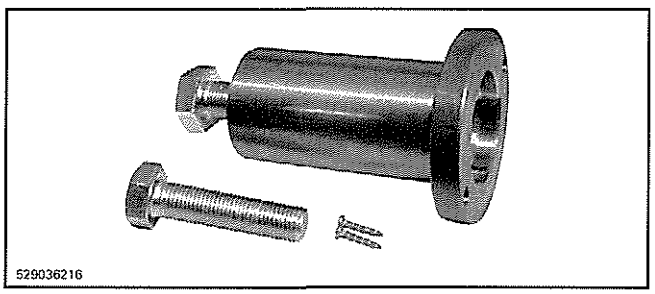
3. Install CRANKSHAFT PROTECTOR (PTO) (P/N 420 876 552).





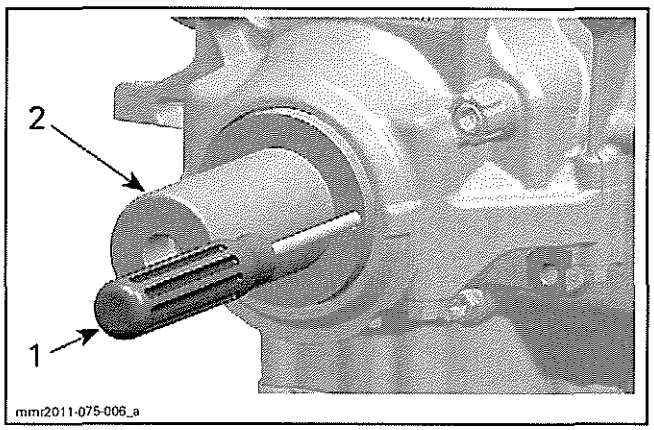
1. Crankshaft protector

4. Lean the PTO OIL SEAL INSTALLER (P/N 529 036 216) flange on the oil seal.



5. Carefully punch two holes into the old oil seal using an suitable pin.

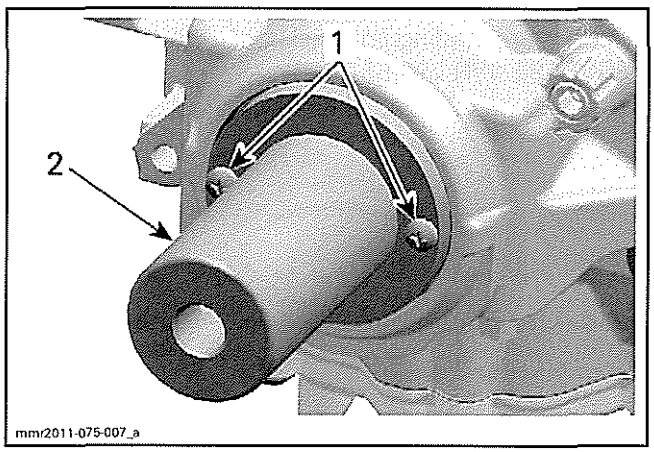
NOTE: The holes punched into the old seal must allow the self tapping screws to bite into the seal.



1. Pin
2. Oil seal installer

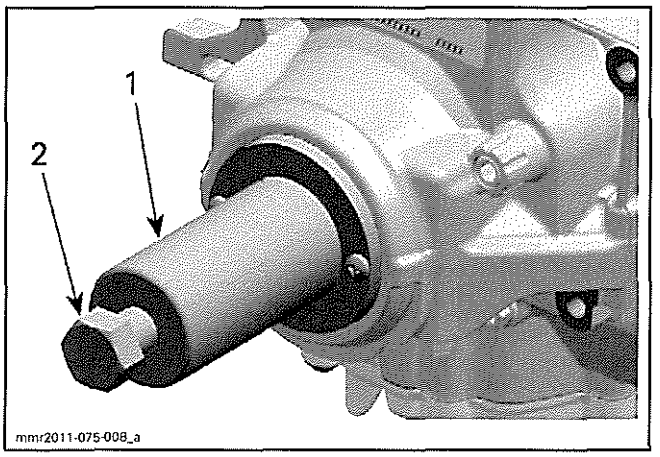
6. Screw the provided self tapping screws through the seal installer holes and into the oil seal.

NOTICE If self tapping screws other than the ones provided are used, their length must not exceed 16 mm (5/8 in).



1. Self tapping screws
2. Oil seal installer

7. Thread the provided M16 x 1.5 x 40 mm into the seal installer, then pull the old seal off the crankcase by screwing in.



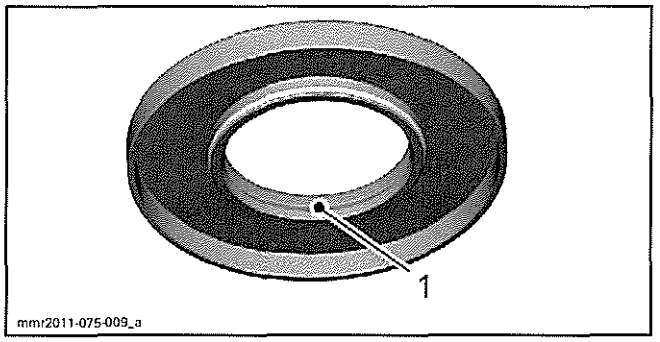
1. Oil seal installer
2. M16 x 1.5 x 40 mm hex. screw

8. Remove crankshaft protector and clean oil seal area.

PTO Oil Seal Installation

NOTE: Check the oil seal running surface of crankshaft for grooves, before installation of NEW oil seal.

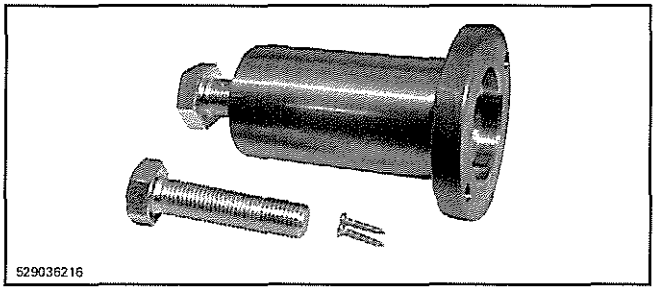
1. Lubricate sealing lip of oil seal with SUPER LUBE GREASE (P/N 293 550 030).



1. Lubricate inner sealing lip

NOTICE **Oil seal must be installed with sealing lip towards the engine.**

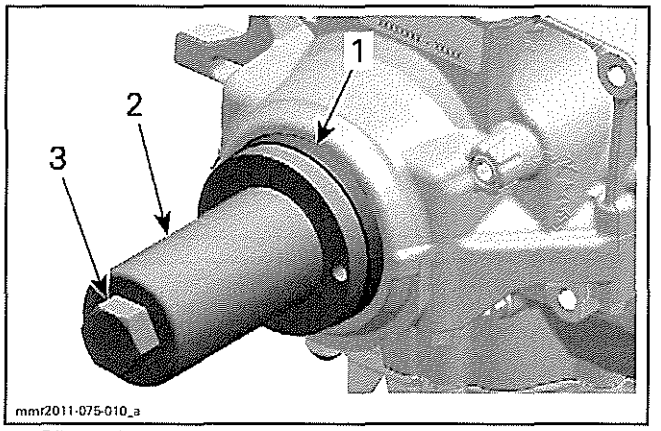
2. Insert the NEW oil seal using the PTO OIL SEAL INSTALLER (P/N 529 036 216).



2.1 Lean the oil seal installer flange on the oil seal.

2.2 Thread the provided M14 x 1.5 x 55 mm screw in the crankshaft.

2.3 Screw in to push the seal in place.



1. Oil seal installer
2. Oil seal
3. M14 x 1.5 x 55 mm hex. screw

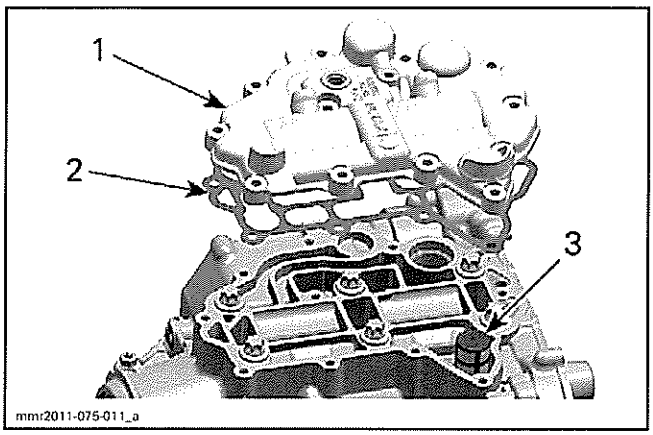
CYLINDER BLOCK

Cylinder Block Disassembly

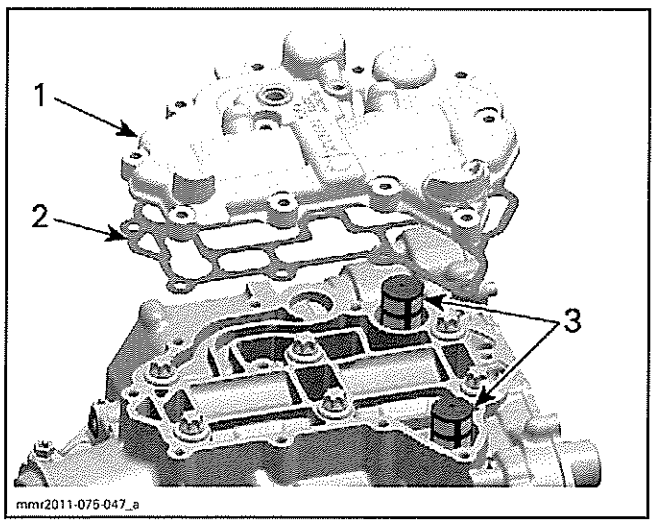
1. Remove engine from the vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
2. Refer to *PERIODIC MAINTENANCE PROCEDURES* and drain engine oil.
3. Refer to *CYLINDER HEAD* subsection and remove:
   - Ignition coils
   - Valve cover
   - Spark plugs.
4. Lock crankshaft, refer to *CRANKSHAFT LOCKING PROCEDURE* in this subsection.
5. Remove air intake manifold. Refer to *AIR INTAKE SYSTEM* subsection.
6. Refer to *COOLING SYSTEM* subsection and remove:
   - Water pump
   - Water pump drive gears
   - Thermostat.
7. Refer to *LUBRICATION SYSTEM* subsection and remove:
   - Oil tank
   - Oil cooler (applicable models)
   - Oil pressure regulator
   - Oil pump gears and oil pumps.
8. Refer to *MAGNETO AND STARTER* subsection and remove:
   - Magneto cover

- Rotor
- Starter drive gears
- Electric starter.

9. Refer to *TIMING CHAIN* subsection and remove:
   - Timing chain tensioner
   - Timing chain
   - Timing chain guides.
10. Refer to *CYLINDER HEAD* subsection and remove:
    - Camshaft holders
    - Cylinder head.
11. Remove oil sump cover and oil strainer(s).



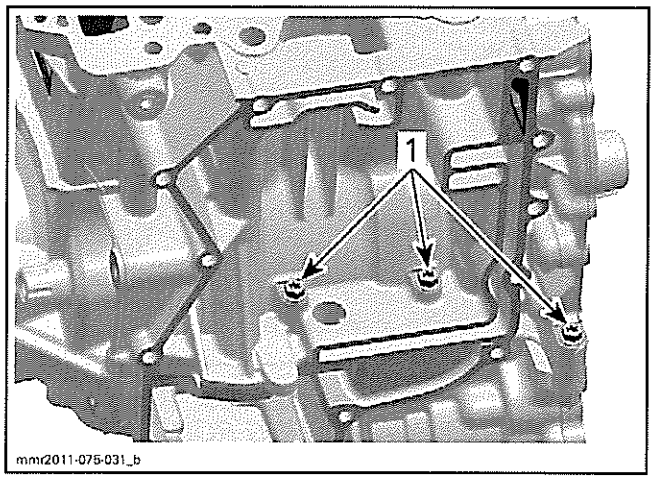
MODELS WITH ONE OIL STRAINER
1. *Oil sump cover*
2. *Engine oil strainer*
3. *Gasket*



MODELS WITH TWO OIL STRAINERS
1. *Oil sump cover*
2. *Engine oil strainers*
3. *Gasket*

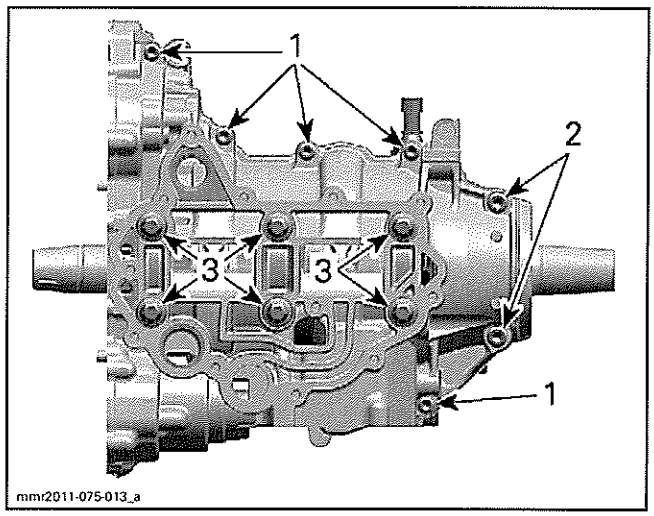
NOTE: Before splitting the cylinder block, measure crankshaft axial play. Refer to *CRANKSHAFT* in this subsection.

12. Remove crankshaft locking tool.
13. Remove the upper cylinder block half screws.



1. *Upper cylinder block half screws (M6)*

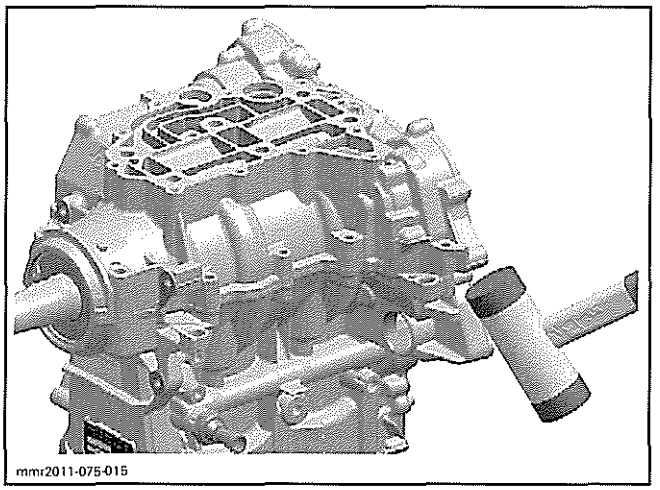
14. Remove the lower cylinder block half screws starting with the smaller ones.



1. *M6 screws*
2. *M8 screws*
3. *M9 screws (discard)*

15. Carefully remove cylinder block lower half by using a soft hammer.

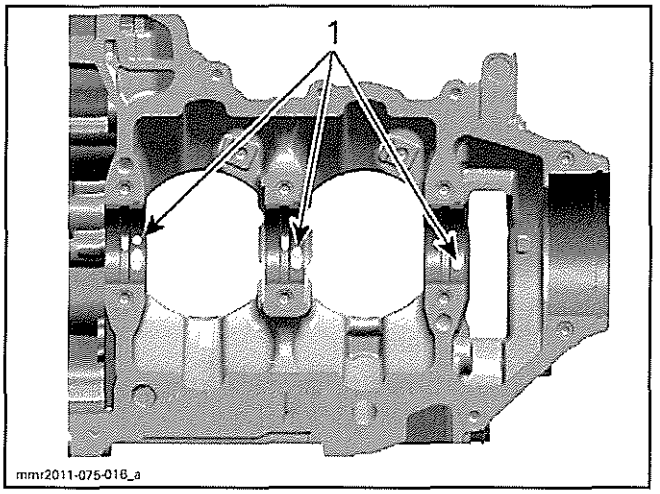
NOTE: Take care not to damage the sealing surfaces of the cylinder block halves.



16. Remove connecting rod caps. Refer to *PISTONS AND CONNECTING RODS* in this subsection.
17. Refer to *CRANKSHAFT* in this subsection and remove:
    - Crankshaft thrust washers
    - Crankshaft.
18. Remove pistons and connecting rods. See procedure in this subsection.

Plain Bearing Removal

When the plain bearings need to be removed from the cylinder block, mark them to identify the correct position at installation. See the illustration as an example.

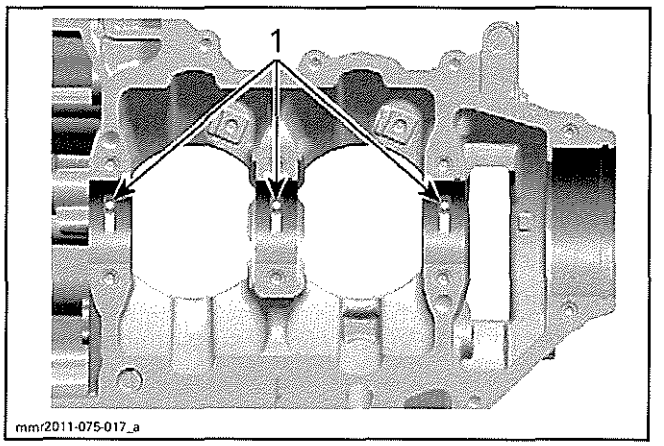


1. Mark on crankshaft plain bearings

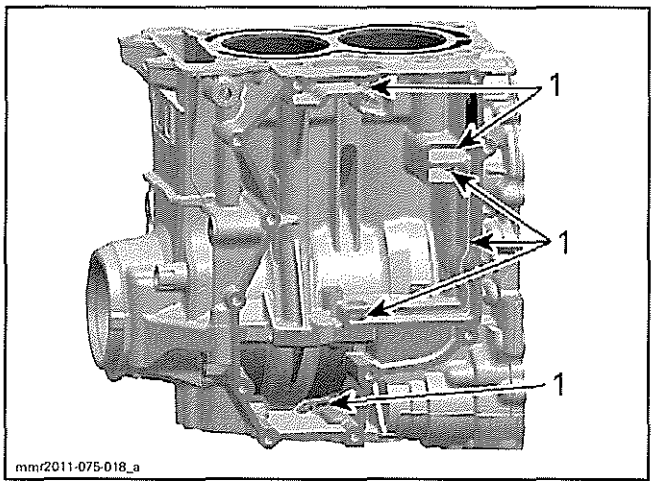
Cylinder Block Cleaning

Clean cylinder block in a part cleaner, then use compressed air to dry it.

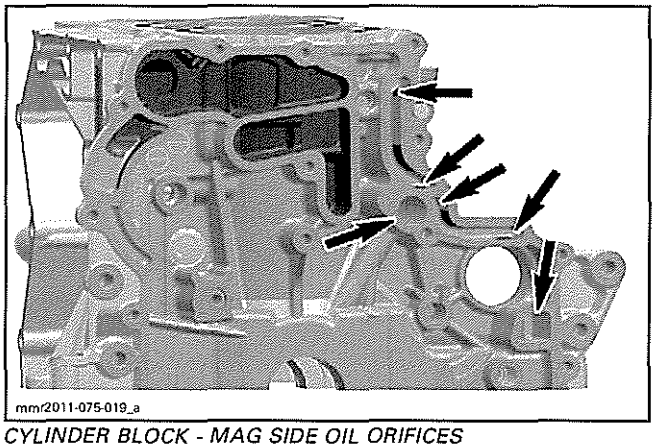
Blow the oil orifices using compressed air and make sure they are not clogged.



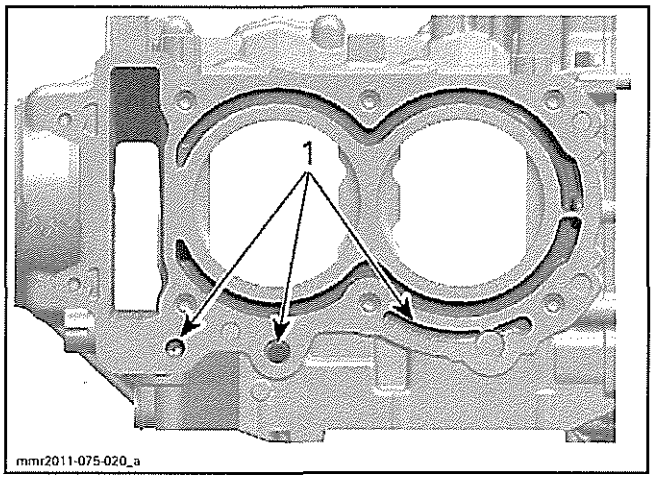
CYLINDER BLOCK UPPER HALF
1. Oil orifices



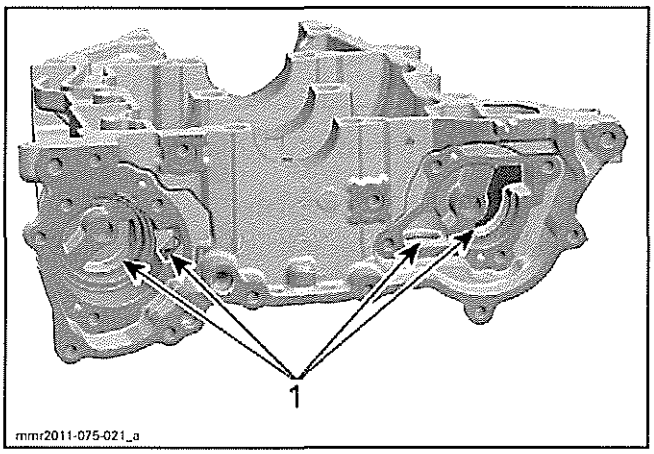
CYLINDER BLOCK - REAR
1. Oil orifice



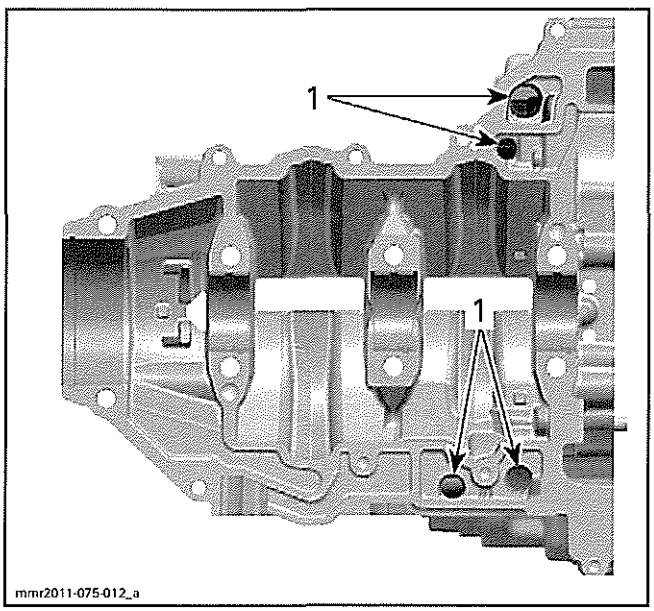
CYLINDER BLOCK - MAG SIDE OIL ORIFICES



CYLINDER BLOCK - TOP
1. Oil orifice



CYLINDER BLOCK LOWER HALF
1. Oil orifices



CYLINDER BLOCK LOWER HALF
1. Oil orifices

Clean all metal components in a solvent.

Clean cylinder block mating surfaces with LOCTITE CHISEL (GASKET REMOVER) (P/N 413 708 500) and a brass brush. Brush a first pass in one direction then make the final brushing perpendicularly (90°) to the first pass (cross hatch).

NOTE: Do not wipe with rags. Use a new clean hand towel only.

Cylinder Block Inspection

Check cylinder block for cracks or other damage.

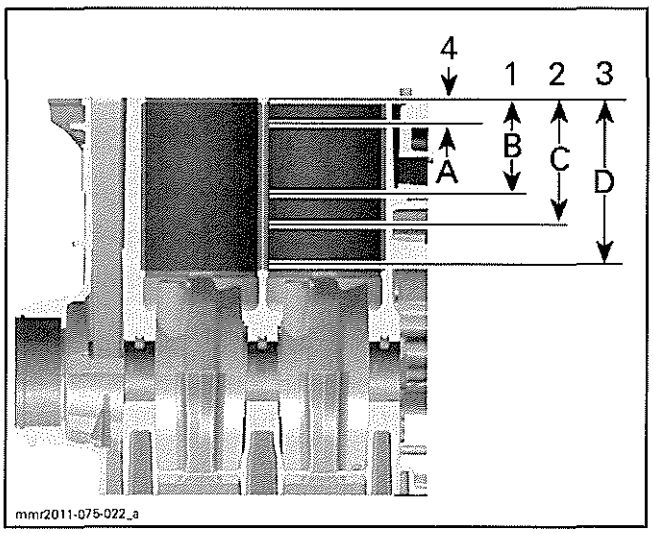
Check cylinder block mating surfaces for flatness using a straight edge.

Replace cylinder block if necessary.

Check cylinder bores for cracks, scoring and wear ridges on top and bottom of the cylinders.

Cylinder Taper

Measure cylinder bore diameter at 4 recommended positions. See illustration.



TYPICAL
1. First measure
2. Second measure
3. Third measure
4. Fourth measure

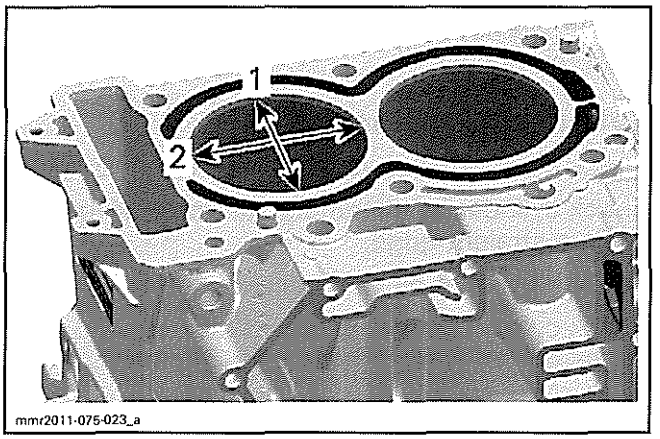
A. 5 mm to 10 mm (.197 in to .394 in)
B. 30 mm to 35 mm (1.181 in to 1.378 in)
C. 57 mm to 62 mm (2.244 in to 2.441 in)
D. 111 mm to 113 mm (4.37 in to 4.449 in)

The difference between measurements should not exceed the service limit mentioned in next table.

CYLINDER TAPER	
NEW MAXIMUM	0.030 mm (.0012 in)
SERVICE LIMIT	0.050 mm (.002 in)

Cylinder Out of Round

Measure cylinder bore diameter as shown and at the same measuring points as for *CYLINDER TAPER.*



1. Piston pin axis
2. Parallel to piston pin axis

To obtain the cylinder out of round, calculate the difference between the perpendicular measures.

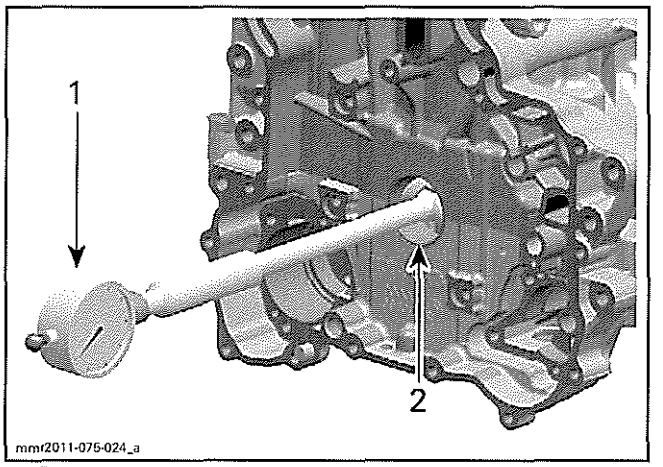
CYLINDER OUT OF ROUND	
NEW MAXIMUM	0.008 mm (.0003 in)
SERVICE LIMIT	0.030 mm (.0012 in)

Crankshaft Plain Bearings Inside Diameter

Check the plain bearings for scoring or other damages.

Measure plain bearing inside diameter and compare with crankshaft bearing journal diameter (refer to *CRANKSHAFT* in this subsection). Proceed as follows.

- Use the OLD plain bearings and put both cylinder block halves together.
- Tighten screws as described in *CYLINDER BLOCK ASSEMBLY.*
- Measure the inside diameter of the crankshaft plain bearings using a bore gauge.



1. Bore gauge
2. Crankshaft plain bearing

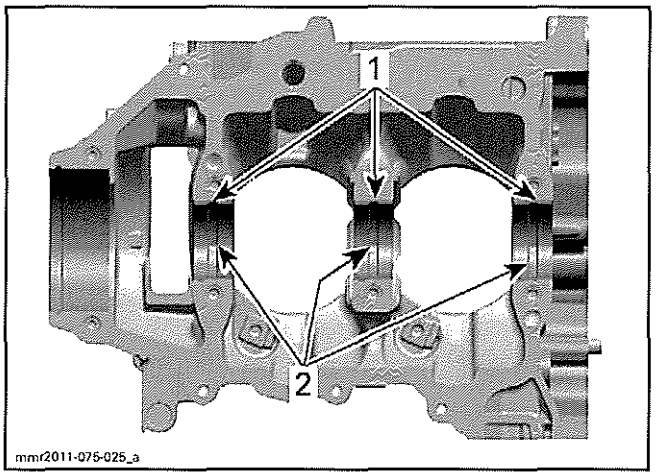
CRANKSHAFT PLAIN BEARING INSIDE DIAMETER	
SERVICE LIMIT	36.080 mm (1.4205 in)

Replace bearings if they are out of specifications.

Cylinder Block Assembly

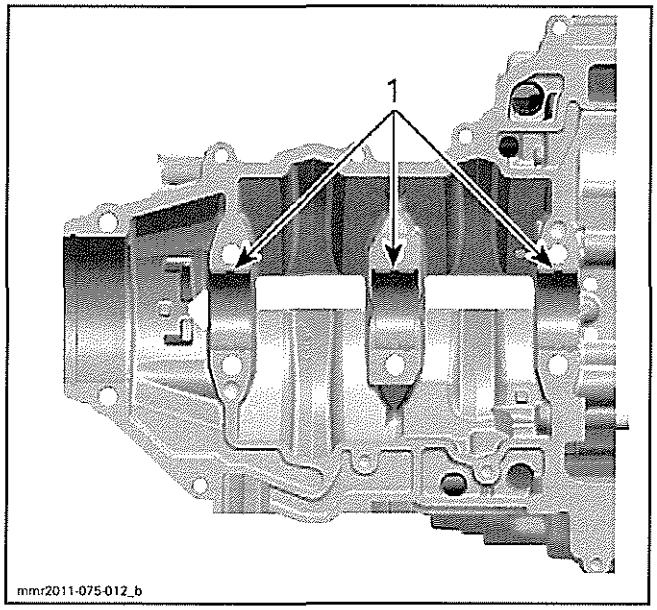
For assembly, reverse the disassembly procedure. Pay attention to the following details.

1. Correctly reinstall plain bearings as follows.
   1.1 Use NEW bearings if diameters are out of specification. Refer to *PLAIN BEARING INSPECTION* in this subsection.
   1.2 Install bearings with lubrication grooves in the cylinder block upper half.



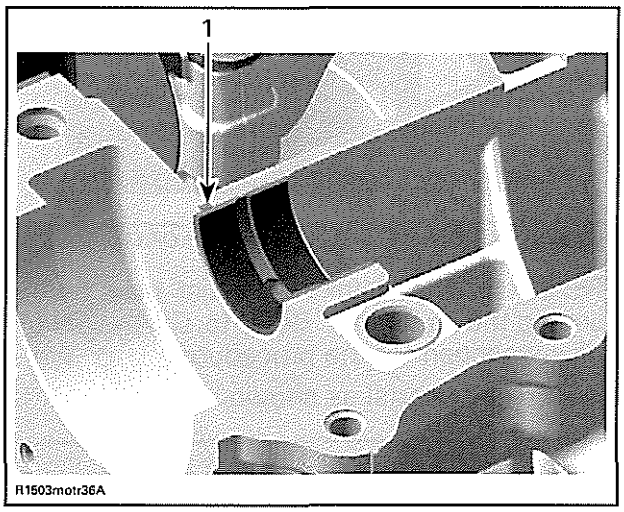
1. Plain bearings
2. Lubrication grooves

   1.3 Install flat bearings in the cylinder block lower half.



1. Flat bearings

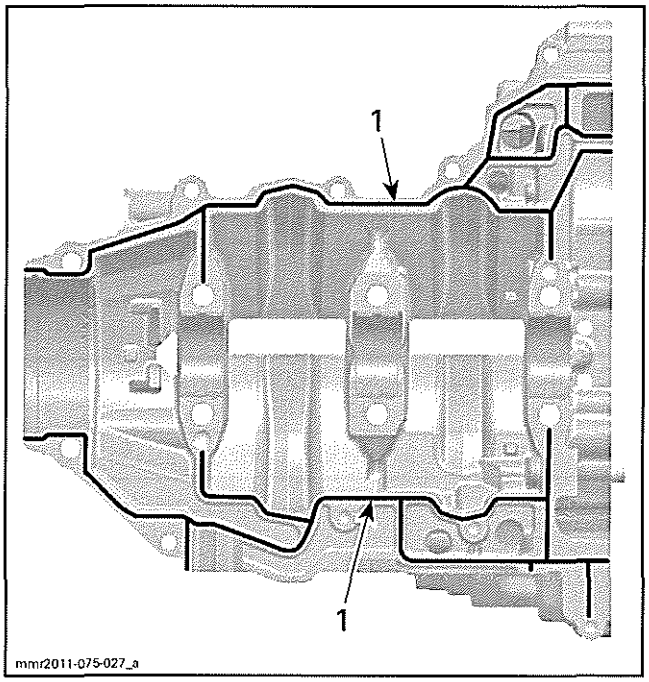
1.4 Bearings must to be flush with the cylinder block split surface and their protrusions have to fit in the notched areas in the cylinder block seat.



TYPICAL
1. Bearing protrusion in cylinder block notch

2. Install pistons, refer to *PISTONS AND CONNECTING RODS* in this subsection.
3. Apply engine oil on all plain bearings.
4. Install the following components:
   - Crankshaft and thrust washers (refer to *CRANKSHAFT*)
   - Connecting rod caps (refer to *PISTONS AND CONNECTING RODS*).
5. Apply LOCTITE 5910 (P/N 293 800 081) on mating surface of cylinder block lower half as shown on next illustration.

IMPORTANT: When beginning the application of the cylinder block sealant, the assembly and first tightening have to be done within 12 minutes. It is suggested to have all you need on hand to save time.



1. Apply Loctite 5910 following this pattern

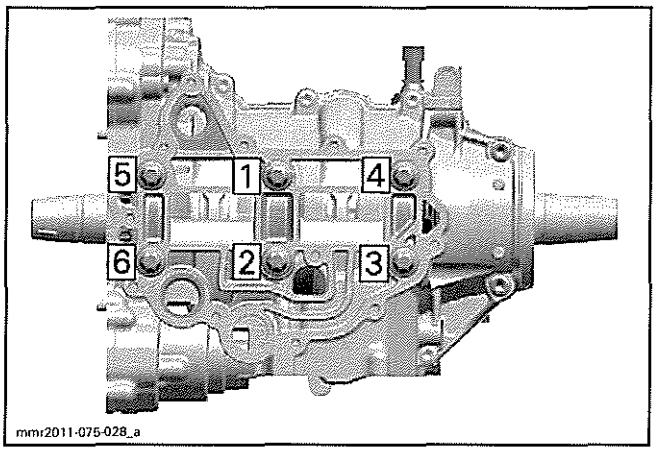
NOTICE Ensure not to apply too much sealant, as it will spread out inside the cylinder block.

6. Install NEW cylinder block M9 screws and tighten as follows.

NOTICE This assembly uses stretch screws. Always use NEW screws and strictly adhere to the tightening procedure.

CYLINDER BLOCK M9 SCREWS TIGHTENING TORQUE	
First step	20 N•m ± 2 N•m (15 lbf•ft ± 1 lbf•ft)
Second step	Additional 120° ± 5°

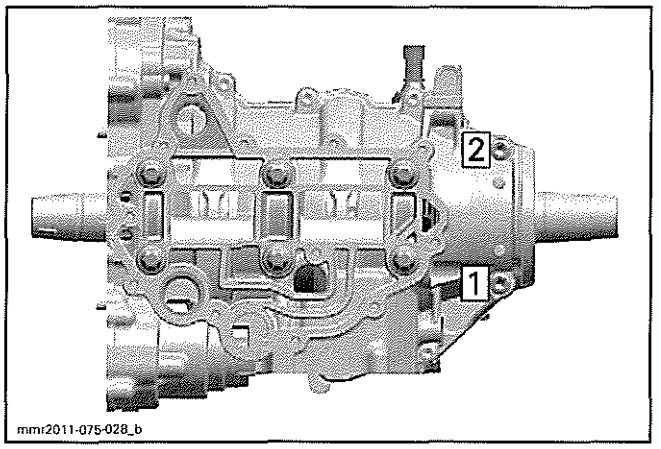
NOTE: Use a torque angle gauge to carry out the second step.



M9 SCREWS TIGHTENING SEQUENCE - FIRST AND SECOND STEPS

7. Install the M8 screws and tighten as follows.

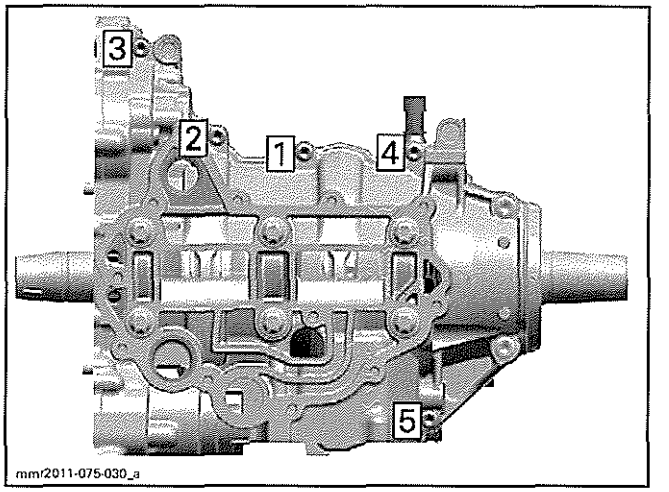
CYLINDER BLOCK M8 SCREWS TIGHTENING TORQUE
23 N•m ± 2 N•m (17 lbf•ft ± 1 lbf•ft)



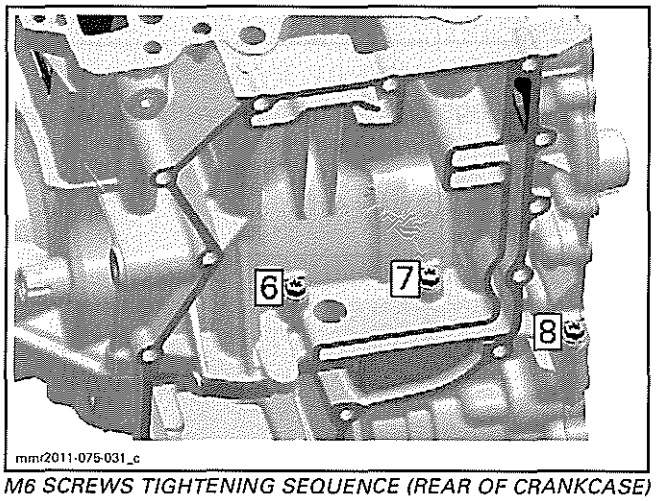
M8 SCREWS TIGHTENING SEQUENCE

8. Install the M6 screws and tighten as follows.

CYLINDER BLOCK M6 SCREWS TIGHTENING TORQUE
11 N•m ± 1 N•m (97 lbf•**in** ± 9 lbf•**in**)



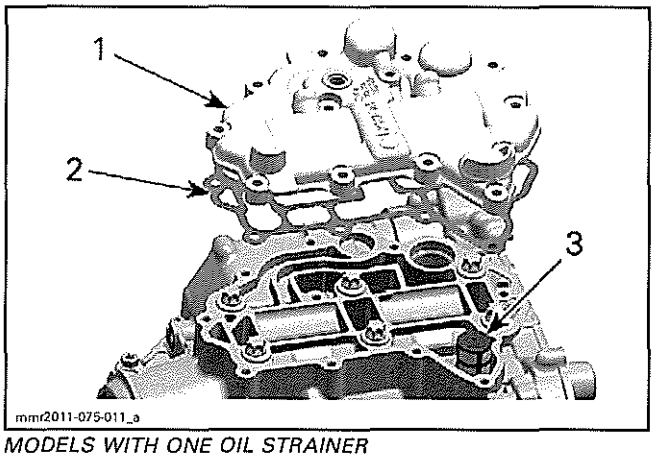
M6 SCREWS TIGHTENING SEQUENCE (BOTTOM OF CRANKCASE)



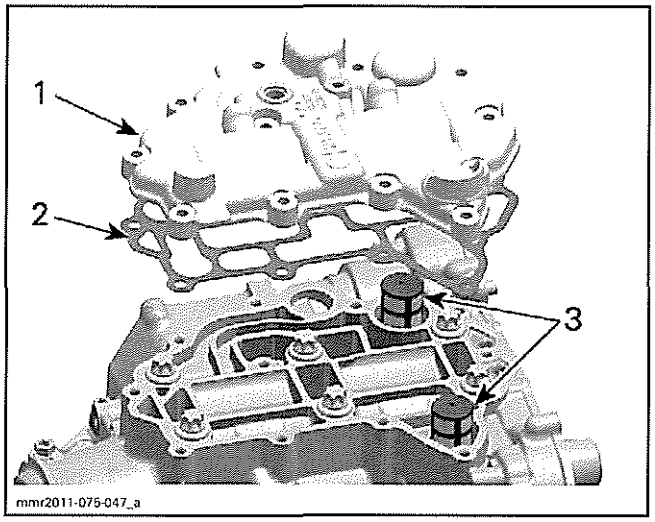
M6 SCREWS TIGHTENING SEQUENCE (REAR OF CRANKCASE)

NOTE: Check the crankshaft axial play before continuing the assembly. Refer to *CRANKSHAFT* in this subsection for the procedure.

9. Install oil strainer(s) as shown.



MODELS WITH ONE OIL STRAINER
1. *Oil sump cover*
2. *Engine oil strainer*
3. *Gasket*



MODELS WITH TWO OIL STRAINERS
1. *Oil sump cover*
2. *Engine oil strainers*
3. *Gasket*

10. Reassemble engine in accordance with the proper assembly procedures.

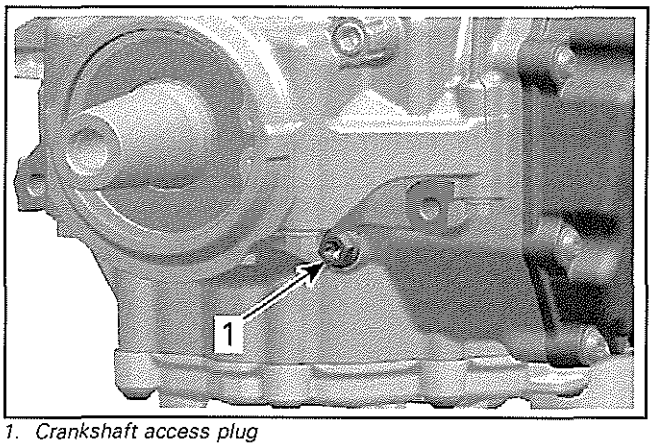
CRANKSHAFT

Crankshaft Locking Procedure

Crankshaft must be locked whenever the magneto rotor retaining nut it has to be removed or whenever working on the valve train.

NOTICE When working on the valve train or timing chain, crankshaft must be locked with the camshafts "IN" and "EX" marks facing each other.

1. If working on the valve train or timing chain, remove the valve cover. Refer to *CYLINDER HEAD* subsection.
2. Remove spark plugs.
3. If engine is installed in the vehicle, remove drive pulley Refer to *DRIVE PULLEY (eDrive)*.
4. Remove crankshaft access plug and discard gasket ring.

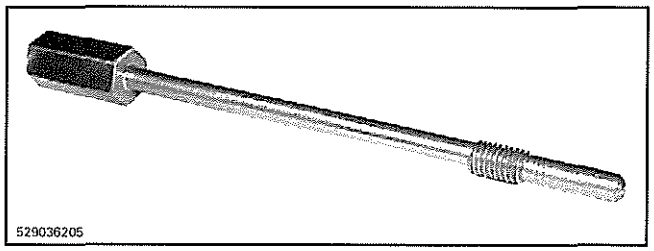


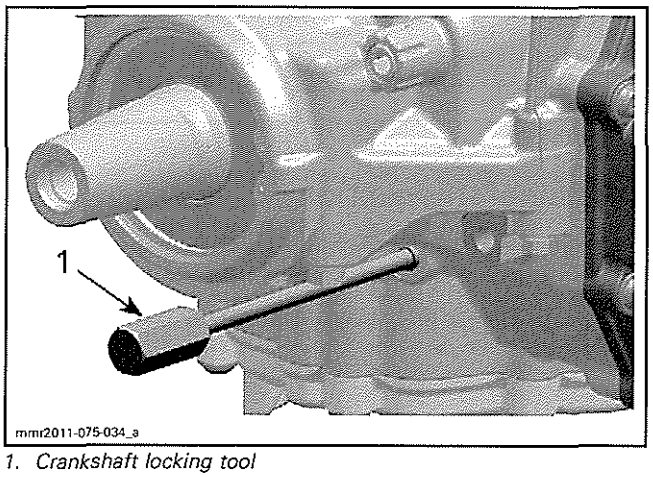
1. *Crankshaft access plug*

5. Turn engine counterclockwise to bring crankshaft to locking position.

NOTICE Crankshaft locking position is reached when camshafts "IN" and "EX" marks face each other. When crankshaft is locked, neither first nor second cylinder is set to TDC.

6. Use a flashlight to check if the groove in the crankshaft is aligned with the hole.
7. Lock crankshaft using the CRANKSHAFT LOCKING TOOL (P/N 529 036 205).



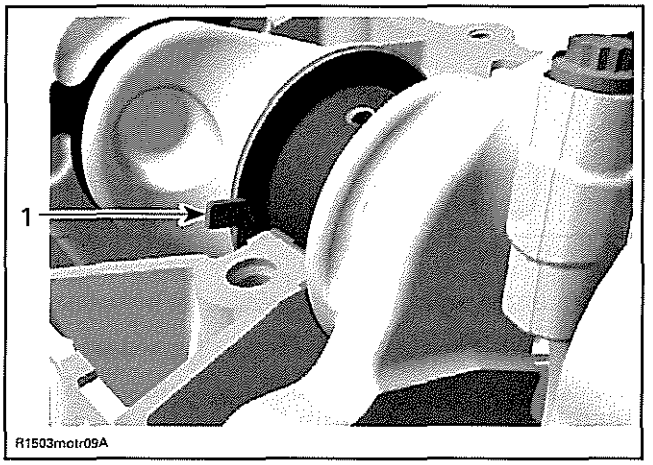


1. *Crankshaft locking tool*

Crankshaft Removal

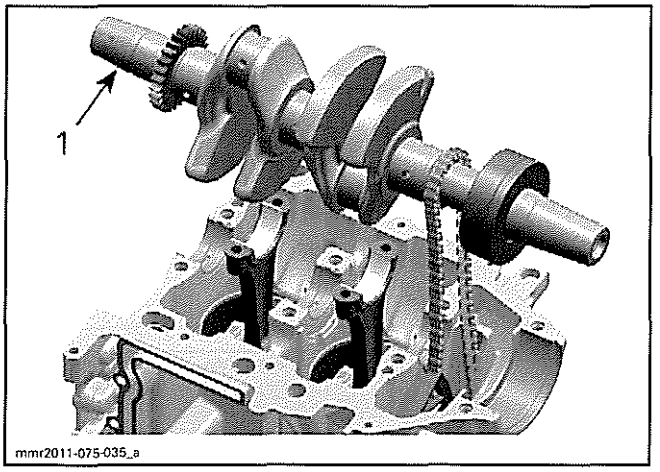
1. Disassemble *CYLINDER BLOCK*, see procedure in this subsection.

2. Remove connecting rod caps. Refer to *PISTONS AND CONNECTING RODS* in this subsection.
3. Remove crankshaft thrust washers.



TYPICAL
1. Thrust washer

4. Remove crankshaft from cylinder block.

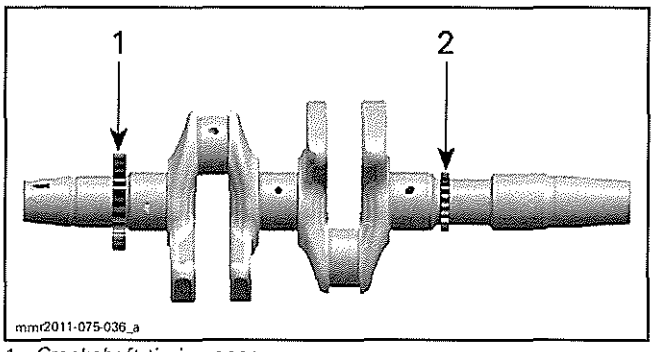


1. Crankshaft

Crankshaft Inspection

Check each bearing journal of crankshaft for scoring, scuffing, cracks or other signs of wear.

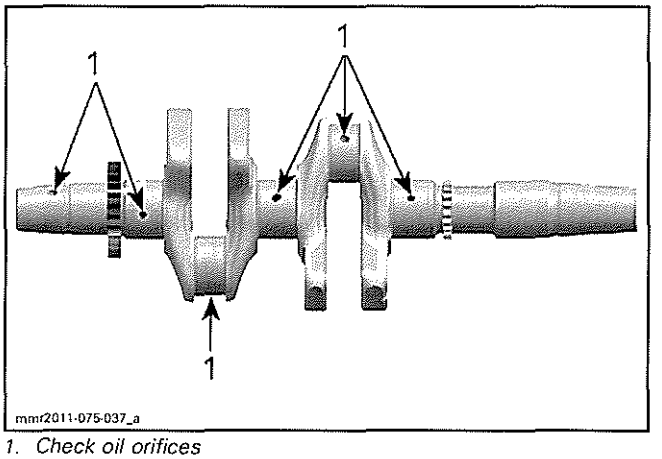
Check if crankshaft gears are worn or otherwise damaged.



1. Crankshaft timing gear
2. Oil pump drive gear

Replace crankshaft if damaged.

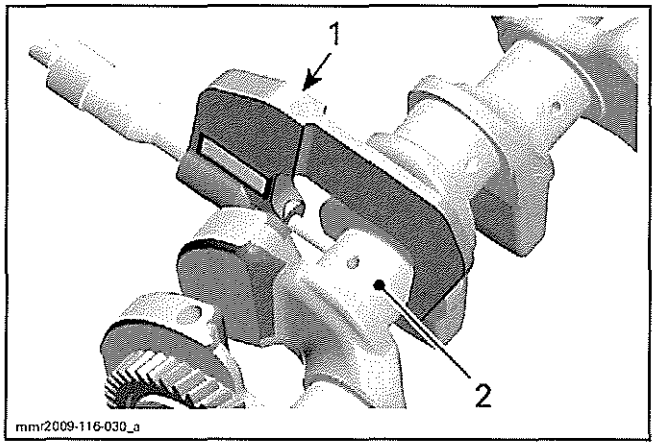
Blow the oil orifices using compressed air and make sure they are not clogged.



1. Check oil orifices

Crankshaft Radial Play

Measure crankshaft bearing journal diameter, using a micrometer.



TYPICAL
1. Micrometer
2. Crankshaft area for plain bearing

To obtain the radial play, calculate the difference between the bearing journal diameter and the crankshaft plain bearings inner diameter (see *CYLINDER BLOCK*).

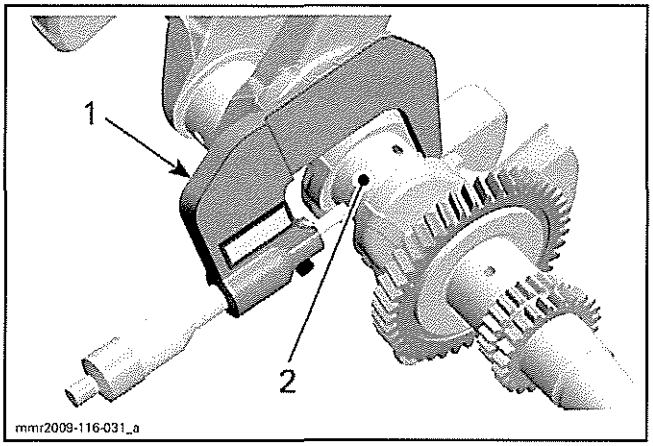
CRANKSHAFT BEARING JOURNAL DIAMETER	
NEW	35.990 mm to 36.006 mm (1.4169 in to 1.4176 in)
SERVICE LIMIT	35.960 mm (1.4157 in)

CRANKSHAFT RADIAL PLAY (CALCULATED)	
SERVICE LIMIT	0.09 mm (.0035 in)

Crankshaft Pin Diameter

Measure crankshaft pin diameter, using a micrometer.

To obtain the radial play, calculate the difference between the crankshaft pin diameter and the connecting rod plain bearings inner diameter (see *CONNECTING ROD INSPECTION*).

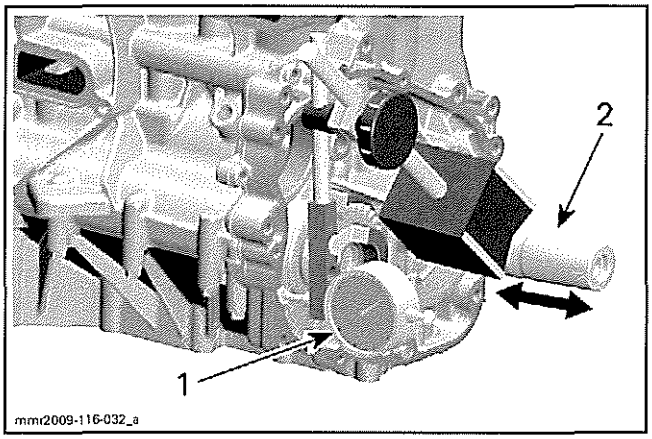


TYPICAL
1. *Micrometer*
2. *Crankshaft pin area for plain bearing*

CONNECTING ROD BIG END RADIAL PLAY (CALCULATED)	
SERVICE LIMIT	0.08 mm (.0031 in)

Crankshaft Axial Play

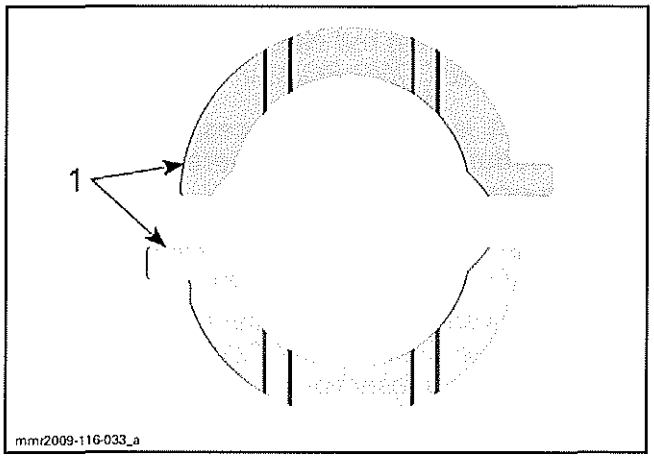
With the crankshaft in the cylinder block, measure the crankshaft axial play, using a dial indicator.



TYPICAL
1. *Dial indicator*
2. *Crankshaft*

CRANKSHAFT AXIAL PLAY	
NEW	0.120 mm to 0.392 mm (.005 in to .015 in)
SERVICE LIMIT	0.450 mm (.018 in)

If play is out of specification, replace the crankshaft thrust washers and repeat measurement.



TYPICAL
1. *Crankshaft thrust washers*

Crankshaft Installation

For installation, reverse the removal procedure. Pay attention to following details.

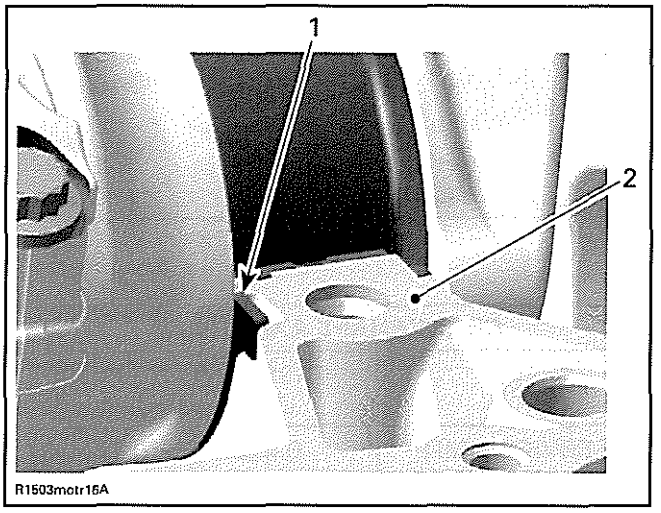
1. Install pistons and connecting rods in the cylinder block, refer to *PISTON AND CONNECTING ROD* in this subsection.
2. Turn cylinder block upside down.

NOTICE Be careful that connecting rods do not hit the cylinder block.

3. Apply engine oil on all plain bearings.
4. Install crankshaft along with the timing chain.

5. Properly reinstall crankshaft thrust washers with the slots facing against crankshaft counterweights.

NOTE: Thrust washers have to be flush with the cylinder block sealing surface.



TYPICAL
1. Thrust washer
2. Sealing surface

6. Install connecting rod caps. Refer to *PISTONS AND CONNECTING RODS* in this subsection.

NOTICE It is absolutely necessary to follow this procedure. Otherwise severe engine damage can occur.

7. Install cylinder block lower half. Refer to *CYLINDER BLOCK* in this subsection.
8. Lock crankshaft before further assembly of the engine. See *CRANKSHAFT LOCKING PROCEDURE* in this subsection.

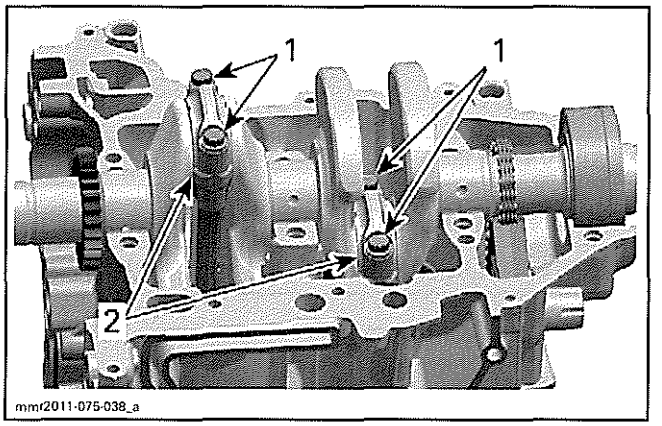
PISTONS AND CONNECTING RODS

Piston and Connecting Rod Removal

NOTE: It is recommended to measure connecting rod big end axial play prior to remove connecting rod. Refer to *CONNECTING ROD INSPECTION.*

1. Disassemble *CYLINDER BLOCK* as per procedure in this subsection.
2. Remove connecting rod cap.

NOTICE Mark cylinder position of connecting rod before disassembly.

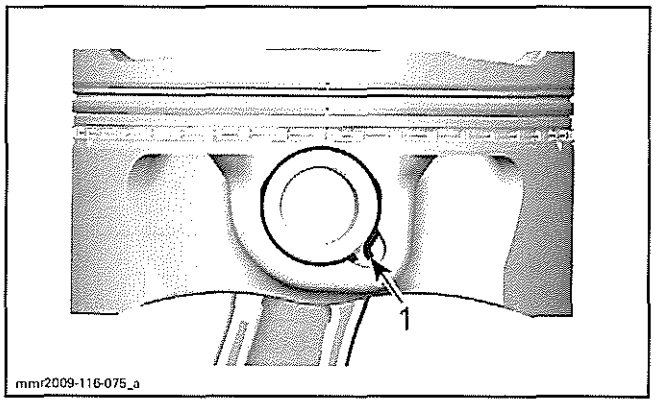


1. Connecting rod screws
2. Connecting rod cap

3. Remove *CRANKSHAFT* as per procedure in this subsection.
4. Turn cylinder block and push piston with connecting rod out of the cylinder.

Piston and Connecting Rod Disassembly

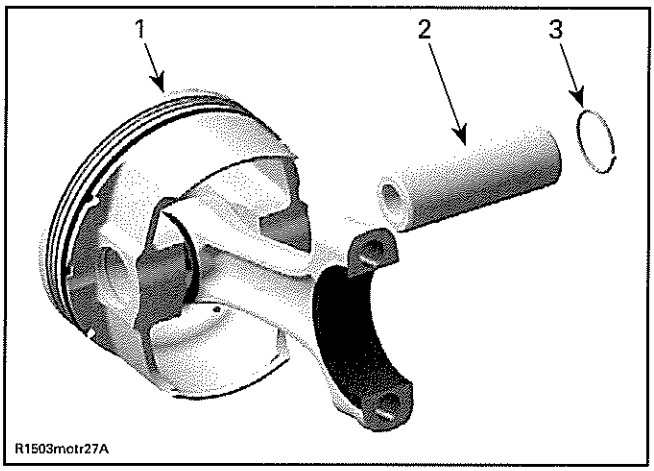
1. Remove one piston pin circlip and discard it.



TYPICAL
1. Piston pin circlip

NOTE: The removal of both piston pin circlips is not necessary to remove the piston pin.

2. Push piston pin out of the piston.



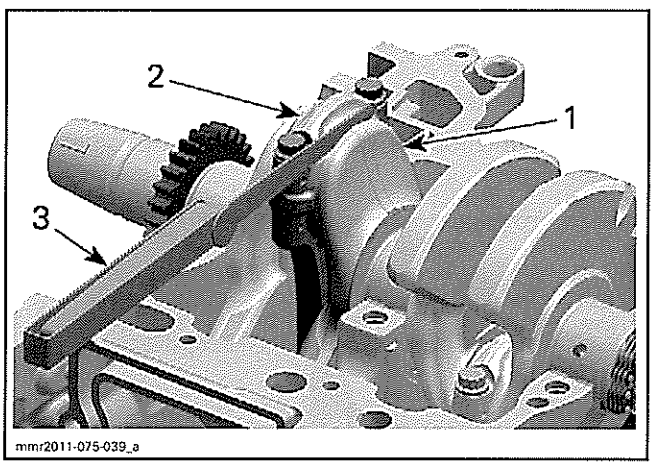
TYPICAL
1. *Piston*
2. *Piston pin*
3. *Circlip*

3. Detach piston from connecting rod.

Connecting Rod Inspection

Connecting Rod Big End Axial Play

Using a feeler gauge, measure distance between butting face of connecting rod and crankshaft counterweight. If the distance exceeds specified tolerance, replace the worn part.

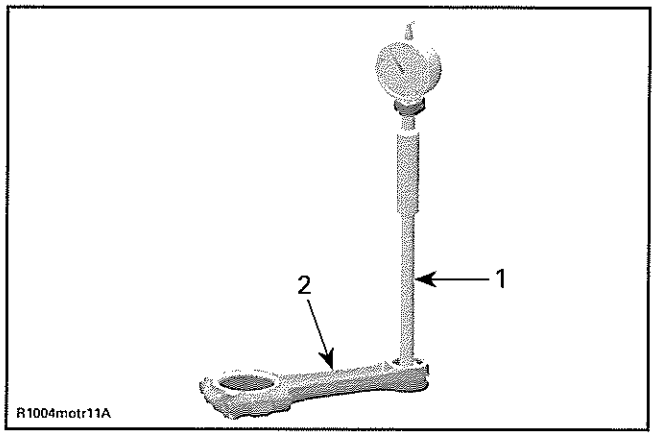


1. *Crankshaft*
2. *Connecting rod*
3. *Feeler gauge*

CONNECTING ROD BIG END AXIAL PLAY	
NEW	0.100 mm to 0.352 mm (.004 in to .014 in)
SERVICE LIMIT	0.450 mm (.018 in)

Connecting Rod Small End Radial Play

Measure connecting rod small end, using a bore gauge.



TYPICAL
1. *Bore gauge*
2. *Connecting rod*

CONNECTING ROD SMALL END DIAMETER	
NEW	17.010 mm to 17.020 mm (.6697 in to .6701 in)
SERVICE LIMIT	17.060 mm (.6717 in)

If the connecting rod small end diameter is out of specification, replace the connecting rod.

To obtain the radial play, calculate the difference between the piston pin diameter (*PISTON PIN INSPECTION*) and the connecting rod small end inner diameter.

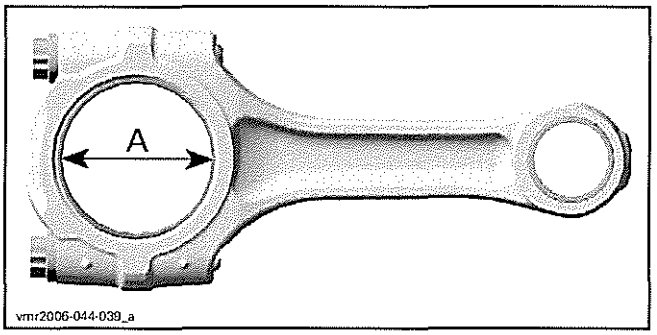
CONNECTING ROD SMALL END RADIAL PLAY	
SERVICE LIMIT	0.040 mm (.0016 in)

Connecting Rod Big End Radial Play

1. Measure inside diameter of connecting rod big end.
   1.1 Install the OLD plain bearings as they were mounted initially.
   1.2 Perform the tightening procedure as described in *PISTON AND CONNECTING ROD INSTALLATION* in this subsection.

   NOTE: To measure the connecting rod big end diameter, ALWAYS use the OLD connecting rod screws.

   1.3 Measure inside diameter in longitudinal direction of the connecting rod.



TYPICAL
A. Connecting rod big end bearing

CONNECTING ROD BIG END DIAMETER	
SERVICE LIMIT	36.06 mm (1.4197 in)

To obtain the connecting rod big end radial play, calculate the difference between the big end diameter and the crankshaft pin diameter (see *CRANKSHAFT INSPECTION*).

CONNECTING ROD BIG END RADIAL PLAY	
SERVICE LIMIT	0.080 mm (.0031 in)

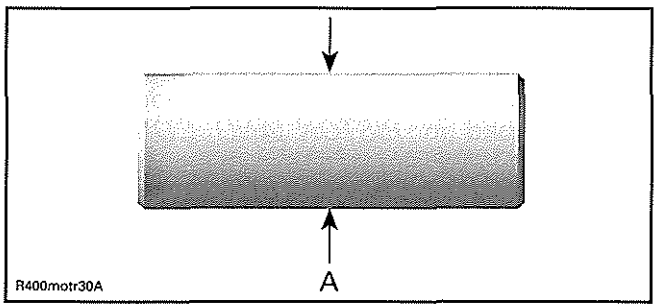
If connecting rod big end diameter is out of specification, install NEW plain bearings.

Piston Pin Inspection

Using synthetic abrasive woven, clean piston pin from deposits.

Inspect piston pin for scoring, cracks or other damage.

Measure piston pin diameter, using a micrometer. See the following illustration for the proper measurement position.



TYPICAL
A. Measure piston pin diameter here

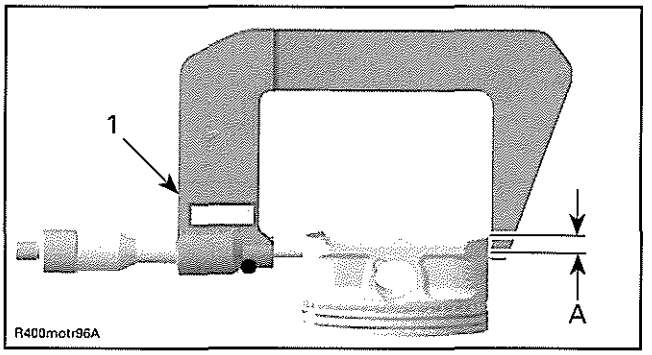
PISTON PIN DIAMETER	
NEW	16.996 mm to 17.00 mm (.6691 in to .6693 in)
SERVICE LIMIT	16.986 mm (.6687 in)

Replace the piston pin if it is out of specification.

Piston Inspection

Inspect piston for scoring, scuffing, cracks or other damage. Replace piston and piston rings if necessary.

Using a micrometer, measure piston perpendicularly (90°) to piston pin axis at 8.5 mm (11/32 in) from the skirt edge.



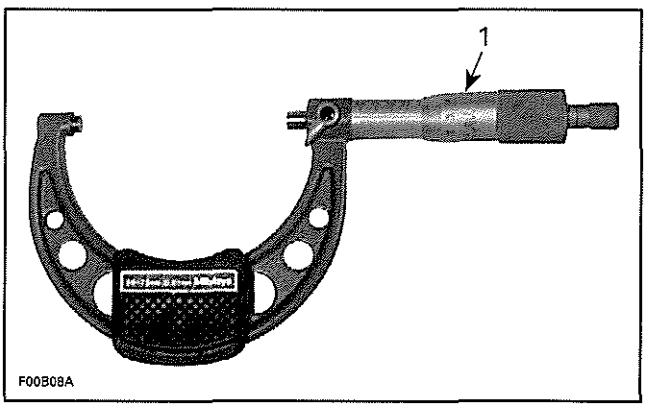
TYPICAL
1. Measuring perpendicularly (90°) to piston pin axis
A. 8.5 mm (11/32 in)

PISTON MEASUREMENT	
NEW NOMINAL	73.950 mm to 73.966 mm (2.911 in to 2.912 in)
SERVICE LIMIT	73.92 mm (2.9102 in)

Replace piston if it is out of specification.

Piston/Cylinder Clearance

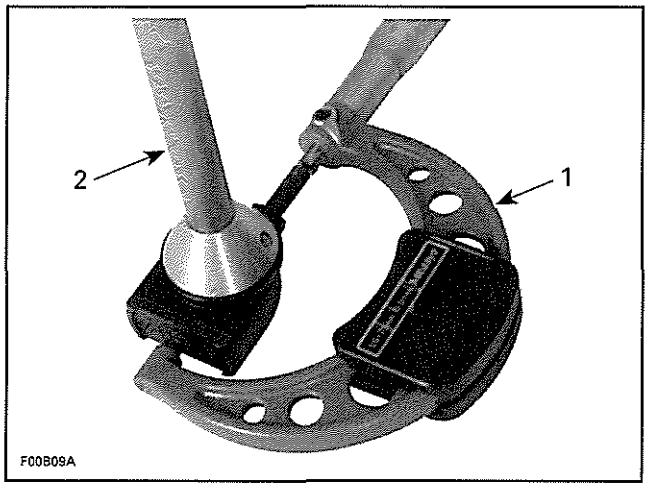
1. Adjust and lock a micrometer to the piston dimension.



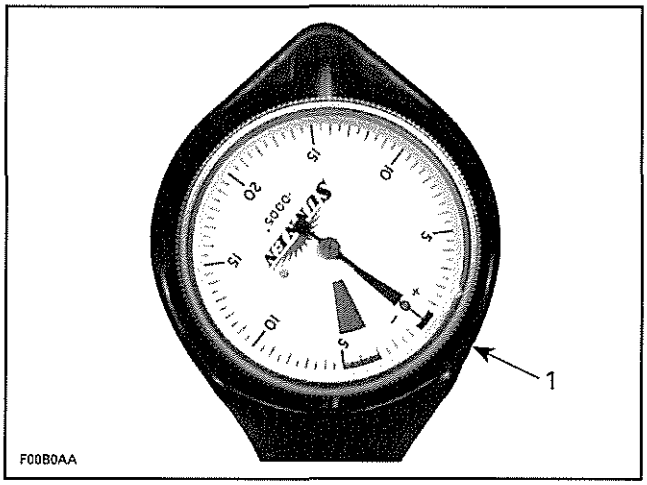
TYPICAL
1. Micrometer set to the piston dimension

NOTE: Make sure used piston is not worn.

2. With the micrometer locked at step 1, adjust a cylinder bore gauge to the micrometer dimension and set the indicator to 0 (zero).



TYPICAL
1. *Use the micrometer to set the cylinder bore gauge*
2. *Cylinder bore gauge*



TYPICAL
1. *Indicator set to 0 (zero)*

NOTE: Make sure the cylinder bore gauge indicator is set exactly at the same position as with the micrometer, otherwise the reading will be false.

3. Position the cylinder bore gauge 35 mm (1-3/8 in) below the cylinder head mating surface, measuring perpendicularly (90°) to piston pin axis.
4. Read the measurement on the cylinder bore gauge. The result is the exact piston/cylinder clearance.

PISTON/CYLINDER CLEARANCE	
NEW NOMINAL	0.037 mm to 0.067 mm (.0015 in to .0026 in)
SERVICE LIMIT	0.08 mm (.0031 in)

If clearance exceeds the specified tolerance, replace the piston and repeat the measurement procedure.

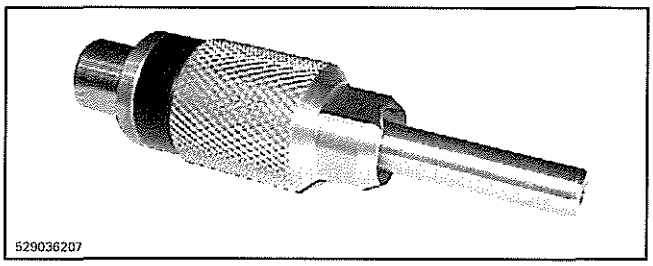
Piston and Connecting Rod Assembly

For assembly, reverse the disassembly procedure. Pay attention to the following details.

1. Apply engine oil on the piston pin.
2. Insert piston pin into piston and connecting rod.

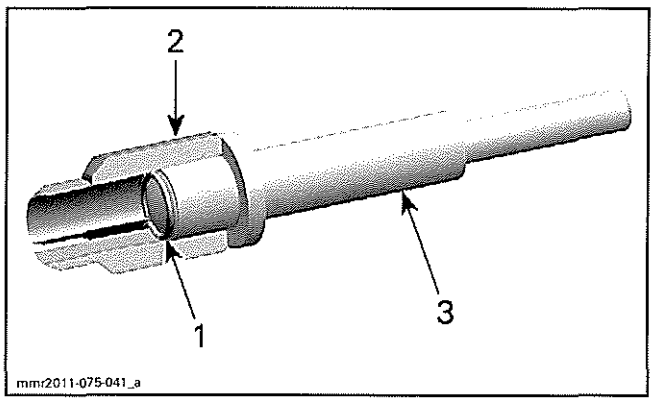
NOTE: Ensure to reinstall all parts in their original position as marked during removal.

3. Install NEW piston pin circlip(s) by using the PISTON CIRCLP INSTALLER (P/N 529 036 207). Proceed as follows.



NOTICE Always replace removed piston pin circlips by NEW ones.

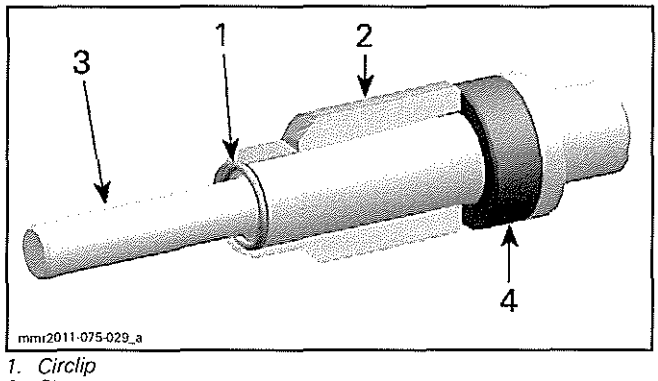
3.1 Place the circlip in the sleeve and push piston circlip installer handle until circlip reaches the mid position in the sleeve.



TYPICAL
1. *Circlip*
2. *Sleeve*
3. *Installer handle*

3.2 Put the distance sleeve on the installer handle.

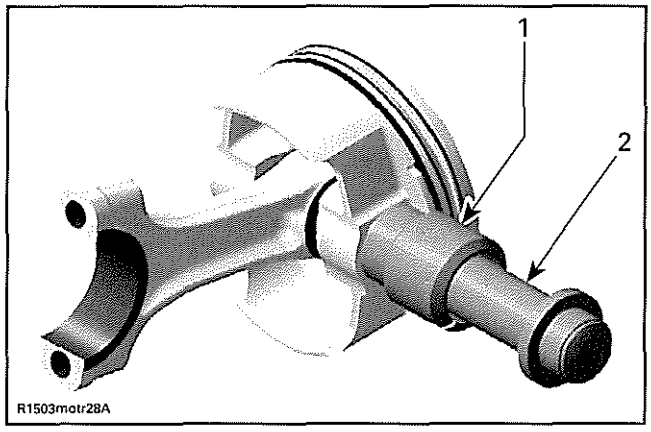
3.3 Push piston circlip installer handle until distance sleeve makes contact with the sleeve.



1. *Circlip*
2. *Sleeve*
3. *Installer handle*
4. *Distance sleeve*

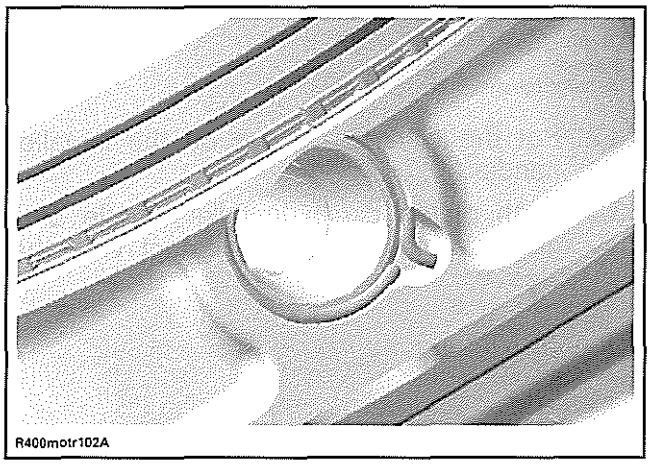
3.4 Remove distance sleeve and insert installer handle into the sleeve.

3.5 Insert the end of the handle into the piston pin, then push to engage the circlip into the piston groove.



TYPICAL
1. *Sleeve with piston circlip inside*
2. *Piston clip installer handle*

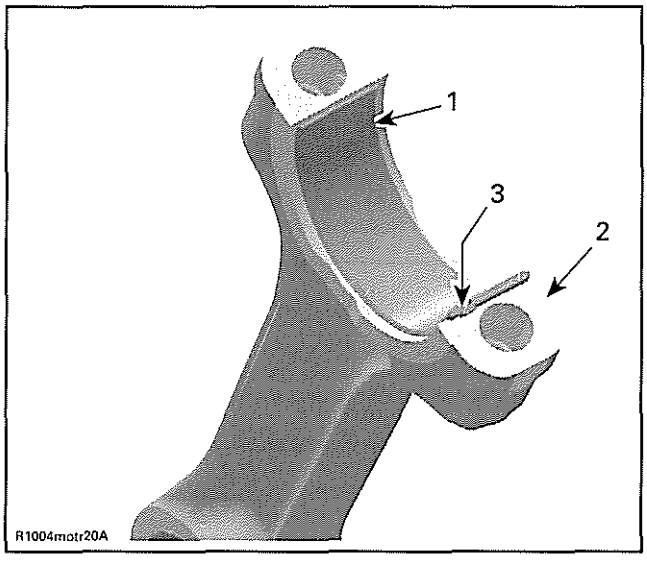
NOTE: Take care that the hook of the piston pin circlip is positioned properly.



CORRECT POSITION OF THE PISTON PIN CIRCLIP

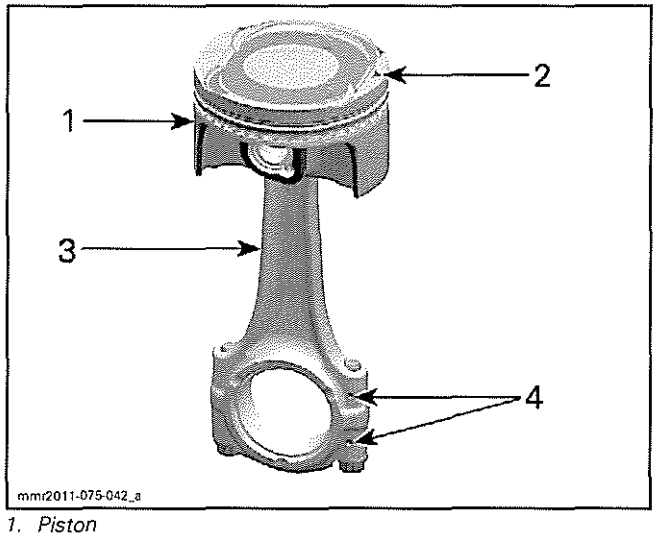
NOTICE If piston pin circlip installation fails, repeat step 3 by using a NEW circlip.

4. Correctly install plain bearings and carefully clean split surface on both sides (cracked area) with compressed air.



TYPICAL
1. *Half bearing of connecting rod big end*
2. *Split surface of the connecting rod*
3. *Protrusion of bearing in line with connecting rod groove*

NOTICE The arrow on top of the piston and the punched marks on the connecting rods must always point towards exhaust.



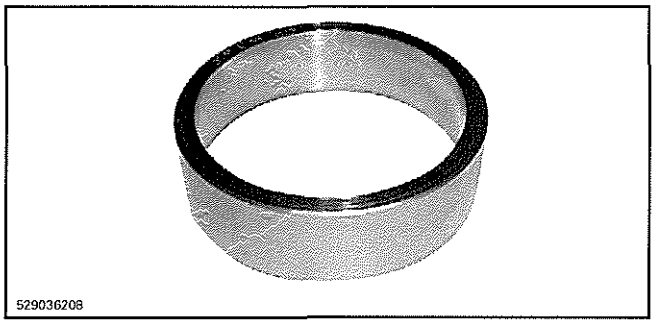
1. *Piston*
2. *Arrow on top*
3. *Connecting rod*
4. *Punched marks*

Piston and Connecting Rod Installation

1. Use engine oil and lubricate:
   - Piston
   - Piston rings

– Cylinder bore
– Connecting rod bearings.

2. Slide piston into cylinder bore by using the PISTON RING COMPRESSOR (P/N 529 036 208). Pay attention to the following.

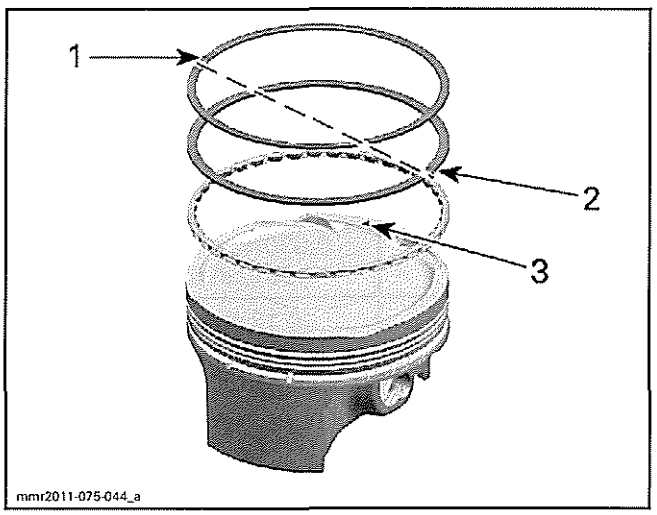


2.1 If reused, install piston in its original bore.

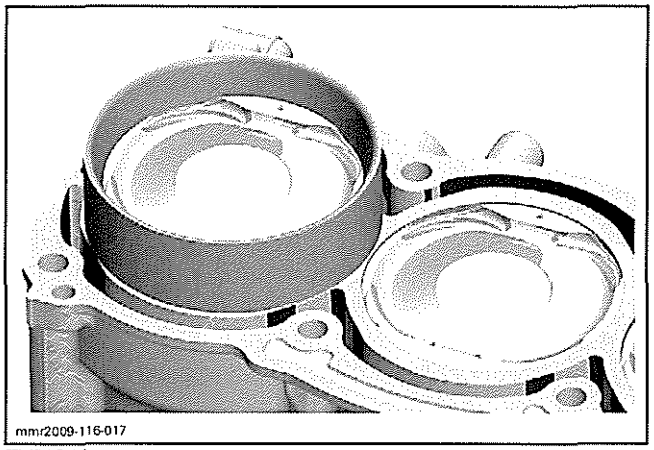
2.2 Piston rings are properly installed (spacing). See procedure in this subsection.

2.3 The arrow on top of the piston must point towards exhaust.

NOTICE The ring gaps of both compression rings should always be 180° from each other and 90° from the arrow on top of the piston.

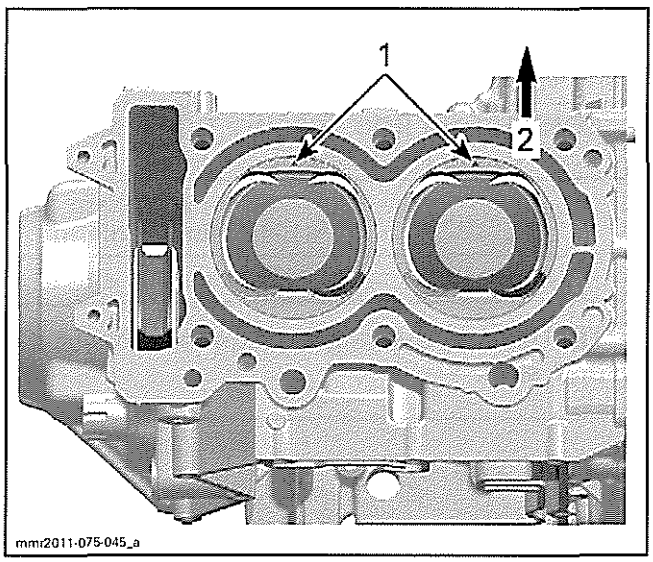


RING GAPS AT 180° FROM EACH OTHER AND 90° FORM ARROW
1. *Rectangular ring - ring gap*
2. *Taper-face ring - ring gap*
3. *Arrow*



TYPICAL

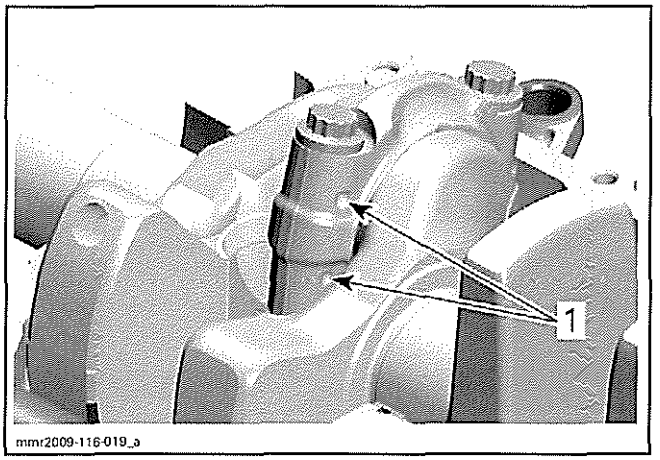
NOTICE Piston installed with the arrow in the wrong direction would cause serious engine damage.



1. *Arrows*
2. *Exhaust*

3. Turn cylinder block upside down.
4. Install *CRANKSHAFT* as per procedure in this subsection.
5. Oil the crankshaft pin.
6. Install connecting rod caps.

NOTE: Printed marks on connecting rod and cap must point together.



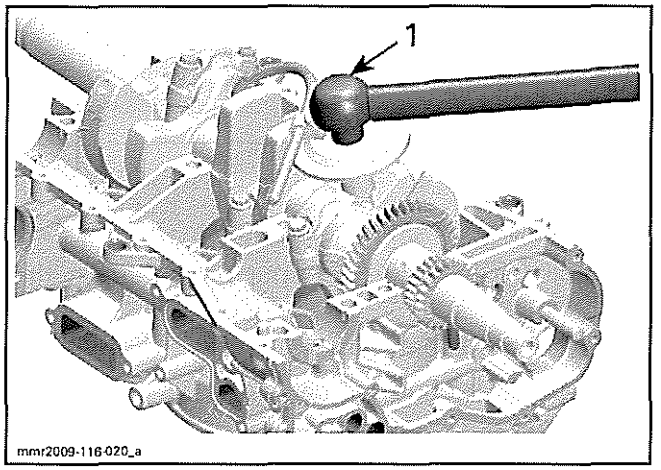
TYPICAL
1. Printed marks

NOTICE This assembly uses stretch screws. Always use NEW screws and strictly adhere to the tightening procedure.

7. Apply oil on the connecting rod screw heads and tighten as follows:

CONNECTING ROD SCREWS TIGHTENING TORQUE	
First step	12 N•m ± 0.2 N•m (106 lbf•**in** ± 2 lbf•**in**)
Second step	Additional 70° ± 5°

NOTE: Use a torque angle gauge to carry out the second step.



1. Torque angle gauge

NOTICE Failure to strictly follow this procedure may cause screws to loosen and lead to severe engine damage.

8. Install all other removed parts.

PISTON RINGS

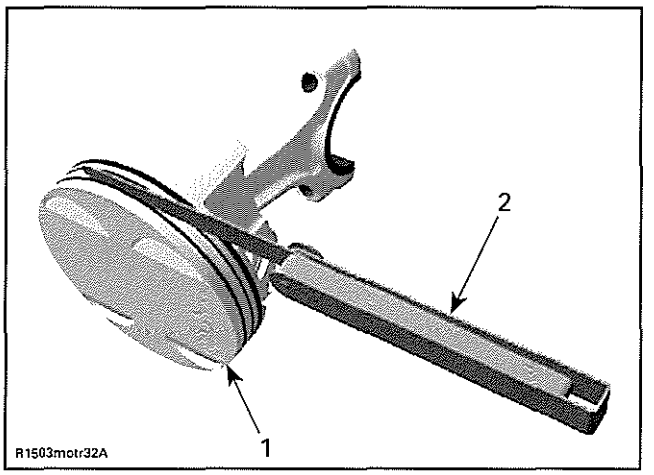
Piston Ring Removal

1. Remove piston, see procedure in this subsection.
2. Remove rings from piston.

Piston Ring Inspection

Ring/Piston Groove Clearance

Using a feeler gauge measure each ring/piston groove clearance.



TYPICAL
1. Piston
2. Feeler gauge

RING/PISTON GROOVE CLEARANCE	
UPPER COMPRESSION RING	
NEW	0.030 mm to 0.066 mm (.0012 in to .0026 in)
SERVICE LIMIT	0.12 mm (.0047 in)
LOWER COMPRESSION RING	
NEW	0.020 mm to 0.056 mm (.0008 in to .0022 in)
SERVICE LIMIT	0.12 mm (.0047 in)0.12 mm
OIL SCRAPER RING	
NEW	0.010 mm to 0.040 mm (.0004 in to .0016 in)
SERVICE LIMIT	0.15 mm (.0059 in)

If clearance is out of specification, the piston and rings should be replaced.

Ring End Gap

1. Place piston ring in the cylinder bore between 8 mm to 16 mm (5/16 in to 5/8 in) from the top of cylinder.

NOTE: In order to correctly position the ring in the cylinder bore, use a piston as a pusher.

2. Using a feeler gauge, check ring end gap.

RING END GAP	
UPPER COMPRESSION RING	
NEW	0.20 mm to 0.35 mm (.008 in to .014 in)
SERVICE LIMIT	1.2 mm (.047 in)
LOWER COMPRESSION RING	
NEW	0.30 mm to 0.50 mm (.012 in to .02 in)
SERVICE LIMIT	1.2 mm (.047 in)
OIL SCRAPER RING	
NEW	0.20 mm to 0.70 mm (.0079 in to .0276 in)
SERVICE LIMIT	1.2 mm (.047 in)

If ring end gap is out of specification, replace piston rings.

Piston Ring Installation

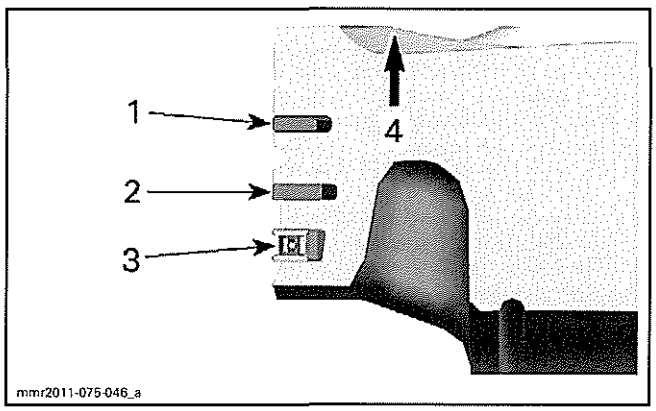
1. Install piston rings in the following order.

   NOTE: Use a ring expander to prevent breakage during installation. The oil ring must be installed by hand.

   1.1 Install oil scraper ring.

   1.2 Install the lower compression ring with the letter "N" facing up.

   1.3 Install upper compression ring with the letter "N" facing up.



1. Rectangular ring
2. Taper-face ring
3. Oil scraper ring
4. Letter "N" facing up

NOTICE Ensure that upper and lower compression rings are not interchanged.

2. Check that rings rotate smoothly after installation.

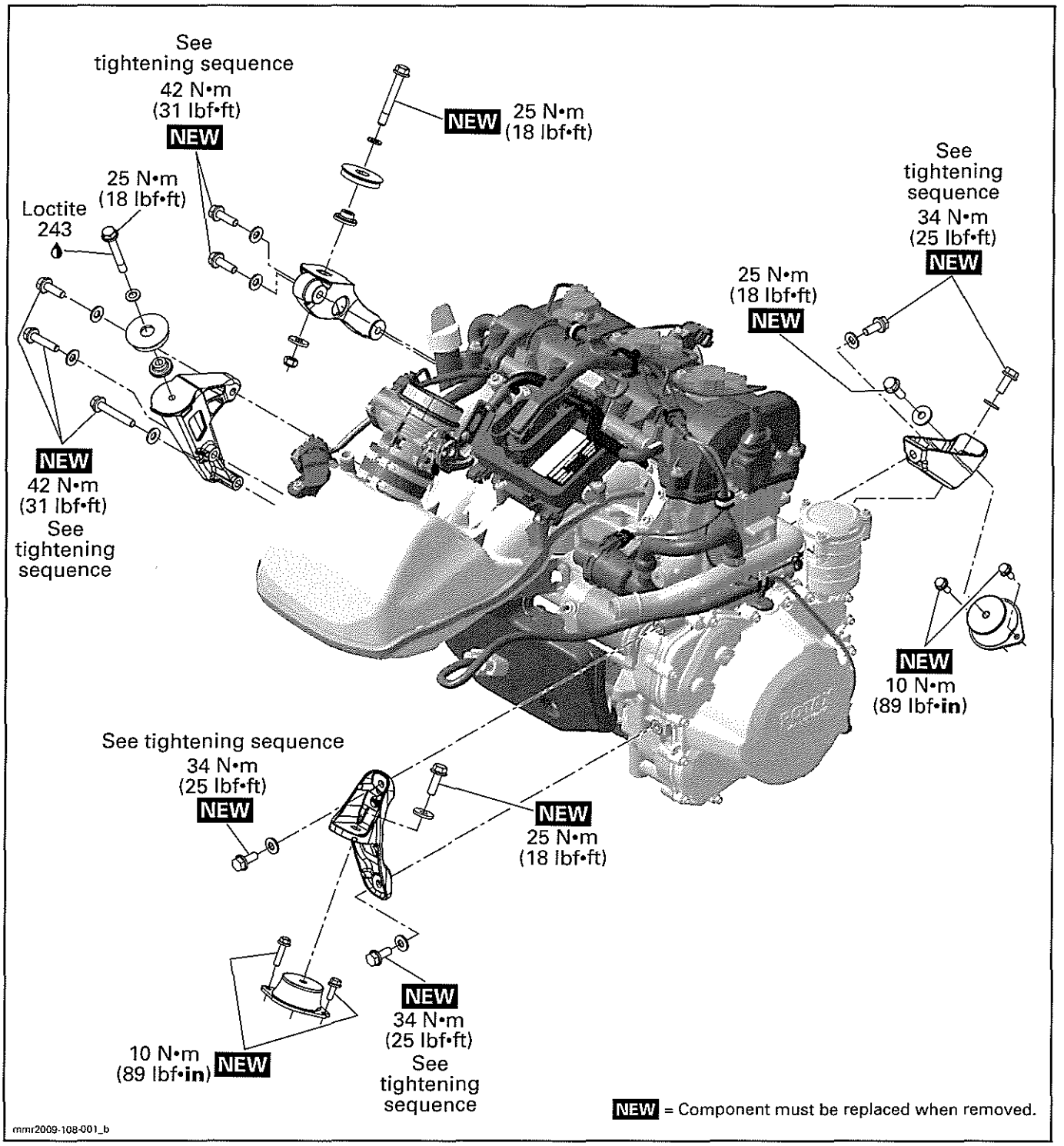
ENGINE REMOVAL AND INSTALLATION

SERVICE TOOLS

Description	Part Number	Page
ENGINE LIFTING TOOL	529 036 151	281, 285, 289

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 243 (BLUE)	293 800 060	288


See tightening sequence
42 N•m (31 lbf•ft)
NEW
NEW 25 N•m (18 lbf•ft)
25 N•m (18 lbf•ft)
Loctite 243
See tightening sequence
34 N•m (25 lbf•ft)
NEW
25 N•m (18 lbf•ft)
NEW
NEW
42 N•m (31 lbf•ft)
See tightening sequence
NEW
10 N•m (89 lbf•in)
See tightening sequence
34 N•m (25 lbf•ft)
NEW
NEW
25 N•m (18 lbf•ft)
NEW
34 N•m (25 lbf•ft)
See tightening sequence
10 N•m (89 lbf•in) NEW
NEW = Component must be replaced when removed.
mmr2009-108-001_b

GENERAL

During assembly/installation, use the torque values and service products as in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, cotter pin, etc.) must be replaced.

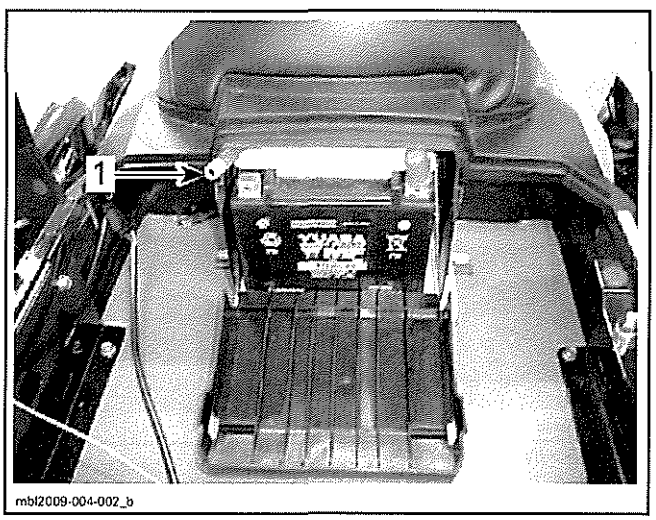
NOTICE Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.

PROCEDURES

ENGINE

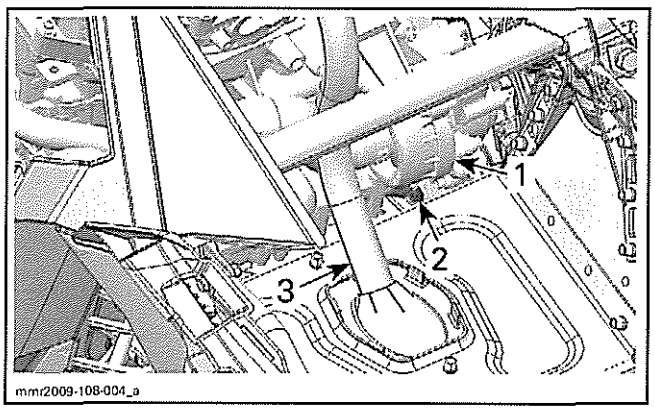
Engine Removal

1. Place vehicle at a workstation where a hoist can be used.
2. Refer to *BODY* subsection and remove:
   - LH and RH side panels
   - Hood
   - Air intake silencer.
3. Remove the fuel tank. Refer to *FUEL TANK AND FUEL PUMP* subsection.
4. Disconnect the negative (–) cable from battery.



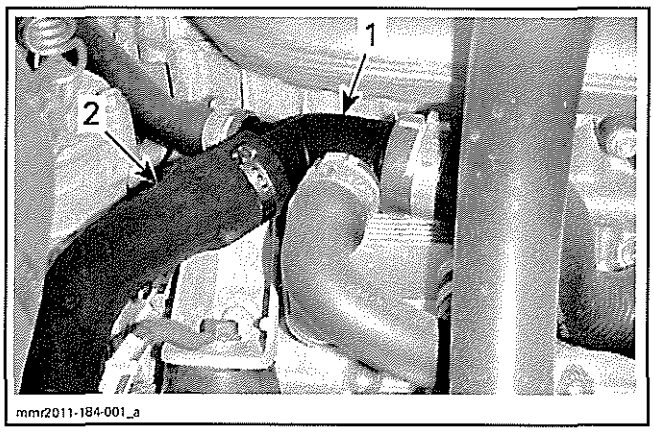
1. Negative (-) battery cable

5. Refer to *EXHAUST SYSTEM* subsection and remove:
   - Muffler
   - Exhaust pipe
   - Exhaust manifold.
6. Drain the cooling system. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.



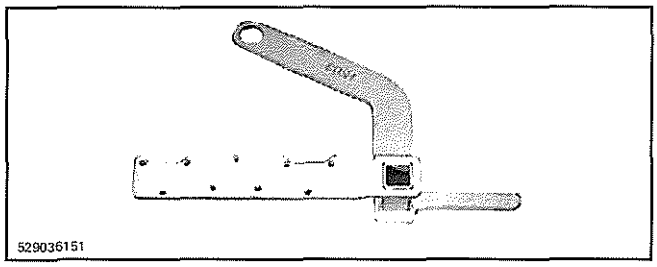
TYPICAL
1. Water pump
2. Drain screw
3. Steering column

7. Remove the radiator hose at the water pump coolant inlet manifold.

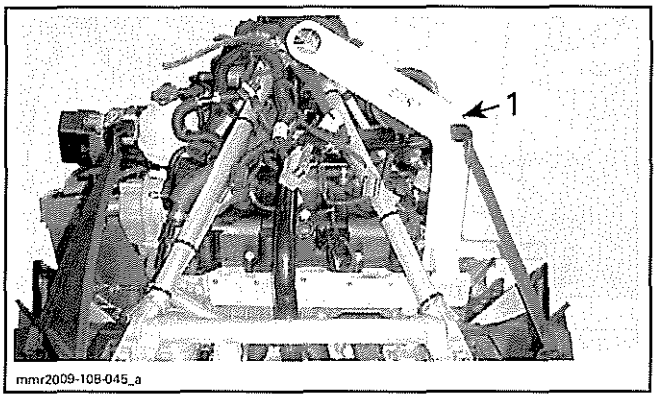


FRONT OF ENGINE
1. Water pump coolant inlet manifold
2. Radiator hose

8. Remove the drive pulley. Refer to *DRIVE PULLEY (TRA IV)* subsection.
9. Remove the driven pulley. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 HO E-TEC AND 1200 4-TEC)* subsection.
10. Use the ENGINE LIFTING TOOL (P/N 529 036 151).
    10.1 Install the tool instead of exhaust manifold.



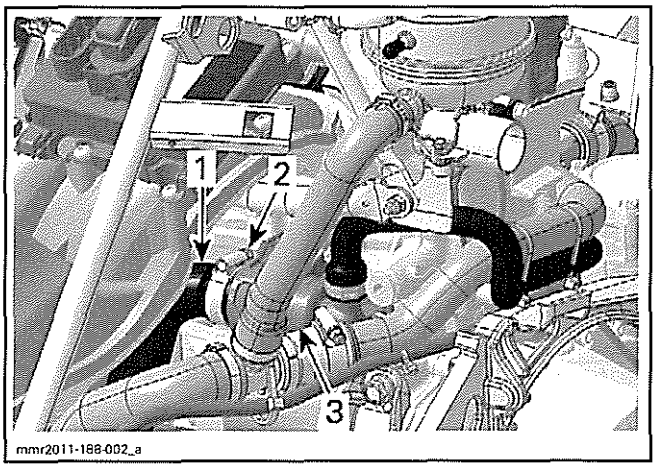
10.2 Using exhaust manifold nuts, secure the tool.



TYPICAL
1. Engine lifting tool

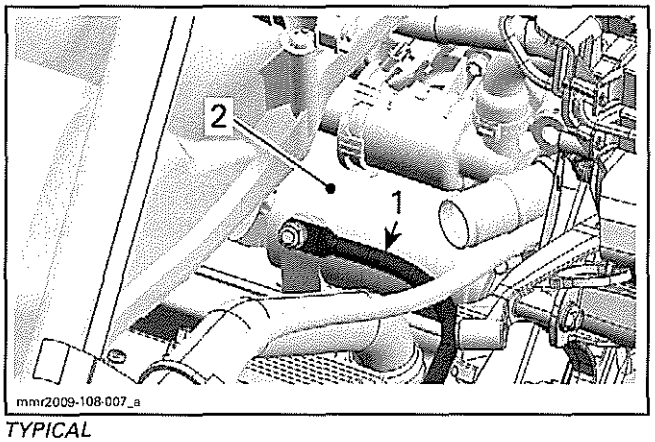
10.3 Install a hoist.

11. Disconnect the engine coolant outlet hose from thermostat.



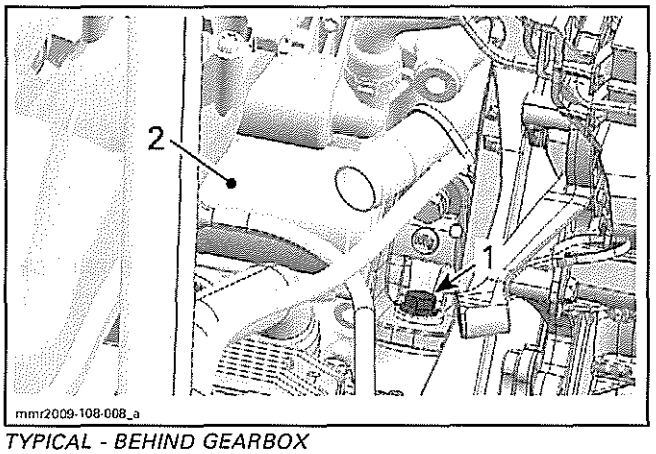
RH REAR VIEW - GEARBOX NOT SHOWN
1. Coolant outlet hose
2. Clamp to remove
3. Thermostat

12. Disconnect starter cable from starter.



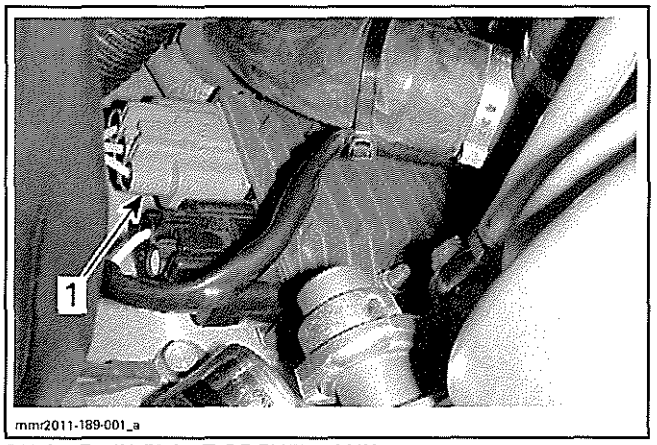
TYPICAL
1. Starter cable
2. Starter

13. Remove the RH rear engine rubber mount screw.



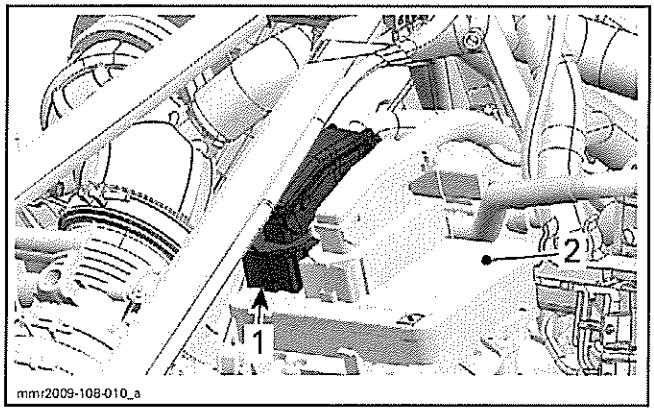
TYPICAL - BEHIND GEARBOX
1. Engine rubber mount screw
2. Starter

14. Unplug the magneto connector from the voltage regulator.



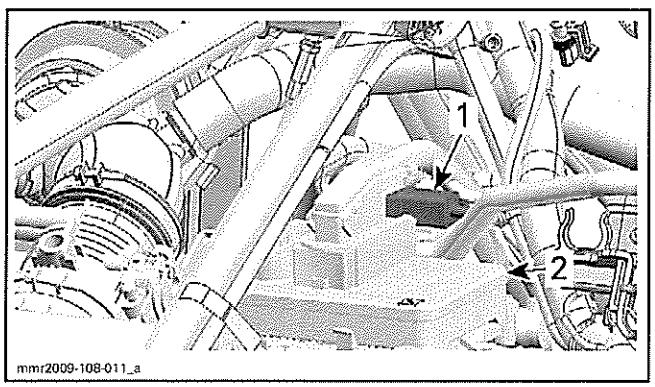
RH SIDE - IN FRONT OF FUEL TANK
1. Magneto connector

15. Unplug the connector B from the ECM.



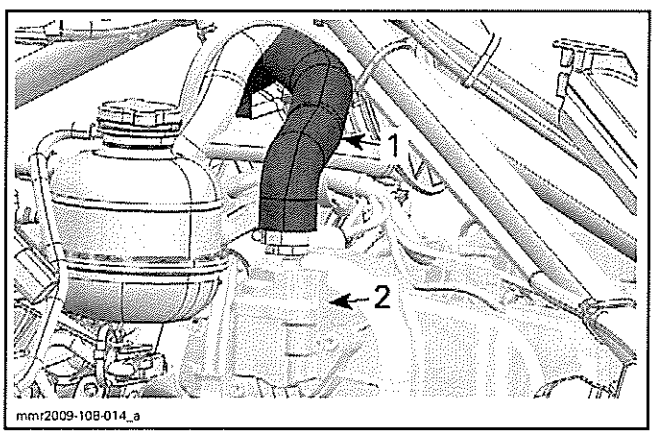
1. B connector
2. ECM

16. Unplug the engine connector.



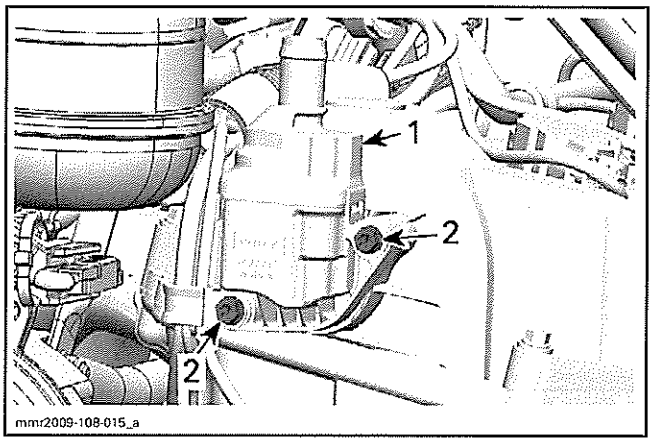
1. Engine connector
2. ECM

17. Cut locking ties securing the harness of ECM connector B to ECM support.
18. Remove throttle body, refer to *ELECTRONIC FUEL INJECTION (EFI)* subsection.
19. Disconnect the breather hose.



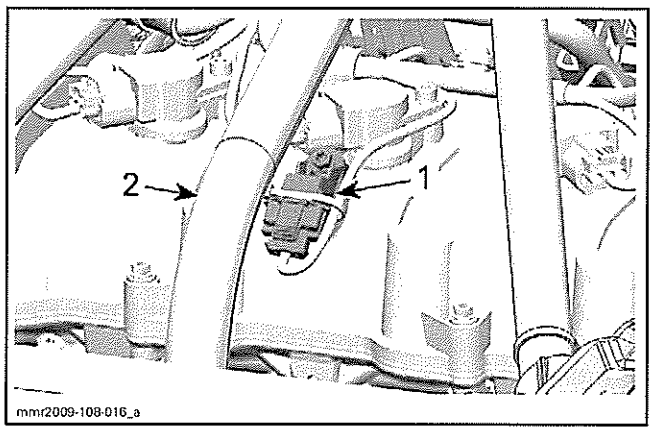
1. Breather hose
2. Breather

20. Remove breather from engine.



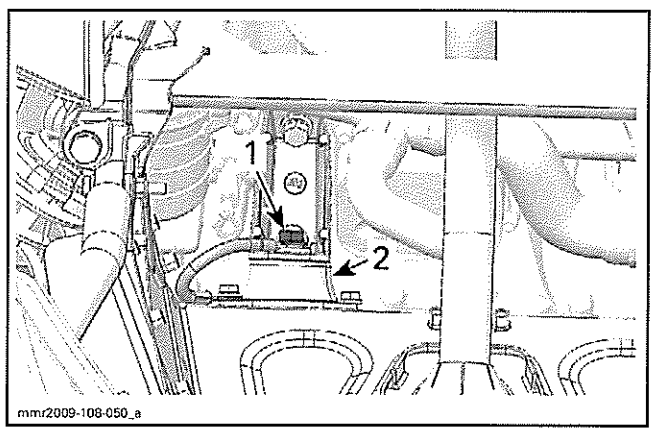
1. Breather
2. Remove these screws

21. Remove screw securing the camshaft position sensor (CAPS) then move the sensor aside.



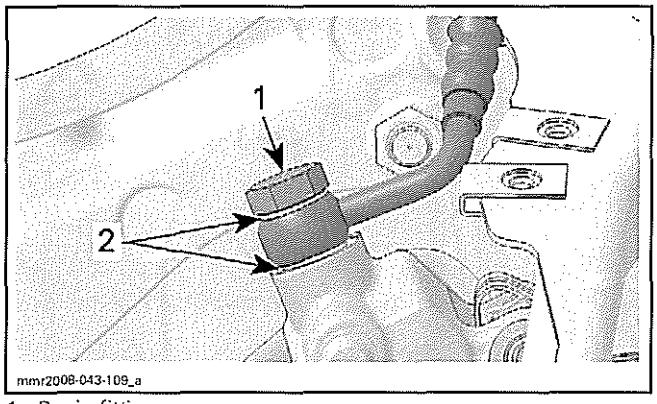
1. CAPS sensor
2. Steering column

22. Remove screw securing the front RH engine support to engine rubber mount.



1. Engine support screw
2. Engine rubber mount

23. Remove the brake caliper Banjo fitting then move the brake hose aside. Discard sealing washers.



1. Banjo fitting
2. Sealing washers

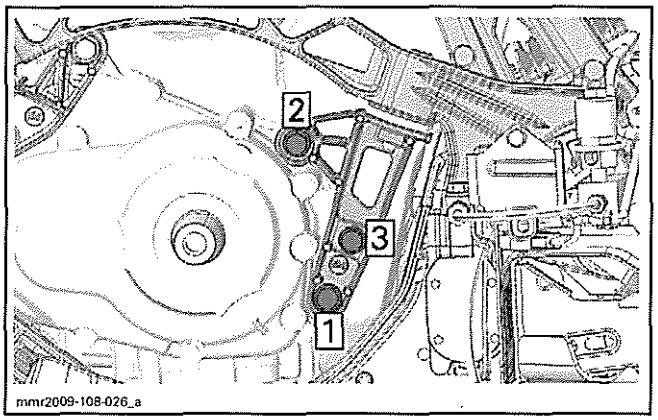
24. Remove the countershaft bearing support along with the brace and rear engine support. Refer to *DRIVE SYSTEM AND BRAKE* section.
25. Lift engine and slide it out of vehicle.

Engine Installation

To install the engine, reverse the removal procedure. However, pay attention to the following.

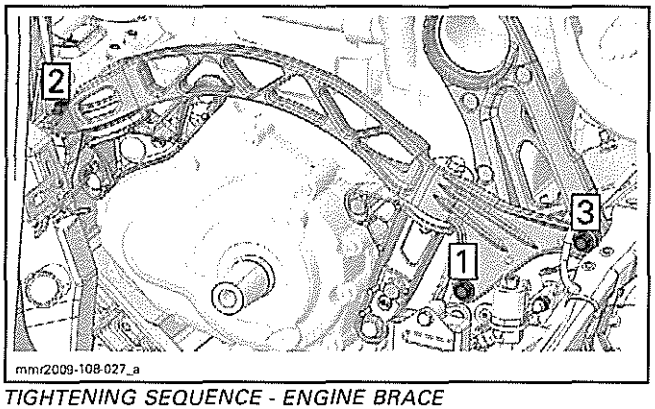
1. Install **NEW** self-locking fasteners where required, refer to exploded view.
2. Loosely install all engine support, countershaft bearing support and rubber mounts retaining fasteners before beginning the tightening sequence.
3. Tighten fasteners in this order:

LH REAR ENGINE SUPPORT	
Screw tightening torque (follow sequence)	42 N•m (31 lbf•ft)



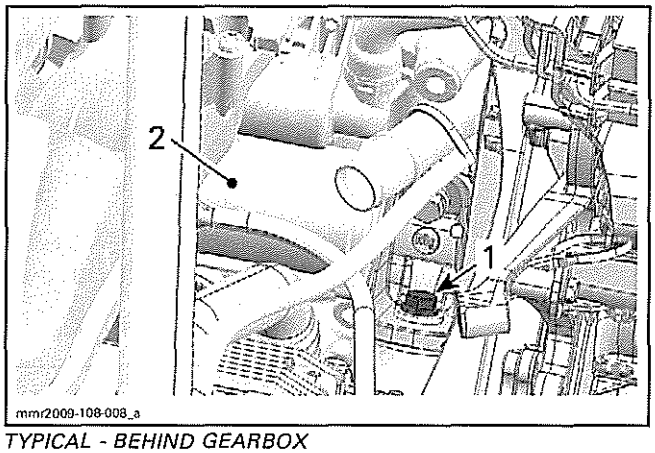
TIGHTENING SEQUENCE - LH REAR ENGINE SUPPORT

ENGINE BRACE	
Screw tightening torque (follow sequence)	25 N•m (18 lbf•ft)



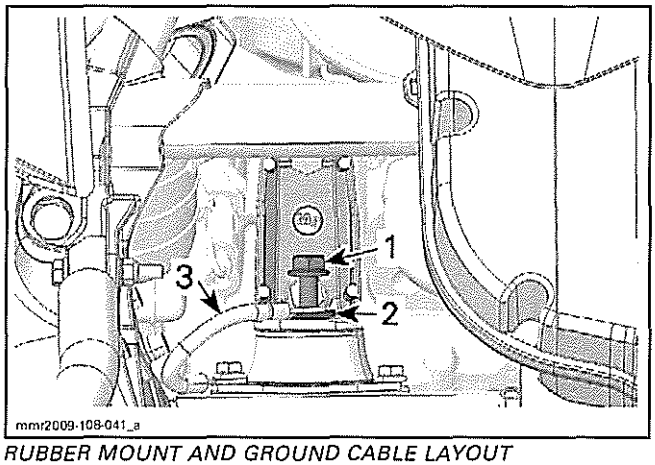
TIGHTENING SEQUENCE - ENGINE BRACE

RH REAR RUBBER MOUNT	
Screw tightening torque	25 N•m (18 lbf•ft)



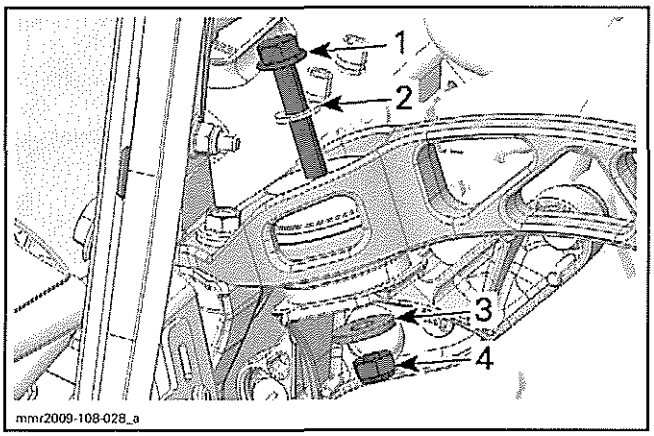
TYPICAL - BEHIND GEARBOX
1. Engine rubber mount screw
2. Starter

RH FRONT RUBBER MOUNT	
Screw tightening torque	25 N•m (18 lbf•ft)



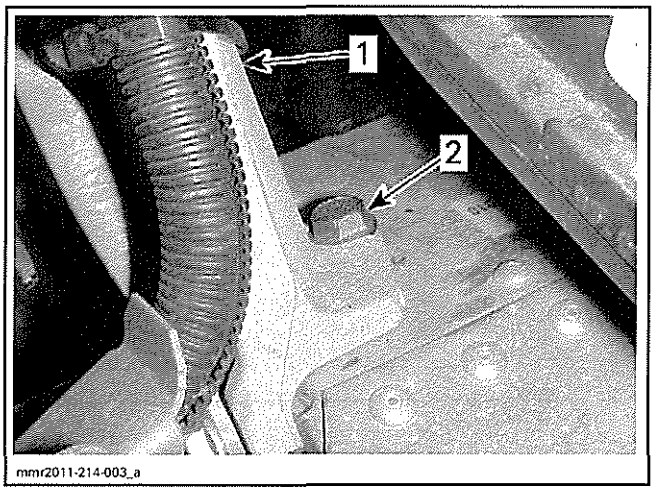
RUBBER MOUNT AND GROUND CABLE LAYOUT
1. Engine rubber mount screw
2. Washer
3. Ground cable

LH FRONT RUBBER MOUNT	
Bolt tightening torque	25 N•m (18 lbf•ft)



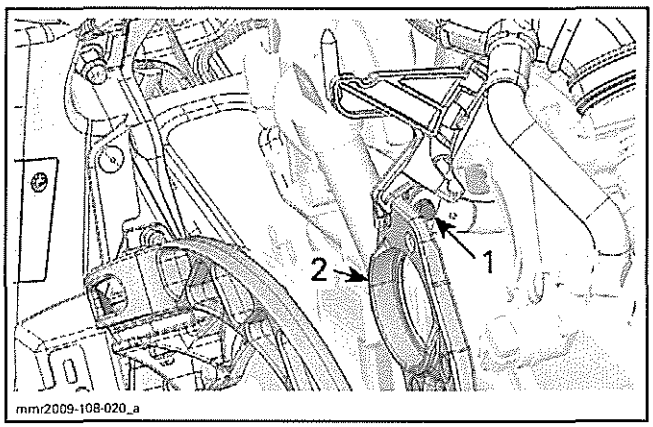
LH FRONT RUBBER MOUNT PARTS LAYOUT
1. *Bolt*
2. *Small flat washer*
3. *Large flat washer with Teflon*
4. *Nut*

REAR OF COUNTERSHAFT BEARING SUPPORT	
Screw tightening torque	34 N•m (25 lbf•ft)



1. *Countershaft bearing support*
2. *Screw*

COUNTERSHAFT BEARING SUPPORT TO FRAME MEMBERS	
Bolt tightening torque	14 N•m (124 lbf•**in**)



1. *Bolt*
2. *Countershaft bearing support*

4. Install all other removed parts.

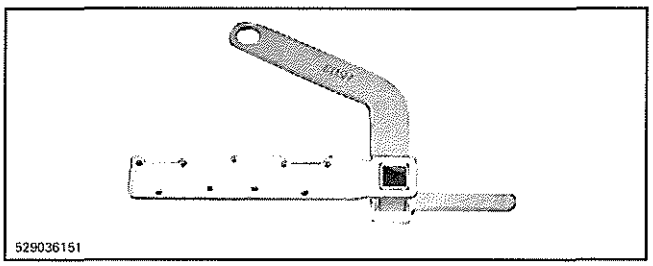
ENGINE SUPPORTS

Engine Support Inspection

Check if engine supports are cracked, bent or damaged. Replace if necessary.

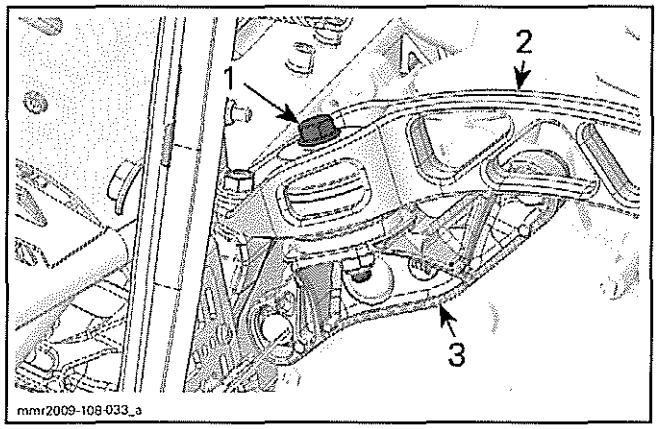
Engine Support Removal

NOTE: Remove the exhaust manifold and install the ENGINE LIFTING TOOL (P/N 529 036 151) before beginning the engine support removal procedure.



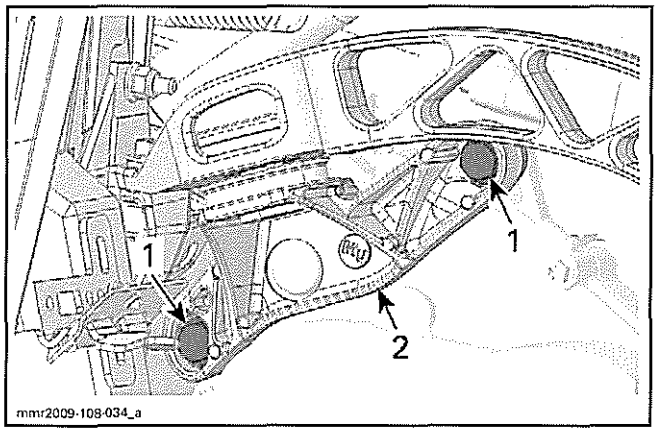
PTO Side Front Engine Support

1. Remove drive pulley, refer to *DRIVE PULLEY (TRA IV)* subsection.
2. Remove driven pulley. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 HO E-TEC AND 1200 4-TEC)* subsection.
3. Remove the bolt securing the engine rubber mount to the front engine support. Discard the nut.



1. Engine rubber mount bolt
2. Brace
3. Engine support

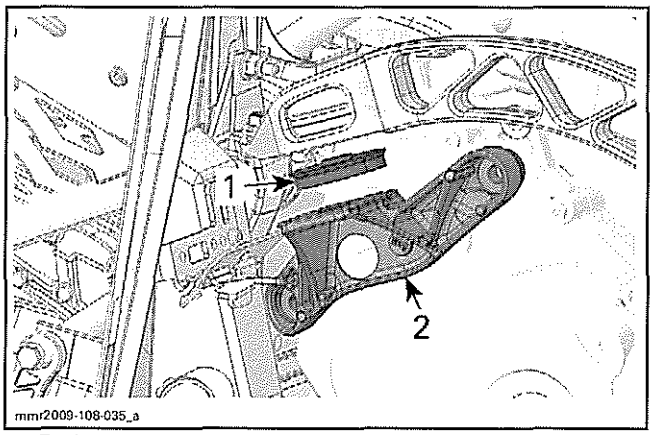
4. Remove screws securing the front engine support to the engine. To reach the front screw, use the following tools:
   - A 1/4 inch drive ratchet
   - A long extension adaptor
   - An universal joint
   - A short 13 mm socket.



1. Front engine support screws
2. Engine support

Discard engine support screws.

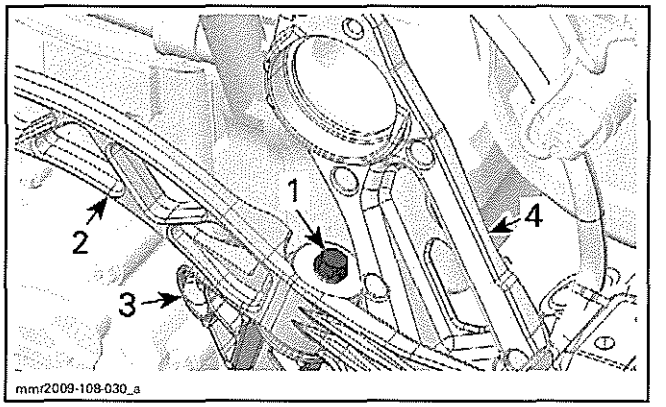
5. Remove the engine stopper and the engine support.



1. Engine stopper
2. Front engine support

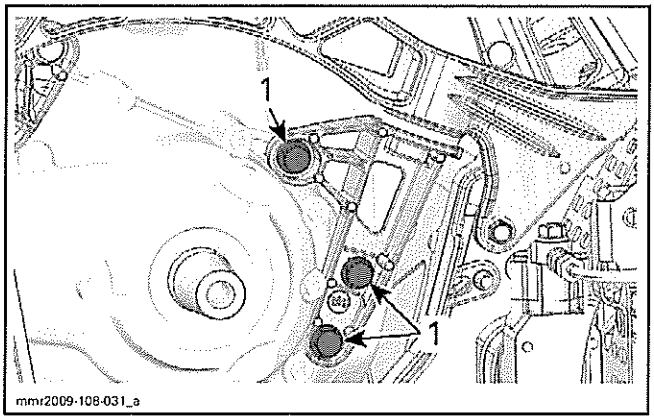
PTO Side Rear Engine Support

1. Remove drive pulley, refer to *DRIVE PULLEY (TRA IV)* subsection.
2. Remove driven pulley. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 HO E-TEC AND 1200 4-TEC)* subsection.
3. Loosen the bolt securing the rear engine rubber mount to rear engine support.



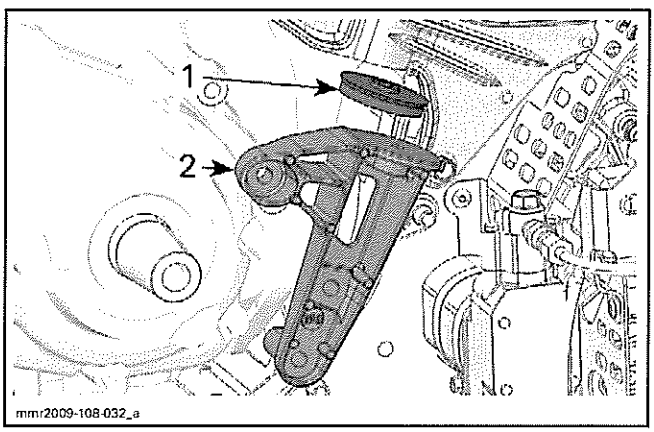
1. Engine rubber mount bolt
2. Brace
3. Engine support
4. Countershaft bearing support

4. Remove and discard the screws securing the rear engine support to the engine.



1. *Rear engine support screws*

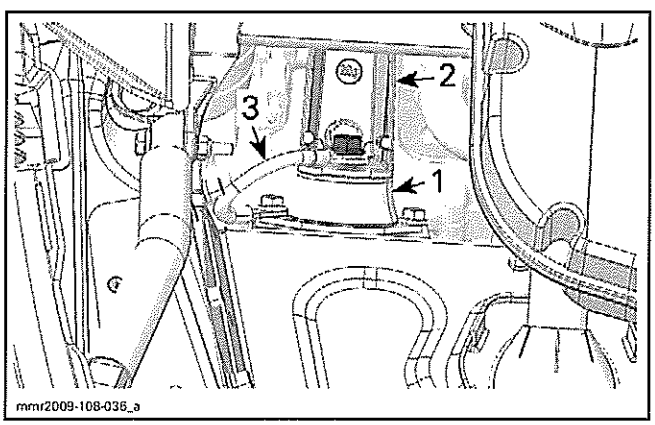
5. Remove the engine stopper and the engine support.



1. *Engine stopper*
2. *Rear engine support*

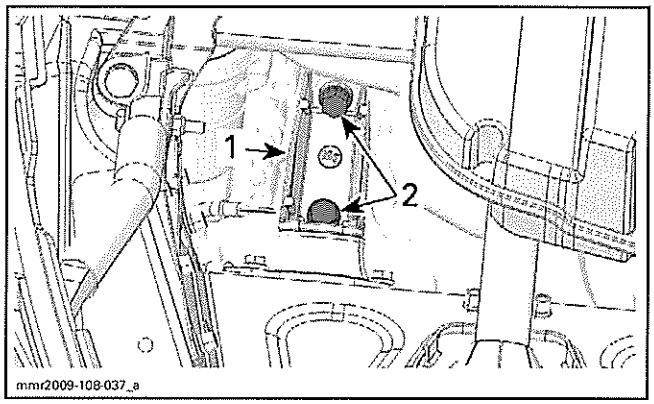
MAG Side Front Engine Support

1. Remove and discard the screw securing the ground cable and front engine support to engine rubber mount.



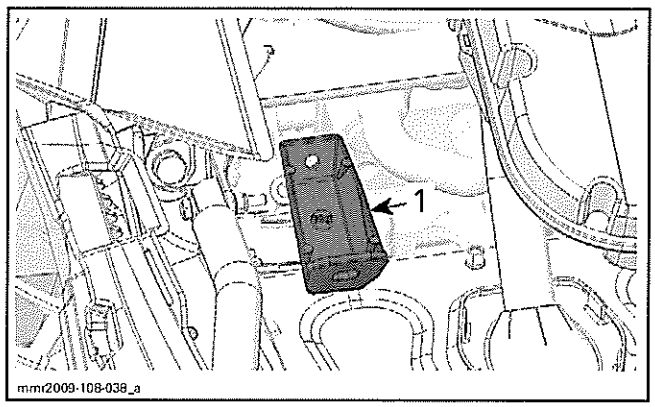
1. *Rubber mount*
2. *Engine support*
3. *Ground cable*

2. Remove and discard both screws retaining the engine support to the engine.



1. *Engine support*
2. *Engine support screws*

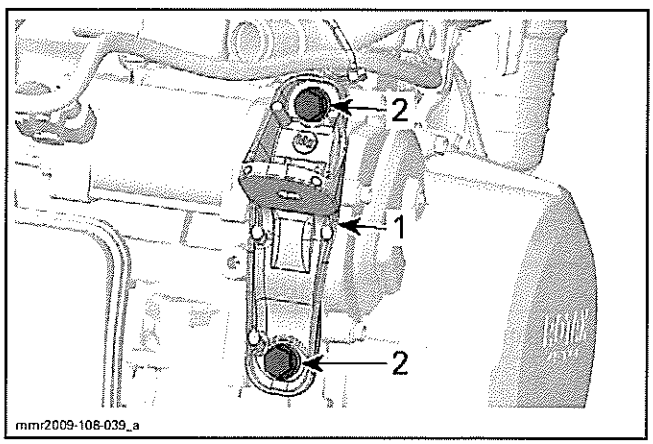
3. Remove engine support.



1. *Engine support*

MAG Side Rear Engine Support

1. Remove engine from the vehicle. Refer to *ENGINE REMOVAL* in this subsection.
2. Remove and discard both engine support screws.



1. *Engine support*
2. *Engine support screws*

Engine Support Installation

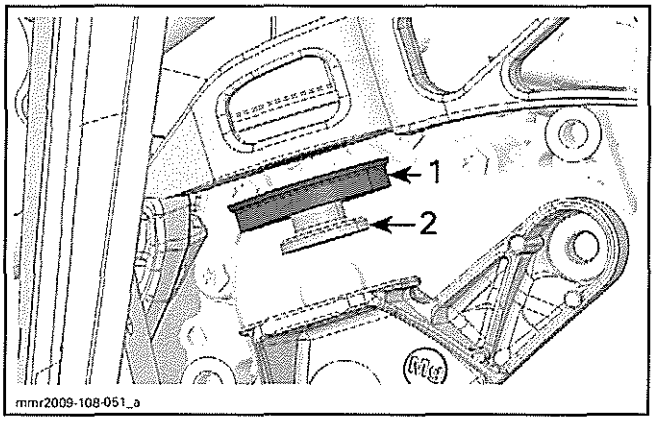
General Procedure

Install NEW self-locking fasteners where required, refer to exploded view.

Install all fasteners loosely before tightening.

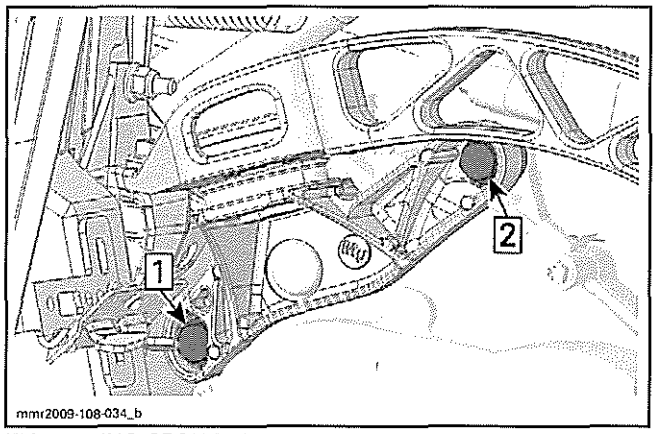
PTO Side Front Engine Support

1. Install the engine stopper and bushing.



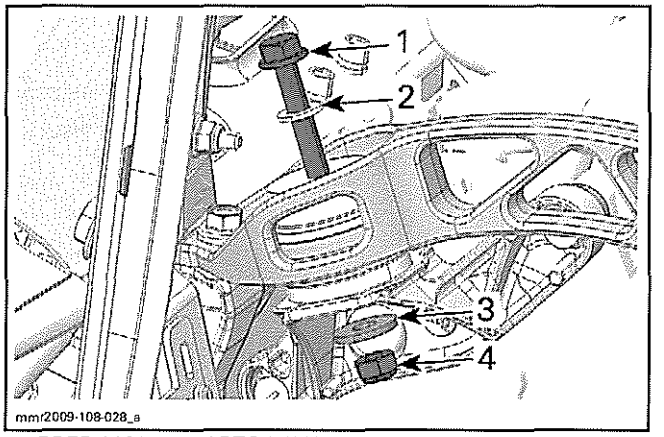
1. Engine stopper
2. Engine stopper bushing

PTO FRONT ENGINE SUPPORT	
Screw tightening torque (follow sequence)	42 N•m (31 lbf•ft)



TIGHTENING SEQUENCE

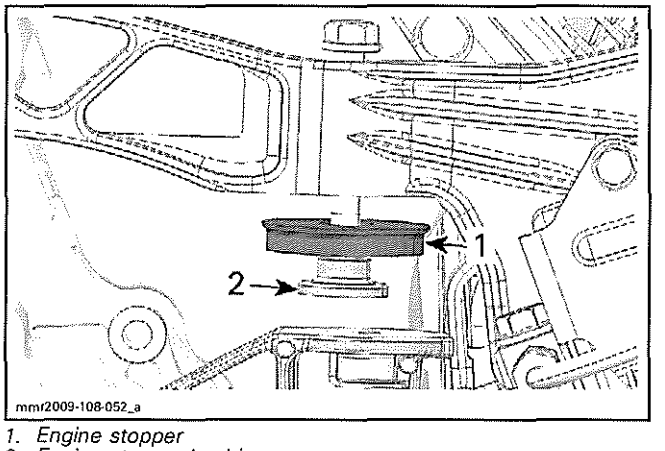
PTO FRONT RUBBER MOUNT	
Bolt tightening torque	25 N•m (18 lbf•ft)



RUBBER MOUNT PARTS LAYOUT
1. Bolt
2. Small flat washer
3. Large flat washer
4. Nut

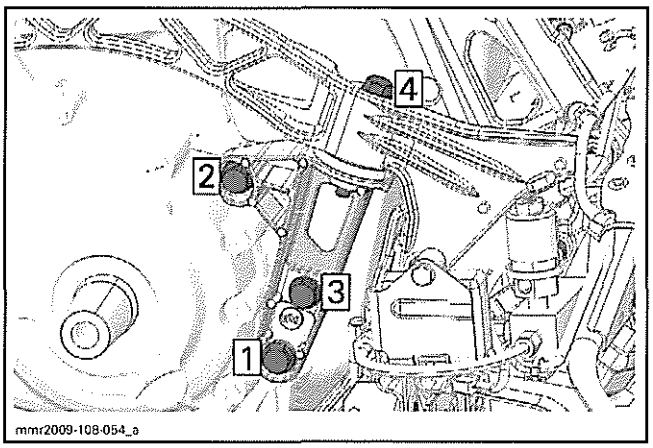
PTO Side Rear Engine Support

1. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on the rubber mount screw threads.
2. Install the engine stopper and bushing.



1. Engine stopper
2. Engine stopper bushing

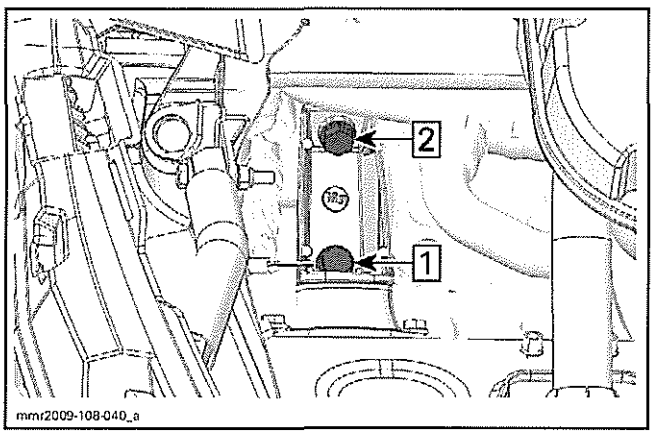
PTO REAR ENGINE SUPPORT	
Engine support screw tightening torque (follow sequence)	42 N•m (31 lbf•ft)
Rubber mount screw tightening torque (follow sequence)	25 N•m (18 lbf•ft)



TIGHTENING SEQUENCE

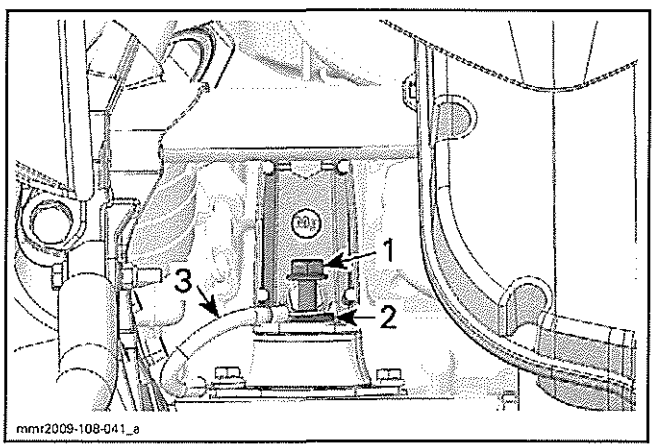
MAG Side Front Engine Support

MAG FRONT ENGINE SUPPORT	
Screw tightening torque (follow sequence)	34 N•m (25 lbf•ft)



TIGHTENING SEQUENCE

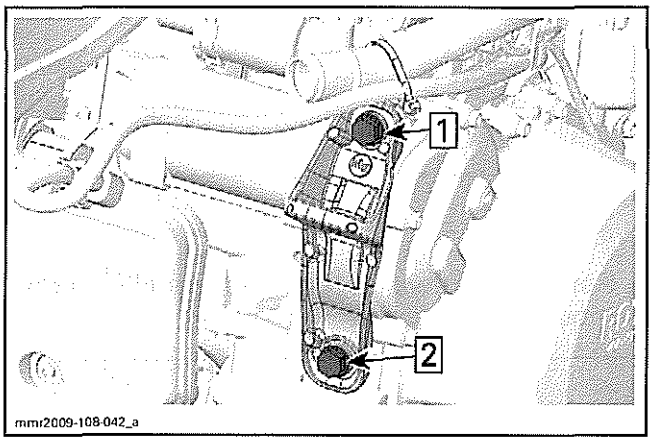
MAG FRONT RUBBER MOUNT	
Screw tightening torque	25 N•m (18 lbf•ft)



RUBBER MOUNT AND GROUND CABLE LAYOUT
1. *Engine rubber mount screw*
2. *Washer*
3. *Ground cable*

MAG Side Rear Engine Support

MAG REAR ENGINE SUPPORT	
Engine support screw tightening torque (follow sequence)	34 N•m (25 lbf•ft)



TIGHTENING SEQUENCE

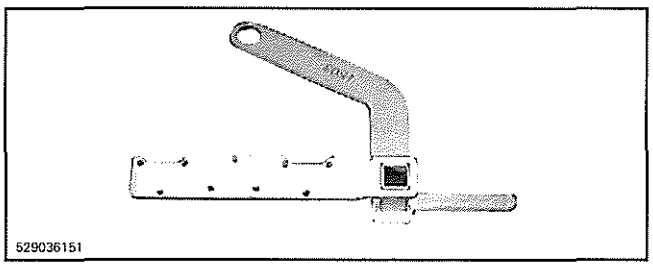
ENGINE RUBBER MOUNTS

Engine Rubber Mount Inspection

Check rubber mounts. Replace them if brittle, cracked or damaged.

Engine Rubber Mount Removal

NOTE: Remove the exhaust manifold and install the ENGINE LIFTING TOOL (P/N 529 036 151) before beginning the engine rubber mount removal procedure.

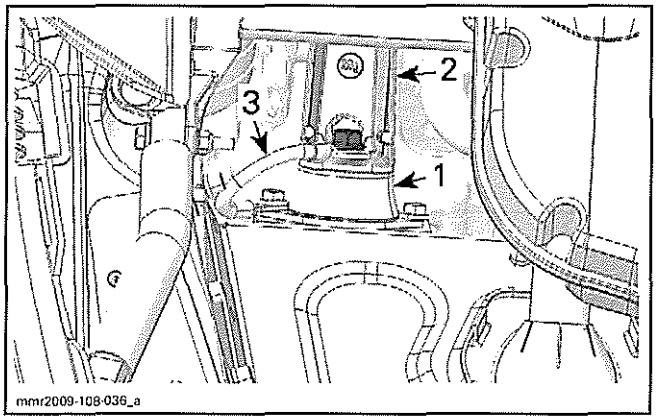


PTO Side Engine Rubber Mounts

The engine rubber mounts located on the brace are not available separately. Replace the brace when an engine rubber mount must be replaced. Refer to *DRIVE SYSTEM AND BRAKE* section.

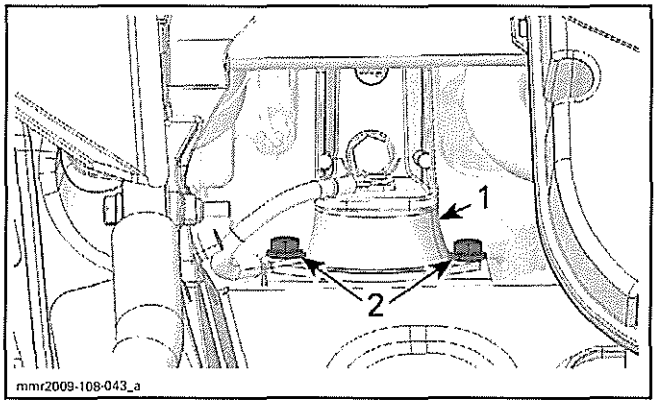
MAG Side Front Engine Rubber Mount

1. Remove and discard screw securing the ground cable and the front engine support to engine rubber mount.



1. *Rubber mount*
2. *Engine support*
3. *Ground cable*

2. Remove screws securing the engine rubber mount to the frame.

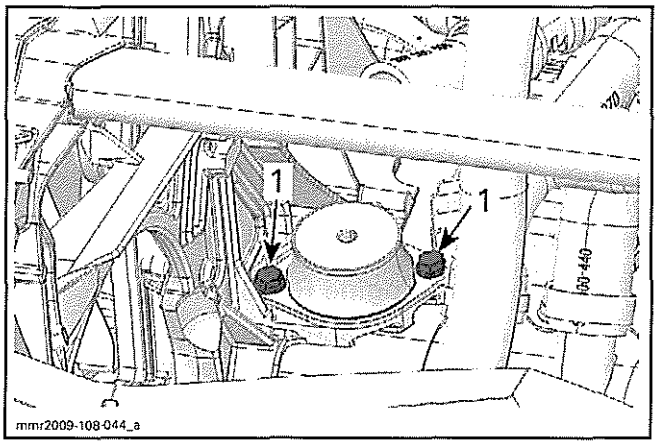


1. *Engine rubber mount*
2. *Retaining screws*

3. Remove the engine rubber mount.

MAG Side Rear Engine Rubber Mount

1. Remove gearbox from the vehicle. Refer to *GEARBOX* subsection.
2. Remove and discard both engine rubber mount screws.



1. *Engine rubber mount screws*

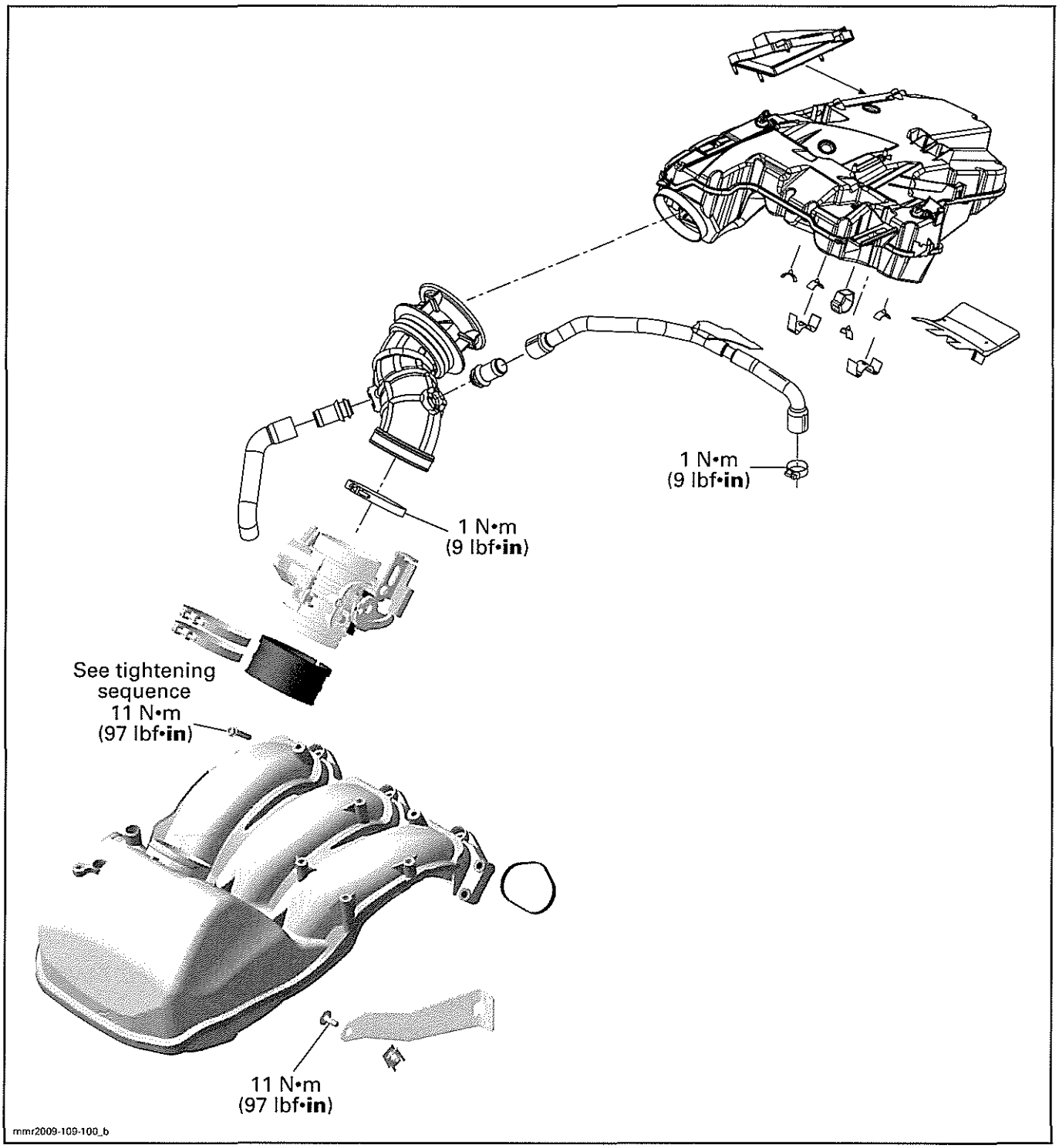
Engine Rubber Mount Installation

The installation is the reverse of the removal procedure.

AIR INTAKE SYSTEM

SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
SNAP-ON FLEXIBLE PICK-UP TOOL	dptc24	295



GENERAL

During assembly/installation, use the torque values and service products as in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices (e.g.: locking tabs, elastic stop nuts, cotter pins, etc.) must be replaced with a new ones.

Hoses or cables removed or disconnected must be installed and routed at the same place.

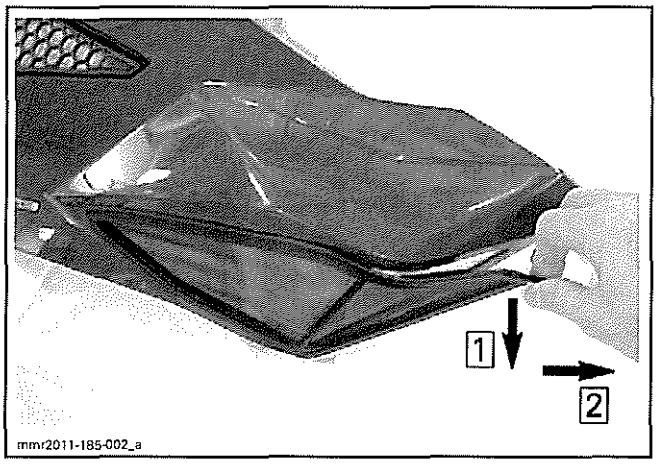
NOTICE **Locking ties removed during a procedure must be replaced and installed at the same location.**

PROCEDURES

AIR FILTER

Air Filter Removal

1. The air filter is located on left hand side of the hood.
2. Refer to *BODY* subsection and remove the hood.
3. To remove the air filter from the hood, proceed as per following illustration.



Step 1: Pull out on tab to release end
Step 2: Slide filter out of hood

Air Filter Cleaning

Clean with fresh water and mild soap.

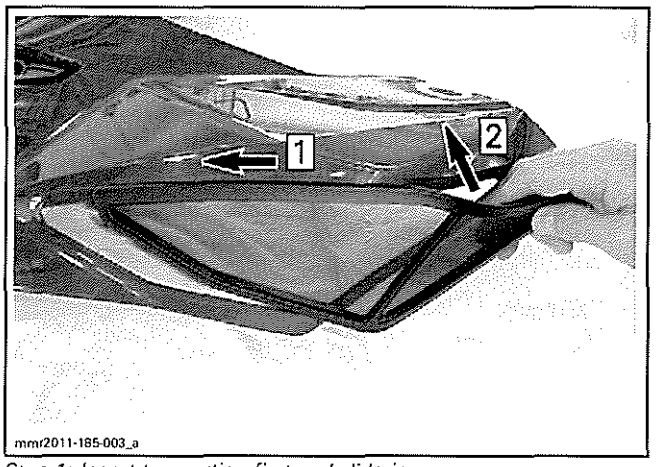
Replace air filter as required.

NOTE: If the filter is very dirty, clean the interior of air intake silencer at the same time.

Air Filter Installation

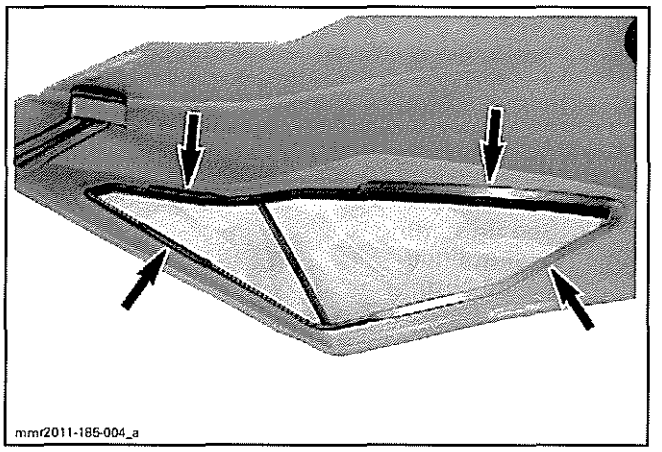
The installation is the reverse of the removal procedure.

Insert top portion of filter on hood, slide it in, then snap in the tab end of the filter.



Step 1: Insert top portion first and slide in
Step 2: Snap in the tab end

NOTE: Ensure filter retaining tabs are all properly engaged.



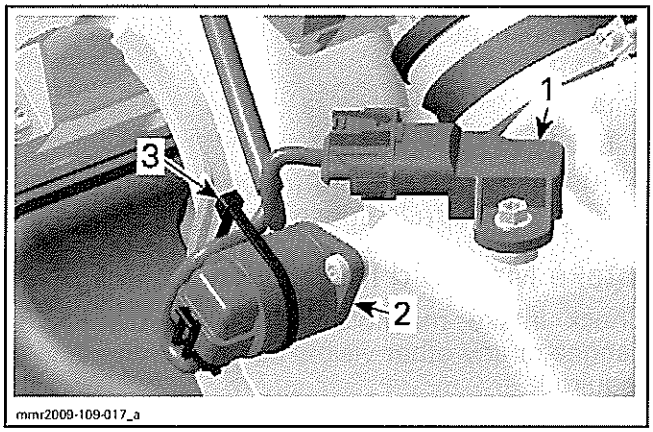
FILTER RETAINING TABS

INTAKE MANIFOLD

Intake Manifold Removal

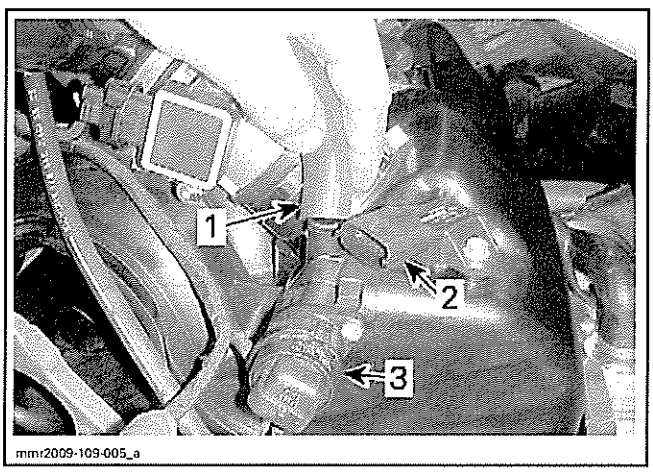
1. Remove fuel tank. Refer to *FUEL TANK AND FUEL PUMP* subsection.
2. Cut locking tie holding secure idle air control valve (IACV) harness to connector.
3. Unplug from intake manifold:
   3.1 Manifold absolute pressure and temperature sensor (MAPTS)

3.2 Idle air control valve (IACV).



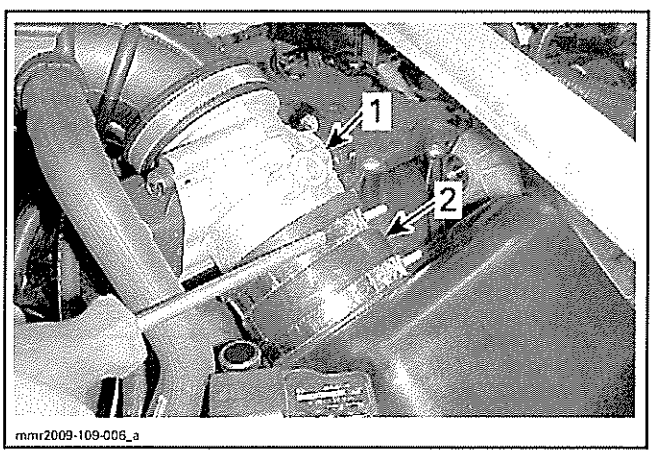
1. *MAPTS connector*
2. *IACV connector*
3. *Locking tie*

4. From intake manifold, disconnect the IACV bypass hose.



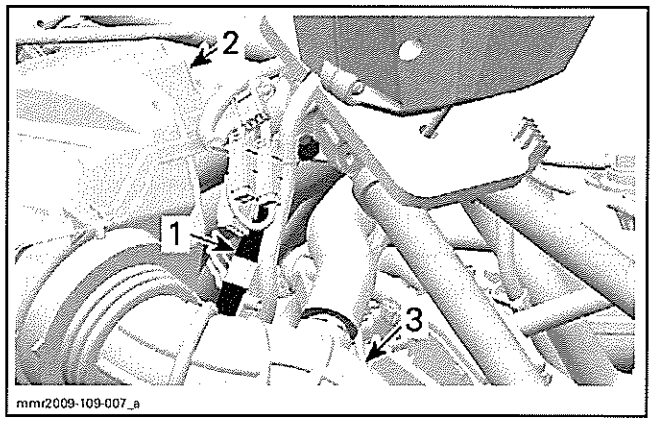
1. *IACV bypass hose*
2. *MAPTS*
3. *IACV*

5. Loosen clamp securing the throttle body to intake adapter.



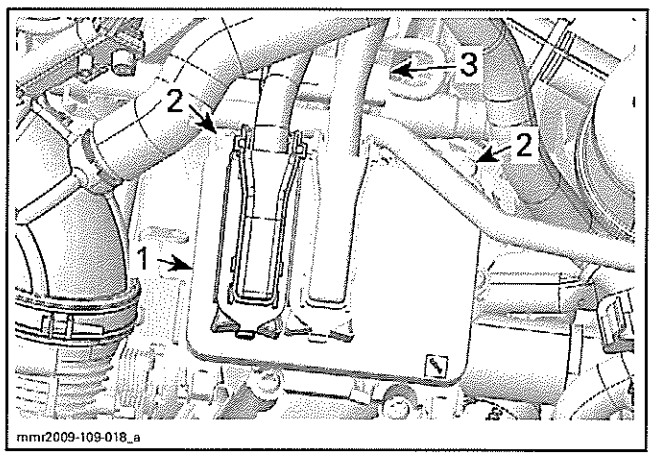
1. *Throttle body*
2. *Intake adapter*

6. Remove the throttle body from intake adapter and move throttle body aside.
7. Remove bolt securing the top of the LH side frame member.



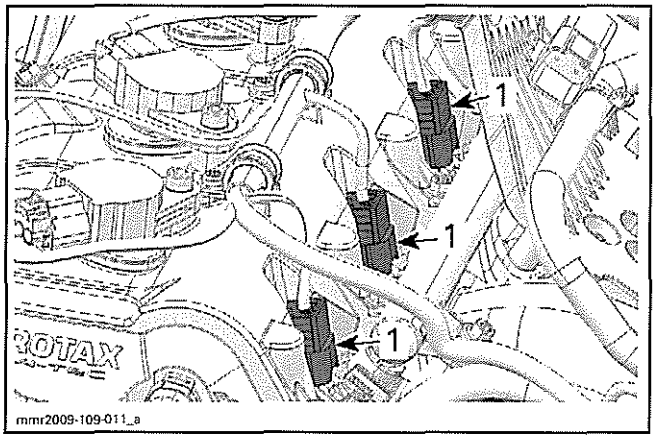
TYPICAL
1. *LH side frame member*
2. *Air intake silencer*
3. *Intake hose*

8. From ECM support, cut locking ties securing:
   - Throttle body heater hose
   - ECM wiring harnesses.
9. Remove the ECM from its support without disconnecting connectors.
   9.1 Remove ECM retaining screws.
   9.2 Move ECM aside.
10. Unplug the engine connector.



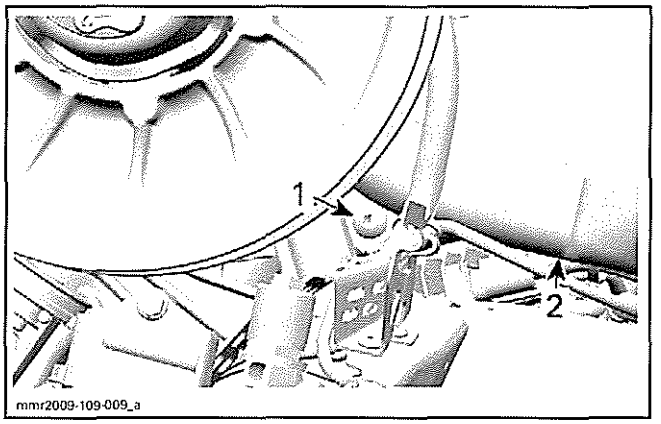
TYPICAL
1. *ECM*
2. *ECM retaining screws*
3. *Engine connector*

11. Remove the engine connector housing from the ECM support.
12. Unplug the three injectors.



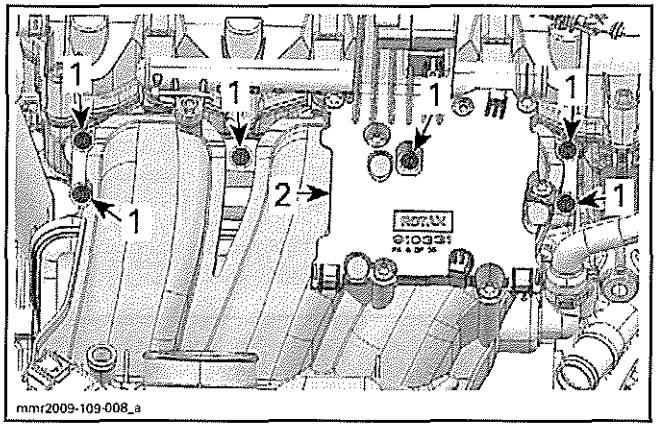
TYPICAL
1. Injector connectors

13. Underneath intake manifold, remove screw retaining it to its bracket.



1. Remove this screw
2. Intake manifold

14. Remove all screws (6) securing the intake manifold to cylinder head.



1. Intake manifold screws
2. ECM support

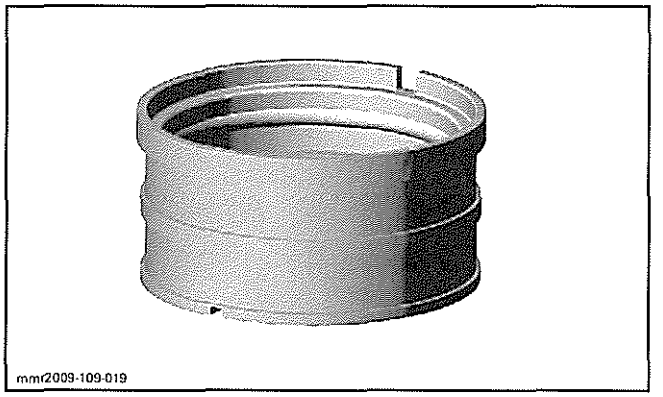
15. Move the intake manifold upward and rearward to pass over the transversal bar.
16. Remove the intake manifold from the vehicle.

If the intake manifold must be replaced, the following parts must be removed from it:
- Intake adapter
- MAPTS
- IACV
- ECM support
- Fuel rail with injectors (refer to *ELECTRONIC FUEL INJECTION* subsection).

Intake Manifold Inspection

Check intake manifold for cracks, warping at flanges or any other visible damages. Replace as required.

Check if intake adapter is cracked, brittle or otherwise damaged.

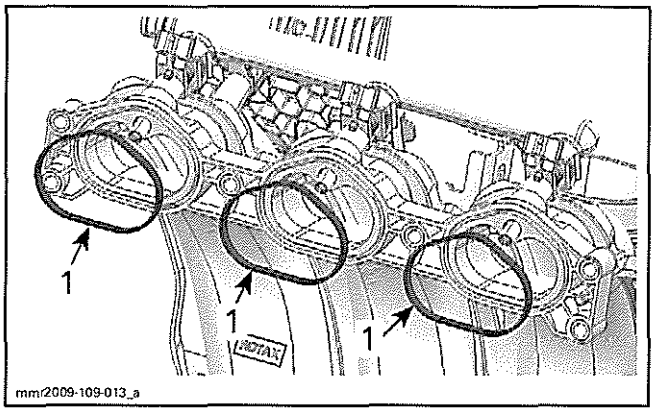


Check if intake manifold gaskets are brittle, hard or damages. Replace as required.

Intake Manifold Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

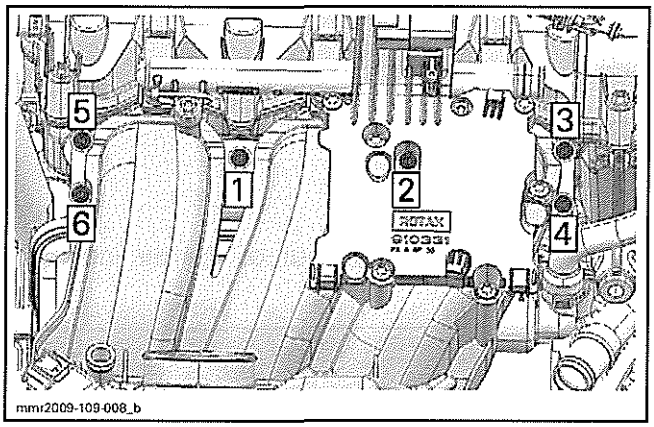
1. Ensure that all gaskets are properly installed.



1. Intake manifold gaskets

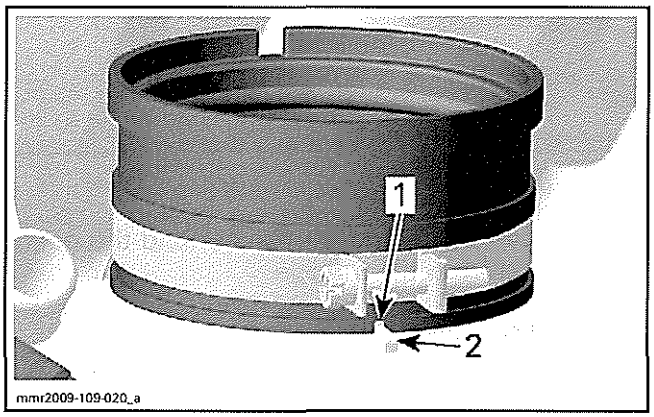
2. Position intake manifold on engine.

3. Using a pick-up tool such as the SNAP-ON FLEXIBLE PICK-UP TOOL (P/N DPTC24), position intake manifold screws in their holes. Turn all screws 3-4 turns.
4. Install and tighten the retaining screw under intake manifold.
5. Tighten intake manifold screws using the following sequence.



INTAKE MANIFOLD TIGHTENING SEQUENCE

6. When installing intake adapter onto intake manifold, make sure to index intake manifold tab with intake adapter notch.



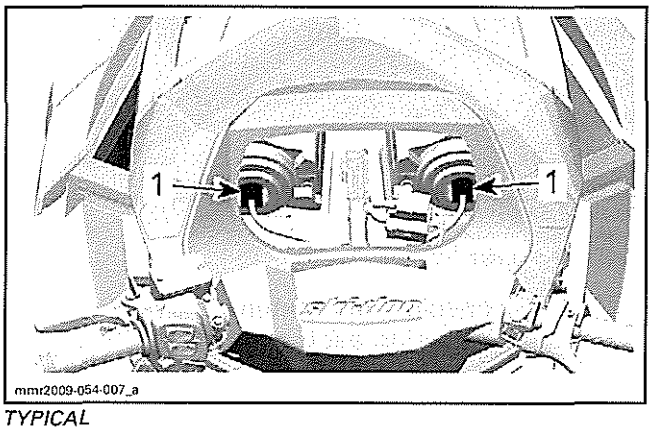
1. Notch in manifold adapter
2. Intake manifold tab

7. Install all other removed parts.

AIR INTAKE SILENCER

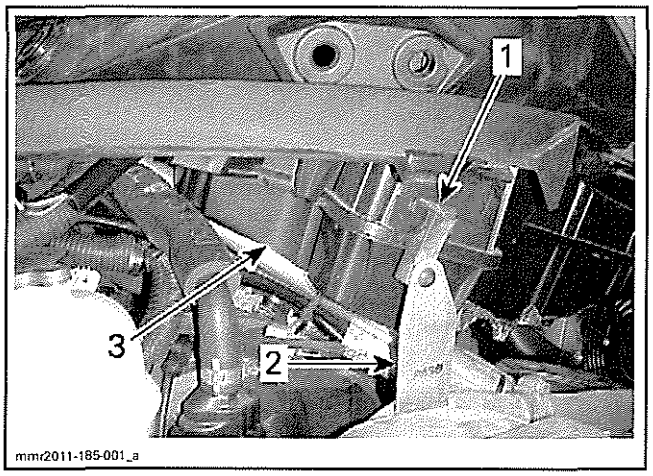
Air Intake Silencer and Gauge Support Removal (as a unit)

1. Refer to *BODY* subsection and remove the following parts:
   - Both side panels
   - Hood
   - Bottom pan cover
   - Windshield.
2. Remove the multifunction gauge. Refer to *LIGHTS, GAUGE AND ACCESSORIES* subsection.
3. Disconnect headlight connectors.



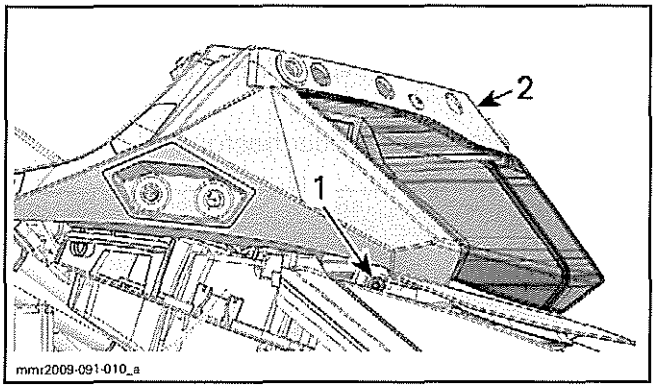
TYPICAL
1. Headlight connectors

4. Unhook rubber attachment on coolant hose support from air intake silencer.



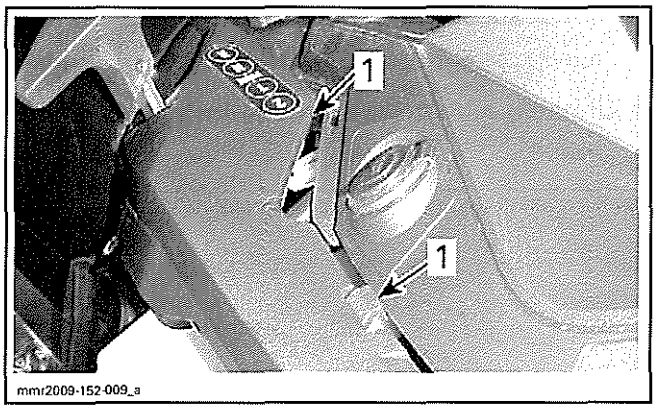
1. Rubber attachment
2. Coolant hose support
3. Air intake silencer

5. Remove screws securing the front portion of the console to the gauge support.



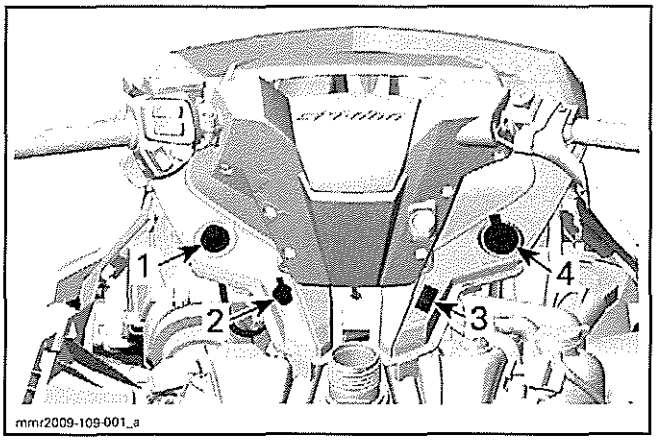
RH SIDE SHOWN
1. *Retaining screw (one each side)*
2. *Gauge support*

6. Detach console front extensions from gauge support (2 tabs on each side).



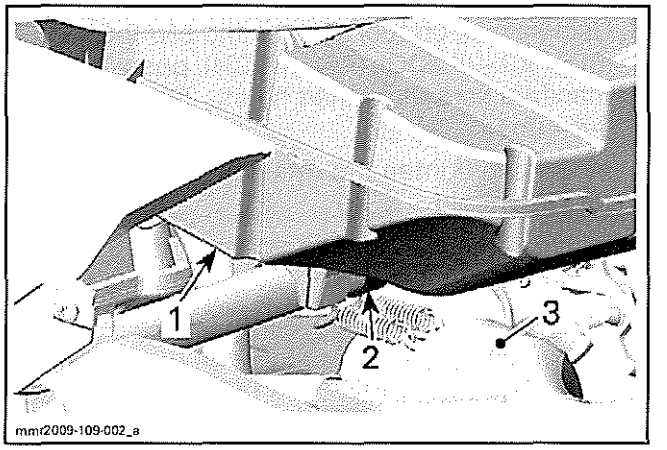
1. *Retaining tabs*

7. Disconnect all switches, connectors or accessories from gauge support as applicable to model.



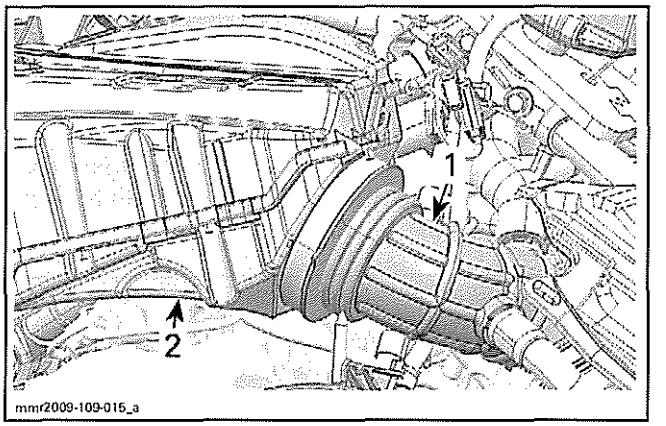
TYPICAL
1. *Engine cut-out switch*
2. *Electric visor jack connector*
3. *Heated seat switch (operator's seat)*
4. *12-volt power outlet*

8. Undo the Velcro strap located on the front lower portion of the air intake silencer.



TYPICAL
1. *Air intake silencer*
2. *Velcro Strap*
3. *Exhaust pipe*

9. Pull the intake hose out of the air intake silencer.



1. *Intake hose*
2. *Air intake silencer*

10. Remove the air intake silencer and the gauge support from the vehicle.

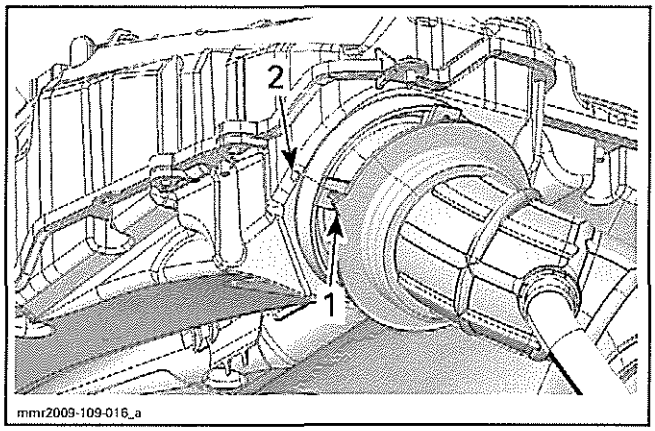
Air Intake Silencer Removal

1. Proceed with *AIR INTAKE SILENCER AND GAUGE SUPPORT REMOVAL AS A UNIT.*
2. Separate air intake silencer from gauge support, refer to *BODY* subsection.

Air Intake Silencer Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

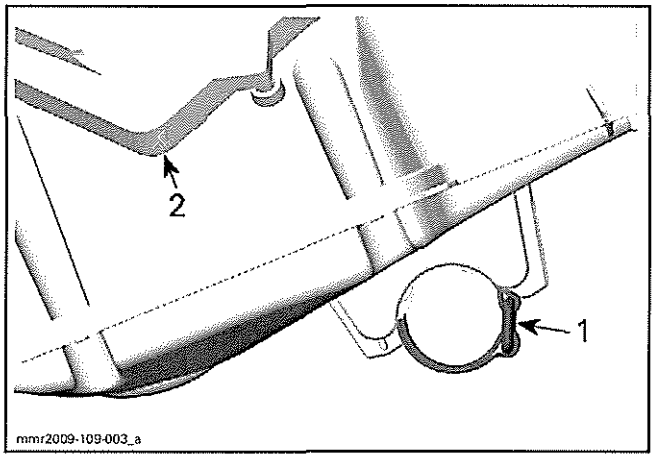
1. Insert intake hose into air intake silencer. Be sure to align the intake hose tip and air intake silencer arrow.



1. Intake hose tip
2. Air intake silencer arrow

NOTE: The intake hose is fully inserted when the last rib has a good 360° contact with the air intake silencer flange.

2. Make sure to route Velcro strap correctly.



1. Ring of Velcro strap toward the rear of vehicle
2. Air filter

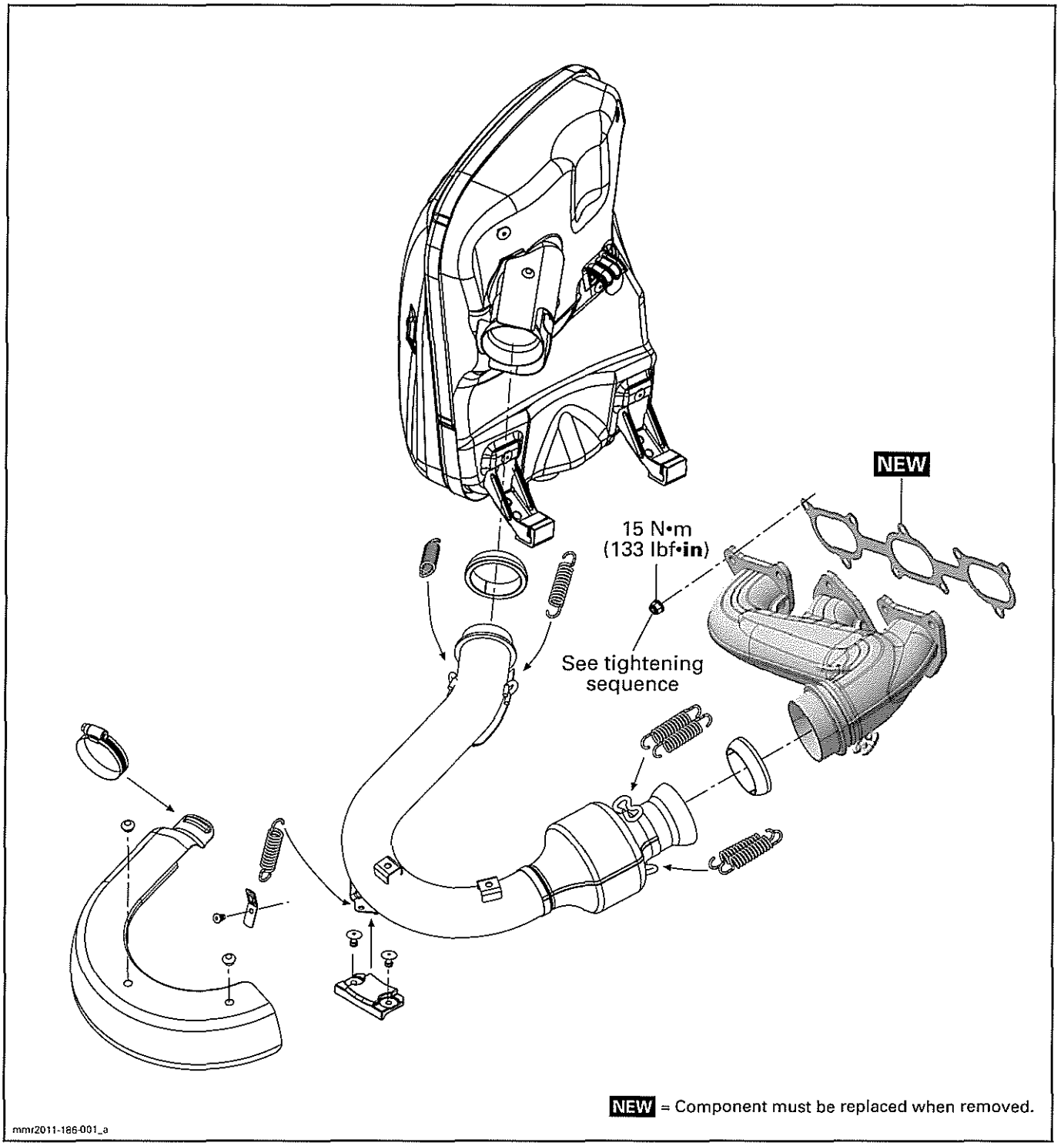
EXHAUST SYSTEM

SERVICE TOOLS

Description	Part Number	Page
SPRING INSTALLER/REMOVER	529 035 983	301–303

SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
SNAP-ON 10 MM SOCKET	tmm10	302
SNAP-ON WOBBLE 8" EXTENSION	tmxwp8	302


NEW
15 N•m
(133 lbf•in)
See tightening
sequence
NEW = Component must be replaced when removed.
mmr2011-186-001_a

GENERAL

⚠ WARNING

To avoid potential burns, never touch exhaust system components immediately after the engine has been running as these components are very hot. Let engine and exhaust system cool down before performing any servicing.

During assembly/installation, use the torque value and service products as in the exploded view.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices (e.g.: locking tabs, elastic stop nuts, self-locking fasteners, cotter pins, etc.) must be replaced with new ones.

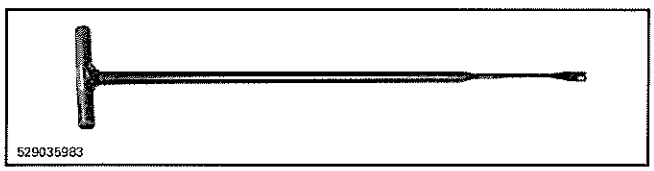
PROCEDURES

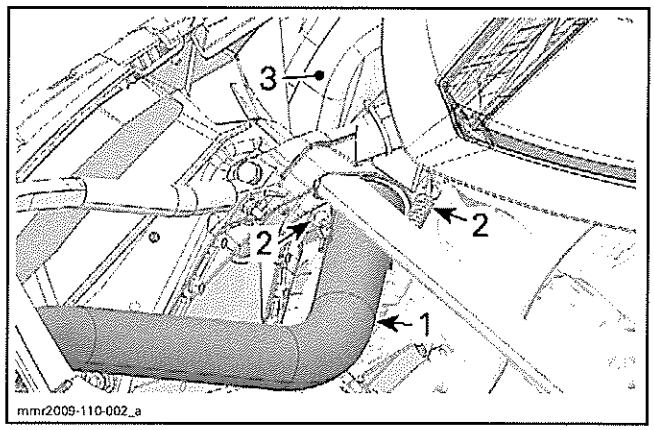
EXHAUST PIPE

Exhaust Pipe Removal

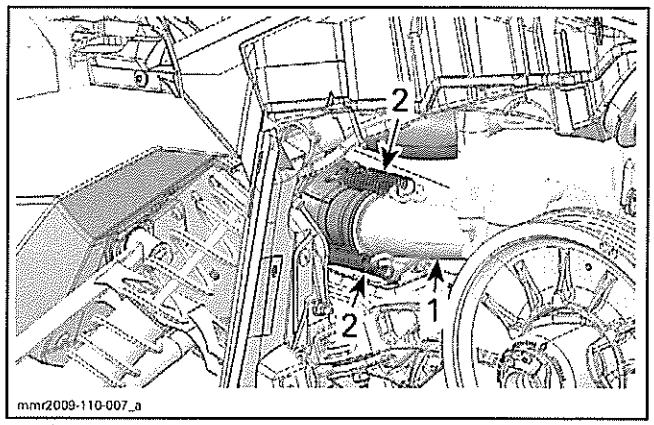
1. Refer to *BODY* subsection and remove:
   - Both side panels
   - Hood
   - Bottom pan cover.
2. Remove the drive belt guard, refer to *DRIVE BELT* subsection.
3. Remove exhaust springs securing exhaust pipe to muffler and exhaust manifold.

SPRING INSTALLER/REMOVER (P/N 529 035 983)



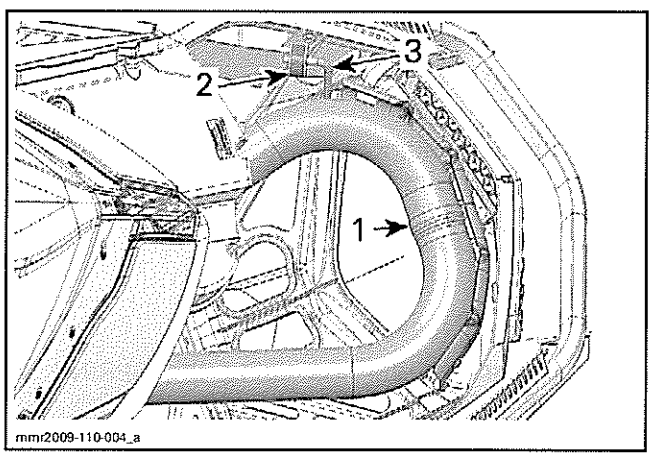


1. *Exhaust pipe*
2. *Exhaust springs*
3. *Muffler*



AIR INTAKE SILENCER REMOVED FOR CLARITY
1. *Exhaust manifold*
2. *Exhaust springs (4)*

4. Move exhaust pipe forward to free it from the muffler and exhaust manifold.

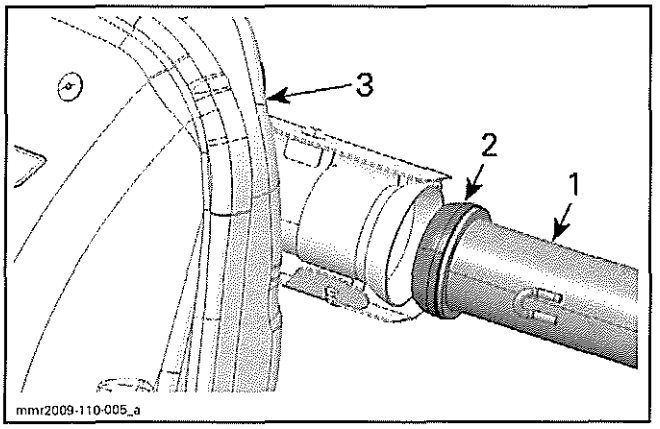


1. *Exhaust pipe*
2. *Rubber damper*
3. *Retaining rod*

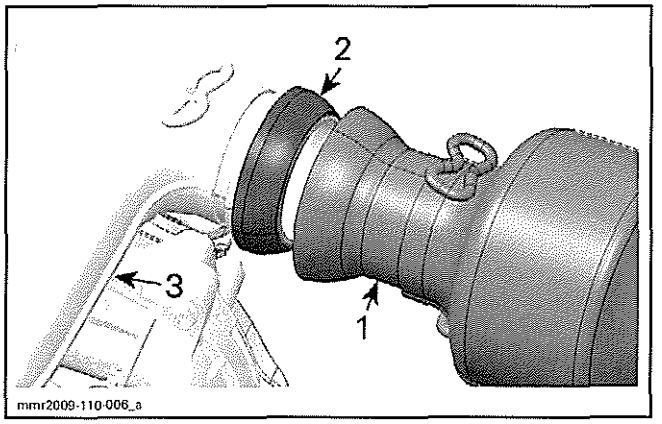
5. Remove exhaust pipe from vehicle.

NOTE: Be careful not to drop or damage exhaust gaskets at each end of exhaust pipe.

6. Remove both exhaust gaskets.



MUFFLER SIDE
1. *Exhaust pipe*
2. *Exhaust gasket*
3. *Muffler*



EXHAUST MANIFOLD SIDE
1. *Exhaust pipe*
2. *Exhaust gasket*
3. *Exhaust manifold*

Exhaust Pipe Inspection

Check exhaust pipe and shields for:
- Damages
- Cracks.

Also inspect condition of exhaust pipe gaskets. Replace as required.

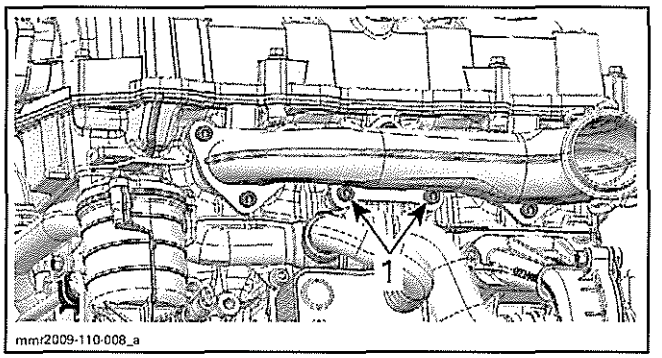
Exhaust Pipe Installation

1. Install exhaust pipe gaskets.
2. Position exhaust pipe in vehicle.
3. Install exhaust springs using the SPRING INSTALLER/REMOVER (P/N 529 035 983).
4. Install all other removed parts.

EXHAUST MANIFOLD

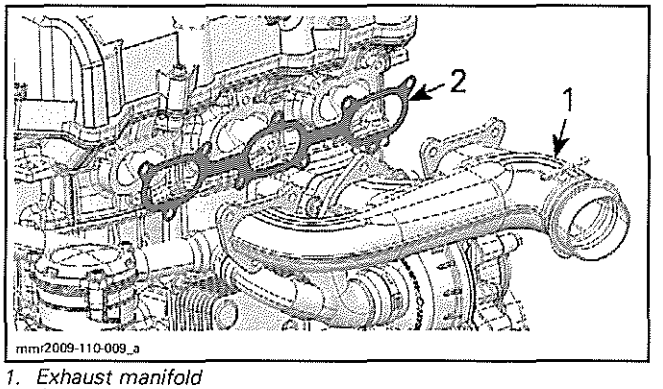
Exhaust Manifold Removal

1. Remove *EXHAUST PIPE*, see procedure in this subsection.
2. Remove manifold retaining nuts using a 10 mm thin wall socket (1/4 drive) such as the SNAP-ON 10 MM SOCKET (P/N TMM10), and a wobble extension such as the SNAP-ON WOBBLE 8" EXTENSION (P/N TMXWP8).
   2.1 First, loosen both lower central nuts.



1. *Lower central nuts*

   2.2 Loosen the 7 other remaining nuts.
   2.3 Lift front portion of the exhaust manifold and remove lower retaining nuts.
   2.4 Remove the top retaining nuts.
3. Remove the exhaust manifold.
4. Remove and discard the exhaust manifold gasket.



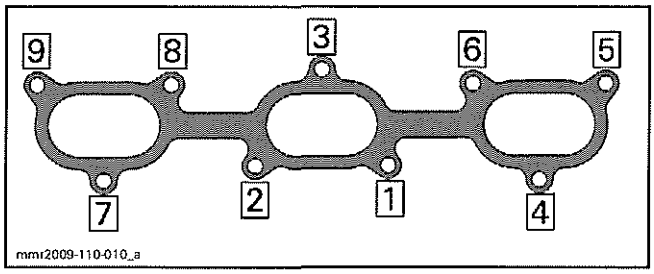
1. *Exhaust manifold*
2. *Gasket*

Manifold Inspection

Check exhaust manifold for cracks or other damages. Replace if necessary.

Manifold Installation

1. Install exhaust manifold with a NEW gasket.
2. Position exhaust manifold on cylinder head.
3. Lift front portion of the exhaust manifold and install both lower central retainingnuts.
4. Install all other retaining nuts.
5. Tighten manifold retaining nuts as specified.



TIGHTENING SEQUENCE

MANIFOLD TORQUE
15 N•m (133 lbf•**in**)

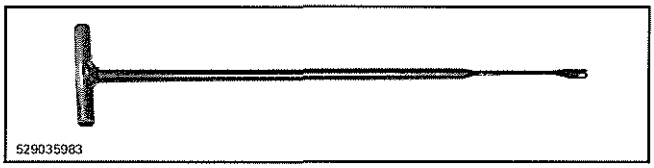
6. Install exhaust pipe.

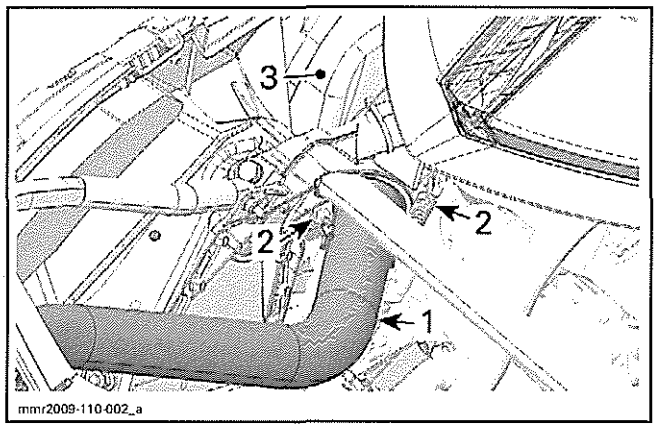
MUFFLER

Muffler Removal

1. Refer to *BODY* subsection and remove the following:
   - RH side panel
   - Hood.
2. Remove exhaust springs securing the exhaust pipe to the muffler.

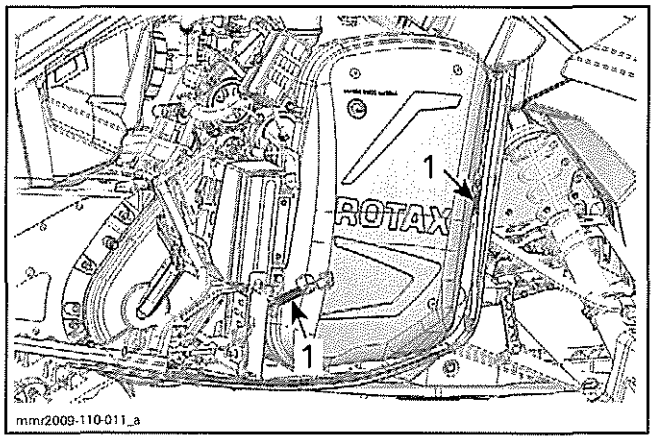
SPRING INSTALLER/REMOVER (P/N 529 035 983)





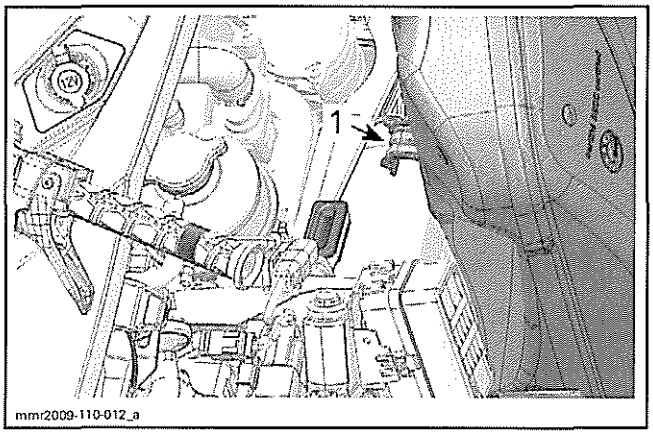
1. *Exhaust pipe*
2. *Exhaust springs*
3. *Muffler*

3. Remove exhaust springs securing the muffler to the vehicle.



1. *Muffler exhaust springs*

4. Lift up muffler to free the retaining hook (engine side of muffler).



ENGINE SIDE OF MUFFLER
1. *Retaining hook*

5. Remove the muffler.

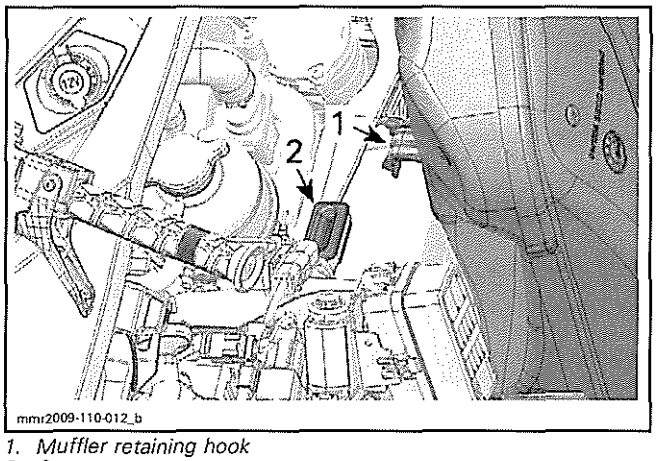
Muffler Inspection

Check the muffler for cracks or other damages.

Muffler Installation

For installation, reverse the removal procedure.

NOTE: Make sure muffler retaining hook is inserted in the grommet.



1. Muffler retaining hook
2. Grommet

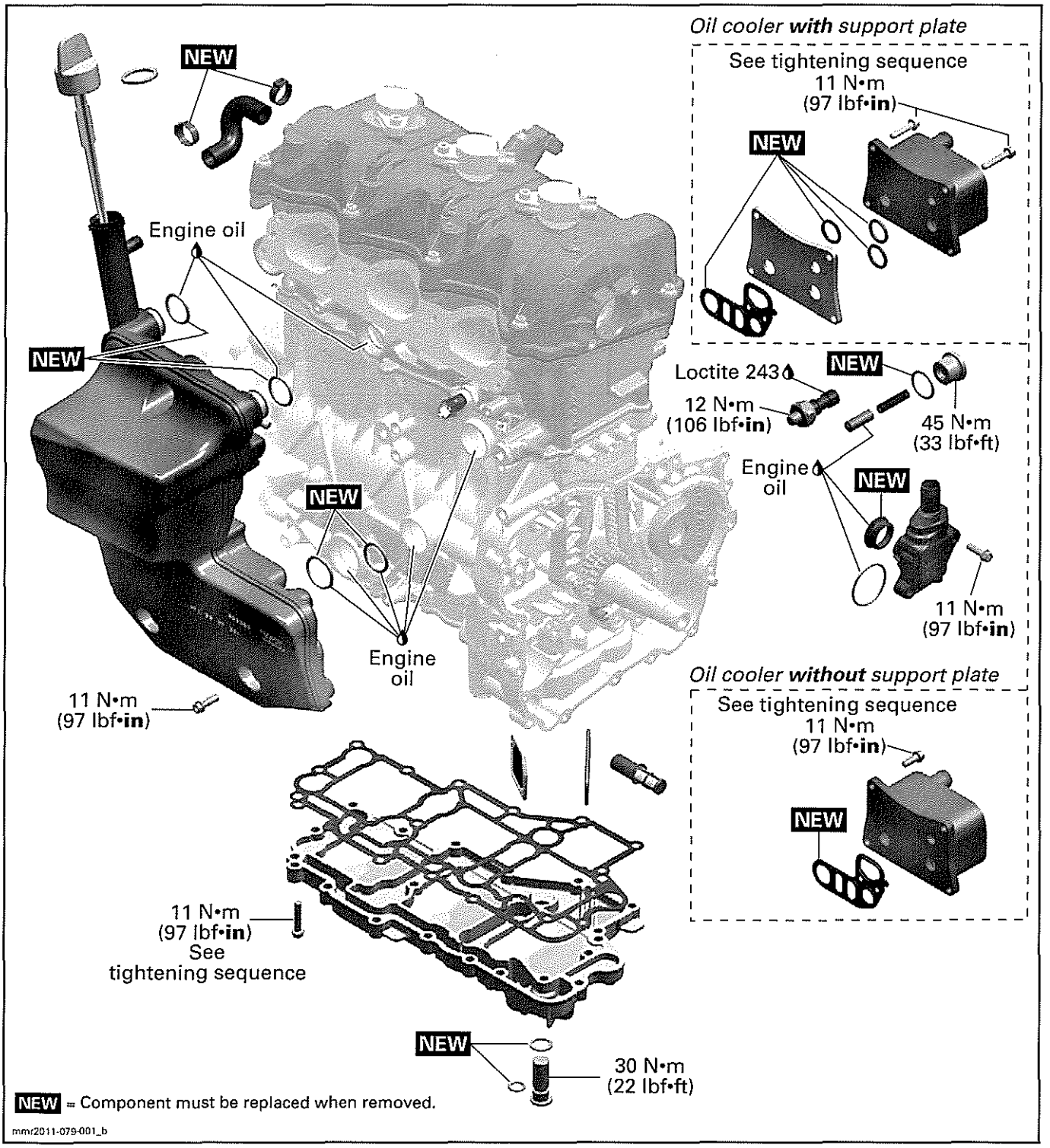
LUBRICATION SYSTEM

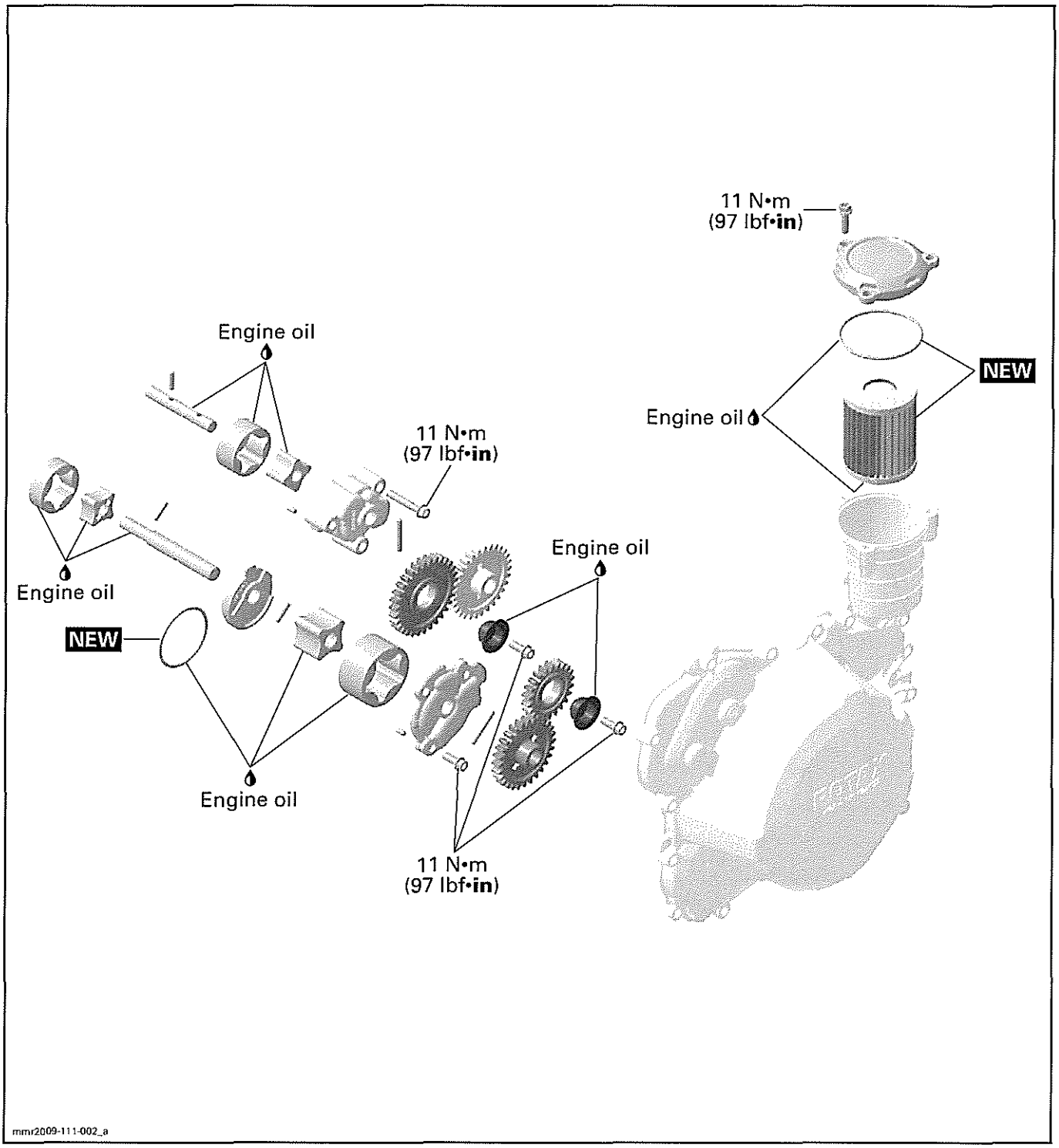
SERVICE TOOLS

Description	Part Number	Page
ADAPTER HOSE	529 035 652	309
ECM ADAPTER TOOL	420 277 010	312
FLUKE 115 MULTIMETER	529 035 868	311
OIL PRESSURE TEST CAP	529 036 158	309
PRESSURE GAUGE	529 035 709	310

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 243 (BLUE)	293 800 060	313


NEW
Engine oil
NEW
NEW
Engine oil
11 N•m
(97 lbf•in)
11 N•m
(97 lbf•in)
See
tightening sequence
NEW
30 N•m
(22 lbf•ft)
Oil cooler with support plate
See tightening sequence
11 N•m
(97 lbf•in)
NEW
Loctite 243
NEW
12 N•m
(106 lbf•in)
45 N•m
(33 lbf•ft)
Engine
oil
NEW
11 N•m
(97 lbf•in)
Oil cooler without support plate
See tightening sequence
11 N•m
(97 lbf•in)
NEW
NEW = Component must be replaced when removed.
mmr2011-079-001_b


11 N•m
(97 lbf•in)
NEW
Engine oil
Engine oil
11 N•m
(97 lbf•in)
Engine oil
Engine oil
NEW
Engine oil
11 N•m
(97 lbf•in)
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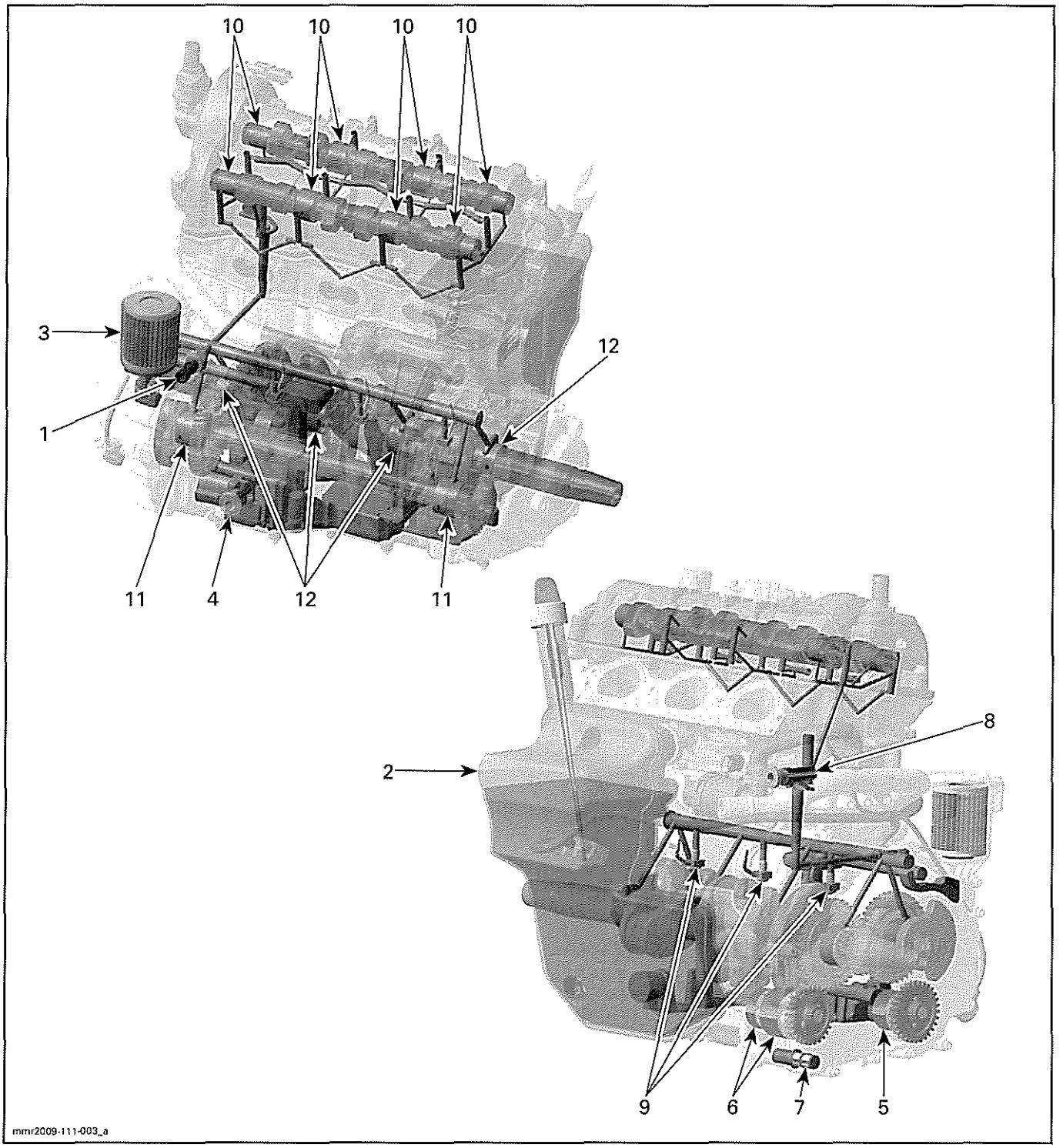
ENGINE LUBRICATION CIRCUIT



1. *Oil pressure switch*
2. *Oil tank*
3. *Oil filter*
4. *Oil pressure regulator*
5. *Oil pressure pump*
6. *Oil suction pumps*
7. *Oil strainer*
8. *Hydraulic chain tensioner*
9. *Oil spray nozzles*
10. *Camshaft plain bearings*
11. *Balancer shaft plain bearings*
12. *Crankshaft plain bearings*

GENERAL

During assembly/installation, use the torque values and service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to. Locking devices (e.g.: locking tabs, elastic stop nuts, cotter pins, etc.) must be replaced with new ones.

Hoses, cables or locking ties removed during a procedure must be reinstalled as per factory standards.

SYSTEM DESCRIPTION

This engine uses dry sump lubrication. The oil from the cylinder block, PTO cover and magneto cover is pumped by two suction pumps. Both pumps are integrated into one module.

The 26 mm (1.024 in) large oil suction pump returns the crankshaft and PTO chamber oil to the oil reservoir.

The 14 mm (.551 in) small oil suction pump returns the magneto chamber oil, back to the oil reservoir.

An oil filter and 3 oil strainers are used to filter dirt and debris from the oil circuit.

Two oil strainers are located between oil sump cover and cylinder block. The other oil strainer is located inside the cylinder block, on the engine magneto side.

The oil pressure is provided by a pump and regulated by a spring loaded pressure regulator.

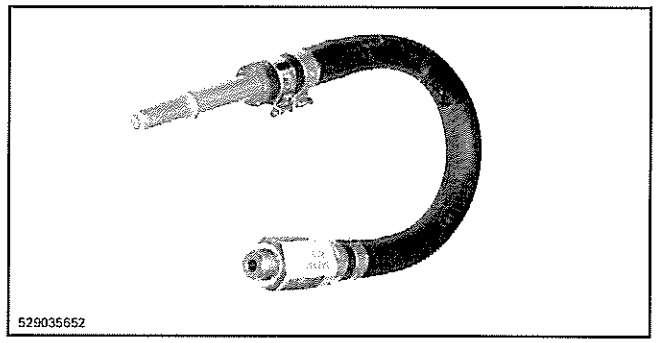
INSPECTION

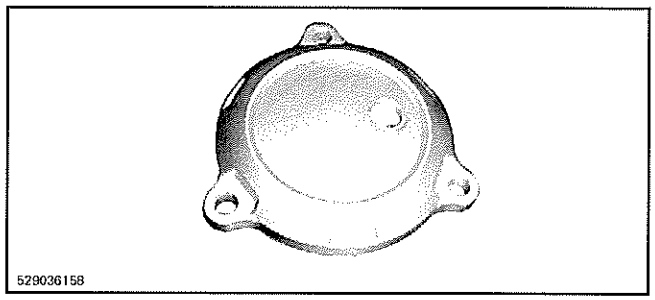
ENGINE OIL PRESSURE

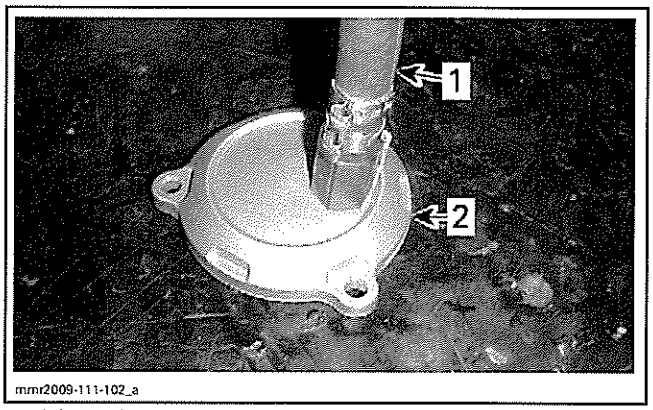
1. Remove the RH side panel.
2. Remove muffler. Refer to *EXHAUST SYSTEM* subsection.
3. Replace *OIL FILTER*, see procedure in this subsection.

NOTICE To avoid possible erroneous reading during the oil pressure test, it is important to replace the oil filter by a new one. The result of the oil pressure test will be false if the oil filter is clogged.

4. Completely tighten the ADAPTER HOSE (P/N 529 035 652) on the OIL PRESSURE TEST CAP (P/N 529 036 158).

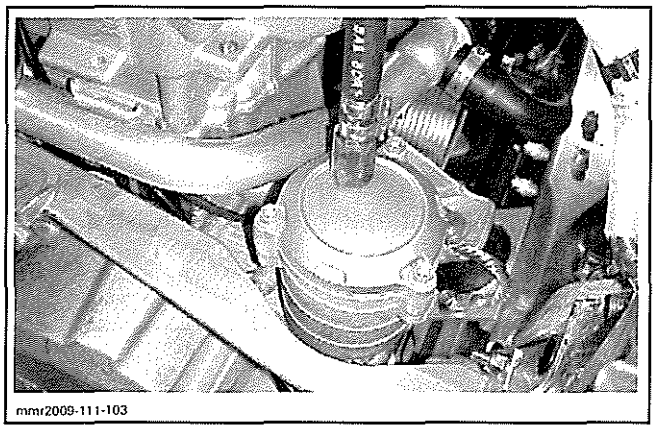






1. Adapter hose
2. Oil pressure test cap

5. Install the oil pressure test cap on the oil filter reservoir. Position adapter hose near engine.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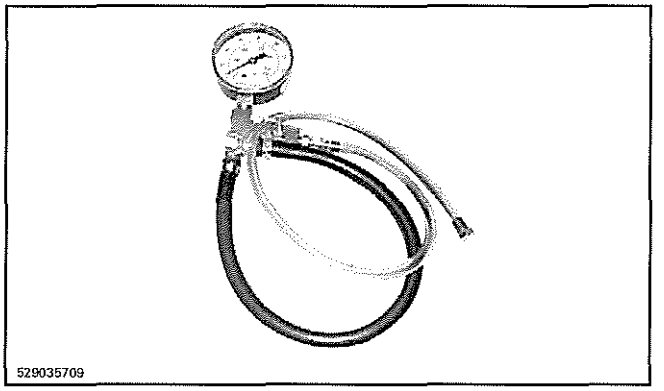
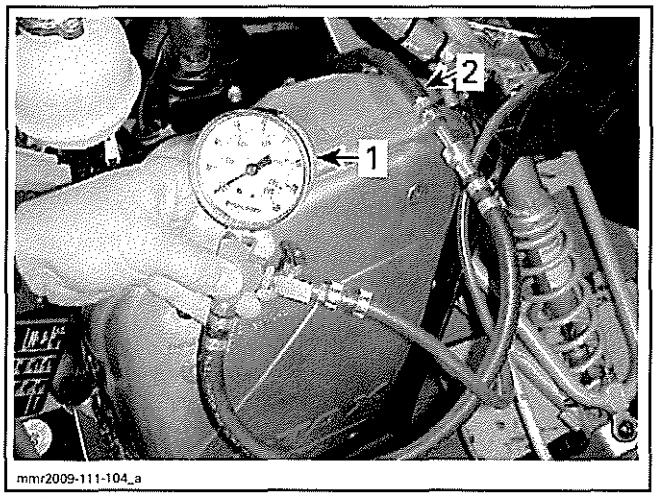
6. Install the muffler.
7. Connect the PRESSURE GAUGE (P/N 529 035 709) to adapter hose.


529035709



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1. *Pressure gauge*
2. *Adapter hose*

8. Start engine and check the oil pressure.

The engine oil pressure should be within the following specification with the recommended oil at the proper level and with engine at normal operating temperature.

ENGINE OIL PRESSURE AT NORMAL OPERATING TEMPERATURE	
ENGINE SPEED	MINIMUM PRESSURE
Idle	60 kPa (8.7 PSI)
7800 RPM	350 kPa (51 PSI)

9. If engine oil pressure is out of specifications, stop the engine and remove the oil dipstick.
10. Measure the oil temperature inside the oil tank by using a temperature measuring device, available from after market suppliers.

NOTE: Oil temperature must be below 100°C (212°F) when checking the engine oil pressure.

11. Reinstall the oil dipstick and restart engine.
12. With the oil temperature below 100°C (212°F) check the engine oil pressure again.
13. If engine oil pressure is still out of specification, refer to *TROUBLESHOOTING* in this subsection.
14. Remove engine oil pressure test tools.
15. Reinstall all removed parts.

TROUBLESHOOTING

Always check for fault codes. If a fault code is detected, service the fault code first.

LOW OR NO ENGINE OIL PRESSURE

1. **Oil level is too low.**
   - *Refill engine oil.*
   - *Check for high oil consumption. See below.*
   - *Check for oil leaks (oil leaking out of leak indicator hole, gaskets, oil cooler, oil seal or O-rings). Repair or replace.*
2. **Defective or clogged oil filter.**
   - *Replace engine oil and filter.*
3. **Use of a bad grade oil.**
   - *Replace engine oil with BRP recommended oil.*
4. **Oil pressure regulator valve sticks open, or spring load is insufficient.**
   - *Clean oil regulator piston and its bore. Replace if necessary.*
   - *Measure spring free length. Replace if out of specification.*
5. **Oil pump(s) worn or damaged.**
   - *Check if oil pump drive gears are damaged. Replace if necessary.*
   - *Check oil pump rotors and its bore for wear limits. Replace if out of specification.*

6. Engine oil strainers are clogged.
   - *Remove and clean engine oil strainers.*
7. Heavy wear on plain bearings.
   - *Check radial clearance of plain bearings. Replace if out of specification.*

HIGH OIL CONSUMPTION

1. Oil in breathing system.
   - *Check if breather V-ring is brittle, hard or damaged. Replace V-ring.*
2. Valve stem seals worn or damaged.
   - *Replace valve stem seals.*
3. Piston rings worn out (blue colored exhaust smoke).
   - *Replace piston rings.*

OIL CONTAMINATION (WHITE APPEARANCE)

1. Oil seal and rotary seal on water pump shaft leaking.
   - *Replace oil seal and water pump shaft assembly. Change engine oil.*
2. Cylinder head gasket leaking.
   - *Replace cylinder head gasket. Change engine oil.*
3. Cylinder head screws not properly tightened.
   - *Retighten screws with recommended torque. Change engine oil.*
4. Oil cooler gasket leaking.
   - *Replace gasket. Change engine oil.*

PROCEDURES

OIL PRESSURE SWITCH (OPS)

OPS Activation

The oil pressure switch activates if engine oil pressure falls between 20 kPa and 40 kPa (2.9 PSI and 5.8 PSI).

OPS Access

1. Remove hood.

OPS Inspection

First, ensure oil pressure is adequate. Refer to *ENGINE OIL PRESSURE.*

If the oil pressure is good, check the resistance of the oil pressure switch.

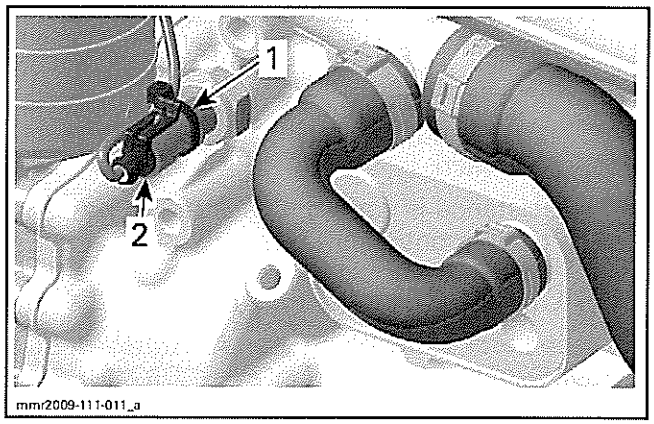
OPS Resistance Test

The engine must be warm to check the oil pressure switch properly.

⚠ WARNING

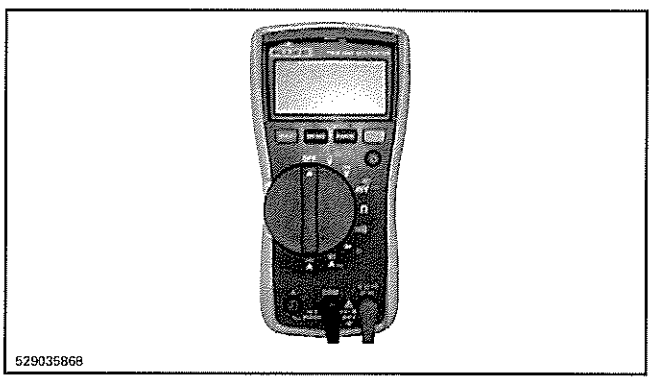
Be careful when working near hot part. To avoid potential burns, never touch exhaust system components immediately after the engine has been running as these components are very hot. Always use long sleeves and gloves.

1. Cut locking tie and disconnect the OPS switch connector.



TYPICAL
1. Cut locking tie
2. OPS switch connector

2. Using the FLUKE 115 MULTIMETER (P/N 529 035 868), check the oil pressure switch resistance.



3. Read result and compare to table.

RESISTANCE (Ω)		
ENGINE NOT RUNNING		
OPS pin	Engine ground	Close to 0 Ω (normally closed switch)

If resistance is out of specification, replace the oil pressure switch.

If the resistance is correct, continue procedure.

4. Start engine.
5. Read result and compare to table.

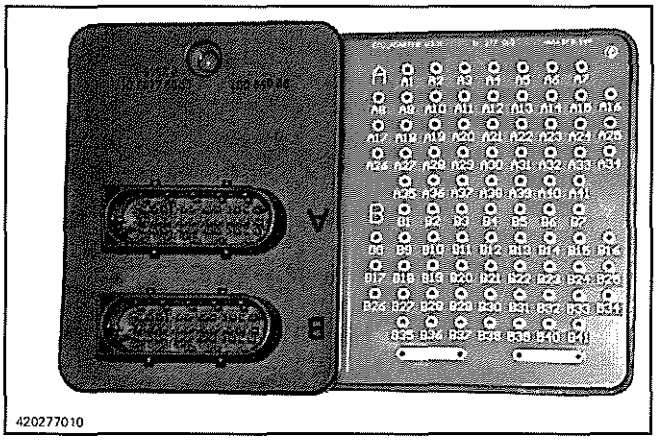
RESISTANCE (Ω)		
ENGINE RUNNING		
OPS pin	Engine ground	Infinitely high (OL)

If resistance is out of specification, replace the oil pressure switch.

If the resistance is correct, check the oil pressure switch circuit continuity.

OPS Circuit Continuity Test

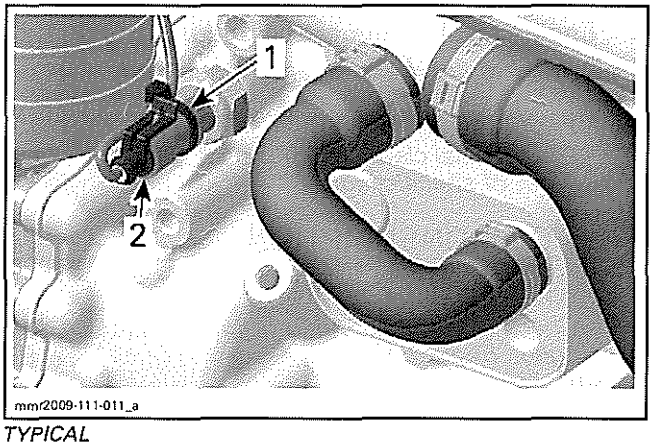
1. Disconnect ECM connector A. Refer to *ECM CONNECTOR ACCESS* in *ELECTRONIC FUEL INJECTION (1200 4-TEC)* subsection.
2. Connect the ECM ADAPTER TOOL (P/N 420 277 010), to the ECM connector A.



3. Check continuity as follows.

CIRCUIT CONTINUITY		
OPS connector	ECM A pin E3	Close to 0 Ω

4. Cut locking tie and disconnect the OPS switch connector.



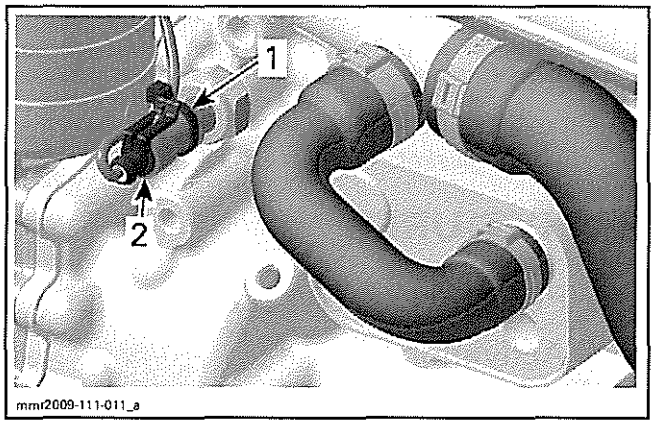
TYPICAL
1. Cut locking tie
2. OPS switch connector

If continuity and OPS resistance are good, try a new ECM.

If the continuity is bad, repair or replace defective wire or connectors.

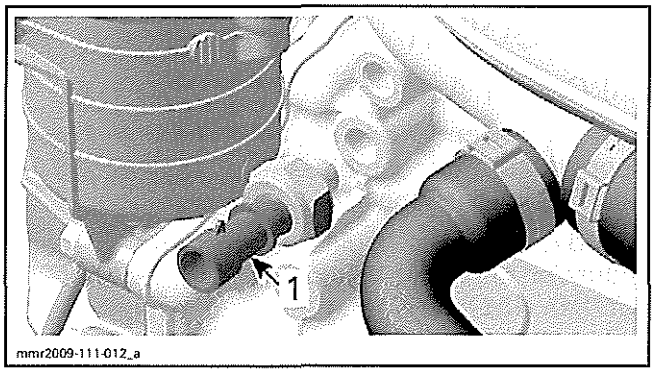
OPS Removal

1. Remove the front engine support on MAG side. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
2. Cut locking tie and disconnect the OPS switch connector.



TYPICAL
1. Cut locking tie
2. OPS switch connector

3. Unscrew and remove the OPS switch.



TYPICAL
1. Oil pressure switch

OPS Installation

1. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on threads of oil pressure switch.
2. Tighten oil pressure switch to the specified torque.

OIL PRESSURE SWITCH TORQUE
12 N•m (106 lbf•**in**)

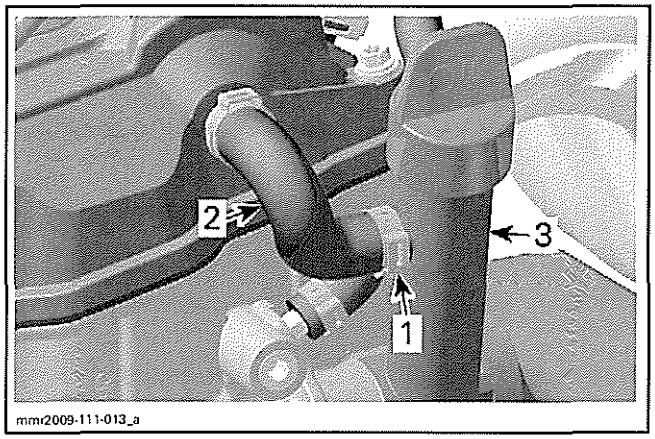
3. Install engine support and all other removed parts.

NOTICE When installing the locking tie on the OPS connector, take care that the wires do not to make a sharp bend.

OIL TANK

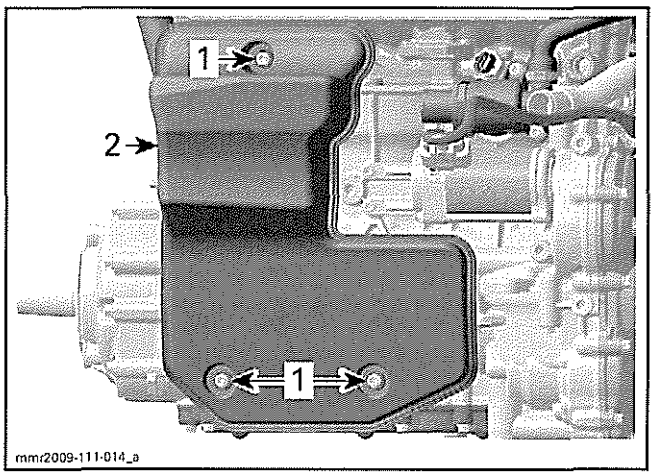
Oil Tank Removal

1. Remove the engine from vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
2. Drain engine oil. Refer to *ENGINE OIL REPLACEMENT* in this subsection.
3. Cut and discard the Oetiker clamp securing the oil tank vent hose to filler tube.
4. Remove oil tank vent hose.



1. Cut Oetiker clamp
2. Oil tank vent hose
3. Filler tube

5. Unscrew oil tank retaining screws.



1. Retaining screws
2. Oil tank

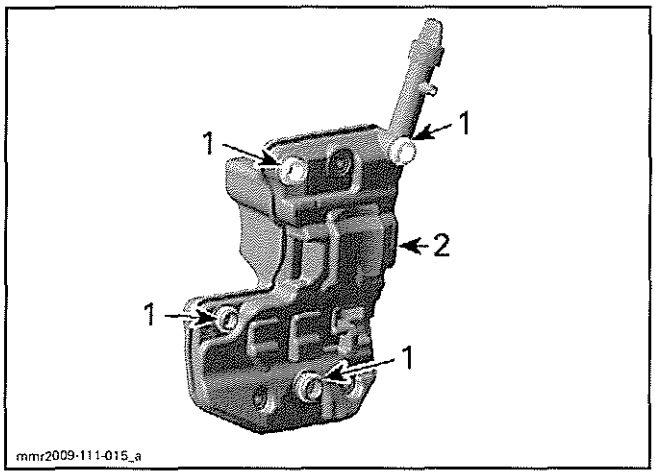
6. Place a drain pan underneath oil tank.
7. Remove oil tank from the engine.

Oil Tank Installation

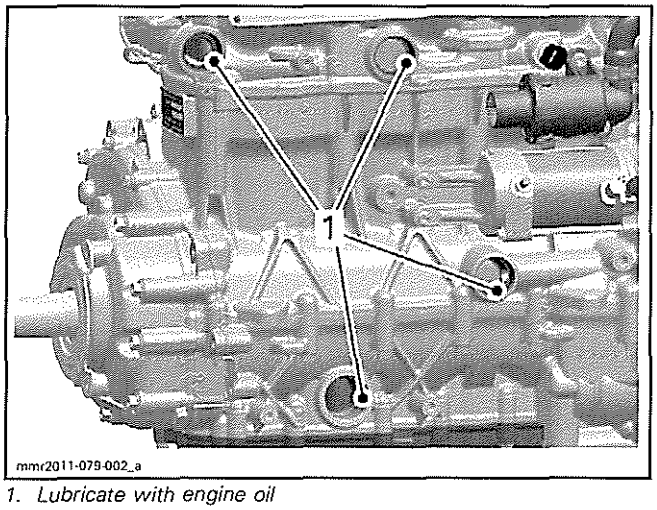
The installation is the reverse of the removal procedure. However, pay attention to the following details.

1. Install NEW oil tank O-rings.

NOTE: Apply engine oil on O-rings and in bores of the cylinder block to avoid damaging the O-rings during installation.



1. *New O-rings - apply engine oil*
2. *Oil tank*



1. *Lubricate with engine oil*

2. Properly fit oil tank to engine and move oil tank parallel to the engine in its final position.

NOTICE Ensure not to damage the O-rings during installation.

3. Install NEW Oetiker clamp to oil tank vent hose.
4. Tighten oil tank retaining screws to the specified torque.

OIL TANK SCREWS TIGHTENING TORQUE
11 N•m (97 lbf•**in**)

5. Wipe off any oil spillage.
6. Install the engine in the vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
7. Fill up oil tank and check oil level. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

OIL COOLER

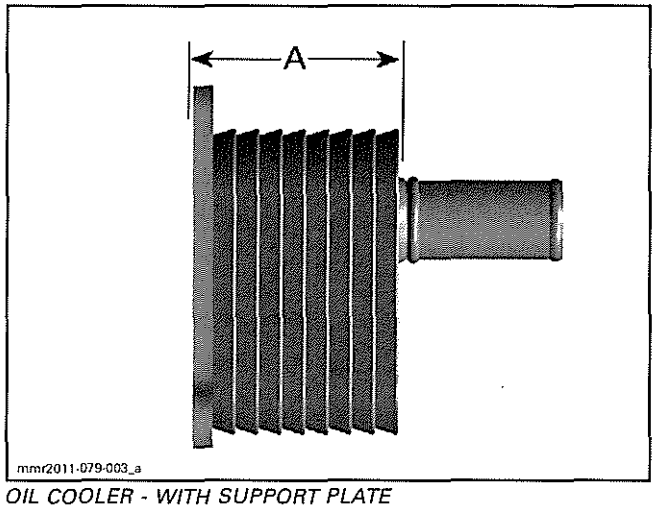
Oil Cooler Access

Remove secondary air intake silencer and gauge support as an assembly. Refer to *AIR INTAKE SYSTEM* subsection.

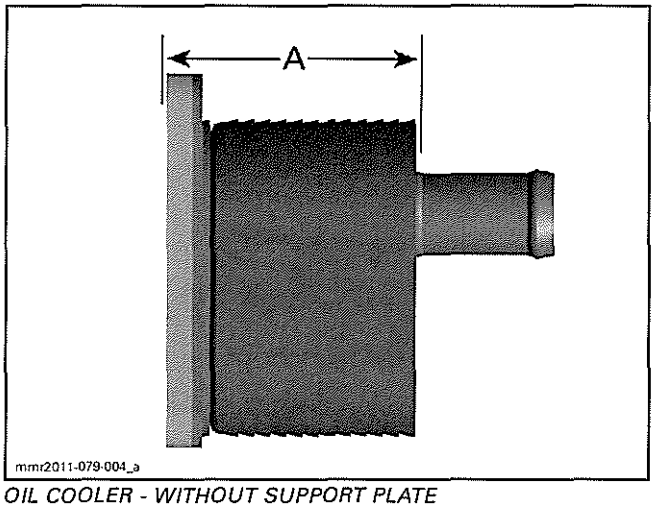
Remove the front engine support and its rubber mount on engine MAG side. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.

Oil Cooler Identification

Identify the oil cooler type by its dimension.

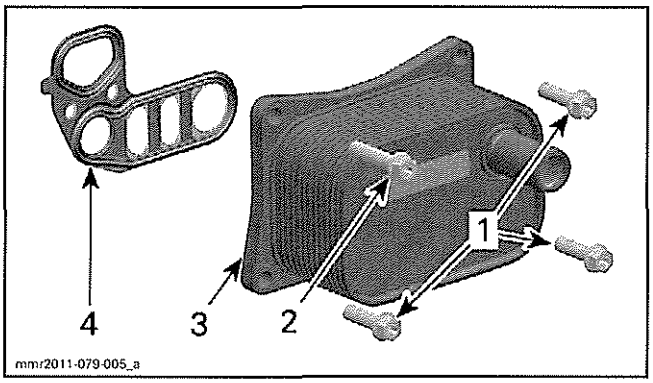


OIL COOLER - WITH SUPPORT PLATE
A. 41.6 mm (1.64 in)

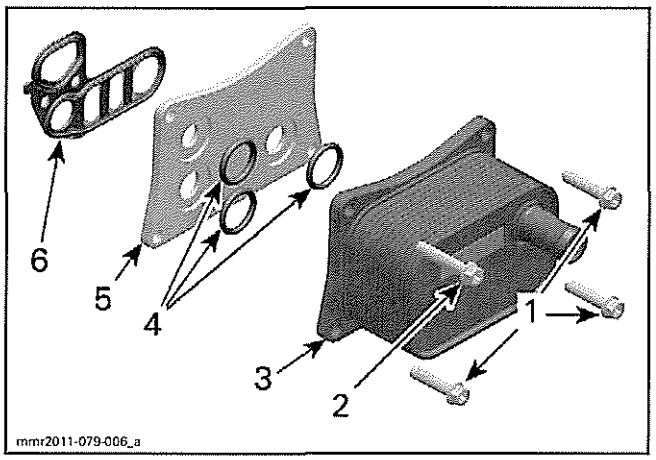


OIL COOLER - WITHOUT SUPPORT PLATE
A. 48.2 mm (1.9 in)

Oil Cooler Parts Layout



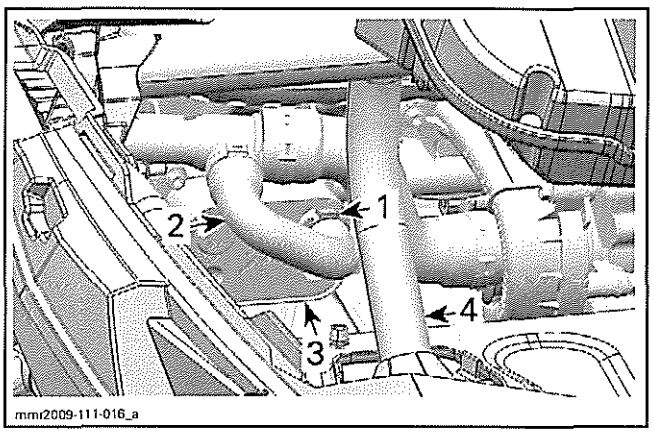
OIL COOLER - WITHOUT SUPPORT PLATE
1. *M6 x 20 screws*
2. *M6 x 25 screw*
3. *Oil cooler*
4. *Gasket*



OIL COOLER - WITH SUPPORT PLATE
1. *3x screws M6 x 25*
2. *1x screw M6 x 30*
3. *Oil cooler*
4. *O-rings*
5. *Support plate*
6. *Gasket*

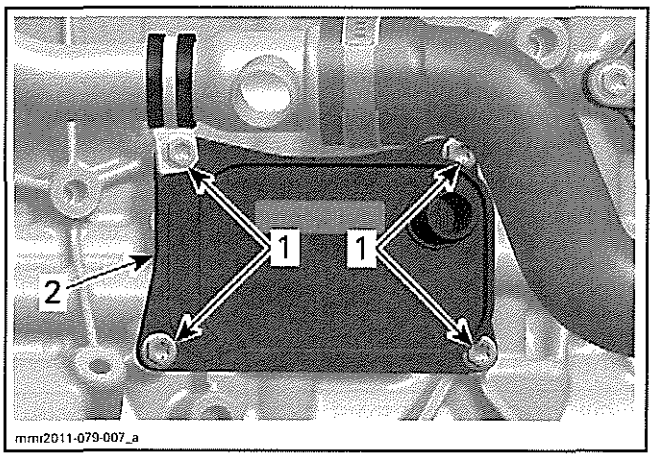
Oil Cooler Removal

1. Drain engine oil. Refer to *PERIODIC MAINTENANCE PROCEDURES* in this subsection.
2. Drain cooling system. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.
3. Cut and discard Oetiker clamp securing coolant hose to oil cooler.
4. Disconnect the coolant hose from oil cooler.



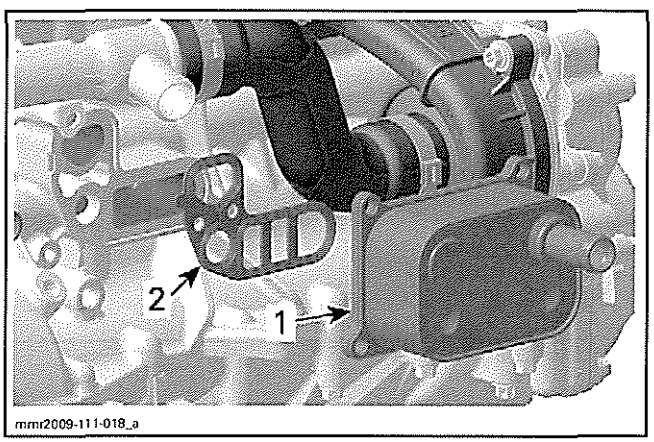
1. *Oetiker clamp*
2. *Coolant hose*
3. *Oil cooler*
4. *Steering column*

5. Remove oil cooler retaining screws.



1. *Retaining screws*
2. *Oil cooler*

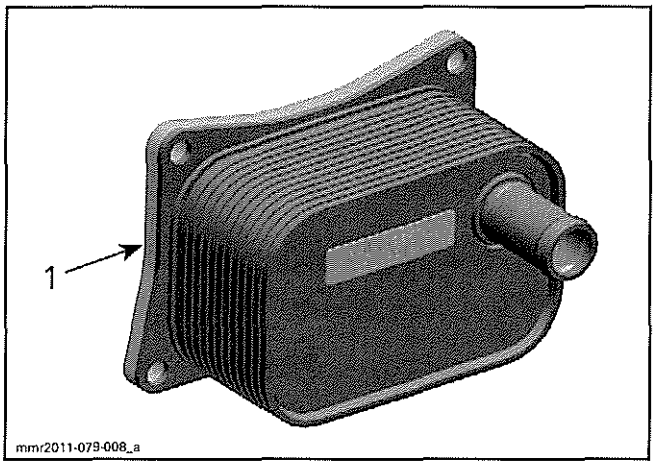
6. Place rags or towels under oil cooler to catch remaining oil and coolant.
7. Remove oil cooler and its gasket.



TYPICAL
1. *Oil cooler*
2. *Gasket*

Oil Cooler Inspection

Check oil cooler for cracks and other damage.



1. Check for cracks

Replace parts as necessary.

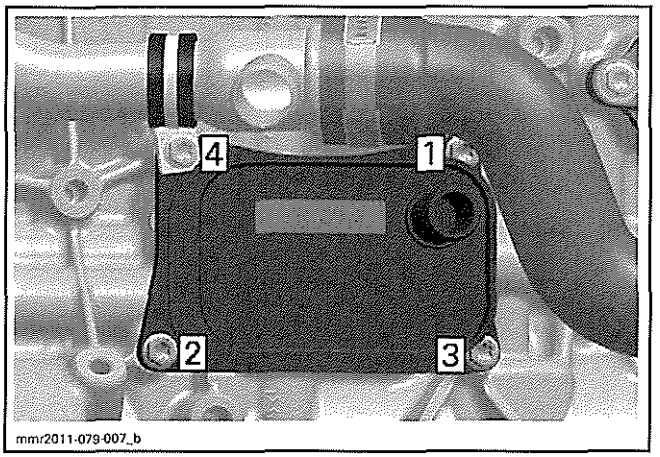
Oil Cooler Installation

For installation, reverse the removal procedure. Pay attention to the following.

NOTE: When replacing the oil cooler, make sure to identify the oil cooler type. Respect mounting layout according to the oil cooler used. See *OIL COOLER IDENTIFICATION*.

Tighten oil cooler retaining screws as follows.

OIL COOLER SCREWS TIGHTENING TORQUE (FOLLOW SEQUENCE)
11 N•m (97 lbf•**in**)



TIGHTENING SEQUENCE

Install a NEW Oetiker clamp on coolant hose.

Wipe off any oil and coolant spillage.

Install the engine support. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.

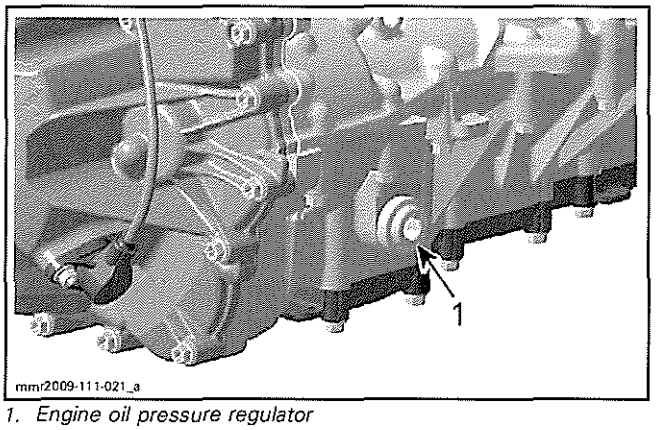
Fill up oil tank and check oil level. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

Refill and bleed cooling system. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

ENGINE OIL PRESSURE REGULATOR

Oil Pressure Regulator Location

The engine oil pressure regulator is located inside the cylinder block on the front side of the engine.



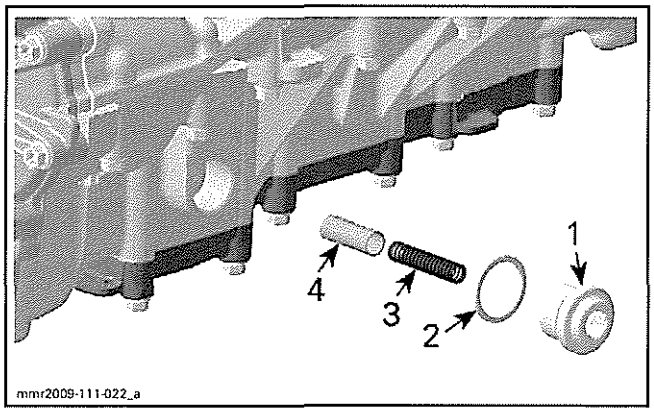
1. Engine oil pressure regulator

Oil Pressure Regulator Access

Remove engine from vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.

Oil Pressure Regulator Removal

1. Drain engine oil. Refer to *PERIODIC MAINTENANCE PROCEDURES* in this subsection.
2. Remove regulator plug and sealing washer. Discard sealing washer.
3. Pull oil pressure regulator parts out of the cylinder block.



1. *Plug*
2. *Sealing washer*
3. *Regulator spring*
4. *Regulator piston*

Oil Pressure Regulator Inspection

Clean bore and thread in the crankcase from any contaminations.

Inspect oil pressure regulator piston and its bore in cylinder block for scoring or other damage.

Check if piston moves easily in its bore.

Check compression spring for free length.

SPRING FREE LENGTH	
NEW NOMINAL	46 mm (1.811 in)
SERVICE LIMIT	45 mm (1.772 in)

Visually check compression spring for squareness.

Replace worn or damaged components.

Oil Pressure Regulator Installation

Install a NEW sealing washer on plug screw.

Tighten regulator plug to the specified torque.

PLUG SCREW TORQUE
45 N•m (33 lbf•ft)

Wipe off any oil spillage.

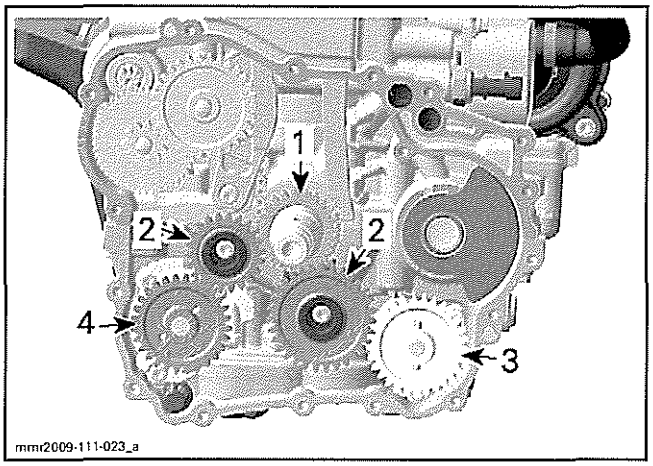
Install engine. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.

Fill up oil tank and check oil level. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

OIL PUMP DRIVE GEARS

Oil Pump Drive Gear Location

The oil pump gears are located on the MAG side, behind the magneto cover.



1. *Oil pump drive gear*
2. *Intermediate gears*
3. *Oil pump gear - pressure pump*
4. *Oil pump gear - suction pumps*

Oil Pump Drive Gear Access

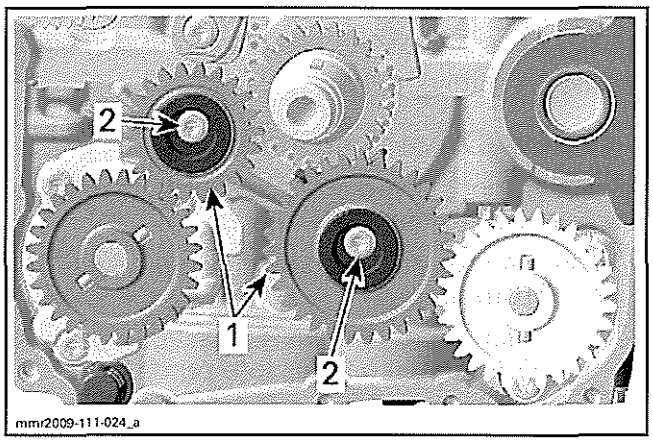
Remove engine from vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.

Refer to *MAGNETO SYSTEM* subsection to remove:

- Magneto cover
- Rotor
- Sprag clutch gear.

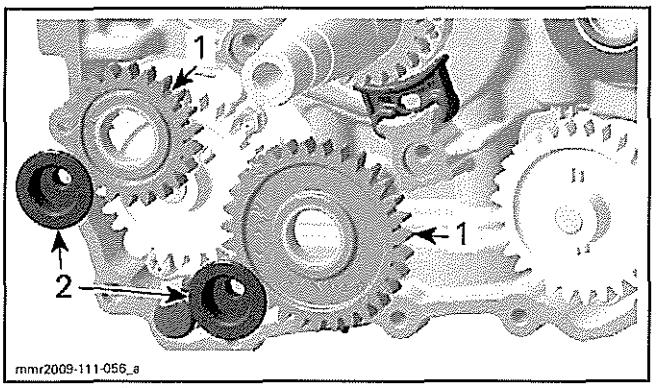
Oil Pump Drive Gear Removal

1. Unscrew oil pump intermediate gear screws.



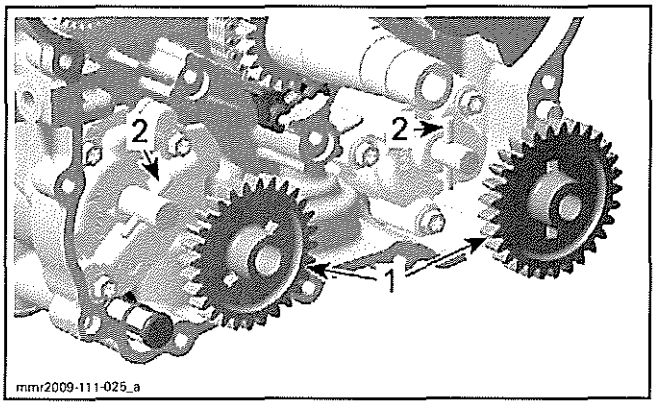
1. *Intermediate gears*
2. *Retaining screws*

2. Remove bearing sleeves and oil pump intermediate gears.



1. Intermediate gears
2. Bearing sleeves

3. Remove oil pump gears and needle pins.



1. Oil pump gears
2. Needle pins

Oil Pump Drive Gear Inspection

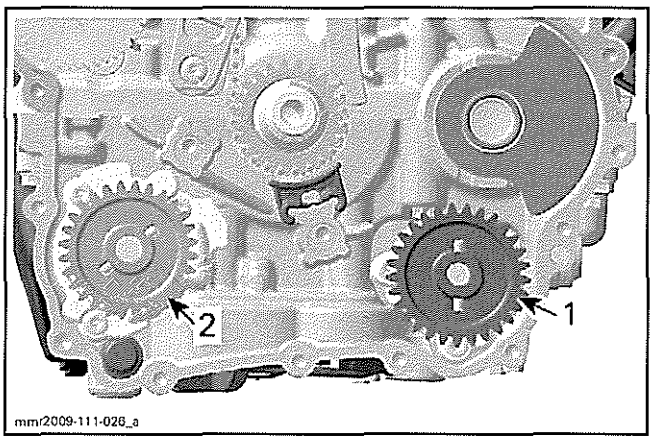
Inspect gears for wear, cracks or other damage.

Replace if damaged.

Oil Pump Drive Gear Installation

For installation, reverse the removal procedure. Pay attention to the following.

1. Ensure not to mix up the oil pump gears, see next illustration.
   1.1 Install the BROWN oil pump gear (29 teeth) on oil pressure pump.
   1.2 Install the BLACK oil pump gear (28 teeth) on oil suction pump.



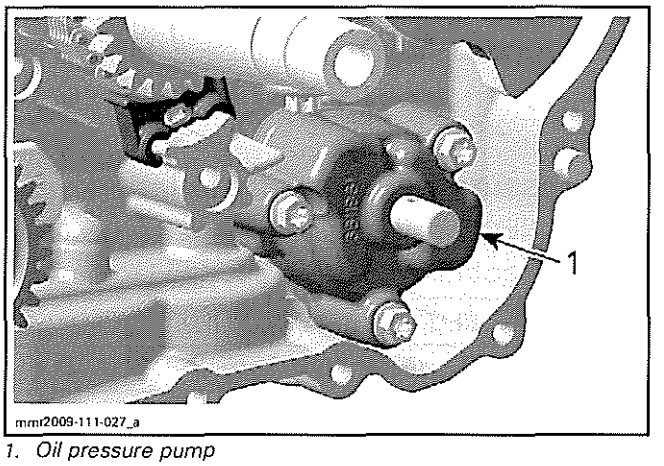
1. BROWN oil pump gear - 29 teeth
2. BLACK oil pump gear - 28 teeth

2. Lubricate intermediate gears bearing sleeves with engine oil, then install gears.
3. Install all other removed parts.
4. Fill up oil tank and check oil level. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

OIL PRESSURE PUMP

Oil Pressure Pump Location

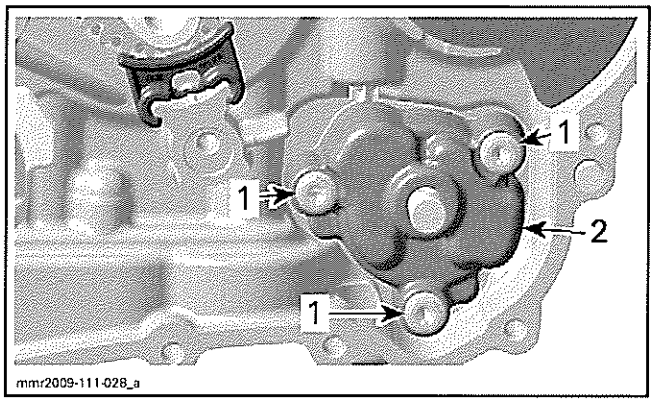
The oil pressure pump is located in the cylinder block, behind the magneto cover.



1. Oil pressure pump

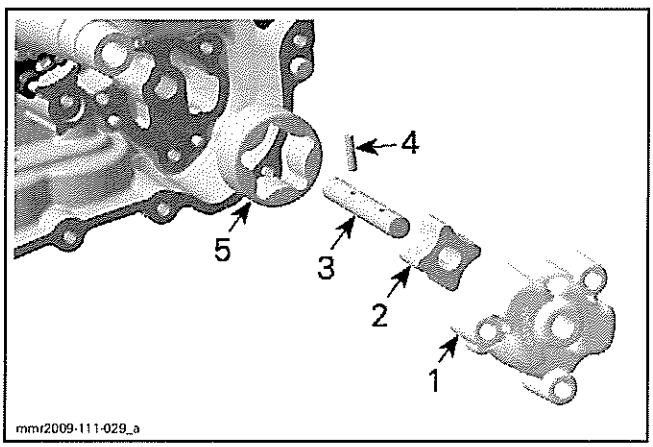
Oil Pressure Pump Removal

1. Remove *OIL PUMP DRIVE GEARS*, see procedure in this subsection.
2. Remove oil pump cover.



1. *Retaining screws*
2. *Oil pump cover*

3. Remove the following parts.



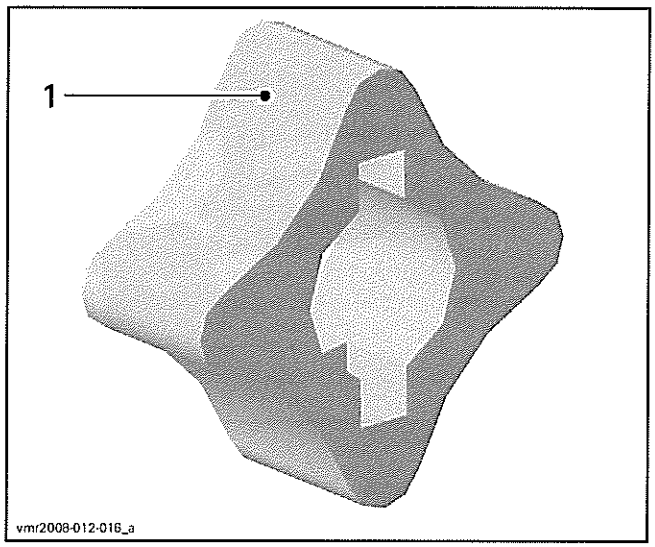
1. *Oil pump cover*
2. *Inner rotor*
3. *Oil pump shaft*
4. *Needle pin*
5. *Outer rotor*

Oil Pressure Pump Inspection

Inspect oil pump and oil pump cover bore for marks, scratches or other damage. Replace any damaged parts.

Check oil pump cover for damage and for surface straightness with a straight edge.

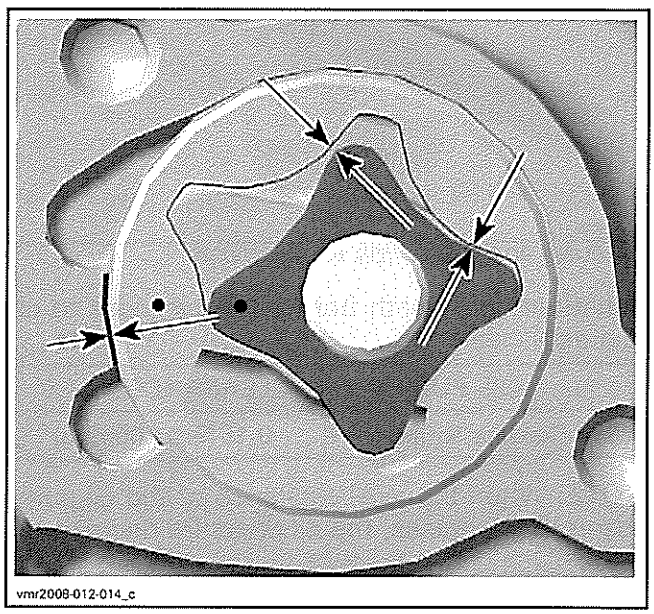
Check inner rotor for corrosion, worn pin slots or other damage. If so, replace inner and outer rotor at the same time.



1. *Pitting on the teeth*

Radial Clearance

Using a feeler gauge, measure the clearance of outer rotor and inner rotor where shown with the arrows.

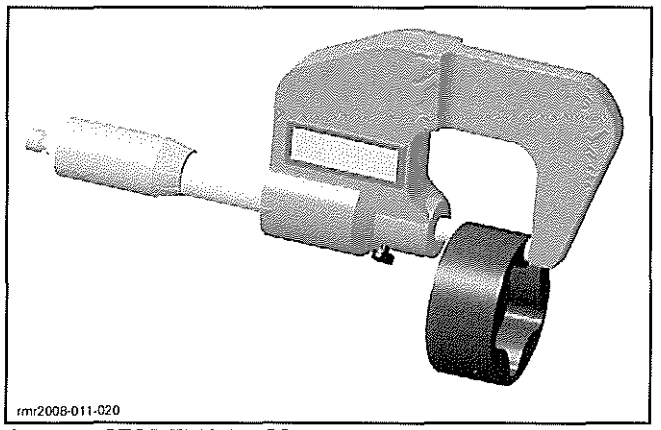


OIL PUMP RADIAL CLEARANCE	
SERVICE LIMIT	0.25 mm (.0098 in)

NOTE: If clearance of inner and outer rotors exceeds the tolerance, replace oil pump.

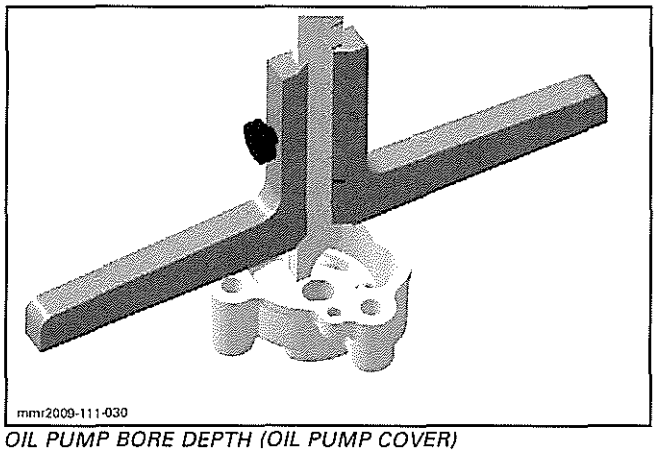
Axial Clearance

Measure outer rotor thickness with a micrometer.



OUTER ROTOR THICKNESS

Using a depth gauge, measure the depth of oil pump cover bore.



OIL PUMP BORE DEPTH (OIL PUMP COVER)

Substract bore depth from rotor thickness to obtain axial clearance.

OIL PUMP AXIAL CLEARANCE	
Service limit	0.15 mm (.0059 in)

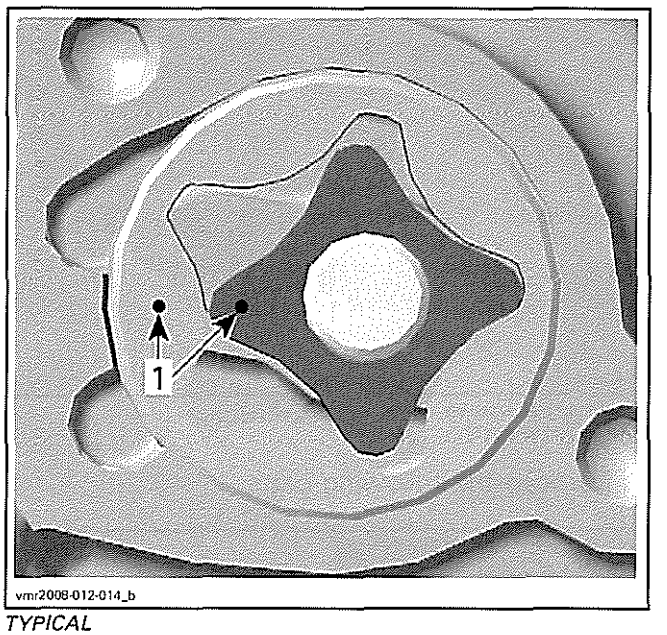
NOTE: When the axial clearance of the oil pump assembly increases, the oil pressure decreases.

Oil Pressure Pump Installation

For installation, reverse the removal procedure. Pay attention to the following.

1. Lubricate inner and outer rotors with engine oil.

NOTICE Install rotors with the marks outwards and aligned together.



TYPICAL
1. Marks on inner and outer rotor

Tighten screws to the specified torque.

OIL PRESSURE PUMP COVER SCREWS TIGHTENING TORQUE
11 N•m (97 lbf•**in**)

After installation of the remaining parts, check for smooth operation of the oil pump assembly by manually rotating the oil pump shaft.

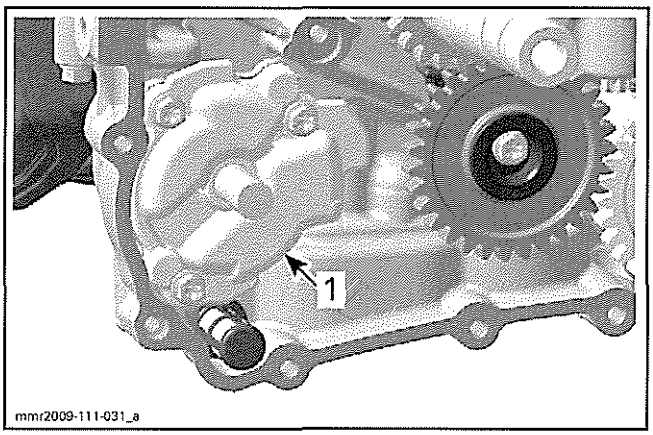
2. Fill up oil tank and check oil level. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

Start engine and make sure oil pressure is within specifications (refer to *ENGINE OIL PRESSURE* in this subsection).

OIL SUCTION PUMP MODULE

Oil Suction Pump Module Location

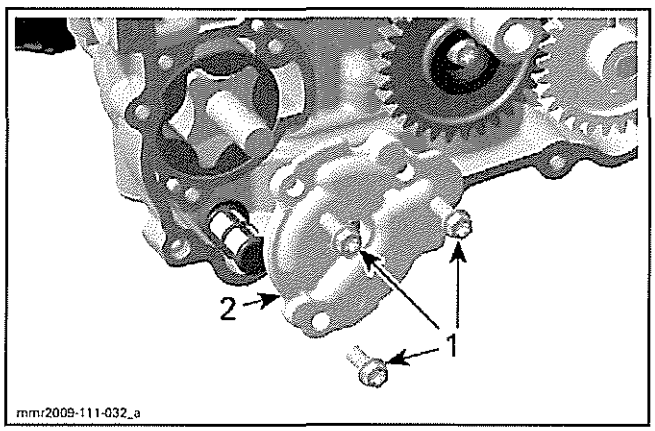
The oil suction pump module is located in the crankcase, behind the magneto cover.



1. Oil suction pump module

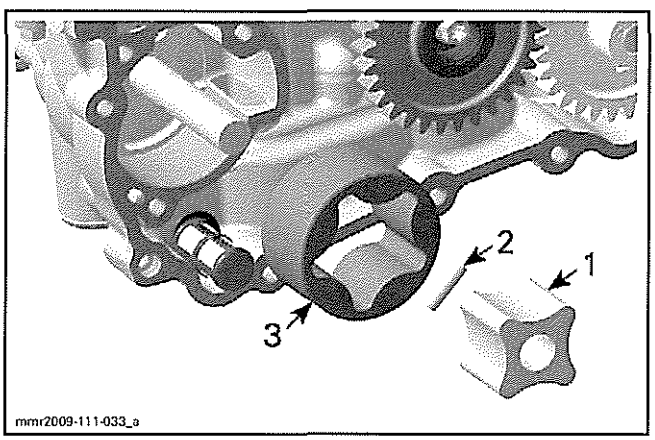
Oil Suction Pump Module Disassembly

1. Remove *OIL PUMP DRIVE GEARS*, see procedure in this subsection.
2. Remove oil pump module cover.



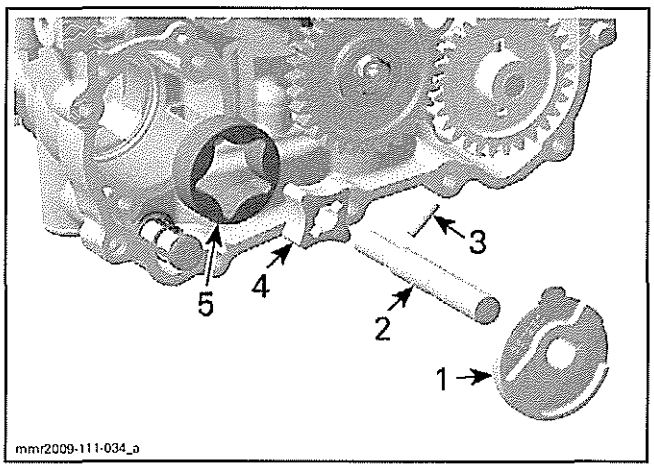
1. Retaining screws
2. Oil pump module cover

3. Disassemble the large oil suction pump as shown.



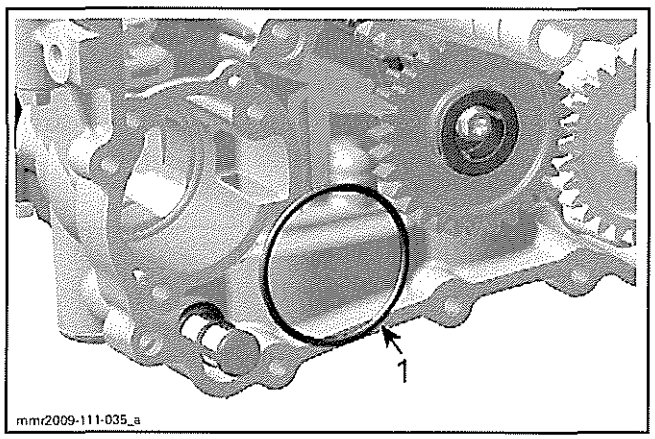
1. Inner rotor
2. Needle pin
3. Outer rotor

4. Disassemble the small oil suction pump as shown.



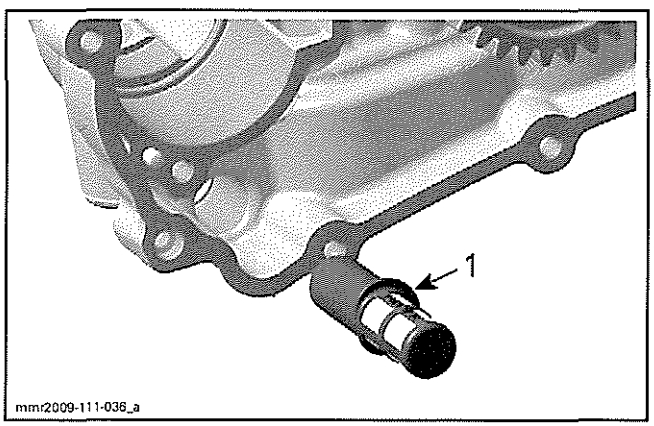
1. Oil pump cover
2. Oil pump shaft
3. Needle pin
4. Inner rotor
5. Outer rotor

5. Remove and discard the oil pump cover O-ring.



1. Oil pump cover O-ring

Remove and clean the engine oil strainer.



1. Engine oil strainer

Oil Suction Pumps Inspection

The inspection of both oil suction pumps is the same as for the oil pressure pump. Refer to *OIL PRESSURE PUMP* in this subsection.

Clean engine oil strainer with a part cleaner then use an air gun to dry it.

Check engine oil strainer for damage and replace if necessary.

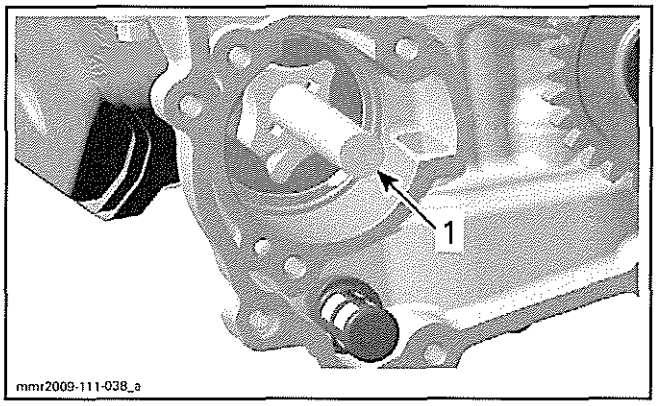
Oil Suction Pump Module Assembly

For installation, reverse the removal procedure. However, pay attention to the following details.

Install oil strainer.

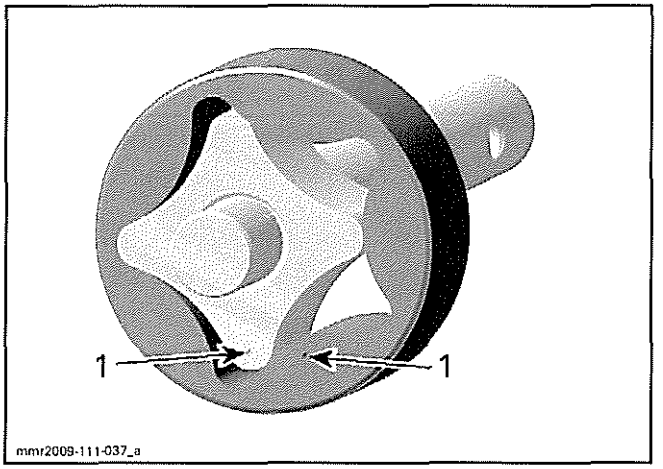
Coat inner and outer rotors with engine oil.

Install oil pump shaft with small oil suction pump rotors into its bore in the cylinder block.



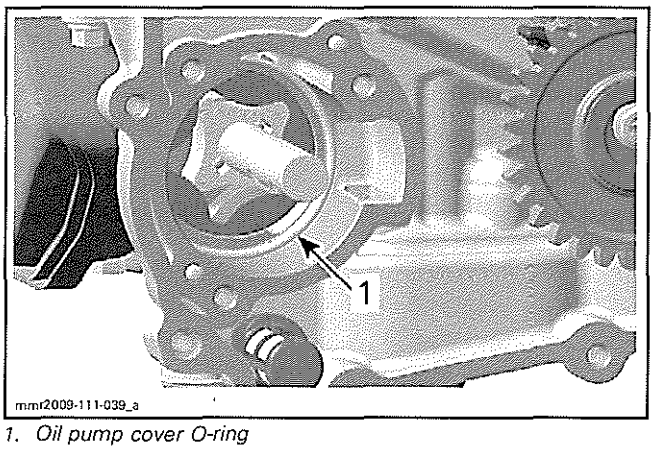
1. Oil pump shaft with small oil suction pump

NOTICE The outer and inner rotor are marked. When installing, make sure both marks are on the same side and are pointed toward the inside of cylinder block.



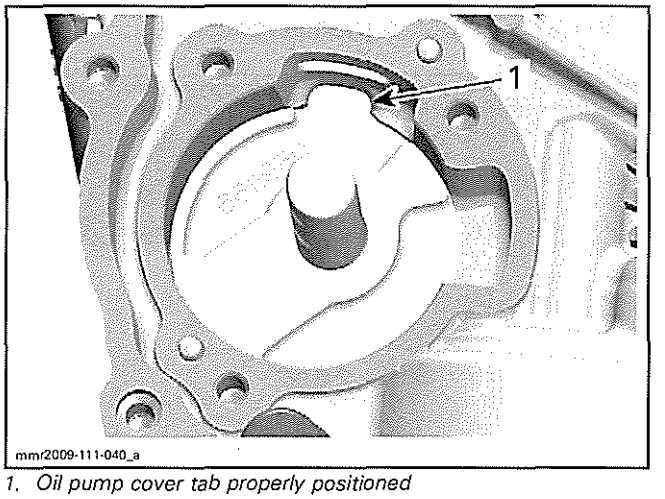
1. Marks on inner and outer rotor

Install a NEW oil pump cover O-ring.



1. Oil pump cover O-ring

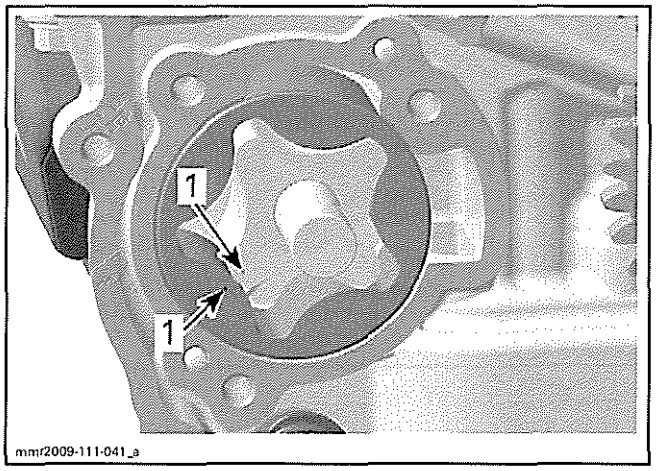
Install oil pump cover. Align the oil pump cover tab with the cylinder block recess. Ensure that cover fits properly in cylinder block.



1. Oil pump cover tab properly positioned

Install needle pin, inner and outer rotor of large oil suction pump.

NOTE: The outer and inner rotor are marked. When installing, make sure both marks are on the same side.



1. Marks on inner and outer rotor

Tighten screws to the specified torque.

OIL SUCTION PUMP MODULE COVER SCREWS TIGHTENING TORQUE
11 N•m (97 lbf•**in**)

Before installation of the oil pump cover, make sure engine oil strainer is in place.

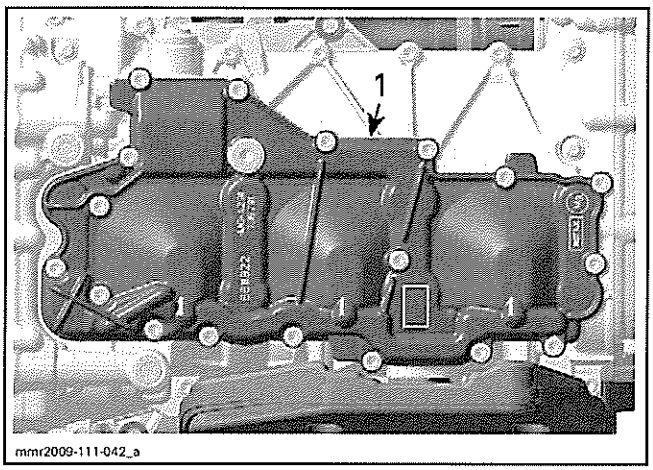
After installation of the remaining parts, check for smooth operation of the oil pump assembly by manually rotating the oil pump shaft.

After engine is completely reassembled, start engine and make sure oil pressure is within specifications (refer to *ENGINE OIL PRESSURE* in this subsection).

OIL SUMP COVER

Oil Sump Cover Location

The oil sump cover is located on the engine bottom.



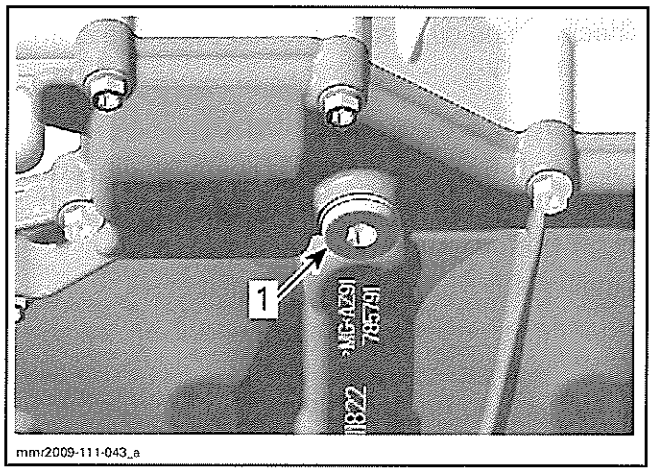
1. Oil sump cover

Oil Sump Cover Access

Remove engine from vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.

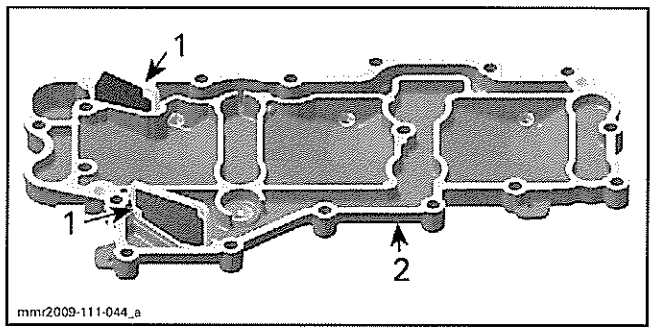
Oil Sump Cover Removal

1. Drain engine oil, refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.



1. Oil drain plug

2. Unscrew oil sump cover retaining screws.
3. Remove oil sump cover. Discard gasket.
4. Remove and clean engine oil strainers.

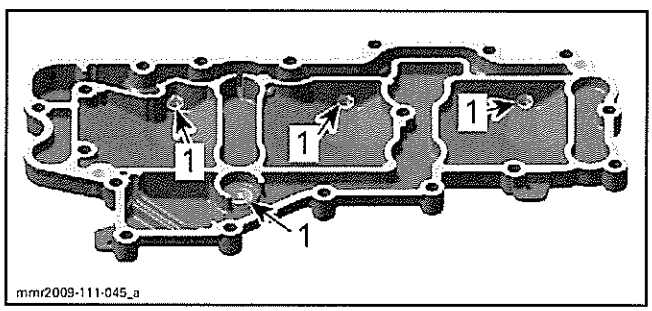


1. Engine oil strainers
2. Oil sump cover

Oil Sump Cover Inspection

Clean oil sump cover and engine oil strainers with a part cleaner, then use an air gun to dry it.

Blow out the oil orifices and check if they are not clogged.



1. Blow out oil orifices

Check oil sump cover for cracks or other damage.

Check oil sump cover for flatness with straight edge.

Replace oil sump cover if necessary.

Check engine oil strainers for damage and change if necessary.

Oil Sump Cover Installation

For installation, reverse the removal procedure. Pay attention to the following details.

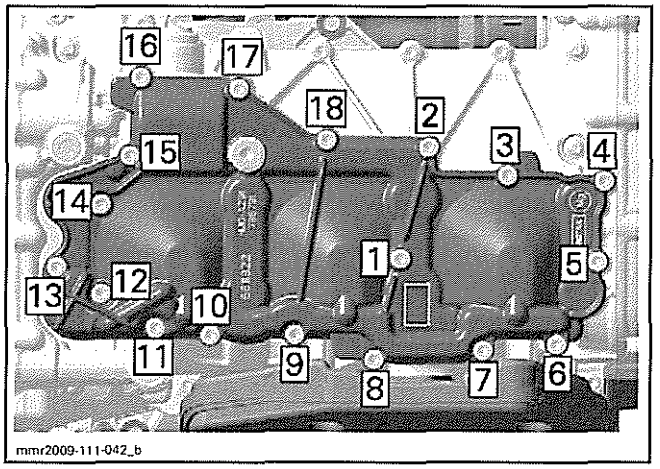
Install both oil strainers.

Install a NEW oil sump cover gasket.

Properly reinstall engine oil strainers into oil sump cover.

Tighten oil sump cover retaining screws as follows.

OIL SUMP COVER SCREWS TIGHTENING TORQUE (FOLLOW SEQUENCE)
11 N•m (97 lbf•**in**)



TIGHTENING SEQUENCE

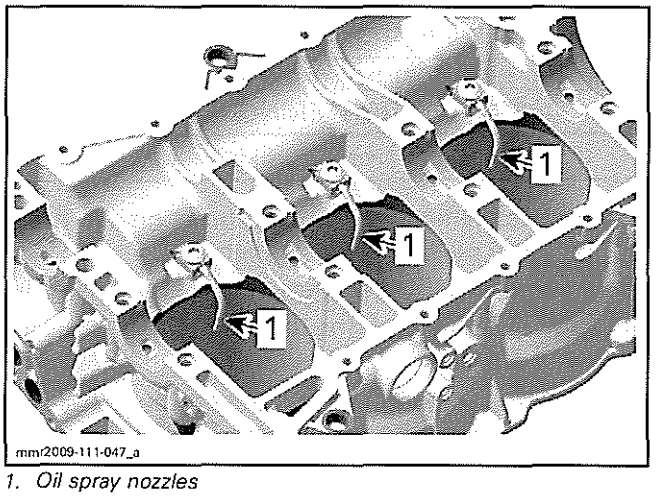
Reinstall oil drain plug using a NEW sealing washer.

Install engine in vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.

Fill up oil tank and check oil level. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

OIL SPRAY NOZZLES

The oil spray nozzles are located, between upper and lower half of cylinder block.

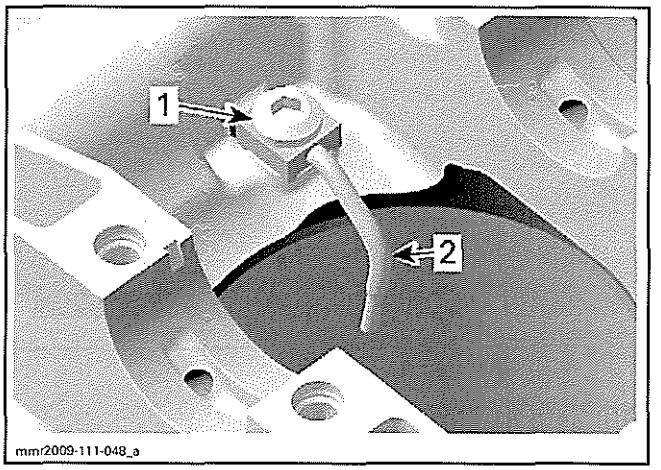


1. Oil spray nozzles

NOTE: Whenever the cylinder block has to be separated, the oil spray nozzles should be cleaned.

Oil Spray Nozzle Removal

1. Remove cylinder block lower half. Refer to *CYLINDER BLOCK* subsection.
2. Remove oil spray nozzle and Banjo fitting from cylinder block upper half.

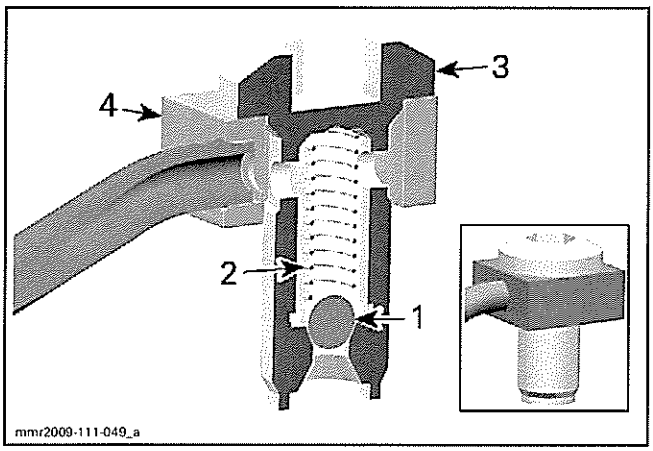


1. Banjo fitting
2. Oil spray nozzle

Oil Spray Nozzle Cleaning and Inspection

Clean oil spray nozzle and Banjo fitting using a part cleaner, then dry using compressed air.

Check if ball inside Banjo fitting moves freely.

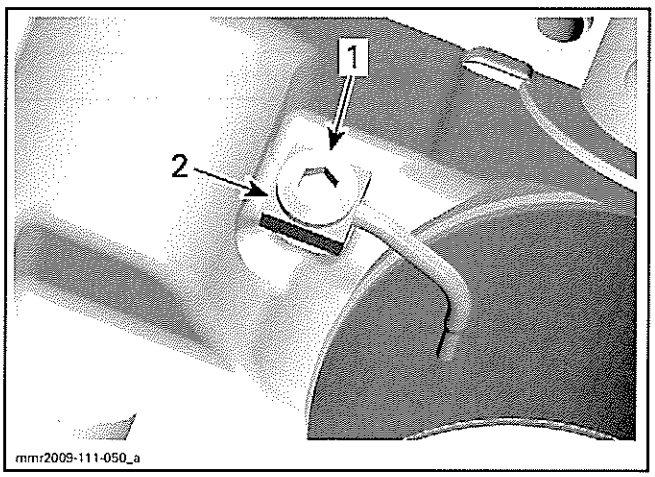


1. *Ball*
2. *Spring*
3. *Banjo fitting*
4. *Oil spray nozzle*

NOTE: If the oil spray nozzle is damaged or bent during work in the cylinder block, it must be replaced immediately.

Oil Spray Nozzle Installation

NOTICE At assembly make sure the contact surface of the oil spray nozzle is well fitted onto the cylinder block. If this is not ensured, the oil spray direction will change, causing potential engine damage.



1. *Oil spray nozzle*
2. *Contact surface*

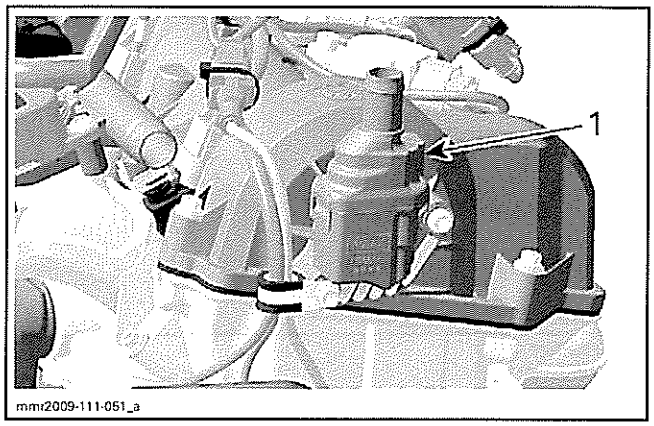
Tighten banjo fitting to the specified torque.

OIL SPRAY NOZZLE BANJO FITTING TIGHTENING TORQUE
19 N•m (168 lbf•**in**)

BREATHER

The engine is equipped with a breather which blocks engine oil and allows vapors to return in the intake system.

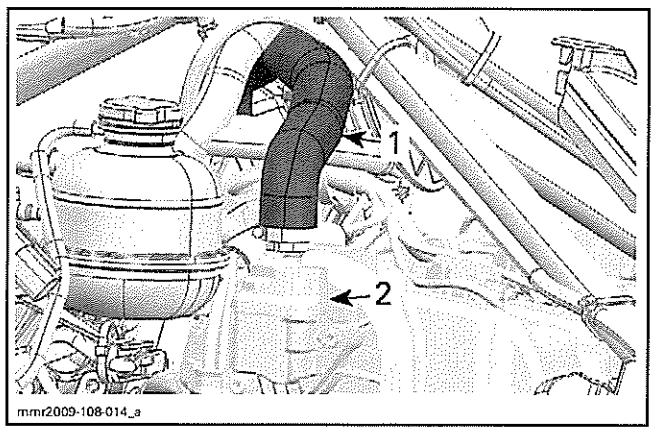
The breather is a mechanical device that does not require electrical supply for its operation.



1. *Breather*

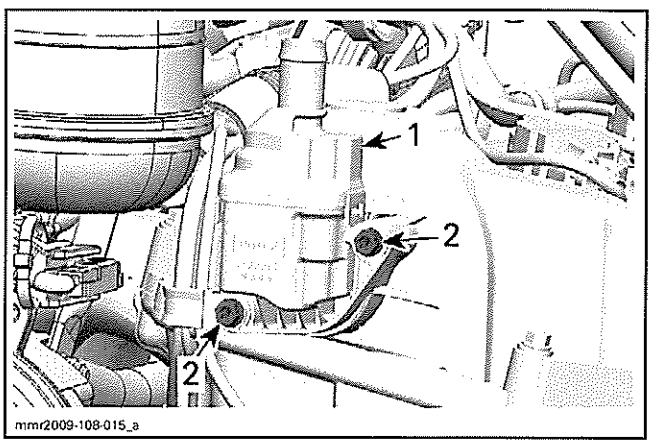
Breather Removal

1. Remove vent hose from breather.



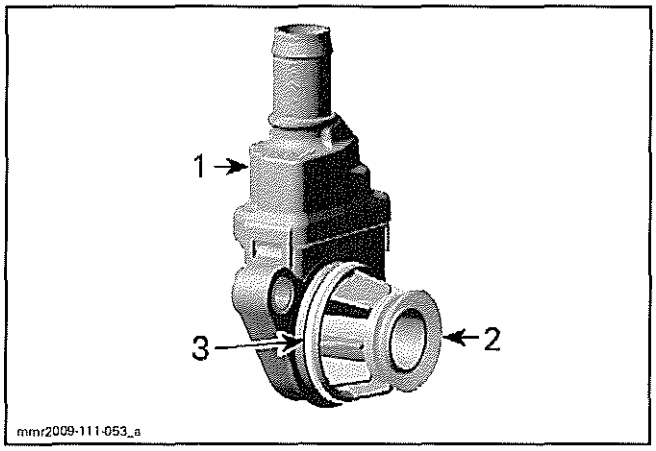
1. *Vent hose*
2. *Breather*

2. Unscrew and remove breather.



1. *Breather*
2. *Retaining screws*

3. Remove O-ring and V-ring from breather.



1. *Breather*
2. *V-ring*
3. *O-ring*

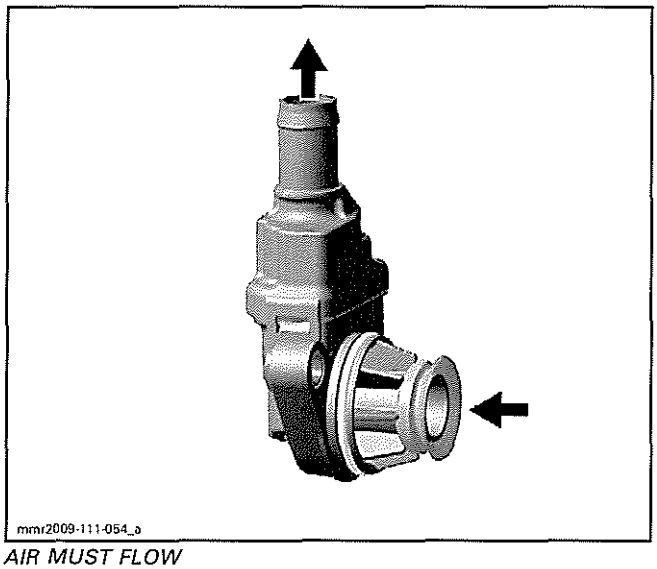
NOTE: Breather cannot be disassembled.

Breather Inspection

Check breather for cracks or other damage.

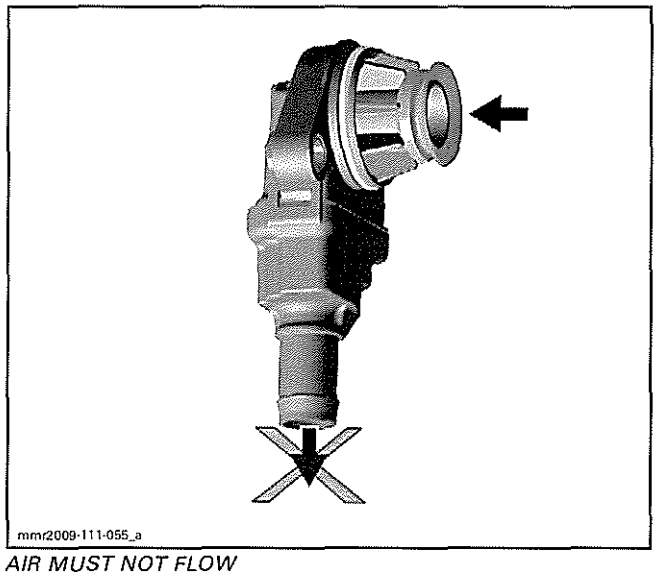
Clean all contact surfaces of breather.

Blow air through inlet port. Air must flow freely to the outlet port.



AIR MUST FLOW

Turn breather upside down and blow air again. Air must NOT flow out.



AIR MUST NOT FLOW

If test fails, replace the breather.

Breather Installation

For installation, reverse the removal procedure. Pay attention to the following detail.

Install breather with a NEW O-ring and a NEW V-ring.

Tighten screws to the specified torque.

BREATHER RETAINING SCREWS TIGHTENING TORQUE
11 N•m (97 lbf•**in**)

COOLING SYSTEM

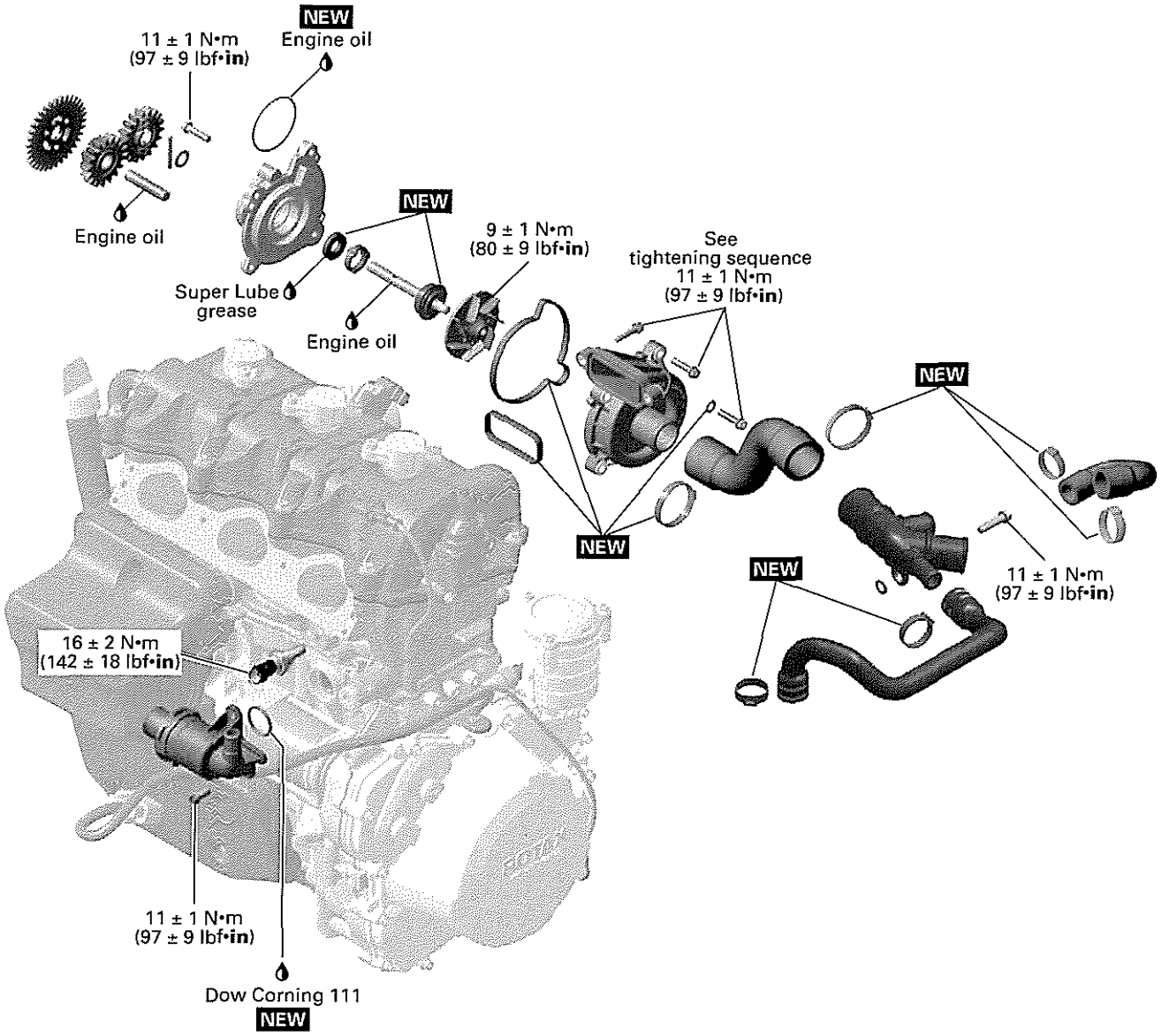
SERVICE TOOLS

Description	Part Number	Page
ECM ADAPTER TOOL	420 277 010	341
HANDLE	420 877 650	335
OIL SEAL PUSHER	529 035 757	335
SEAL PUSHER	529 035 766	336
TEST CAP	529 035 991	330
VACUUM/PRESSURE PUMP	529 021 800	330

SERVICE PRODUCTS

Description	Part Number	Page
DOW CORNING 111	413 707 000	333
SUPER LUBE GREASE	293 550 030	335

ENGINE COMPONENTS



NEW = Component must be replaced when removed.

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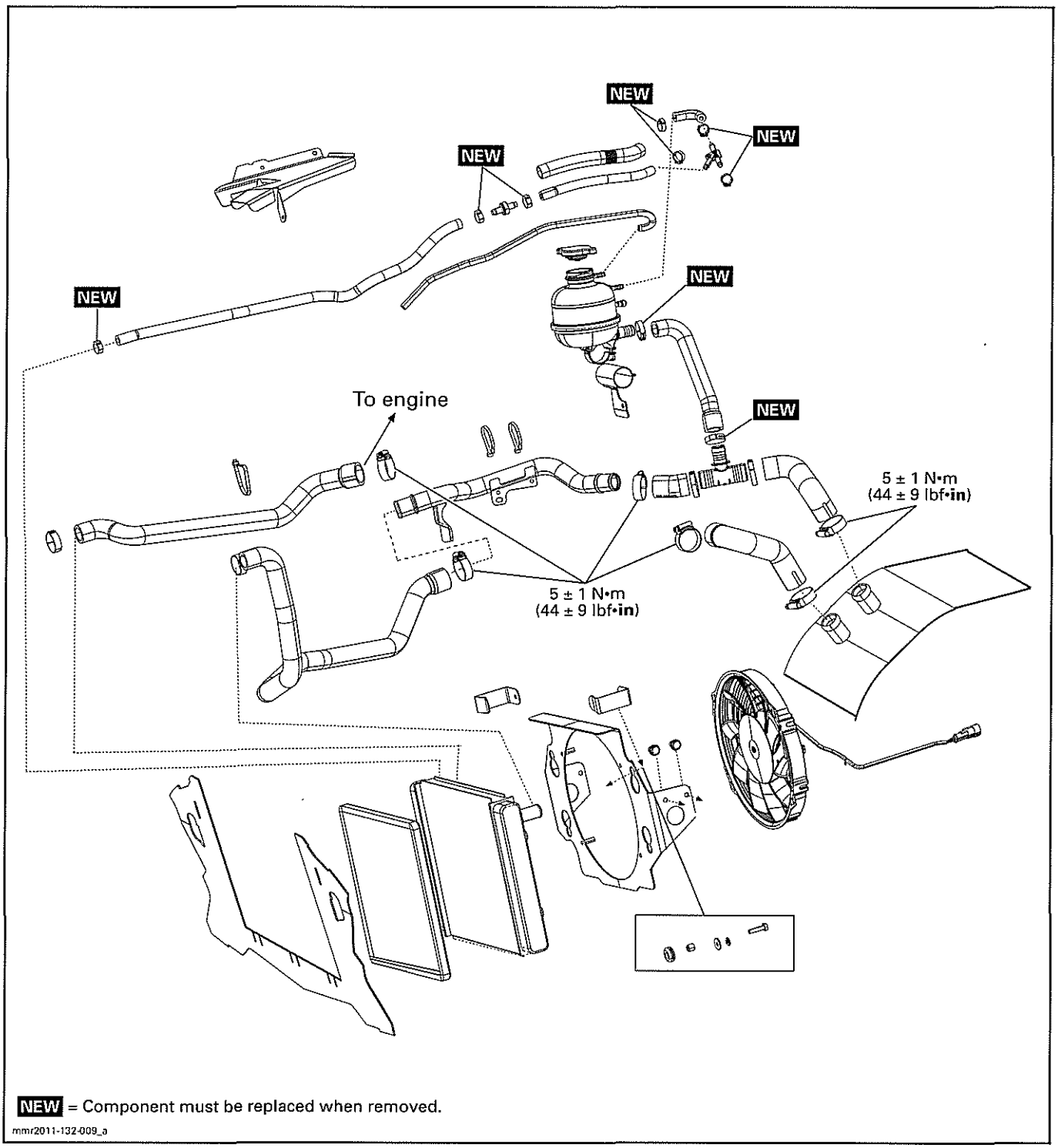
VEHICLE COMPONENTS



NEW = Component must be replaced when removed.

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GENERAL

For a better understanding, some illustrations are taken with engine out of vehicle.

NOTE: It is a good practice to check for fault codes using B.U.D.S. software as a first troubleshooting step. Refer to the *DIAGNOSTIC AND FAULT CODES* subsection.

During assembly/installation, use the torque values and service products as shown in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must strictly be adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, cotter pin, etc.) must be replaced with new ones.

NOTICE **Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.**

INSPECTION

COOLING SYSTEM LEAK TEST

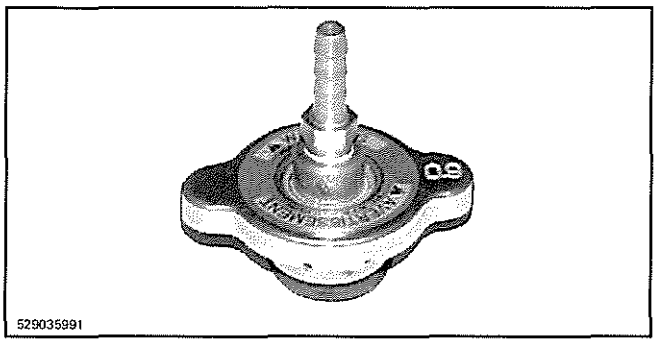
NOTE: This test confirms if there is a leak in the cooling system, including the engine.

⚠ WARNING

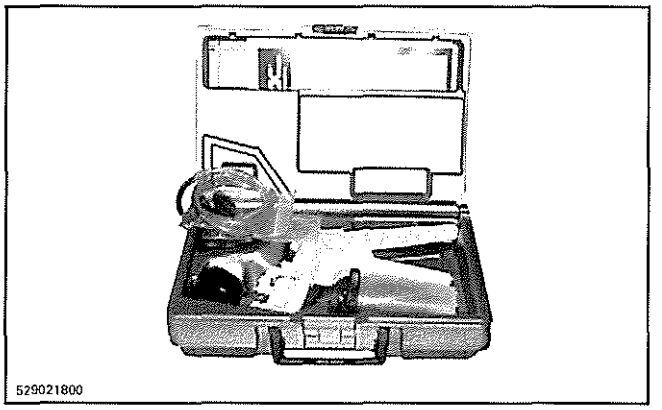
To prevent potential burns, do not remove the heat exchanger cap if the engine is hot.

Remove hood.

Install the TEST CAP (P/N 529 035 991) on coolant reservoir.

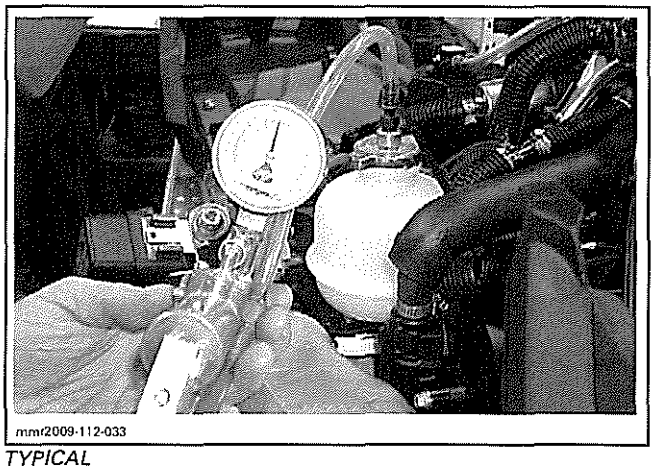


Connect the VACUUM/PRESSURE PUMP (P/N 529 021 800) to the test cap nipple.



Pressurize system through coolant reservoir.

COOLING SYSTEM LEAK TEST
100 kPa (15 PSI)

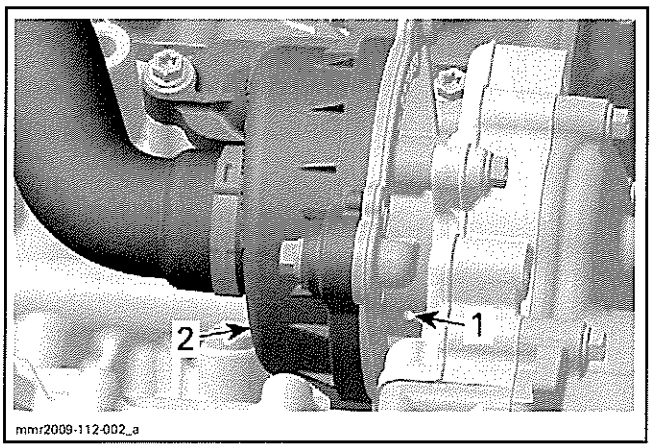


TYPICAL

If pressure drops, check all hoses and engine for coolant leaks. Spray a soap/water solution and look for air bubbles.

Check the water pump leak indicator hole for oil or coolant leakage.

NOTE: Leaking coolant indicates a damaged rotary seal. Leaking oil indicates a damaged oil seal. If either seal is leaking, both seals must be replaced at the same time. Refer to *WATER PUMP* in this subsection.



1. *Leak indicator hole*
2. *Water pump*

TROUBLESHOOTING

The following is provided to help in diagnosing the probable source of troubles. It is a guideline and should not be assumed to show all causes for all problems.

Always check for fault codes. If a fault code is detected, service the fault code first.

ENGINE OVERHEATING

1. Low coolant level.
   - *Refill and check for leaks (coolant leaking out of leak indicator hole, hoses or clamps missing or defective, cylinder head gasket or oil cooler leaks). Repair or replace.*
2. Air in cooling system.
   - *Refill and bleed cooling system.*
3. Defective thermostat (does not open when engine is warm up).
   - *Replace thermostat.*
4. Defective water pump.
   - *Inspect impeller and drive gears and replace defective components.*
5. Coolant temperature sensor defective.
   - *Check and replace.*
6. Dirty heat exchangers.
   - *Clean heat exchanger fins. Replace if required.*
7. Wrong coolant concentration.
   - *Check and adjust coolant concentration according to BRP's recommendations, or replace coolant.*
8. Defective coolant reservoir cap.
   - *Replace cap.*
9. Cooling fan.
   - *Refer to COOLING FAN DOES NOT OPERATE.*
10. Snow guard is too high.
    - *Check and adjust rear suspension.*

COOLING FAN DOES NOT OPERATE

1. Cooling fan fuse
   - *Check cooling fan fuse F10, refer to POWER DISTRIBUTION (1200 4-TEC) subsection.*
2. Cooling fan configuration
   - *Check cooling fan configuration in B.U.D.S., refer to COOLING FAN CONFIGURATION IN B.U.D.S in this subsection.*
3. Defective cooling fan
   - *Check cooling fan motor operation, refer to COOLING FAN MOTOR OPERATION TEST in this subsection.*
4. Cooling fan relay
   - *Check cooling fan relay, refer to POWER DISTRIBUTION 1200 4-TEC subsection.*
   - *Check cooling fan relay power, refer to INPUT VOLTAGE TEST AT COOLING FAN RELAY in this subsection.*
   - *Check cooling fan relay ground, refer to CONTROL CIRCUIT TEST OF COOLING FAN RELAY in this subsection.*

PROCEDURES

COOLANT RESERVOIR CAP

Coolant Reservoir Cap Test

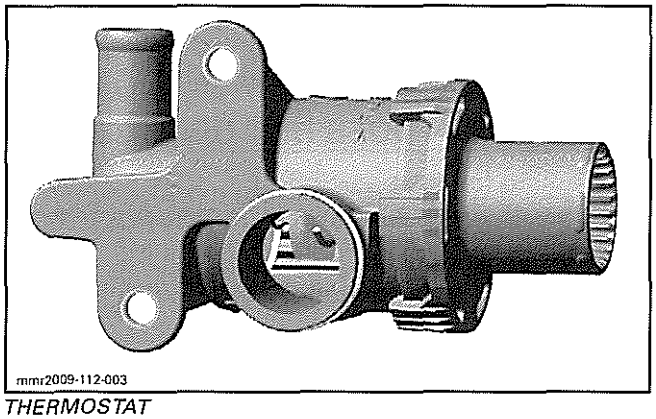
Using a pressure cap tester, check the efficiency of coolant reservoir cap. If the cap does not meet specification, replace the cap.

CAP OPENING PRESSURE
110 kPa (16 PSI)

THERMOSTAT

The thermostat is a dual action type.

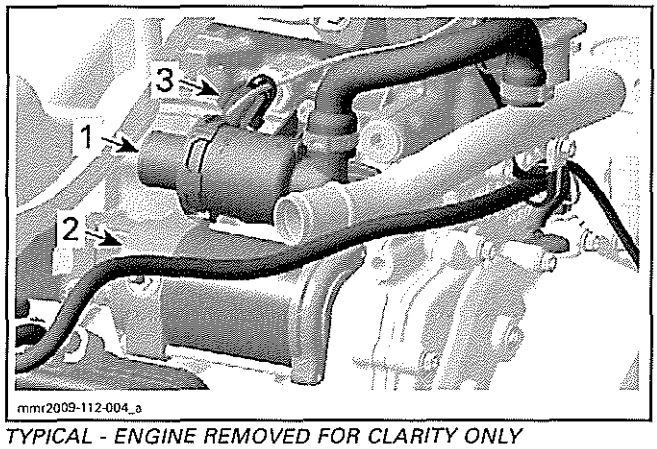
NOTE: Thermostat is integrated in a housing and is replaced as a complete unit.



THERMOSTAT

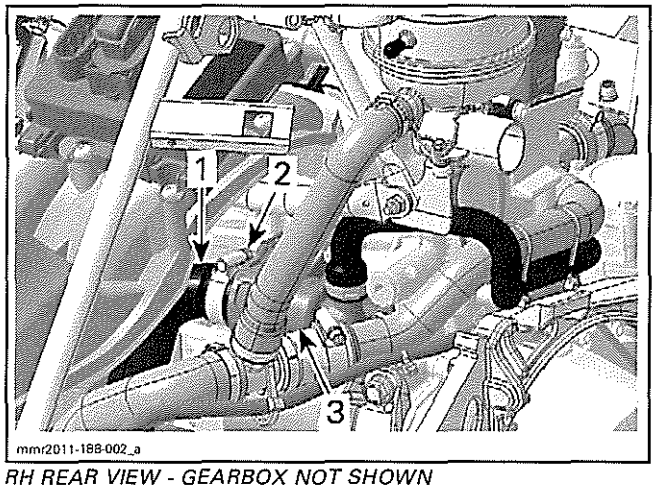
Thermostat Removal

The thermostat is located on the rear side of engine above the electric starter.



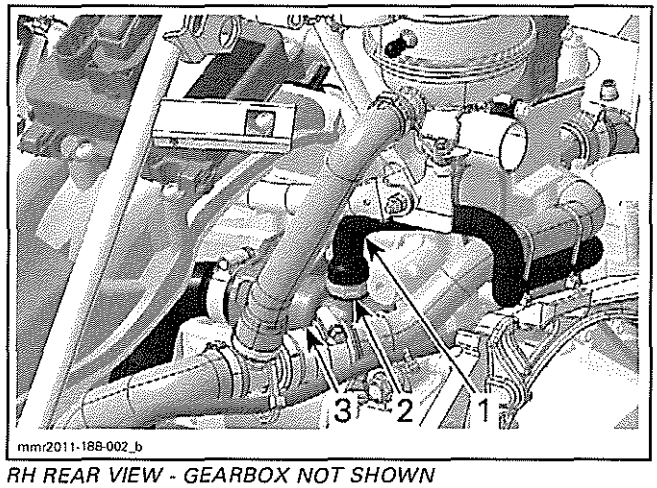
TYPICAL - ENGINE REMOVED FOR CLARITY ONLY
1. *Thermostat*
2. *Electric starter*
3. *Coolant temperature sensor (CTS)*

1. Drain cooling system. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.
2. Move fuel tank rearward. Refer to *FUEL TANK AND FUEL PUMP* subsection.
3. Remove the driven pulley. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 HO E-TEC AND 1200 4-TEC)* subsection.
4. Remove the clamp securing heat exchanger hose to thermostat.



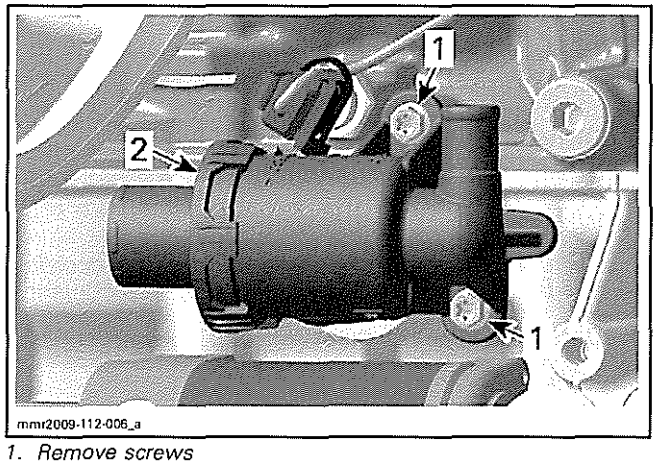
RH REAR VIEW - GEARBOX NOT SHOWN
1. *Heat exchanger hose*
2. *Clamp to remove*
3. *Thermostat*

5. Cut Oetiker clamp retaining the coolant hose on the top of thermostat.



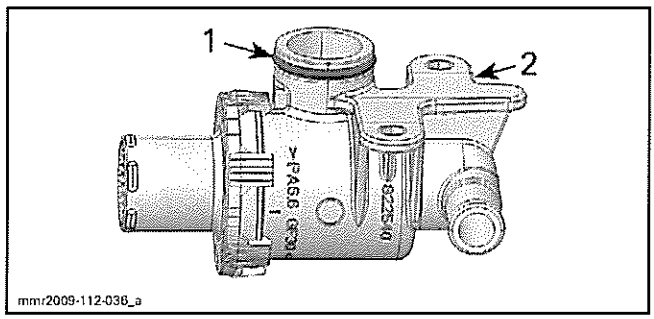
RH REAR VIEW - GEARBOX NOT SHOWN
1. *Coolant hose to water pump*
2. *Oetiker clamp to remove*
3. *Thermostat*

6. Remove retaining screws from the thermostat.



1. *Remove screws*
2. *Thermostat*

7. Pull out thermostat. Catch spilled coolant.
8. Remove the O-ring from the thermostat.



1. O-ring
2. Thermostat housing

Thermostat Test

1. To check the operation of the thermostat, soak it in water and heat the water.
2. Check thermostat opening temperature using a thermometer.

THERMOSTAT OPENING TEMPERATURE
65°C (149°F)

3. Replace thermostat if out of specification.

NOTICE **Do not open thermostat housing. Leakage might occurs under operation and may lead to engine damages.**

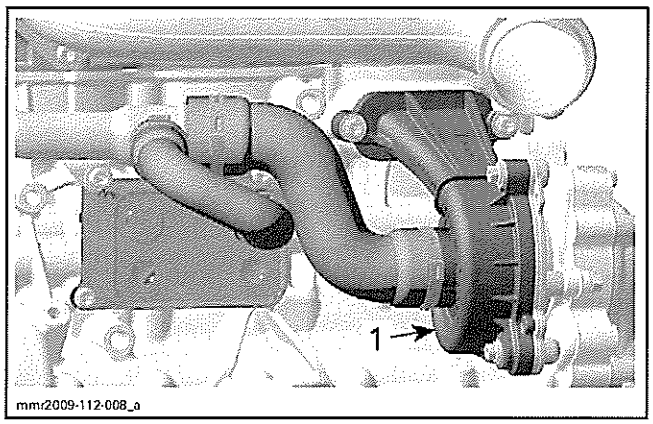
Thermostat Installation

For installation, reverse the removal procedure. However, pay attention to the following.

1. Install a NEW thermostat housing O-ring.
2. Apply DOW CORNING 111 (P/N 413 707 000) on O-ring before installing the thermostat.
3. Install a NEW Oetiker clamp.
4. Install all removed parts.
5. Refill and bleed coolant circuit. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

WATER PUMP

The water pump is located on front side of the engine, underneath the exhaust manifold.



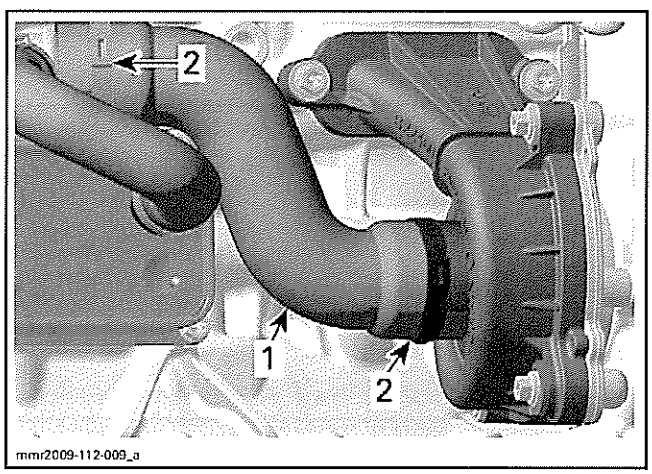
1. Water pump

Water Pump Removal

⚠ WARNING

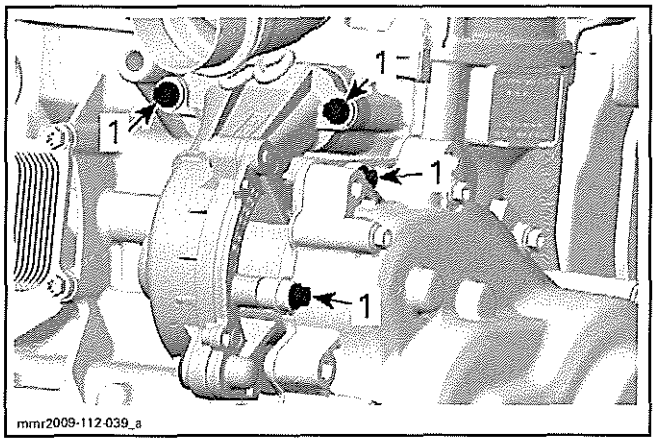
To avoid potential burns, do not remove the coolant tank cap or loosen the cooling drain plug if the engine is hot.

1. Remove the exhaust pipe. Refer to *EXHAUST SYSTEM* subsection.
2. Place a large drain pan under the vehicle bottom pan.
3. Drain cooling system. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.
4. Cut Oetiker clamps securing coolant hose between the rigid tube and water pump.



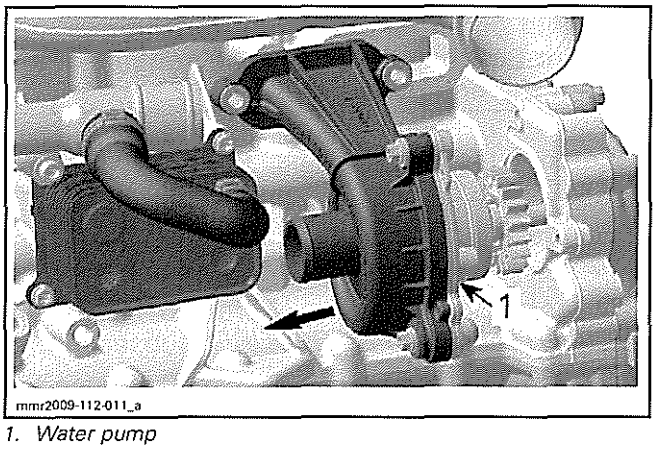
1. Coolant hose
2. Oetiker clamps

5. Remove the coolant hose to make room.
6. Remove screws retaining water pump module.



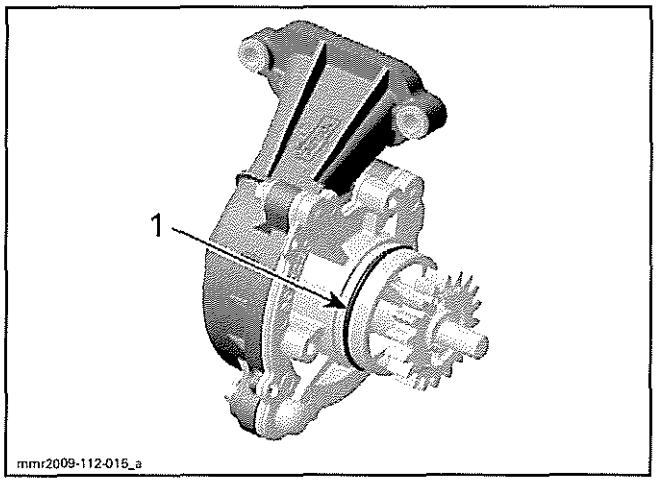
1. Remove screws

7. Pull water pump from engine and remove it from vehicle.



1. Water pump

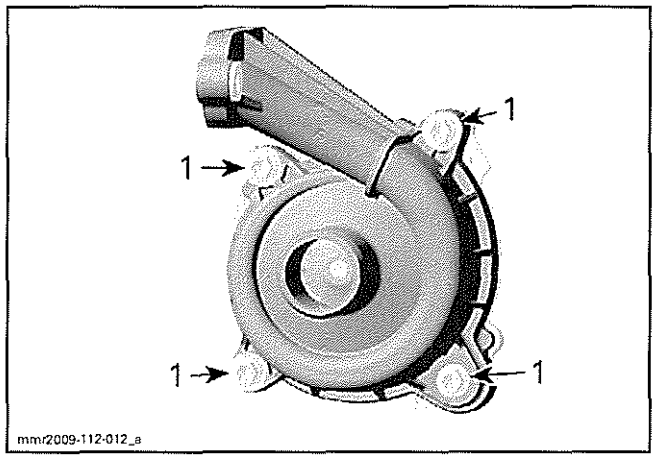
8. Remove and discard the O-ring on water pump module.



1. O-ring

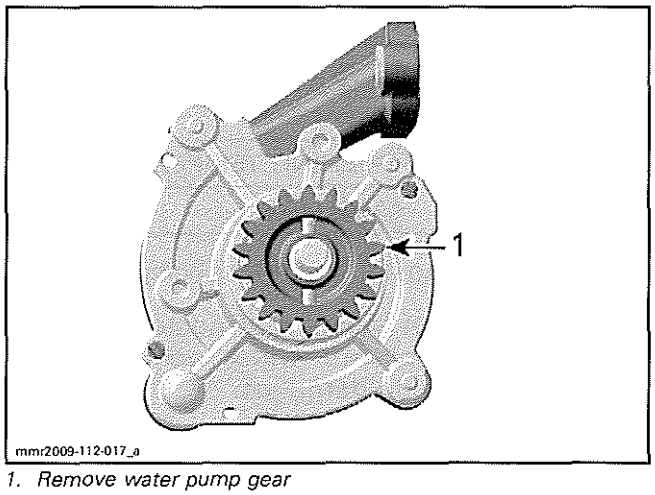
Water Pump Disassembly

1. Remove screws retaining water pump housing.



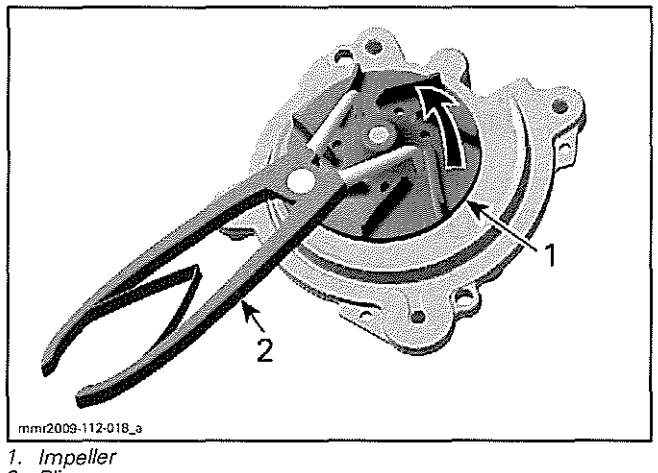
1. Remove screws

2. Remove water pump gear.



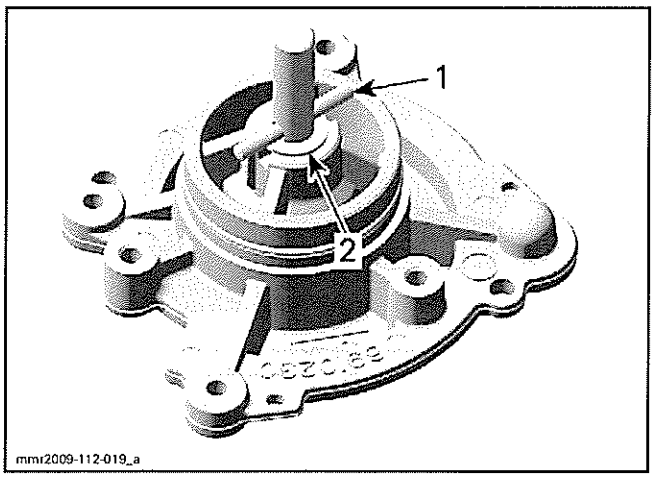
1. Remove water pump gear

3. Fix water pump shaft into a vise with aluminum jaws.
4. Unscrew the impeller counterclockwise using appropriate pliers.



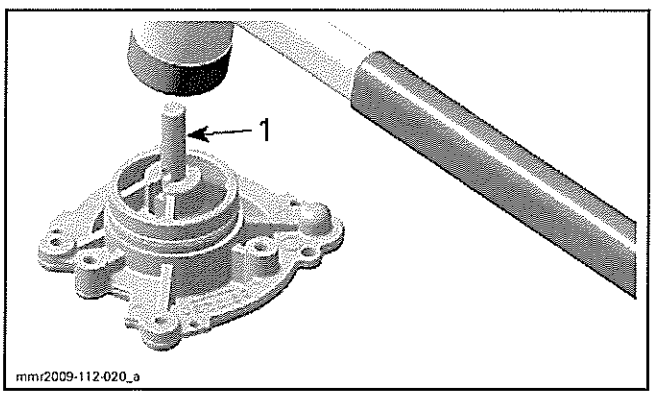
1. Impeller
2. Pliers

5. Remove needle pin and trust washer.



1. *Remove needle pin*
2. *Remove thrust washer*

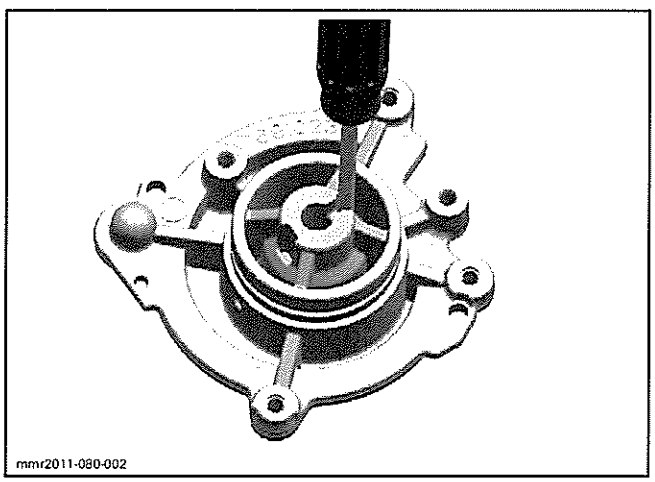
6. Push out water pump shaft using a soft hammer.



1. *Push out water pump shaft*

7. Extract oil seal and remaining parts of rotary seal with a pusher.

NOTE: Be careful not to damage the surface of the rotary seal bore in water pump housing.



Water Pump Inspection

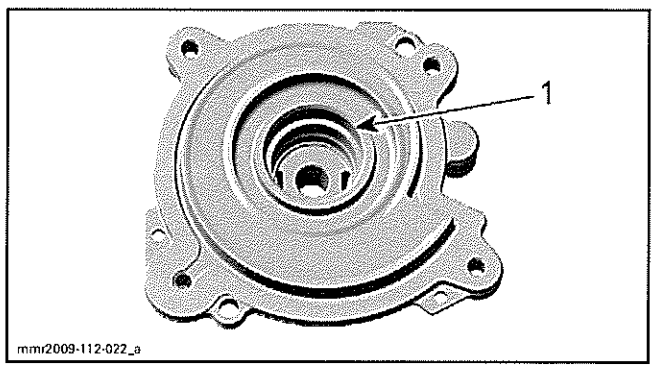
1. Check water pump housing for cracks or other visible damage.
2. Check water pump gear for wear or broken teeth.
3. Check impeller for cracks or other damage.
4. Replace parts if necessary.

Water Pump Assembly

The assembly is the reverse of the disassembly procedure. However, pay attention to the following.

NOTE: Always replace oil seal and water pump shaft with rotary seal together with NEW parts.

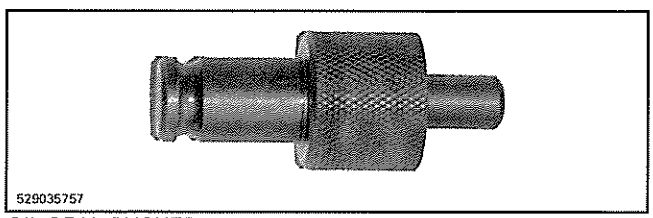
1. Clean rotary seal surface from old sealant.



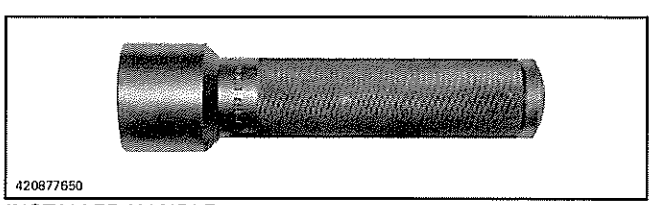
1. *Clean surface*

NOTE: Never use oil in the press fit area of the oil seal and rotary seal.

2. Use the OIL SEAL PUSHER (P/N 529 035 757) and the HANDLE (P/N 420 877 650) to install the oil seal.



OIL SEAL PUSHER

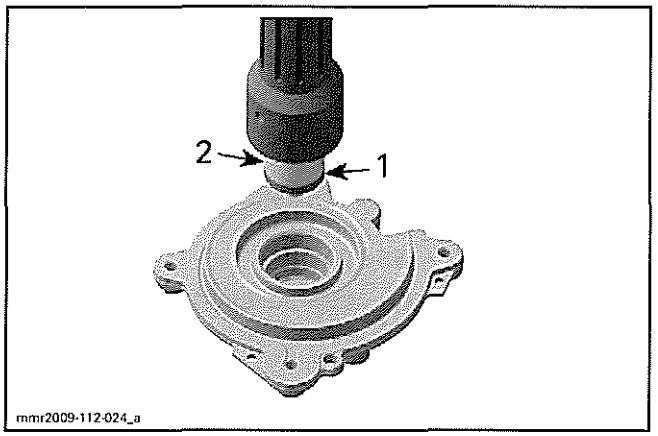


INSTALLER HANDLE

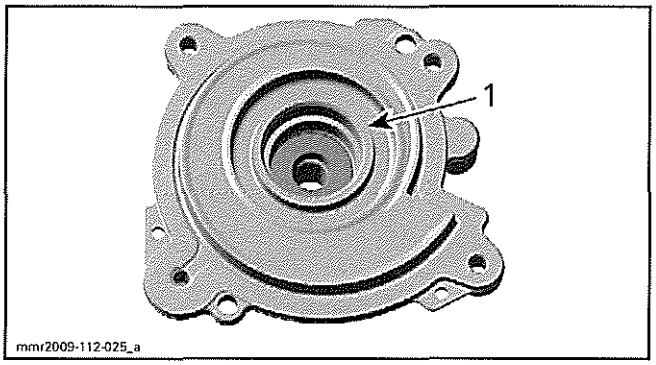
3. Apply SUPER LUBE GREASE (P/N 293 550 030) on sealing lip of the oil seal.

NOTE: When installing the oil seal on the pusher, make sure sealing lip faces outside.

4. Push NEW oil seal in place.

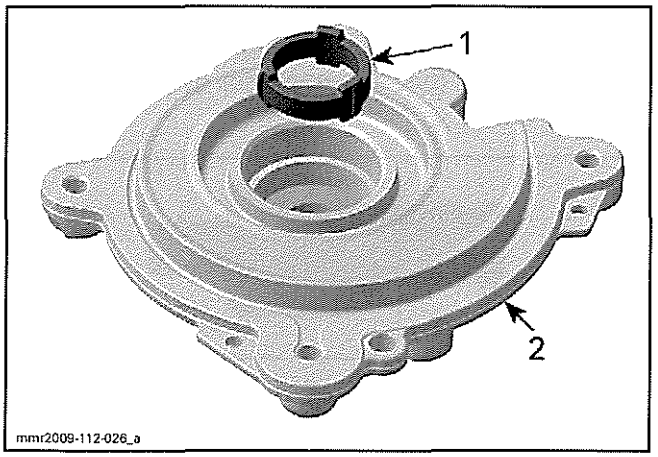


1. Oil seal
2. Oil seal pusher



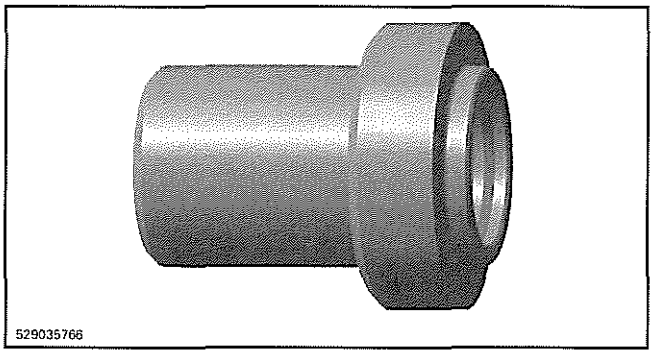
1. Oil seal properly installed

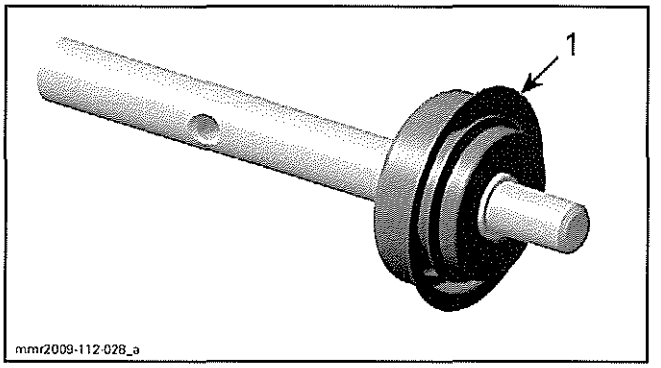
5. Install spacer ring into water pump housing.



1. Spacer ring
2. Water pump housing

6. Slide NEW water pump shaft with rotary seal into water pump housing.
7. Properly install water pump shaft with rotary seal using a press and the SEAL PUSHER (P/N 529 035 766).

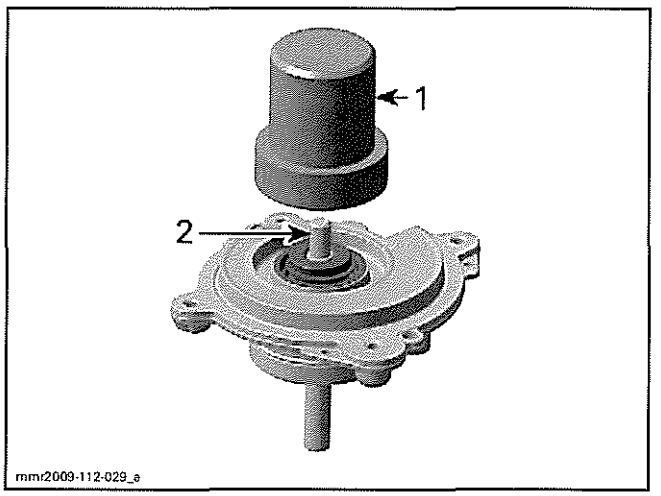




1. Surface where rotary seal is pushed by tool

NOTICE Never use a hammer for the installation of the water pump shaft with rotary seal. Only use a press to avoid damaging the ceramic component.

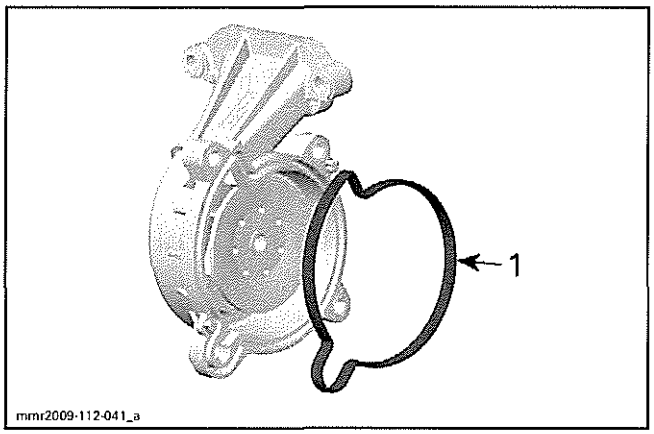
NOTE: Support water pump housing from below with suitable sleeve with straight surface.



1. Water pump shaft with rotary seal
2. Rotary seal installer

NOTE: After installation, water pump shaft with rotary seal must rotate freely.

8. Install NEW gasket to the water pump housing.



1. Gasket

9. Properly reinstall remaining components, refer to procedures above.
10. Install the impeller.

NOTICE Be careful not to damage impeller wings during its installation.

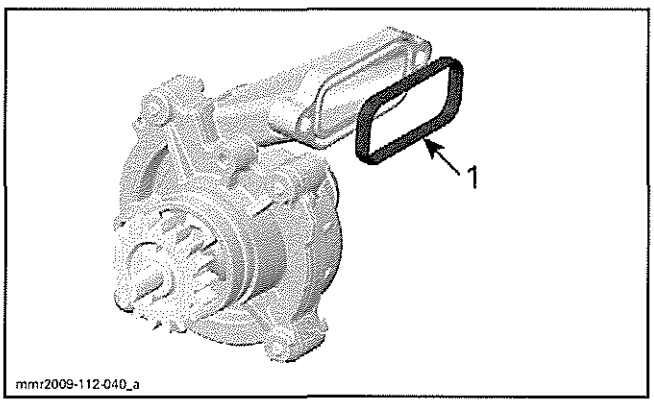
11. Tighten screws of water pump housing in a crisscrossed sequence.

Water Pump Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

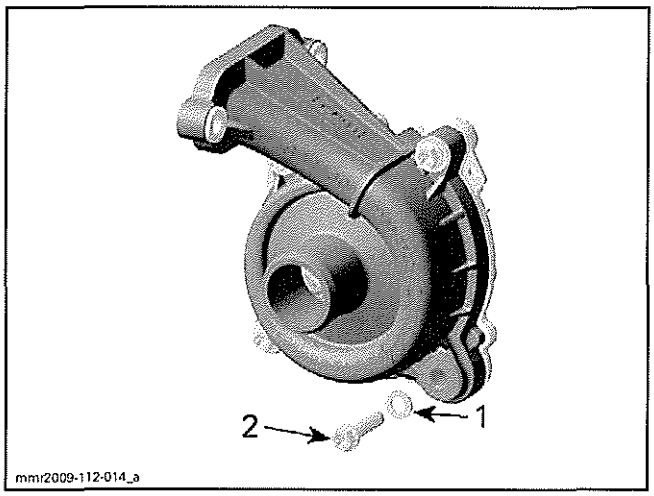
NOTICE To prevent leaking, take care that the gasket is exactly in groove when you reinstall the water pump.

1. Install NEW gasket to the water pump housing.



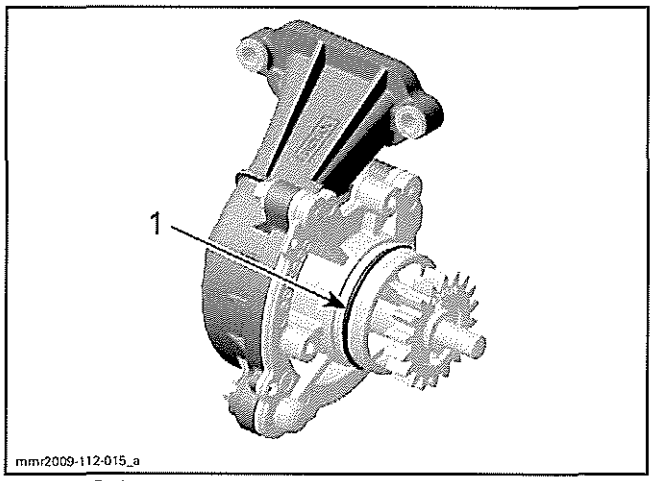
1. Gasket

2. Install NEW sealing washer to the drain plug screw.



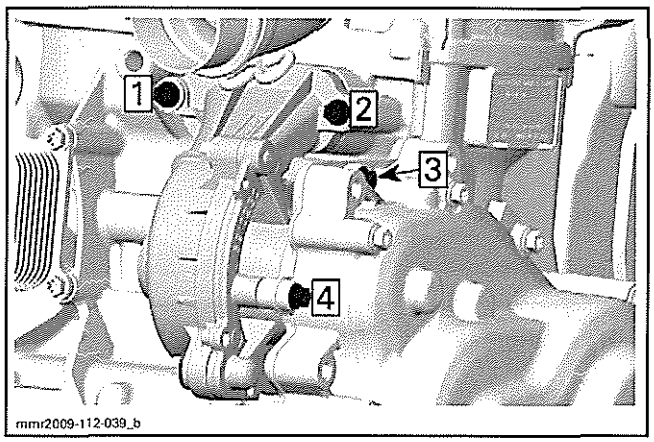
1. Sealing washer
2. Drain plug screw

3. Install NEW O-ring to the water pump module.



1. New O-ring

4. Reinstall water pump on engine and use the following pattern to tighten water pump screws.



TIGHTENING SEQUENCE

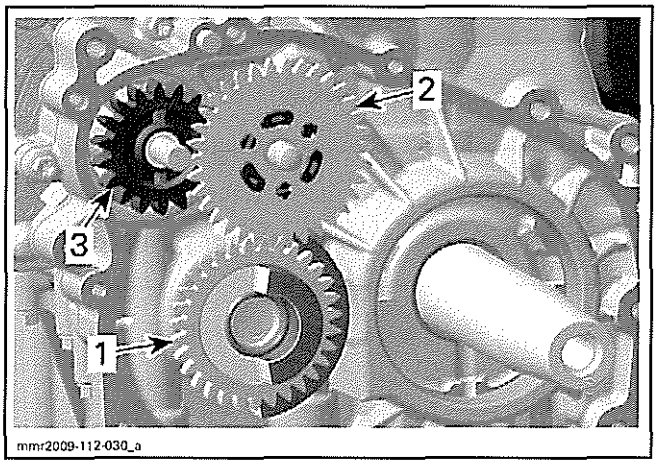
WATER PUMP HOUSING SCREW TORQUE
11 N•m ± 1 N•m (97 lbf•**in** ± 9 lbf•**in**)

5. Tighten hose clamps to specification.

COOLANT HOSE CLAMP TORQUE
5.5 N•m ± 0.5 N•m (49 lbf•**in** ± 4 lbf•**in**)

WATER PUMP DRIVE GEARS

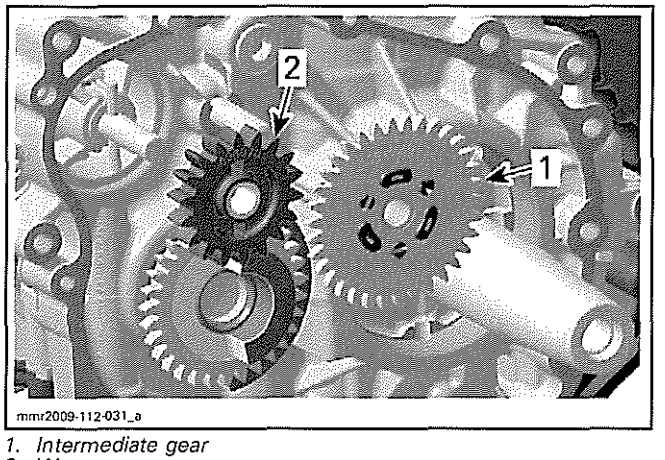
The water pump drive gears are located on the engine PTO side, behind the PTO cover.



1. *Water pump drive gear*
2. *Intermediate gear*
3. *Water pump gear*

Water Pump Drive Gear Removal

1. Remove PTO cover, Refer to *CYLINDER BLOCK* subsection.
2. Remove intermediate gear and water pump gear.



1. *Intermediate gear*
2. *Water pump gear*

NOTE: Water pump drive gear cannot be removed from balancer shaft.

Water Pump Drive Gear Inspection

Inspect gears for wear or other damage.

Replace gear(s) if necessary.

Water Pump Drive Gear Installation

Installation is the reverse of the removal procedure.

HEAT EXCHANGER

Heat Exchanger Cleaning and Inspection

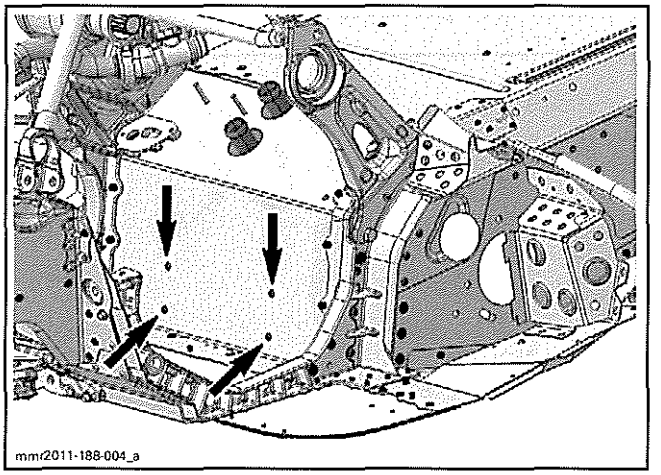
Remove all debris between heat exchanger fins. A clean heat exchanger is more efficient than a dirty one.

Check if the heat exchanger fins are damaged. Replace the rear heat exchanger if necessary.

NOTE: A heat exchanger with many broken fins does not work properly.

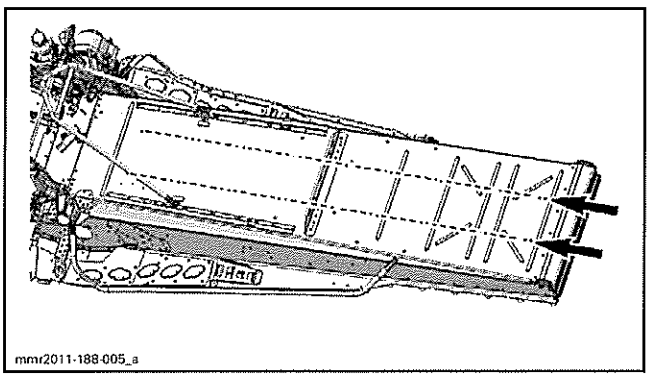
Heat Exchanger Removal

1. Drain cooling system, see *PERIODIC MAINTENANCE PROCEDURES* in this subsection.
2. Remove engine, refer to *ENGINE REMOVAL* subsection.
3. Remove rear suspension refer to the *REAR SUSPENSION* subsection.
4. Remove fuel tank refer to *FUEL TANK AND FUEL PUMP* subsection.
5. From inside the engine compartment, remove the rivets securing the forward portion of the heat exchanger.



RIVETS SECURING FRONT PORTION OF HEAT EXCHANGER

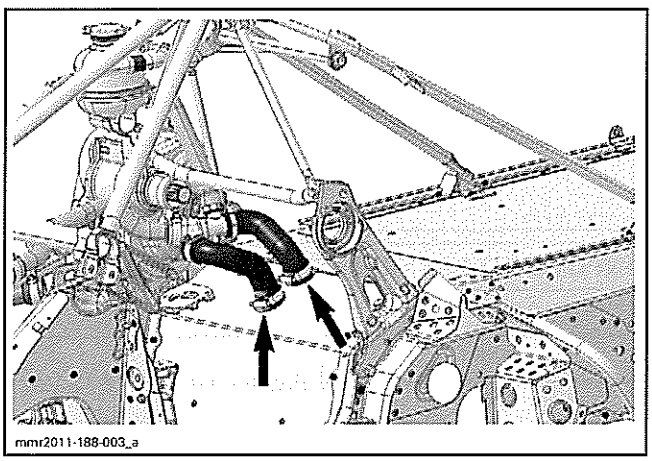
6. Using a grinding disk, grind all rivets retaining rear heat exchanger (2 rows) to frame. Work from top of frame.



RIVETS RETAINING HEAT EXCHANGER (2 ROWS)

NOTE: When pushing the grinded rivets out, support the frame around the rivet with a socket on the opposite side to avoid frame warpage.

7. Disconnect coolant hoses from heat exchanger, then remove heat exchanger from vehicle.



HOSES TO DISCONNECT FROM HEAT EXCHANGER

Heat Exchanger Installation

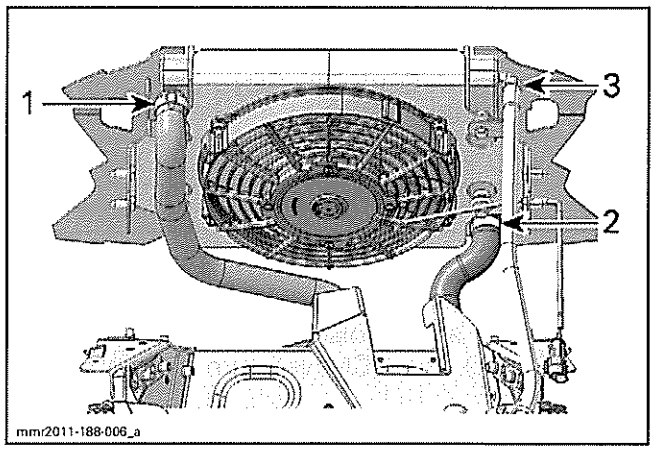
The installation is the reverse of the removal procedure. However, pay attention to the following.

1. Secure heat exchanger to frame using new rivets (head on top).
2. Refill and bleed cooling system as described in *PERIODIC MAINTENANCE PROCEDURES* subsection.
3. Install all removed parts.

RADIATOR

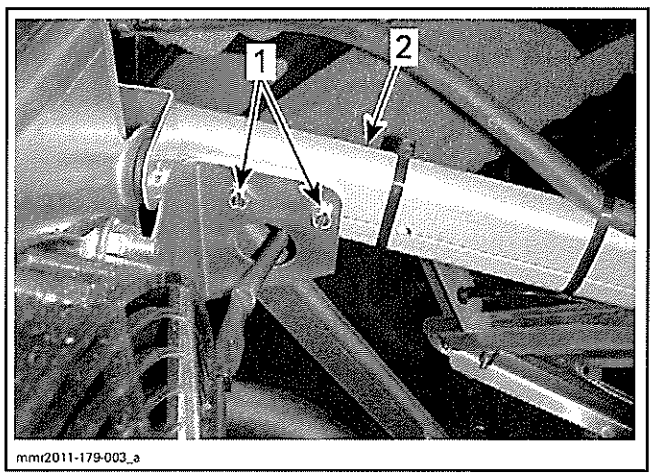
Radiator Removal

1. Drain cooling system, Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.
2. Remove body parts as required for access to the radiator.
3. Disconnect front radiator cooling fan connector near aft end of RH front bumper rail.
4. Disconnect coolant hoses and vent hose from radiator.



1. *Coolant hose from heat exchanger*
2. *Coolant hose to water pump*
3. *Vent hose to coolant reservoir*

5. Remove retaining screws from front radiator support.



1. *Radiator support retaining screws*
2. *Front bumper*

6. Remove front radiator from vehicle.

Radiator Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

Install **new** Oetiker clamps to secure coolant hoses.

HOSE CLAMP TORQUE
5 N•m ± 1 N•m (44 lbf•**in** ± 9 lbf•**in**)

COOLING FAN

Cooling Fan Operating Conditions

RADIATOR COOLING FAN		
ENGINE TEMPERATURE	COOLING FAN RELAY	COOLING FAN OPERATION
> 95°C (203°F)	Close	Starts
< 92°C (198°F)	Open	Stops

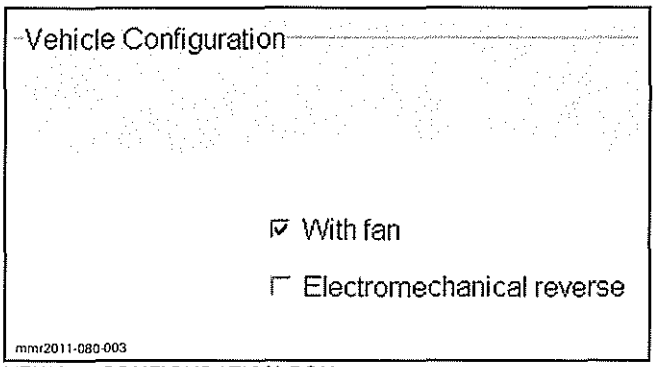
NOTE: If voltage decrease to 11 V and cooling fan is running, the ECM will shut it off. If voltage remains low and coolant temperature reaches 118°C (244°F), the ECM will turn on the cooling fan.

Cooling Fan Relay Location

The cooling fan relay (R2) is located in the fuse box. Refer to *POWER DISTRIBUTION*.

Cooling Fan Configuration in B.U.D.S.

1. Connect vehicle to B.U.D.S., refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. In B.U.D.S., select the following:
   - Read Data button
   - Setting tab
   - ECM page.
3. Ensure that With Fan box is properly checked.



VEHICLE CONFIGURATION BOX

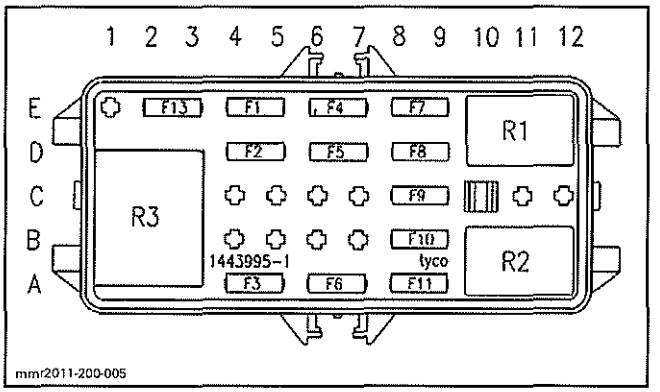
Cooling Fan Motor Operation Test

1. Disconnect front radiator cooling fan connector.
2. Connect cooling fan connector pin 1 (white wire) to a 20 A suitable fused jumper and then directly to the positive battery post.
3. Connect cooling fan connector pin 2 (BK wire) directly to the negative battery post.
4. Check if motor works properly.
5. If motor does not work, replace it.
6. If motor works, refer to *COOLING FAN INPUT VOLTAGE TEST AT MOTOR*.

Cooling Fan Input Voltage Test at Motor

Check input voltage at cooling fan motor, see following table.

Test conditions:
- Engine running with coolant temperature above 95°C (203°F)
- OR cooling fan activated using B.U.D.S., refer to *COOLING FAN MOTOR OPERATION TEST*.



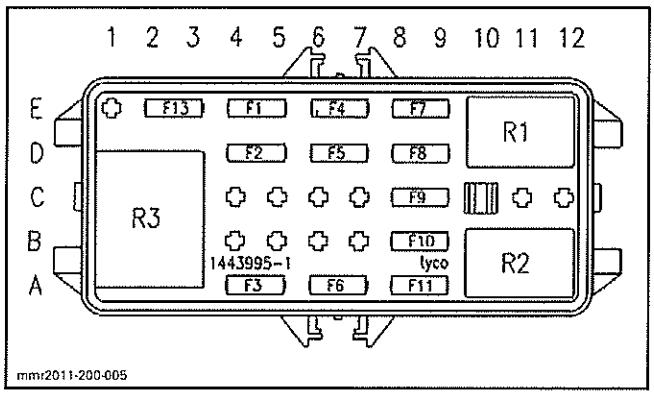
INPUT VOLTAGE TEST AT COOLING FAN MOTOR	
TEST PROBES	VOLTAGE
WH	Battery voltage (±12 Vdc)
BK	

If no voltage is measured, refer to *INPUT VOLTAGE TEST AT COOLING FAN RELAY*.

If voltage is measured, carry out the following:
- Check cooling fan ground circuit continuity.
- Check circuit continuity of cooling fan relay control circuit, refer to *CONTROL CIRCUIT TEST OF COOLING FAN RELAY*.

Input Voltage Test at Cooling Fan Relay

1. Remove cooling fan relay R2.



2. Start engine.
3. Check input voltage to cooling fan relay (R2) as per following tables.

INPUT VOLTAGE TEST, COOLING FAN RELAY COIL	
TEST PROBES	VOLTAGE
Fuse box pin 12 A	Battery voltage (±12 Vdc)
Battery negative (-) post	

If voltage is measured at fuse box pin 12 A:
- Test relay, refer to *POWER DISTRIBUTION (1200 4-TEC)* subsection.
- Test continuity of wire from fuse box pin 10B to cooling fan motor connector.

If voltage is not measured at fuse box pin 12 A, test continuity of wire to Relay/ Gauge fuse F8.

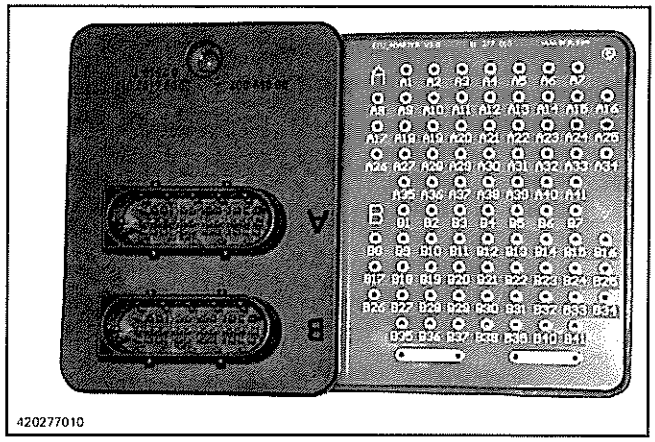
INPUT VOLTAGE TEST, COOLING FAN RELAY POWER CONTACT	
TEST PROBES	VOLTAGE
Fuse box pin 12 B	Battery voltage (±12 Vdc)
Battery negative (-) post	

If voltage is measured at fuse box pin 12 B, test continuity of wire from fuse box pin 10B to cooling fan motor connector.

If voltage is not measured at fuse box pin 12 B, test continuity of wire to battery positive (+) terminal.

Control Circuit Test of Cooling Fan Relay

1. Disconnect ECM-B connector and install it on the ECM ADAPTER TOOL (P/N 420 277 010).



2. Set multimeter to Ω and check for continuity of cooling fan relay control circuit to ECM.

CONTINUITY TEST, COOLING FAN RELAY CONTROL CIRCUIT	
TEST PROBES	VOLTAGE
ECM-B pin 14	Close to 0 Ω
Fuse box pin 10 B	

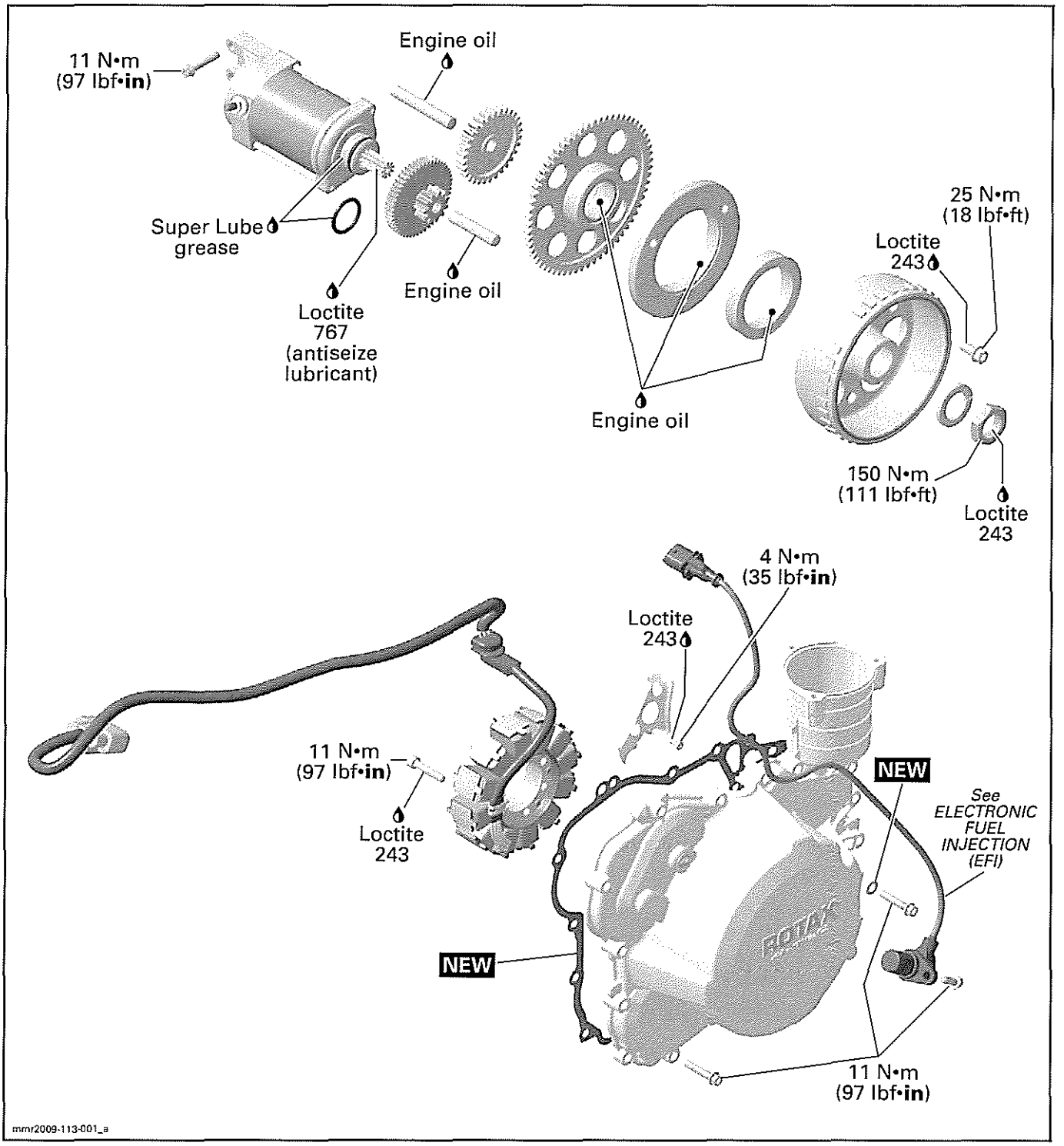
MAGNETO AND STARTER

SERVICE TOOLS

Description	Part Number	Page
CENTER BOLT	529 036 154	346
CRANKSHAFT PROTECTOR (MAG SIDE)	529 036 160	349
FLUKE 115 MULTIMETER	529 035 868	347, 353
MAGNETO PULLER	529 035 748	349

SERVICE PRODUCTS

Description	Part Number	Page
KLÜEBER PASTE 46 MR 401	420 297 616	346
LOCTITE 243 (BLUE)	293 800 060	349–351
LOCTITE 767 (ANTISEIZE LUBRICANT)	293 800 070	352, 354
LOCTITE CHISEL (GASKET REMOVER)	413 708 500	346
PULLEY FLANGE CLEANER	413 711 809	350
SUPER LUBE GREASE	293 550 030	354


11 N•m
(97 lbf•in)
Engine oil
Super Lube grease
Loctite 767 (antiseize lubricant)
Engine oil
Engine oil
25 N•m
(18 lbf•ft)
Loctite 243
150 N•m
(111 lbf•ft)
Loctite 243
4 N•m
(35 lbf•in)
Loctite 243
11 N•m
(97 lbf•in)
Loctite 243
NEW
See ELECTRONIC FUEL INJECTION (EFI)
NEW
11 N•m
(97 lbf•in)
mmr2009-113-001_a

GENERAL

⚠ WARNING

Always disconnect BLACK (-) cable first and reconnect last.

The engine removal is necessary to work on the magneto system.

During assembly/installation, use the torque values and service products as in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must strictly be adhered to.
Locking devices when removed (ex: locking tabs, elastic stop nuts, self-locking fasteners, cotter pin, etc.) must be replaced.

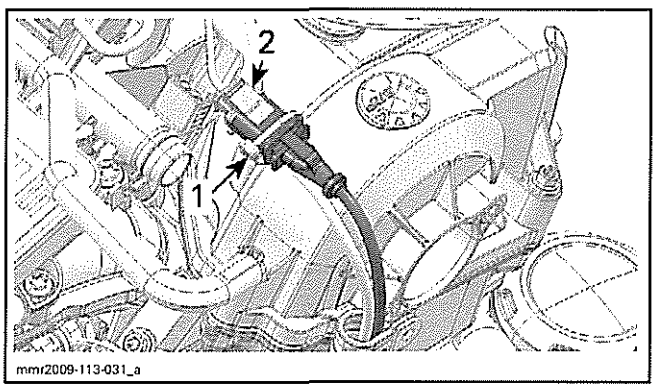
Hoses, cables or locking ties removed during a procedure must be reinstalled as per factory standards.

PROCEDURES

MAGNETO COVER

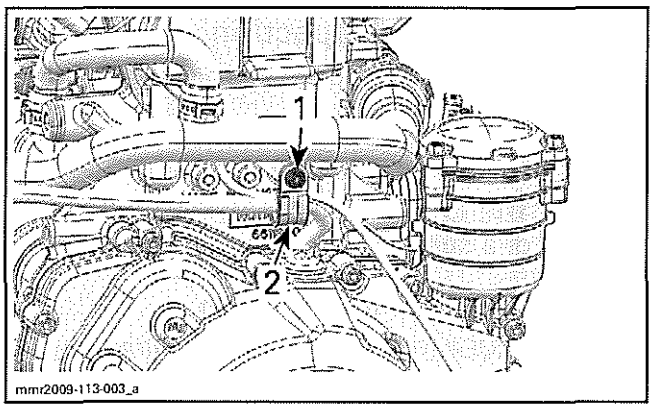
Magneto Cover Removal

1. Remove engine from vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
2. Drain engine oil. Refer to *LUBRICATION SYSTEM* subsection.
3. Cut locking tie and disconnect crankshaft position sensor (CPS) connector.



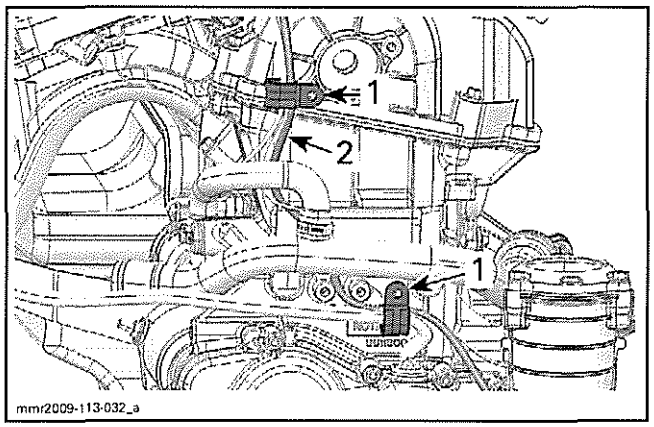
1. Locking tie
2. CPS sensor connector

4. Remove retaining screw and cable clamp.



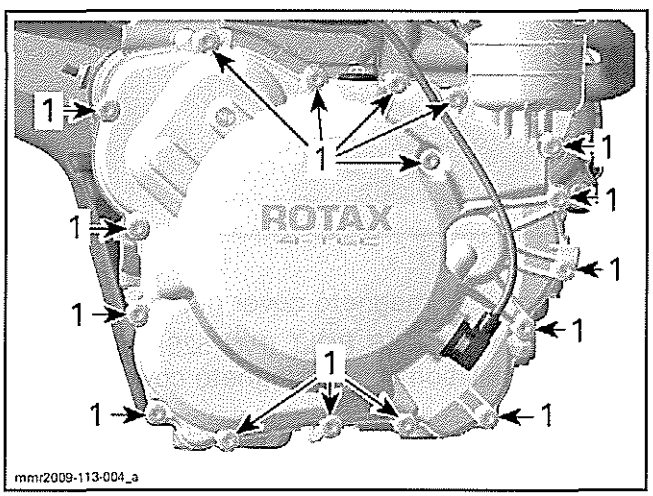
1. Remove screw
2. Cable clamp

5. Remove CPS sensor wire from both cable clamps.



1. Cable clamps
2. CPS sensor wire

6. Place an oil pan under magneto area to catch remaining oil.
7. Remove magneto cover retaining screws and discard sealing washer.



1. Magneto cover screws

8. Pull off magneto cover.
9. Discard magneto cover gasket.

Magneto Cover Inspection

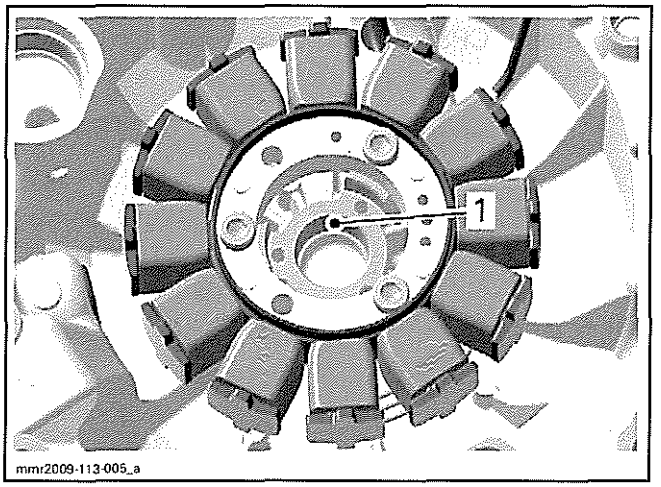
Check magneto cover for cracks or other damage. Replace if necessary.

Magneto Cover Cleaning

Use LOCTITE CHISEL (GASKET REMOVER) (P/N 413 708 500) or a suitable equivalent for cleaning.

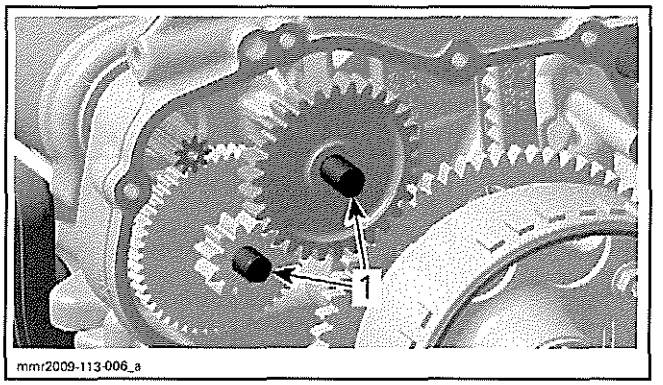
Magneto Cover Installation

1. Apply KLÜEBER PASTE 46 MR 401 (P/N 420 297 616) in bore where crankshaft fits in magneto cover.



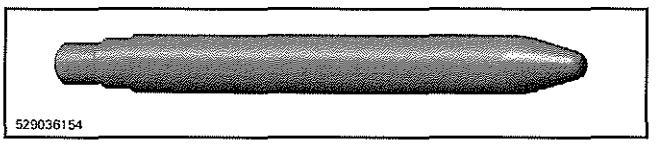
1. Apply Klueber paste

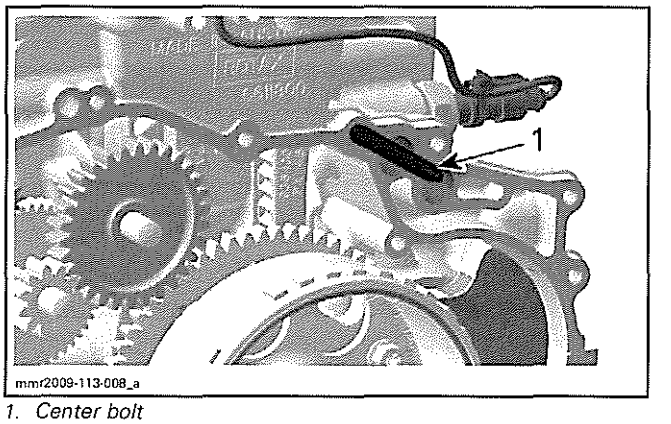
2. Ensure location pins for starter drive gears are in place.



1. Location pins

3. Install a NEW magneto cover gasket.
4. Install the CENTER BOLT (P/N 529 036 154) to ease installation of the magneto cover.

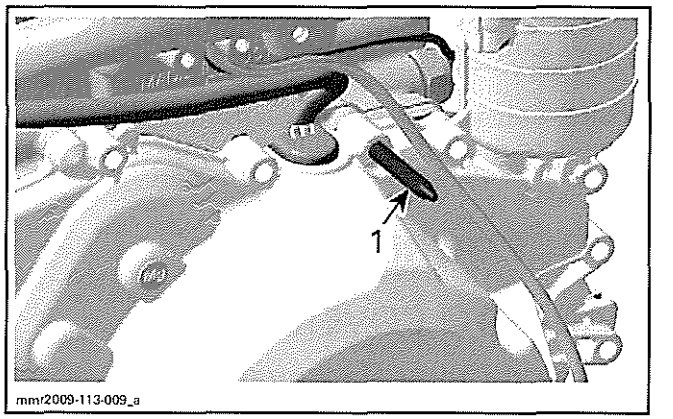




1. Center bolt

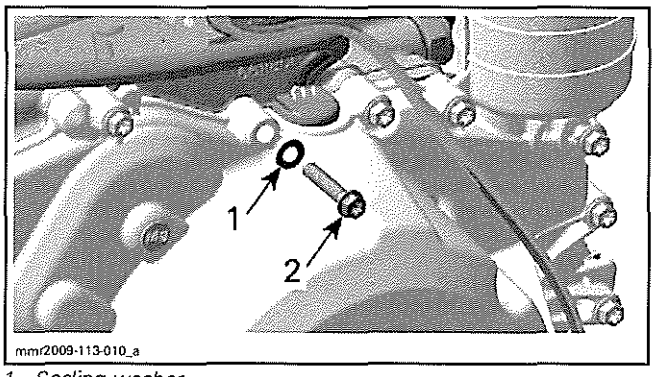
5. Carefully install magneto cover, then remove center bolt.

⚠ **CAUTION** Magneto force between magneto flywheel and stator is very high. Avoid contusion of your fingers.



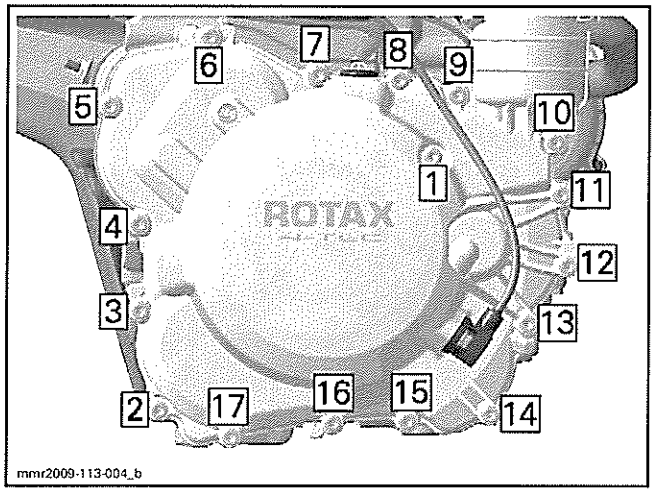
1. Remove center bolt

6. Install a NEW sealing washer to retaining screw.



1. Sealing washer
2. Retaining screw

7. Tighten magneto cover screws as per the following sequence.

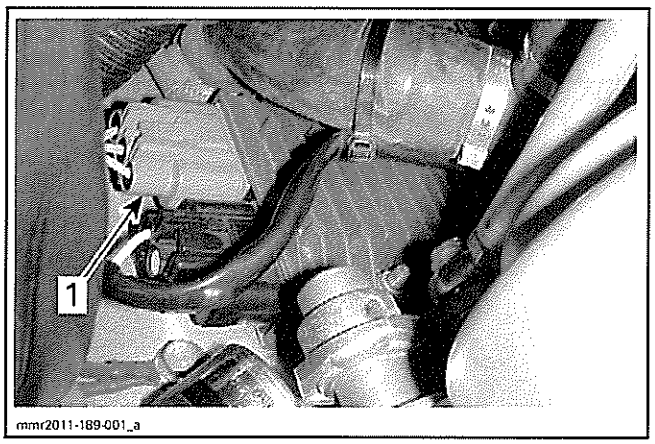


TIGHTENING SEQUENCE

STATOR

Stator Continuity Test

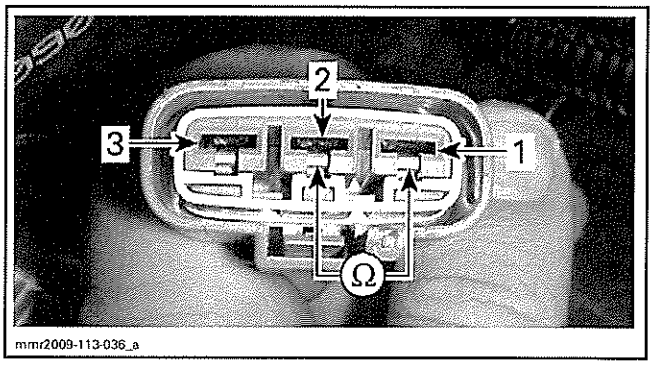
1. Remove RH side panels.
2. Disconnect battery.
3. Disconnect the magneto connector from voltage regulator.



RH SIDE - IN FRONT OF FUEL TANK
1. Magneto connector

4. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Ω.

5. Connect multimeter probes between each pair of YELLOW wires.



1. Pin #1
2. Pin #2
3. Pin #3

6. Read resistance as per following table.

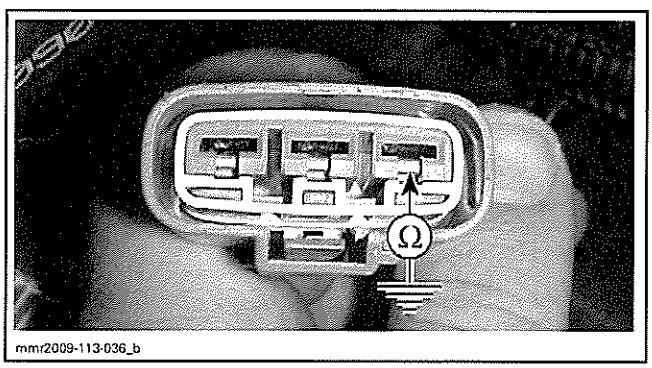
STATOR CONTINUITY TEST	
YELLOW WIRES (EACH PAIR)	RESISTANCE @ 20°C (68°F)
Pins 1 and 2	0.1 - 1 Ω
Pins 1 and 3	
Pins 2 and 3	

If any resistance reading is not as specified, the stator or the wiring (including connector) is shorted to ground and needs to be repaired or replaced.

If resistance is good, perform the stator insulation test.

Stator Insulation Test

1. Connect multimeter between any YELLOW wire and chassis ground.



2. Read resistance.

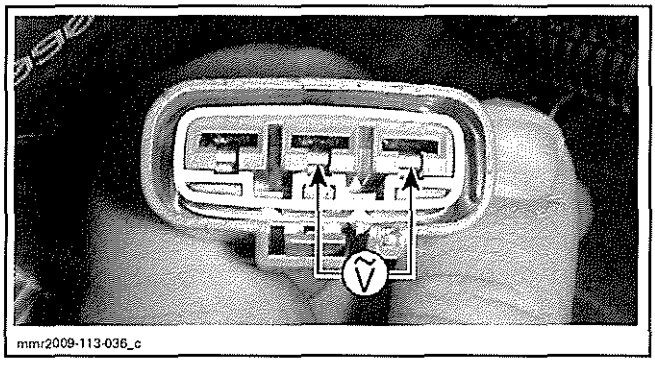
STATOR INSULATION TEST	
PROBE POSITIONS	RESISTANCE @ 20°C (68°F)
Any YELLOW wire and chassis ground	Infinity (OL)

If any resistance reading is not as specified, the stator or the wiring is shorted to ground and needs to be repaired or replaced.

If the insulation test is good, perform the output voltage test.

Stator Output Voltage Test

1. Connect battery and start engine. Let engine reach its operating temperature.
2. Set multimeter to Vac scale.
3. Connect multimeter between each pair of YELLOW wires.



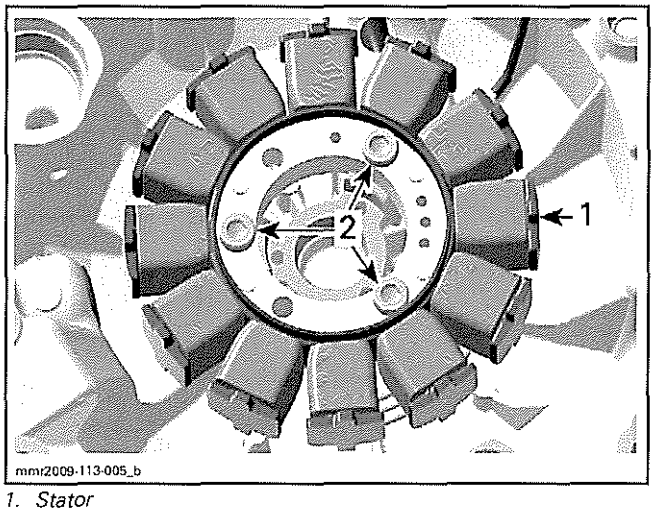
4. Read voltage.

STATOR OUTPUT VOLTAGE TEST		
TEST ENGINE SPEED	TERMINAL	VOLTAGE
Idle speed	1 and 2	± 25 Vac
	1 and 3	
	2 and 3	

If any voltage reading is lower than specification, replace the stator.

Stator Removal

1. Remove the *MAGNETO COVER*, see procedure in this subsection.
2. Remove stator retaining screws.



1. Stator
2. Stator retaining screws

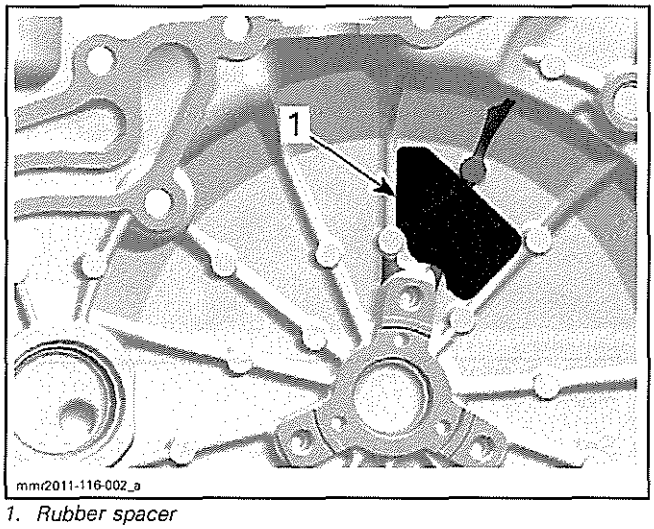
3. Pull out stator.

Stator Inspection

Check stator windings and insulation for cracks and other damages. If damaged replace it.

Check if stator wires are brittle, hard or otherwise damaged.

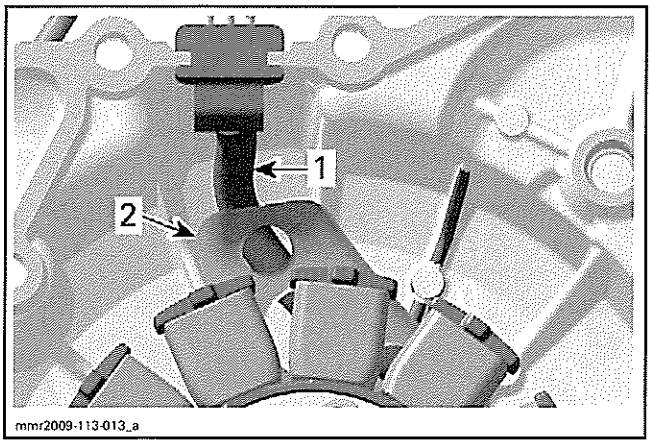
Check if rubber spacer is brittle, hard or otherwise damaged. Replace if necessary.



1. Rubber spacer

Stator Installation

1. Ensure that rubber spacer is located properly in ignition cover.
2. Ensure that the stator cable is underneath the cable holder during installing of the stator.



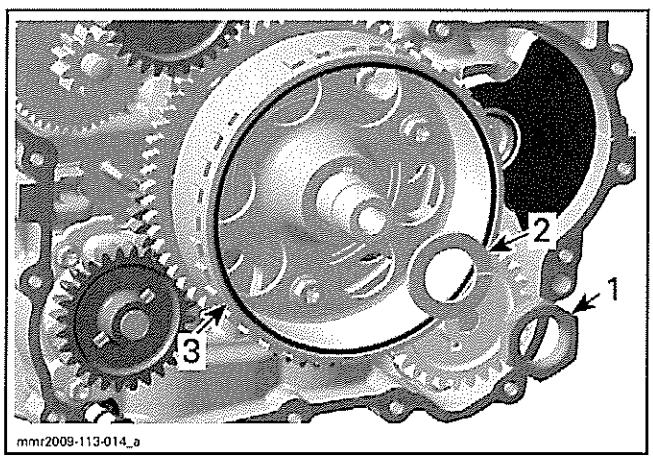
1. *Stator cable*
2. *Cable holder*

3. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on threads of stator screws.
4. Install screws and tighten them to 11 N•m (97 lbf•**in**).
5. Reinstall *MAGNETO COVER*, see procedure in this subsection.

ROTOR

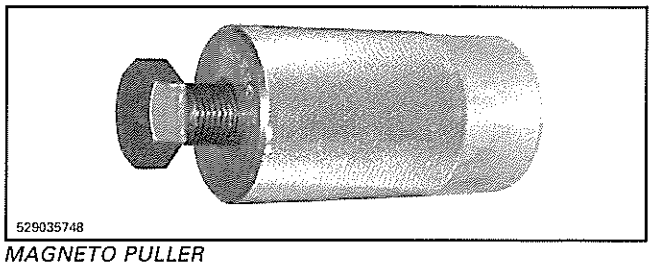
Rotor Removal

1. Remove the *MAGNETO COVER*, see procedure in this subsection.
2. Lock crankshaft. Refer to *CYLINDER BLOCK* subsection.
3. Remove rotor retaining nut and lock washer.

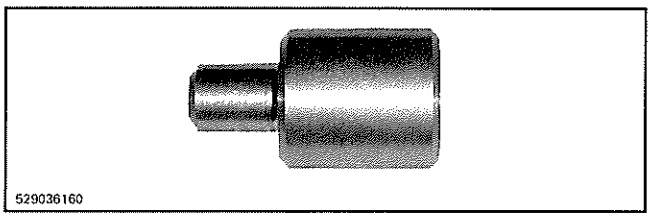


1. *Retaining nut*
2. *Lock washer*
3. *Rotor*

4. Install the MAGNETO PULLER (P/N 529 035 748) and the CRANKSHAFT PROTECTOR (MAG SIDE) (P/N 529 036 160) then remove rotor.



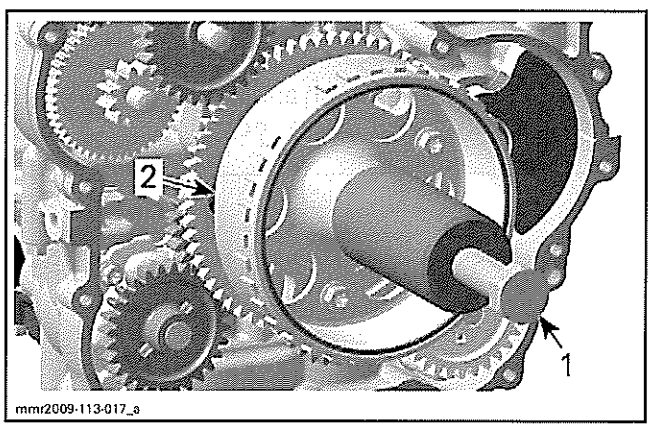
MAGNETO PULLER



CRANKSHAFT PROTECTOR

NOTE: Use grease to fit protector on crankshaft end prior to screw in the magneto puller.

5. Screw in magneto puller bolt to remove rotor.



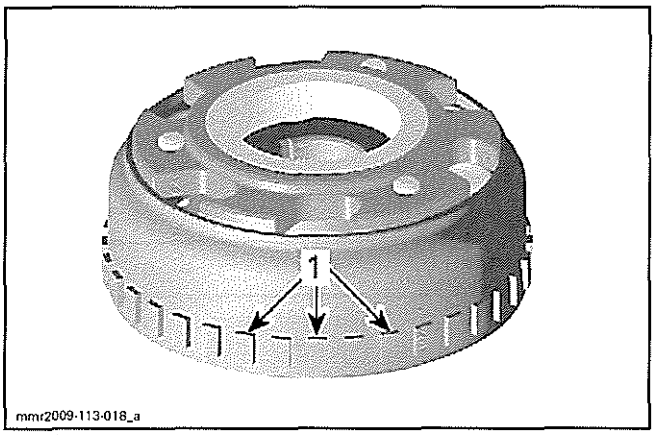
1. *Magneto puller bolt*
2. *Rotor*

Rotor Inspection

Check inner side of rotor for scratches or other damage.

Check woodruff key and keyway for wear or damages.

Check trigger wheel teeth for wear or other damages.



1. Trigger wheel teeth

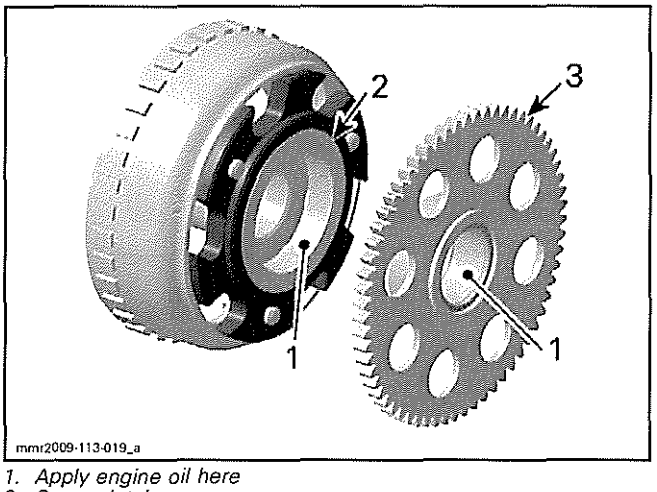
Replace parts as necessary.

Rotor Installation

1. Clean crankshaft taper and rotor with PULLEY FLANGE CLEANER (P/N 413 711 809).

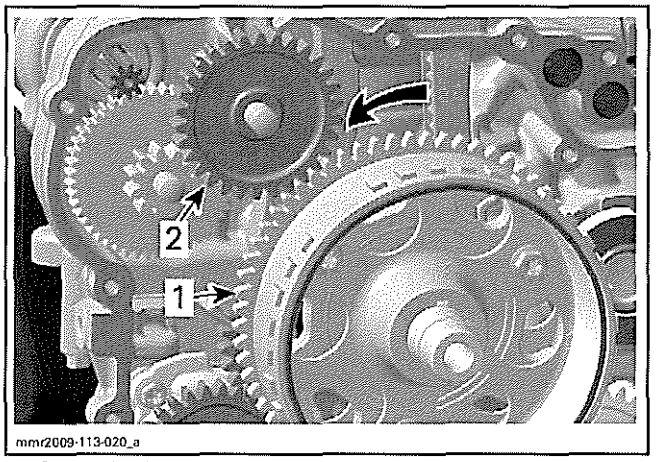
NOTICE **Taper on crankshaft and rotor must be free of grease.**

2. Apply oil on sprag clutch and needle bearing and install sprag clutch gear onto rotor.



1. Apply engine oil here
2. Sprag clutch
3. Sprag clutch gear

3. Slide rotor onto crankshaft. The woodruff key and groove must be aligned.
4. Rotate sprag clutch gear counterclockwise to align intermediate gear teeth with sprag clutch gear.



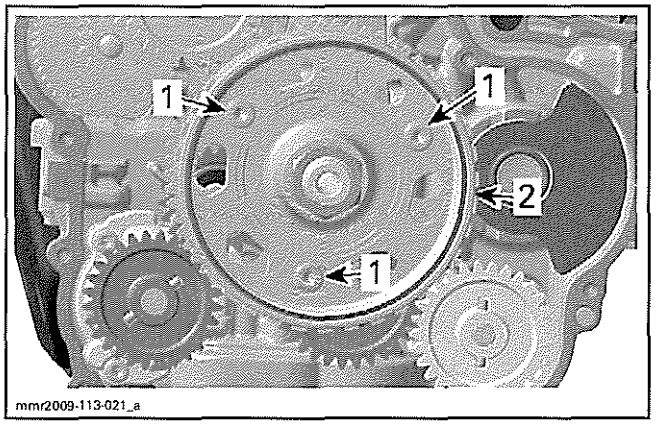
1. Sprag clutch gear
2. Intermediate gear

5. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on threads of rotor nut.
6. Install washer and nut.
7. Tighten nut to 150 N•m (111 lbf•ft).

SPRAG CLUTCH

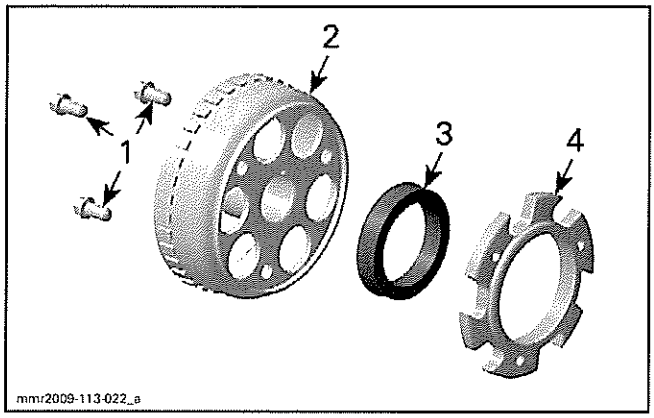
Sprag Clutch Removal

1. Remove the *MAGNETO COVER*, see procedure in this subsection.
2. Lock crankshaft. Refer to *CYLINDER BLOCK* subsection.
3. Loosen and remove sprag clutch housing screws.



1. Sprag clutch housing screws
2. Rotor

4. Remove *ROTOR*, see procedure in this subsection.
5. Remove sprag clutch housing.
6. Remove sprag clutch from sprag clutch housing.



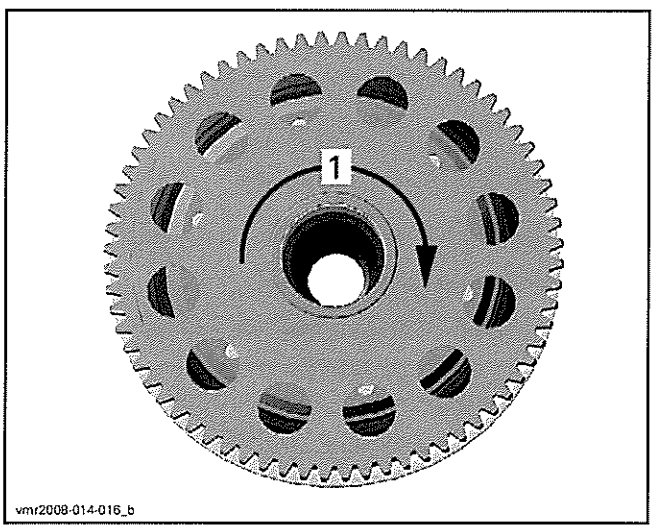
1. *Sprag clutch housing screws*
2. *Rotor*
3. *Sprag clutch*
4. *Sprag clutch housing*

Sprag Clutch Inspection

Inspect sprag clutch and sprag clutch housing for wear and damage.

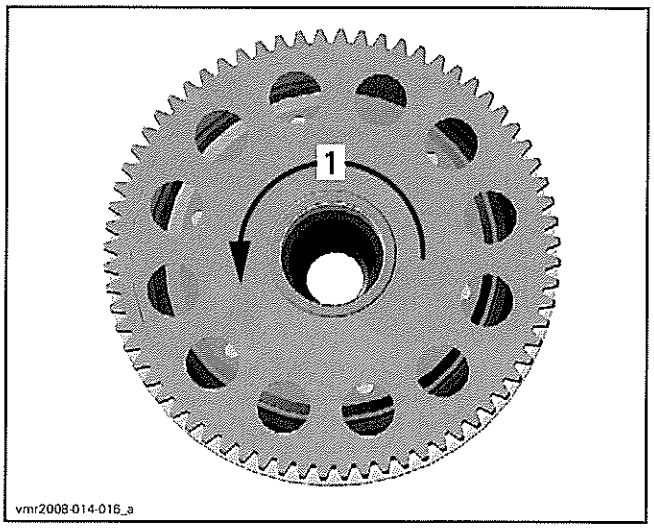
Check the collar of the sprag clutch gear, refer to *SPRAG CLUTCH GEAR*.

Rotate sprag clutch gear clockwise. Gear must rotate freely.



1. *Free*

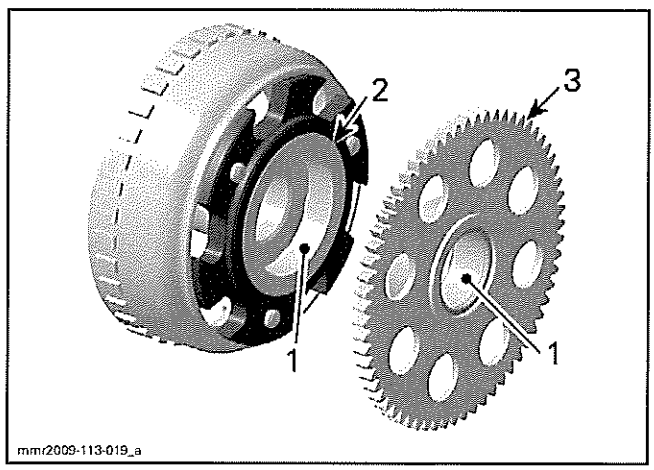
Rotate sprag clutch gear counterclockwise. Gear must lock.



1. *Lock*

Sprag Clutch Installation

1. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on threads of sprag clutch housing screws.
2. Loosely install screws.
3. Apply engine oil on sprag clutch and sprag clutch gear needle bearing.



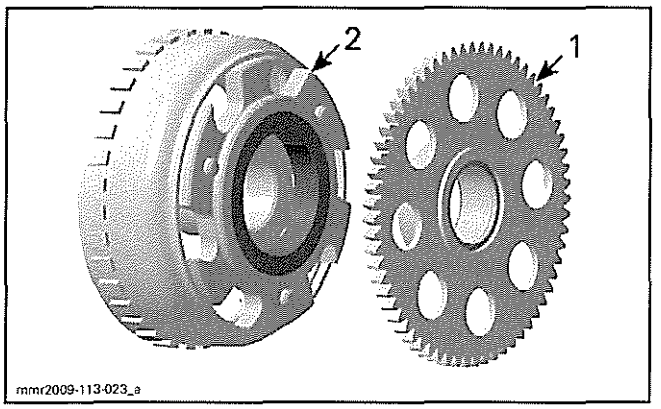
1. *Apply engine oil here*
2. *Sprag clutch*
3. *Sprag clutch gear*

4. Install *ROTOR*, see procedure in this subsection.
5. Tighten sprag clutch housing screws to 25 N•m (18 lbf•ft).
6. Install all other removed parts.

SPRAG CLUTCH GEAR

Sprag Clutch Gear Removal

1. Remove rotor and sprag clutch gear together. Refer to *ROTOR* in this subsection.
2. Pull sprag clutch gear from the rotor.

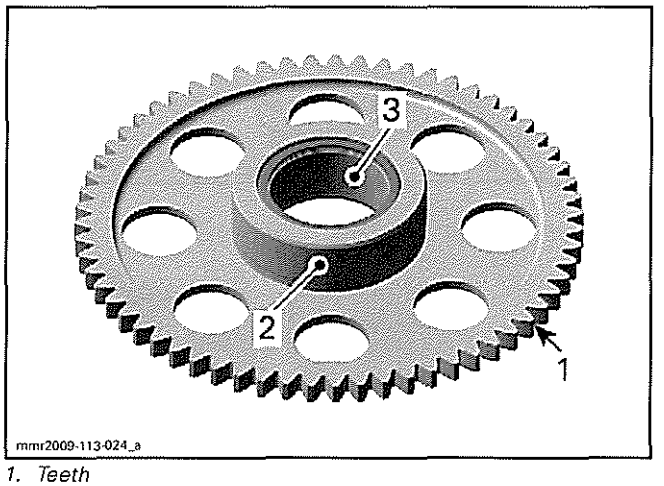


1. Sprag clutch gear
2. Rotor

Sprag Clutch Gear Inspection

Inspect gear, especially teeth and sprag clutch collar for wear and other damage.

Check needle bearing for wear and pittings.



1. Teeth
2. Collar
3. Needle bearing

Replace sprag clutch gear if necessary.

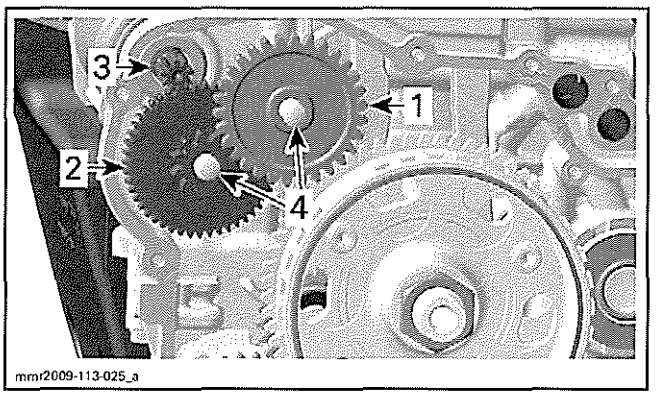
Sprag Clutch Gear Installation

The installation is the reverse of the removal procedure. Pay attention to the following detail.

NOTE: Apply engine oil on needle bearing and collar of sprag clutch gear.

STARTER DRIVE GEARS

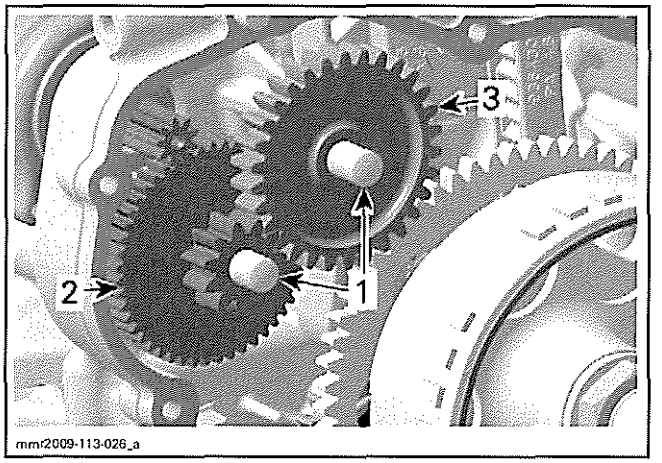
The starter drive gears are located on the engine MAG side behind the magneto cover.



1. Intermediate gear
2. Starter double gear
3. Starter gear
4. Location pins

Starter Drive Gear Removal

1. Remove *MAGNETO COVER*, see procedure in this subsection.
2. Remove location pins, starter double gear and intermediate gear.



1. Location pins
2. Starter double gear
3. Intermediate gear

Starter Drive Gear Inspection

Inspect starter drive gears and location pins for wear and damage.

Replace parts as necessary.

Starter Drive Gear Installation

The installation is the reverse of the removal procedure. Pay attention to the following detail.

1. Apply engine oil on the location pins and LOCTITE 767 (ANTISEIZE LUBRICANT) (P/N 293 800 070) on starter gear.

STARTER

Starter Operation Test

1. Remove tether cord cap from engine cut-off switch and set the emergency engine stop switch to OFF.
2. Using booster cables and a fully charged battery or power pack, carefully supply current directly to the starter.

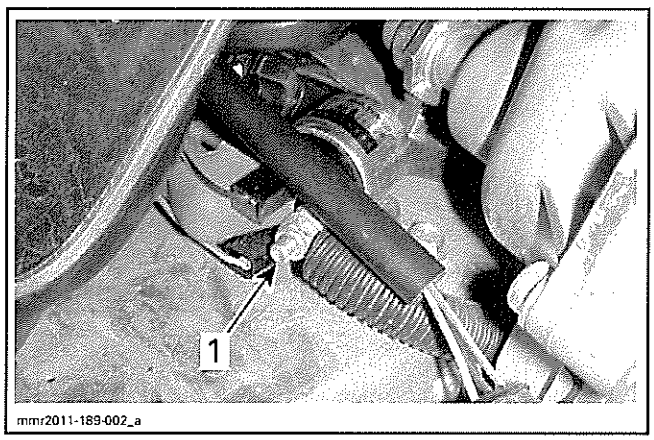
⚠ WARNING

Sparks can occur when connecting jumper cables. To avoid fire hazard, be sure that no flammable liquids or fuel vapors are in the test area.

2.1 Disconnect ground cable from the battery.

2.2 Connect the BLACK (-) booster cable to chassis.

2.3 Connect the remaining booster cable to the starter terminal of the solenoid.



1. Starter terminal of the solenoid

If starter turns, ensure the cable and connections from the battery to starter solenoid are in good condition.

– If they are good, the test the solenoid. Refer to *STARTING SYSTEM* subsection.

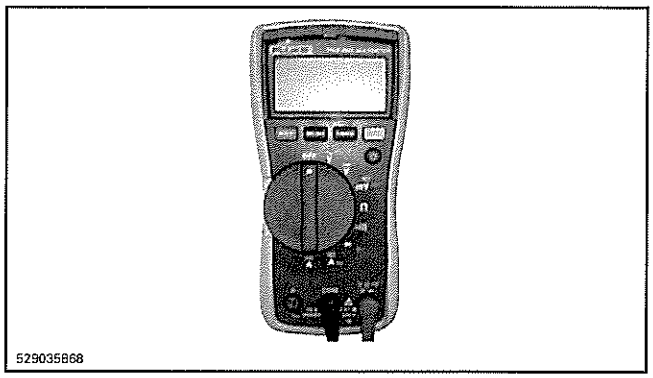
If starter does not turn, check the starter cable and connections.

– If good, replace the starter.

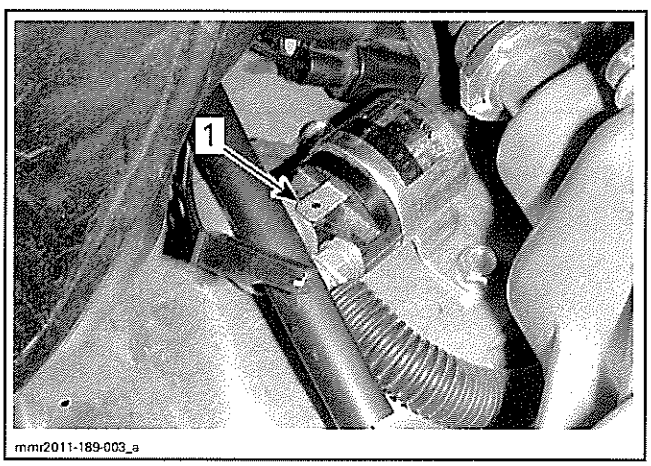
Starter Voltage Drop Test (at Battery)

NOTE: Use this test if starter turns slowly even though cable are in good condition and a know good battery is installed. This points out if a starter problem makes it draw too much current.

1. Set the emergency engine stop switch to OFF.
2. Install probes of the FLUKE 115 MULTIMETER (P/N 529 035 868) on battery posts.



3. Select Vdc.
4. Disconnect the ORANGE/BLACK wire from the starter solenoid
5. Crank engine as follows:
   - Connect one end of a fused jumper to the free solenoid terminal.
   - Wake the ECM up by briefly pressing on the start button.
   - Touch chassis with the other end of the fused jumper.



1. Free solenoid terminal

6. Check battery voltage as the starter is cranking.

NOTE: Battery voltage will drop approximately 2 Vdc and fluctuate with starter cranking load.

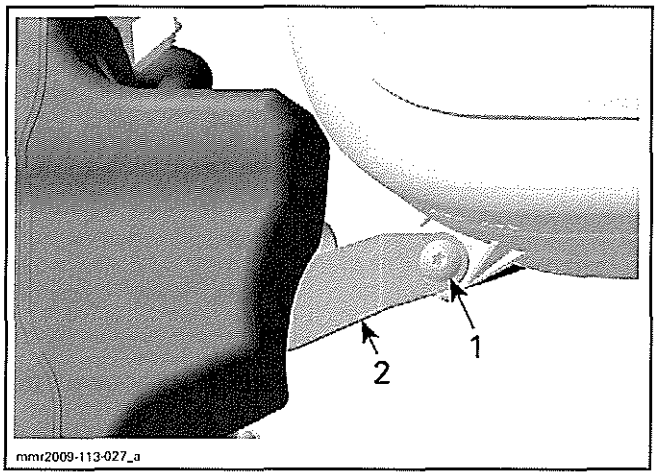
If the result is close to battery voltage, the starter is in good condition.

If the result is below battery voltage (- 2 Vdc and more), the starter may be defective.

Starter Removal

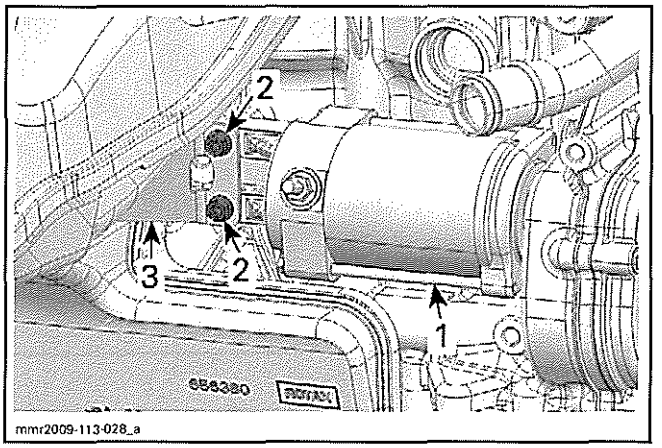
1. Remove fuel tank. Refer to *FUEL TANK AND FUEL PUMP* subsection.

2. Disconnect battery cables. Refer to *CHARGING SYSTEM* subsection.
3. Remove driven pulley. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 HO E-TEC AND 1200 4-TEC)* subsection.
4. Remove retaining screw from intake manifold support.



UNDERNEATH LH SIDE OF THE INTAKE MANIFOLD
1. *Support retaining screw*
2. *Intake manifold support*

5. Remove the starter cable from starter.
6. Remove starter retaining screws and intake manifold support.



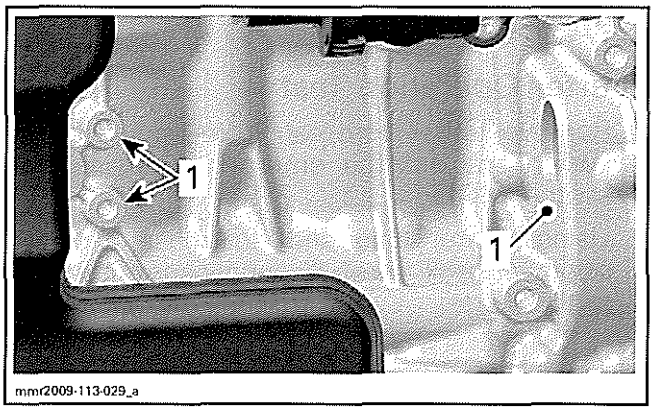
1. *Starter*
2. *Starter retaining screws*
3. *Intake manifold support*

7. Pull electric starter out from cylinder block.
8. Remove starter from vehicle.

Starter Installation

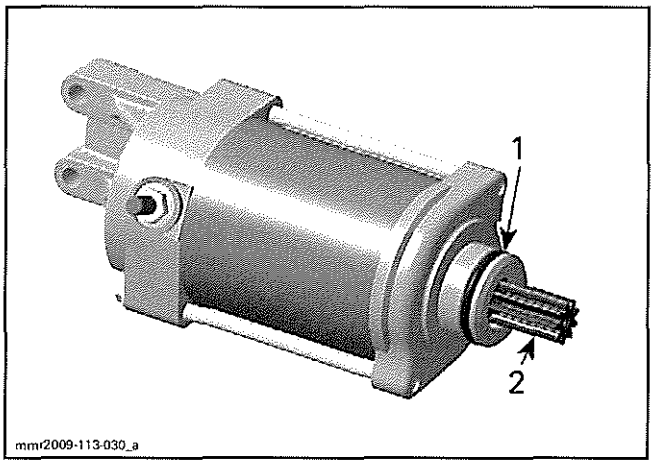
1. Ensure starter and engine mating surfaces are free of debris.

NOTICE Serious problems may arise if the starter is not properly aligned.



1. *Clean mating surfaces*

2. Apply SUPER LUBE GREASE (P/N 293 550 030) on the starter O-ring and LOCTITE 767 (ANTISEIZE LUBRICANT) (P/N 293 800 070) on starter gear before installation.



1. *Apply Super Lube grease*
2. *Apply antiseize lubricant*

3. Install starter screws with the air intake manifold support.
4. Tighten screws to 11 N•m (97 lbf•**in**).
5. Connect the starter cable to the starter and torque nut to 7 N•m (62 lbf•**in**).
6. Install all other removed parts.
7. Reconnect battery cables.

⚠ WARNING

Always connect the RED (+) starter cable first, then the BLACK (-) battery cable last. Whenever connecting the RED (+) cable to the starter motor, always make sure the BLACK (-) battery cable is disconnected to prevent electric shock.

8. Test for proper starter operation.

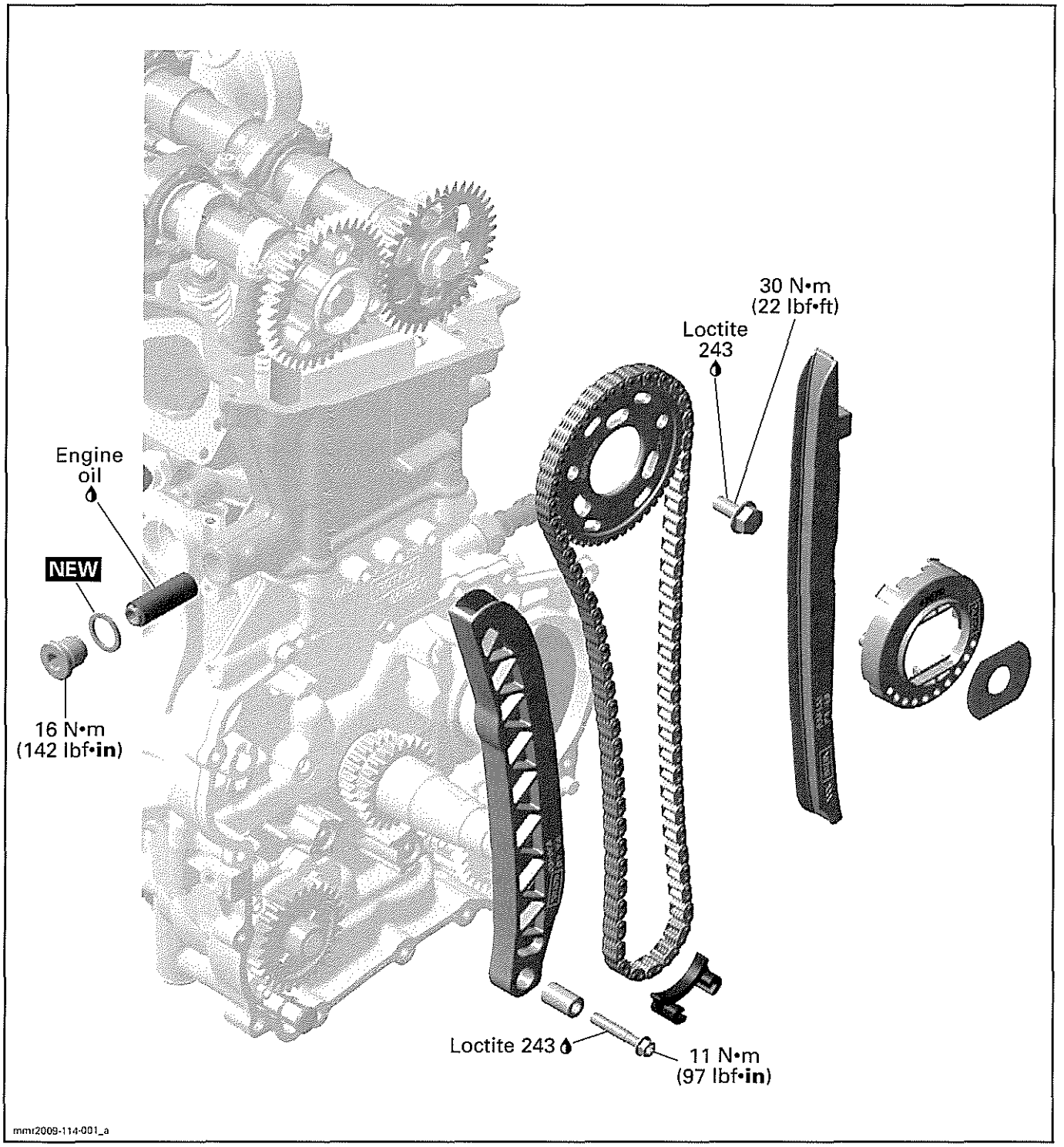
TIMING CHAIN

SERVICE TOOLS

Description	Part Number	Page
CAMSHAFT LOCKING TOOL	529 036 149	358

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 243 (BLUE)	293 800 060	359, 361


30 N•m
(22 lbf•ft)
Loctite
243
Engine
oil
NEW
16 N•m
(142 lbf•in)
Loctite 243
11 N•m
(97 lbf•in)
mmr2009-114-001_a

GENERAL

The engine removal is necessary to work on the following components:
- Timing chain
- Timing chain guide (tensioner side).

Always disconnect BLACK (-) cable from the battery, then RED (+) cable before working on the engine.

⚠ WARNING

Always disconnect BLACK (-) cable first and reconnect last.

During assembly/installation, use the torque values and service products as in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices (e.g.: locking tabs, elastic stop nuts, cotter pin, etc.) must be replaced with new ones.

Hoses, cables or locking ties removed during a procedure must be reinstalled as per factory standards.

When disassembling parts that are duplicated in the engine, (e.g.: valves, springs, etc.), it is strongly recommended to note their position and to keep the parts of the same assembly as a "group". If you find a defective component, it will be much easier to find the cause of the failure. Since parts were broke-in together during the engine operation, they will maintain their matched fit when parts are reassemble together within their "group".

TROUBLESHOOTING

The following is provided to help in diagnosing the probable source of troubles. It is a guideline and should not be assumed to show all causes for all problems.

Always check for fault codes. If a fault code is detected, service the fault code first.

UNUSUAL ENGINE NOISE OR VIBRATIONS

1. Faulty chain tensioner.
   - *Replace chain tensioner.*
2. Chain guide(s) worn out.
   - *Replace chain guide(s).*
3. Stretched timing chain or worn out sprockets.
   - *Replace timing chain and sprockets.*
4. Timing chain gear screws got loose.
   - *Retighten screws with recommended torque.*
5. Incorrect camshaft timing adjustment.
   - *Replace damaged components and readjust camshaft timing.*

ENGINE LACKS ACCELERATION OR POWER

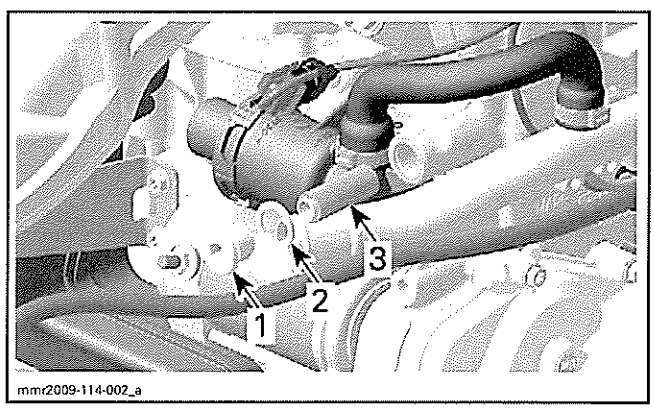
1. Incorrect camshaft timing adjustment.
   - *Replace damaged components and readjust camshaft timing.*

PROCEDURES

TIMING CHAIN TENSIONER

Timing Chain Tensioner Removal

1. Lock crankshaft, refer to procedure in *CYLINDER BLOCK* subsection.
2. Remove the driven pulley. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 HO E-TEC AND 1200 4-TEC)* subsection.
3. Loosen the coolant reservoir clamp and move reservoir aside.
4. Remove tensioner plug and discard the sealing washer.
5. Pull out chain tensioner.



ENGINE REMOVED FOR CLARITY PURPOSE ONLY
1. *Plug screw*
2. *Sealing washer*
3. *Chain tensioner*

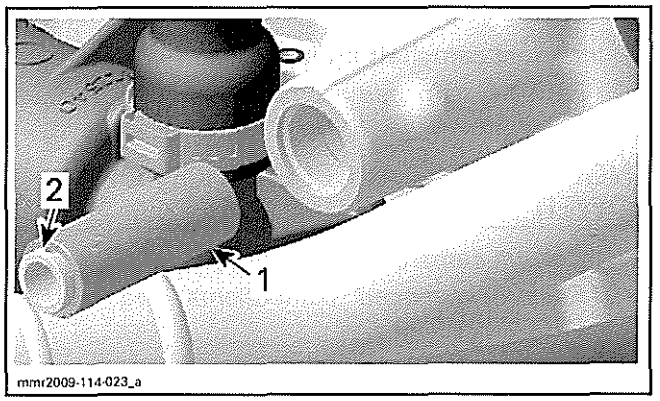
Timing Chain Tensioner Inspection

Check chain tensioner for free movement in bore and for scoring.

Compress chain tensioner and check if it works properly.

Timing Chain Tensioner Installation

1. Apply engine oil on chain tensioner.
2. Insert chain tensioner into housing, the plunger pointing outside of engine.



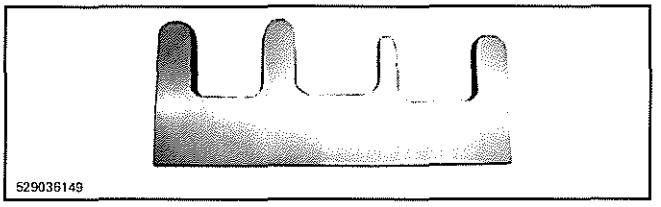
1. Chain tensioner
2. Plunger

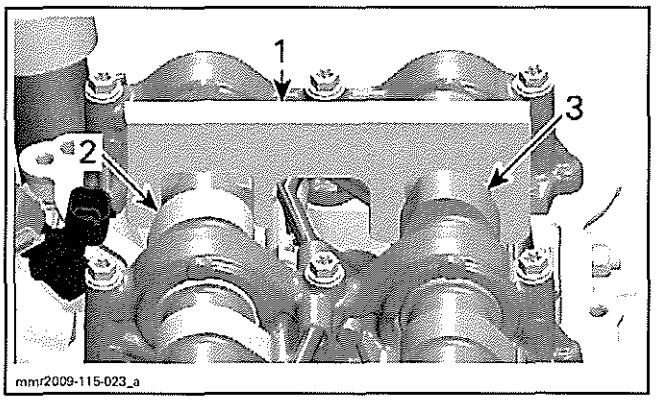
3. Install plug with a NEW sealing washer.
4. Tighten plug to 16 N•m (142 lbf•**in**).
5. Install all other removed parts.

TIMING CHAIN GEAR

Timing Chain Gear Removal

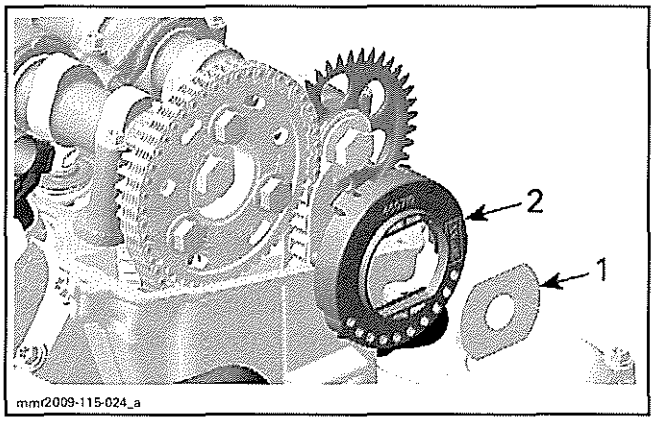
1. Remove *VALVE COVER*, see procedure in *CYLINDER HEAD* subsection.
2. Lock crankshaft, refer to procedure in *CYLINDER BLOCK* subsection.
3. Lock camshaft using the CAMSHAFT LOCKING TOOL (P/N 529 036 149).





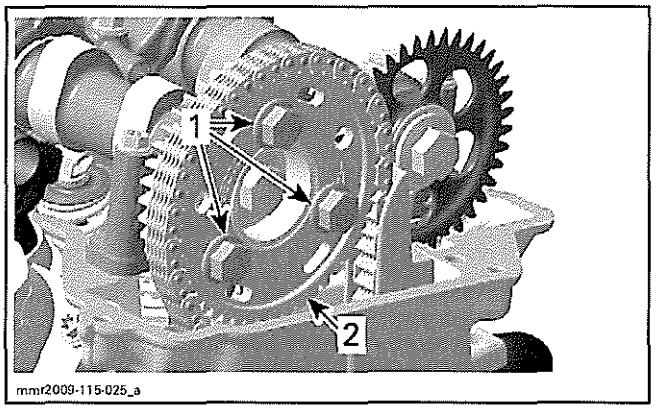
1. Camshaft locking tool
2. Intake camshaft
3. Exhaust camshaft

4. Remove thrust washer and breather cover.



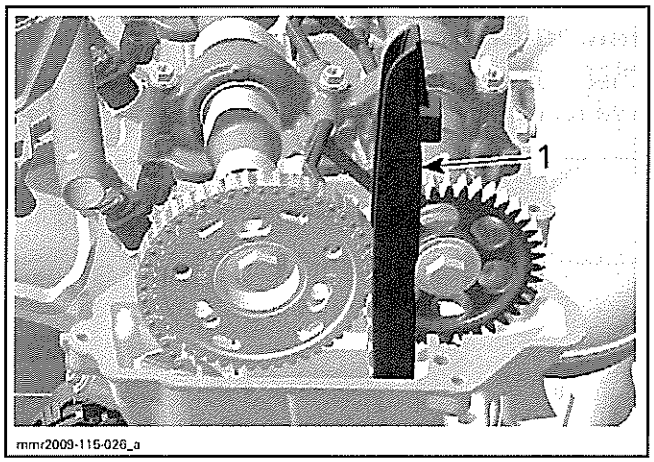
1. Thrust washer
2. Breather cover

5. Unscrew and remove timing chain gear screws.



1. Timing chain gear screws
2. Timing chain gear

6. Remove *TIMING CHAIN TENSIONER*, see procedure in this subsection.
7. Remove timing chain guide.



1. Timing chain guide

8. Remove timing chain gear.

NOTE: Secure timing chain with a retaining wire.

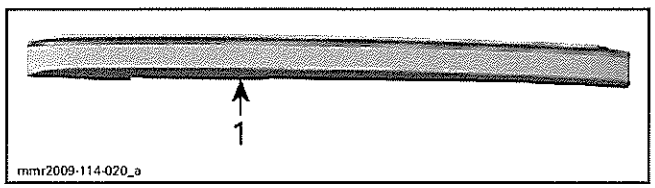
Timing Chain Gear Inspection

Check timing chain gear for wear or deterioration. If the gear is worn or damaged, replace timing chain gear and timing chain as a set.

NOTE: For crankshaft timing gear inspection, refer to *CYLINDER BLOCK* subsection.

Check chain guide for wear, cracks or deforming. Replace as required.

Replace chain guide if grooves depth (caused by timing chain) exceed 1.2 mm (.0472 in).



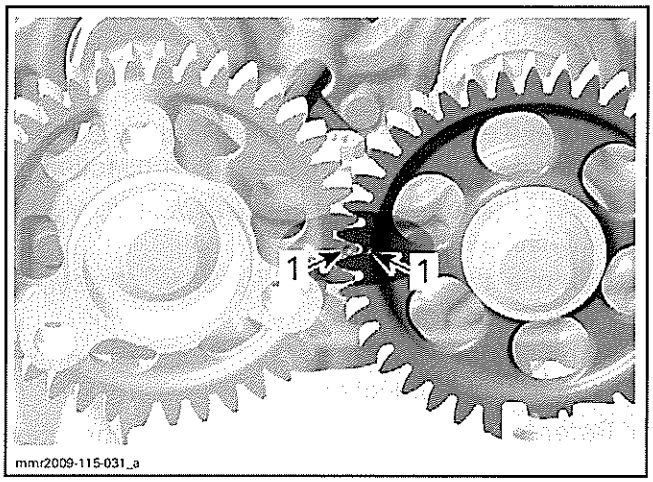
1. Chain guide

Timing Chain Gear Installation

The installation is the reverse of the removal procedure. However, pay attention to the following details.

NOTICE **Improper camshaft timing will damage engine components. Make sure camshafts and crankshaft are still locked. If not, lock them before beginning this procedure.**

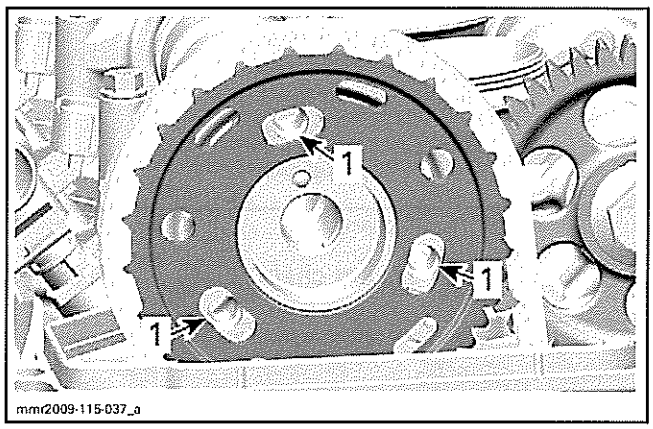
1. Check that marks on camshaft timing gears are still aligned.



CAMSHAFT TIMING GEARS
1. Marks must be aligned

2. Install timing chain over timing gear. The timing gear mark "IN" must be pointing outside (must be visible from the MAG side).
3. Install timing chain gear over camshaft timing gear on intake side.

NOTE: Timing chain gear fits only in one position. The threaded holes for retaining screws must be in the center of slots.



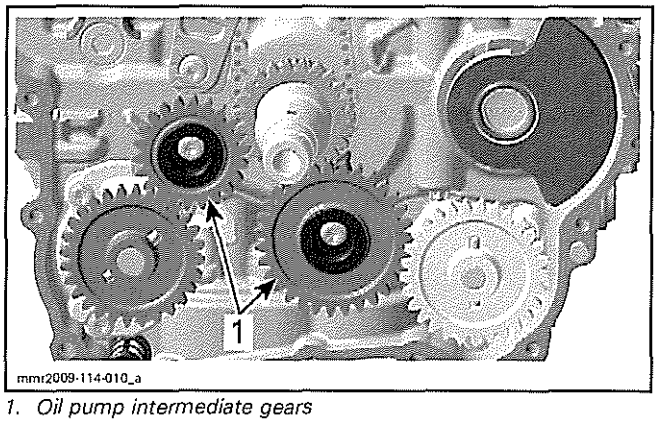
CORRECT POSITION
1. Threaded holes are in center of slots

4. Install timing chain guide.
5. Install *TIMING CHAIN TENSIONER*, see procedure in this subsection.
6. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on threads of timing chain gear screws.
7. Tighten screws to 30 N•m (22 lbf•ft).
8. Remove camshaft locking tool and crankshaft locking tool.
9. Install remaining parts.

TIMING CHAIN

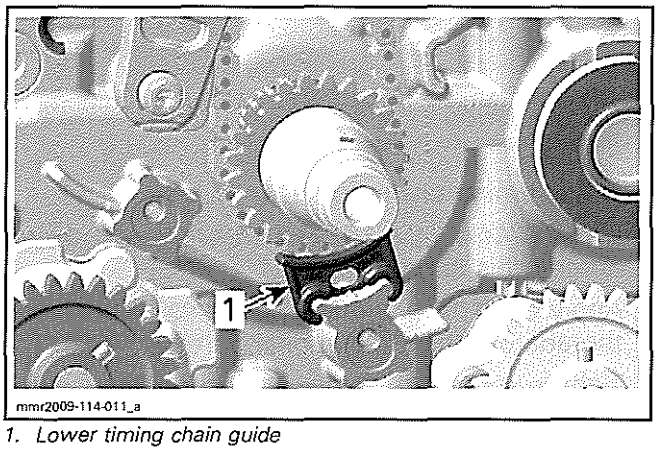
Timing Chain Removal

1. Remove engine from vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
2. Drain engine oil. Refer to *LUBRICATION SYSTEM* subsection.
3. Remove the valve cover. Refer to *CYLINDER HEAD* subsection.
4. Remove the *TIMING CHAIN GEAR*, see procedure in this subsection.
5. Refer to *MAGNETO AND STARTER* subsection and remove the following parts:
   - Magneto cover
   - Rotor
   - Starter drive gears.
6. Remove oil pump intermediate gears.



1. Oil pump intermediate gears

7. Remove lower timing chain guide.



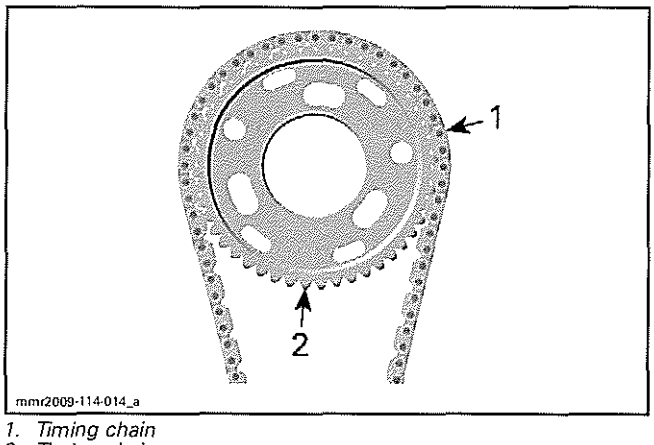
1. Lower timing chain guide

8. Remove timing chain.

NOTE: Mark the operating direction of the timing chain before removal.

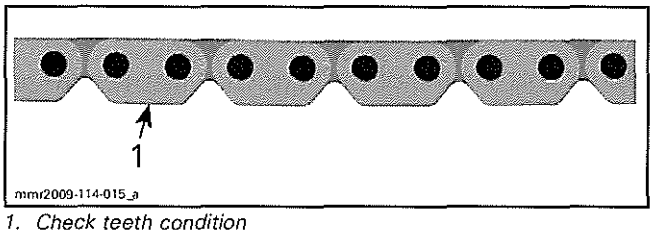
Timing Chain Inspection

Check timing chain on timing chain gear for excessive radial play.



1. Timing chain
2. Timing chain gear

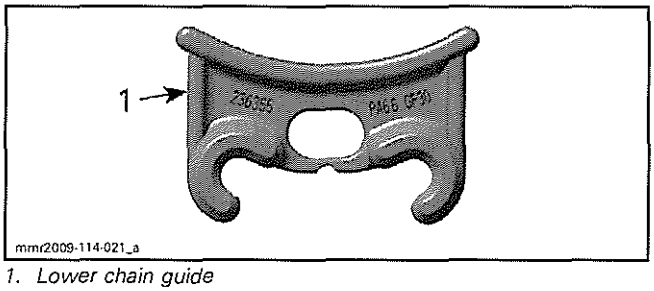
Check timing chain for wear and teeth condition.



1. Check teeth condition

If timing chain is excessively worn or damaged, replace timing chain and timing chain gear as a set.

Check lower chain guide for wear, cracks or deforming. Replace as required.



1. Lower chain guide

Replace lower chain guide if grooves depth (caused by timing chain) exceed 1.2 mm (.0472 in).

NOTE: Check also the chain guide (tensioner side).

Timing Chain Installation

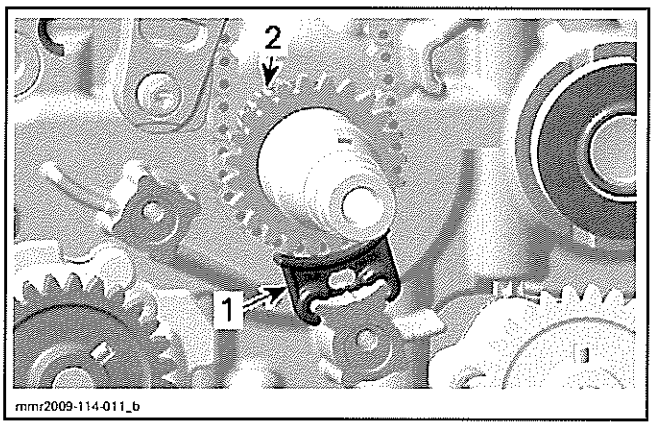
The installation is the reverse of the removal procedure. However, pay attention to the following details.

NOTICE Improper camshaft timing will damage engine components. Make sure camshafts and crankshaft are still locked. If not, lock them before beginning this procedure.

1. Install timing chain.

NOTE: If the same timing chain is reinstalled, make sure to reinstall it in the same operating direction as marked during removal procedure.

2. Reinstall lower chain guide to fit timing chain correctly on crankshaft timing gear.



1. Lower chain guide
2. Crankshaft timing gear

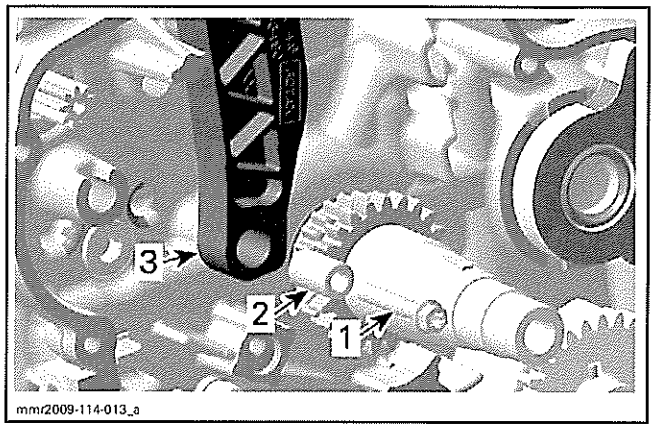
3. Continue with *TIMING CHAIN GEAR INSTALLATION* (see procedure in this subsection), to achieve proper camshaft timing.
4. Install all other removed parts.

CHAIN GUIDE (TENSIONER SIDE)

Chain Guide Removal (Tensioner Side)

NOTE: Removal of chain guide is not recommended if there is no need for replacement.

1. Remove the *TIMING CHAIN GEAR*, see procedure in this subsection.
2. Remove the camshaft timing gear on intake side. Refer to *CYLINDER HEAD* subsection.
3. Remove:
   - Retaining screw
   - Distance sleeve
   - Chain guide (tensioner side).

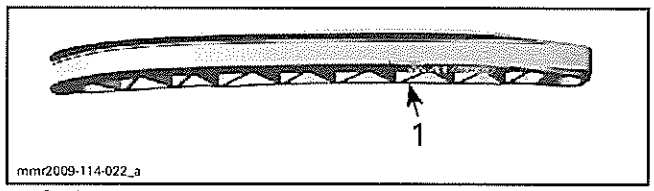


1. Retaining screw
2. Distance sleeve
3. Chain guide

Chain Guide Inspection (Tensioner Side)

Check chain guide for wear, cracks or deforming. Replace as required.

Replace chain guide if grooves depth (caused by timing chain) exceed 1.2 mm (.0472 in).



1. Chain guide

Chain Guide Installation (Tensioner Side)

The installation is the reverse of the removal procedure. However, pay attention to the following details.

NOTICE Improper camshaft timing will damage engine components. Make sure camshafts and crankshaft are still locked. If not, lock them before beginning this procedure.

1. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on retaining screw of chain guide.
2. Tighten retaining screw to 11 N•m (97 lbf•**in**).
3. Properly reinstall intake camshaft timing gear on camshaft. Refer to *CYLINDER HEAD* subsection.

CYLINDER HEAD

SERVICE TOOLS

Description	Part Number	Page
CAMSHAFT LOCKING TOOL	529 036 149	376
ENGINE LEAK DOWN TEST KIT	529 035 661	367
VALVE SPRING COMPRESSOR CUP	529 036 161	383
VALVE SPRING COMPRESSOR	529 035 724	383

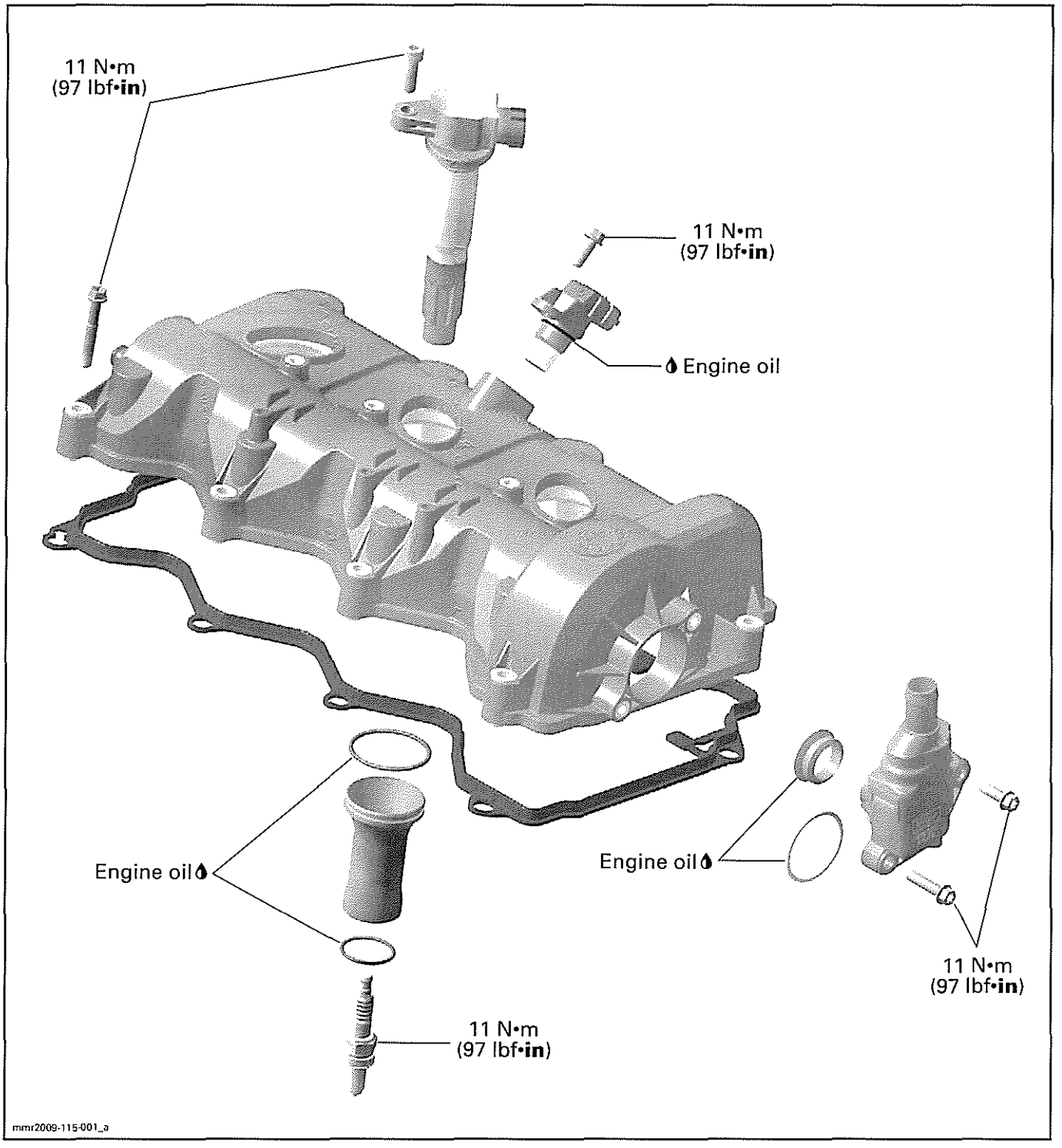
SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
SNAP-ON VALVE HOLDER	VL2	386
SNAP-ON VALVE STEM SEAL PLIERS	YA 8230	385

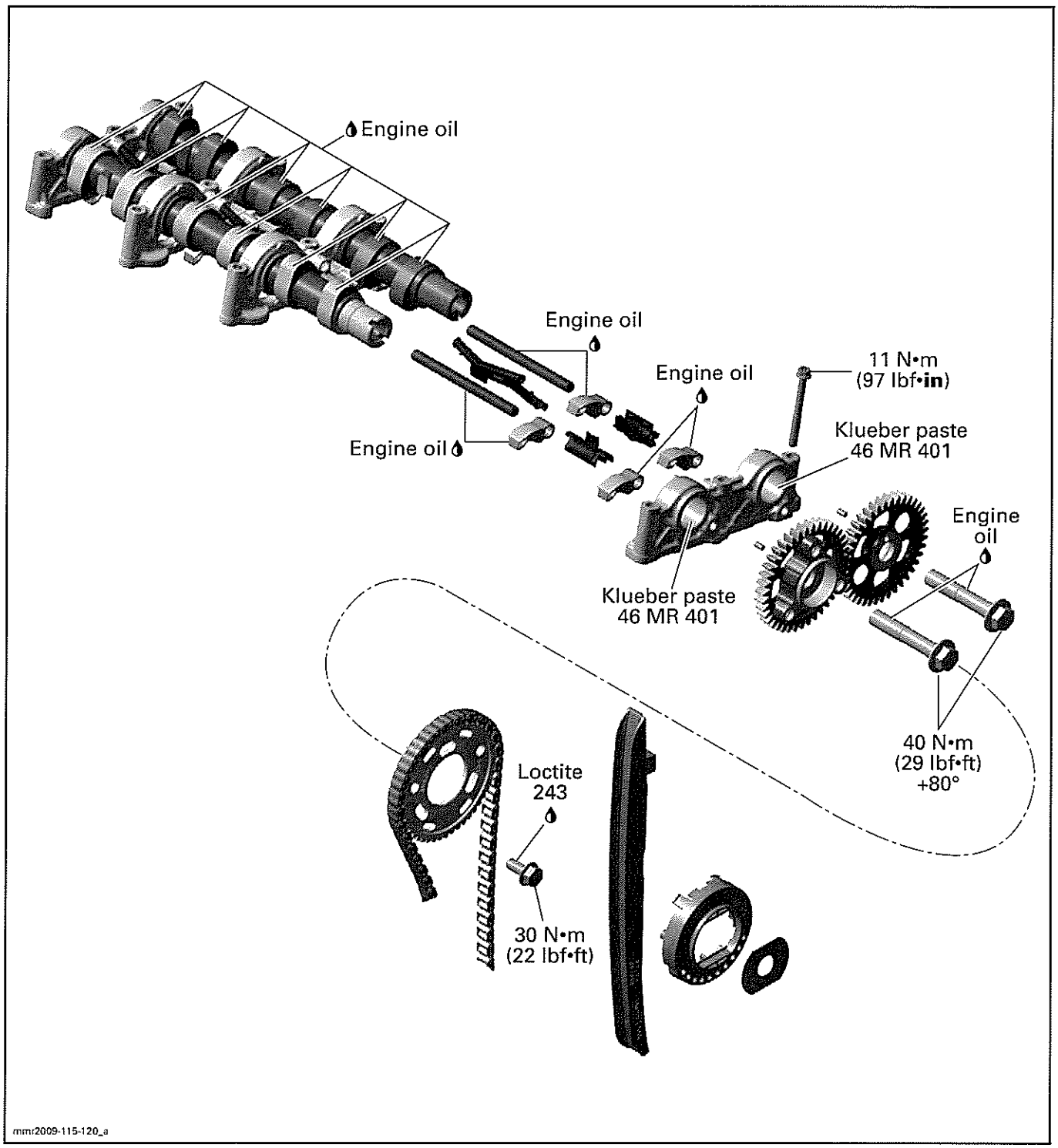
SERVICE PRODUCTS

Description	Part Number	Page
KLÜEBER PASTE 46 MR 401	420 297 616	380

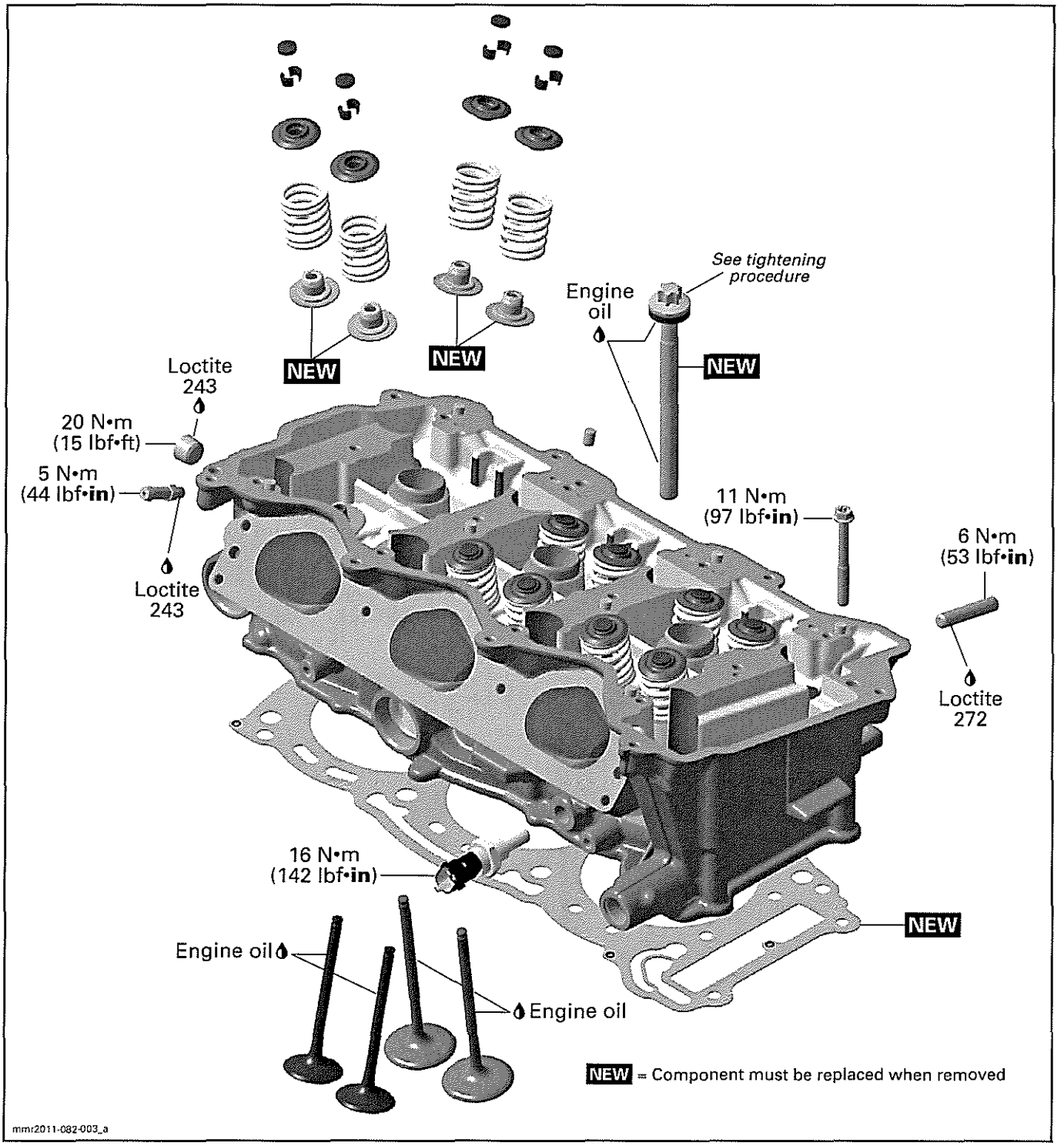
VALVE COVER


11 N•m
(97 lbf•in)
11 N•m
(97 lbf•in)
Engine oil
Engine oil
Engine oil
11 N•m
(97 lbf•in)
11 N•m
(97 lbf•in)
mmr2009-115-001_a

CAMSHAFTS


Engine oil
Engine oil
Engine oil
Engine oil
11 N•m
(97 lbf•in)
Klueber paste
46 MR 401
Engine
oil
Klueber paste
46 MR 401
40 N•m
(29 lbf•ft)
+80°
Loctite
243
30 N•m
(22 lbf•ft)
mmr2009-115-120_a

CYLINDER HEAD



GENERAL

NOTE: For a better understanding, some illustrations are taken with engine out of vehicle.

Always disconnect BLACK (-) cable from the battery, then RED (+) cable before working on the engine.

⚠ WARNING

Always disconnect BLACK (-) cable first and reconnect last.

During assembly/installation, use the torque values and service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices (e.g.: locking tabs, cotter pin, etc.) must be replaced.

Hoses, cables or locking ties removed during a procedure must be reinstalled as per factory standards.

When disassembling parts that are duplicated in the engine, (e.g.: valves, springs, etc.), it is strongly recommended to note their position and to keep the parts of the same assembly as a "group". If you find a defective component, it will be much easier to find the cause of the failure. Since parts were break-in together during the engine operation, they will keep their matched fit when parts are reassemble together within their "group".

INSPECTION

CYLINDER LEAK TEST

General

Before performing the cylinder leak test, verify the following:

- Clamp tightness
- Hoses condition.

NOTE: For best accuracy, the leak test should be done with the engine at normal operating temperature.

⚠ WARNING

Prevent burning yourself due to handling on the hot engine.

NOTE: The following steps are the same for each cylinder.

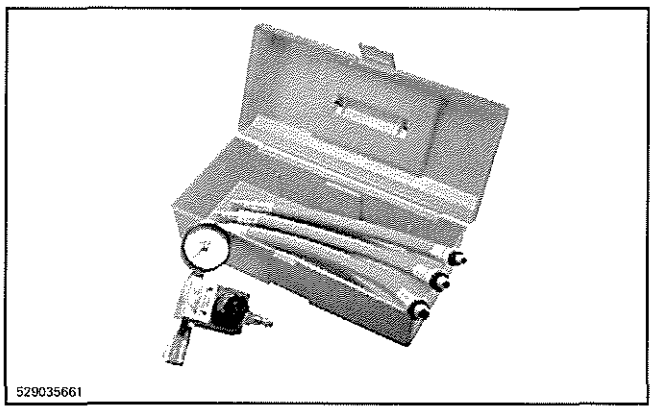
Preparation

1. Remove the *VALVE COVER*, see procedure in this subsection.
2. Remove spark plugs.
3. Using the drive pulley, turn the engine counterclockwise to bring piston to TDC of compression stoke. Use a dial gauge or a suitable tool to position the piston to TDC.

NOTE: The piston must be set precisely to TDC of compression stroke. If this is not ensured the engine will continue to rotate when pressure builds up.

Leak Test

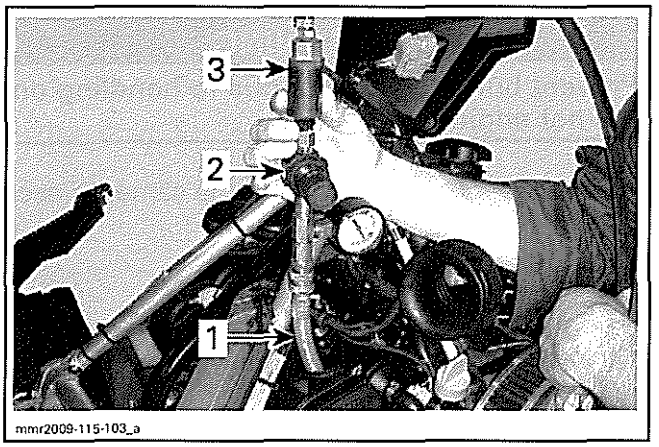
1. Install a gauge adaptor of the ENGINE LEAK DOWN TEST KIT (P/N 529 035 661) into spark plug hole.



2. Connect the leak down tester to an adequate air supply.
3. Set needle of measuring gauge to zero.

NOTE: All testers have specific instructions on gauge operation and required pressure. Refer to manufacturer's instructions.

4. Supply combustion chamber with air pressure.



1. Gauge adaptor
2. Leak tester
3. Air supply hose

5. Gently tap on each valve spring retainer to remove carbon deposits from valves.
6. Note the amount or percentage of leakage (depending on tester).

LEAKAGE PERCENTAGE	ENGINE CONDITION
0% to 15%	Excellent condition
16% to 25%	Good condition
26% to 40%	Fair condition; reduced engine performance
41% and higher	Poor condition, diagnose and repair engine

Diagnosis

Listen for air leaks.

- Air escaping on intake port or throttle body means leaking intake valve(s).
- Air escaping on exhaust port means leaking exhaust valve(s).
- Air bubbles out of coolant tank means leaking cylinder head gasket.
- Air or coolant escaping from cylinder head means damaged gasket or loosened screws.
- Air escaping into crankcase area means excessively worn cylinder or broken piston rings.
- Air or oil escaping from crankcase means damaged gasket or loosened screws.

Repair Tips

Blue exhaust gas means damaged or worn piston rings or valve stem seals.

White exhaust gas means damaged cylinder head gasket.

Coolant tank cap opening without overheat means damaged cylinder head gasket.

Assembly

Reverse the preparation procedure.

TROUBLESHOOTING

The following is provided to help in diagnosing the probable source of troubles. It is a guideline and should not be assumed to show all causes for all problems.

Always check for fault codes. If a fault code is detected, service the fault code first. Refer to *DIAGNOSTIC AND FAULT CODES* subsection.

NOTE: When diagnosing an engine problem, always perform the cylinder leak test. This will help pinpoint a problem. Refer to *CYLINDER LEAK TEST* in this subsection.

UNUSUAL ENGINE NOISE OR VIBRATIONS

1. Improper valve clearance adjustment.
   - *Adjust valve clearance.*
2. Cam followers or cam follower shaft worn out.
   - *Check and replace damaged parts.*
3. Cam follower spacers got loose.
   - *Check if cam follower spacers are in place.*
4. Camshaft(s) or camshaft holder(s) worn out.
   - *Check and replace damaged parts.*
5. Faulty chain tensioner.
   - *Replace chain tensioner. Refer to TIMING CHAIN subsection.*
6. Chain guide(s) worn out.
   - *Replace chain guide(s). Refer to TIMING CHAIN subsection.*
7. Stretched timing chain or worn out sprockets.
   - *Replace timing chain and sprockets. Refer to TIMING CHAIN subsection.*
8. Timing chain gear screws got loose.
   - *Retighten screws with recommended torque.*
9. Incorrect camshaft timing.
   - *Replace damaged components and readjust camshaft timing.*

OIL LEAKAGE FROM CYLINDER HEAD

1. Valve cover gasket is leaking.
   - *Replace valve cover gasket and retighten valve cover with recommended torque.*
   - *Check valve cover for cracks or other damage.*

2. Spark plug tube O-rings are leaking.
   - *Replace spark plug tube O-rings.*
   - *Clean spark plug area from oil spillage.*
3. Breather is leaking.
   - *Replace breather O-ring.*
4. Cylinder head gasket is leaking.
   - *Check cylinder head for damage.*
   - *Replace cylinder head gasket and retighten screws with recommended torquing procedure.*

ENGINE SUDDENLY TURNS OFF OR LACKS ACCELERATION OR POWER

1. Valve clearance too tight.
   - *Adjust valve clearance.*
2. Incorrect camshaft timing.
   - *Replace damaged components and readjust camshaft timing.*
3. Intake or exhaust valves are leaking.
   - *Perform a CYLINDER LEAK TEST. Repair or replace damaged components.*
4. Broken valve spring(s).
   - *Replace defective parts.*

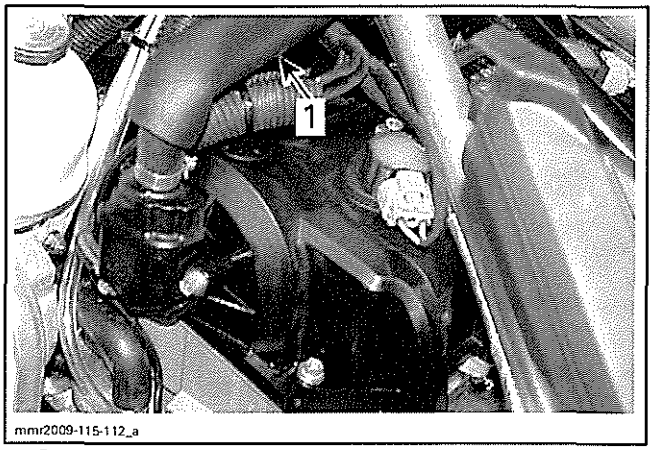
PROCEDURES

VALVE COVER

Valve Cover Removal (In Vehicle)

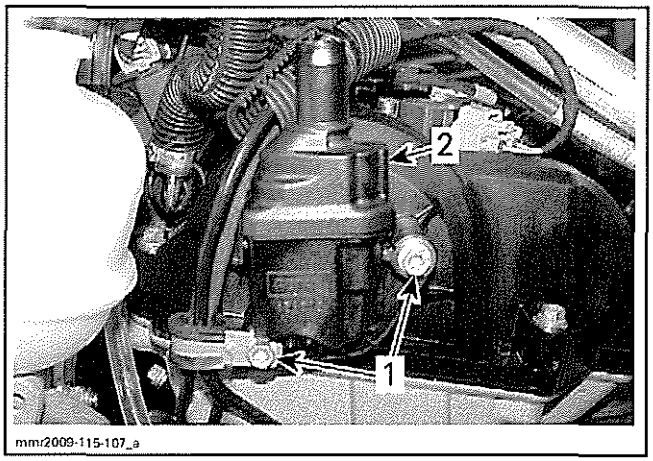
Use this procedure when you need to do the following:
– Check valve clearance.
– Perform a cylinder leak test.
– Work on camshaft timing gears, camshaft or cam followers.

1. Remove the air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.
2. Remove the muffler and the exhaust manifold. Refer to *EXHAUST SYSTEM* subsection.
3. Disconnect breather hose from valve cover and air intake adapter.



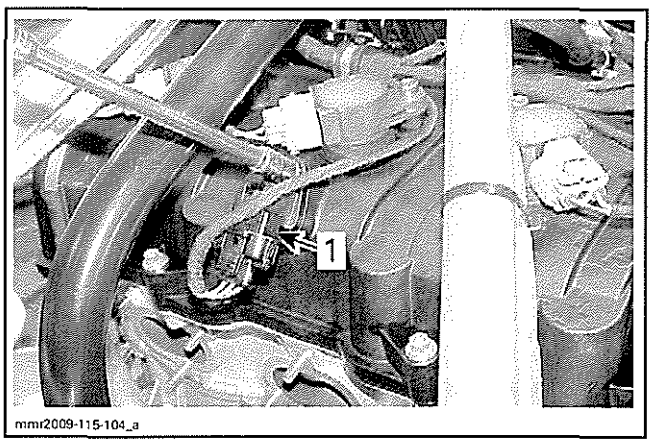
1. Breather hose

4. Remove breather from valve cover.



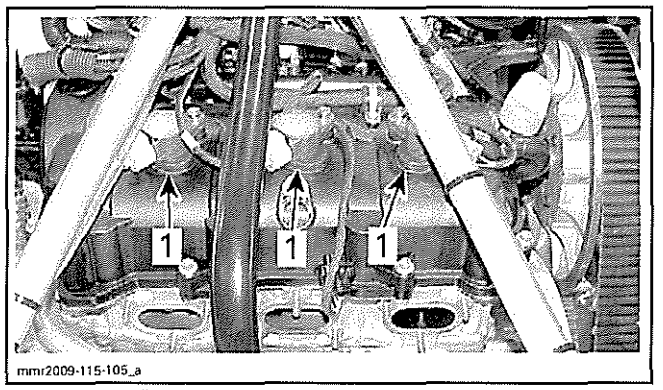
1. Retaining screws
2. Breather

5. Cut locking tie retaining the CAPS sensor connector to sensor.
6. Unplug and remove the CAPS sensor from the valve cover.



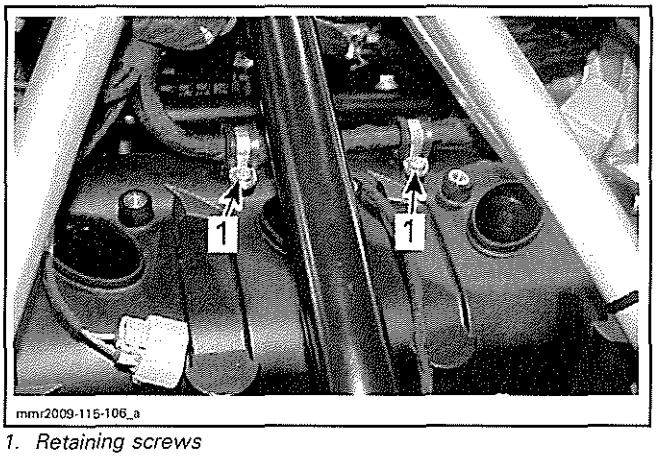
1. CAPS sensor

7. Unplug and remove ignitions coils.



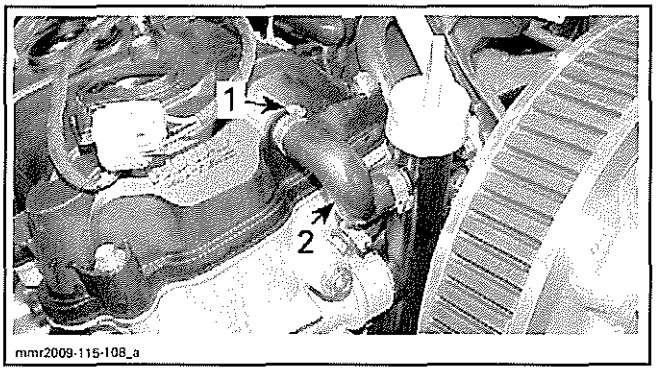
1. Ignition coils

8. Remove screws securing the harness to valve cover.



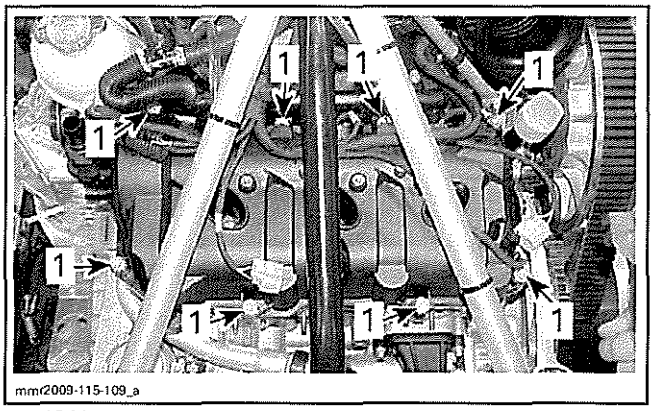
1. Retaining screws

9. Unplug all fuel injectors.
10. Disconnect vent tube from the valve cover.



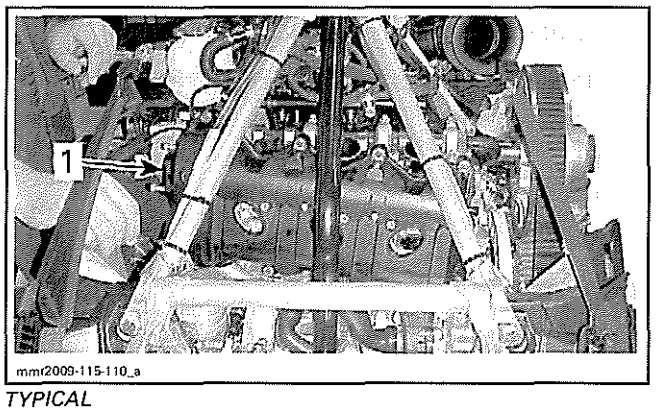
1. Cut this Oetiker clamp
2. Vent tube

11. Remove screws (8) retaining valve cover.



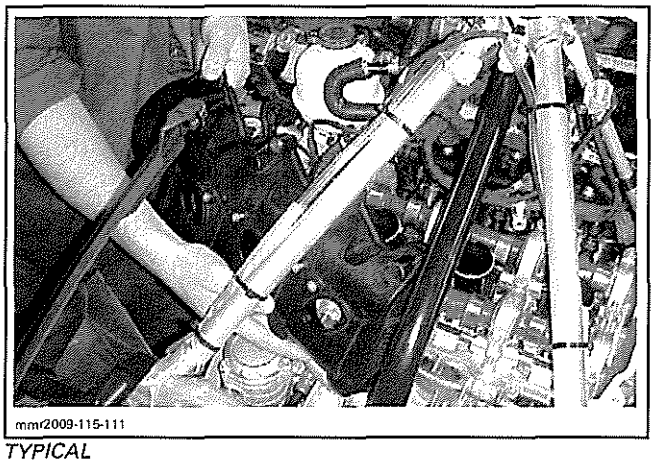
TYPICAL
1. Valve cover screws

12. Pull up the valve cover.
13. Tilt the front of the valve cover toward the exhaust manifold.



TYPICAL
1. Valve cover

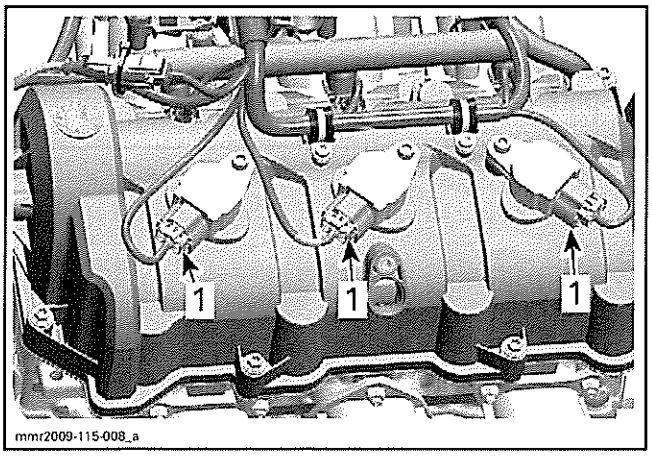
14. Move the valve cover towards the RH side of the vehicle.



TYPICAL

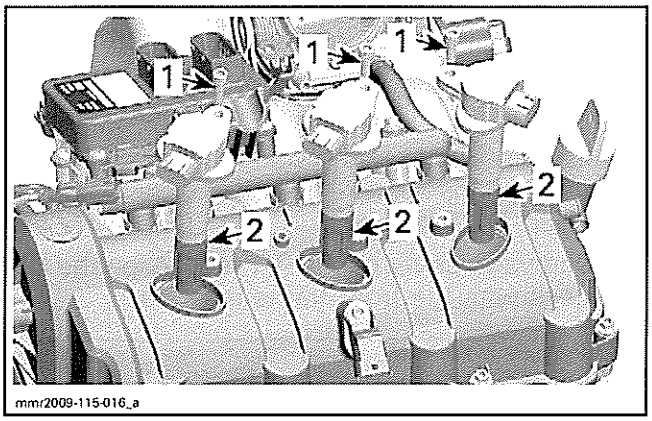
Valve Cover Removal (Engine Removed)

1. Unplug ignition coils.



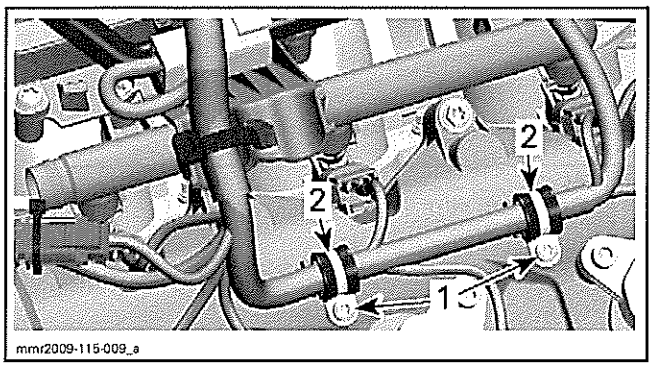
1. *Ignition coil connectors*

2. Remove ignition coils.



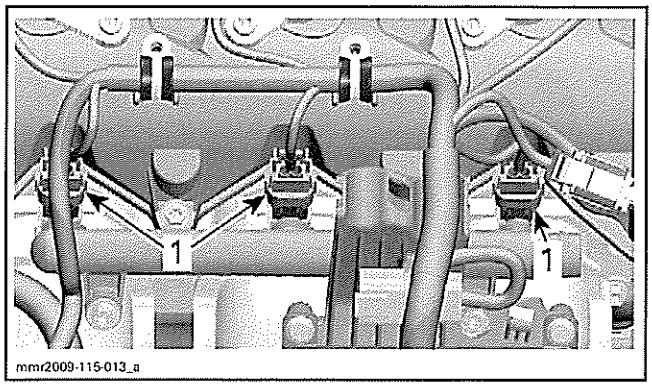
1. *Retaining screws*
2. *Ignition coils*

3. Remove screws securing the harness to the valve cover.



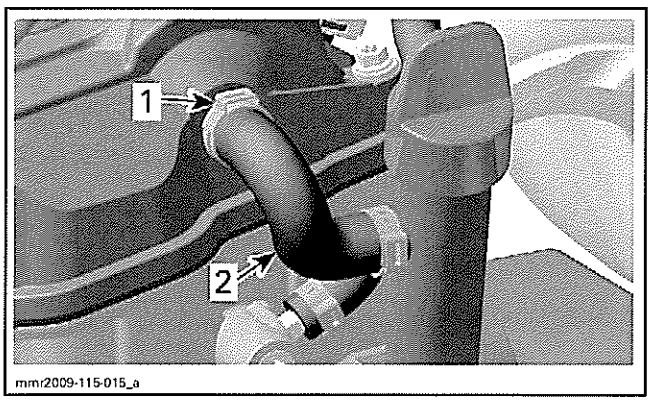
1. *Retaining screws*
2. *Cable clamps*

4. Unplug the fuel injector connectors.



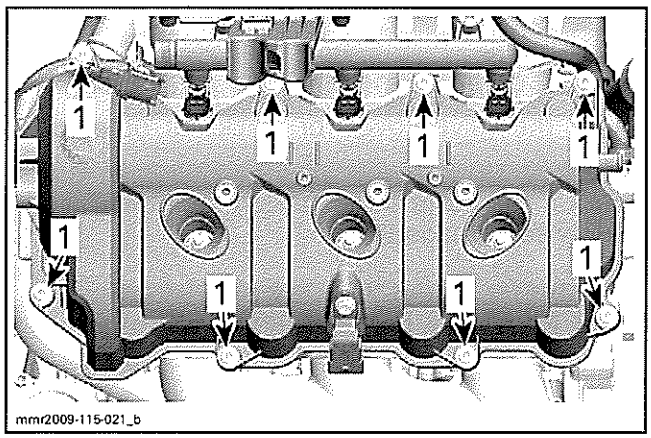
1. *Injector connectors*

5. Cut Oetiker clamp and remove vent tube from valve cover.



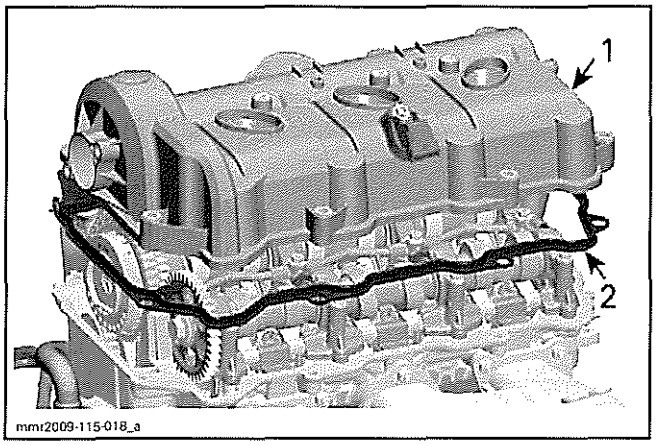
1. *Oetiker clamp*
2. *Vent tube*

6. Remove screws (8) retaining the valve cover.



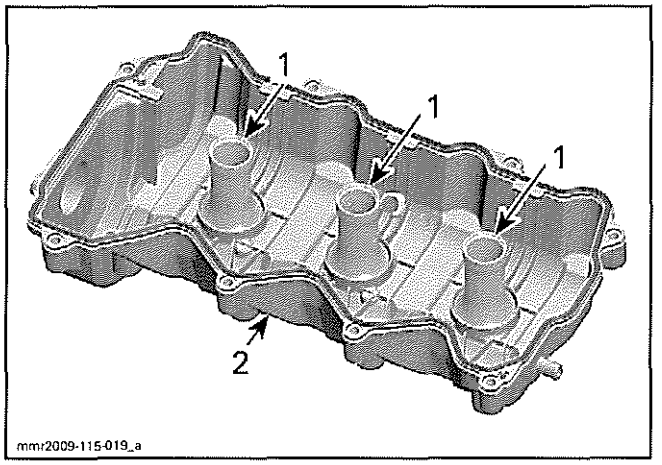
1. *Valve cover screws*

7. Remove valve cover and its gasket.



1. Valve cover
2. Gasket

8. Remove spark plug tubes from valve cover.



1. Spark plug tubes
2. Valve cover

Valve Cover Inspection

Check the valve cover for cracks or other damages.

Check if the valve cover gasket is brittle, hard or otherwise damaged.

Replace defective parts.

Spark Plug Tube Inspection

Check spark plug tubes for cracks or other damages.

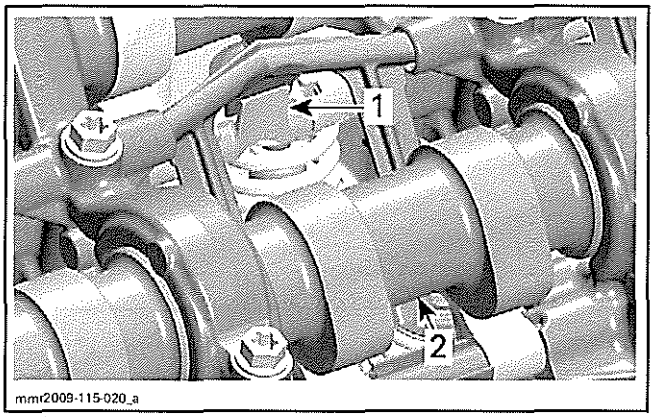
Check if O-rings are brittle, hard or otherwise damaged.

Replace defective parts.

Valve Cover Installation

For installation reverse the removal procedure. Pay attention to the following details.

1. Apply engine oil on spark plug tube O-rings before installation.
2. Ensure that cam follower spacers (for the intake camshaft) are in place during installation of spark plug tubes.

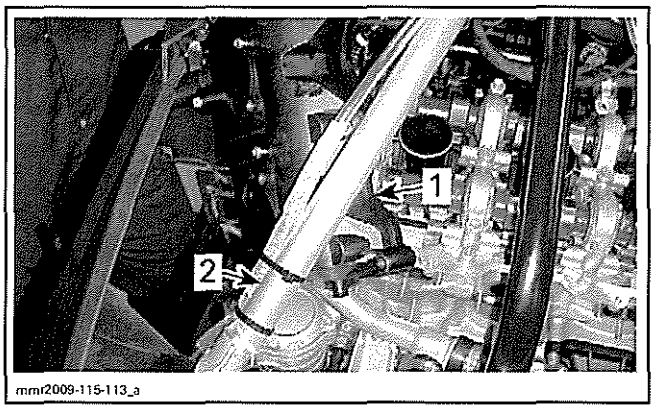


1. Cam follower spacer properly in place
2. Exhaust camshaft

3. Properly fit gasket into the groove of valve cover.

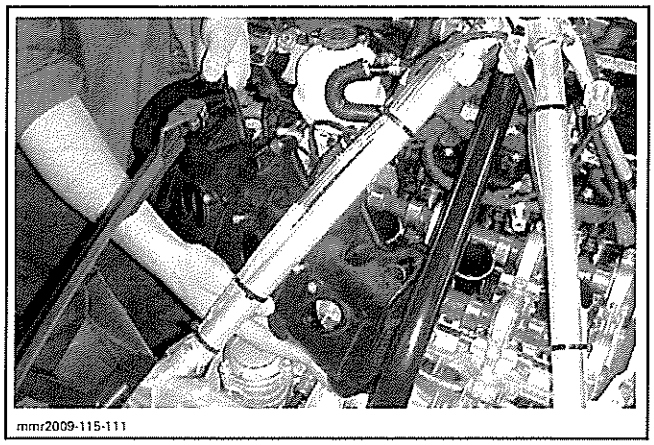
If the engine is not in the vehicle, go to step 8. If the engine is installed in the vehicle, continue with next step.

4. Insert valve cover by the RH side. Align the first recess with the front frame member.



TYPICAL
1. First recess of valve cover
2. Front frame member

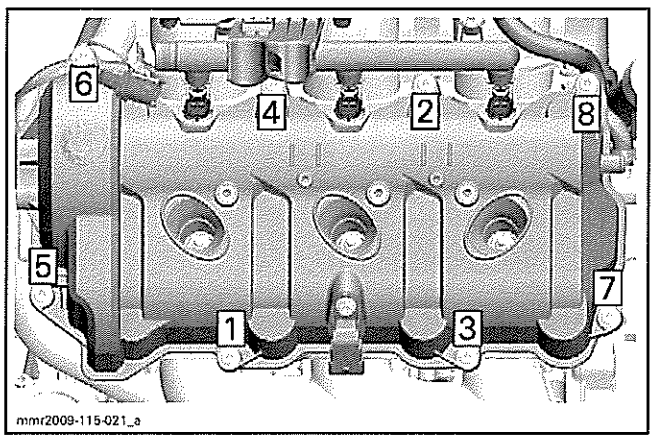
5. Slide the valve cover inside engine compartment.



TYPICAL

6. Install valve cover on cylinder head.
7. Push down the valve cover to insert spark plug tubes.
8. Install valve cover screws according to the following sequence.

VALVE COVER SCREW TIGHTENING TORQUE
11 N•m (97 lbf•**in**)

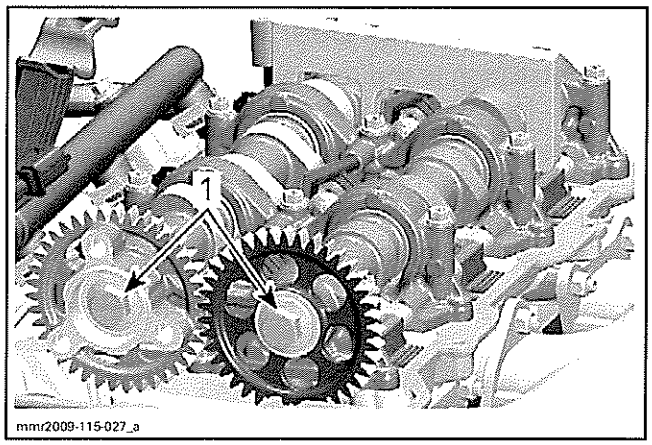


TIGHTENING SEQUENCE

CAMSHAFT TIMING GEARS

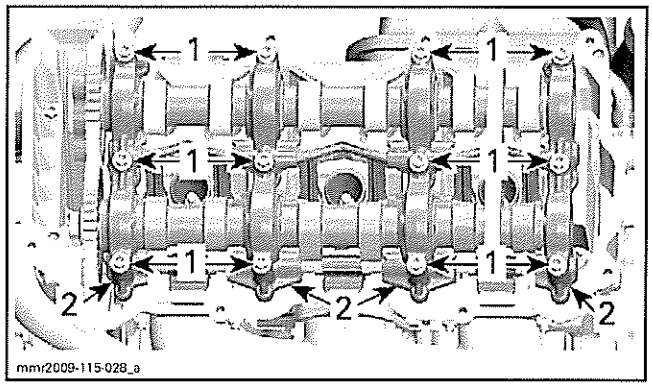
Camshaft Timing Gear Removal

1. Lock camshaft, refer to procedure in *CAMSHAFT LOCKING PROCEDURE* in this subsection.
2. Remove timing chain gear. Refer to *TIMING CHAIN* subsection.
3. Using a breaker bar and a 16 mm socket, loosen camshaft timing gears screws.



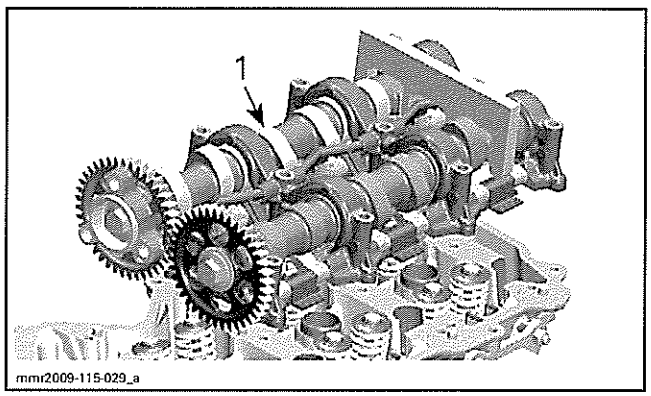
1. Camshaft timing gears screws

4. Remove retaining screws of camshaft holders.



1. Retaining screws
2. Camshaft holders

5. Remove camshafts from cylinder head.



1. Camshafts

6. Remove camshaft timing gears from camshafts.

Camshaft Timing Gear Inspection

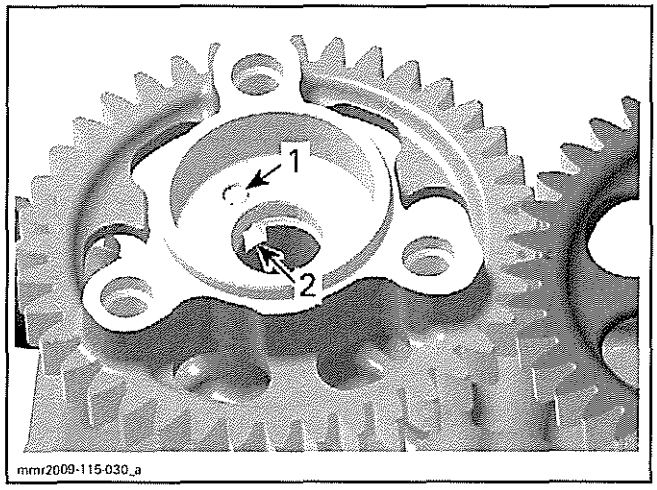
Check camshaft timing gears for wear or deterioration.

Replace both camshaft timing gears as a set, if damaged.

Camshaft Timing Gear Installation

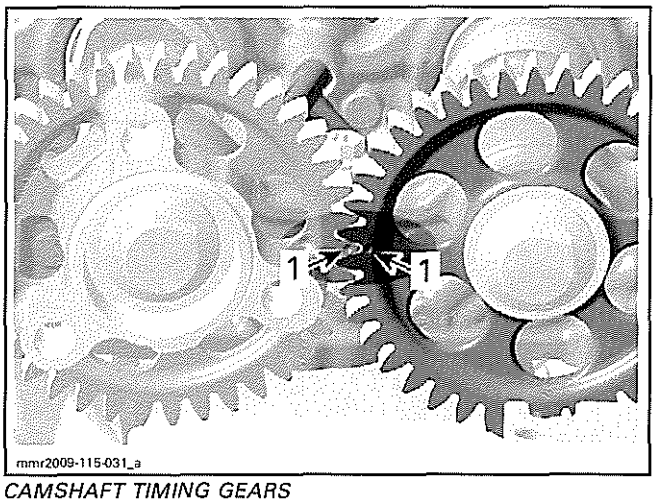
The installation is the reverse of the removal procedure. However, pay attention to the following.

1. Properly reinstall camshaft timing gears on camshafts as follows:
   1.1 Ensure that needle pin of camshaft timing gear fits into groove in camshaft.



1. Needle pin
2. Groove

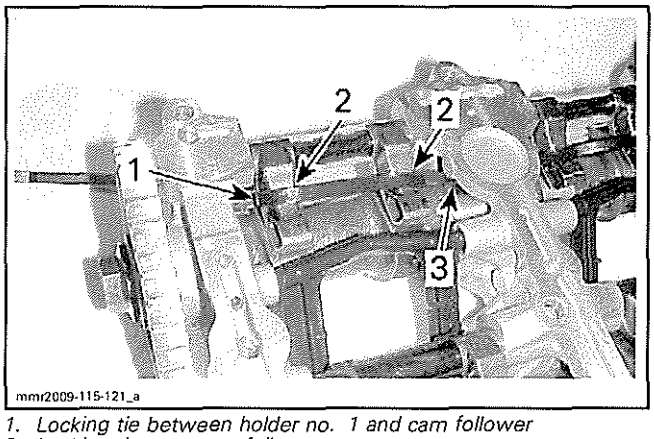
2. Marks on camshaft timing gears must be aligned during installation.



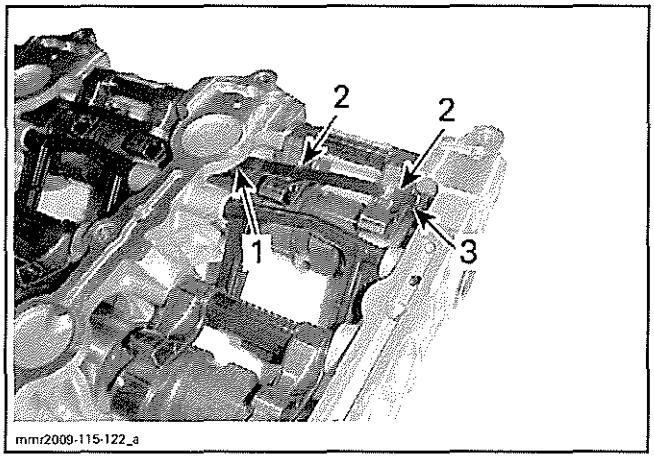
CAMSHAFT TIMING GEARS
1. Marks must be aligned

3. If camshaft locking tool has been removed, reinstall it on camshafts.
4. Apply engine oil on threads of camshaft timing gear screws and install them. Do not torque yet.
5. Turn the camshafts upside down.
6. Using a long locking tie attach cam followers.

NOTE: The locking tie will retain cam followers during the installation of the camshafts. Use the same procedure for both camshafts.

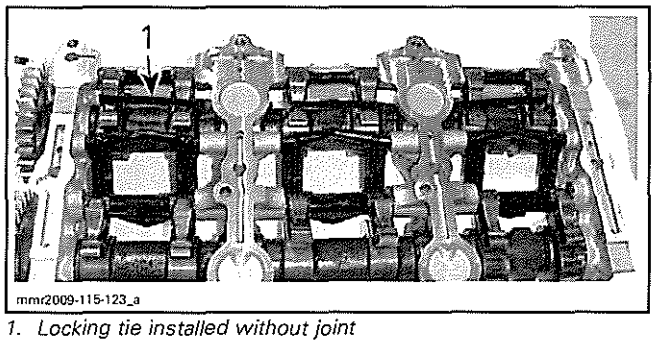


1. Locking tie between holder no. 1 and cam follower
2. Locking tie over cam followers
3. Locking tie between camshaft and its holder no. 2

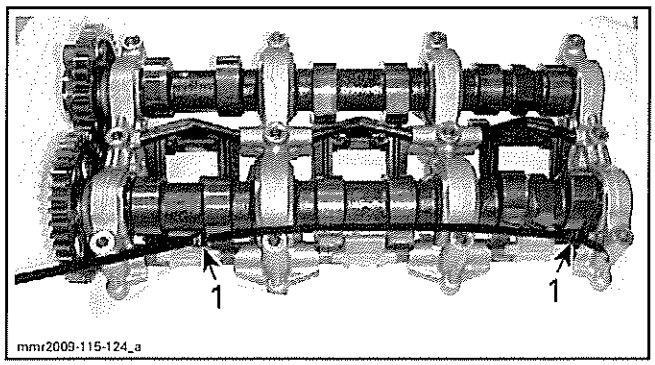


1. Locking tie between camshaft and its holder no. 3
2. Locking tie over cam followers
3. Locking tie between cam follower and holder no. 4

NOTE: If two locking ties must be used to attach one side, make sure both attachment ends are on the top side of camshafts.

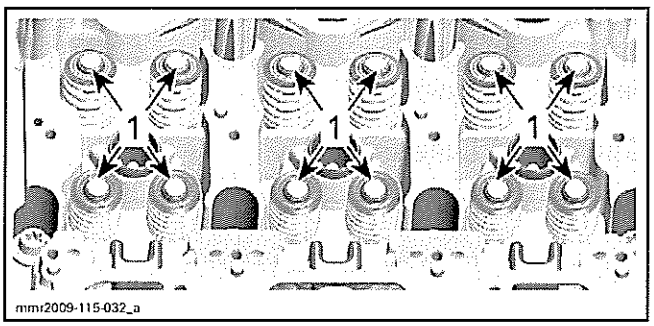


1. Locking tie installed without joint



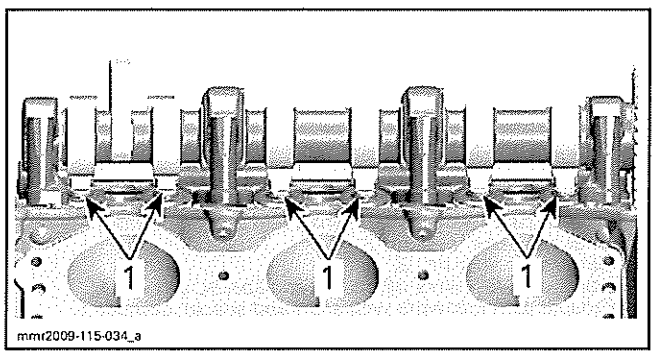
1. Both attachment ends on the top of camshafts

7. Ensure all valve adjustment shims are in place, prior to install camshafts.



1. Adjustment shims are in place

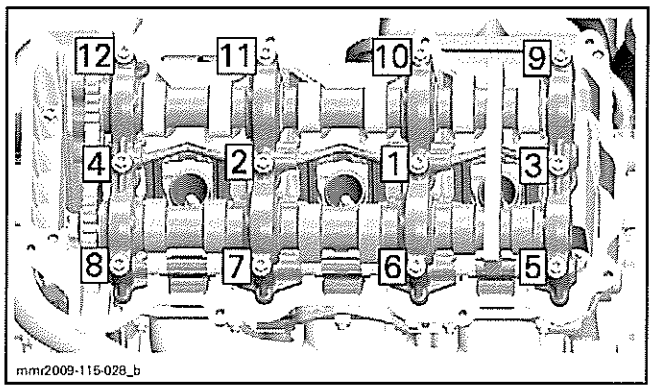
8. Carefully reinstall camshafts as follows.
   8.1 Move camshafts to their final position.
   8.2 Check if all shims and all cam followers are in place.



1. Cam followers position over shims

   8.3 Install loosely all screws securing camshaft holders.
   8.4 Remove locking ties by pulling them out of camshafts.
   8.5 Tighten camshaft holders according to specification and the following sequence.

CAMSHAFT HOLDERS TIGHTENING TORQUE
11 N•m (97 lbf•**in**)

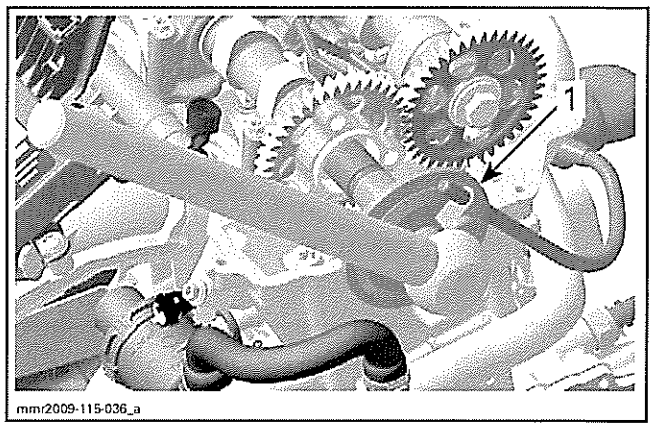


TIGHTENING SEQUENCE

9. Tighten each camshaft timing gear screw according to the following procedure:
   9.1 Tighten to the following specification (FIRST STEP).

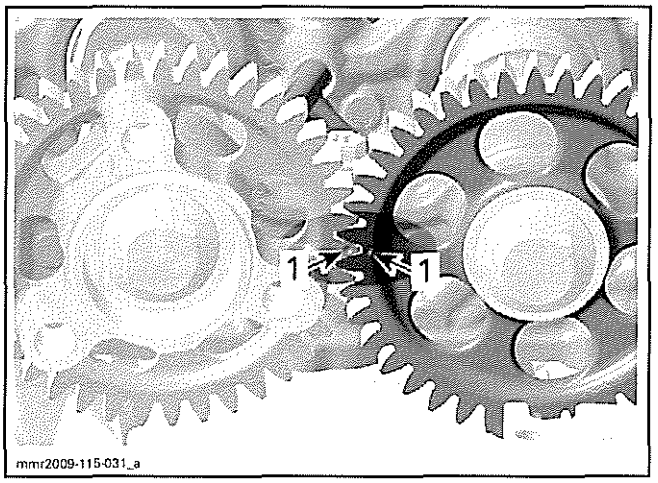
CAMSHAFT TIMING GEAR TORQUE (FIRST STEP)
40 N•m (30 lbf•ft)

   9.2 Finish tightening by turning an additional 80° rotation with a torque angle gauge (FINAL TORQUE).



1. Torque angle gauge

NOTE: Make sure that crankshaft and camshaft are still locked. In this condition, marks on camshaft timing gears must be aligned.



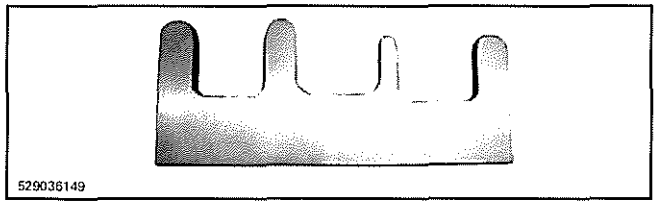
CAMSHAFT TIMING GEARS
1. Marks must be aligned

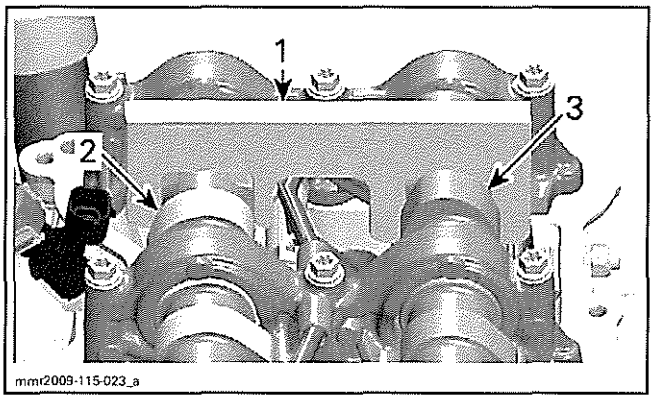
10. Properly install timing chain gear. Refer to *TIMING CHAIN* subsection.
11. Remove camshaft locking tool and crankshaft locking tool.
12. Check valve clearance. Refer to *VALVE CLEARANCE* in this subsection.
13. Install remaining parts.

CAMSHAFTS

Camshaft Locking Procedure

1. Remove *VALVE COVER*, see procedure in this subsection.
2. Lock crankshaft, refer to procedure in *CYLINDER BLOCK* subsection.
3. Lock camshaft using the CAMSHAFT LOCKING TOOL (P/N 529 036 149).



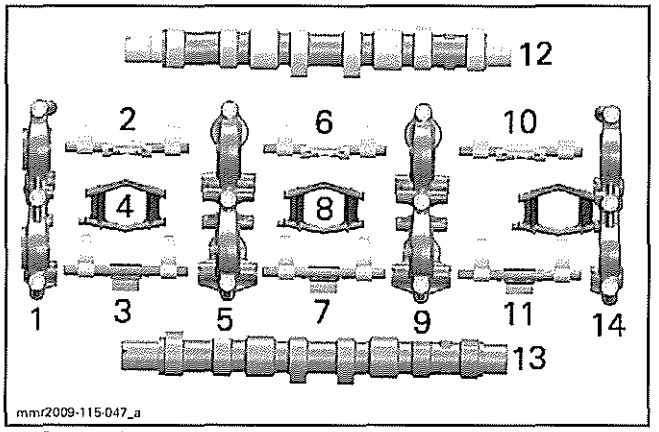


1. Camshaft locking tool
2. Intake camshaft
3. Exhaust camshaft

Camshaft Removal

Refer to *CAMSHAFT TIMING GEAR* in this subsection to remove camshafts.

Camshaft Disassembly

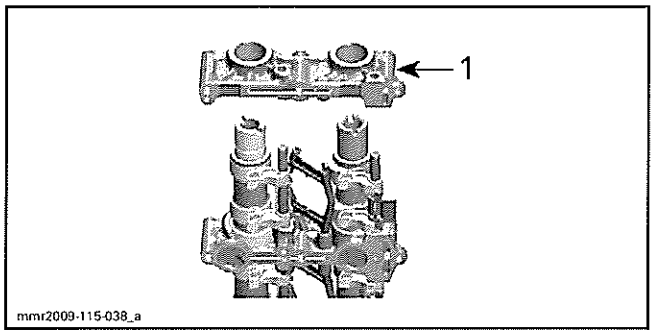


1. Camshaft holder no. 1
2. Intake cam followers with shaft and spacer, cylinder 3
3. Exhaust cam followers with shaft and spacer, cylinder 3
4. Oil supply tube, cylinder 3
5. Camshaft holder no. 2
6. Intake cam followers with shaft and spacer, cylinder 2
7. Exhaust cam followers with shaft and spacer, cylinder 2
8. Oil supply tube, cylinder 2
9. Camshaft holder no. 3
10. Intake cam followers with shaft and spacer, cylinder 1
11. Exhaust cam followers with shaft and spacer, cylinder 1
12. Intake camshaft
13. Exhaust camshaft
14. Camshaft holder no. 4

NOTE: When disassembling parts that are duplicated (e.g.: cam followers), it is strongly recommended to note their position and to keep them as a group.

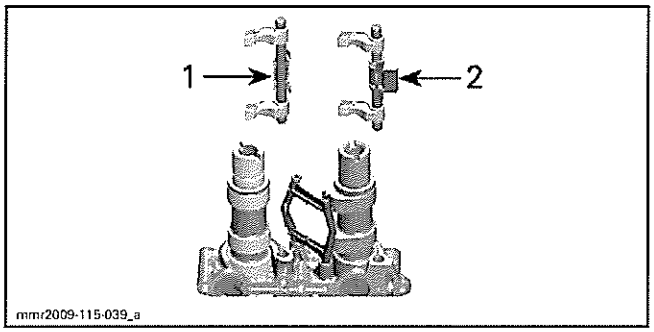
Place camshafts on a clean rag in vertical position and proceed as follows.

1. Remove the camshaft holder no. 1.



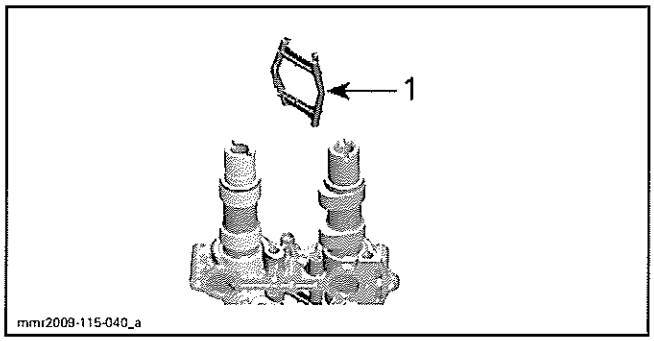
1. Camshaft holder no. 1

2. Remove intake and exhaust cam followers of cylinder no. 3 with their shaft and spacer.



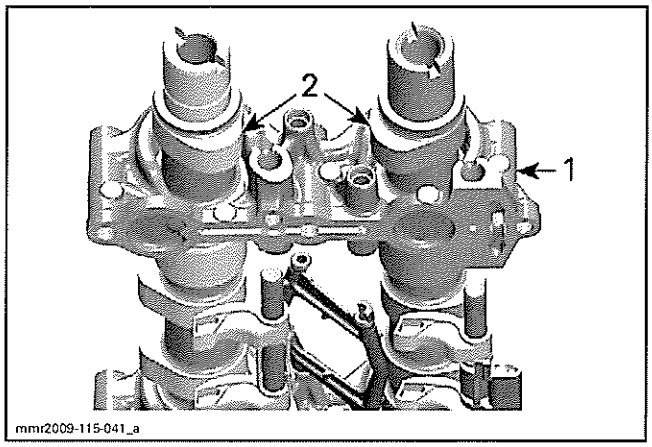
1. Intake cam follower with shaft and spacer
2. Exhaust cam follower with shaft and spacer

3. Remove oil supply tube.

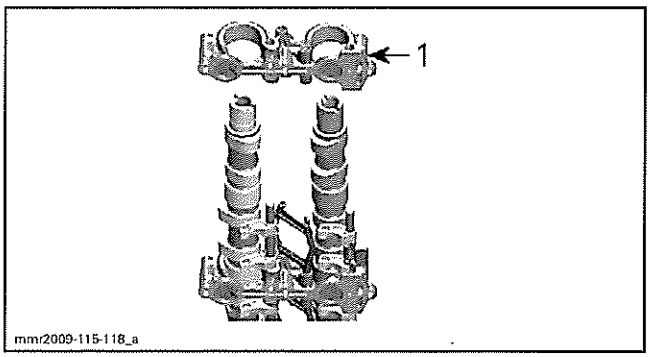


1. Oil supply tube

4. Turn camshafts to clear lobes from camshaft holder no. 2. Remove holder.

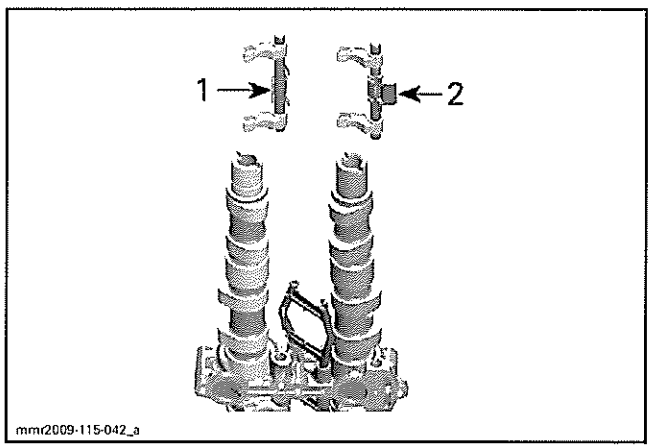


1. Camshaft holder no. 2
2. Camshaft lobes



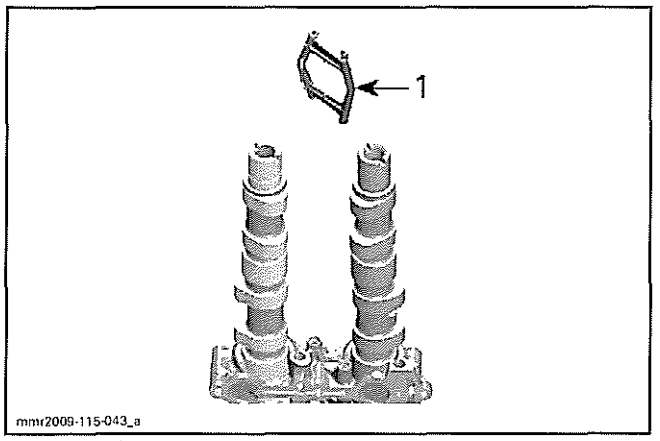
1. Camshaft holder no. 2

5. Remove intake and exhaust cam followers of cylinder no. 2 with their shaft and spacer.



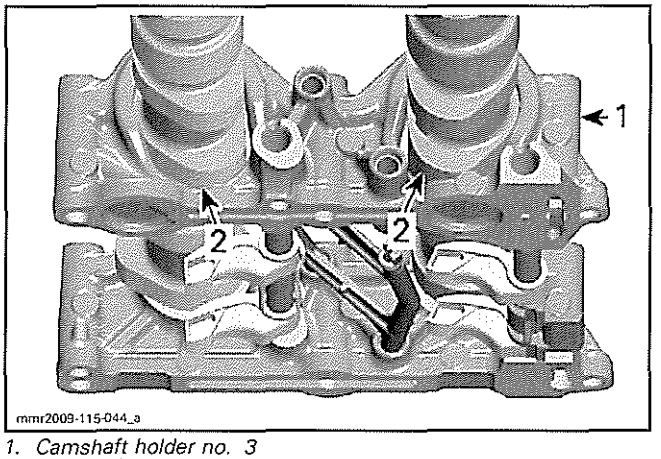
1. Intake cam follower with shaft and spacer
2. Exhaust cam follower with shaft and spacer

6. Remove oil supply tube.

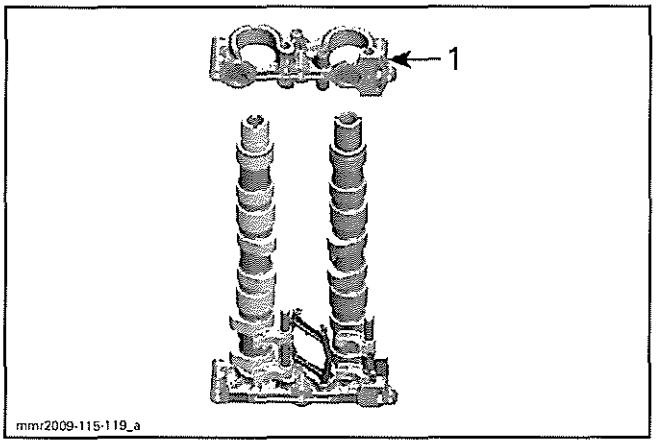


1. *Oil supply tube*

7. Turn camshafts to clear lobes from camshaft holder no. 3. Remove holder.

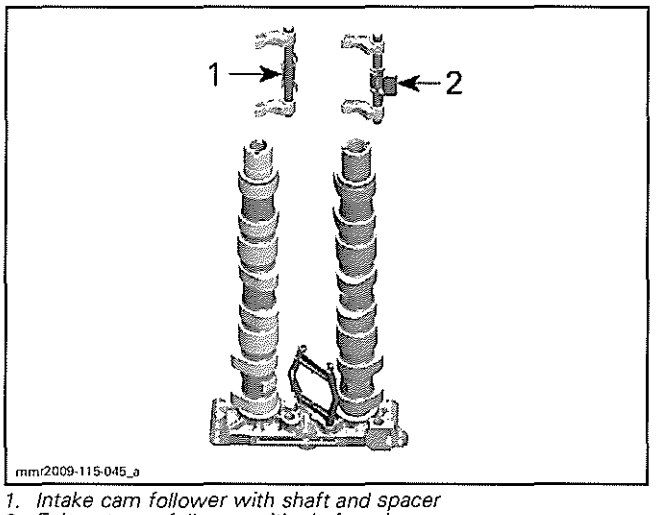


1. *Camshaft holder no. 3*
2. *Camshaft lobes*



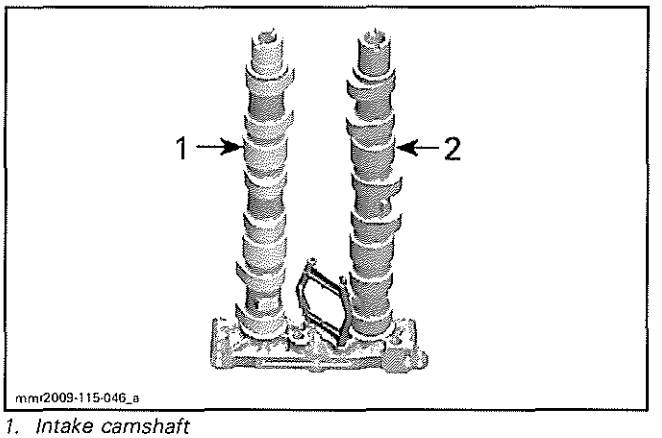
1. *Camshaft holder no. 3*

8. Remove intake and exhaust cam followers of cylinder no. 1 with their shaft and spacer.



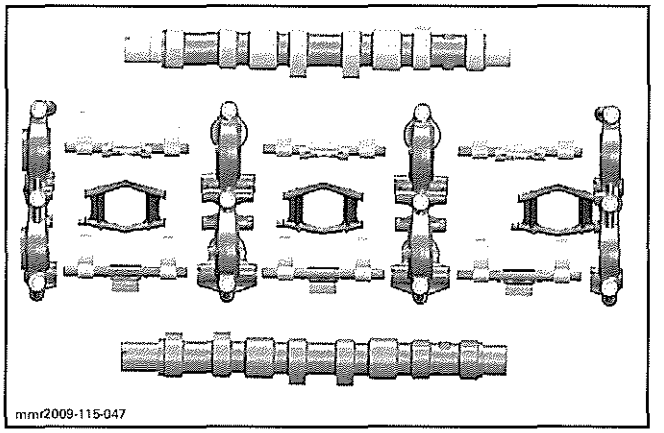
1. *Intake cam follower with shaft and spacer*
2. *Exhaust cam follower with shaft and spacer*

9. Remove intake and exhaust camshafts.



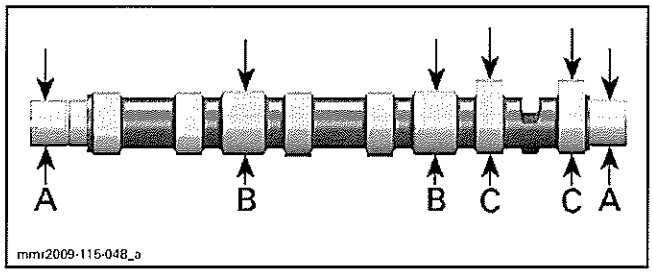
1. *Intake camshaft*
2. *Exhaust camshaft*

NOTE: Place all components in their original assembly order on a clean rag, to ease reassembly.



Camshaft Inspection

1. Check each lobe and bearing journal for scoring, scuffing, cracks, or other signs of wear.
2. Measure camshaft bearing journal diameter and lobe height, using a micrometer.



A. Camshaft journal (MAG, PTO)
B. Camshaft journal (center)
C. Camshaft lobe

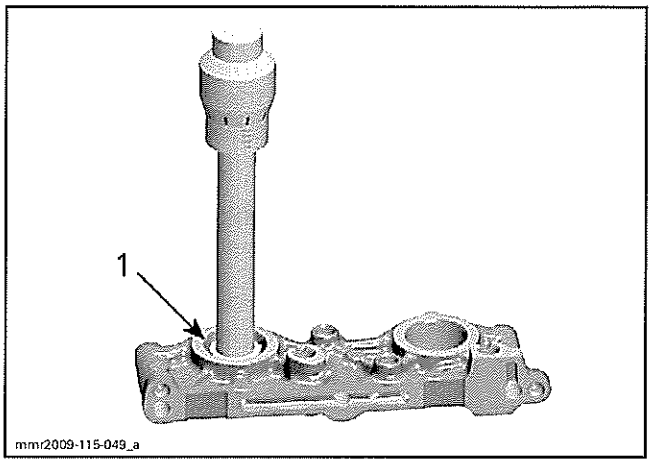
CAMSHAFT JOURNAL DIAMETER	
PTO AND MAG JOURNAL	
NEW	23.967 mm to 23.980 mm (.9436 in to .9441 in)
SERVICE LIMIT	23.950 mm (.9429 in)
CENTER JOURNAL	
NEW	32.959 mm to 32.975 mm (1.2976 in to 1.2982 in)
SERVICE LIMIT	32.942 mm (1.2969 in)

CAMSHAFT LOBE HEIGHT	
INTAKE CAMSHAFT	
NEW	38.12 mm to 38.32 mm (1.5008 in to 1.5087 in)
SERVICE LIMIT	38.09 mm (1.4996 in)
EXHAUST CAMSHAFT	
NEW	37.86 mm to 38.06 mm (1.4906 in to 1.4984 in)
SERVICE LIMIT	37.83 mm (1.4894 in)

Replace parts if necessary.

Camshaft Holder Inspection

1. Check each camshaft holder for scoring, scuffing, cracks, or other signs of wear.
2. Use a bore gauge and measure the inner diameter of camshaft holder bores (camshaft holders no. 1 and no. 4).



1. Camshaft holder bore

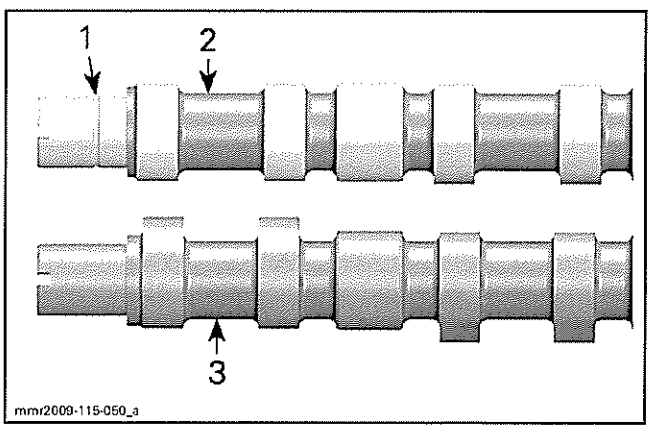
INNER BORE DIAMETER (CAMSHAFT HOLDER)	
NEW	24.007 mm to 24.020 mm (.9452 in to .9457 in)
SERVICE LIMIT	24.070 mm (.9476 in)

Replace parts if necessary.

Camshaft Assembly

NOTICE The camshafts are not identical in design. Do not mix-up the camshafts during assembly. Any mix-up of the components will lead to engine damage.

The intake camshaft has an identification groove and must be on the LH side during camshaft assembly.



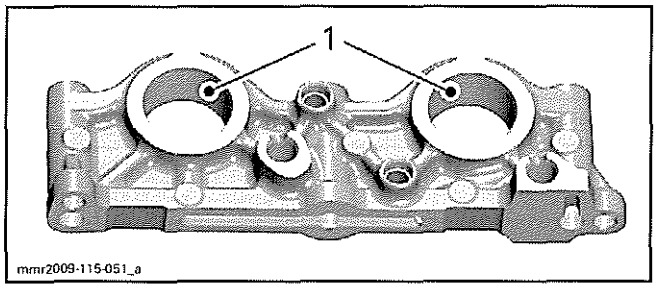
1. Identification groove
2. Intake camshaft
3. Exhaust camshaft

The assembly is the reverse of the disassembly procedure. However, pay attention to the following.

NOTICE During assembly, make sure to fit the components exactly in their original position on their respective cylinder. Any inversion of the components may cause damage to the engine.

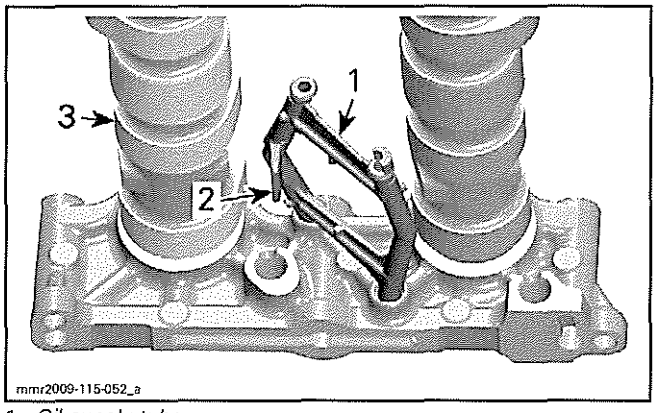
1. Apply KLÜEBER PASTE 46 MR 401 (P/N 420 297 616) on camshaft holder bores during assembly.

NOTICE Do not use other lubricant. Camshaft seizure can happen if another lubricant is used.



1. Apply Klueber paste here

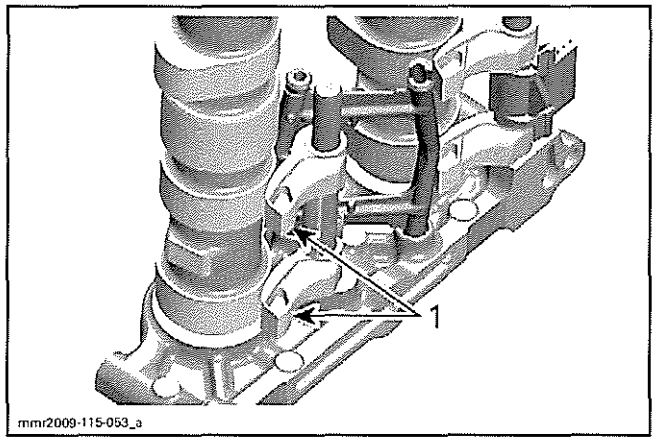
2. Ensure that the flat spot of oil supply tube tab faces to intake camshaft.



1. Oil supply tube
2. Flat side of tab
3. Intake camshaft

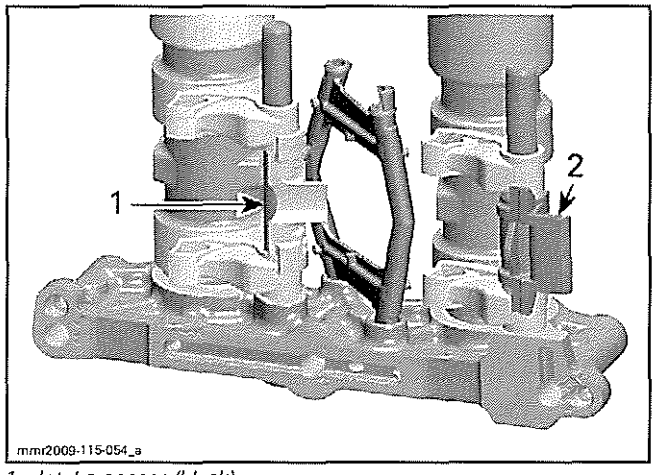
3. Properly reinstall cam follower with its shaft and spacer into camshaft holders as follows.

   3.1 Fit the cam followers as next illustration.



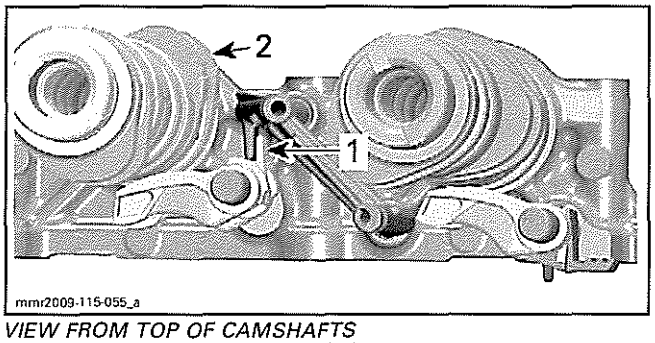
1. Cam followers properly installed

NOTE: Do not mix-up cam follower spacers of intake and exhaust camshaft. Intake spacers are black and exhaust spacers are white colored.



1. Intake spacer (black)
2. Exhaust spacer (white)

   3.2 Ensure that the flat spot of intake spacer (black) contacts the flat spot of oil tube, see next illustration.



VIEW FROM TOP OF CAMSHAFTS
1. Exhaust spacer properly installed
2. Intake camshaft

4. Properly fit camshaft holders onto oil supply tubes during assembly.

NOTE: After the reassembly of camshafts is completed, check for easy movement of camshaft and cam followers.

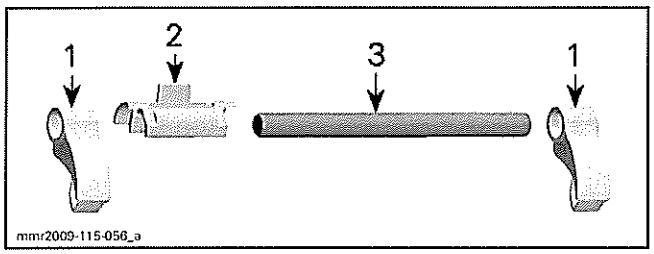
Camshaft Installation

Refer to *CAMSHAFT TIMING GEAR INSTALLATION* in this subsection.

CAM FOLLOWERS

Cam Follower Removal

1. Remove camshafts. Refer to *CAMSHAFT TIMING GEAR.*
2. Disassemble camshafts. Refer to *CAMSHAFT.*
3. Remove cam followers and spacer from cam follower shaft.

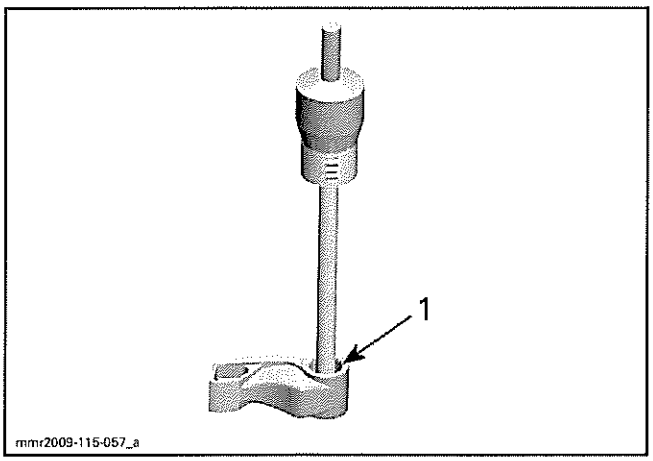


1. *Cam followers*
2. *Spacer*
3. *Cam follower shaft*

Cam Follower Inspection

Check surfaces of cam follower for scoring, wear or other damages.

Measure cam follower bore inner diameter, using a small bore gauge.



1. *Cam follower bore*

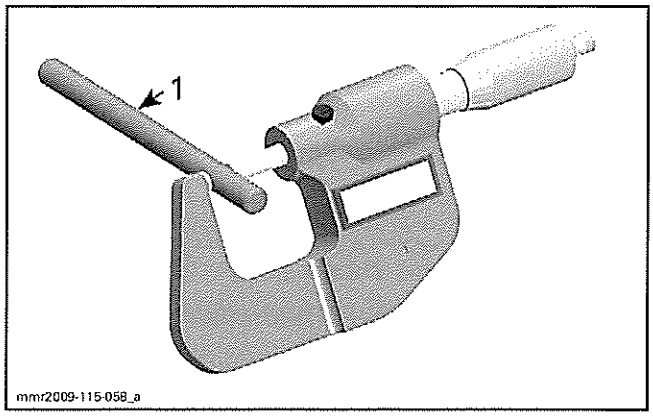
CAM FOLLOWER BORE INNER DIAMETER	
NEW	8.013 mm to 8.049 mm (.3155 in to .3169 in)
SERVICE LIMIT	8.060 mm (.3173 in)

Replace cam follower, if out of specification.

Cam Follower Shaft Inspection

Check cam follower shaft for scoring, wear or other damages.

Measure cam follower shaft diameter, using a micrometer.



1. *Cam follower shaft*

CAM FOLLOWER SHAFT DIAMETER	
NEW	7.972 mm to 7.980 mm (.3139 in to .3142 in)
SERVICE LIMIT	7.960 mm (.3134 in)

Replace cam follower shaft, if out of specification.

Cam Follower Spacer Inspection

Inspect cam follower spacer for cracks or other damage.

Check if clamping force on cam follower shaft is still adequate.

Replace spacer if necessary.

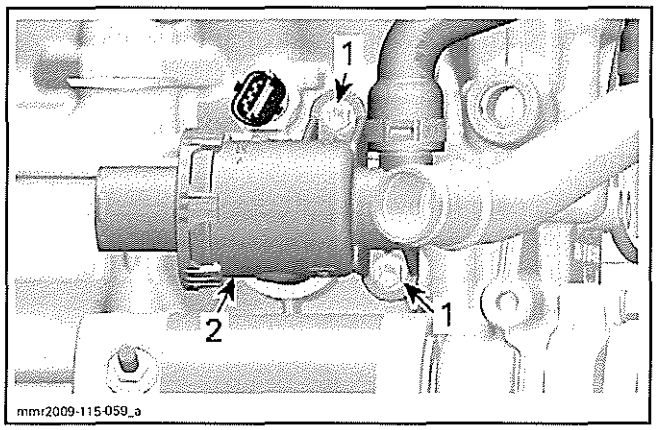
Cam Follower Installation

Refer to *CAMSHAFT* assembly steps in this section.

CYLINDER HEAD

Cylinder Head Removal

1. Remove engine from vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
2. Remove the intake manifold. Refer to *AIR INTAKE SYSTEM* subsection.
3. Remove oil tank from engine. Refer to *LUBRICATION SYSTEM* subsection.
4. Remove screws securing the thermostat to engine. Move thermostat aside.

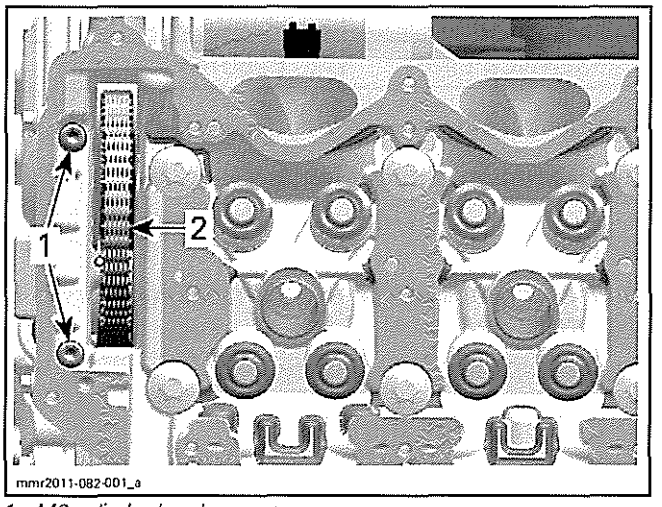


1. Retaining screws
2. Thermostat

5. Remove the *CAMSHAFT TIMING GEARS*, see procedure in this subsection.
6. Remove valve adjustment shims from spring retainers.

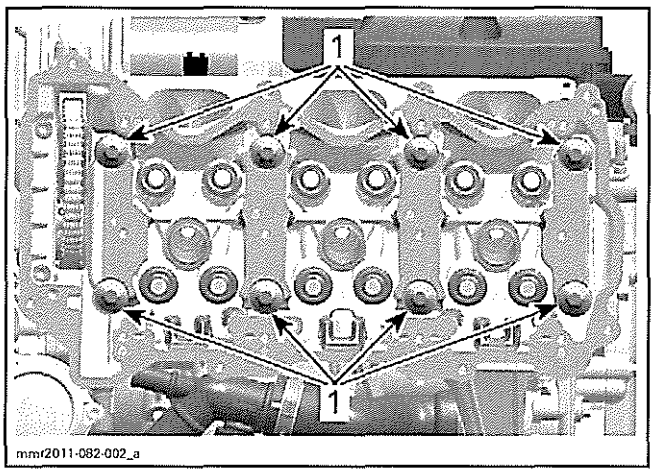
NOTE: Identify the position of each valve adjustment shim very carefully, so it can be reinstalled in its original place.

7. Remove M6 cylinder head screws.



1. M6 cylinder head screws
2. Timing chain

8. Remove and discard M10 cylinder head screws.

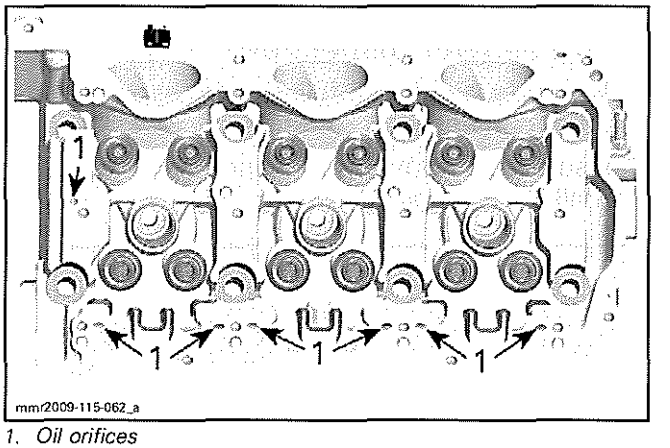


1. M10 cylinder head screws

9. Pull up cylinder head.
10. Remove and discard cylinder head gasket.

Cylinder Head Cleaning

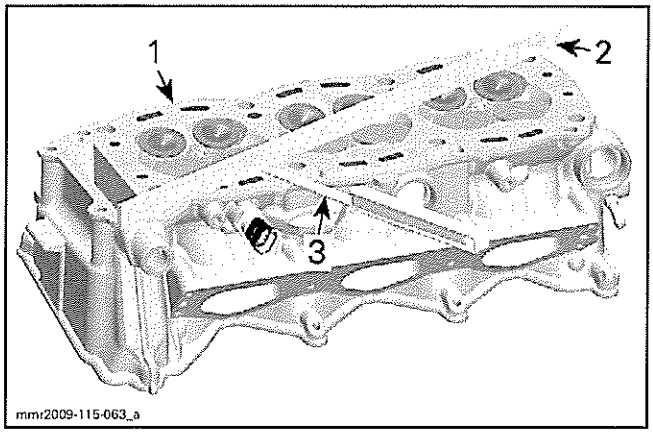
1. Remove carbon deposits from combustion chamber, exhaust port and piston top.
2. Clean cylinder head, especially cylinder head screw surface from oil spillage.
3. Blow out the oil orifices and check if they are not clogged.



1. Oil orifices

Cylinder Head Inspection

1. Check for cracks between valve seats or other damages, if so, replace cylinder head.
2. Check cylinder head mating surface for flatness using a straight edge.



1. *Cylinder head*
2. *Straight edge*
3. *Feeler gauge*

Check cylinder head warpage.

CYLINDER HEAD WARPAGE	
Maximum	0.10 mm (.0039 in)

If warpage exceeds specification, resurface the cylinder head as follows.

Use a 400 - 600 grit wet sandpaper on a surface plate and gently grind off the mating surface.

NOTE: To ensure an even surface, rotate cylinder head several times during resurfacing.

Replace cylinder head, if resurfacing fails.

Cylinder Head Installation

For installation, reverse the removal procedure. Pay attention to the following details.

1. Install NEW cylinder head gasket.

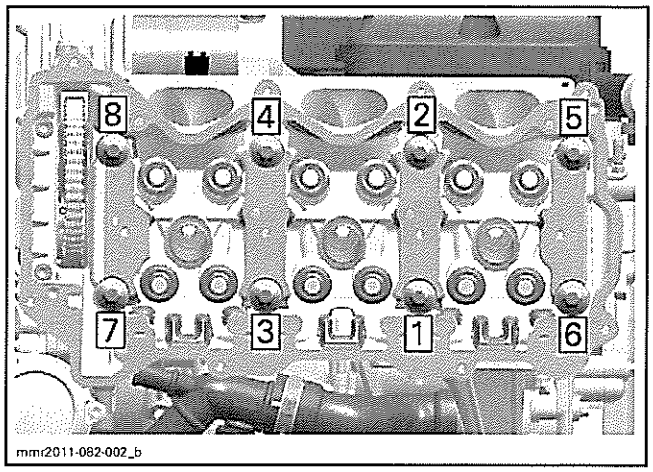
NOTICE **Each installation of the cylinder head requires a NEW cylinder head gasket. Using a gasket twice will cause engine damage.**

2. Install NEW M10 cylinder head screws, proceed as follows.

   NOTICE **For this assembly, stretch screws are used. As the screws have been stretched from the previous installation, it is very important to use NEW screws at assembly. Failure to replace screws and to strictly follow the torque procedure may cause screws to loosen and lead to engine damage.**

   2.1 Apply engine oil on screw threads and under screw head.

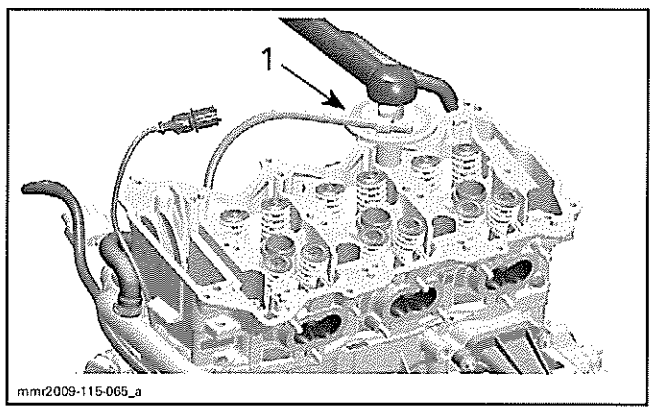
   2.2 First torque M10 screws to 30 N•m (22 lbf•ft) using the following sequence.



TIGHTENING SEQUENCE

   2.3 Using the same sequence, tighten M10 screws by turning a 90° rotation with a torque angle gauge.

   2.4 Finally tighten M10 screws by another 90° turn using an angle torque wrench.



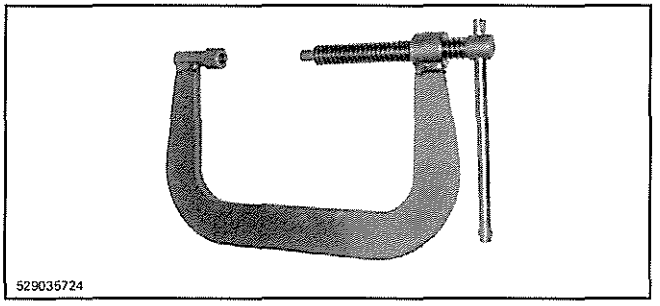
1. *Torque angle gauge*

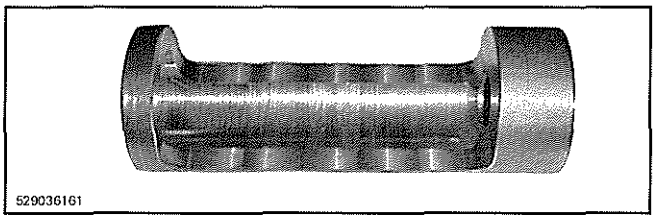
3. Install M6 screws and them torque to 11 N•m (97 lbf•**in**).
4. Reinstall valve adjustment shims in their original position as marked during removal.
5. Properly reinstall camshafts, refer to *CAMSHAFT TIMING GEAR INSTALLATION.*

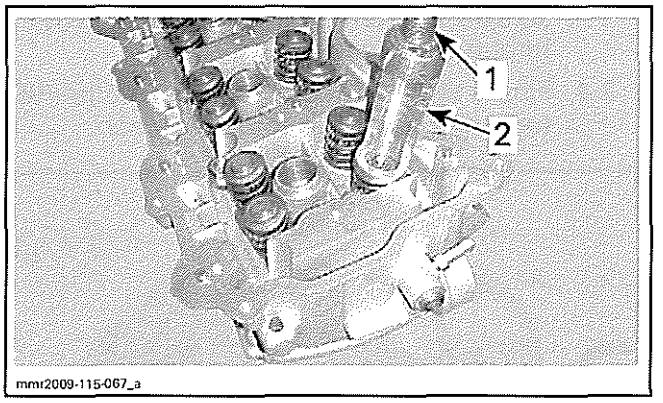
VALVE SPRINGS

Valve Spring Removal

1. Remove *CYLINDER HEAD*, see procedure in this subsection.
2. Compress valve spring, using the VALVE SPRING COMPRESSOR (P/N 529 035 724) and the VALVE SPRING COMPRESSOR CUP (P/N 529 036 161).

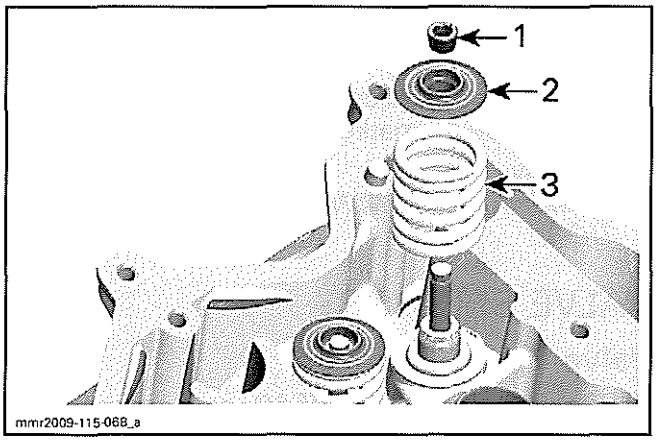






1. Valve spring compressor clamp
2. Valve spring compressor cup

3. Remove valve cotters.
4. Withdraw valve spring compressor tools.
5. Remove valve spring retainer and valve spring.

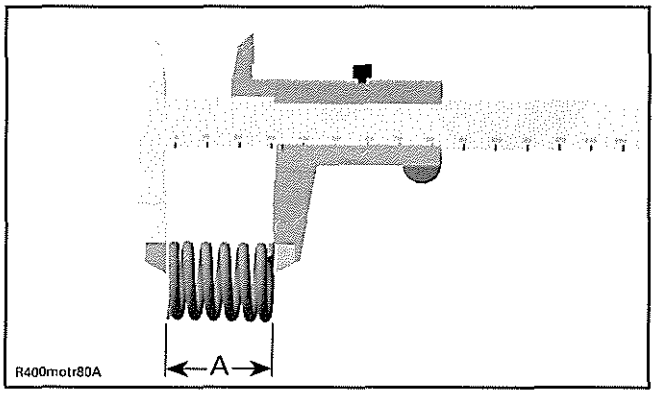


1. Valve cotters
2. Valve spring retainer
3. Valve spring

NOTE: Identify the position of each part very carefully, so it can be reinstalled in its original place.

Valve Spring Inspection

1. Check valve spring for rust, corrosion or other visible damages.
2. Check valve spring free length and straightness.



A. Spring free length

VALVE SPRING FREE LENGTH	
NEW	36.7 mm (1.4449 in)
SERVICE LIMIT	35.5 mm (1.3976 in)

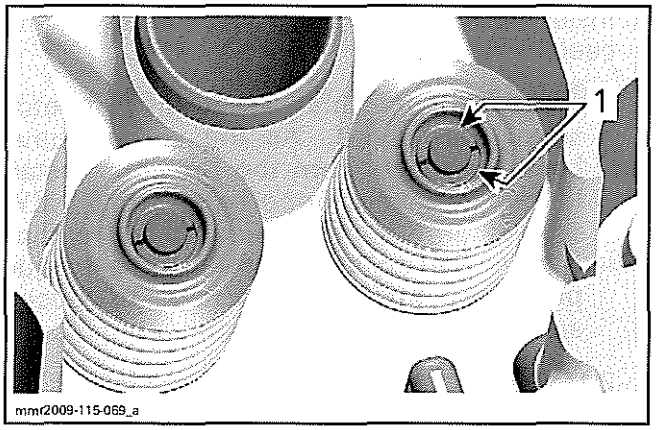
Replace valve spring, if out of specification.

Valve Spring Installation

For installation, reverse the removal procedure. Pay attention to the following details.

NOTE: Ensure to reinstall all parts in their original position as marked during removal.

1. Apply some grease on valve cotters, so that they remain in place while releasing the valve spring.
2. Make sure valve cotters are properly engaged into valve stem groove.



1. Valve cotters

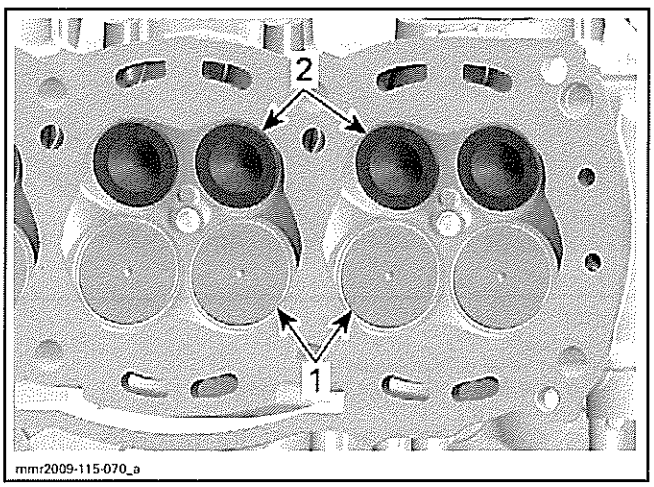
3. After spring is installed, ensure it is properly locked by lightly tapping on valve stem end with a soft hammer so that valve opens and closes a few times.

NOTICE Improperly locked valve spring will cause severe engine damage and hitting the valve stem end with excessive force could damage the valve.

VALVES

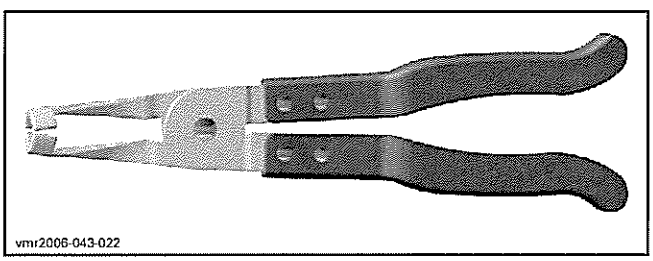
Valve Removal

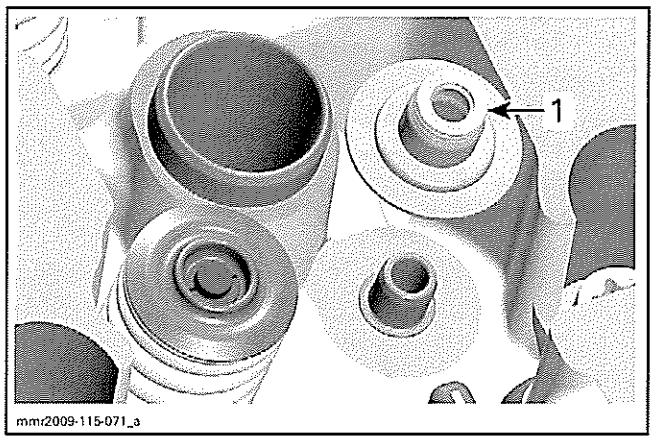
1. Remove *VALVE SPRING*, see procedure in this subsection.
2. Push on the valve stem, then pull valves out of cylinder head.



1. Intake valves 37 mm
2. Exhaust valves 31 mm

3. Remove and discard valve stem seal with special pliers such as the SNAP-ON VALVE STEM SEAL PLIERS (P/N YA 8230).



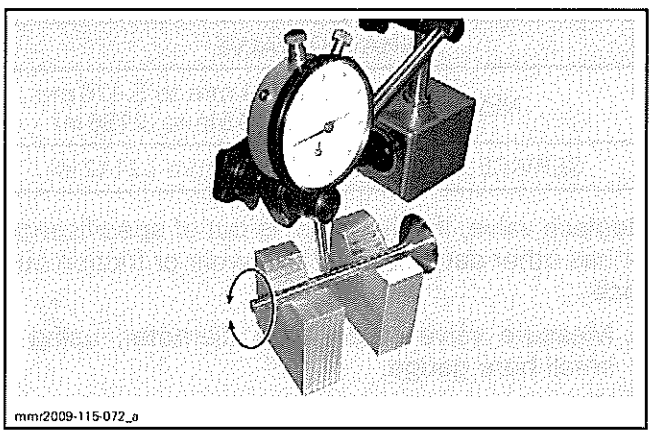


1. Valve stem seal

NOTE: Identify the position of each part very carefully, so it can be reinstalled in its original place.

Valve Inspection

Inspect valve surface, check for abnormal stem wear and bending.

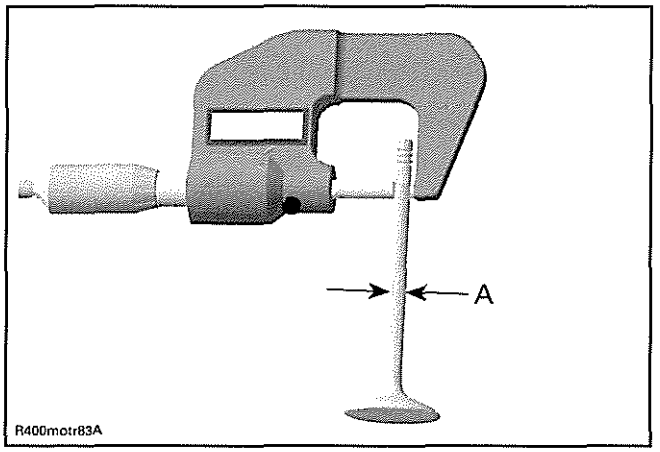


VALVE OUT OF ROUND INTAKE AND EXHAUST VALVE	
NEW	0.005 mm (.0002 in)
SERVICE LIMIT	0.06 mm (.0024 in)

Replace valve, if out of specification.

Valve Stem and Valve Guide Clearance

1. Measure valve stem at three places, using a micrometer.



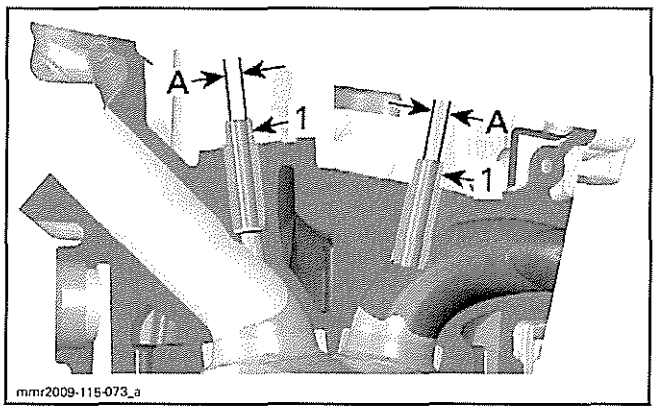
A. Valves stem diameter

VALVE STEM DIAMETER	
INTAKE VALVE	
NEW	5.471 mm to 5.486 mm (.2154 in to .216 in)
SERVICE LIMIT	5.450 mm (.2146 in)
EXHAUST VALVE	
NEW	5.461 mm to 5.476 mm (.215 in to .2156 in)
SERVICE LIMIT	5.440 mm (.2142 in)

Replace valve, if valve stem is out of specification or has other damages such as wear or friction surface.

2. Measure valve guide inner diameter, using a small bore gauge.

NOTE: Clean valve guide from carbon deposits before measuring.

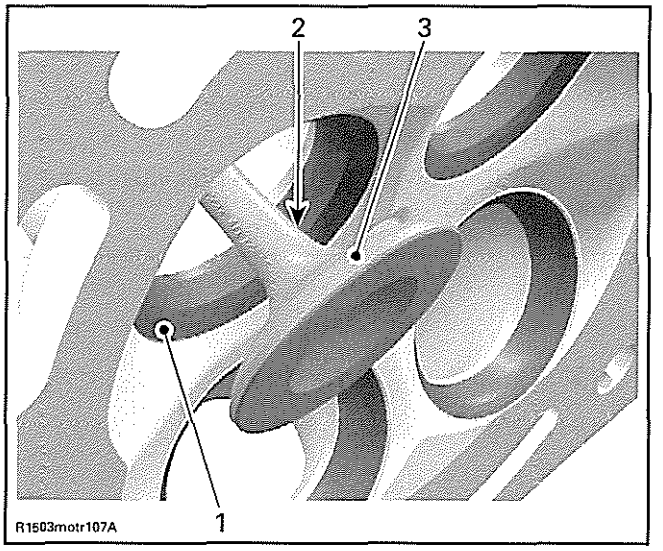


1. Valve guides
A. Valve guide inner diameter

VALVE GUIDE INNER DIAMETER	
NEW	5.505 mm to 5.518 mm (.2167 in to .2172 in)
SERVICE LIMIT	5.568 mm (.2192 in)

Replace cylinder head, if valve guide is out of specification.

Valve Face and Seat

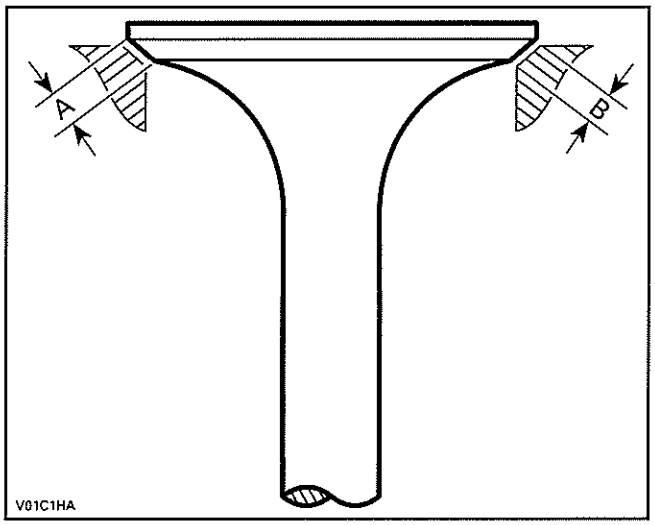


TYPICAL
1. Valve seat
2. Exhaust valve contaminated area
3. Valve face (contact surface to valve seat)

1. Check valve face and seat for burning, pitting and other signs of damage.
2. Check if valve seats properly in cylinder head. Proceed as follows.
   2.1 Apply some lapping compound on valve face and work valve on its seat with a lapping tool such as the SNAP-ON VALVE HOLDER (P/N VL2).

   NOTE: The location of contact area should be in center of valve face.

   2.2 Repeat procedure until valve seat and valve face fit together.
3. Measure valve seat contact width, using a caliper.



A. Valve face contact width
B. Valve seat contact width

VALVE SEAT CONTACT WIDTH	
INTAKE VALVE	
NEW	1.60 mm to 1.80 mm (.063 in to .0709 in)
SERVICE LIMIT	2.20 mm (.0866 in)
EXHAUST VALVE	
NEW	1.40 mm to 1.80 mm (.0551 in to .0709 in)
SERVICE LIMIT	2.40 mm (.0945 in)

Replace parts if out of specification.

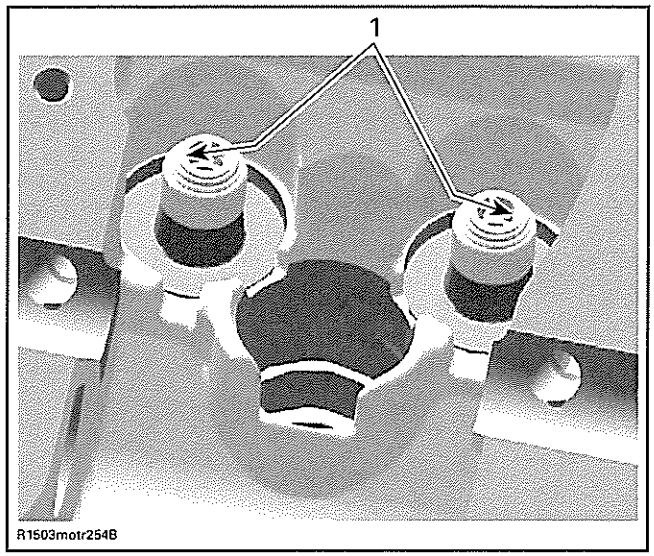
Valve Installation

For installation reverse the removal procedure. Pay attention to the following details.

NOTE: Ensure to reinstall all parts in their original position as marked during removal.

1. Install a NEW valve stem seal whenever valve is removed.
2. Apply engine oil on valve stem and carefully slide through cylinder head and valve stem seal.

NOTICE Be careful when valve stem is passed through sealing lip of valve stem seal.



TYPICAL
1. Sealing lips of valve stem seal

3. Install *VALVE SPRING*. See procedure in this subsection.
4. Install all other removed parts.

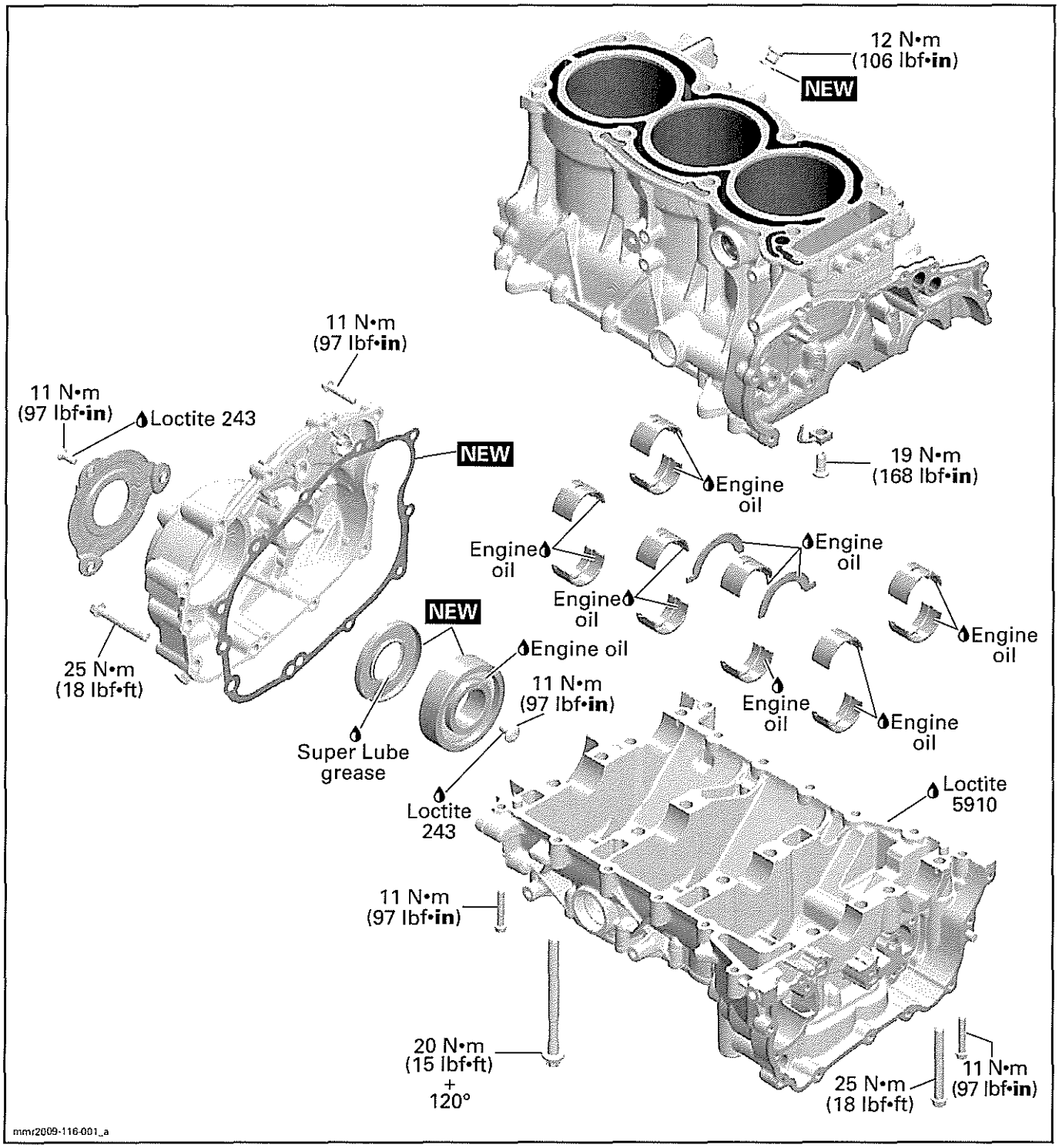
CYLINDER BLOCK

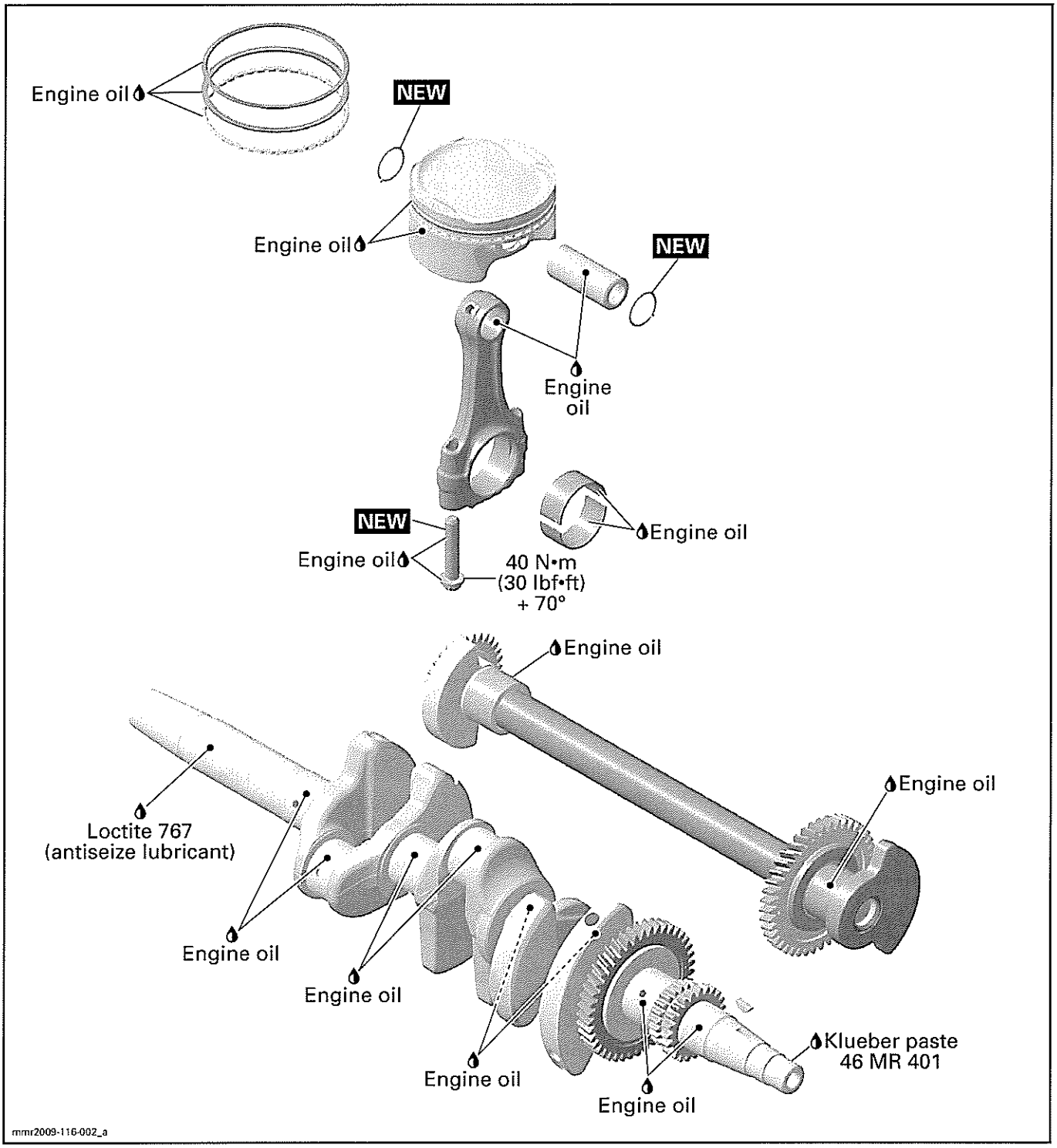
SERVICE TOOLS

Description	Part Number	Page
CRANKSHAFT LOCKING BOLT	529 036 148	401, 404
DIAL INDICATOR ADAPTER	529 036 159	401
OIL SEAL INSTALLER	529 036 155	393
PISTON CIRCLIP INSTALLER	529 036 153	409
PISTON RING COMPRESSOR	529 036 156	410
TDC DIAL INDICATOR	414 104 700	401

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 243 (BLUE)	293 800 060	393–394, 400
LOCTITE 5910	293 800 081	399
LOCTITE 767 (ANTISEIZE LUBRICANT)	293 800 070	395
LOCTITE CHISEL (GASKET REMOVER)	413 708 500	397
SUPER LUBE GREASE	293 550 030	393


12 N•m
(106 lbf•in)
NEW
11 N•m
(97 lbf•in)
11 N•m
(97 lbf•in)
Loctite 243
NEW
19 N•m
(168 lbf•in)
Engine oil
Engine oil
Engine oil
Engine oil
Engine oil
Engine oil
NEW
Engine oil
25 N•m
(18 lbf•ft)
11 N•m
(97 lbf•in)
Engine oil
Engine oil
Super Lube grease
Loctite 243
Loctite 5910
11 N•m
(97 lbf•in)
20 N•m
(15 lbf•ft)
+
120°
25 N•m
(18 lbf•ft)
11 N•m
(97 lbf•in)
mmr2009-116-001_a


Engine oil
NEW
Engine oil
NEW
Engine oil
NEW
Engine oil
Engine oil
40 N•m
(30 lbf•ft)
+ 70°
Engine oil
Engine oil
Loctite 767
(antiseize lubricant)
Engine oil
Engine oil
Engine oil
Engine oil
Klueber paste
46 MR 401
Engine oil
mmr2009-116-002_a

GENERAL

When disassembling parts that are duplicated in the engine, (e.g.: pistons, connecting rods etc.), it is strongly recommended to note their position (cylinder 1, 2 or 3) and to keep them as a "group". If you find a defective component, it would be much easier to find the cause of the failure within the group of parts. Besides, since used parts have matched together during the engine operation, they will keep their matched fit when you reassemble them together within their "group".

Even though many parts do not need to be removed to reach other parts, it is recommended to remove these parts anyway in order to check them.

During assembly/installation, use torque values and service products as in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, cotter pins, etc.) must be replaced.

Hoses, cables or locking ties removed during a procedure must be reinstalled as per factory standards.

TROUBLESHOOTING

The following is provided to help in diagnosing the probable source of troubles. It is a guideline and should not be assumed to show all causes for all problems.

Always check for fault codes. If a fault code is detected, service the fault code first. Refer to *DIAGNOSTIC AND FAULT CODES* subsection.

UNUSUAL ENGINE NOISE OR VIBRATIONS

1. Heavy wear on plain bearings.
   - *Check radial play of plain bearings. Replace if out of specification.*
2. Crankshaft and balancer shaft are not properly aligned.
   - *Disassemble cylinder block and check if marks are properly aligned.*
3. Crankshaft axial play out of specification.
   - *Measure crankshaft axial play. If crankshaft axial play is out of specification, replace thrust washers.*
4. Balancer shaft axial play out of specification.
   - *Measure balancer shaft axial play. If balancer shaft axial play is out of specification, replace balancer shaft or cylinder block.*
5. Connecting rod axial play out of specification.
   - *Measure connecting rod axial play on crankshaft. Replace connecting rod or crankshaft if out of specification.*
6. Connecting rod screws got loose.
   - *Replace damaged components and retighten screws with the recommended torque.*
7. Crankshaft PTO ball bearing is worn.
   - *Remove PTO cover and check ball bearing for excessive play. Replace ball bearing if necessary.*

BLUE SMOKE IN THE EXHAUST

1. Oil scrapper rings worn out.
   - *Replace piston rings.*

ENGINE SUDDENLY TURNS OFF (POOR IDLING)

1. Piston rings worn out.
   - *Replace piston rings.*
2. Piston/cylinder clearance out of specification.
   - *Check piston/cylinder clearance. Replace if out of specification.*
3. Melted or broken piston.
   - *Check if oil spray nozzle is not clogged. Refer to LUBRICATION SYSTEM subsection. Replace piston and cylinder block if necessary.*

PROCEDURES

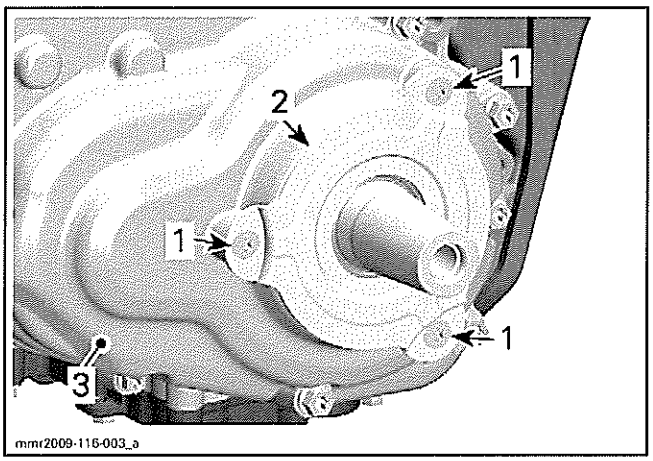
PTO COVER

Oil Seal Replacement (PTO Cover)

NOTE: To replace the PTO cover oil seal, it is not necessary to remove engine from vehicle or remove PTO cover from the engine.

Oil Seal Removal

1. Remove drive pulley. Refer to *DRIVE PULLEY* subsection.
2. Unscrew and remove oil seal retainer.



1. *Retaining screws*
2. *Oil seal retainer*
3. *PTO cover*

3. Remove PTO oil seal with a small flat screwdriver.

NOTICE Avoid scoring surfaces with tool.

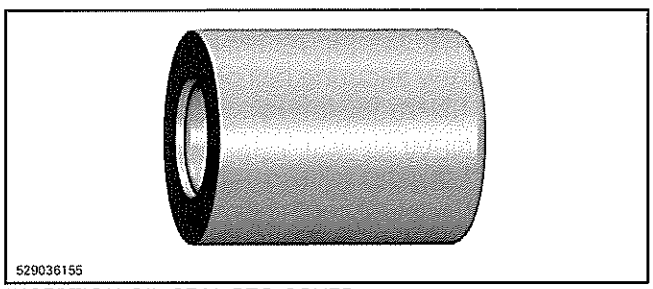
Oil Seal Installation

NOTE: Check the oil seal running surface of crankshaft for grooves, before installation of NEW oil seal.

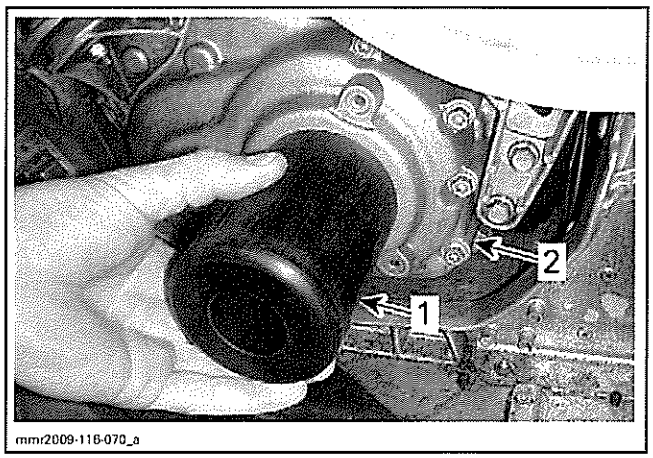
1. Lubricate sealing lip of oil seal with SUPER LUBE GREASE (P/N 293 550 030).

NOTICE Oil seal must be installed with sealing lip toward the engine.

2. Push the NEW oil seal in place by using the OIL SEAL INSTALLER (P/N 529 036 155).



INSERTION OIL SEAL PTO COVER

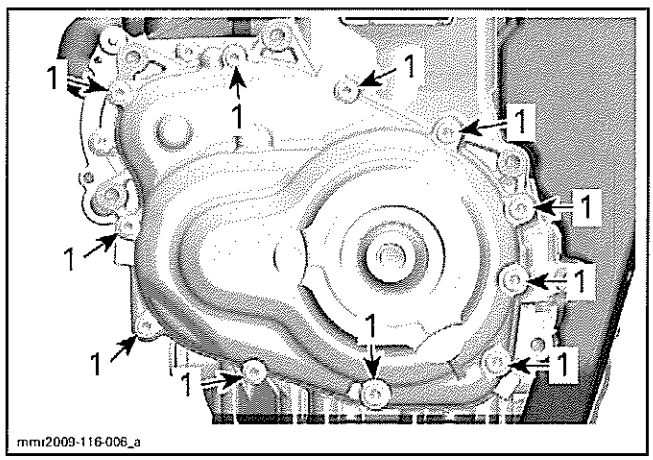


1. *Insertion oil seal*
2. *PTO cover*

3. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on oil seal retainer screws and torque them to 11 N•m (97 lbf•**in**).

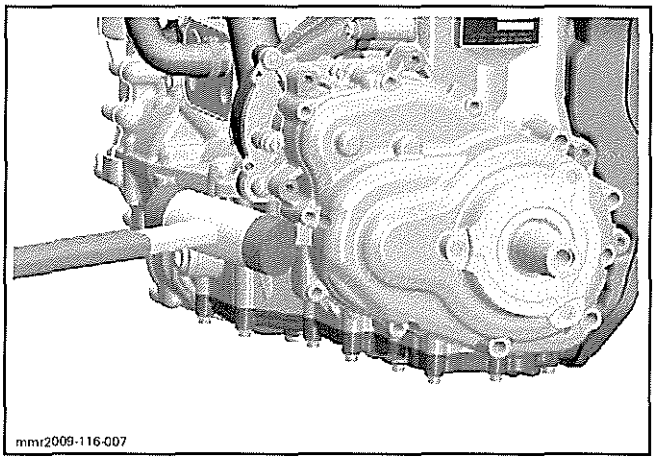
PTO Cover Removal

1. Remove engine from vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
2. Drain engine oil, refer to *LUBRICATION SYSTEM* subsection.
3. Unscrew and remove PTO cover screws.



1. *Retaining screws*

4. Remove PTO cover by using a soft hammer.



PTO Cover Inspection

Check the PTO cover for cracks or other damages.

Check the sealing surface for flatness using a straight edge.

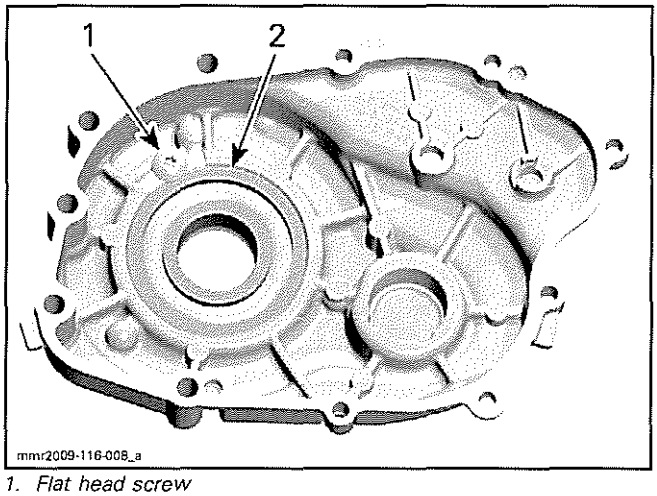
Inspect ball bearing for excessive play and smooth operation.

Replace damaged parts.

Bearing Replacement (PTO Cover)

Bearing Removal

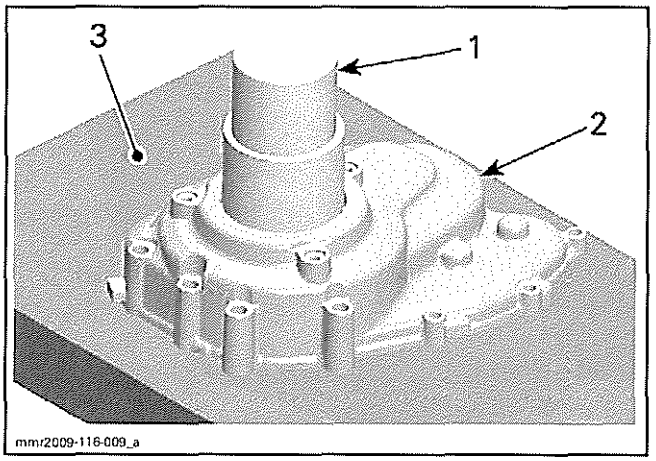
1. Unscrew flat head screw, securing ball bearing in place.



1. Flat head screw
2. Ball bearing

2. Remove oil seal retainer and oil seal, see *OIL SEAL REPLACEMENT (PTO COVER)* in this subsection.
3. Push-out the ball bearing from the outside towards the inside by using a suitable pusher and a press.

NOTE: The PTO cover has to be supported on a suitable straight surface, in order to prevent damage of the sealing surface.



1. Suitable pusher
2. PTO cover
3. Straight support

4. Discard the ball bearing.

Bearing Installation

NOTICE Never reinstall a ball bearing that has been removed. Unless otherwise instructed, never use a hammer to install ball bearings. Use a press only.

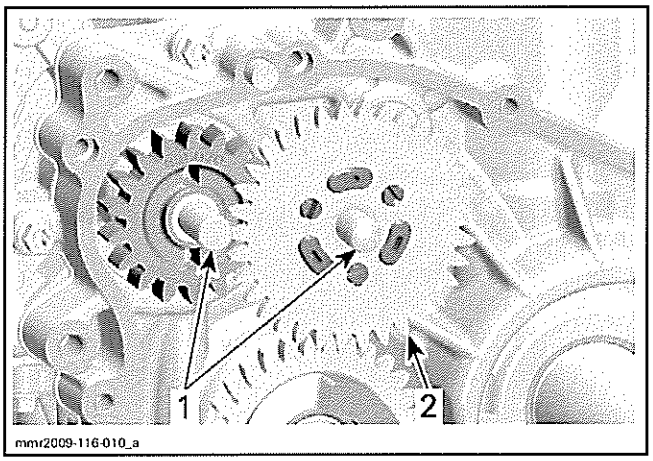
1. Support the PTO cover with a suitable support underneath the bearing seat.
2. Carefully press-in the NEW ball bearing from the inside towards the outside by using a suitable steel tube with an outer diameter of 76 mm (2.992 in).

NOTICE Never push on the inner race of the bearing, during installation.

3. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on flat head screw securing ball bearing and torque screw to 11 N•m (97 lbf•**in**).
4. Reinstall a NEW oil seal, refer to *OIL SEAL REPLACEMENT (PTO COVER)* in this subsection.

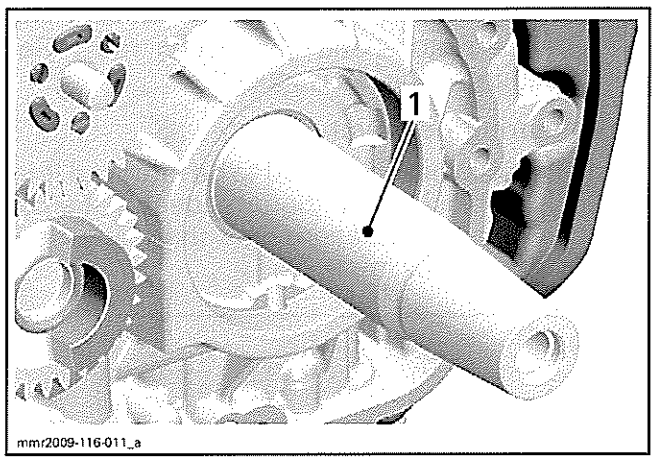
PTO Cover Installation

1. Install NEW PTO cover gasket.
2. Ensure that location pins and water pump intermediate gear are in place, before installing the PTO cover.



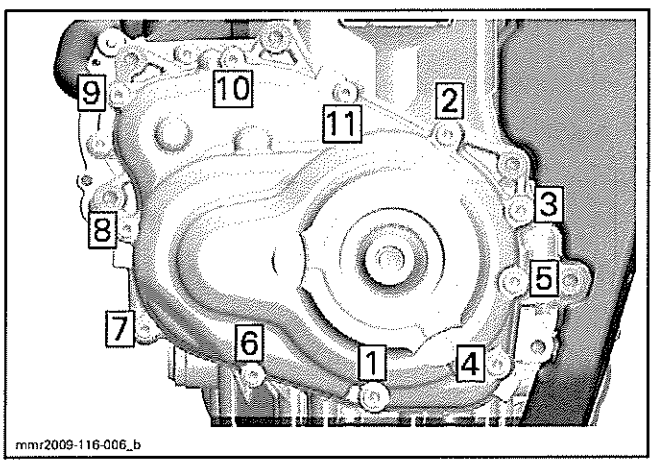
1. Location pins
2. Water pump intermediate gear

3. Apply LOCTITE 767 (ANTISEIZE LUBRICANT) (P/N 293 800 070) on crankshaft where bearing fits before installing the PTO cover.



1. Apply Loctite 767 (antiseize lubricant) here

4. Tighten PTO cover screws according to the following sequence.

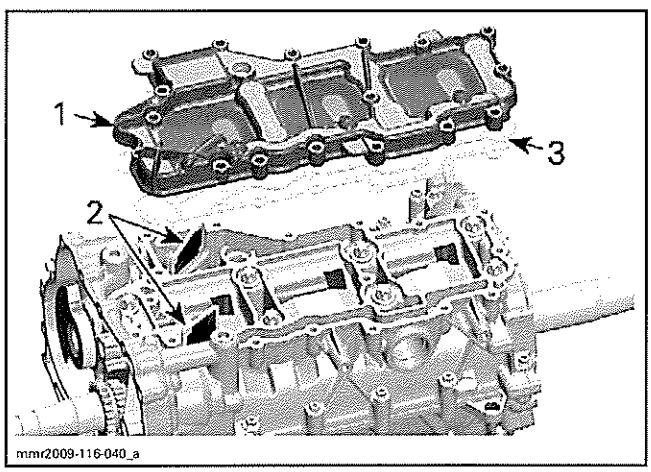


TIGHTENING SEQUENCE

CYLINDER BLOCK

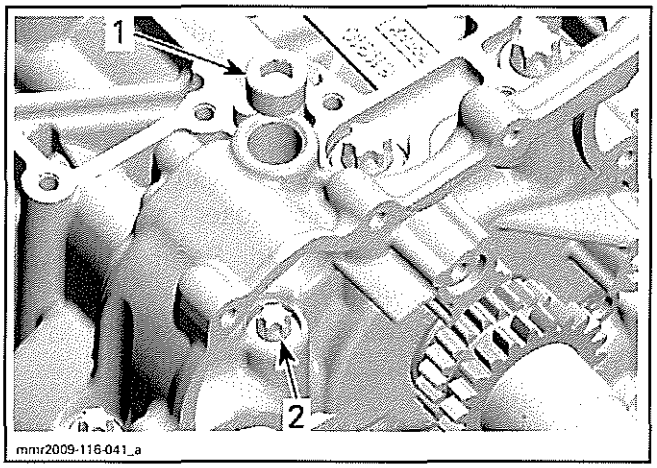
Cylinder Block Disassembly

1. Remove engine from vehicle. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection.
2. Drain engine oil. Refer to *LUBRICATION SYSTEM* subsection.
3. Lock crankshaft, refer to *CRANKSHAFT LOCKING PROCEDURE* in this subsection.
4. Remove air intake manifold. Refer to *AIR INTAKE SYSTEM* subsection.
5. Refer to *COOLING SYSTEM* subsection to remove the following parts:
   - All hoses and clamps
   - Water pump
   - Water pump drive gears.
6. Refer to *LUBRICATION SYSTEM* subsection to remove the following parts:
   - Oil tank
   - Oil cooler
   - Oil pressure regulator
   - Oil pump gears and oil pumps.
7. Refer to *MAGNETO AND STARTER* subsection to remove the following parts:
   - Magneto cover
   - Rotor
   - Starter drive gears
   - Electric starter.
8. Remove timing chain and timing chain guides, refer to *TIMING CHAIN* subsection.
9. Remove cylinder head. Refer to *CYLINDER HEAD* subsection.
10. Remove oil sump cover and oil strainers. Refer to *LUBRICATION SYSTEM* subsection.



1. Oil sump cover
2. Engine oil strainers
3. Gasket

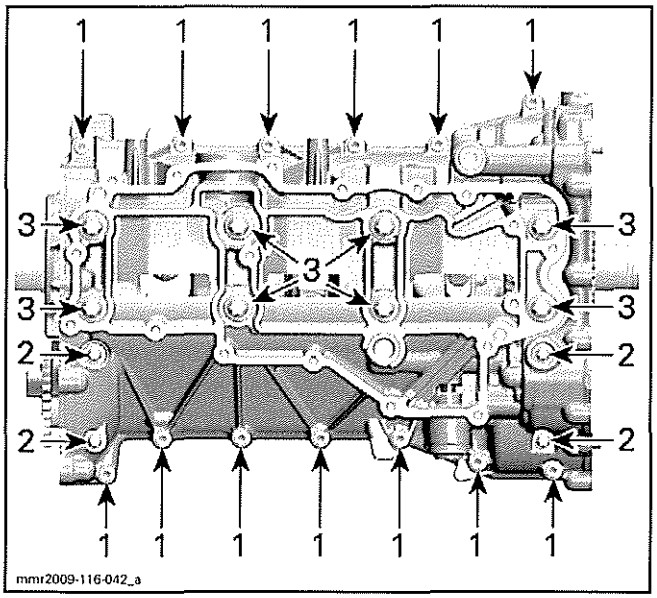
11. Remove plug screw to get access to M8 cylinder block screw.



1. Remove plug screw
2. M8 cylinder block screw

NOTE: Before splitting the cylinder block, measure crankshaft and balancer shaft axial play. Refer to *CRANKSHAFT* and *BALANCER SHAFT* in this subsection.

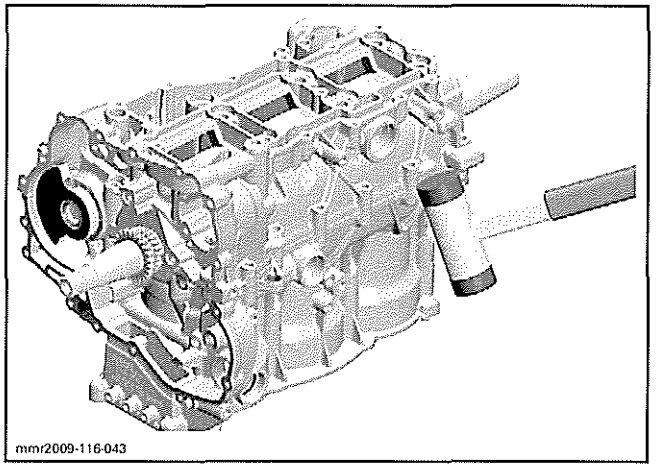
12. Remove cylinder block screws.



1. Screws M6 x 30 (qty 13)
2. Screws M8 x 70 (qty 4)
3. Screws M9 x 113 (qty 8)

13. Carefully remove cylinder block lower half by using a soft hammer.

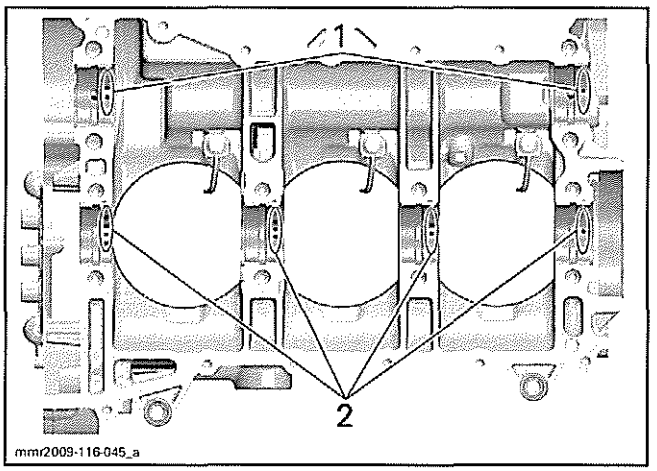
NOTE: Ensure not to damage the sealing surface of the cylinder block halves.



14. Remove connecting rod caps. Refer to *PISTONS AND CONNECTING RODS.*
15. Remove balancer shaft and crankshaft. See procedure in this subsection.
16. Remove crankshaft thrust washers.
17. Remove pistons and connecting rods. See procedure in this subsection.

Plain Bearing Removal

When the plain bearings need to be removed from the cylinder block, mark them to identify the correct position at installation. See the following illustration for an example.

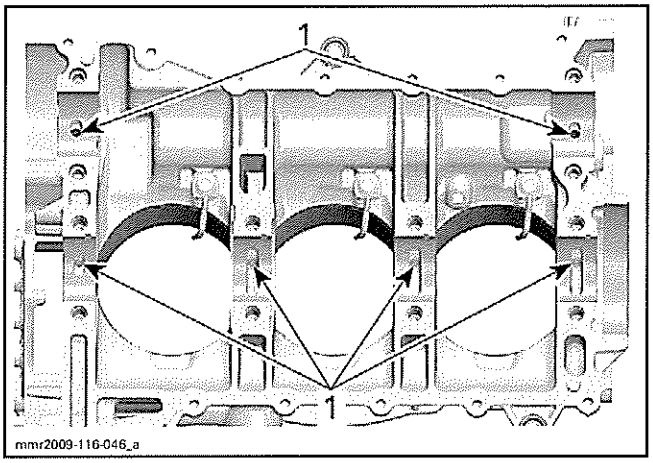


1. Mark on balancer shaft plain bearings
2. Mark on crankshaft plain bearings

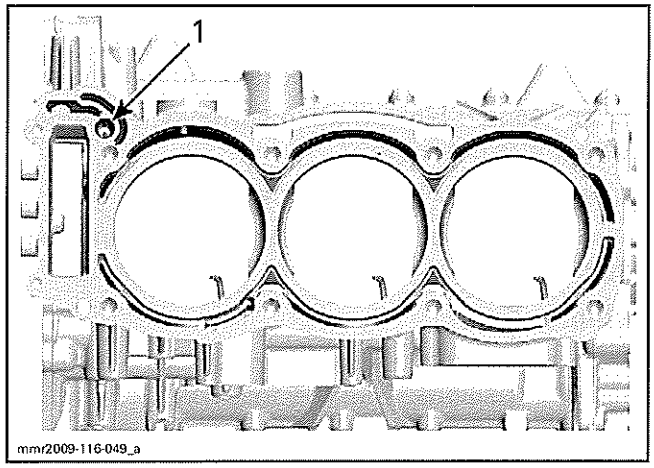
Cylinder Block Cleaning

Clean cylinder block using a part cleaner, then use compressed air to dry it.

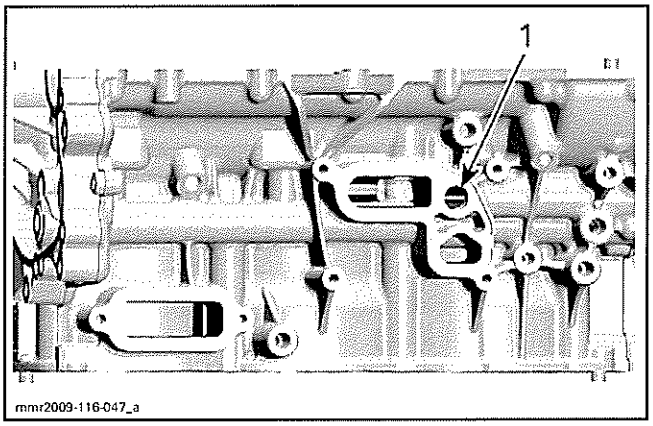
Blow out the oil orifices and check if they are not clogged.



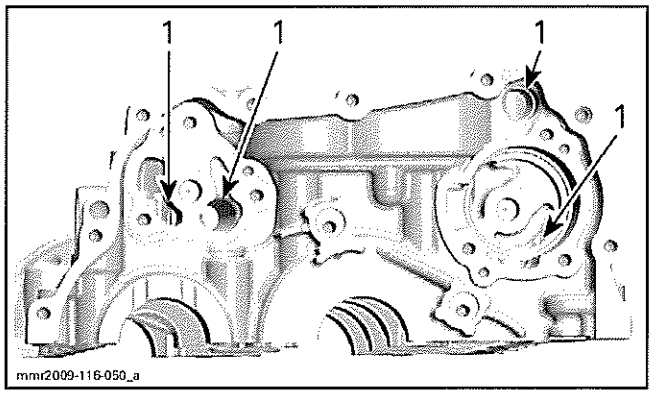
CYLINDER BLOCK UPPER HALF
1. Check oil orifices



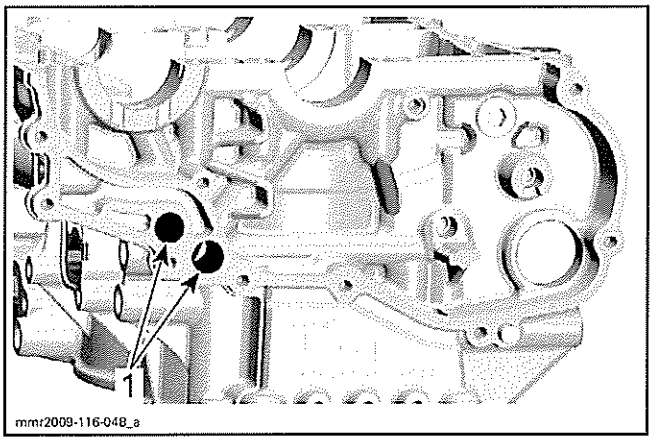
CYLINDER BLOCK UPPER HALF
1. Check oil orifice



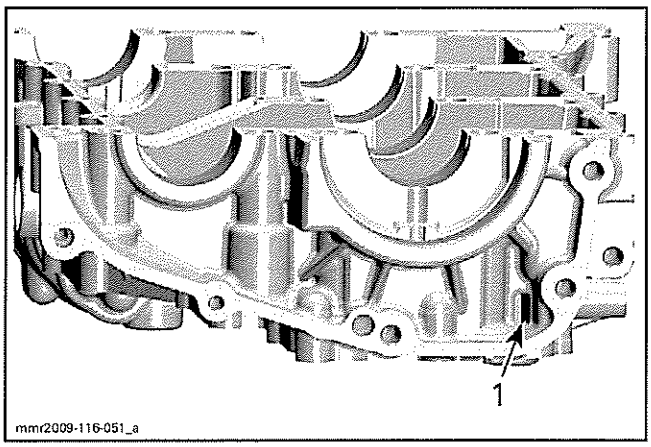
CYLINDER BLOCK UPPER HALF
1. Check oil orifice



CYLINDER BLOCK LOWER HALF
1. Check oil orifices



CYLINDER BLOCK UPPER HALF
1. Check oil orifices



CYLINDER BLOCK LOWER HALF
1. Check oil orifices

Clean all metal components in a solvent.

Clean cylinder block mating surfaces with LOCTITE CHISEL (GASKET REMOVER) (P/N 413 708 500) and a brass brush. Brush a first pass in one direction then make the final brushing perpendicularly (90°) to the first pass (cross hatch).

NOTE: Do not wipe with rags. Use a new clean hand towel only.

Cylinder Block Inspection

Check cylinder block for cracks or other damages.

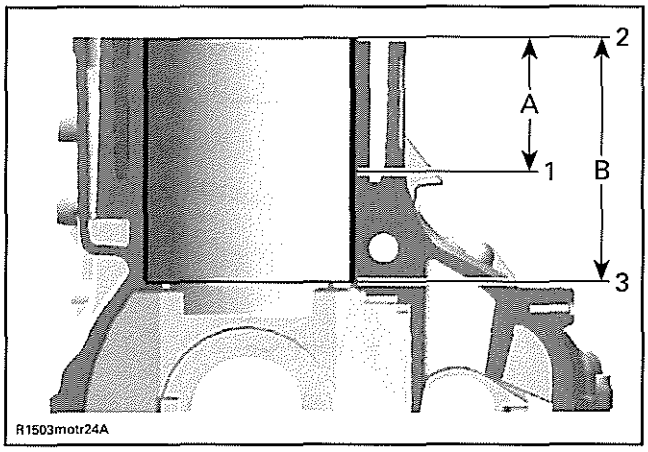
Check cylinder block mating surfaces for flatness using a straight edge.

Replace cylinder block if necessary.

Check cylinder bore for cracks, scoring and wear ridges on the top and bottom of the cylinder.

Cylinder Taper

Measure cylinder bore diameter at 3 recommended positions. See the following illustration.



TYPICAL
1. *First measuring diameter*
2. *Second measuring diameter*
3. *Third measuring diameter*

A. 60 mm (2.362 in)
B. 101 mm (3.976 in)

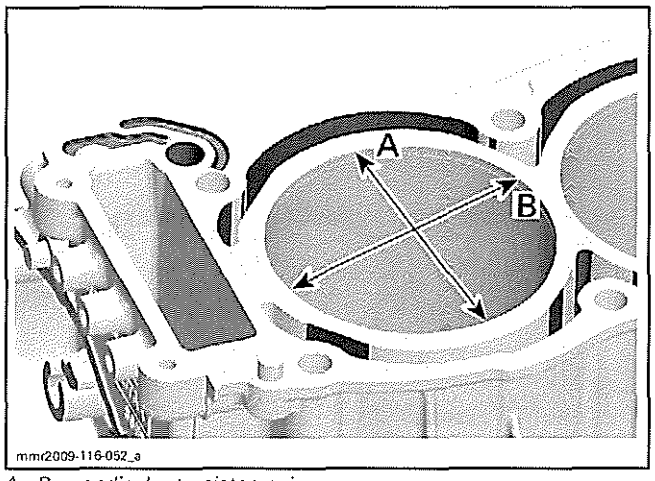
The difference between measurements should not exceed the service limit mentioned in next table.

CYLINDER TAPER	
NEW MAXIMUM	0.030 mm (.0012 in)
SERVICE LIMIT	0.090 mm (.0035 in)

Cylinder Out of Round

Measure cylinder bore diameter in piston axis direction from top of cylinder. Take another measurement 90° from first one and compare.

NOTE: Take the same measuring points as described in *CYLINDER TAPER*.



A. Perpendicular to piston axis
B. Parallel to piston axis

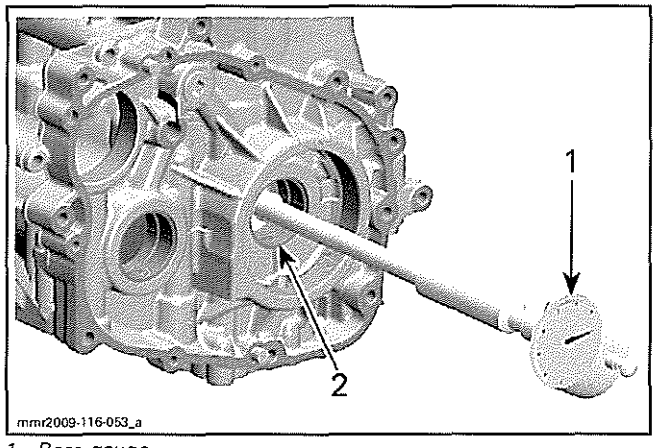
CYLINDER OUT OF ROUND	
NEW MAXIMUM	0.008 mm (.0003 in)
SERVICE LIMIT	0.050 mm (.002 in)

Plain Bearings

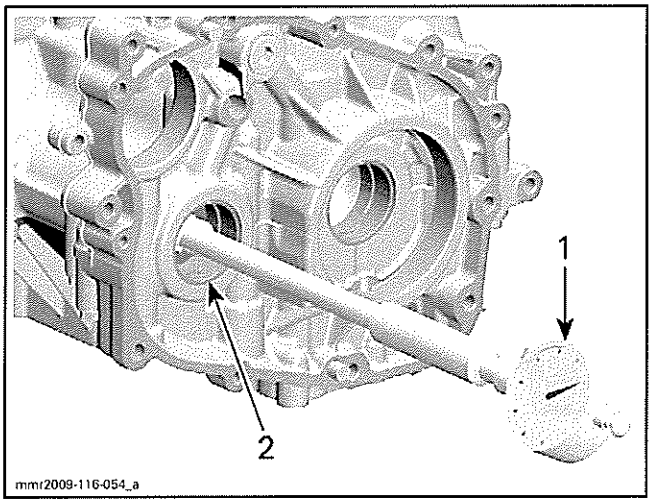
Check the plain bearings for scoring or other damages.

Measure plain bearing inside diameter and compare with crankshaft and balancer shaft bearing journal diameter (refer to *CRANKSHAFT* and *BALANCER SHAFT* in this subsection). Proceed as follows.

- Use the OLD plain bearings and put together both cylinder block halves.
- Perform the torquing procedure as described in *CYLINDER BLOCK ASSEMBLY*.
- Measure the inside diameter of the crankshaft and balancer shaft plain bearings, using a bore gauge.



1. Bore gauge
2. Crankshaft plain bearing



1. Bore gauge
2. Balancer shaft plain bearing

CRANKSHAFT/BALANCER SHAFT PLAIN BEARING INSIDE DIAMETER	
SERVICE LIMIT	36.100 mm (1.4213 in)

Replace bearings if they are out of specifications.

Oil Spray Nozzles

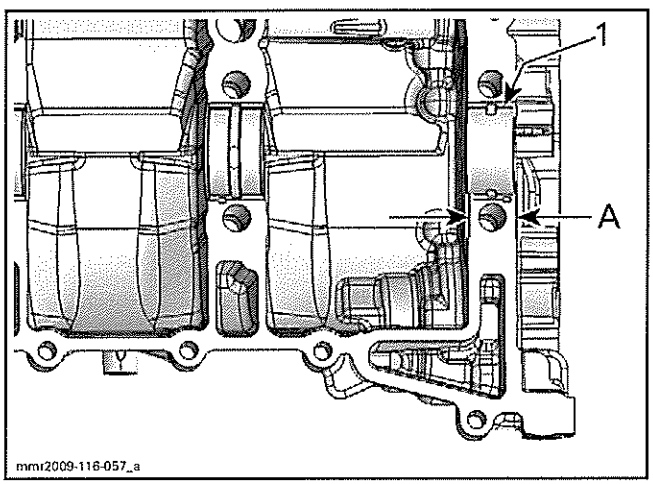
Clean the oil spray nozzles. Refer to *LUBRICATION SYSTEM* subsection.

Cylinder Block Assembly

For assembly, reverse the disassembly procedure. Pay attention to the following details.

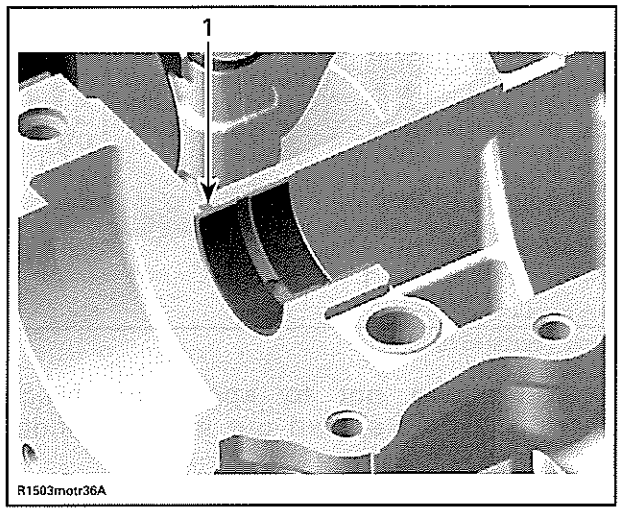
1. Correctly reinstall plain bearings as follows.
   1.1 Use NEW bearings if diameters are out of specification. Refer to *PLAIN BEARING INSPECTION* in this subsection.

   NOTE: The "narrow" plain bearing halves (20 mm (.787 in) wide) must be placed in crankshaft bearing seat, on magneto side.



1. Crankshaft plain bearing - magneto side
A. 20 mm (.787 in)

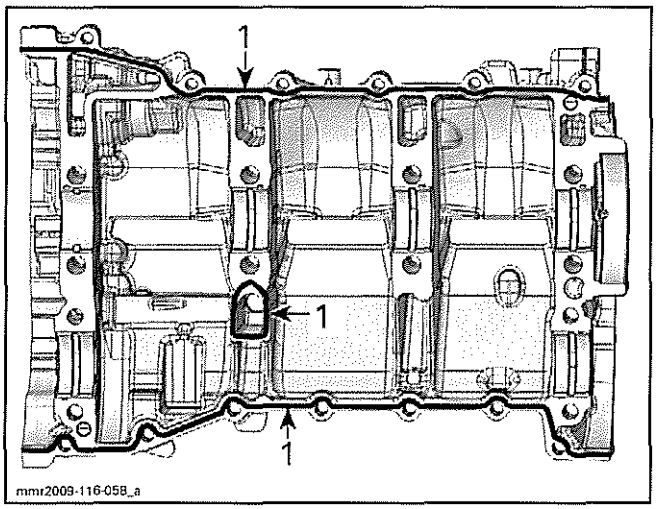
   1.2 Bearings must to be flush with the cylinder block split surface and their protrusions have to fit in the notched areas in the cylinder block seat.



TYPICAL
1. Bearing protrusion in cylinder block notch

2. Install pistons, refer to *PISTONS AND CONNECTING RODS* in this subsection.
3. Apply engine oil on all plain bearings.
4. Install the following components:
   - Crankshaft and thrust washers (refer to *CRANKSHAFT*)
   - Connecting rod caps (refer to *PISTONS AND CONNECTING RODS*)
   - Balancer shaft (refer to *BALANCER SHAFT*).
5. Apply LOCTITE 5910 (P/N 293 800 081) on mating surface of cylinder block lower half as shown on next illustration.

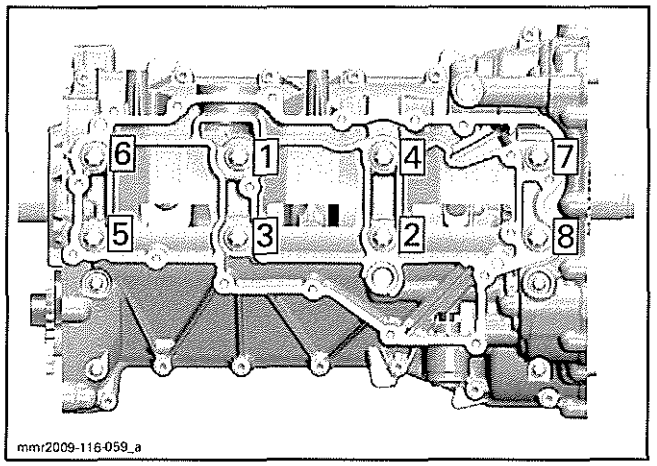
IMPORTANT: When beginning the application of the cylinder block sealant, the assembly and the first torquing should be done within 10 minutes. It is suggested to have all you need on hand to save time.



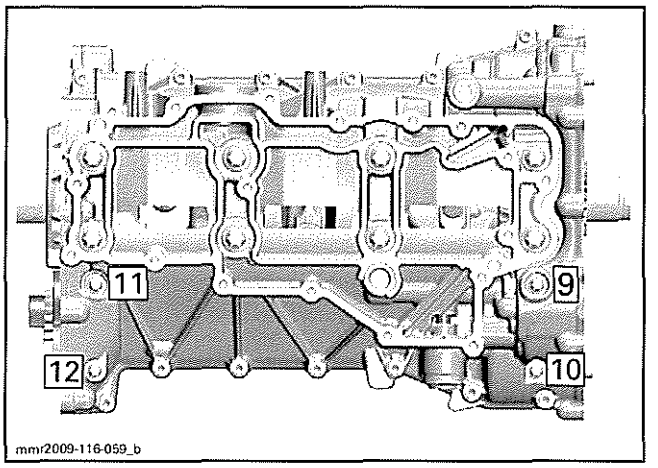
1. Apply Loctite 5910 here

NOTICE Ensure not to apply too much sealant, as it will spread out inside cylinder block.

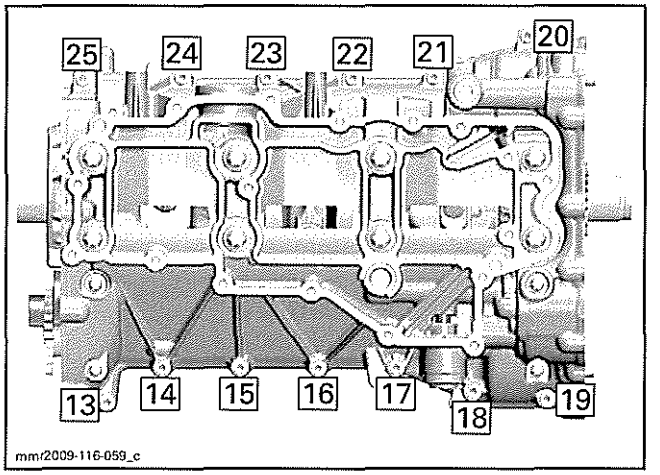
6. Tighten cylinder block screws as per following procedure.
   6.1 Torque M9 cylinder block screws to 20 N•m (15 lbf•ft) following the sequence 1 to 8.
   6.2 Using the same sequence, torque an additional 120° turn, using an torque angle gauge.



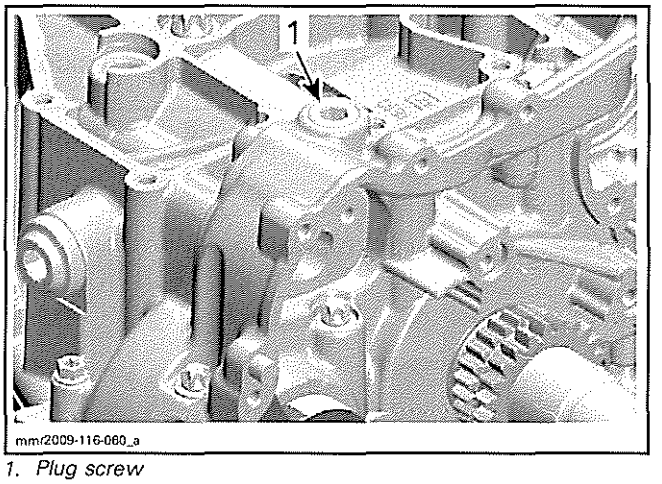
6.3 Torque M8 cylinder block screws to 25 N•m (18 lbf•ft) following the sequence 9 to 12.



6.4 Torque M6 cylinder block screws to 11 N•m (97 lbf•**in**) following the sequence 13 to 25.



7. Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on plug screw and torque to 16 N•m (142 lbf•**in**).



1. Plug screw

NOTE: Before continuing the assembly process, the axial clearance of balancer shaft and crankshaft has to be checked. Refer to *CRANKSHAFT* and *BALANCER SHAFT* in this subsection for the procedure.

8. Reassemble engine in accordance with the proper assembly procedures.

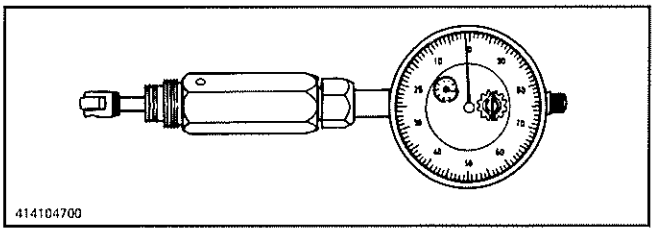
CRANKSHAFT

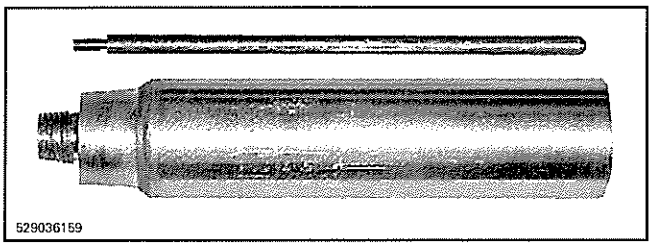
Crankshaft Locking Procedure

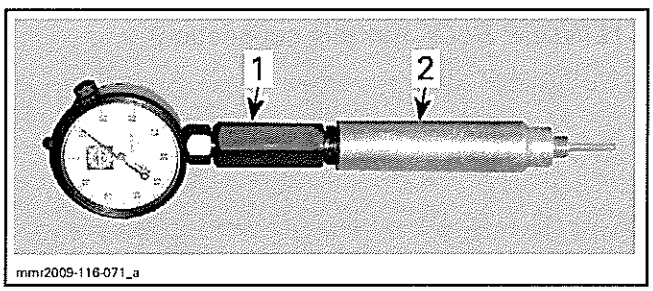
NOTICE **The crankshaft must be locked at TDC for removal and installation work on crankshaft, balancer shaft and camshaft.**

NOTE: When the crankshaft is locked, the piston of cylinder no. 2 is at overlapping TDC. Crankshaft can be not locked at cylinder no. 1 and no. 3 TDC.

1. Remove the valve cover. Refer to *CYLINDER HEAD* subsection.
2. Remove spark plugs.
3. Remove the tip at the end of the TDC DIAL INDICATOR (P/N 414 104 700) and install the DIAL INDICATOR ADAPTER (P/N 529 036 159).

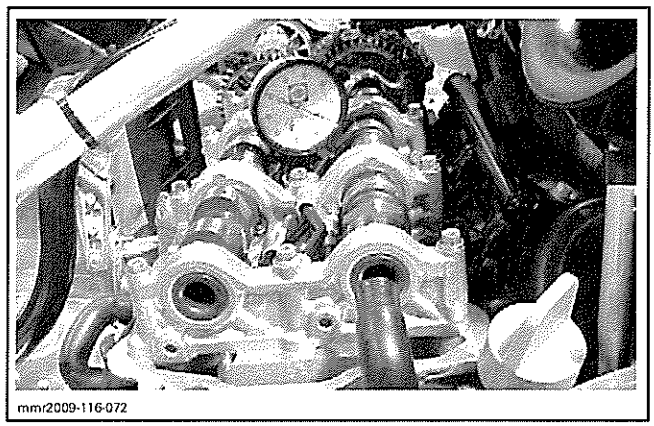




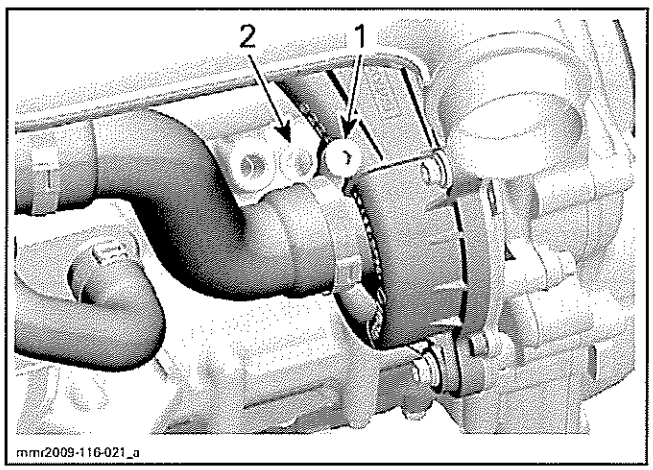


1. *Dial indicator*
2. *Dial indicator adaptor*

4. Install the dial indicator in spark plug hole of cylinder no. 2.

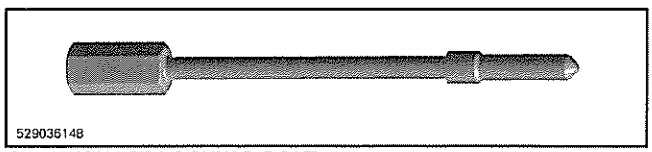


5. Remove crankshaft access plug screw and gasket ring.

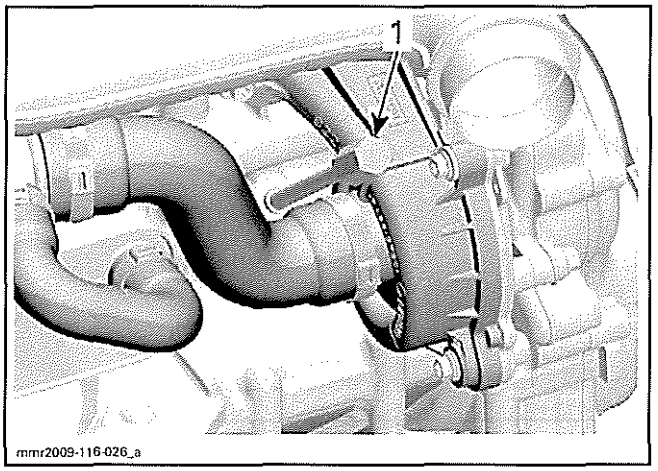


1. *Crankshaft access plug screw*
2. *Gasket ring*

6. Turn engine counterclockwise to bring piston of cylinder no. 2 to overlapping TDC.
7. Use a small screwdriver to check if the groove in the crankshaft is aligned with the hole.
8. Lock crankshaft by using the CRANKSHAFT LOCKING BOLT (P/N 529 036 148).



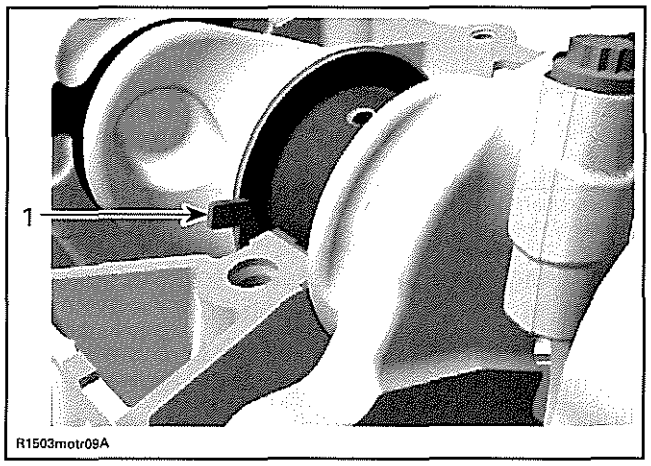
CRANKSHAFT LOCKING BOLT



1. Crankshaft locking bolt

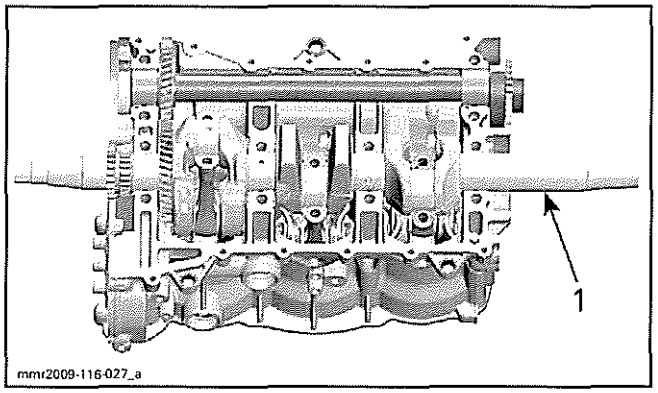
Crankshaft Removal

1. Disassemble *CYLINDER BLOCK*, see procedure in this subsection.
2. Unscrew connecting rod cap screws and remove connecting rod caps. Refer to *PISTONS AND CONNECTING RODS* in this subsection.
3. Remove crankshaft thrust washers.



TYPICAL
1. Thrust washer

4. Remove crankshaft from cylinder block.

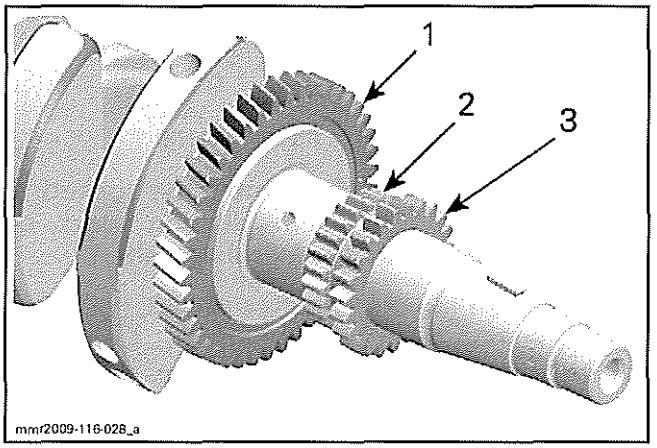


1. Crankshaft

Crankshaft Inspection

Check each bearing journal of crankshaft for scoring, scuffing, cracks or other signs of wear.

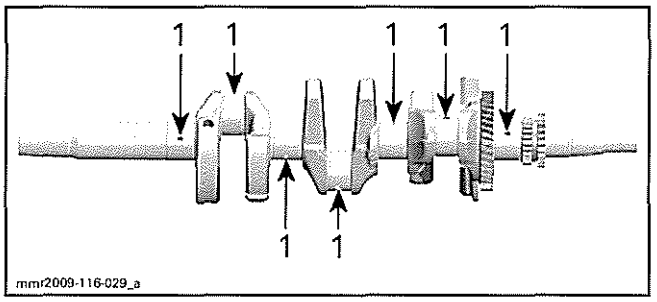
Check if crankshaft gears are worn or otherwise damaged.



1. Balancer gear
2. Crankshaft timing gear
3. Oil pump drive gear

Replace crankshaft if damaged.

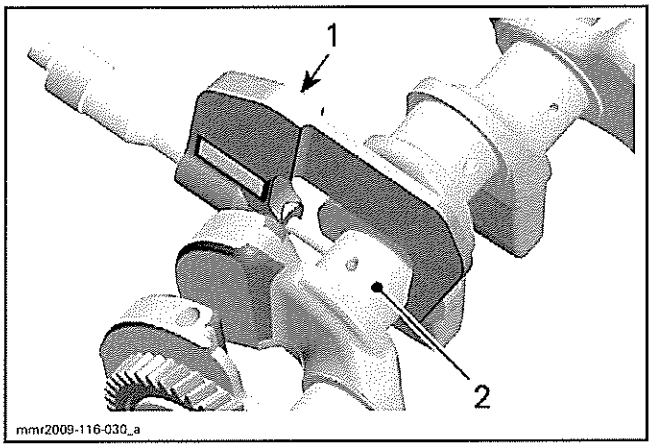
Blow out the oil orifices and check if they are not clogged.



1. Check oil orifices

Crankshaft Radial Play

Measure crankshaft bearing journal diameter, using a micrometer. Compare to inside diameter of crankshaft plain bearings in cylinder block (refer to *CYLINDER BLOCK* in this subsection).



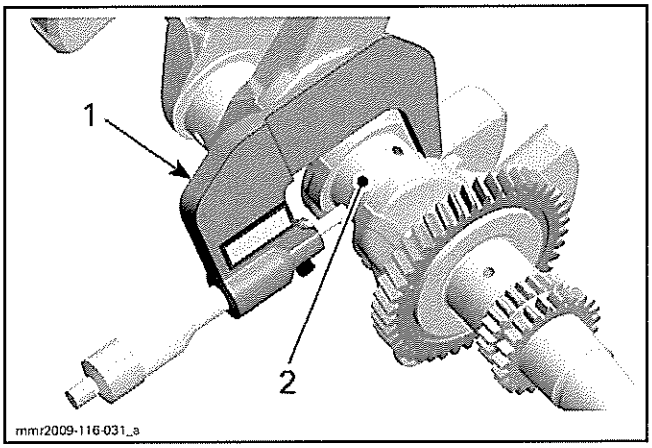
1. *Micrometer*
2. *Crankshaft area for plain bearing*

CRANKSHAFT BEARING JOURNAL DIAMETER	
NEW	35.984 mm to 36.000 mm (1.4167 in to 1.4173 in)
SERVICE LIMIT	35.970 mm (1.4161 in)

CRANKSHAFT RADIAL PLAY	
SERVICE LIMIT	0.10 mm (.0039 in)

Crankshaft Pin Diameter

Measure crankshaft pin diameter, using a micrometer. Compare to inside diameter of connecting rod plain bearings (refer to *CONNECTING ROD INSPECTION* in this subsection).



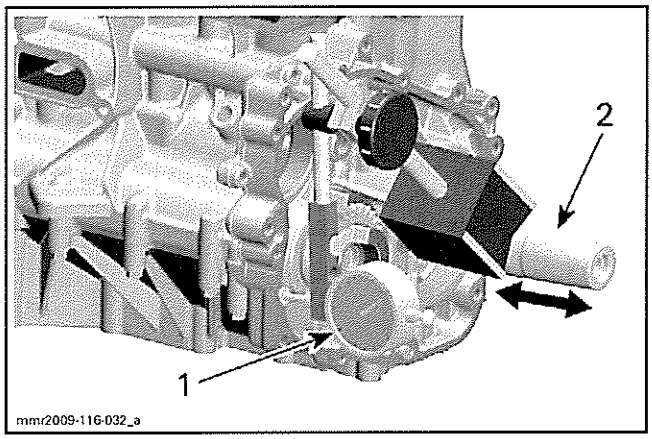
1. *Micrometer*
2. *Crankshaft pin area for plain bearing*

CRANKSHAFT PIN DIAMETER	
NEW	37.984 mm to 38.000 mm (1.4954 in to 1.4961 in)
SERVICE LIMIT	37.970 mm (1.4949 in)

CONNECTING ROD BIG END RADIAL PLAY	
SERVICE LIMIT	0.08 mm (.0031 in)

Crankshaft Axial Play

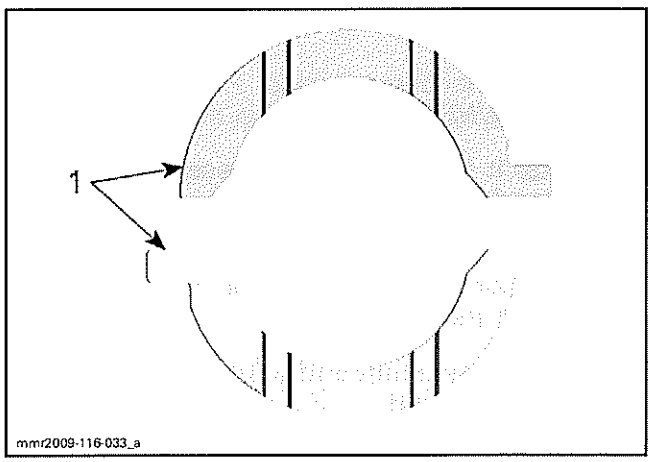
With the crankshaft in cylinder-block, measure the crankshaft axial play, using a dial indicator.



1. *Dial indicator*
2. *Crankshaft*

CRANKSHAFT AXIAL PLAY	
NEW	0.080 mm to 0.313 mm (.0031 in to .0123 in)
SERVICE LIMIT	0.350 mm (.0138 in)

If play is out of specification, replace the crankshaft thrust washers and repeat measurement.



1. *Crankshaft thrust washers*

Crankshaft Installation

For installation, reverse the removal procedure. Pay attention to following details.

1. Install pistons and connecting rods in the cylinder block.
2. Turn cylinder block upside down.

NOTICE Be careful that connecting rods do not hit the cylinder block.

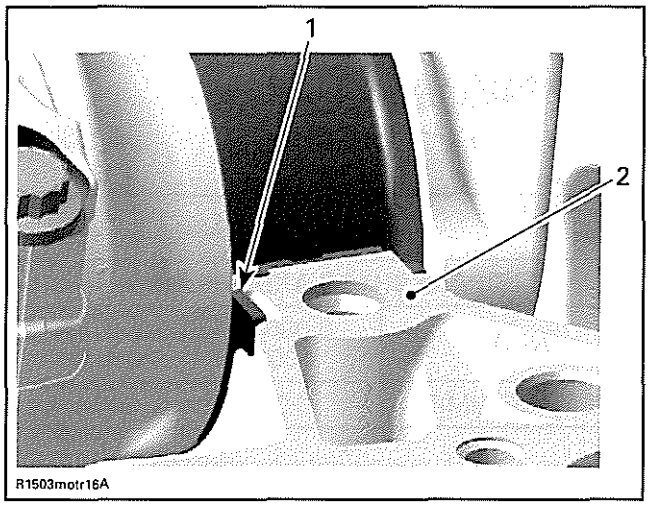
3. Apply engine oil on all plain bearings.

4. Install crankshaft.

NOTICE If the oil spray nozzle is damaged, it must be replaced. Refer to *LUBRICATION SYSTEM* subsection.

5. Properly reinstall crankshaft thrust washers with the slots facing against crankshaft counterweights.

NOTE: Thrust washers have to be flush with the cylinder block sealing surface.



TYPICAL
1. Thrust washer
2. Sealing surface

6. Install connecting rod caps. Refer to *PISTONS AND CONNECTING RODS* in this subsection.

NOTICE It is absolutely necessary to follow this procedure. Otherwise severe engine damage can occur.

7. Install balancer shaft. Refer to *BALANCER SHAFT* in this subsection.

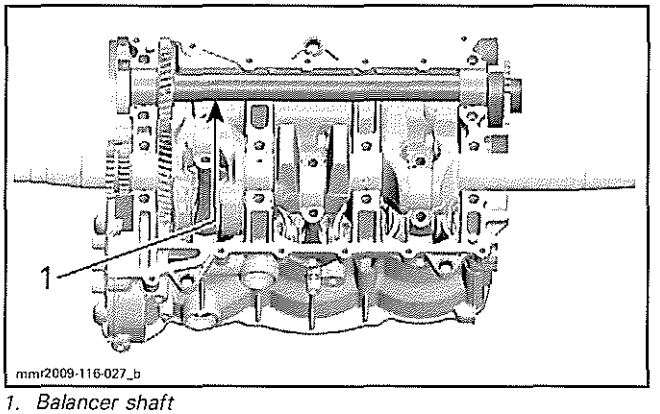
NOTICE Crankshaft and balancer shaft marks have to be aligned.

8. Install cylinder block lower half. Refer to *CYLINDER BLOCK* in this subsection.
9. Install the CRANKSHAFT LOCKING BOLT (P/N 529 036 148) to position crankshaft at TDC, before further assembly of the engine. See *CRANKSHAFT LOCKING PROCEDURE* in this subsection.

BALANCER SHAFT

Balancer Shaft Removal

1. Disassemble *CYLINDER BLOCK*, see procedure in this subsection.
2. Remove balancer shaft.

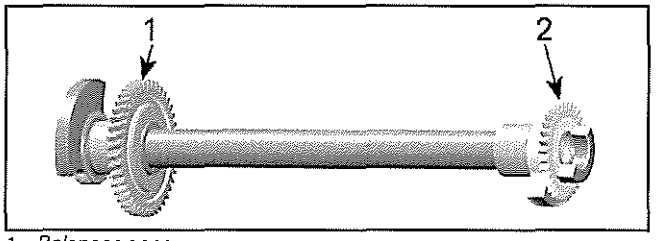


1. Balancer shaft

Balancer Shaft Inspection

Check each bearing journal of balancer shaft for scoring, scuffing, cracks or other signs of wear.

Check if balancer shaft gears are worn or otherwise damaged.



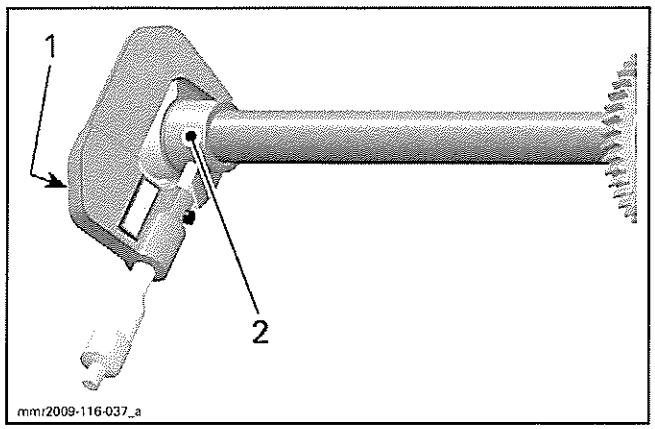
1. Balancer gear
2. Water pump drive gear

Replace balancer shaft if damaged.

Check balancer gear on the crankshaft at the same time and replace crankshaft if necessary (refer to *CRANKSHAFT* in this subsection).

Balancer Shaft Radial Play

Measure balancer shaft bearing journal diameter, using a micrometer. Compare to inside diameter of balancer shaft plain bearings in cylinder block (refer to *CYLINDER BLOCK* in this subsection).



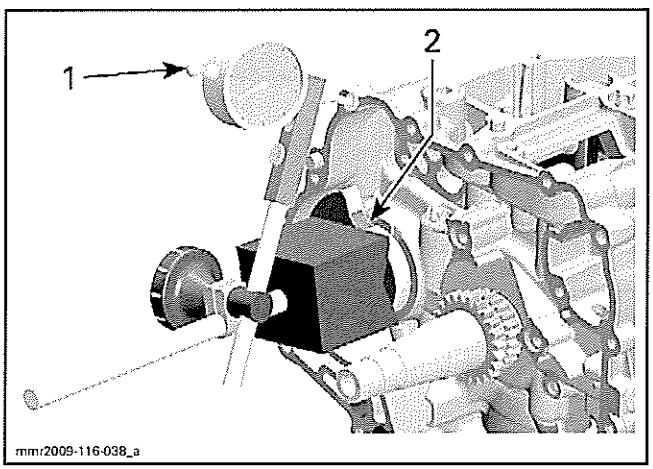
1. *Micrometer*
2. *Balancer shaft area for plain bearing*

BALANCER SHAFT BEARING JOURNAL DIAMETER	
NEW	35.984 mm to 36.000 mm (1.4167 in to 1.4173 in)
SERVICE LIMIT	35.970 mm (1.4161 in)

BALANCER SHAFT RADIAL PLAY	
SERVICE LIMIT	0.10 mm (.0039 in)

Balancer Shaft Axial Play

With the balancer shaft in cylinder-block, measure the balance shaft axial play, using a dial indicator.



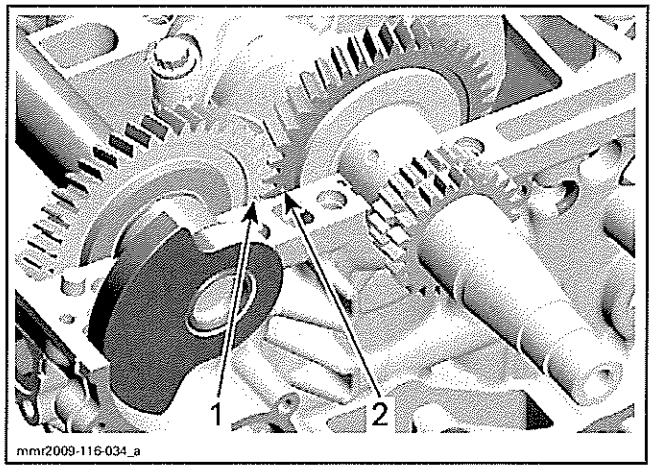
1. *Dial indicator*
2. *Balancer shaft*

BALANCER SHAFT AXIAL PLAY	
NEW	0.10 mm to 0.23 mm (.0039 in to .0091 in)
SERVICE LIMIT	0.35 mm (.0138 in)

Balancer Shaft Installation

For installation, reverse the removal procedure. Pay attention to following detail.

NOTICE Balancer shaft and crankshaft marks have to be aligned.



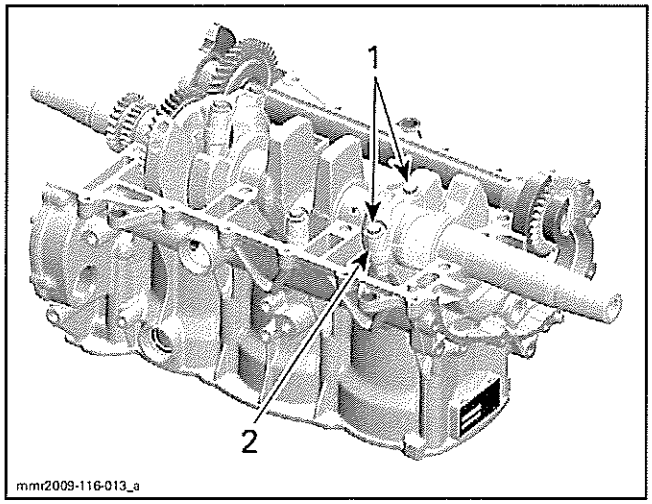
1. *Mark on balancer shaft*
2. *Mark on crankshaft*

PISTONS AND CONNECTING RODS

Piston and Connecting Rod Removal

1. Disassemble *CYLINDER BLOCK* as per procedure in this subsection.
2. Unscrew connecting rod screws and remove connecting rod cap.

NOTE: Before removing the connecting rod caps, mark them to remember the right position when reassembling. It is recommended to measure connecting rod big end axial play prior to remove connecting rod. Refer to *CONNECTING ROD INSPECTION.*



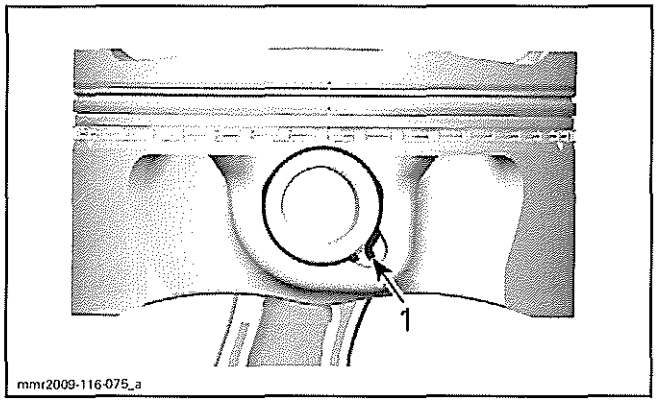
1. *Connecting rod screws*
2. *Connecting rod cap*

3. Remove *CRANKSHAFT* and *BALANCER SHAFT* as per procedure in this subsection.

4. Turn cylinder block and push piston with connecting rod out of the cylinder.

Piston and Connecting Rod Disassembly

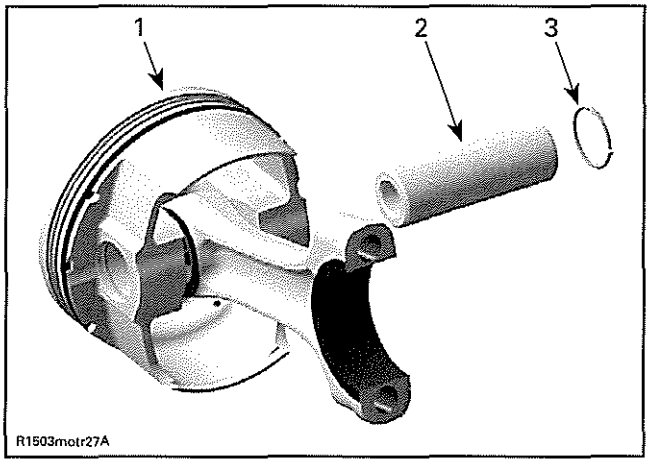
1. Remove one piston pin circlip and discard it.



1. Piston pin circlip

NOTE: The removal of both piston pin circlips is not necessary to remove piston pin.

2. Push piston pin out of piston.



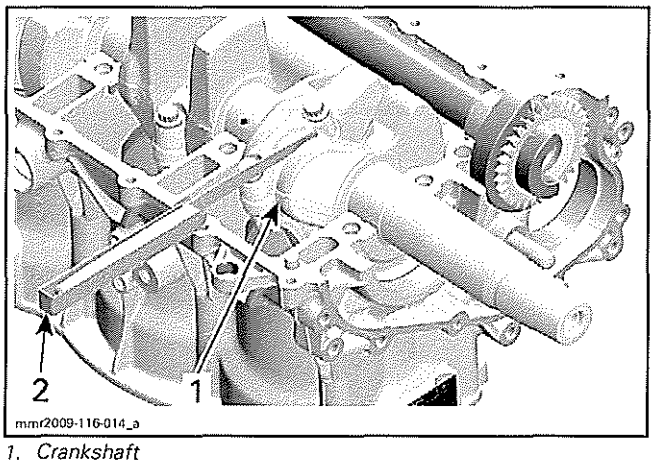
TYPICAL
1. Piston
2. Piston pin
3. Circlip

3. Detach piston from connecting rod.

Connecting Rod Inspection

Connecting Rod Big End Axial Play

Using a feeler gauge, measure distance between butting face of connecting rod and crankshaft counterweight. If the distance exceeds specified tolerance, replace the worn part.

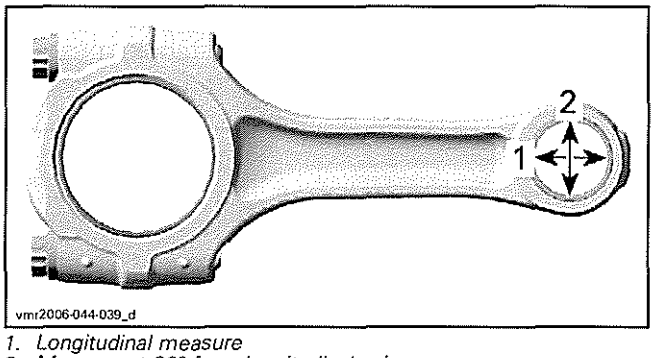


1. Crankshaft
2. Feeler gauge

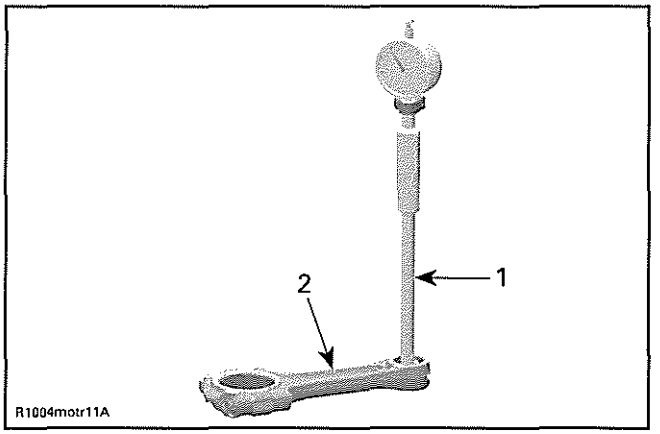
CONNECTING ROD BIG END AXIAL PLAY	
NEW	0.100 mm to 0.352 mm (.004 in to .014 in)
SERVICE LIMIT	0.400 mm (.016 in)

Connecting Rod Small End Radial Play

Measure inside diameter as shown using a bore gauge.



1. Longitudinal measure
2. Measure at 90° from longitudinal axis



TYPICAL
1. Bore gauge
2. Connecting rod

CONNECTING ROD SMALL END DIAMETER	
NEW	22.01 mm to 22.02 mm (.8665 in to .8669 in)
SERVICE LIMIT	22.04 mm (.8677 in)

If the connecting rod small end diameter is out of specification, replace the connecting rod.

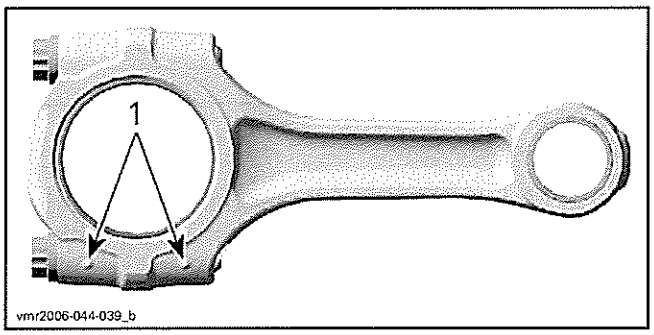
Measure piston pin diameter (refer to *PISTON PIN INSPECTION*) and compare to inside diameter of connecting rod to obtain connecting rod small end radial play.

CONNECTING ROD SMALL END RADIAL PLAY	
SERVICE LIMIT	0.045 mm (.0018 in)

Connecting Rod Big End Radial Play

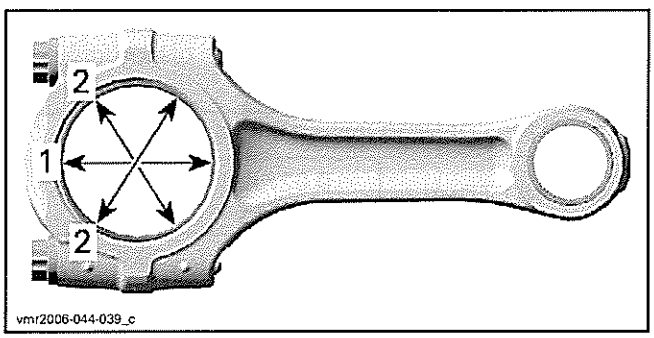
1. Measure inside diameter of connecting rod big end and compare to crankshaft pin diameter.
   1.1 Install the OLD plain bearings as they were mounted initially.
   1.2 Perform the tightening procedure as described in *PISTON AND CONNECTING ROD INSTALLATION* in this subsection.

   NOTE: Match the dots on the cap and connecting rod. ALWAYS use the OLD connecting rod screws.



1. Dots

   1.3 Measure inside diameter as shown.



1. Longitudinal measure
2. Measures at 60° from longitudinal axis

CONNECTING ROD BIG END DIAMETER	
SERVICE LIMIT	38.060 mm (1.4984 in)

CONNECTING ROD BIG END RADIAL PLAY	
SERVICE LIMIT	0.080 mm (.0031 in)

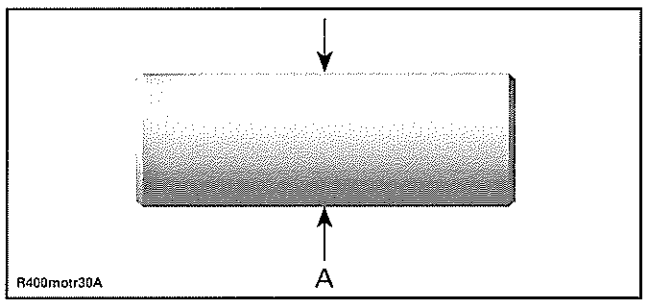
If connecting rod big end diameter is out of specification, install NEW plain bearings.

Piston Pin Inspection

Using synthetic abrasive woven, clean piston pin from deposits.

Inspect piston pin for scoring, cracking or other damages.

Measure piston pin diameter, using a micrometer. See the following illustration for the proper measurement position.



A. Measure piston pin diameter here

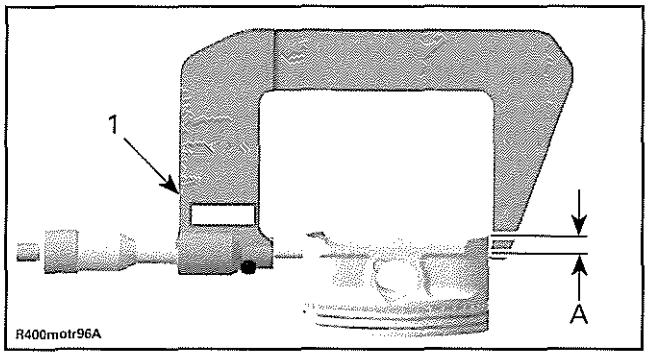
PISTON PIN DIAMETER	
NEW	21.991 mm to 21.996 mm (.8658 in to .866 in)
SERVICE LIMIT	21.985 mm (.8656 in)

Replace the piston pin, if it is out of specification.

Piston Inspection

Inspect piston for scoring, scuffing, cracking or other damages. Replace piston and piston rings if necessary.

Using a micrometer, measure piston at 8 mm (.315 in) perpendicularly (90°) to piston pin axis.



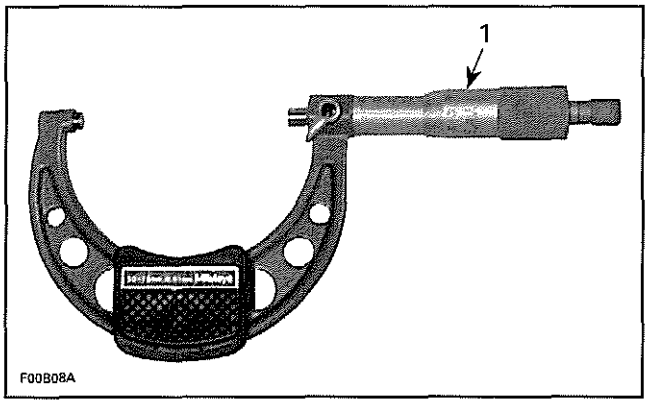
1. Measuring perpendicularly (90°) to piston pin axis
A. 8 mm (.315 in)

PISTON MEASUREMENT	
NEW NOMINAL	90.950 mm to 90.966 mm (3.5807 in to 3.5813 in)
SERVICE LIMIT	90.900 mm (3.5787 in)

Replace the piston, if it is out of specification.

Piston/Cylinder Clearance

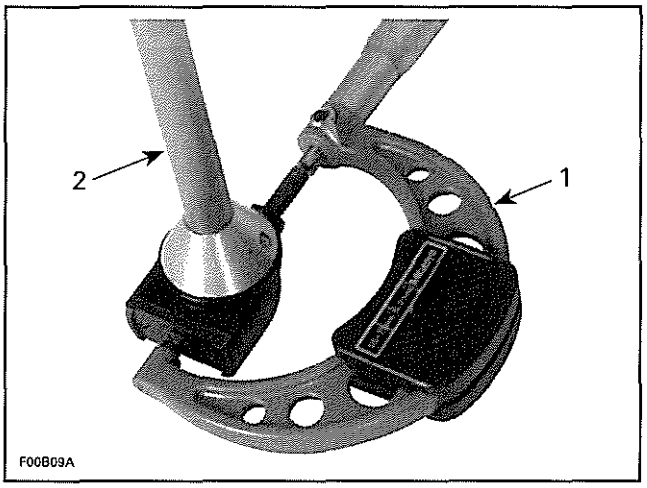
1. Adjust and lock a micrometer to the piston dimension.



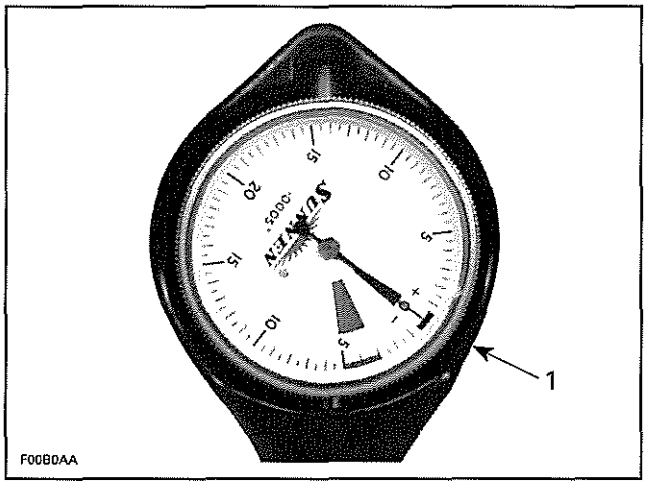
1. Micrometer set to the piston dimension

NOTE: Make sure used piston is not worn.

2. With the micrometer set to the dimension, adjust a cylinder bore gauge to the micrometer dimension and set the indicator to 0 (zero).



1. Use the micrometer to set the cylinder bore gauge
2. Cylinder bore gauge



TYPICAL
1. Indicator set to 0 (zero)

NOTE: Make sure the cylinder bore gauge indicator is set exactly at the same position as with the micrometer, otherwise the reading will be false.

3. Position the cylinder bore gauge 30 mm (1.181 in) below the cylinder head mating surface, measuring perpendicularly (90°) to piston pin axis.
4. Read the measurement on the cylinder bore gauge. The result is the exact piston/cylinder clearance.

PISTON/CYLINDER CLEARANCE	
NEW NOMINAL	0.027 mm to 0.057 mm (.0011 in to .0022 in)
SERVICE LIMIT	0.100 mm (.0039 in)

If clearance exceeds the specified tolerance, replace the piston and repeat the measurement procedure.

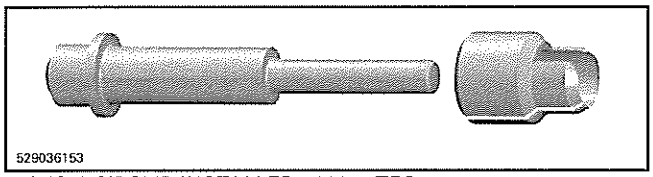
Piston and Connecting Rod Assembly

For assembly, reverse the disassembly procedure. Pay attention to the following details.

1. Apply engine oil on the piston pin.
2. Insert piston pin into piston and connecting rod.

NOTE: Ensure to reinstall all parts in their original position as marked during removal.

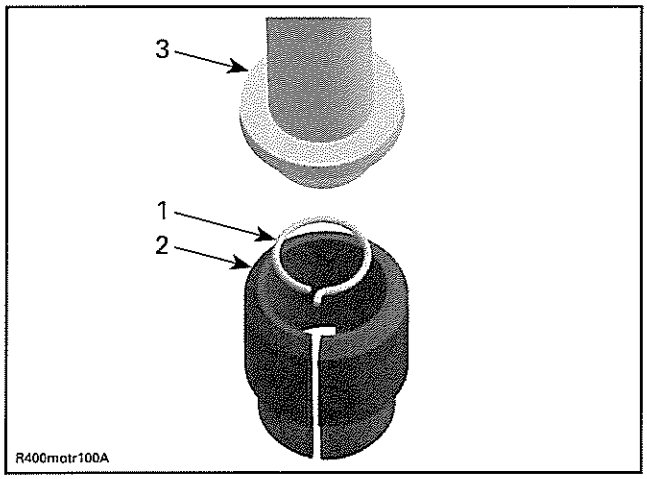
3. Install NEW piston pin circlip(s) by using the PISTON CIRCLIP INSTALLER (P/N 529 036 153). Proceed as follows.



PISTON CIRCLIP INSTALLER 1200 4-TEC

NOTICE Always replace disassembled piston pin circlips by NEW ones.

3.1 Place circlip in sleeve as per following illustration.

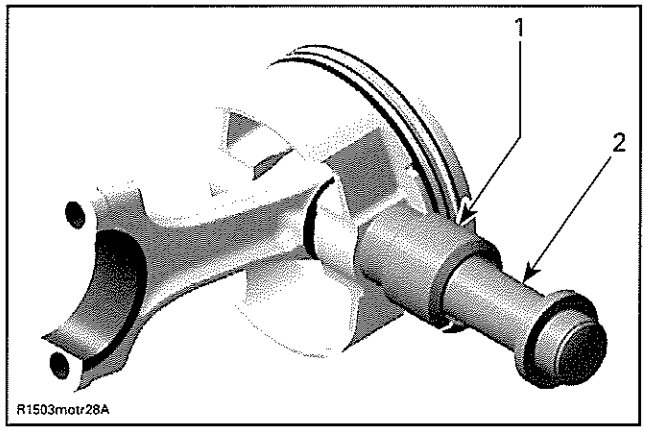


1. Circlip
2. Sleeve
3. Piston circlip installer handle

3.2 Push piston circlip installer handle until circlip reaches mid position in sleeve.

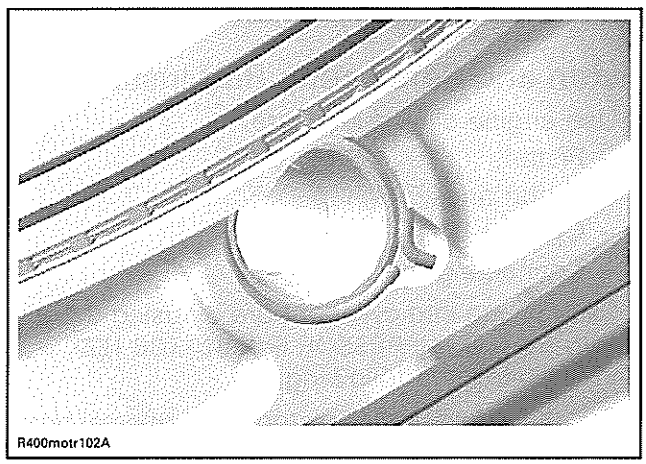
3.3 Insert the end of the handle into piston pin.

3.4 Hold piston and push handle to engage the circlip into piston groove.



TYPICAL
1. Sleeve with piston circlip inside
2. Piston clip installer handle

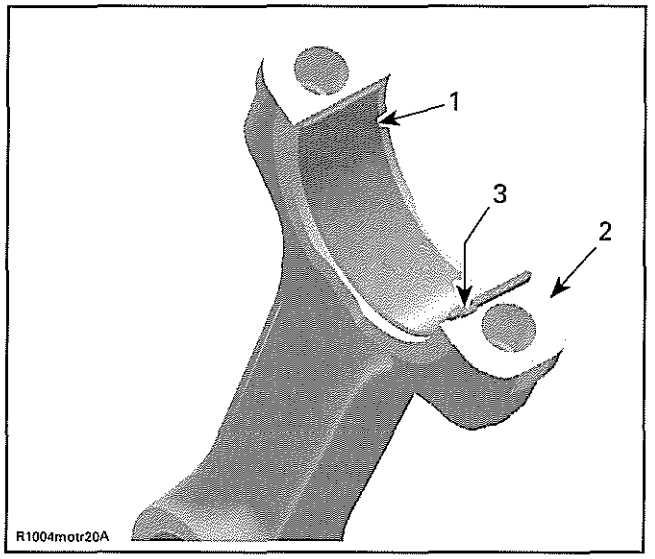
NOTE: Take care that the hook of the piston pin circlip is positioned properly.



CORRECT POSITION OF THE PISTON PIN CIRCLIP

NOTICE If piston pin circlip installation fails, repeat step 3 by using a NEW circlip.

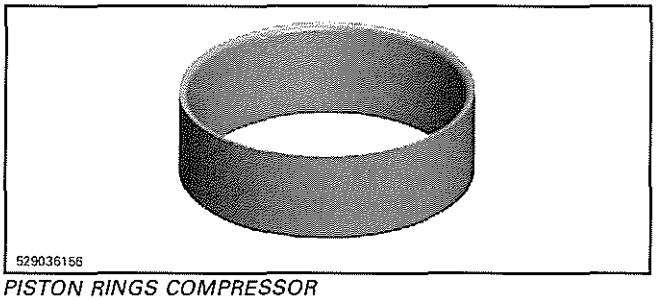
4. Correctly install plain bearings and carefully clean split surface on both sides (cracked area) with compressed air.



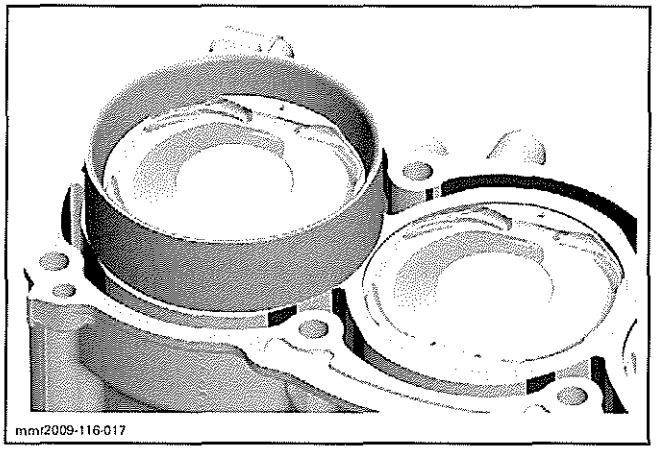
TYPICAL
1. *Half bearing of connecting rod big end*
2. *Split surface of the connecting rod*
3. *Protrusion of bearing in line with connecting rod groove*

Piston and Connecting Rod Installation

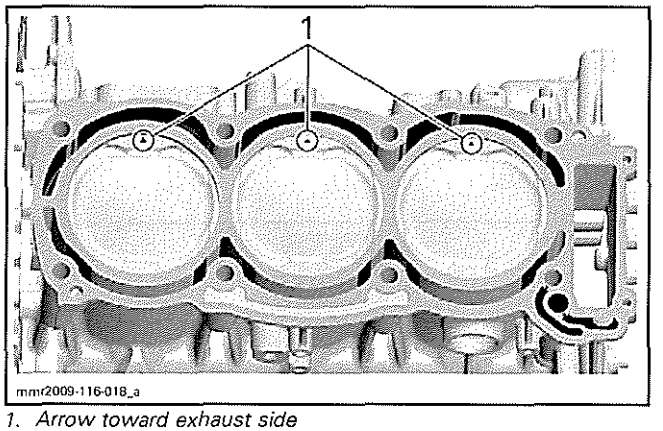
1. Use engine oil and lubricate:
   - Piston
   - Piston rings
   - Cylinder bore
   - Connecting rod bearings.
2. Slide piston into cylinder bore by using the PISTON RING COMPRESSOR (P/N 529 036 156). Pay attention to the following.
   - 2.1 If reused, install piston in its original bore.
   - 2.2 Piston rings are properly installed (spacing). See procedure in this subsection.
   - 2.3 The arrow on top of the piston must be installed towards exhaust.



PISTON RINGS COMPRESSOR



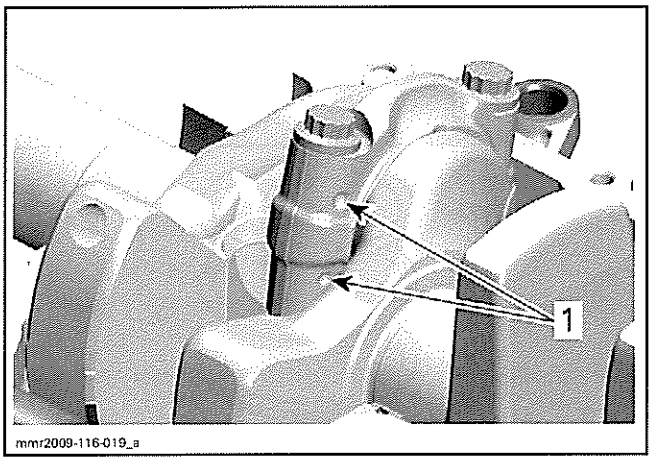
NOTICE Piston installed with the arrow in the wrong direction will cause serious engine damage.



1. Arrow toward exhaust side

3. Turn cylinder block upside down.
4. Install *CRANKSHAFT* as per procedure in this subsection.
5. Oil the crankshaft crank pin.
6. Match the dots on the caps and connecting rods and install caps.

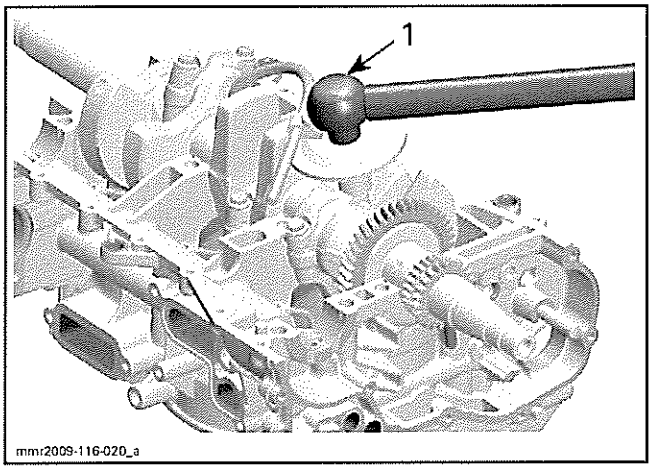
NOTE: Connecting rods are symmetrical and can be installed in one direction or the other.



1. Dots

NOTICE Always use NEW connecting rod screws for the final assembly of the connecting rod. As the screws have been stretched from the previous assembly, it is very important to use NEW screws at assembly.

7. Apply oil on head of NEW connecting rod screws and torque as per following procedure.
   7.1 First, torque screws to 40 N•m (30 lbf•ft).
   7.2 Finish tightening the screws with an additional 70° turn, using an torque angle gauge.



1. Torque angle gauge

NOTICE Failure to strictly follow this procedure may cause screws to loosen and lead to severe engine damage.

8. Install *BALANCER SHAFT* as per procedure in this subsection.
9. Install all other removed parts.

PISTON RINGS

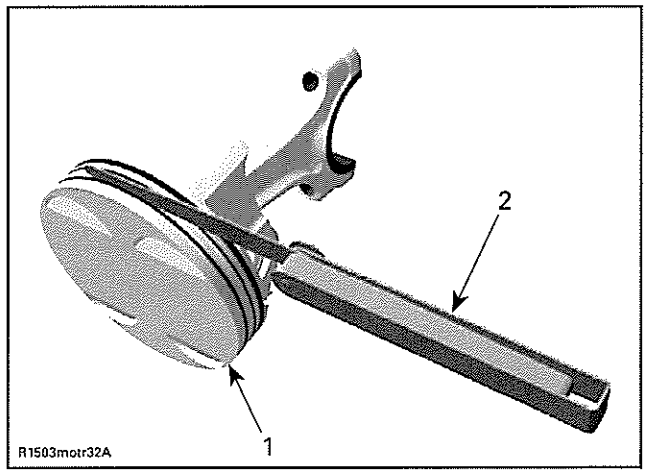
Piston Ring Removal

1. Remove piston, see procedure in this subsection.
2. Remove rings from piston.

Piston Ring Inspection

Ring/Piston Groove Clearance

Using a feeler gauge measure each ring/piston groove clearance.



TYPICAL
1. Piston
2. Feeler gauge

RING/PISTON GROOVE CLEARANCE	
UPPER COMPRESSION RING	
NEW	0.030 mm to 0.070 mm (.0012 in to .0028 in)
SERVICE LIMIT	0.150 mm (.0059 in)
LOWER COMPRESSION RING	
NEW	0.020 mm to 0.060 mm (.0008 in to .0024 in)
SERVICE LIMIT	0.150 mm (.0059 in)
OIL SCRAPER RING	
NEW	0.010 mm to 0.180 mm (.0004 in to .0071 in)
SERVICE LIMIT	0.250 mm (.0098 in)

If the clearance is out of specification, the piston and rings should be replaced.

Ring End Gap

1. Place piston ring in the cylinder bore between 8 mm to 16 mm (.315 in to .63 in) from top of cylinder.

NOTE: In order to correctly position the ring in the cylinder bore, use piston as a pusher.

2. Using a feeler gauge, check ring end gap.

RING END GAP	
UPPER COMPRESSION RING	
NEW	0.25 mm to 0.40 mm (.0098 in to .0157 in)
SERVICE LIMIT	0.60 mm (.0236 in)
LOWER COMPRESSION RING	
NEW	0.20 mm to 0.40 mm (.0079 in to .0157 in)
SERVICE LIMIT	0.70 mm (.0276 in)
OIL SCRAPER RING	
NEW	0.20 mm to 0.70 mm (.0079 in to .0276 in)
SERVICE LIMIT	1.00 mm (.0394 in)

If the ring end gap is out of specification, replace piston rings.

Piston Ring Installation

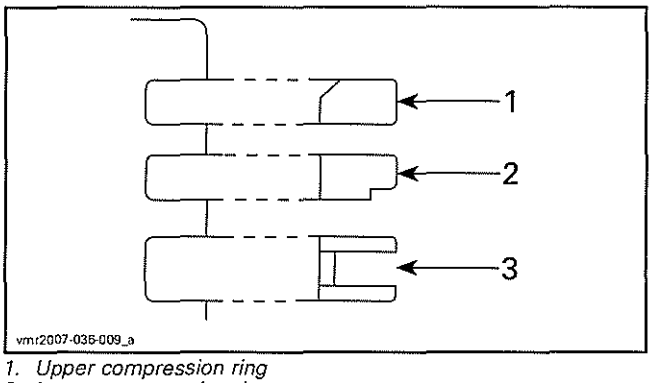
1. Install the piston rings in the following assembly order.

   NOTE: Use a ring expander to prevent breakage during installation. The oil ring must be installed by hand.

   1.1 Install oil scraper ring.

   1.2 Install the lower compression ring with the word "N" and "TOP" facing up.

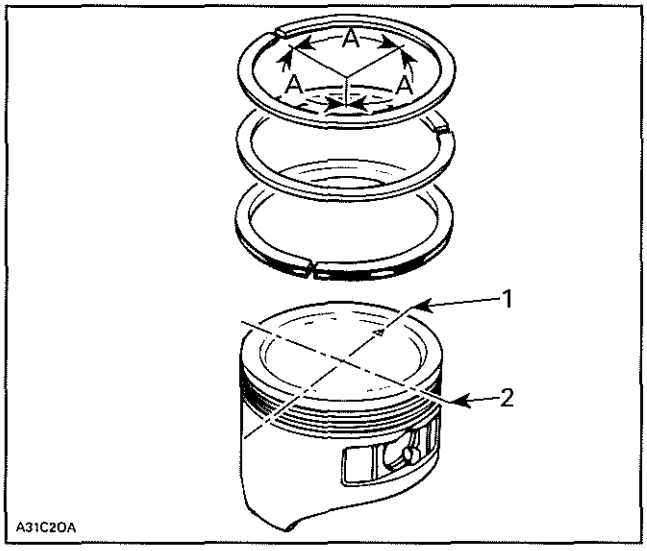
   1.3 Install upper compression ring with the word "N" and "TOP" facing up.



1. Upper compression ring
2. Lower compression ring
3. Oil scraper ring

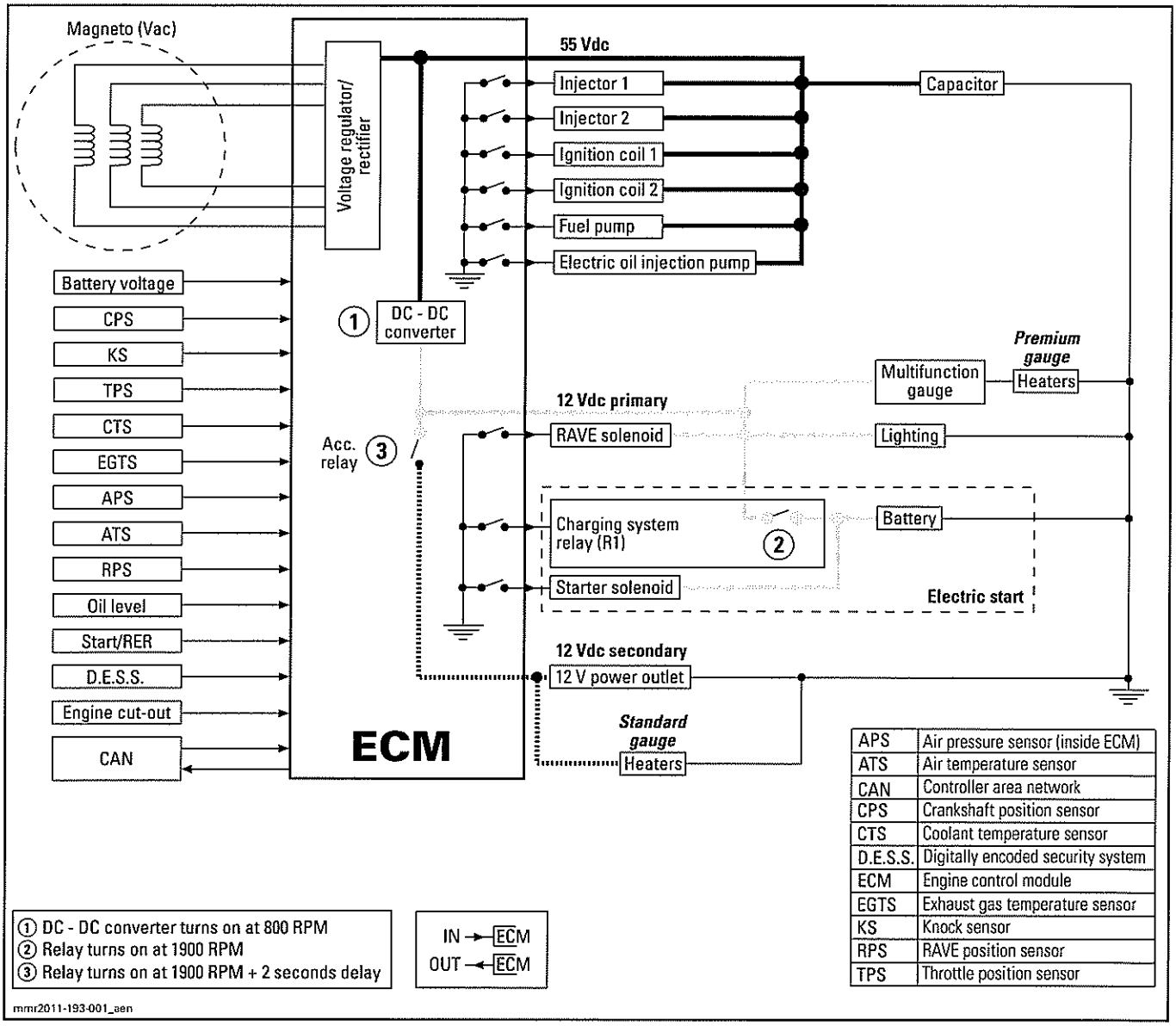
2. Check that rings rotate smoothly after installation.

3. Space the piston ring end gaps 120° apart and do not align the gaps with the piston pin bore or the thrust side axis.



TYPICAL
1. DO NOT align ring gap with piston trust side axis
2. DO NOT align ring gap with piston pin bore axis
A. 120°

OVERVIEW (600 HO E-TEC)



APS	Air pressure sensor (inside ECM)
ATS	Air temperature sensor
CAN	Controller area network
CPS	Crankshaft position sensor
CTS	Coolant temperature sensor
D.E.S.S.	Digitally encoded security system
ECM	Engine control module
EGTS	Exhaust gas temperature sensor
KS	Knock sensor
RPS	RAVE position sensor
TPS	Throttle position sensor

GENERAL

SYSTEM DESCRIPTION

A highly advanced engine management system (EMS) has been used on this 2-stroke engine to ensure a high power output with a clean combustion with practically no exhaust smoke.

There are 8 main systems that are controlled by the engine management system (EMS):

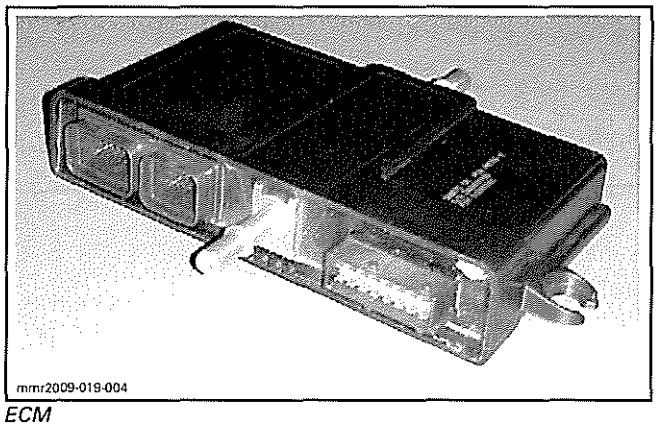
1. E-TEC Direct fuel injection
2. Ignition system
3. Starting system
4. Rotax electronic reverse (RER)
5. Digitally encoded security system (D.E.S.S.)
6. Lubrication system
7. 3D RAVE
8. Electrical accessories.

The engine management system features a monitoring system that self-diagnoses its electronic components. For more information, refer to *DIAGNOSTIC AND FAULT CODES*.

The power distribution is also controlled by the engine management system.

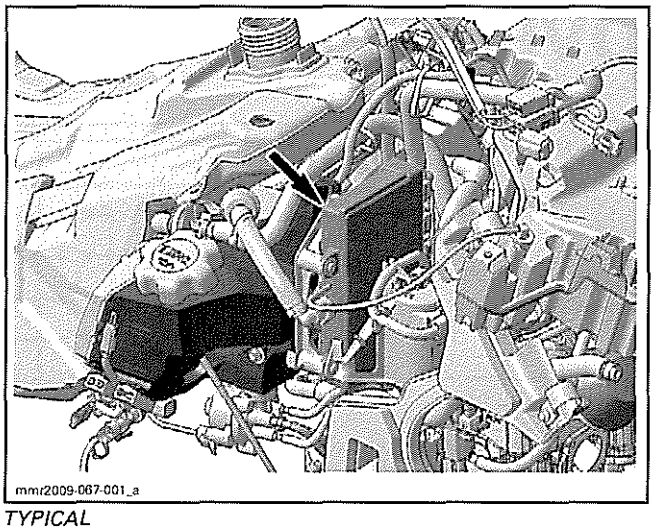
Engine Control Module (ECM)

The ECM is the central point of the engine management system. It reads the inputs, makes computations, uses pre-determined parameters and sends the proper signals to the outputs for proper engine management.



ECM

The ECM is located near oil injection reservoir.



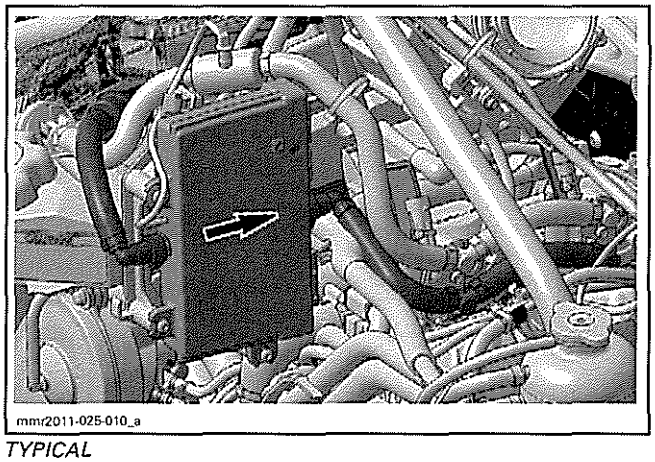
TYPICAL

The ECM features a permanent memory that will keep the fault codes, customer information and other engine information when the engine is stopped.

ECM Cooling

Since the ECM manages all the vehicle power needs and incorporates the voltage regulator/rectifier and other power components, a lot of heat needs to be dissipated.

The constant fresh fuel flow from fuel pump is used to cool down the ECM.



TYPICAL

Throttle Protection

If throttle is not completely closed during engine startup, engine RPM will be limited to idle speed by the ECM.

To revert to normal operation, release the throttle completely and then depress it again.

Cold Engine Protection

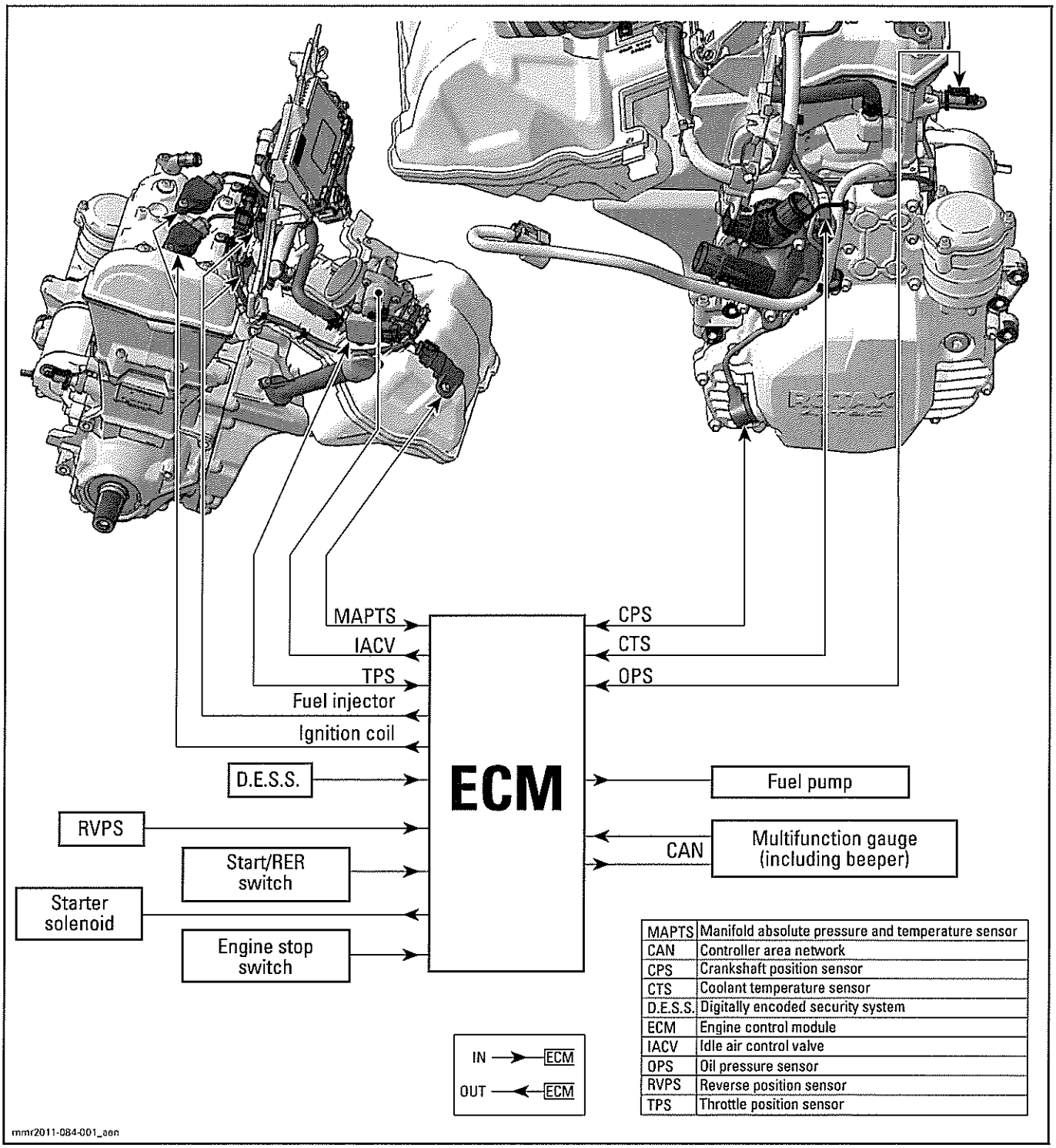
Engine speed is limited to 7000 RPM.	Max. RPM allowed to the engine in reverse. RAVE valves are kept closed.
	Max. RPM allowed when engine is cold. Air temperature is below -25°C (-13°F). RAVE valves are kept at mid position. Oil injection pump duty cycle is increased to warm up oil.
	NOTE: When coolant temperature is below 20°C (68°F), RAVE valves are kept at mid position and no RPM limitation takes place. Oil injection pump works in its usual mode.
Engine speed is limited to 8600 RPM.	Maximum engine RPM allowed.

Engine Maximum RPM Protection

Engine speed is limited to 7000 RPM.	Max. RPM allowed to the engine in reverse. RAVE valves are kept closed.
Engine speed is limited to 8600 RPM.	Maximum engine RPM allowed.

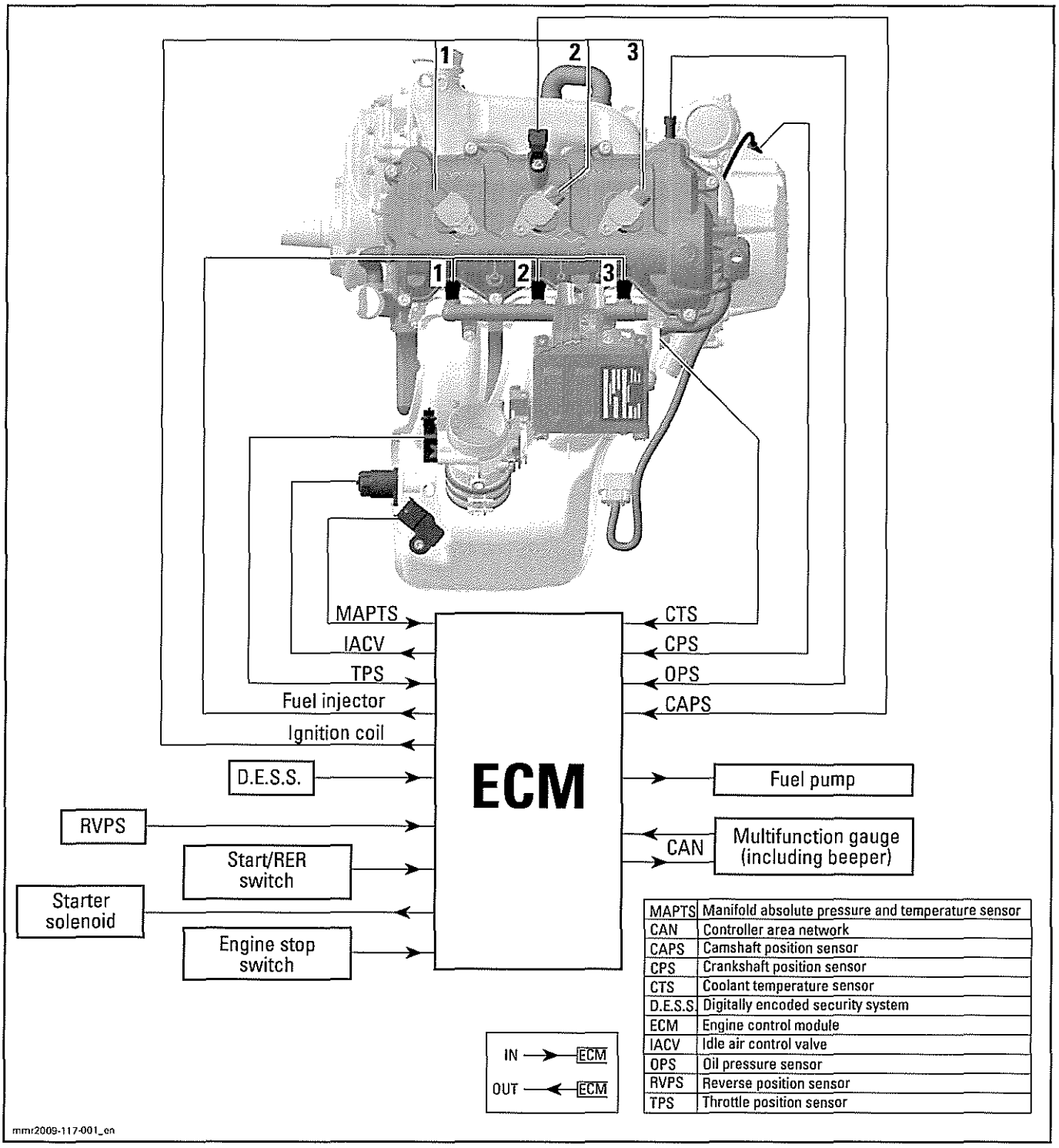
OVERVIEW (600 ACE AND 1200 4-TEC)

600 ACE Models



MAPTS	Manifold absolute pressure and temperature sensor
CAN	Controller area network
CPS	Crankshaft position sensor
CTS	Coolant temperature sensor
D.E.S.S.	Digitally encoded security system
ECM	Engine control module
IACV	Idle air control valve
OPS	Oil pressure sensor
RVPS	Reverse position sensor
TPS	Throttle position sensor

1200 4-TEC Models



MAPTS	Manifold absolute pressure and temperature sensor
CAN	Controller area network
CAPS	Camshaft position sensor
CPS	Crankshaft position sensor
CTS	Coolant temperature sensor
D.E.S.S.	Digitally encoded security system
ECM	Engine control module
IACV	Idle air control valve
OPS	Oil pressure sensor
RVPS	Reverse position sensor
TPS	Throttle position sensor

GENERAL

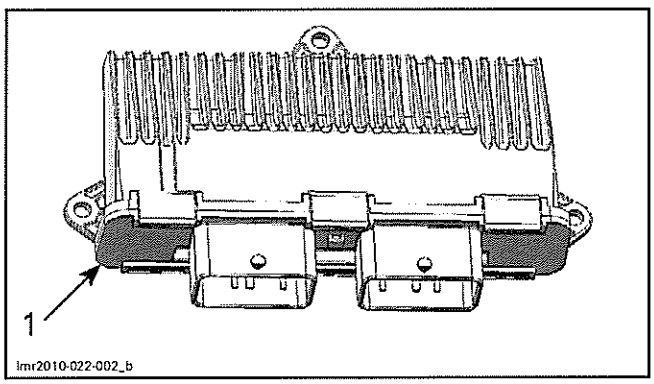
SYSTEM DESCRIPTION

The engine management system (EMS) controls or interacts with the following systems:

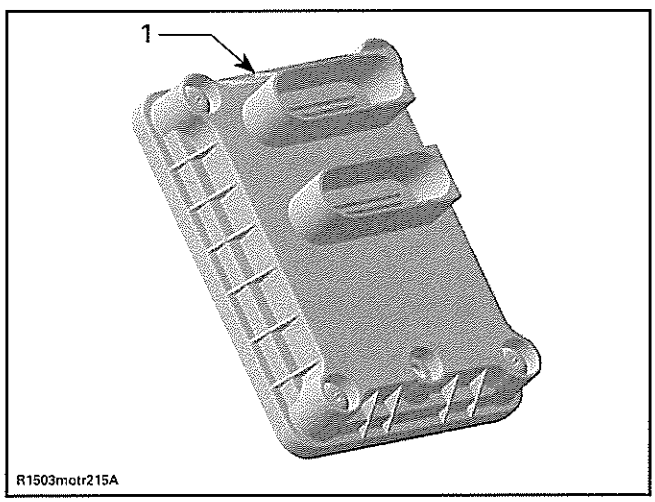
- Electronic fuel injection (EFI)
- Digitally Encoded Security System (D.E.S.S.)
- Starting system
- Ignition system
- Electronic reverse (1200 4-TEC)
- Lubrication system
- Electrical accessories.

The EMS also offers a monitoring system and diagnostic mode to help troubleshooting some problems. Refer to *DIAGNOSTIC AND FAULT CODES* section for more details.

Engine Control Module (ECM)

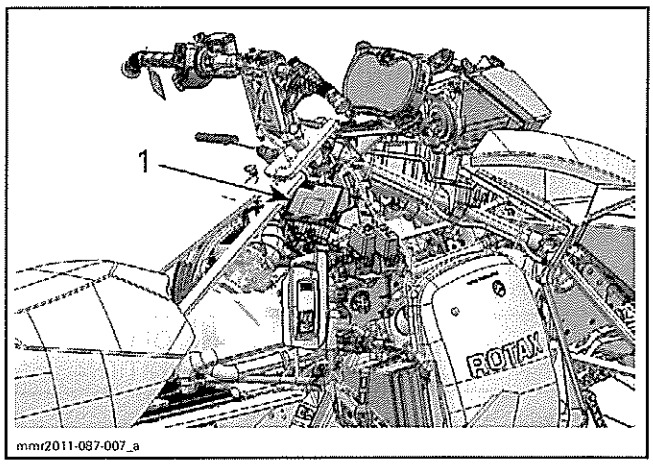


600 ACE MODELS
1. Typical ECM

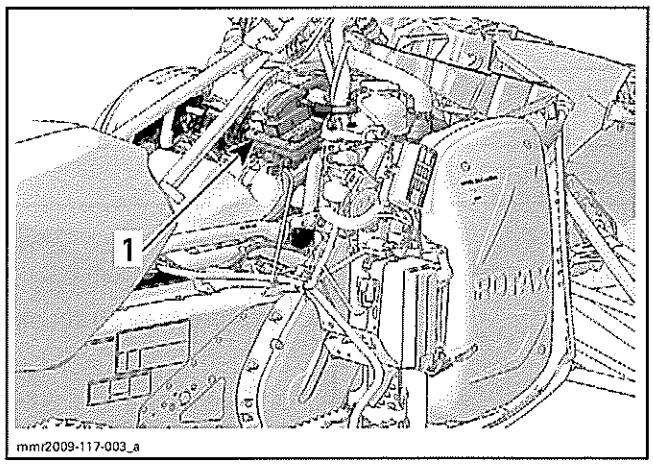


1200 4-TEC MODELS
1. Typical ECM

The ECM is located above the air intake manifold.



600 ACE MODELS — TYPICAL ECM LOCATION, FUEL TANK REMOVED FOR CLARITY
1. ECM



1200 4-TEC MODELS — TYPICAL ECM LOCATION, FUEL TANK REMOVED FOR CLARITY
1. ECM

The ECM is the central point of the engine management system. It reads the inputs, makes computations, uses pre-determined parameters and sends the proper signals to the outputs for proper engine management.

The ECM features a permanent memory that will keep the fault codes, customer information and other engine information when the engine is stopped and when battery is removed.

Throttle Protection

If throttle is not completely closed during engine startup, engine will not start.

To revert to normal operation, release the throttle completely.

Engine Drowned Mode

This mode is intended to crank an engine that is fuel flooded. When this mode is active, fuel injectors and ignition coils are disabled.

To activate the drowned mode:

1. Fully squeeze throttle lever and hold.
2. Press the START/RER button.
3. The mode is now on.

To exit this mode, release throttle and start engine normally.

Engine Overheat Protection

COOLANT TEMP.	ENGINE OPERATING CONDITION	EMS ACTION
Above 70°C (158°F)	Idling more than 12 minutes	Engine is stopped. 5 seconds before stopping engine: • Beeper is activated. • SHUTDOWN is displayed in multifunction gauge (premium gauge).
Within 111°C (232°F) and 117°C (243°F)	Idling more than 12 minutes	Beeper is continuously activated. Temperature light is turned ON. ENGINE_TEMP is displayed in multifunction gauge (premium gauge).
Above 110°C (230°F)	Riding	
Above 118°C (244°F)	Idling more than 30 seconds	Engine is stopped. 5 seconds before stopping engine: • Beeper is activated. • SHUTDOWN is displayed in multifunction gauge (premium gauge).
	Riding	Beeper is activated. Temperature light is turned ON. ENGINE_TEMP is displayed in multifunction gauge (premium gauge). Check engine light is turned ON. Engine speed is limited to 5500 RPM. A fault code is set.

COMMUNICATION TOOLS AND B.U.D.S.

SERVICE TOOLS

Description	Part Number	Page
12 V BATTERY SUPPLY CABLE	529 035 997	421, 427
MPI-2 DIAGNOSTIC CABLE	710 000 851	421, 426
MPI-2 INTERFACE CARD	529 036 018	421, 425
T-HARNESS	529 035 869	421, 424, 426

SERVICE TOOLS – OTHER SUPPLIER

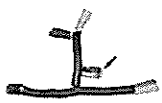
Description	Part Number	Page
MALE-FEMALE EXTENSION SERIAL CABLE	DB9	427

GENERAL

Refer to *PROCEDURES* for instructions on the communication tools.

If communication problems occurs, refer to *TROUBLESHOOTING*.

REQUIRED TOOLS

MANDATORY TOOLS	
A personal computer (laptop or desktop)	
MPI-2 INTERFACE CARD (P/N 529 036 018)	
MPI-2 DIAGNOSTIC CABLE (P/N 710 000 851)	
T-HARNESS (P/N 529 035 869)	
600 HO E-TEC ONLY: 12 V BATTERY SUPPLY CABLE (P/N 529 035 997)	
OPTIONAL TOOL	
Extension cable available at electronic retail outlets. Do not exceed 7.5 m (25 ft)	

TROUBLESHOOTING

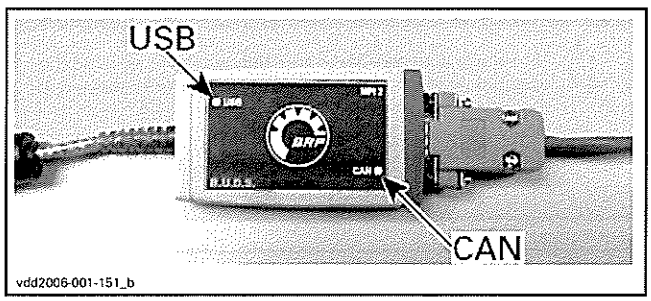
DIAGNOSTIC TIPS

IMPORTANT: Make sure all connections have been made **before starting B.U.D.S.** to allow proper operation.

MPI-2 Connection Troubleshooting

The MPI-2 includes 2 status lights to show the connection conditions: USB and CAN.
Both lights must be GREEN so that MPI-2 works properly. Otherwise, refer to the following charts.

Flashing GREEN lights indicate the communication is active.



Prerequisite for USB Communication:
- PC Computer turned on.
- MPI-2 connected to PC computer.

COMMUNICATION PROBLEM (USB)	
STATUS	WHAT TO DO
Light is OFF	– Check USB connection between MPI-2 and PC computer. – Check USB operation on PC computer (hardware or Windows drivers).

Prerequisite for CAN Communication:

1. MPI-2 connected to diagnostic connector.
2. Tether chord cap installed on engine cut-off switch.
3. B.U.D.S. started and logged.

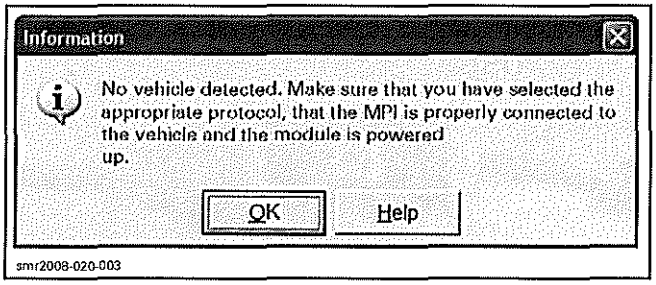
COMMUNICATION PROBLEM (CAN)	
STATUS	WHAT TO DO
Light is OFF	– Check MPI protocol in B.U.D.S. – Check connection between MPI-2 and diagnostic cable connector. – Check connection between diagnostic cable connector and T-harness. – Check fuse, wiring and connectors, and diode of T-harness. – Check connection between T-harness and diagnostic connector. – E-TEC models: Check that battery supply cable is connected to a 12 V battery. – Check that ECM is powered.
Light is RED	– Check CAN wires and connectors on vehicle.

Communication Problems with B.U.D.S.

Vehicle not Detected in B.U.D.S.:

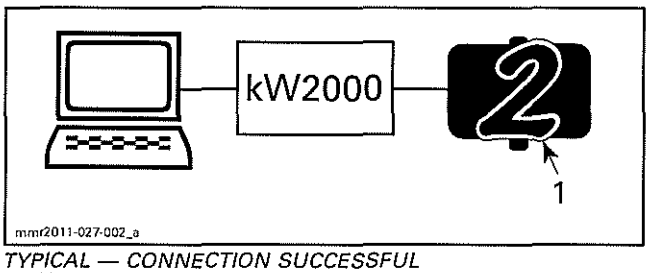
600 HO E-TEC Models

If **No vehicle detected...** message is displayed in B.U.D.S.:



Make sure both USB and CAN lights of MPI-2 are GREEN. Otherwise, ensure the status bar shows the Kw2000 and the appropriate number of modules to its right according to the vehicle model.

VEHICLE MODEL	PROTOCOL	NUMBER OF MODULES
600 HO E-TEC	Kw2000	2 (ECM and gauge)



TYPICAL — CONNECTION SUCCESSFUL
1. Number of modules

B.U.D.S. Screen is Cycling

1200 4-TEC Models

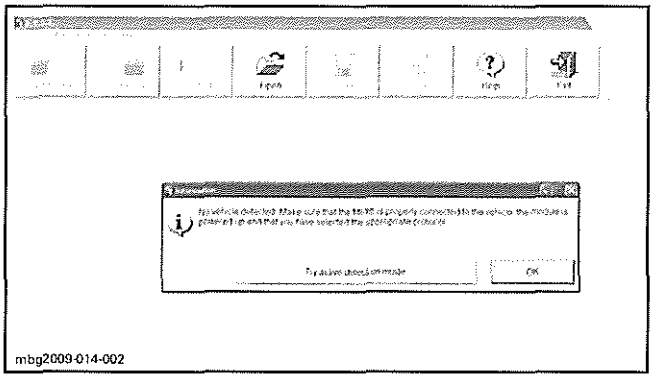
When T-harness is connected to the vehicle diagnostic connector and the following is observed:

– Fuel pump is continuously cycling ON and OFF.
– **Read Data** and **Write Data** buttons in B.U.D.S. are continuously cycling black and gray.

Install tether chord cap on engine cut-off switch.

No Vehicle is Detected

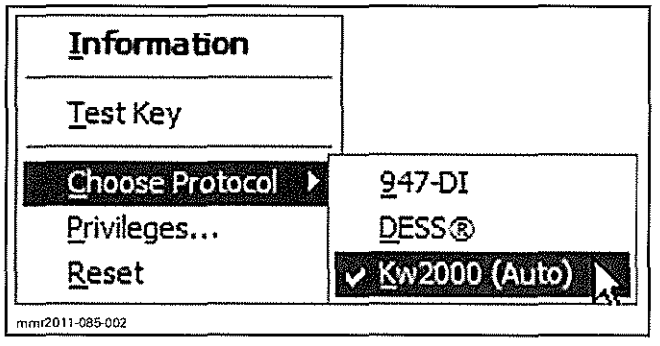
If the following message is displayed, it should disappear as soon as B.U.D.S. communicates. Otherwise, click on the **Try active detection mode** button.



If B.U.D.S. is trapped in a loop that continually displays **No vehicle detected...**, exit B.U.D.S. then restart it.

If B.U.D.S. still does not detect a vehicle, manually set the following communication protocol.

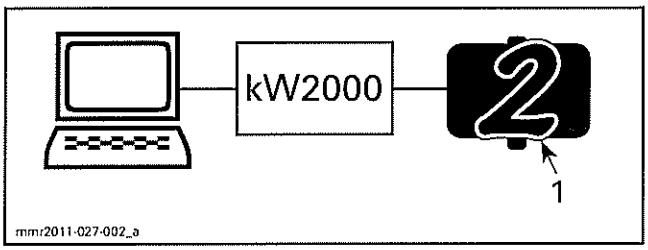
In **MPI** under **Choose protocol**. Select **Kw2000 (Auto)**.



Missing Module

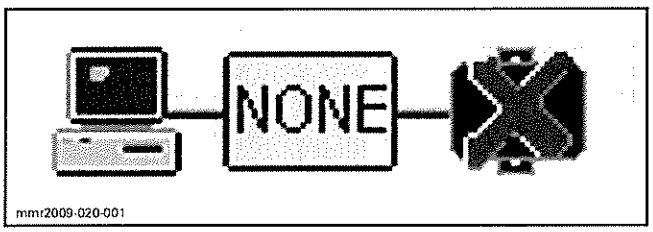
Ensure the appropriate number of modules is shown in the status bar.

MODEL	NUMBER OF MODULES
600 HO E-TEC	2 (ECM and gauge)
600 ACE	
1200 4-TEC	



TYPICAL — CONNECTION SUCCESSFUL
1. Number of modules

If an "X" is shown in the status bar, it means that no "ECU" is communicating with the MPI. Check the following:

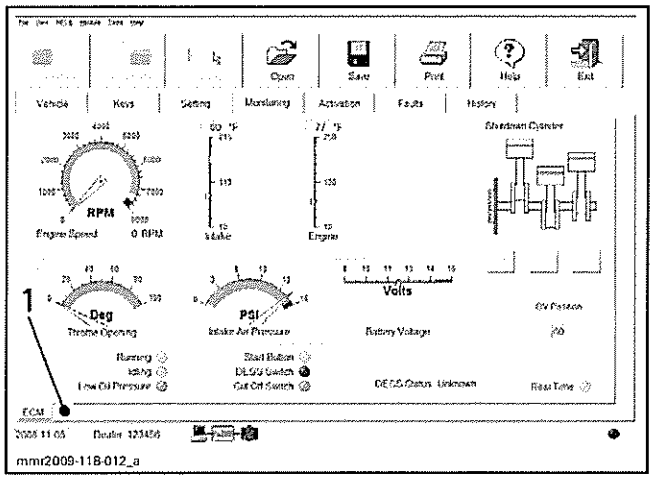


- Check MPI protocol in B.U.D.S.
- Check connections between the PC computer and the vehicle.

If one or more "ECU" is (are) not communicating with the MPI, a module may not be powered or is defective.

Check to find which module is missing in B.U.D.S.

The tab of the missing module will not be visible at the bottom of B.U.D.S. screen.



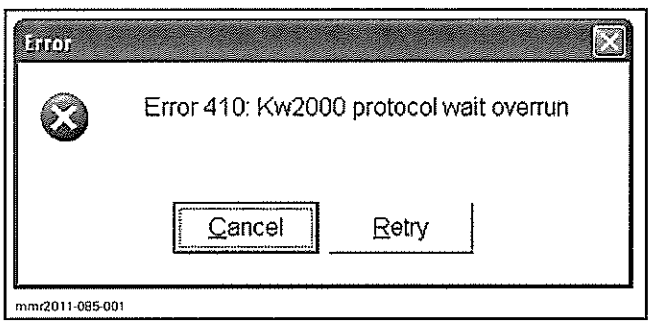
TYPICAL
1. Cluster tab not visible meaning this "ECU" is not communicating

If the module is missing, check wiring and power supply to that module.

Error 410: KW2000 Protocol Wait Overrun

1200 4-TEC Models

If the following message is displayed, click on the Retry button to complete the ongoing procedure.



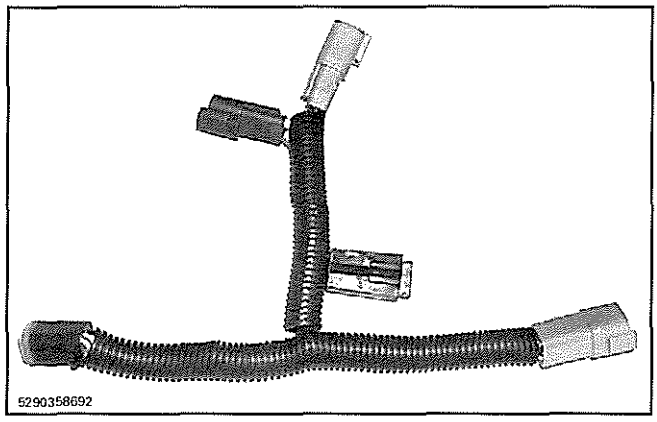
Engine cannot be Started when Using B.U.D.S.

600 ACE Models

If engine cannot be started when using B.U.D.S. proceed as follows:

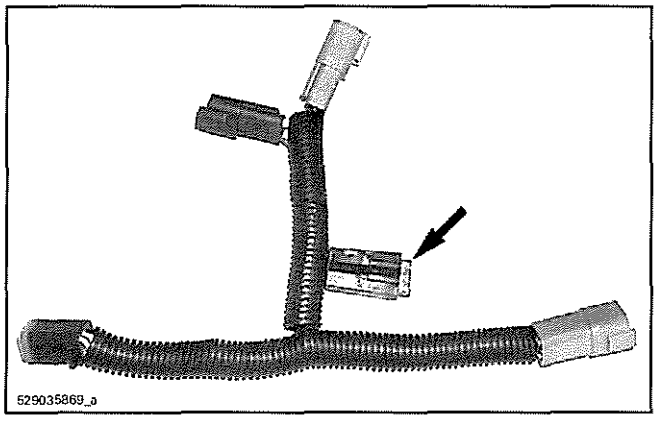
1. Remove tether chord cap from engine cut-off switch.
2. Unplug T-harness from the diagnostic connector.
3. Wait until the ECM shuts down (indicated by the gauge that turns off after approximately 10 seconds).
4. Install tether chord cap to engine cut-off switch.
5. Plug T-harness to the diagnostic connector.
6. Start B.U.D.S. and logon.
7. In B.U.D.S., click Read Data.
8. Start engine.

T-Harness Operation Test

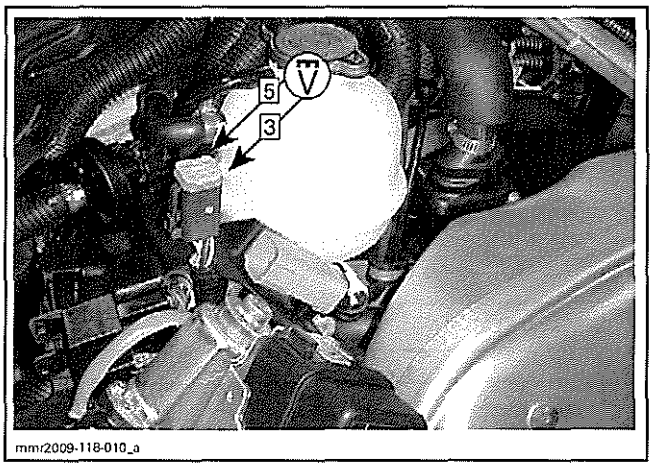


When the T-HARNESS (P/N 529 035 869) is connected to the vehicle diagnostic connector, ECM and multifunction gauge should turn on. Otherwise, check the following and repair or replace T-harness if any test failed.

1. T-harness fuse.

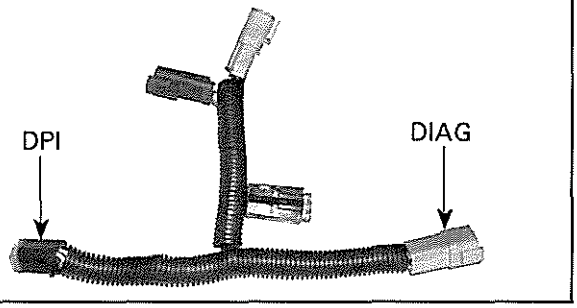


2. Vehicle battery voltage.
   2.1 Charge battery if it is too low.
3. Battery power between pins 5 and 3 of vehicle diagnostic connector.

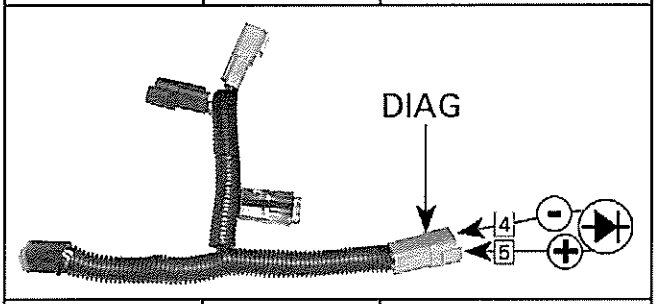
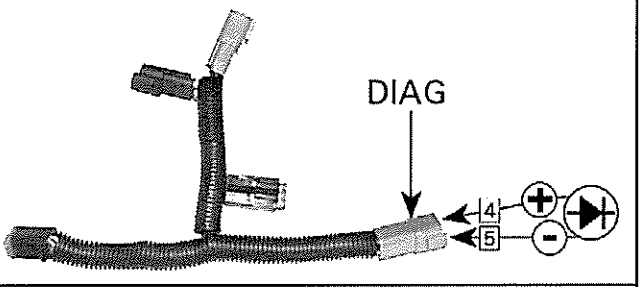


   3.1 If battery voltage is not read, check vehicle wiring harness.
4. Wiring and connectors of the T-harness.

T-HARNESS CONTINUITY TEST			
"DPI" CONNECTOR	"DIAG" CONNECTOR	FUNCTION	TEST
1	1	CAN line	Continuity (close to 0 Ω)
2	2	CAN line	
3	3	Ground	
4	4	None	N.A.
5	5	Vehicle battery	Continuity (close to 0 Ω)
6	6	None	N.A.



5. Diode in the T-harness.

T-HARNESS DIODE TEST		
"DIAG" CONNECTOR		TEST
FROM	TO	
5	4	Close to 0.5 V
		
4	5	Open
		

Notes:
Set multimeter to ⏩

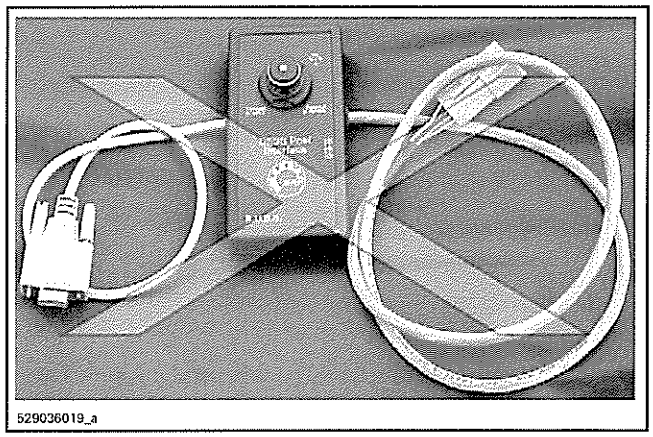
Probe diode paying attention to proper polarity. The + sign indicates the RED probe.

PROCEDURES

MULTI-PURPOSE INTERFACE-2 (MPI-2)

The MPI-2 (Multi-Purpose Interface-2) is used with B.U.D.S. software to communicate with the ECM (engine control module) and other modules such as the multifunction gauge.

NOTICE Do not use the D.E.S.S. post interface.



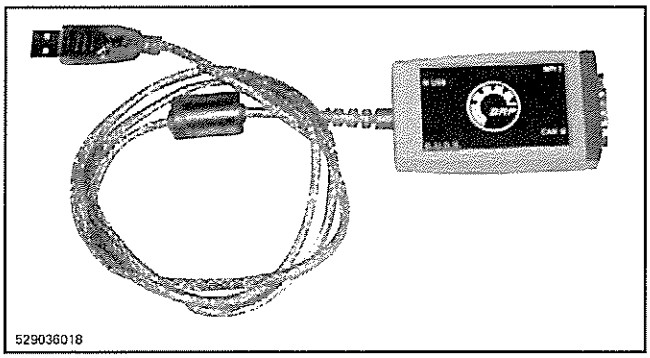
MPI-2 Connections with Vehicle

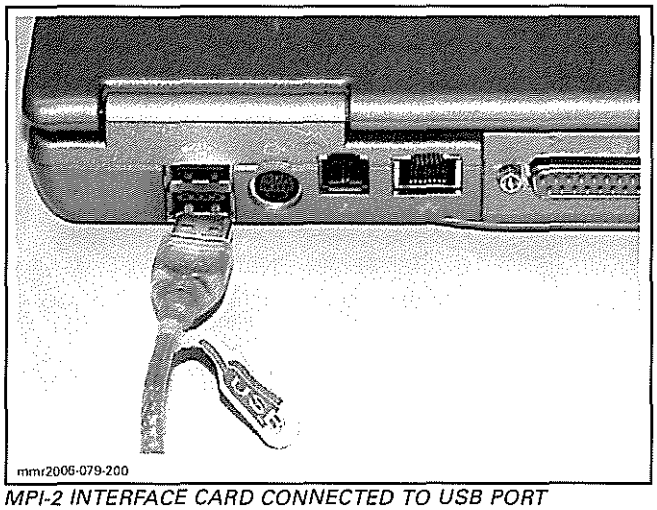
⚠ WARNING

If the computer you are using is connected to the power outlet, there is a potential risk of electrocution when working in contact with water. Be careful not to touch water while working with the computer.

NOTE: Some components will generate heat when leaving vehicle in diagnostic mode for a long period. Always disconnect MPI supply harness and supply cable from vehicle/battery when not working on vehicle.

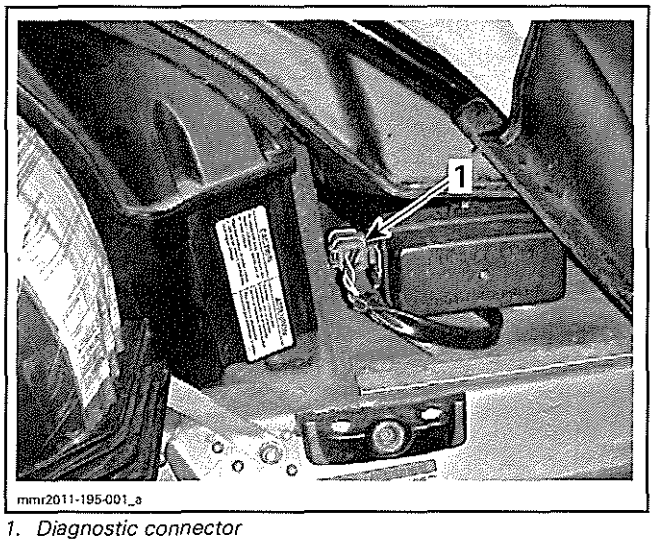
Connect the MPI-2 INTERFACE CARD (P/N 529 036 018) to the USB port of a PC (personal computer).





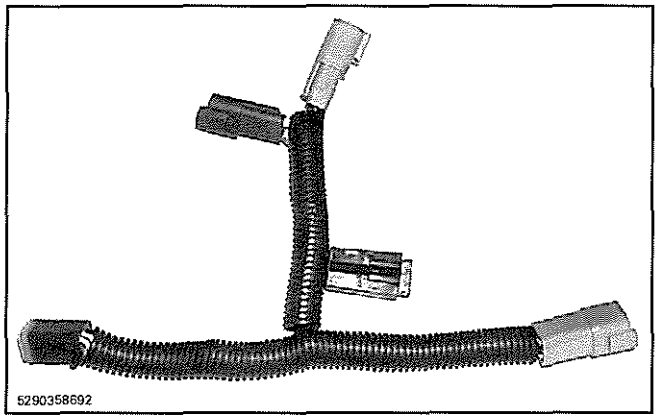
MPI-2 INTERFACE CARD CONNECTED TO USB PORT

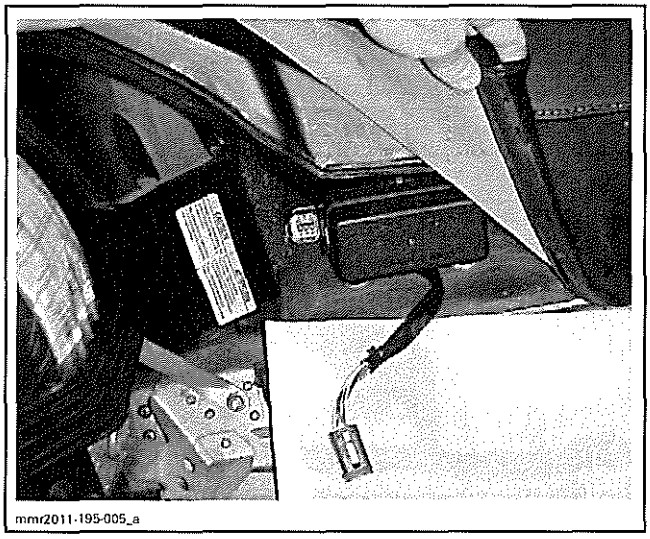
Remove the diagnostic connector from the protective cap besides fuse box on the left side of the vehicle.

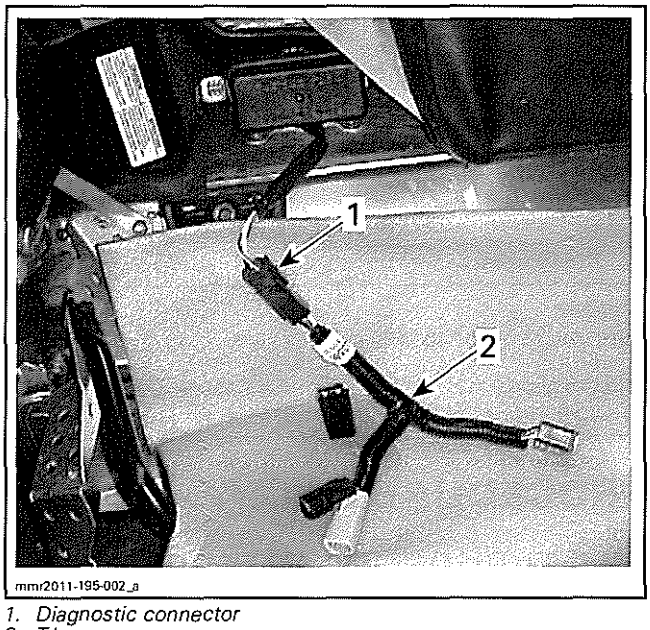


1. Diagnostic connector

Connect the T-HARNESS (P/N 529 035 869) to vehicle diagnostic connector.

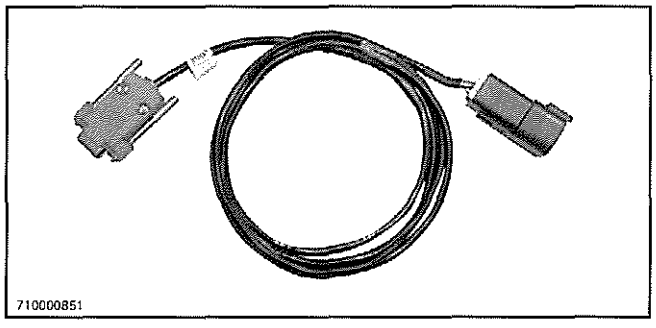


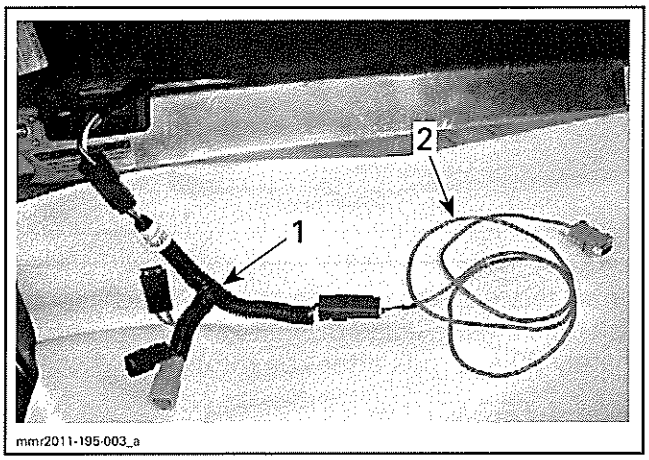




1. Diagnostic connector
2. T-harness

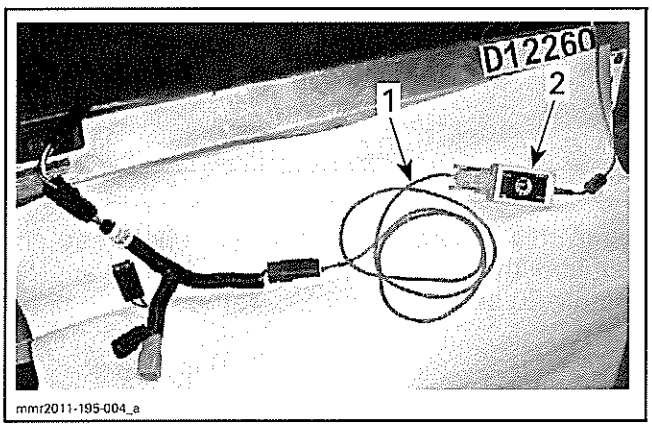
Connect the MPI-2 DIAGNOSTIC CABLE (P/N 710 000 851) to T-harness connector.





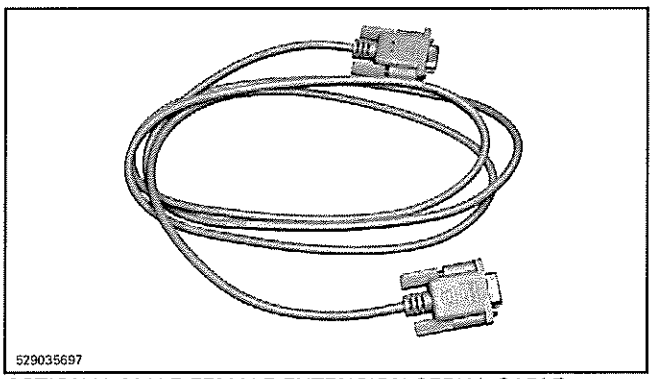
1. *T-harness*
2. *Diagnostic cable connected to T-harness*

Connect the diagnostic cable to the MPI-2 interface card.



1. *MPI-2 interface card*
2. *Diagnostic cable*

NOTE: An optional MALE-FEMALE EXTENSION SERIAL CABLE (P/N DB9) available at electronic retail outlets can be used. Do not exceed 7.6 m (25 ft).

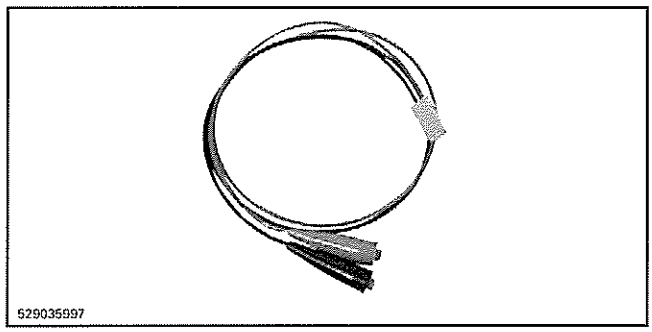


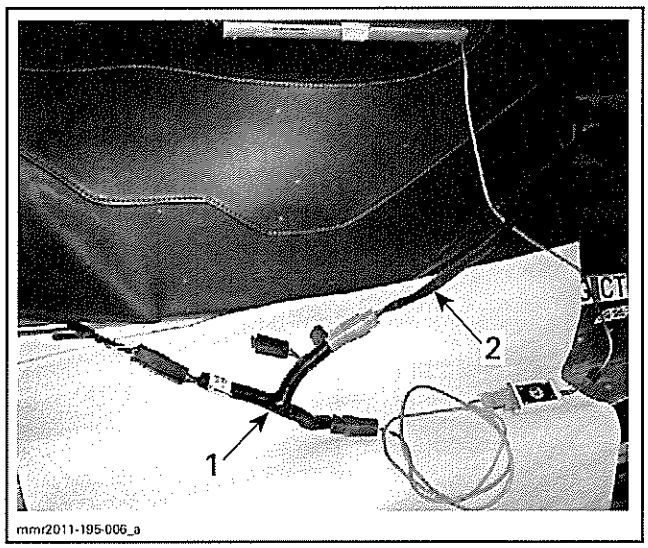
OPTIONAL MALE-FEMALE EXTENSION SERIAL CABLE

NOTICE Connecting MPI-2 directly to diagnostic connector (without T-harness) may prevent proper communication. Always use the T-harness.

600 HO E-TEC Models

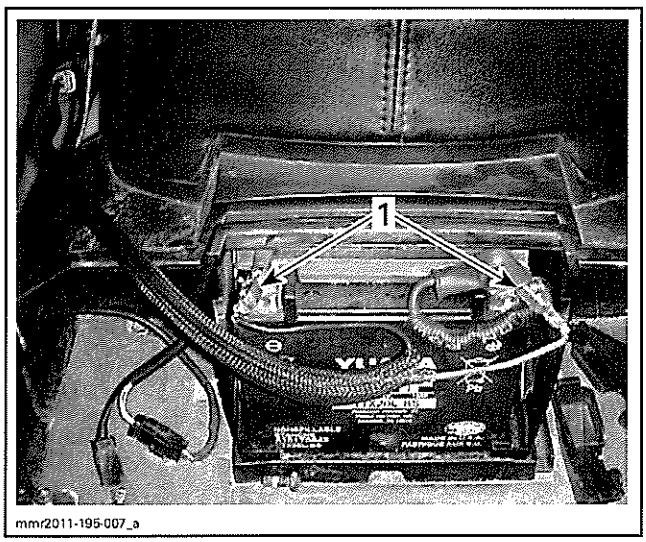
Connect the12 V BATTERY SUPPLY CABLE (P/N 529 035 997) to T-harness.





1. *T-harness*
2. *12 V battery supply cable*

Connect the battery supply cable to the vehicle battery posts. Ensure to match harness wire color with battery cable color.



1. *Connect 12 V battery supply cable to battery posts*

B.U.D.S. SOFTWARE

B.U.D.S. (Bombardier Utility and Diagnostic Software) is designed to allow electrical component inspection, diagnostic options and adjustments such as the closed throttle.

For more information pertaining to the use of the B.U.D.S. software, use its help which contains detailed information on its functions.

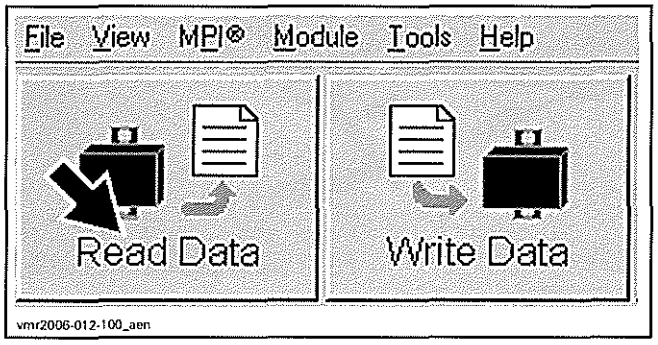
Use the proper B.U.D.S. version available on BOSSWeb.

IMPORTANT: Make sure tether chord cap is on engine cut-off switch and all connections have been made **before starting B.U.D.S.** to allow proper operation.

Reading Data from Electronic Modules using the B.U.D.S. Software

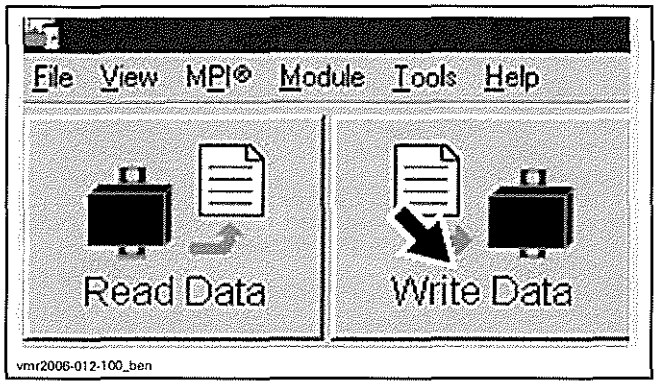
Start B.U.D.S. and logon.

Read ECM by clicking the **Read Data** button.



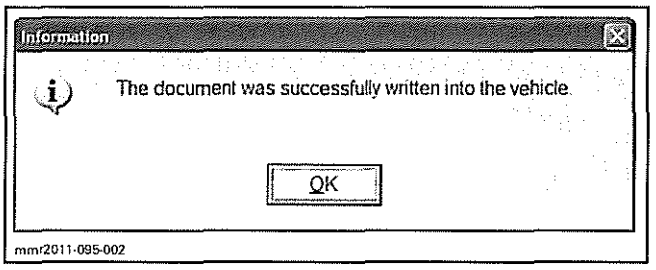
Writing Data Changes in ECM

When finished, save new data in ECM by clicking the **Write Data** button.



600 ACE Models

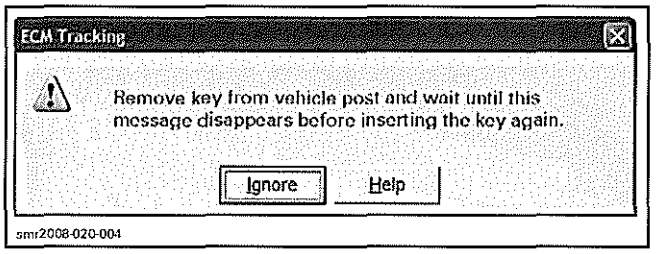
Anytime a change is brought in ECM through B.U.D.S., wait for the following window that confirms that the ECM has been written properly.



When this occurs, remove tether chord cap and wait until the message disappears (it lasts approximately 20 seconds after key removal).

1200 4-TEC Models

Anytime a change is brought in ECM through B.U.D.S., there will be an ECM Tracking box that will say **Remove key from vehicle....**



When this occurs, remove tether chord cap and wait until the message disappears (it lasts approximately 20 seconds after key removal).

All Models

Disconnect T-harness and other MPI connections.

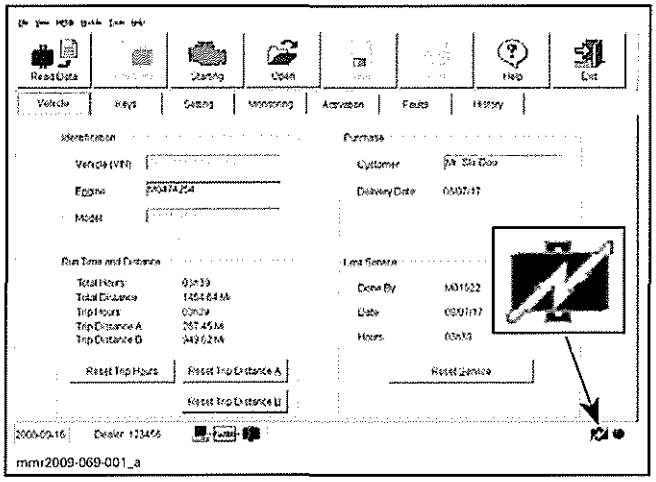
Reconnect the 6-pin connector in its protective cap.

NOTICE **Failure to secure the diagnostic connector in its protective cap would allow corrosion and damage to the terminals.**

NOTE: There is a 120 Ω resistor in protective cap to minimize the possibility of communication error.

Electronic Modules ("ECU") Update

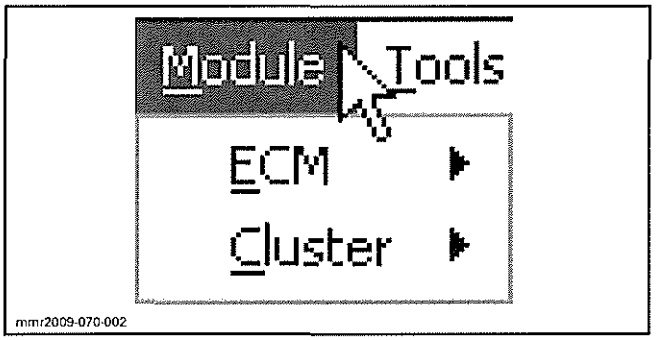
Whenever B.U.D.S. is started, check if there is an update icon in B.U.D.S. status bar.



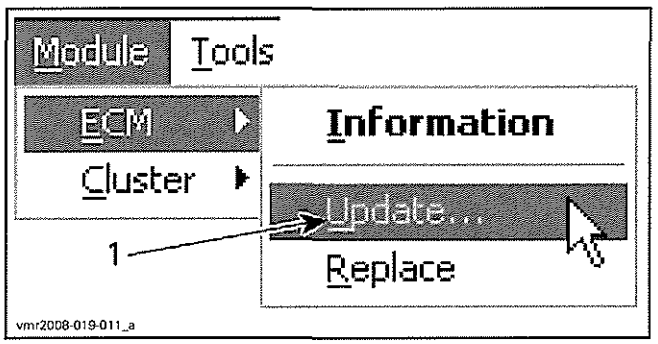
TYPICAL

The icon indicates that a file is available in B.U.D.S. to update any of the following electronic modules: ECM or multifunction gauge.

Use the **Module** menu and check all modules one at a time.

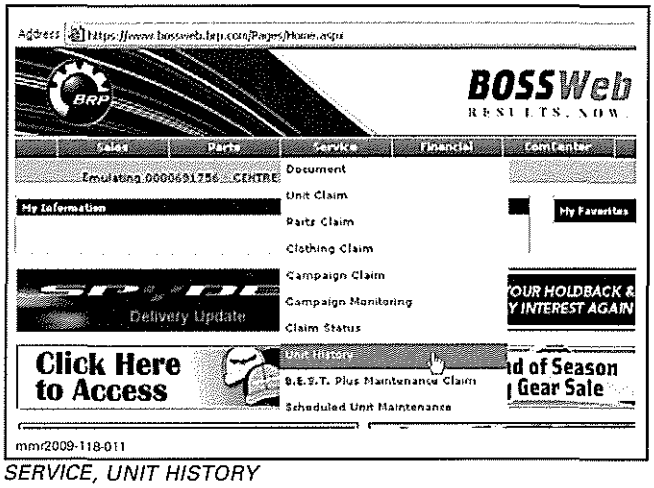


1. If the **Update** option is **greyed out**, no update file is available for this module.
2. If the **Update** option is **black**, an update file is available for this module.



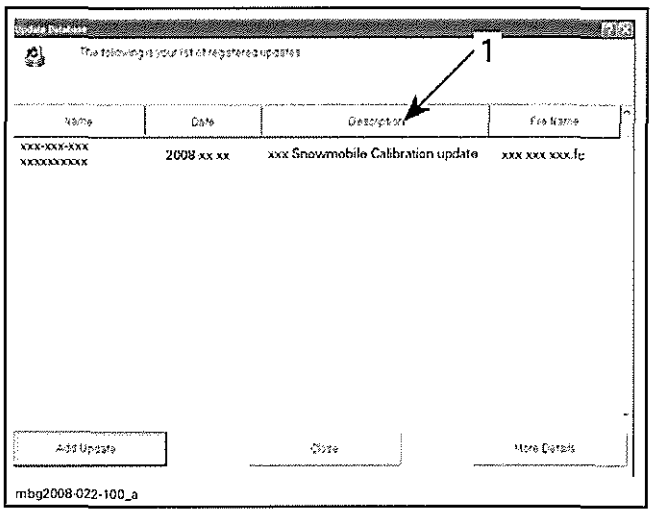
1. Greyed out: No update to perform
Black: Update file available

Before applying an update, log in BOSSWeb and look in **Service** for the **Unit history** to find out if any information or publication related to the vehicle is available. If so, carefully follow the given instructions.



SERVICE, UNIT HISTORY

NOTE: When selecting the update menu in B.U.D.S., a dialog box will appear and the update file description may give some clue to find the vehicle-related information in BOSSWeb.



TYPICAL
1. File description

NOTICE Failure to strictly follow a procedure to update a module may permanently damage the module.

DIAGNOSTIC AND FAULT CODES

GENERAL

MONITORING SYSTEM

The EMS features a monitoring system that self-diagnose its electronic components.

When a predefined condition (engine overheat for example) or a fault occurs, the ECM sends a signal to the multifunction gauge and/or audible signals to a beeper to inform you of this particular condition.

The ECM monitors the following functions and components.

600 HO E-TEC

COMPONENT
EMS (ECM, TPS, CTS, CPS, knock sensor, RAVE valve solenoids, APS, ATS, EGTS, RPS, ignition coils, fuel injectors and THCM) (**Summit 800R E-TEC models**)
12 V overload and 55 V voltage
D.E.S.S.
RER
Low oil level, oil temperature, electronic oil injection pump
Engine RPM
Coolant temperature
CAN
CTS
Starter solenoid
Fuel pump
Charging system relay

600 ACE and 1200 4-TEC

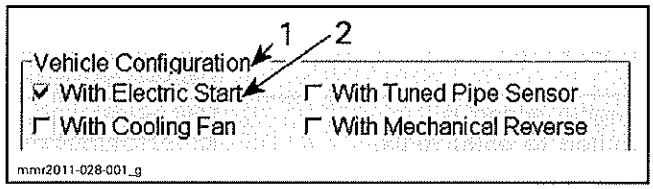
COMPONENT
EMS (ECM, TPS, CPS, CAPS (**1200 4-TEC** only), MAPTS, OPS, CTS, RVPS, IACV, ignition coils and fuel injectors)
12 V low/high voltage and overload
D.E.S.S.
Relays (R1 and R2. Also R3 on 600 ACE)
Engine oil pressure
Engine RPM
Coolant temperature
CAN
Starter solenoid
Fuel pump

Battery Charging Relay Monitoring

600 HO E-TEC

To enable the battery charging relay to be monitored by the ECM, the proper option must be selected in B.U.D.S.

Connect and start B.U.D.S. Check **With Electric Start** in **ECM** page under **Setting** tab.

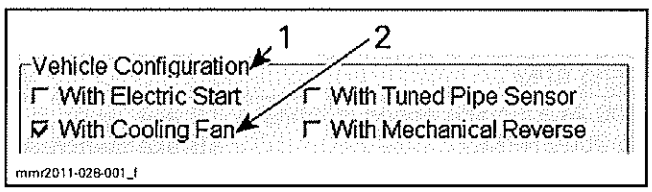


SETTING AND ECM TABS
1. *Vehicle configuration area*
2. *Check*

Cooling Fan Relay Monitoring

To enable the cooling fan relay to be monitored by the ECM, the proper option must be selected in B.U.D.S.

Connect and start B.U.D.S. Check **With Cooling Fan** in **ECM** page under **Setting** tab.



TYPICAL — SETTING AND ECM TABS
1. *Vehicle configuration area*
2. *Check*

Limp Home Mode

The ECM may automatically set default parameters to ensure the safe operation of the vehicle if a component of the engine management system is not operating properly.

NOTE: Sensor failures will not lead automatically to a limp home mode. The check engine LED will turn on and in some cases the beeper.

The engine RPM may be limited if some critical components fail. In this case, releasing throttle and letting the engine returning to idle speed may allow normal operation to come back. If it does not work, try removing the tether cord, wait until multifunction gauge turns off then reinstall tether cord.

These performance-reduced modes allow the rider to go back home while minimizing the risk of a complete power loss due to engine failure.

EMS Action According to Malfunctions

600 HO E-TEC

EMS ACTION	CAUSE
Engine is gradually stopped. Continuous fast short beeps and a shutdown message is displayed in multifunction gauge until shutdown.	Fuel pump wiring short circuit to ground or open circuit.
	Fuel pump current requirement is too high.
	Engine idle overheat protection: – Engine idled more than 5 seconds while engine temperature raised above 95°C (203°F). – Engine idled more than 5 minutes while engine temperature raised above 37°C (99°F).
Engine speed is limited to 2500 RPM.	D.E.S.S. key is not recognized by the ECM. The antitheft system is active. RAVE valves are kept at closed position.
Engine speed is limited to 5500 RPM (RAVE valves are kept closed).	Oil injection pump wiring shorted to ground or open circuit.
	Low voltage in the 55 Vdc system. Voltage dropped by 5 V.
	Engine overheat (85°C (185°F)). ECM overheat (100°C (212°F) and above).
	Exhaust gas temperature too high (800°C (1,472°F) and above).
	High engine detonation.

600 ACE and 1200 4-TEC

EMS ACTION	CAUSE
Engine speed is limited to 2000 RPM.	Tether cord is bad or unread. TPS voltage is too low or too high.Intake leakage. MAPTS (manifold absolute pressure and temperature sensor) is too low or too high.
Engine speed is limited to 2500 RPM.	Low engine oil pressure.
600 ACE:Engine speed is limited to 3000 RPM.	Brake lever is held down. Brake switch is stuck.
Engine speed is limited to 4500 RPM.	TPS connector is disconnected or faulty. IACV (idle air control valve) connector is disconnected or faulty. Low engine oil pressure.
Engine speed is limited to 8500 RPM.	Maximum engine RPM allowed.
Engine power is reduced.	Transmission is set to reverse.

Pilot Lamps

Warning lights in multifunction gauge and/or a beeper provide signals as vehicle operation feedback or to indicate a problem.

Pilot lamp can flash alone or in combination with another lamp.

Beeper codes will be heard and messages will be displayed to catch your attention.

NOTE: Message display is not available on all gauges.

PILOT LAMP(S)		BEEPER	MESSAGE DISPLAY (1)	DESCRIPTION
	Blinking	3 short beeps	REV. FAIL	Reverse did not engage, try again. If reverse still fails to engage, see *CHAINCASE AND REVERSE*.
	Blinking, then ON	4 short beeps every 30 seconds	ENGINE OVERHEAT	Engine is overheating, run in loose snow or stop engine immediately and let engine cool down. Check coolant level, refer to *MAINTENANCE*. Do not run the engine if condition persists.
	Blinking, then ON	Short beeps repeating rapidly	ENGINE OVERHEAT	Critical overheat. Stop engine immediately and let engine cool down. Check coolant level, refer to *MAINTENANCE*. Do not run the engine if condition persists.
	ON	4 short beeps every 5 minutes	LOW OIL	Low engine oil pressure. Stop vehicle in a safe place then, check oil level. Fill to proper level.
	ON	4 short beeps every 5 minutes	LOW BAT HIGH BAT	Indicate a low or high battery voltage condition.
	Blinking, then ON	4 short beeps	CHECK ENGINE	Engine fault.
—		4 short beeps every 5 minutes	KNOCK	Engine detonation (RPM is limited when this condition occurs). – Ensure recommended fuel is used. – Check fuel quality, replace if necessary.
—		4 short beeps every 5 minutes	REV LIMIT	Engine RPM limited for protection when certain faults occur.
—		Short beeps repeating rapidly	SHUTDOWN	Shutdown procedure in force due to engine overheating or fuel pump problem, remove tether cord cap from engine cut-off switch.
—		—	COMMUNICATION	Communication problem between ECM and gauge. Stop engine, remove D.E.S.S. key (tether cord cap). Wait a few minutes, then start engine.
D.E.S.S.	Blinking	2 short beeps	—	Good key, vehicle ready to operate.
		2 short beeps, repeating slowly	CHECK KEY	Unable to read key (bad connection). Make sure the key is clean and correctly snapped on post.
		Short beeps repeating rapidly	BAD KEY	Invalid key or key not programmed. Use the proper key for the vehicle or have the programmed.
(Blinking)		—	—	Fuel level sender problem.

PILOT LAMP(S)	BEEPER	MESSAGE DISPLAY (1)	DESCRIPTION
—	—	THROTTLE OPEN	Throttle applied while attempting an engine start (engine cranks but won't run). Release throttle while starting.
—	—	DROWN MODE	Throttle wide open while attempting an engine start (engine cranks but won't run). Release throttle while starting.
(1) Message display is only available on premium gauge.			

FAULT CODES

A fault code is an indication that a glitch or malfunction is detected by the monitoring system of the vehicle.

When there is a problem, the EMS (engine management system) can provide fault codes to ease the troubleshooting.

The faults registered in the ECM (engine control module) are kept when the battery is disconnected.

Fault codes are broadcasted to the CAN bus and can be displayed in B.U.D.S. or in the premium multifunction gauge.

Many fault codes at the same time is likely to be caused by burnt fuse(s), a faulty relay or a problem with the vehicle wiring harness.

When using the service action suggested in the Fault section of B.U.D.S., a system circuit is referred to as follows:

MODEL	SYSTEM CIRCUIT REFERENCE	MEANING
600 HO E-TEC	J1A-26	Connector "J1A" on the ECM at the pin 26
600 ACE	A-J1	Connector "A" on the ECM at the pin J1
1200 4-TEC	A-26	Connector "A" on the ECM at the pin 26

IMPORTANT: After a problem has been solved, ensure to clear the fault(s) in the ECM using the B.U.D.S. software. This will properly reset their states.

How to Read Fault Codes Using B.U.D.S. Software

Refer to *COMMUNICATION TOOLS/B.U.D.S. SOFTWARE* section.

For more information pertaining to the faults code status and report, refer to B.U.D.S. online help or to the EMS fault code tables.

How to Read Fault Codes on the Premium Multifunction Gauge

Fault codes can also be displayed in the premium multifunction gauge. Refer to *LIGHTS, GAUGE AND ACCESSORIES*.

SPECIFIC FAULT CODES

The following gives additional information related to specific fault codes.

Fault Code P062C

600 ACE

If the speedometer works properly, you can ignore this fault code.

Fault Code P16C0, P16C1, P16C2 and P16C9

600 ACE

Check emergency engine stop switch and engine cut-off switch. If they test good and work properly, you can ignore these fault codes.

Fault Code U0155

600 ACE

If the tachometer works properly, you can ignore this fault code.

Fault Code P2279

600 ACE and 1200 4-TEC

Check intake system for leaks.

- If there is no leak and engine runs normally. Check for a faulty MAPTS (manifold absolute pressure and temperature sensor), a faulty TPS (throttle position sensor) or for a cracked air intake silencer.
- If there is no leak and fault code persists, check for fault codes pertaining to IACV (idle air control valve) or MAPTS.

Fault Code P0339

1200 4-TEC

This code could occur if the CPS picked up some electromagnetic interference from the magneto rotor.

The engine will not start or it may start and run but will hesitate when depressing throttle lever.

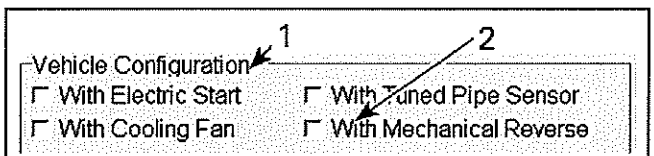
Test the CPS as described in *ELECTRONIC FUEL INJECTION*. If CPS tested good, try a new magneto rotor.

Fault Code P0750 and P0755

1200 4-TEC

This code occurs when the **Electromechanical reverse** option is selected in B.U.D.S. and the vehicle is equipped with a mechanical reverse.

Connect and start B.U.D.S. to uncheck **With Mechanical Reverse** in **ECM** page under **Setting** tab.



SETTING AND ECM TABS
1. *Vehicle configuration area*
2. *Uncheck*

FUEL TANK AND FUEL PUMP

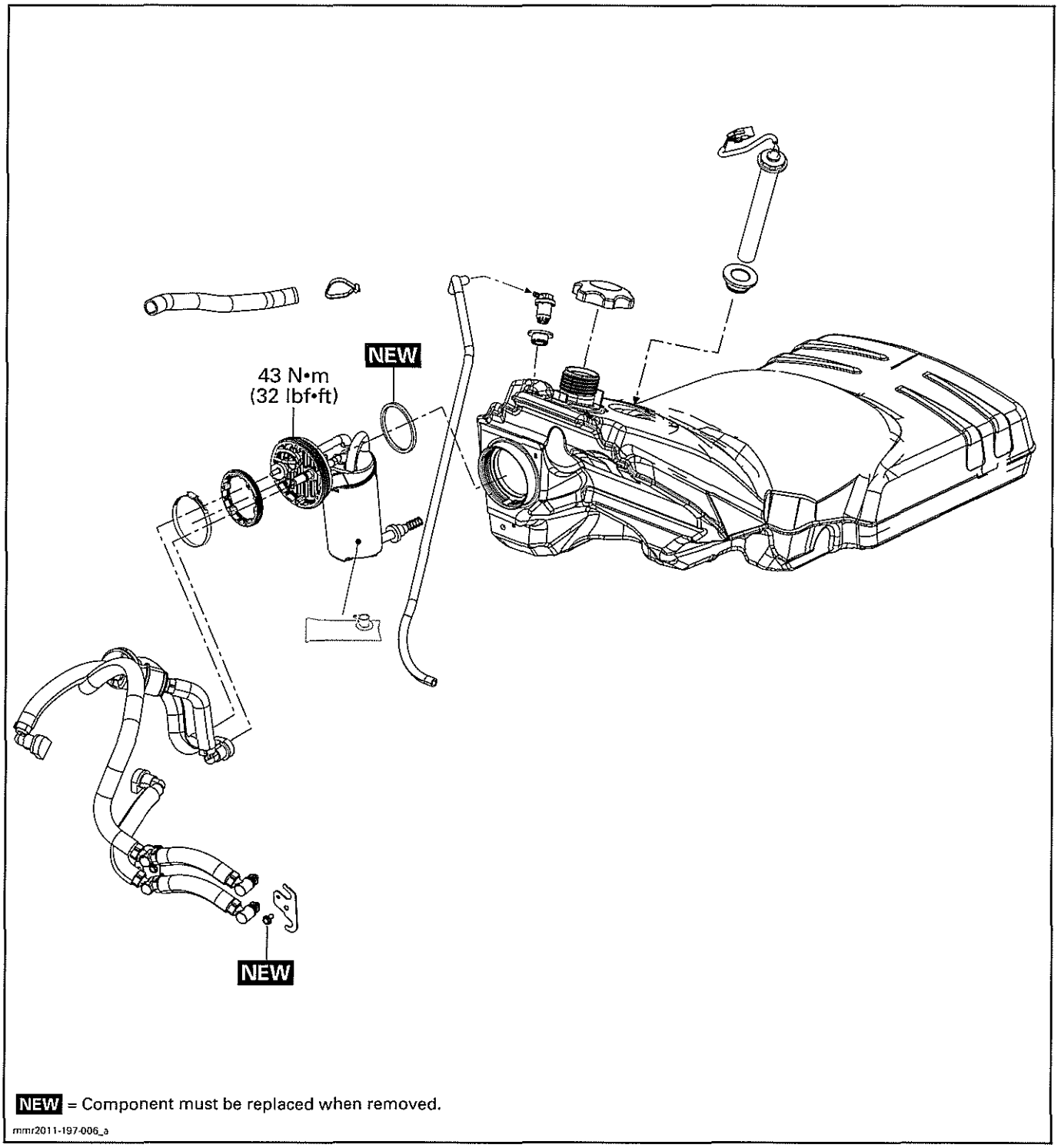
SERVICE TOOLS

Description	Part Number	Page
FLUKE 115 MULTIMETER	529 035 868	452, 457–458
FUEL HOSE ADAPTER	529 036 023	446–447
FUEL PUMP NUT TOOL	529 036 118	453
FUEL PUMP NUT TOOL	529 036 214	453
LEAK TEST KIT	529 033 100	444
PRESSURE GAUGE	529 035 709	446–447
SMALL HOSE PINCHER	295 000 076	444
T-HARNESS	529 035 869	443, 448
VACUUM/PRESSURE PUMP	529 021 800	444–445

SERVICE PRODUCTS

Description	Part Number	Page
DIELECTRIC GREASE	293 550 004	460
XPS BRAKES AND PARTS CLEANER	219 701 705	457

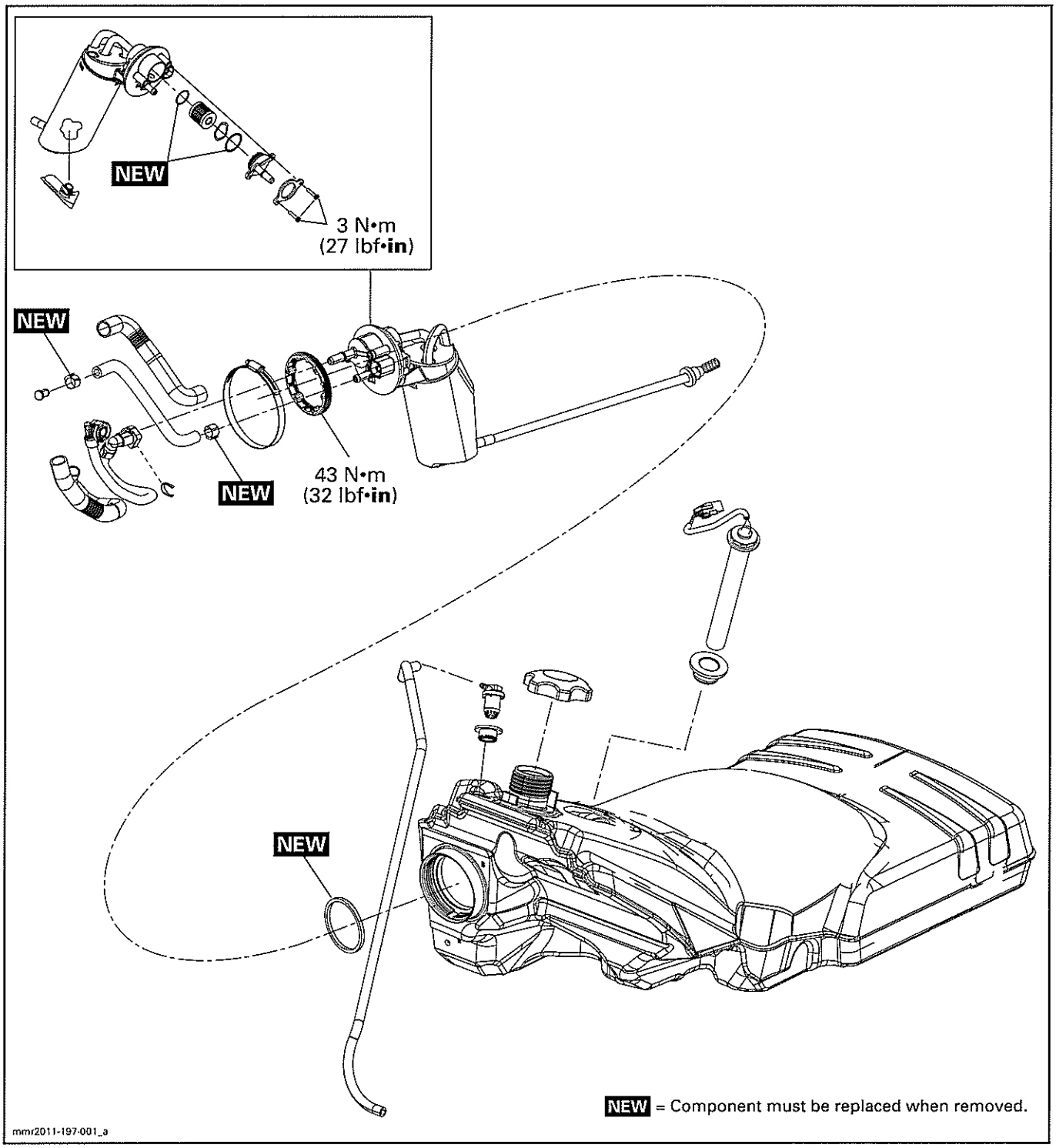
600 HO E-TEC Models



NEW = Component must be replaced when removed.

mmr2011-197-006_a

600 ACE and 1200 4-TEC Models



GENERAL

NOTE: It is a good practice to check for fault codes using B.U.D.S. as a first troubleshooting step. Refer to *DIAGNOSTIC AND FAULT CODES*.

⚠ WARNING

Always disconnect battery prior to working on the fuel system.

⚠ WARNING

Always proceed with care and use appropriate safety equipment when working on pressurized fuel system. Wear safety glasses and work in a well ventilated area. Fuel lines remain under pressure at all times.

Always release fuel pressure before disconnecting a fuel hose. Refer to *FUEL PUMP* in this subsection.

⚠ WARNING

The fuel hose may be under pressure. Cover the fuel line connection with an absorbent shop rag. Slowly disconnect the fuel hose to release the remaining pressure. Do not allow fuel to spill on hot parts. Fuel is flammable and explosive under certain conditions. Wipe off any fuel spillage inside engine compartment.

⚠ WARNING

When replacing fuel system components, use only BRP parts. They ensure to meet proper operation and safety requirements.

⚠ WARNING

After working on the fuel system, pressurize the fuel system to check for leaks. Refer to *FUEL SYSTEM PRESSURIZATION AND LEAK TEST*. Failure to do so may result in severe injury or a life threatening situation should a leak occur.

SYSTEM DESCRIPTION

Fuel Pump

An electric fuel pump is mounted in the upper RH front part of the fuel tank.

A 12 Vdc high pressure fuel pump with an integrated jet pump is used.

When the START/RER button is depressed with the emergency engine shut off switch set to ON and the tether cord cap on the engine cut-out switch, the electric fuel pump turns on for a few seconds to pressurize the fuel system in preparation for the engine start. When the engine runs, the fuel pump is ON continuously to provide a constant fuel pressure to the injectors.

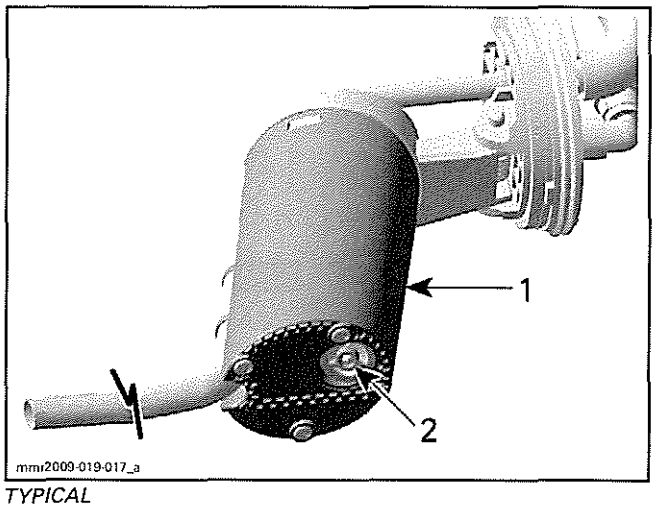
600 HO E-TEC Models

NOTE: Although the fuel pump is connected to the 55/60 Vdc system, the ECM modulates the voltage (Pulse Width Modulation) between 9 and 16 Vdc depending on the engine RPM. The fuel pump comes on upon engine cranking and its output will change as voltage changes.

All Models

To ensure a constant delivery of fuel to the engine for all riding conditions when the fuel level is low, a rear pickup and a fuel pump reservoir is used.

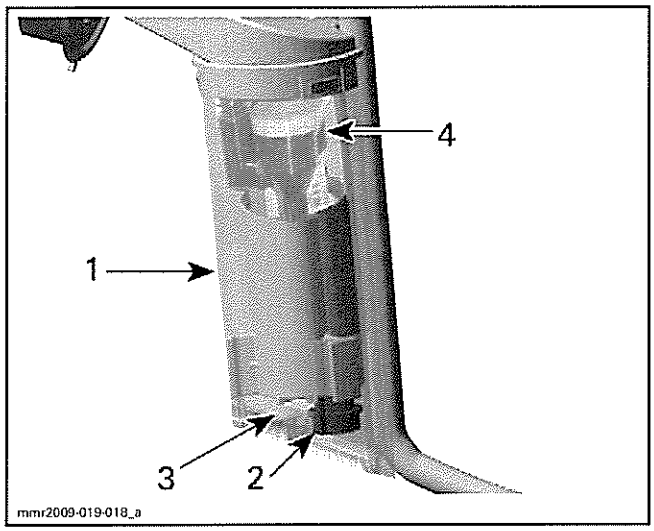
The fuel pump reservoir is actually the housing of the fuel pump module in which the fuel pump is located. A check valve at the bottom of the housing allows the fuel in the tank to enter the fuel pump reservoir.



TYPICAL
1. *Fuel pump reservoir*
2. *Check valve*

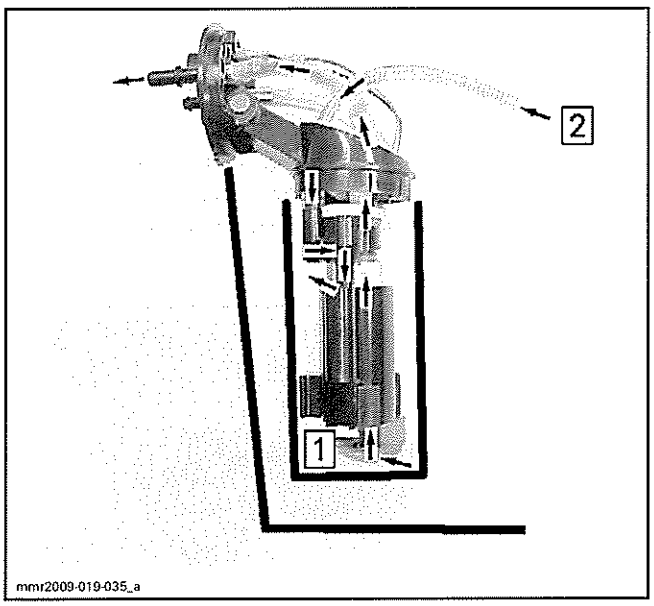
When the fuel pump runs, it draws the fuel from the fuel pump reservoir and feeds it to the injection system. This causes fuel in the tank to be drawn into the fuel pump reservoir through its bottom inlet check valve.

At the same time, a portion of the fuel flow from the electric fuel pump flows through a jet pump that contains a venturi.



TYPICAL - VIEW INSIDE FUEL PUMP RESERVOIR
1. *Fuel pump reservoir*
2. *Bottom inlet*
3. *Check valve (open upwards)*
4. *Venturi*

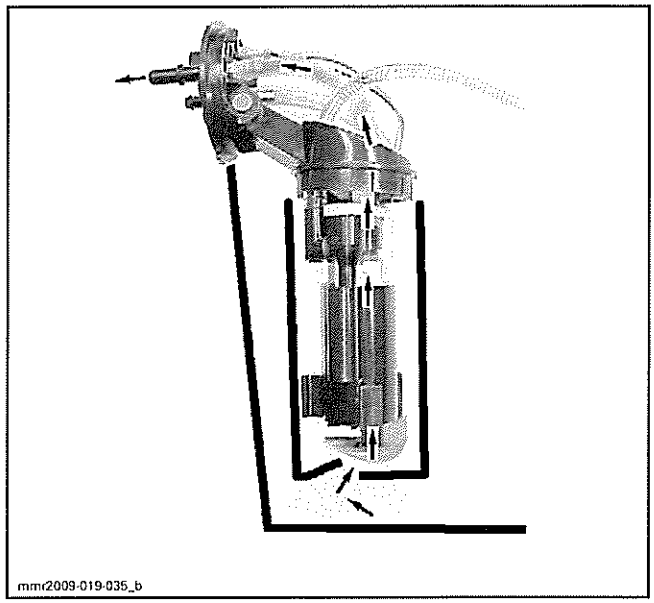
As the fuel accelerates through the venturi, it generates a low pressure area at a connection to the remote pickup, which draws fuel into the fuel pump reservoir from the remote pickup.



TYPICAL
Step 1: Bottom inlet draws fuel from fuel pump reservoir
Step 2: Low pressure from venturi draws fuel from rear pickup into fuel pump reservoir

When riding the vehicle on a level surface, fuel is drawn into the fuel pump reservoir through its check valve and through the remote pickup simultaneously, as long as there is enough fuel in the tank to cover the remote pickup.

When riding downhill with a low amount of fuel in the tank, the fuel moves towards the front of fuel tank. The check valve opens and fuel enters the fuel pump reservoir from the fuel tank through the check valve only as there is no fuel at the remote pickup.



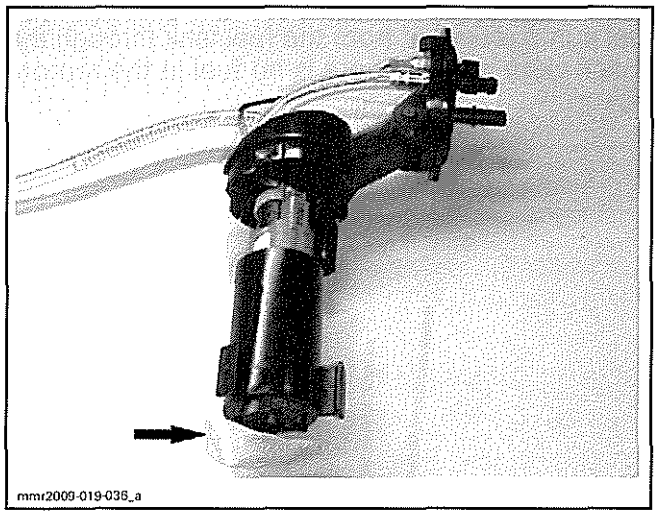
When riding uphill with a low amount of fuel in the tank, the fuel moves towards the rear of the fuel tank. The check valve closes and traps the fuel in the pump reservoir. The fuel pump continues to draw fuel from the fuel pump reservoir, which is now only fed by the jet pump using the rear pickup. This prevents air from being drawn into the fuel lines from the fuel tank.

The continuous fuel flow is also used to cool the electric fuel pump.

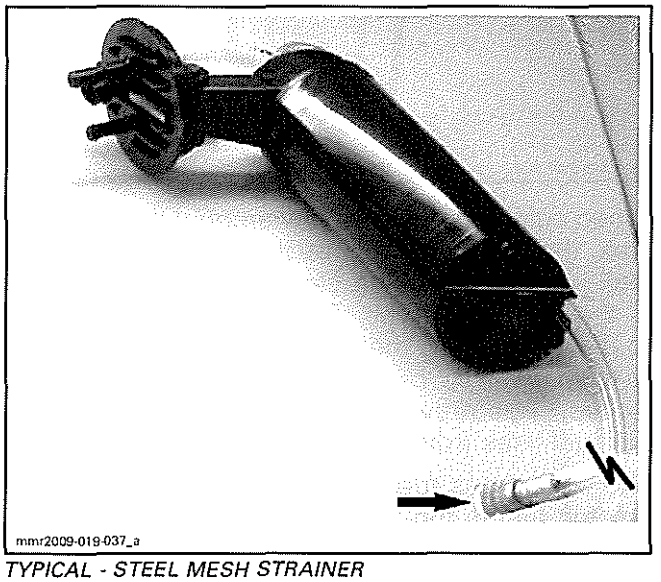
Fuel Pickup

Fuel enters the fuel pump reservoir from either a check valve at the bottom of the fuel pump reservoir, or from a remote pickup in the rear portion of the fuel tank.

The remote pickup uses a replaceable steel mesh strainer to filter out relatively large dirt particles and prevent clogging of the jet pump. The fuel entering the fuel pump reservoir through the check valve will be filtered by the fuel pump prefilter.



TYPICAL - FUEL PUMP PREFILTER



TYPICAL - STEEL MESH STRAINER

Fuel Pressure Regulator

600 HO E-TEC Models

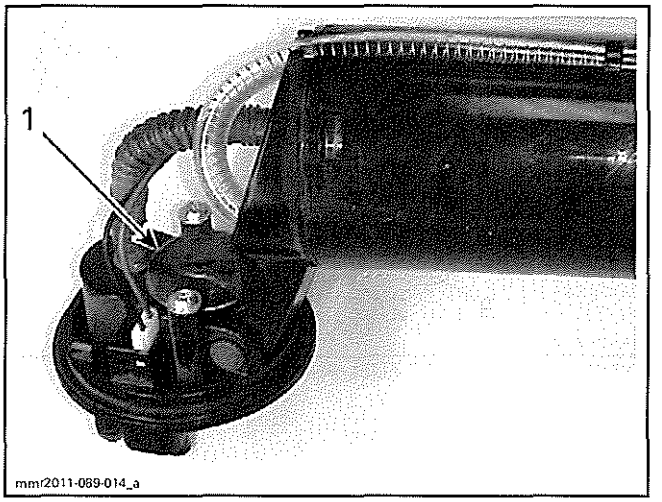
An external in-line fuel pressure regulator made of plastic is mounted over the oil tank. It is basically a spring loaded valve that opens and closes the path of fuel returning to the tank, thus maintaining a constant fuel pressure in the system.

NOMINAL REGULATED FUEL PRESSURE (600 HO E-TEC)
Approximately 303 kPa (44 PSI) at 2000 RPM (will be lower at idle)

600 ACE and 1200 4-TEC Models

A fuel pressure regulator integral to the fuel pump module is used to maintain a constant fuel pressure at the outlet of the fuel pump module.

NOMINAL REGULATED FUEL PRESSURE (600 ACE AND 1200 4-TEC)
Approximately 400 kPa (58 PSI)



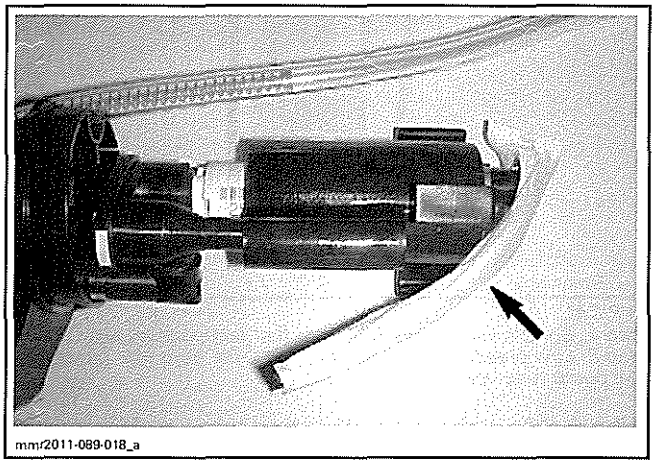
1. Fuel pressure regulator

If the fuel pump output pressure is not within specification, replace the fuel pump.

Fuel Filters

Other than the steel mesh strainer used on the remote pickup, two other replaceable filters are used to filter the fuel.

A fuel pump prefilter is used at the electric fuel pump inlet. It is a replaceable nylon mesh filter located within the fuel pump module housing (fuel pump reservoir).



FUEL PUMP PREFILTER (FUEL RESERVOIR REMOVED)

The fuel pump prefilter protects the fuel pump and prevents clogging of the fuel passages within the fuel pump module.

600 HO E-TEC Model

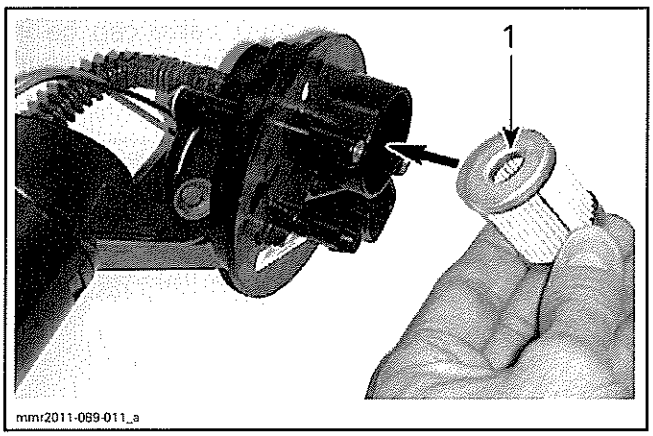
The second filter is an in-line filter on the fuel injector supply hose. It is located in front of fuel tank, above the oil tank.

It is a replaceable metallic canister type filter used to deliver dirt-free fuel to the injectors.

The fuel filter is sold as a kit that comprises an assembly of hoses, the filter, and the quick connect fittings.

600 ACE and 1200 4-TEC Models

The second filter is located at the fuel pump module outlet, within the fuel pump module mounting flange.

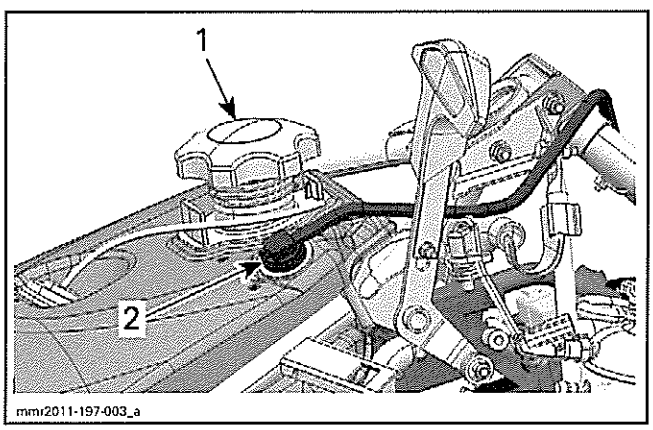


1. Fuel pump outlet filter

It is a replaceable paper cartridge type filter that is used to deliver dirt-free fuel to the injectors.

Fuel Tank Vent

The fuel tank is vented through a combination type check valve that allows ambient air pressure to enter the fuel tank at all times.



TYPICAL - VENT LOCATION
1. Fuel tank cap
2. Fuel tank vent valve

As fuel is consumed by the engine, a negative pressure would occur in the fuel tank. This could eventually prevent the engine from receiving proper fuel pressure. The **zero pressure relieve function** of the valve allows the higher outside air pressure in.

If pressure builds up and exceeds 2.0 kPa to 4.8 kPa (.3 PSI to .7 PSI) in the fuel tank, the check valve opens and lets the excess pressure vent out of the tank.

Fuel Level Sensor

A float type fuel level sensor varies its resistance with fuel level thus providing a signal to the multifunction gauge for fuel level indication.

INSPECTION

FUEL SYSTEM PRESSURIZATION AND LEAK TEST

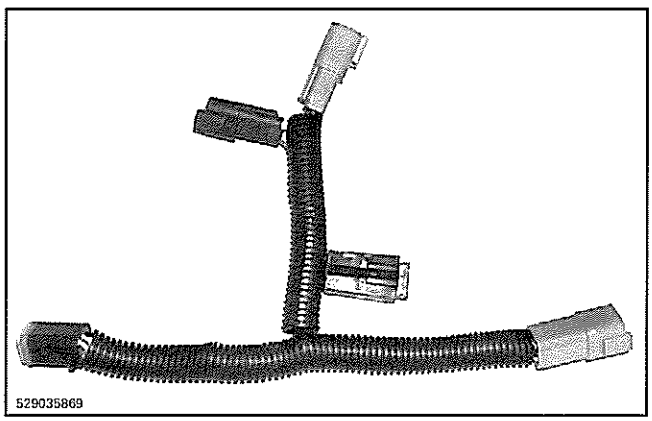
⚠ WARNING

Before starting the engine, carry out a fuel system pressurization and leak test each time a component has been removed from the fuel system.

1. Ensure all fuel lines are properly connected.
2. Set emergency engine stop switch to RUN.

NOTE: DO NOT install the tether cord cap on the engine cut-off switch.

3. Install the T-HARNESS (P/N 529 035 869) on the vehicle diagnostic connector.

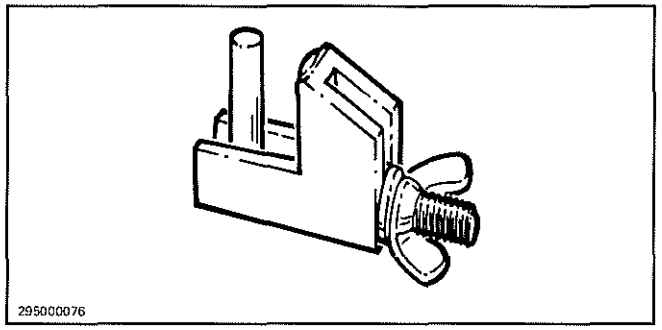


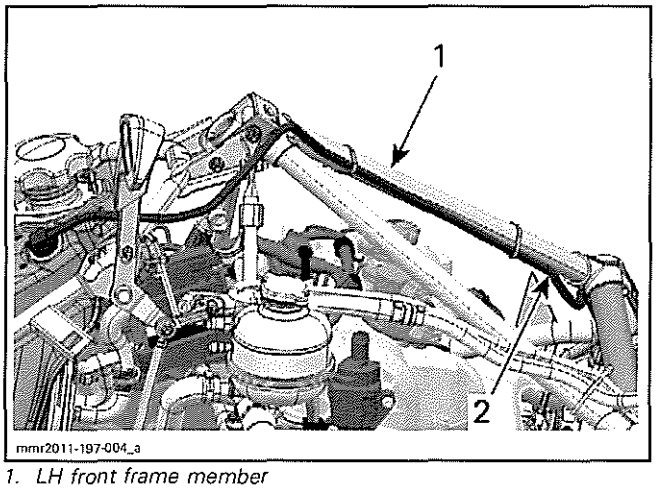
NOTE: This will power the fuel pump and pressurize the fuel system. It may be necessary to disconnect and reconnect the T-harness 3 - 4 times to cycle the fuel pump to bleed air.

4. Inspect engine compartment to detect any fuel leakage or an abnormally strong fuel odor which, may be an indication of a fuel leak that is not readily visible.
5. Repair any leak before using vehicle.

FUEL TANK LEAK TEST

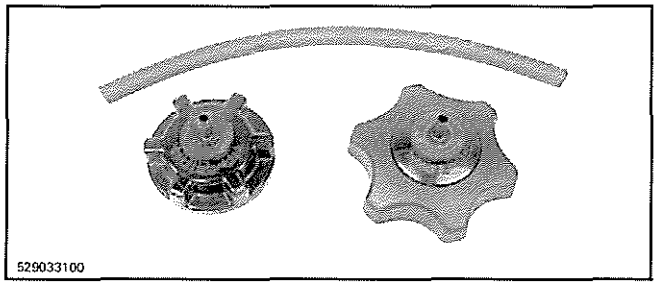
1. Refer to *BODY* subsection and remove the following to access to fuel vent hose:
   - LH and RH side panels
   - Hood.
2. Install a SMALL HOSE PINCHER (P/N 295 000 076) on the vent line.



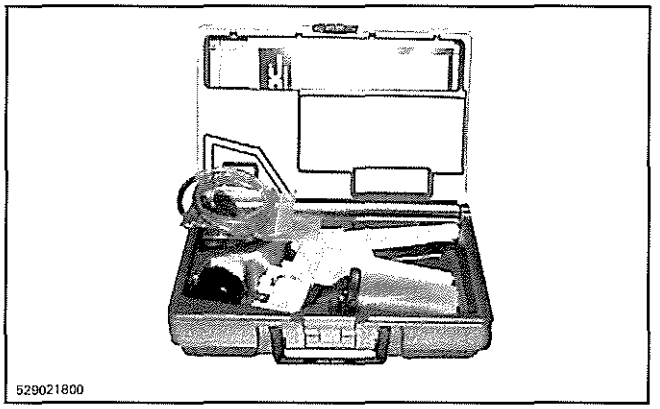


1. LH front frame member
2. Hose pincher on vent line here

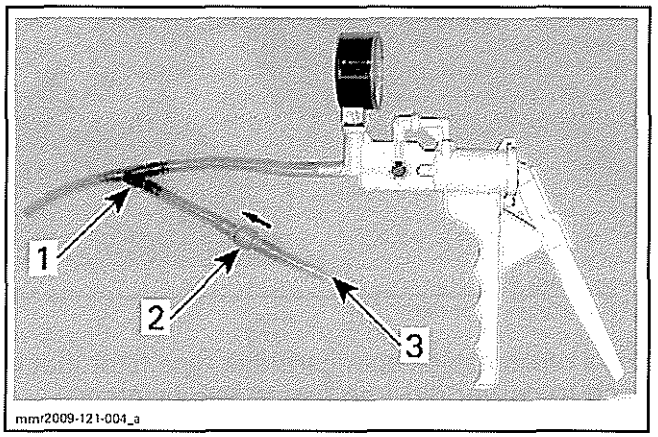
3. Install the appropriate test cap from the LEAK TEST KIT (P/N 529 033 100) on fuel tank neck.



4. Install VACUUM/PRESSURE PUMP (P/N 529 021 800) on pressure test fuel cap.



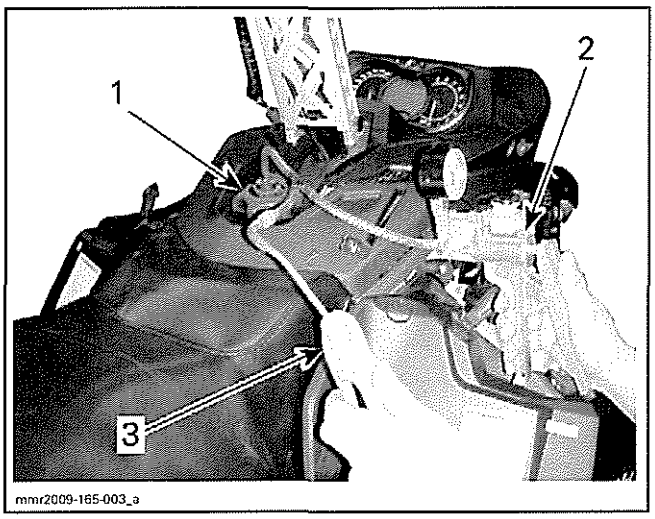
NOTE: A Y-fitting and a check valve can be installed to use compressed air for rapid pressure build-up when fuel tank is not full.



1. Y-fitting P/N 293 710 059
2. Check valve P/N 275 500 505
3. Apply compressed air here

5. Slowly increase air pressure in the fuel tank to near fuel tank test pressure specified in the following table.

NOTICE Do not exceed the specification when pressurizing the fuel tank.



TYPICAL
1. *Pressure test fuel tank cap*
2. *Vacuum/pressure pump*
3. *Compressed air supply*

6. Set vacuum/pressure pump selector to pressure.
7. Complete pressurizing fuel tank to specification using the vacuum/pressure pump.

FUEL TANK LEAK TEST	
TEST PRESSURE	TIME WITHOUT PRESSURE DROP
21 kPa (3 PSI)	3 minutes

If pressure drops, locate fuel leak and repair or replace leaking component.

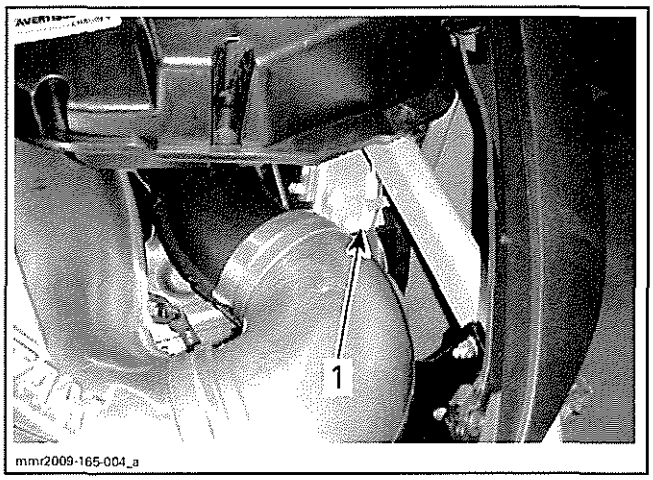
To ease locating a leak, spray soapy water on components; bubbles will indicate the location of the leak.

NOTE: If a leak is detected, always ensure the leak is not in the test equipment before assuming it is in the fuel system.

Fuel Tank Vent Valve Test

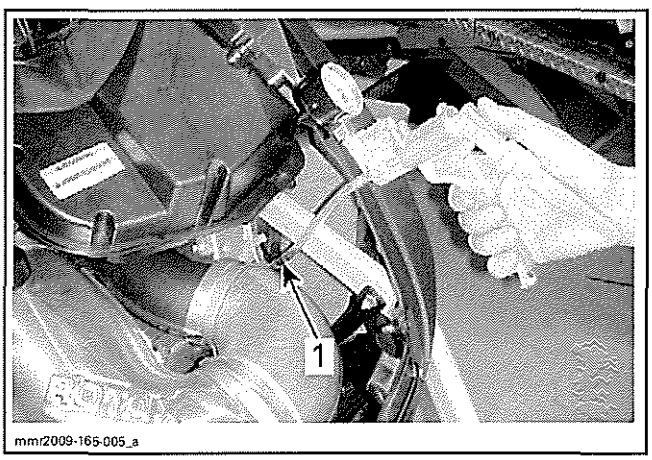
While the fuel tank is still pressurized from the previous test, carry out the following:

1. Place a finger over the fuel tank vent hose outlet.



TYPICAL - E-TEC MODEL ILLUSTRATED
1. *Fuel tank vent outlet*

2. While removing the hose pincher, alternately touch and release vent hose outlet. You should feel pressurized air flowing out, indicating the pressure relief valve function of the vent valve is working. Otherwise, replace the vent valve.
3. Release any remaining pressure in the fuel tank by slowly unscrewing pressure test cap.
4. Remove the pressure test cap.
5. Install the VACUUM/PRESSURE PUMP (P/N 529 021 800) on the end of the vent line and apply air pressure through the check valve. Air must flow freely towards the fuel tank neck.



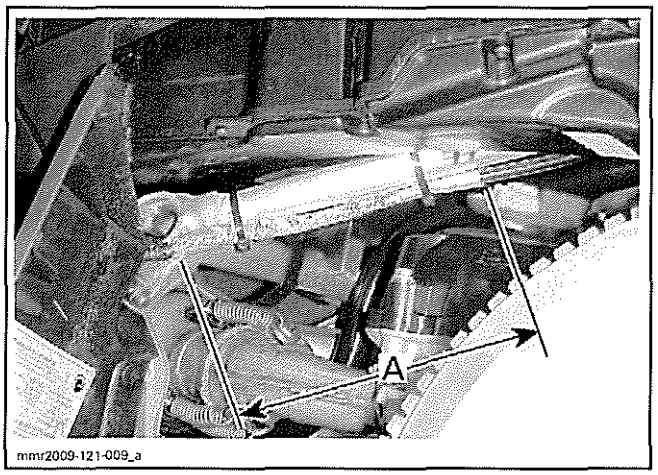
TYPICAL
1. *Apply pressure through vent hose end*

If fuel vent check valve does not function as indicated in test, replace vent valve.

6. Remove vacuum/pressure pump.
7. Secure vent line as prior to vent valve test.
8. Install the vehicle fuel tank cap.

Expedition Models

NOTE: Ensure there is a heat shield in good condition on the vent tube where illustrated.



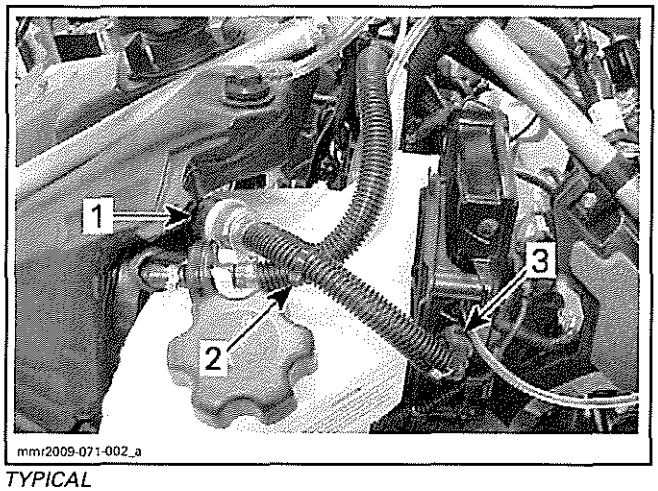
TYPICAL
A. Heat shield in this area

NOTICE A damaged or missing heat shield could allow the tube to melt due to exhaust system heat.

FUEL PUMP PRESSURE TEST (600 HO E-TEC)

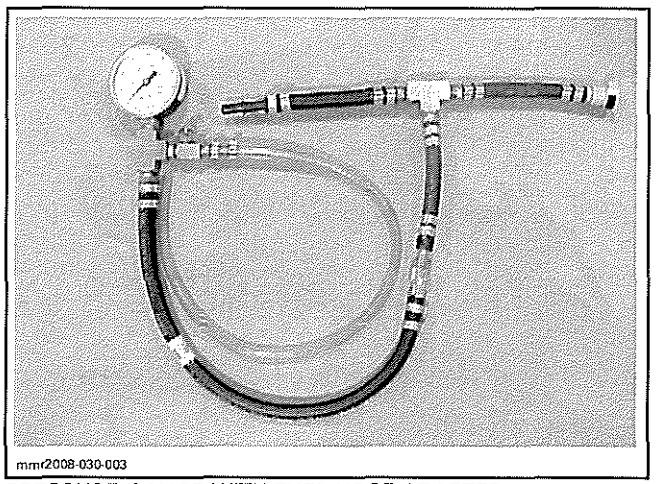
The pressure test will show the available pressure at the fuel pump outlet. It validates the pressure regulator and the fuel pump.

1. Ensure there is enough gas in fuel tank.
2. Release the fuel pressure in the system. Refer to *ELECTRIC FUEL PUMP (600 HO E-TEC)* in this subsection.
3. Install a rag under the ECM hose quick connect to catch fuel spillage.
4. Disconnect fuel supply hose from ECM.

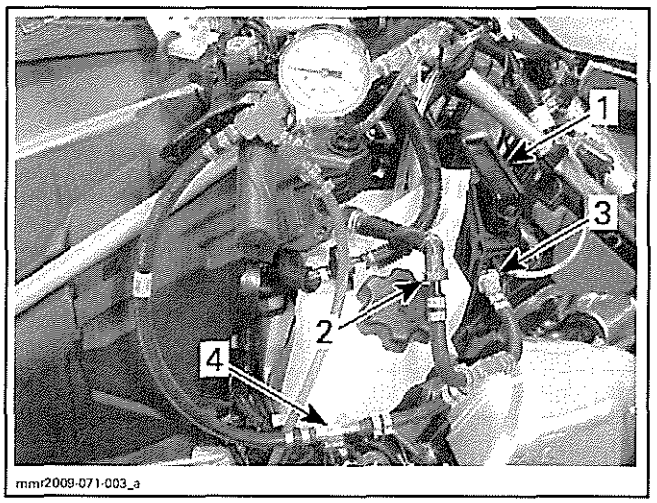


TYPICAL
1. ECM
2. Fuel pressure hose
3. Release button, quick disconnect fitting

5. Install the FUEL HOSE ADAPTER (P/N 529 036 023) and the PRESSURE GAUGE (P/N 529 035 709) between fuel pressure hose and ECM.



PRESSURE GAUGE WITH FUEL HOSE ADAPTER



TYPICAL
1. ECM
2. Fuel pressure hose fitting
3. Fuel hose adapter to ECM fitting
4. Fuel hose adapter to pressure gauge

⚠ WARNING

When carrying out pressure test, ensure fuel is not leaking from test equipment onto hot exhaust system or electrical components. Ensure fuel hose do not come into contact with hot engine parts or hot exhaust system.

6. Start engine.
7. Run engine above 2000 RPM and observe the fuel pressure.

FUEL PRESSURE
303 kPa (44 PSI)

If pressure is lower than specified, momentarily block the return hose while monitoring the pressure gauge.

NOTICE Do not block the fuel return for more than 2 seconds.

If pressure rises to reach or exceed specification with the fuel return blocked, replace fuel regulator.

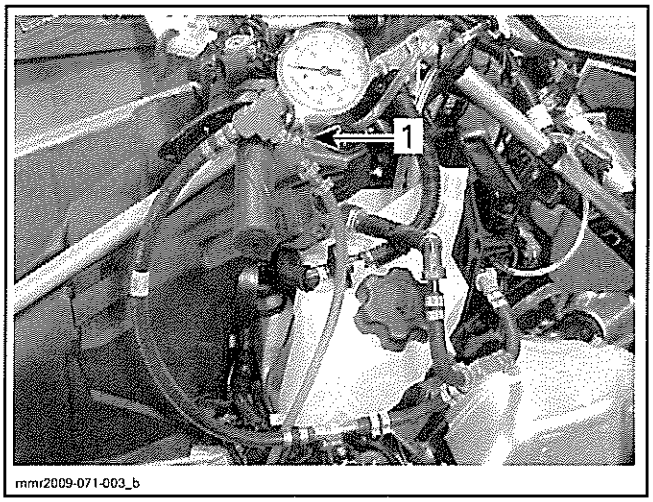
If pressure does not rise with the fuel return blocked, refer to *PRESSURE BELOW SPECIFICATIONS* in the following table.

FUEL PRESSURE TROUBLESHOOTING	
RESULT	POSSIBLE CAUSE
Pressure above specifications	Defective fuel regulator
Pressure below specifications	Clogged fuel filter
	Defective fuel regulator
	Defective fuel pump
	Leak in the fuel system circuit

8. Stop engine.

Fuel pressure should remain stable.

9. If fuel pressure drops, check the following for leaks:
   - Tools
   - Hoses
   - Fuel injectors
   - Fuel pressure regulator
   - Fuel pump.
10. Release fuel pressure in the system. Refer to *ELECTRIC FUEL PUMP (E-TEC)* in this subsection.
11. Bleed away any remaining fuel in the pressure gauge and fuel hose adapter using the bleed valve on the fuel hose adapter.



TYPICAL
1. Pressure gauge bleed valve

12. Remove pressure gauge and fuel hose adapter.
13. Reinstall the fuel pressure hose on ECM and gently but firmly pull on hose to ensure quick disconnect fitting is properly locked and secure on the ECM.
14. Reinstall all remaining removed parts.

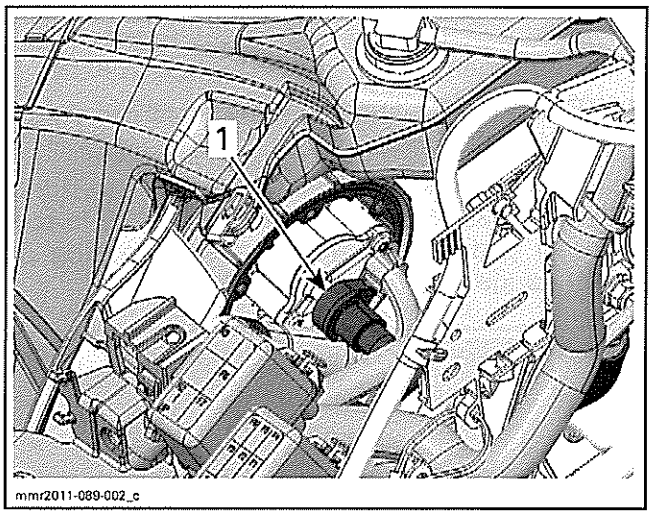
FUEL PUMP PRESSURE TEST (600 ACE AND 1200 4-TEC)

The pressure test will show the available pressure at the fuel pump outlet. It validates the pressure regulator and the fuel pump.

1. Ensure there is enough gas in fuel tank.
2. Connect applicable B.U.D.S. to the vehicle diagnostic connector. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
3. Release the fuel pressure. Refer to *FUEL PUMP* in this subsection.

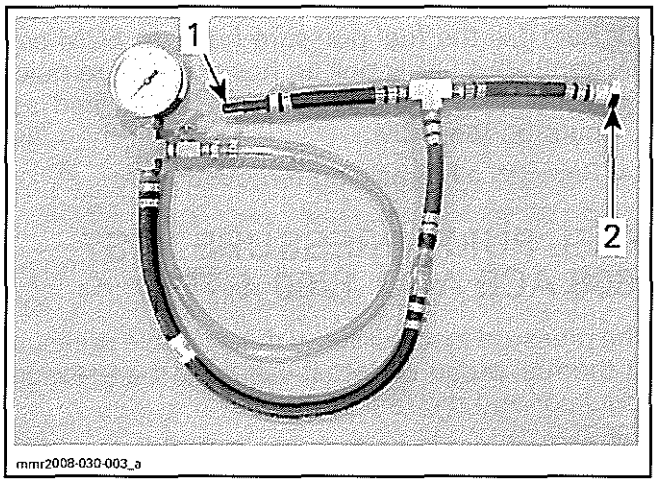
NOTE: Ensure battery cables are connected.

4. Disconnect the quick connect fitting from fuel pump.



TYPICAL
1. Disconnect this fitting

5. Install the FUEL HOSE ADAPTER (P/N 529 036 023) and the PRESSURE GAUGE (P/N 529 035 709) between the disconnected fuel hose and the fuel pump fitting.



PRESSURE GAUGE WITH FUEL HOSE ADAPTER
1. *Connects to fuel hose*
2. *Connects to fuel pump*

6. Install pressure gauge to the fuel hose adapter.

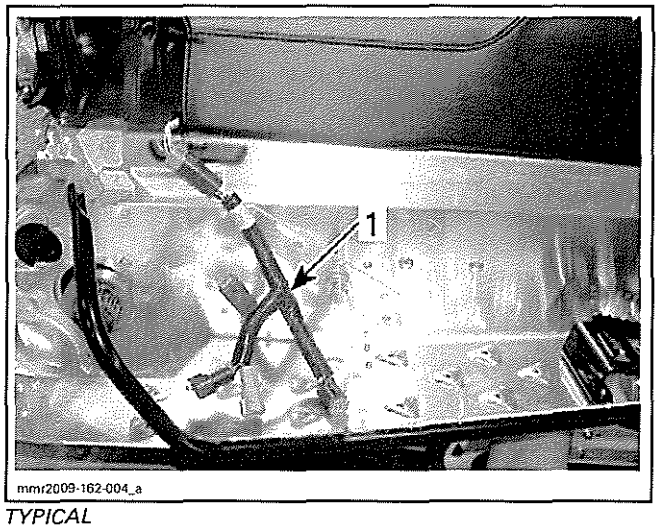
⚠ WARNING

When carrying out pressure test, ensure fuel is not leaking from test equipment. Ensure fuel hose do not come into contact with hot parts.

7. Set emergency engine stop switch to RUN.

NOTE: DO NOT install the tether cord cap on the engine cut-off switch.

8. Activate fuel pump by installing the T-HARNESS (P/N 529 035 869) on the vehicle diagnostic connector and observe fuel pressure reading on test gauge.



TYPICAL
1. *T-harness connected to diagnostic connector*

NOTE: Do not crank engine at this time.

NOTE: If fuel pressure drops, refer to *FUEL PUMP PRESSURE TEST* chart further.

9. Install the tether cord cap on the engine cut-off switch.

10. Start engine and observe pressure reading.

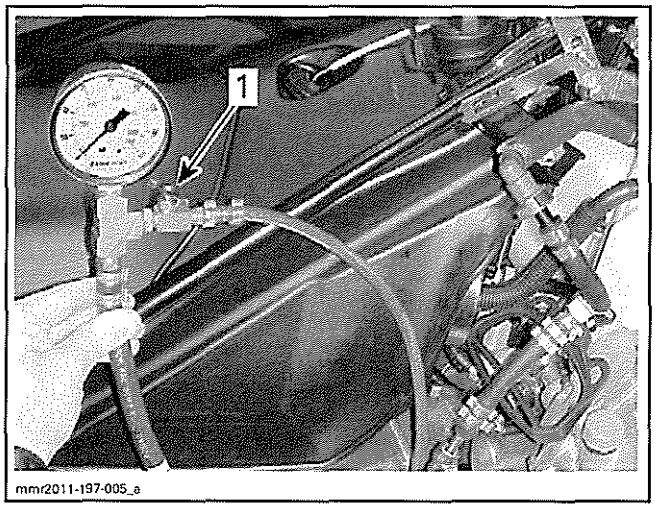
NOMINAL FUEL PUMP PRESSURE
Approximately 400 kPa (58 PSI)

11. Stop engine.

FUEL PRESSURE TEST	
RESULT	POSSIBLE CAUSE
Pressure drops (engine OFF)	Leaking test equipment
	Leaking fuel system hoses
	Leaking fuel injector(s)
	Leaking fuel pressure regulator
Pressure above specifications	Defective fuel pressure regulator.
	Test gauge not properly calibrated.
Pressure below specifications	Clogged fuel filter.
	Defective fuel pressure regulator.
	Leak in the fuel system circuit.
	Defective fuel pump.
	Leaking fuel injector(s) (engine OFF).
	Test gauge not properly calibrated.

NOTE: If the fuel pressure regulator is at fault, the fuel pump module must be replaced.

12. Release any remaining fuel pressure into an appropriate container using the bleed valve on the fuel hose adapter.



1. *Pressure gauge bleed valve*

13. Remove test equipment.

14. Reconnect fuel hose to fuel pump.

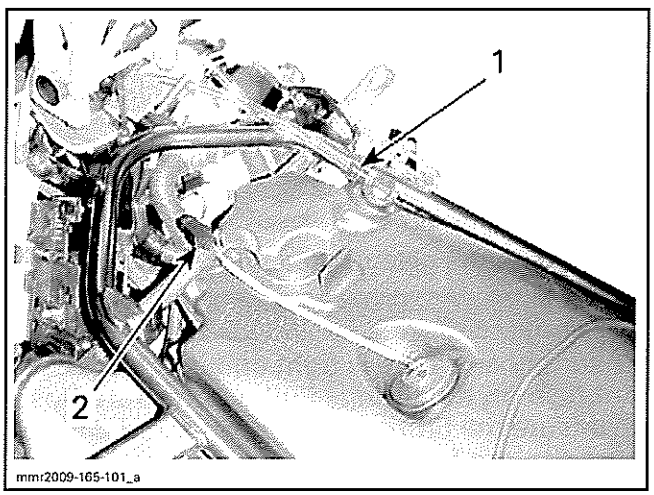
15. Pressurize the fuel system to check for leaks. Refer to *FUEL SYSTEM PRESSURIZATION AND LEAK TEST* in this subsection.
16. Reinstall all remaining removed parts.

PROCEDURES

FUEL TANK

Fuel Tank Removal

1. Remove the following items. Refer to *BODY* subsection:
   - Both side panels
   - Hood
   - Seat (s).
2. Remove gauge support and air inlet silencer as a unit, refer to *AIR INTAKE SYSTEM* subsection.
3. Remove console panel, refer to *BODY* subsection.
4. Disconnect fuel vent line from fuel tank elbow.
5. Disconnect fuel gauge level sensor.



TYPICAL
1. Vent line
2. Gauge level sensor connector

6. Remove both rear frame members, refer to *FRAME* subsection.

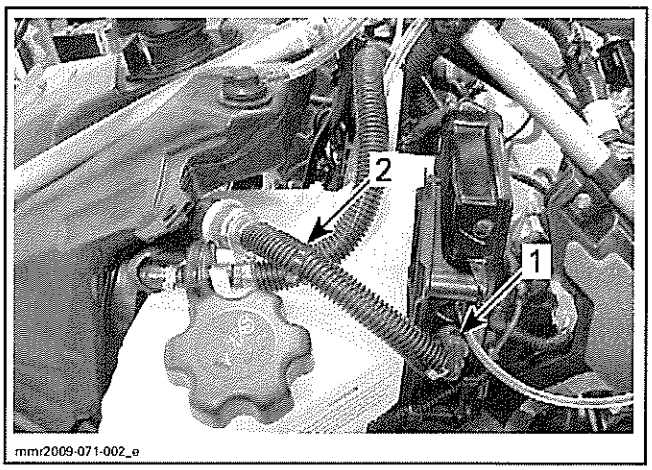
600 HO E-TEC Model

7. Release fuel pressure. Refer to *FUEL PUMP* in this subsection.
8. Disconnect ground cable from battery. Refer to *CHARGING SYSTEM* subsection.
9. Disconnect the magneto connector.

⚠ WARNING

The magneto connector must be disconnected to prevent any spark in the engine compartment and to remove power from the fuel pump. Otherwise, if engine is cranked, fuel vapors may ignite in presence of a spark creating a fire hazard.

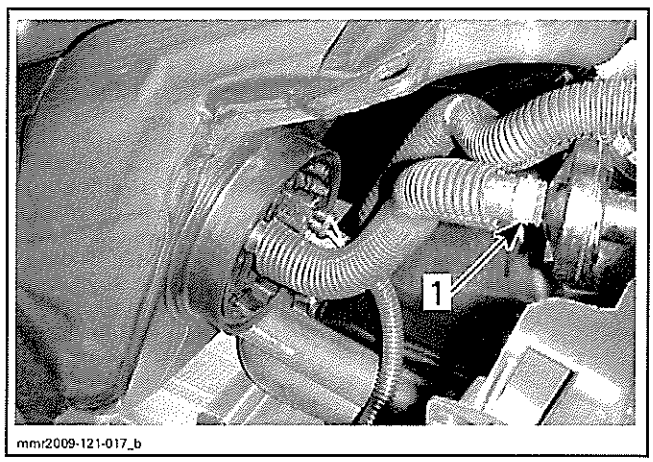
10. Cut the locking tie securing the pressure and return hoses together.
11. Install a rag under the ECM hose quick connect to catch fuel spillage.
12. Disconnect fuel supply hose from ECM.



TYPICAL
1. Fuel pressure hose fitting at ECM
2. Locking tie to remove

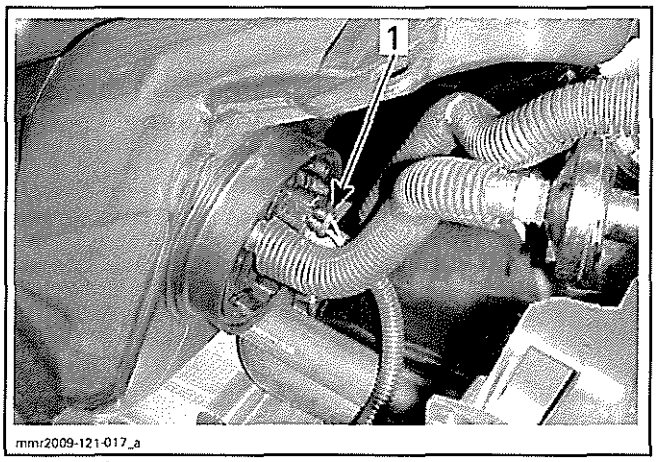
13. Cut the Oetiker clamp and disconnect the fuel return hose at the fuel pressure regulator.

NOTE: Use sheet metal snips to cut the Oetiker clamps in order to avoid putting strain on the fuel pump fittings.



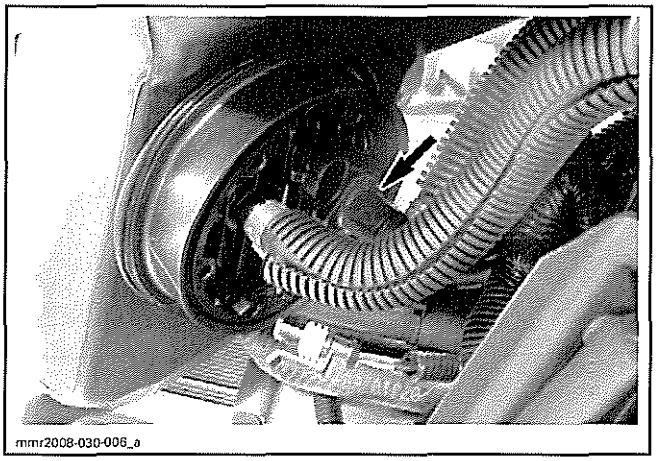
RH SIDE OF VEHICLE
1. Cut this clamp

14. Disconnect fuel pump electrical connector.



RH SIDE OF VEHICLE
1. Fuel pump connector

15. Carefully disconnect the quick connect fitting from fuel pump.

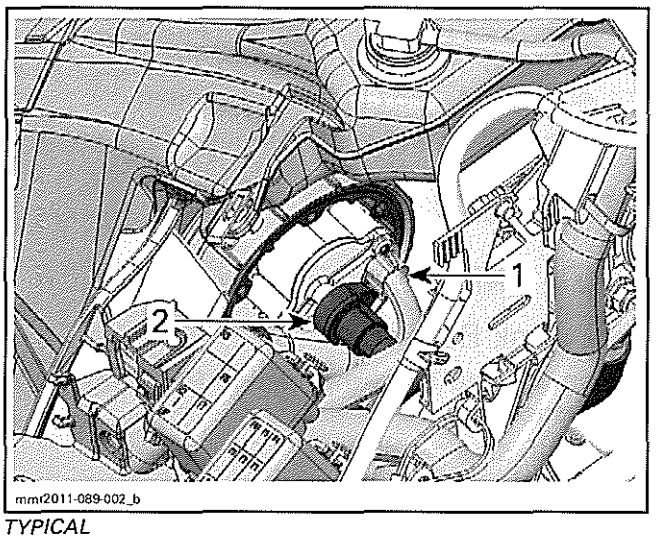


RH SIDE OF VEHICLE
1. Disconnect this fitting

16. Pull out fuel tank.

600 ACE and 1200 4-TEC Models

1. Release fuel pressure. Refer to *FUEL PRESSURE RELEASE* in this subsection.
2. Disconnect ground cables from battery. Refer to *CHARGING SYSTEM* subsection.
3. Disconnect the electrical connector and fuel pressure hose from the fuel pump.



TYPICAL
1. Fuel pump electrical connector
2. Fuel pressure hose

4. Remove fuel tank.

Fuel Tank Installation

Installation procedures are the reverse of the removal procedures. However, pay attention to the following.

600 HO E-TEC Model

1. Position fuel tank on vehicle close to its normal position and make the following connections in the specified order:
   - Fuel return hose to fuel pressure regulator using a NEW Oetiker clamp
   - Fuel pump pressure hose
   - Fuel pump electrical connector.

⚠ WARNING

Ensure hose clamp is tight and that hose cannot turn on the fitting. Pull on pressure hose to ensure the fitting is properly locked and secured to the fuel pump.

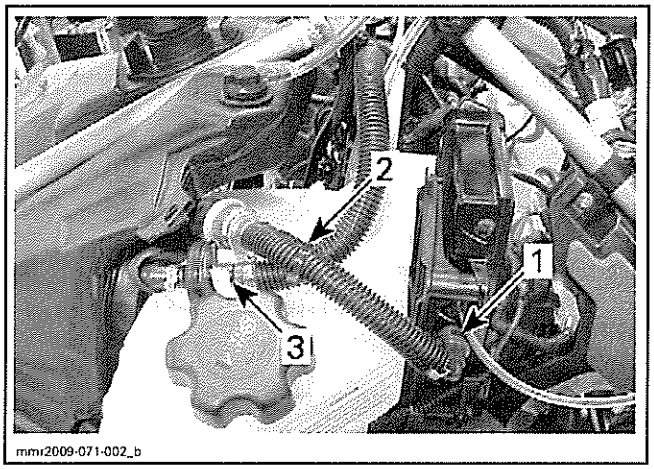
2. Remove hose pincher and move tank forward to its normal position.
3. Connect pressure hose to ECM and pull on hose to ensure it is properly locked and secure.

⚠ WARNING

Pull on pressure hose to ensure the fitting is properly locked and secured to the ECM.

4. Secure the following to oil injector tank as prior to removal
   - Pressure hose

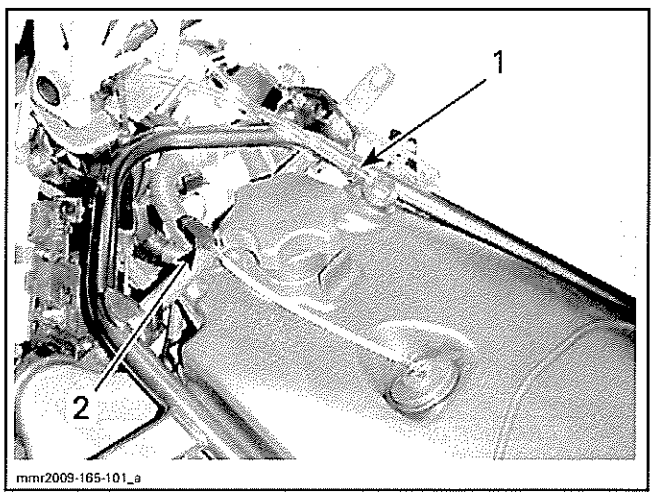
– Return hose
– Pressure regulator.



TYPICAL
1. *Ensure quick disconnect secure on ECM*
2. *Locking tie installed*
3. *Pressure regulator in holder*

5. Connect the following:
   – Fuel tank vent hose
   – Fuel level sensor connector.

NOTICE Ensure vent tube is not kinked or pinched.



TYPICAL
1. *Vent line*
2. *Gauge level sensor connector*

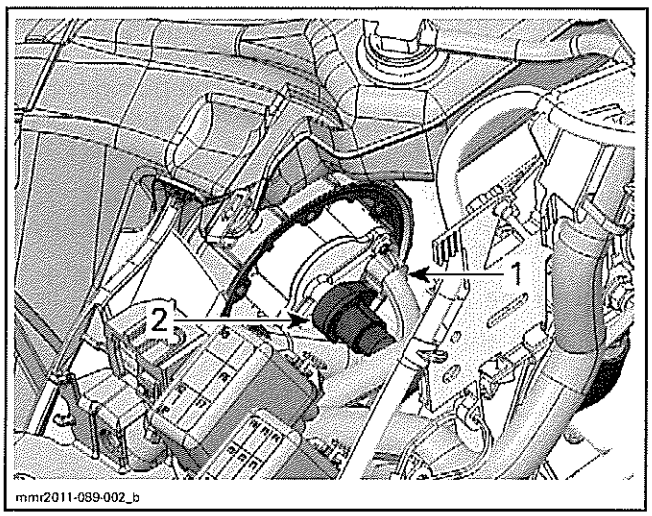
6. Reconnect battery and magneto connector, refer to *CHARGING SYSTEM (600 HO E-TEC)* subsection.
7. Carry out a fuel tank leak test. Refer to *FUEL TANK LEAK TEST* in this subsection.
8. Refuel tank.
9. Pressurize the fuel system to check for leaks. Refer to *FUEL SYSTEM PRESSURIZATION AND LEAK TEST* in this subsection.
10. Install the remaining removed parts, refer to applicable subsections for details.

600 ACE and 1200 4-TEC Models

1. Position fuel tank on vehicle close to normal position and make the following connections:
   – Fuel pump electrical connector
   – Fuel pump pressure hose.

⚠ WARNING

Pull on pressure hose to ensure the fitting is properly locked and secured to the fuel pump.



TYPICAL - RH SIDE OF VEHICLE
1. *Fuel pump connector*
2. *Fuel pressure hose*

2. Move fuel tank to its normal position and connect:
   – Fuel level sensor connector
   – Fuel tank vent hose.
3. Reconnect battery.
4. Carry out a fuel tank leak test. Refer to *FUEL TANK LEAK TEST* in this subsection.
5. Pressurize the fuel system to check for leaks. Refer to *FUEL SYSTEM PRESSURIZATION AND LEAK TEST*.
6. Install all remaining parts, refer to applicable subsections for details.

FUEL PUMP

Releasing Fuel Pump Pressure

1. Connect B.U.D.S. to the vehicle diagnostic connector. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.

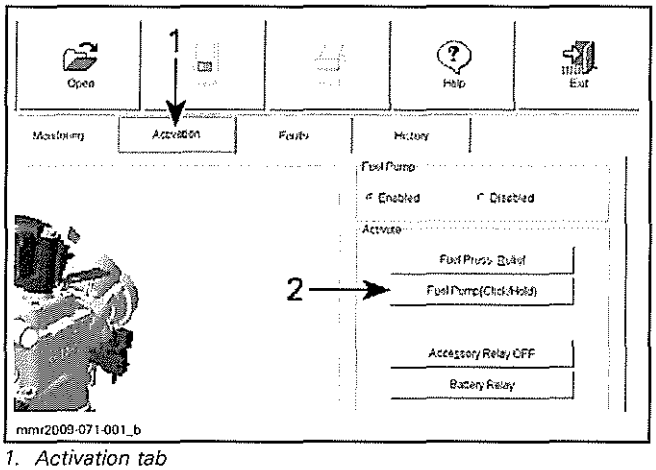
2. Release the fuel pressure by selecting the following in B.U.D.S.:
   2.1 Read Data
   2.2 Activation tab
   2.3 ECM tab in the lower LH corner of the Activation page
   2.4 Fuel Press. Relief button in the Activate area.
3. Run engine until it runs out of gas.

Fuel Pump Operational Test

600 HO E-TEC

NOTE: Activating the fuel pump as described in this procedure can be used for purging air from the fuel system whenever a fuel hose has been disconnected and reconnected. The pump should be activated for 15 seconds to ensure proper purging of the system.

1. Connect vehicle to the latest B.U.D.S. software, refer to *COMMUNICATION TOOLS AND B.U.D.S. SOFTWARE* subsection.
2. Select the ECM and Activation tabs.
3. Click on the Fuel Pump (Click/Hold) button in the Activate field.



1. Activation tab
2. Fuel Pump (Click/Hold) button

4. Listen for fuel pump operation.

NOTE: The fuel pump should run as long as you hold the Fuel Pump (Click/Hold) button in B.U.D.S.

If you do not hear the pump come ON, select the Faults tab in B.U.D.S. and check for fault codes.

If there is no fault code, connect a known good fuel pump to the vehicle harness (in parallel) and repeat the test.

If the second fuel pump functions when connected to the vehicle harness, then replace the fuel pump installed in the vehicle.

600 ACE and 1200 4-TEC

1. Set emergency engine stop switch to RUN.
2. Install the tether cord cap on the engine cut-off switch.
3. Briefly press START/RER button, DO NOT crank engine.

You should hear the fuel pump running for approximately 2 seconds.

If the fuel pump does not run:

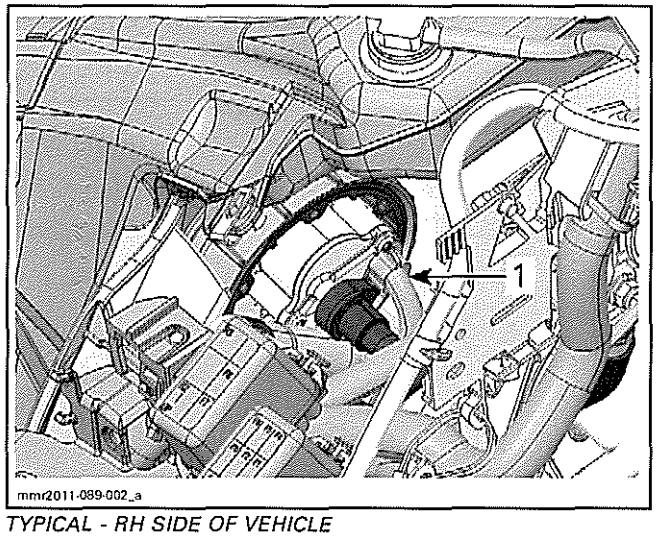
- Ensure ECM is powered. Refer to *ELECTRONIC FUEL INJECTION* subsection.
- Check Fuel Pump/Starter Solenoid fuse. If fuse is faulty, replace it and repeat test. If fuse is good, carry out the *FUEL PUMP INPUT VOLTAGE TEST* in this subsection.

Fuel Pump Input Voltage Test

600 ACE and 1200 4-TEC Only

1. Disconnect fuel pump connector.

NOTE: A screwdriver can be used to disconnect and reconnect the connector.



TYPICAL - RH SIDE OF VEHICLE
1. Fuel pump connector

2. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Vdc.
3. Set emergency engine stop switch to RUN.
4. Briefly press START/RER button, DO NOT crank engine.
5. Probe terminals and read the input voltage as follows.

FUEL PUMP HARNESS CONNECTOR		VOLTAGE
Pin C (+ probe)	Pin A (- probe)	Battery voltage for approximately 2 seconds, then voltage should drop by approximately 0.5 V

If test succeeded, power and ground circuits are good. Replace fuel pump.

If test failed, carry out the following test.

6. Briefly press START/RER button, DO NOT crank engine.

FUEL PUMP HARNESS CONNECTOR		VOLTAGE
Pin C (+ probe)	Battery ground (- probe)	Battery voltage

If battery voltage is read, carry out a continuity test of the fuel pump control circuit to the ECM. Refer to the wiring diagram.

If battery voltage is not read, carry out a continuity test of the fuel pump power circuit. Refer to the wiring diagram.

Fuel Pump Removal

1. Release fuel system pressure. Refer to *RELEASING FUEL PUMP PRESSURE* in this subsection.
2. Disconnect ground cable from battery. Refer to *CHARGING SYSTEM.*

600 HO E-TEC Model

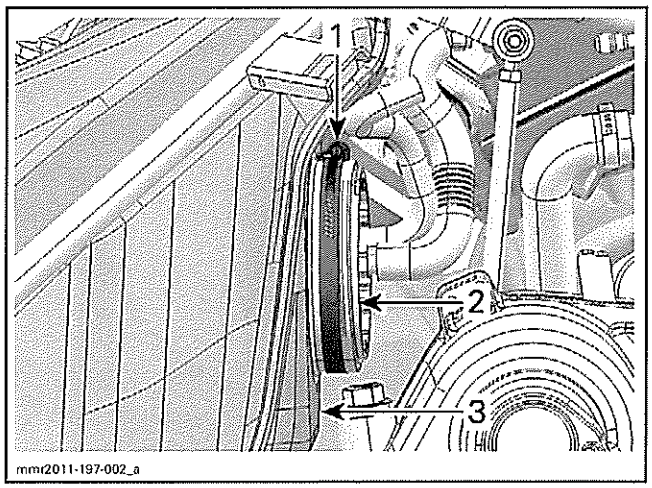
3. Disconnect magneto connector.

⚠ WARNING

The magneto connector must be disconnected to prevent any spark in the engine compartment and to remove power from the fuel pump. Otherwise, if engine is cranked, fuel vapors may ignite in presence of a spark creating a fire hazard.

All Models

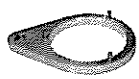
4. Remove fuel tank. Refer to *FUEL TANK REMOVAL* in this subsection.
5. Empty fuel tank.
6. Remove gear clamp from fuel pump mounting flange on fuel tank.

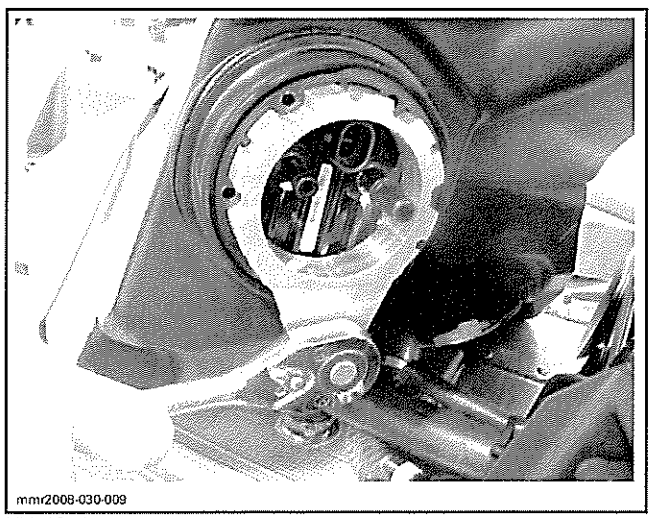


TYPICAL
1. *Gear clamp to remove*
2. *Fuel pump*
3. *Fuel tank*

7. Remove fuel pump retaining nut using appropriate fuel pump nut tool.

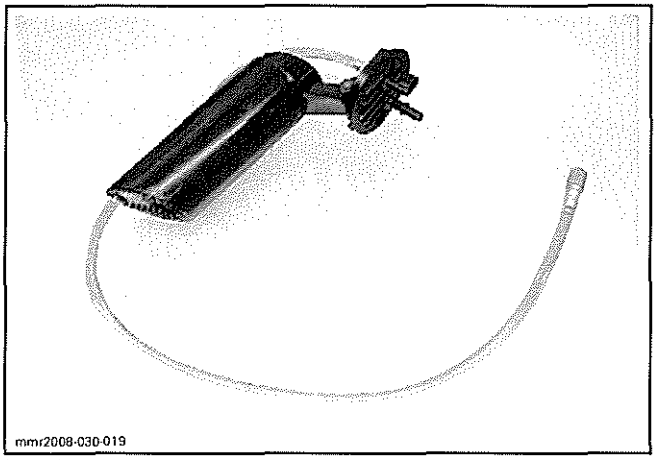
600 HO E-TEC	
FUEL PUMP NUT TOOL (P/N 529 036 118)	

600 ACE AND 1200 4-TEC	
FUEL PUMP NUT TOOL (P/N 529 036 214)	



TYPICAL

8. Remove fuel pump.



TYPICAL

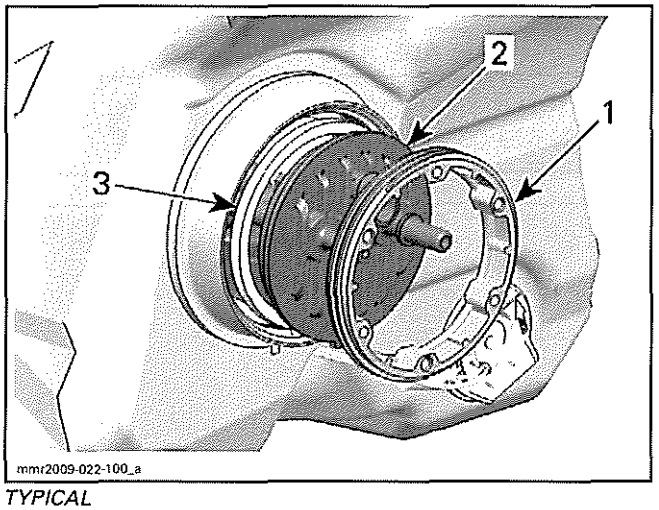
9. Remove and discard fuel pump gasket.

Fuel Pump Installation

For installation, reverse the removal procedure. However, pay attention to the following.

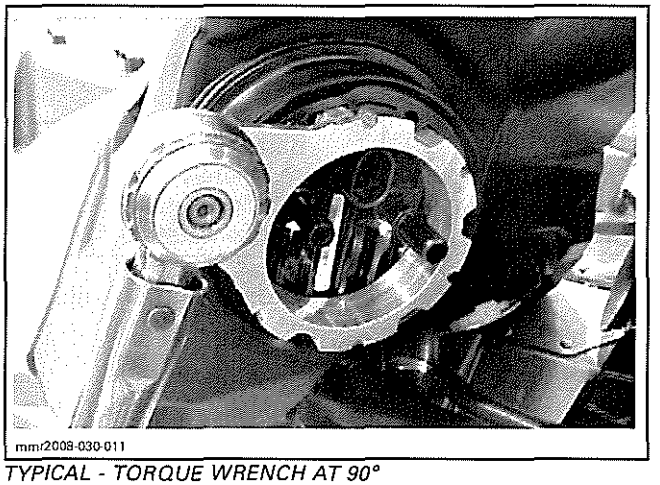
1. Install a NEW gasket on the fuel pump.

NOTE: Locate gasket between the fuel pump and the fuel fuel tank.



TYPICAL
1. *Nut*
2. *Fuel pump*
3. *Gasket*

2. Install a torque wrench perpendicularly (90°) to the appropriate fuel pump nut tool as indicated in *FUEL PUMP REMOVAL*.
3. Torque fuel pump nut as specified in exploded view.



TYPICAL - TORQUE WRENCH AT 90°

TORQUE - FUEL PUMP NUT
43 N•m (32 lbf•ft)

4. Reinstall fuel tank. Refer to the *FUEL TANK INSTALLATION* in this subsection.
5. Refuel tank.
6. Carry out a fuel tank leak test, refer to *FUEL TANK LEAK TEST* in this subsection.
7. Carry out a fuel system leak test, refer to *FUEL SYSTEM PRESSURIZATION AND LEAK TEST* in this section.

⚠ WARNING

After working on the fuel system, carry out a fuel system pressurization and leak test to ensure there aren't any fuel leaks.

FUEL PRESSURE REGULATOR (600 ACE AND 1200 4-TEC)

The fuel pressure regulator is integral to the fuel pump module. It ensures proper fuel pump output pressure.

If the fuel pump fails the *FUEL PUMP PRESSURE TEST (600 ACE AND 1200 4-TEC)*, replace the fuel pump module.

FUEL PRESSURE REGULATOR (600 HO E-TEC)

The fuel pressure regulator is an in-line type and is acquired as an assembly with the fuel return hose.

Fuel Pressure Regulator Removal

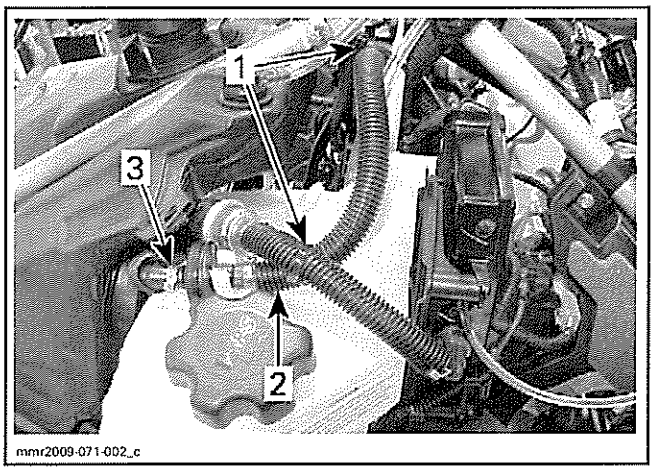
1. Release fuel pressure in the system. Refer to *ELECTRIC FUEL PUMP (E-TEC)* in this subsection.
2. Remove both side panels.

3. Disconnect magneto connector.

⚠ WARNING

The magneto connector must be disconnected to prevent any spark in the engine compartment and to remove power from the fuel pump. Otherwise, if engine is cranked, fuel vapors may ignite in presence of a spark creating a fire hazard.

4. Cut the locking ties securing the fuel return hose to the fuel supply hose and to the upper column.
5. Pull back corrugated plastic sheath and install a small hose pincher on the return hose forward of the fuel pressure regulator.
6. Remove and discard Oetiker clamp on the fuel return hose aft of the fuel pressure regulator.



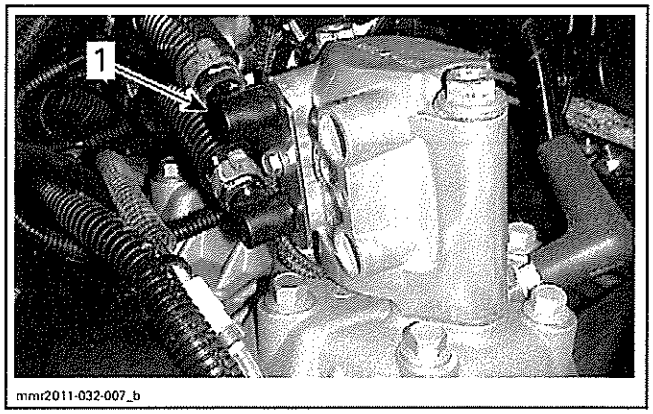
TYPICAL
1. *Locking ties to cut*
2. *Pull back plastic sheath and install hose pincher here*
3. *Remove this Oetiker clamp*

7. Disconnect fuel return hose from the pressure regulator fitting.

NOTE: Place a container under the fuel return hose and drain the fuel remaining in hose.

8. Remove fuel pressure regulator from holder on oil tank.
9. Place a container under the pressure regulator, remove the hose pincher, and drain the fuel in the hose.
10. Disconnect the fuel return hose from both fuel injectors, refer to the *E-TEC DIRECT FUEL INJECTION* section for specific details.

NOTE: Be sure to place shop rags around the injector hose fittings to catch the fuel spillage.



1. *Fuel return hose*

11. Remove fuel pressure regulator hose assembly from vehicle.

Fuel Pressure Regulator Installation

For installation, reverse the removal procedures. However, pay attention to the following.

Be sure to strictly follow the procedures in the *E-TEC DIRECT FUEL INJECTION* subsection when reconnecting fuel return hose to injectors.

Install a NEW Oetiker clamp to retain the fuel return hose to the fuel pressure regulator.

⚠ WARNING

Ensure hose clamp is tight and that hose cannot turn on the fitting.

When installation is complete, carry out a fuel system leak test, refer to *FUEL SYSTEM PRESSURIZATION AND LEAK TEST* in this section.

⚠ WARNING

After working on the fuel system, carry out a fuel system pressurization and leak test to ensure there aren't any leaks.

FUEL PUMP INLET FILTER

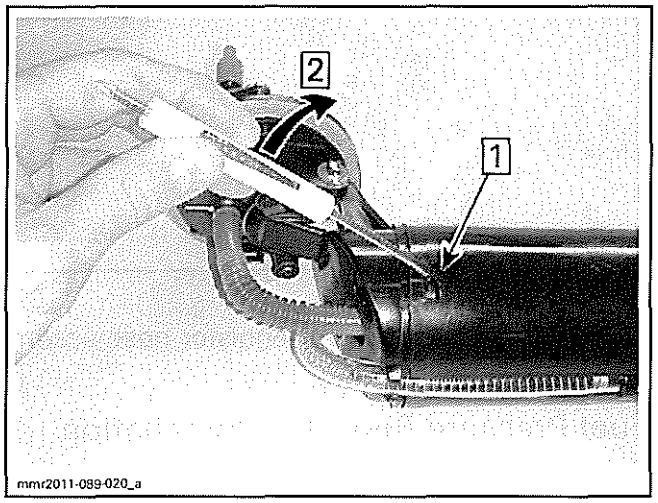
Fuel Pump Inlet Filter Location

The fuel pump inlet filter is attached to the electric fuel pump inlet, within the fuel pump module housing (fuel pump reservoir).

Fuel Pump Inlet Filter Replacement

1. Remove fuel pump module from fuel tank, refer to *FUEL PUMP REMOVAL* in this subsection.
2. Remove fuel pump module housing in the following manner.
   2.1 Insert a flat screwdriver between fuel pump module locking tabs (3) and fuel pump module housing.

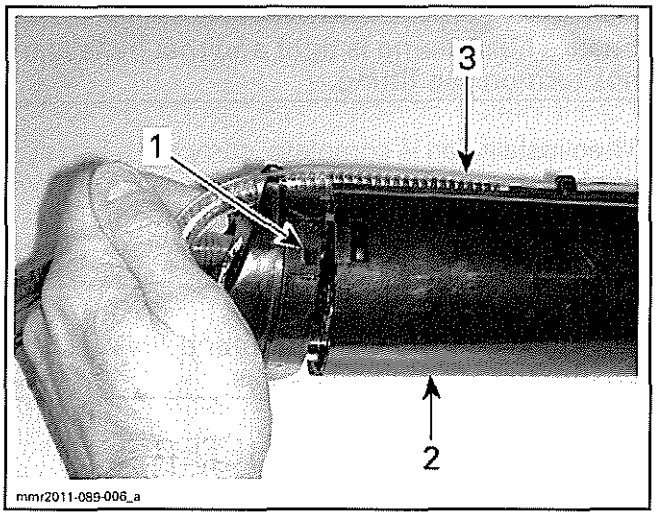
2.2 Carefully pry up on screwdriver handle to depress locking tabs and release fuel pump module housing.



Step 1: Insert flat screwdriver between each locking tab (3) and fuel pump module housing
Step 2: Pry up on screwdriver to depress locking tabs and release housing

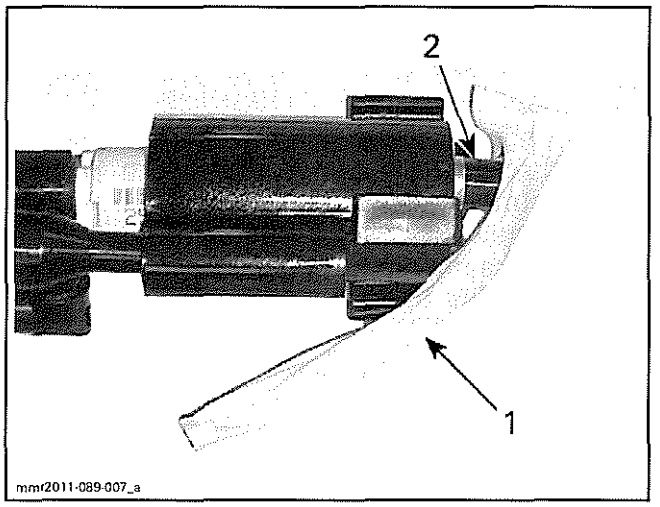
2.3 Pull housing off fuel pump module.

NOTE: It is not necessary to pull the housing off the remote fuel pickup hose.



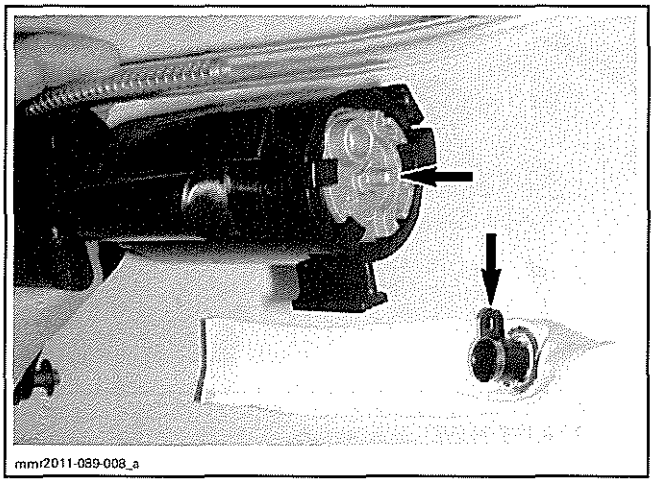
1. *Locking tabs (3)*
2. *Fuel pump housing*
3. *Remote pickup hose*

3. Pull on the flanged portion of inlet filter to remove it from bottom of the fuel pump.



1. *Fuel pump inlet filter*
2. *Inlet filter flange*

4. Install a new filter element by pushing it onto the base of the fuel pump; be sure to insert the tab of the filter element flange onto the alignment pin on the fuel pump base.



FILTER ALIGNMENT PIN AND TAB

5. Install remaining parts in the reverse order of removal.
6. Install and reconnect fuel pump module (pressure hose and electrical connector), refer to *FUEL PUMP INSTALLATION* in this subsection.
7. Carry out a *FUEL TANK LEAK TEST* as detailed in this subsection.
8. Carry out a *FUEL SYSTEM PRESSURIZATION AND LEAK TEST* as detailed in this subsection.
9. Install remaining parts in the reverse order of removal, refer to *FUEL TANK INSTALLATION* in this subsection.

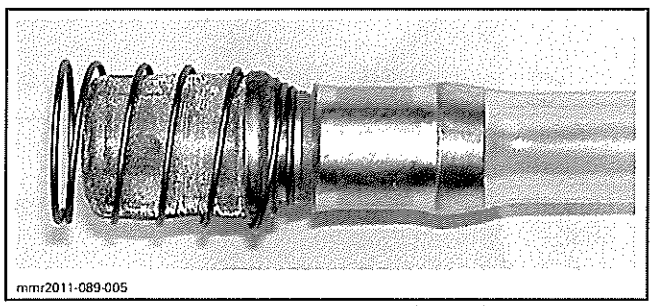
STEEL MESH FILTER

Steel Mesh Filter Location

The steel mesh fuel filter is located on the remote pickup of the fuel pump module.

Steel Mesh Filter Cleaning

1. Remove fuel pump module from fuel tank, refer to *FUEL PUMP REMOVAL* in this subsection.
2. Clean steel mesh filter on fuel pump remote pickup using low pressure filtered air and XPS BRAKES AND PARTS CLEANER (P/N 219 701 705).



STEEL MESH FILTER, FUEL PUMP REMOTE PICK-UP

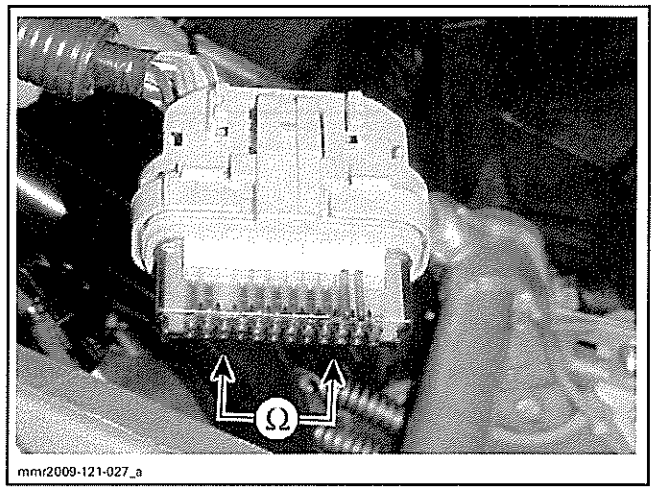
3. Install and reconnect fuel pump module (pressure hose and electrical connector), refer to *FUEL PUMP INSTALLATION* in this subsection.
4. Carry out a *FUEL TANK LEAK TEST* as detailed in this subsection.
5. Carry out a *FUEL SYSTEM PRESSURIZATION AND LEAK TEST* as detailed in this subsection.
6. Install remaining parts in the reverse order of removal, refer to *FUEL TANK INSTALLATION* in this subsection.

FUEL LEVEL SENSOR

Fuel Level Sensor Resistance Test (in Circuit)

1. Disconnect the multifunction gauge connector. Refer to *LIGHTS, GAUGE AND ACCESSORIES.*
2. Use the FLUKE 115 MULTIMETER (P/N 529 035 868).
3. Set multimeter to Ω.
4. Probe terminals and read the sensor resistance as follows.

FLOAT POSITION (ACCORDING TO FUEL LEVEL)	MULTIFUNCTION GAUGE HARNESS CONNECTOR		RESISTANCE @ 20°C (68°F)
Full	Pin 12	Pin 15	8.8 Ω ± 1.3 Ω
Empty			91.5 Ω ± 5.5 Ω

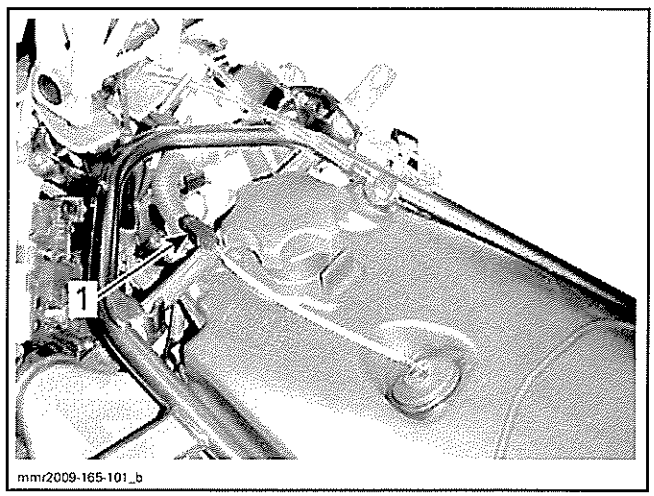


If test succeeded, refer to *FUEL LEVEL SENSOR INPUT VOLTAGE TEST.*

If test failed, refer to *FUEL LEVEL SENSOR RESISTANCE TEST (SENSOR ONLY).*

Fuel Level Sensor Resistance Test (at Component)

1. Remove console. Refer to *BODY.*
2. Disconnect fuel level sensor connector.

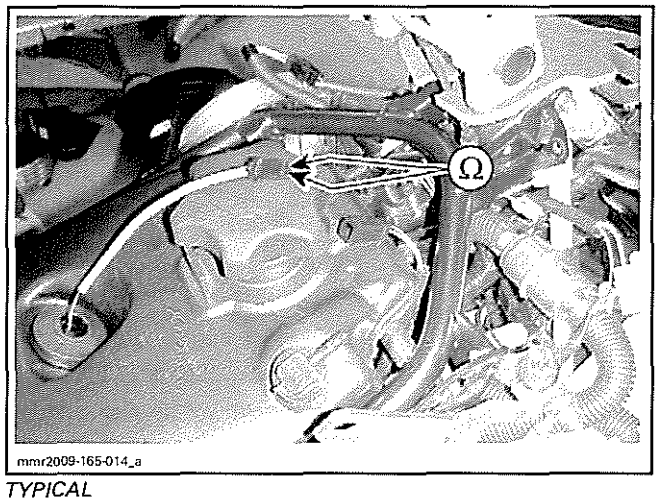


TYPICAL
1. Sensor connector

3. Probe sensor terminals and read the resistance as follows.

IMPORTANT: When the fuel level is changed, it takes approximately 10 seconds before the sensor resistance changes.

FLOAT POSITION (ACCORDING TO FUEL LEVEL)	SENSOR CONNECTOR		RESISTANCE @ 20°C (68°F)
Full	Pin 1	Pin 2	8.8 Ω ± 1.3 Ω
Empty			91.5 Ω ± 5.5 Ω



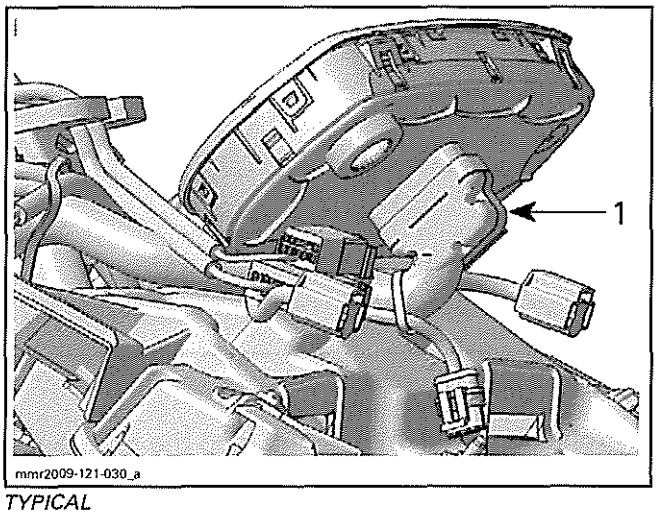
TYPICAL

4. If test failed, replace sensor.
5. If test succeeded, check wiring continuity between multifunction gauge and sensor. Refer to the applicable *WIRING DIAGRAM.*

Fuel Level Sensor Input Voltage Test

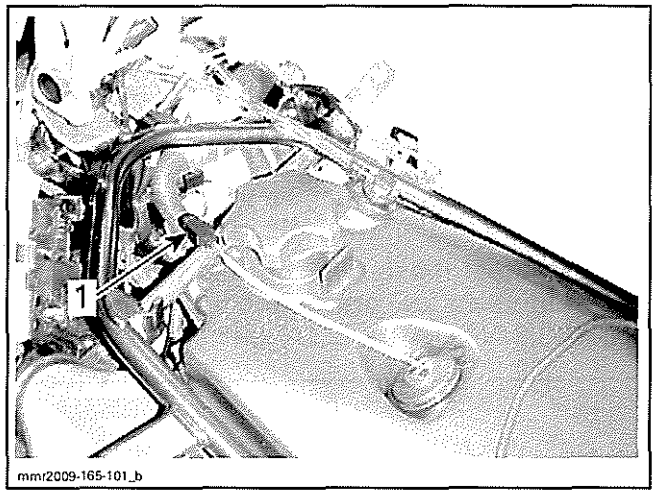
600 ACE and 1200 4-TEC Models

1. Make sure main wiring harness connector is properly connected to multifunction gauge.



TYPICAL
1. Multifunction gauge connected

2. Disconnect fuel level sensor.



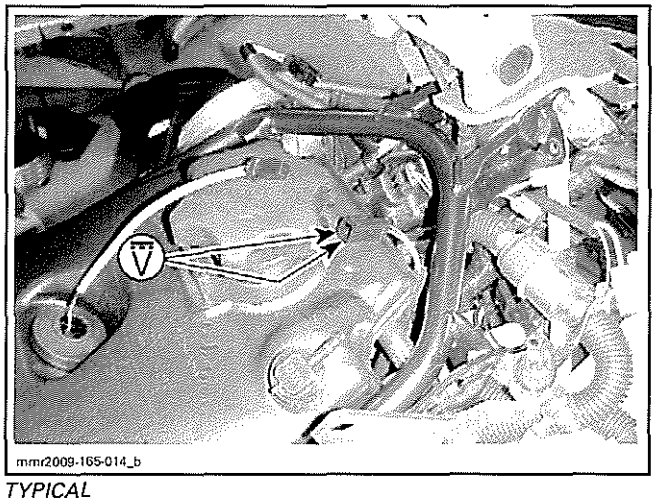
TYPICAL
1. Sensor connector

3. Use the FLUKE 115 MULTIMETER (P/N 529 035 868).
4. Select Vdc.
5. Set emergency engine stop switch to RUN.

Install the tether cord cap on engine cut-off switch.

6. Briefly press START/RER button to wake up multifunction gauge. **DO NOT** crank the engine.
7. Probe terminals of main wiring harness connector and read the voltage as follows.

SENSOR MAIN WIRING HARNESS CONNECTOR		VOLTAGE
Pin 1	Pin 2	Approximately 5 Vdc



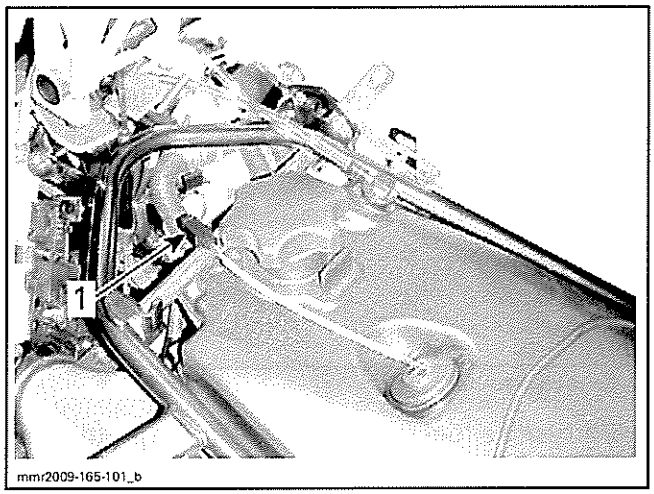
TYPICAL

If test failed, replace multifunction gauge.

If test succeeded, multifunction gauge provides proper voltage to the sensor.

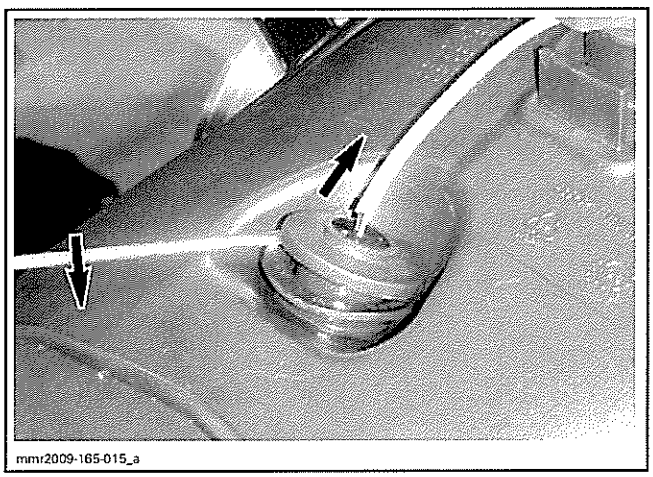
Fuel Level Sensor Removal

1. Drain fuel tank.
2. Remove console. Refer to *BODY.*
3. Disconnect fuel level sensor connector.



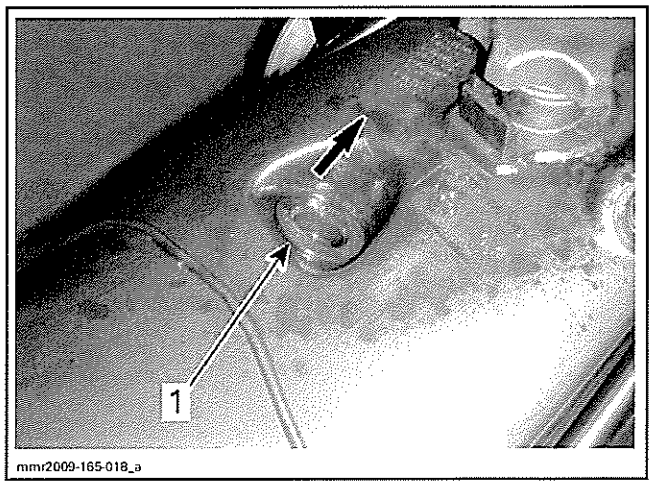
1. Sensor connector

4. Insert a screwdriver between grommet and sensor face plate. Gently pry out sensor from grommet alternating from side to side.



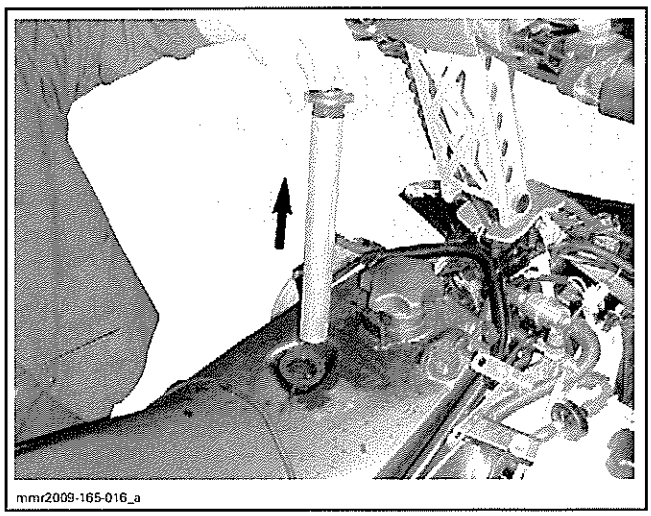
PRY OUT

5. Remove grommet from fuel tank.



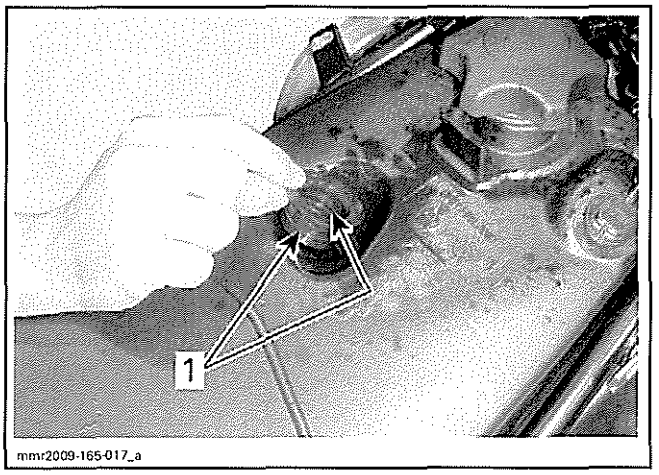
1. Grommet

6. Pull sensor out of fuel tank.



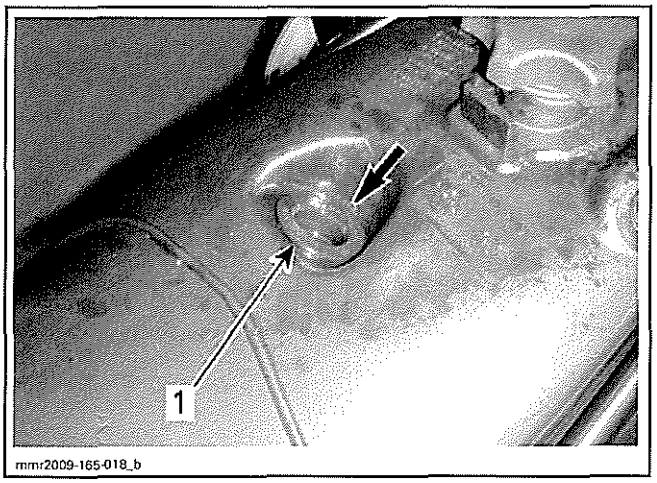
Fuel Level Sensor Installation

1. Fuel level sensor installation is the reverse of removal procedure. However, pay attention to the following.
2. Carry out a resistance test of sensor before installation. Refer to *FUEL LEVEL SENSOR RESISTANCE TEST* in this subsection.
3. To ease grommet and fuel level sensor installation, spray water (NO SOAP) on outer and inner surfaces of grommet.



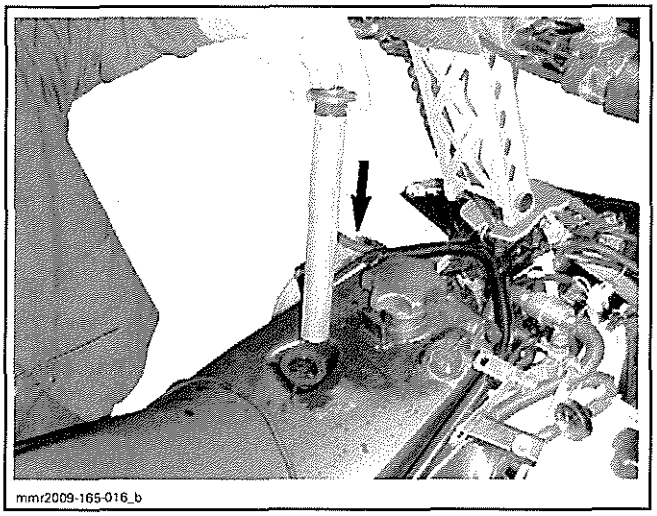
1. Spray water here

4. Insert grommet in fuel tank ensuring it fully locks in position.



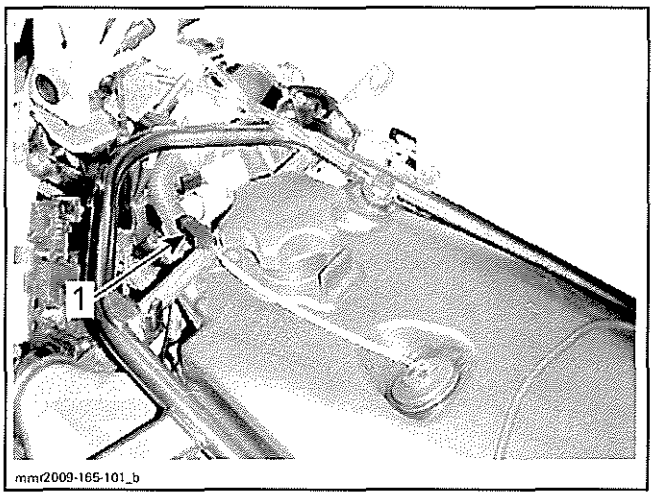
1. Grommet

5. Carefully insert float sensor through hole in grommet gently rotating it in position.



6. Apply DIELECTRIC GREASE (P/N 293 550 004) in connector to prevent corrosion.

7. Plug sensor connector.



1. Sensor connector

8. Carry out a fuel system leak test. Refer to *FUEL TANK LEAK TEST* in this subsection.
9. Test fuel level indication as you fill fuel tank before you complete reassembly of vehicle.

E-TEC DIRECT FUEL INJECTION

SERVICE TOOLS

Description	Part Number	Page
EXTRACTOR ADAPTOR	529 036 136	475
FLUKE 115 MULTIMETER	529 035 868	472–473, 493, 495, 498, 500
INJECTOR RETAINER PLATE	529 036 137	470
SMALL HOSE PINCHER	295 000 076	491

SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
SNAP-ON HAMMER	CJ125-6	475
SNAP-ON SCREW	CJ93-1	475

SERVICE PRODUCTS

Description	Part Number	Page
DIELECTRIC GREASE	293 550 004	478
LOCTITE 243 (BLUE)	293 800 060	495
PULLEY FLANGE CLEANER	413 711 809	492

GENERAL

⚠ WARNING

Always disconnect the magneto connector prior to:
- Disconnecting any fuel hose.
- Removing a fuel injector.
- Removing a spark plug cable or spark plug.

Otherwise, fuel vapors may ignite in presence of a spark creating a fire hazard.

⚠ WARNING

Always release fuel pressure, proceed with care and use appropriate safety equipment when working on the fuel system. Wear safety glasses and work in a well ventilated area.

Release fuel pressure prior to removing fuel system components. Refer to *FUEL PRESSURE RELEASE* in *FUEL TANK AND FUEL PUMP* subsection.

⚠ WARNING

Perform a fuel pressure test each time a component from the fuel system is removed. Prior to start the engine when a fuel hose was disconnected or a fuel injector removed:
- Ensure all fuel lines are properly connected.
- Crank engine to pressurize fuel system. Do not let engine run. If it starts, stop it right away.
- Inspect engine compartment to detect any fuel leak or an abnormally strong fuel odor which may be an indication of a fuel leak that is not readily visible.

SYSTEM DESCRIPTION

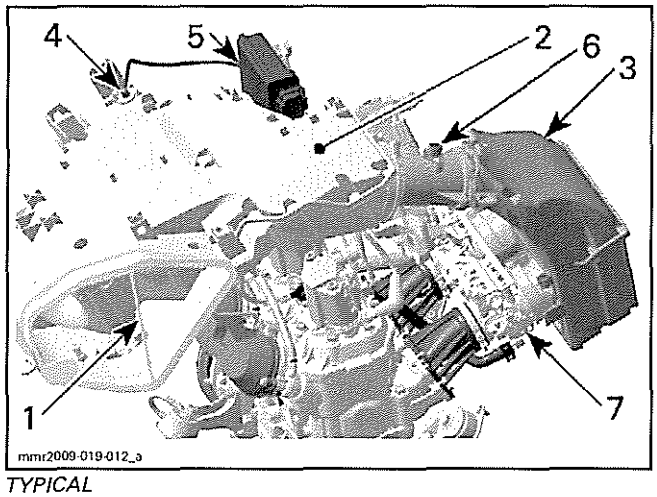
The ECM reads the input signals from different sensors which indicate engine operating conditions at micro-second intervals.

The ECM calculates the proper air/fuel ratio and activates the output to fuel injectors.

Signals from sensors are used by the ECM to determine the injection parameters (fuel maps required for optimum air-fuel ratio).

The crankshaft position sensor (CPS), the throttle position sensor (TPS) are the primary sensors used to control the injection. Other sensors (like temperature sensors, etc.) are used as secondary input.

Air Induction



TYPICAL
1. *Mesh filter*
2. *Secondary air intake silencer*
3. *Primary air intake silencer*
4. *Air pressure fitting and hose*
5. *Air pressure sensor in ECM*
6. *Air temperature sensor*
7. *Throttle body*

Air flows through a mesh filter in the secondary air intake silencer mounted on top of engine. The mesh filter prevents snow from being drawn into the engine.

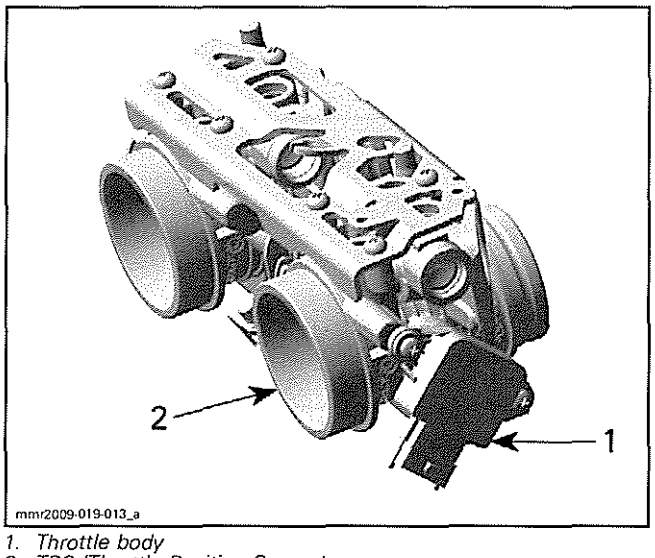
Air pressure is measured in the secondary air intake silencer through a tube connected to the ECM.

Air then flows through the primary air intake silencer.

Air temperature is measured at the inlet of the primary air intake silencer.

Air is then drawn in through a dual throttle bodies mounted on the engine intake side.

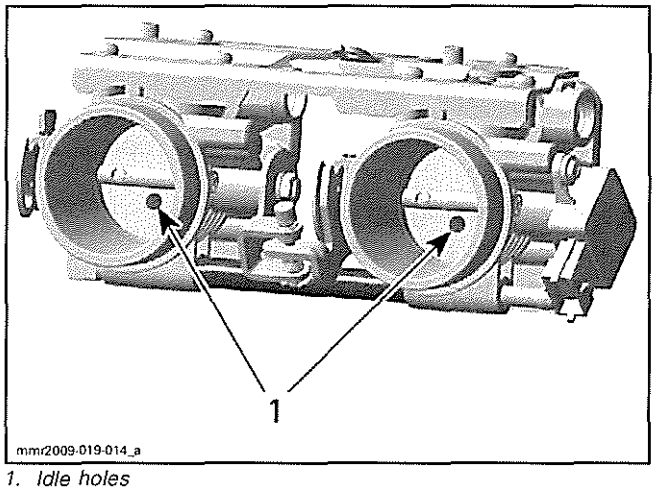
Throttle Body



1. *Throttle body*
2. *TPS (Throttle Position Sensor)*

Dual 46mm Dell'Orto throttle bodies are directly mounted on the intake flange of each cylinder.

The air flow is controlled by two throttle plates. Each throttle plate has a 6.8 mm (.268 in) idle hole.

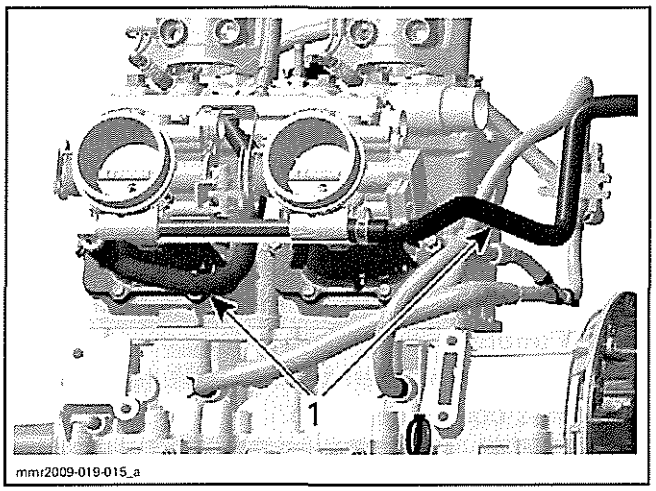


1. *Idle holes*

Since there is a constant airflow through the idle holes of the throttle plates, the idle speed is controlled by the ECM by varying the amount of fuel injected in the combustion chamber and by controlling the injection timing.

The TPS (Throttle Position Sensor) is fitted on the throttle body. The TPS sends throttle angle position to the ECM.

Engine coolant flows through throttle body to prevent potential freezing of throttle plates due to the temperature drop naturally created by the venturi.



TYPICAL
1. Coolant-heated lines

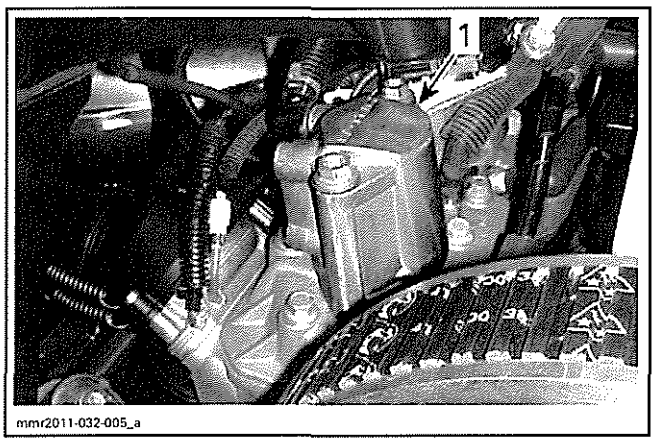
The air then continues through the reed valves into the cylinder base then into the crankcase.

Fuel Injector

The fuel injectors work on the 55/60 Vdc system voltage.

One fuel injector per cylinder is used.

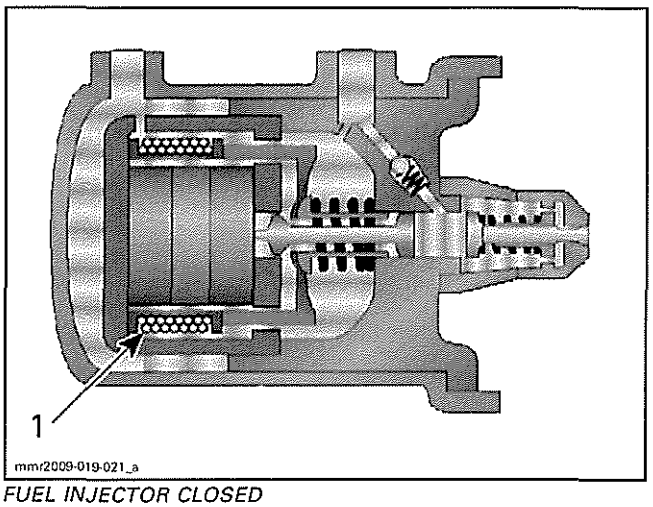
The E-TEC fuel injector is mounted directly on top of the cylinder head.



TYPICAL
1. Fuel injector

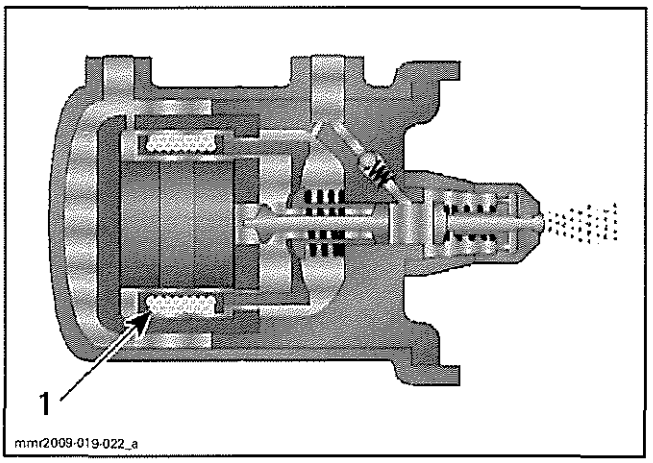
The fuel injector achieves a direct injection right into the combustion chamber. This keeps the piston cooler with less fuel.

A voice coil type is used to open and close the fuel injector nozzle. This allows a quick operation of the fuel injector at the opening stage as well as at the closing stage. This results in the ability of the engine to operate at a high RPM and lowers unburned fuel to the exhaust port.



FUEL INJECTOR CLOSED
1. Voice coil

When a positive current is supplied to the coil by the ECM, the fuel injector plunger moves towards the spring loaded injector needle. As the injector plunger moves, this builds up a pressure in the fuel injector chamber. When the pressure reaches approximately 1724 kPa (250 PSI), it overcomes the injector needle spring strength and the needle opens. Then, the fuel injection takes place while the pressure peaks at 3103 kPa (450 PSI).



FUEL INJECTOR OPENED
1. Voice coil

Swirl channels are used in the fuel injector to better atomize the fuel charge.

The quantity of injected fuel is controlled by varying the injector plunger stroke.

To bring the injector plunger backward to its rest position, current is reversed and the return springs close the injector needle and plunger. Near the end of the return stroke, a brief positive current is applied to "brake" the injector plunger. This results in a quieter operation of the fuel injectors.

In forward engine rotation, the fuel injectors provide a stratified fuel charge to the combustion chamber up to clutch engagement speed. Beyond this RPM, the fuel charge becomes homogeneous.

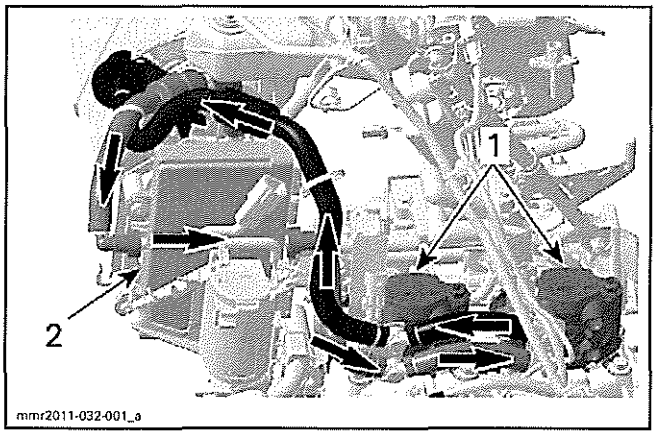
The stratified fuel charge provides for a cleaner combustion, better idling and less smoke.

Fuel Injector Cooling

Fuel is used to maintain proper fuel injector operating temperature.

The flow starts from the fuel pump, through the ECM, then around the voice coil inside the fuel injector housing to cool down the fuel injector components.

Fuel enters the inlet port located at the bottom of the fuel injector housing, and exits through the outlet port on top of the fuel injector.



TYPICAL
1. *Fuel injectors*
2. *ECM*

NOTE: The 600 HO E-TEC does not have a filter on the outlet hose.

ADJUSTMENT

IDLE SPEED

Idle speed is controlled by the EMS (Engine Management System) and is not adjustable with an idle screw.

If idle speed is not as per specification (refer to *TECHNICAL SPECIFICATIONS*), perform the *CLOSED THROTTLE RESET (TPS).*

CLOSED THROTTLE RESET (TPS)

General Information

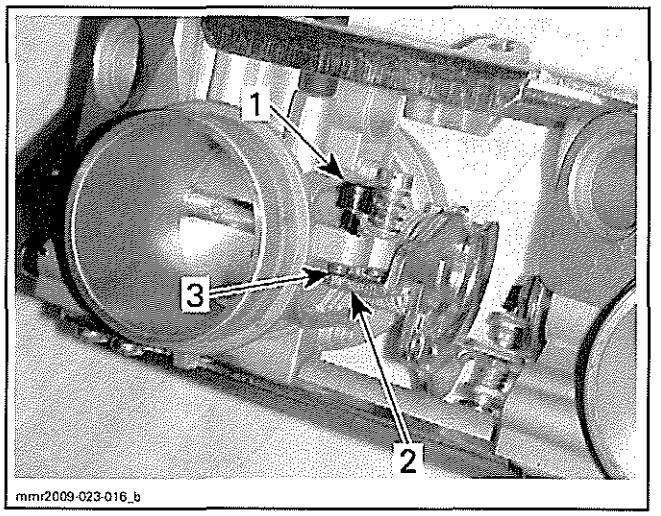
This operation performs a reset of the TPS (throttle position sensor) values in the ECM when the throttle is closed. This reset is very important as the setting of the TPS will determine the basic parameters for all fuel mapping and several ECM calculations for idle speed control of the engine.

Closed throttle reset must be done if:
- TPS is loosened, removed or replaced.
- Throttle body is replaced.
- ECM is replaced.

NOTICE An improperly set TPS may lead to poor engine performance.

Closed Throttle Reset Procedure (TPS)

Check if master zero position screw contacts throttle plate stopper.

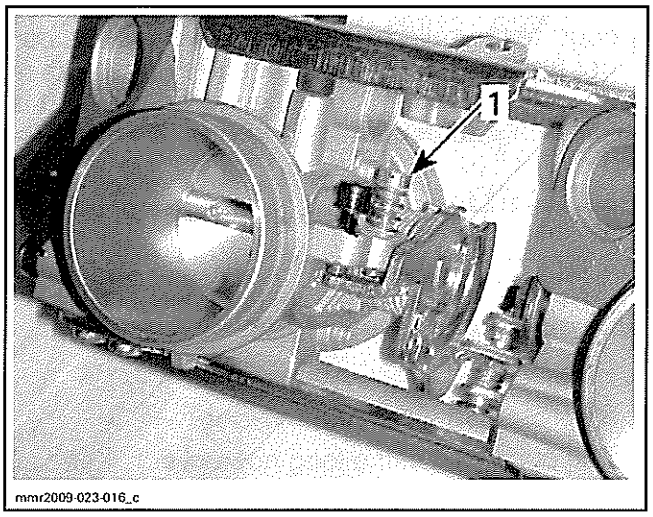


1. *Master zero position screw (capped)*
2. *Throttle plate stopper*
3. *Contact here*

NOTICE Do not alter the setting of any capped screw, otherwise the throttle body must be replaced.

Master Zero Position Screw Does NOT Contact Stopper

Check if idle screw touches the throttle plate lever.



1. Idle screw

If idle screw touches the throttle plate lever, someone tampered with the idle screw. To correct the problem, exceptionally, unscrew idle screw until there is a gap.

If idle screw does not touch the throttle plate lever, adjust throttle cable. Refer to *THROTTLE CABLE* in this section.

Refer to *MASTER ZERO POSITION SCREW DOES CONTACT STOPPER* when the problem is corrected.

Master Zero Position Screw DOES Contact Stopper

Push throttle lever in approximately one quarter travel, then quickly release. Repeat 2 - 3 times to settle throttle plates.

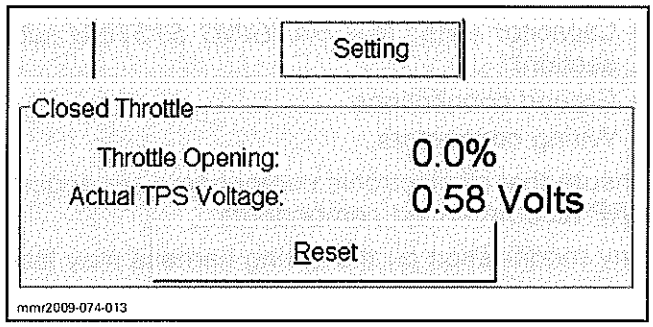
Connect vehicle to the applicable B.U.D.S. Refer to *COMMUNICATION TOOLS/B.U.D.S.* subsection.

IMPORTANT: First ensure there is no fault code related to the TPS. If so, it will not be possible to perform the **Closed Throttle** reset and the **Throttle Opening** could not be set within the specification.

Use B.U.D.S. software and select the **Setting** tab.

The **Throttle Opening** must be within the following specification.

THROTTLE OPENING
(0 % ± 0.2)



If throttle opening is within the % specification, DO NOT reset the **Closed Throttle**. It is not required.

If throttle opening is NOT within the % specification, click on the **Reset** button in the **Closed Throttle** box.

IMPORTANT: If the Actual TPS Voltage is not within 0.3 - 0.7 Volts, the **reset will not be done** and no fault code will be set. Verify the following then carry out the reset again.

- Make sure throttle cable is not stuck, too tight or binding.
- Make sure TPS is not loose.
- Check condition of TPS and its wiring/connectors.

TROUBLESHOOTING

DIAGNOSTIC TIPS

Engine problems are not necessarily related to the injection system.

It is important to ensure the mechanical integrity of the engine is present.

Spark Plugs

Improper spark plug indexing may lead to engine misfiring. Check if BRP spark plugs are installed or if spark plugs are properly indexed.

3D RAVE Valves

RAVE valves improper position may lead to engine misfiring. Check RAVE valves.

Crankshaft Position Sensor (CPS)

Confirm that ECM receives the CPS signal. Refer to *CRANKSHAFT POSITION SENSOR (CPS)* in this subsection.

Electrical System

It is important to check that the electrical system is functioning properly:

- 55/60V system voltage

- Capacitor (refer to *CHARGING SYSTEM* subsection)
- Ground connections
- Wiring connectors.

Ensure that all electronic components are original BRP recommended components.

Any modification on the wiring harness may lead to generate fault codes or bad operation.

Always refer to the wiring diagram when diagnosing an electrical problem.

⚠ WARNING

The EMS operates on high voltage (55 - 60 Vdc), be careful to avoid electrical shocks.

⚠ WARNING

All electrical actuators (example: fuel injectors, fuel pump, ignition coils and electronic oil injection pump) are powered as soon as engine is cranked if the engine stop switch is at the RUN position.

Electrical Connections

Pay particular attention to ensure that pins are not out of their connectors or out of shape.

Make sure that connections are very tight and make good contact, they are corrosion-free and show no signs of moisture ingress. Particularly check ECM ground connections.

NOTE: Do not apply dielectric grease or other lubricant on the ECM connectors.

Check if wiring harness shows any signs of scoring.

Resistance Measurement

When measuring the resistance with an ohmmeter, all values are given for a temperature of 20°C (68°F). The value of a resistor varies with the temperature. The value for common resistor or windings (such as a solenoid) increases as the temperature increases. However, our temperature sensors are NTC types (Negative Temperature Coefficient) except for the EGT sensor which are the opposite. This means that the resistance value decreases as the temperature increases. Use the provided tables for sensor resistance values at given temperatures.

The resistance value of a temperature sensor may test good at a certain temperature, but may be defective at other temperatures.

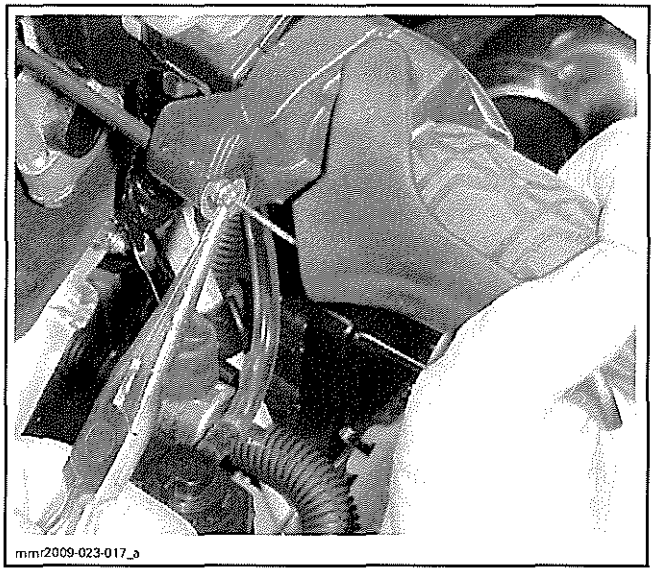
A good test would be to put the sensor in a container filled with ice and water and measure its resistance value. Then heat the water and read its resistance value at different temperatures.

PROCEDURES

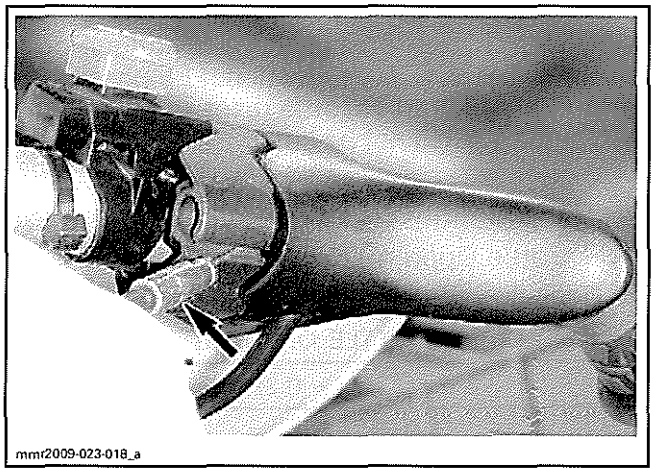
THROTTLE CABLE

Throttle Cable Removal

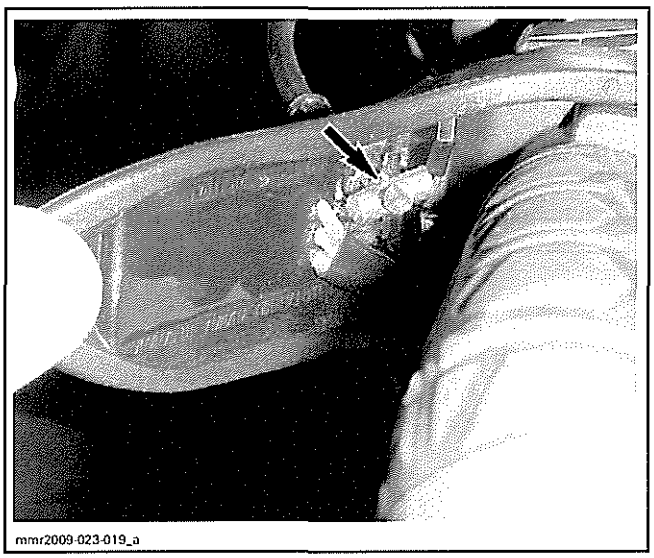
1. Remove handlebar cover.
2. Depress and hold throttle lever.
3. Pull out circlip using long nose pliers. Keep circlip for re-use.



4. Pull throttle cable out of throttle lever housing.



5. Unhook cable end barrel from throttle lever and remove cable.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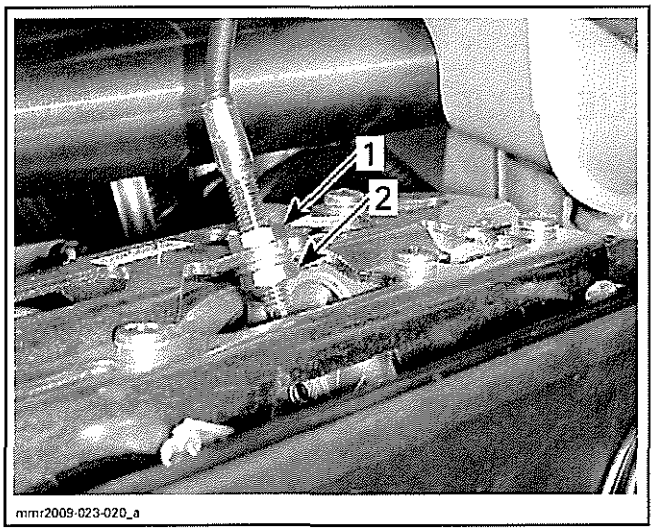
6. Note cable routing before removal.
7. Remove drive belt guard. Refer to *DRIVE BELT* subsection.
8. Remove primary air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.
9. Fully unscrew bottom cable adjuster lock nut.



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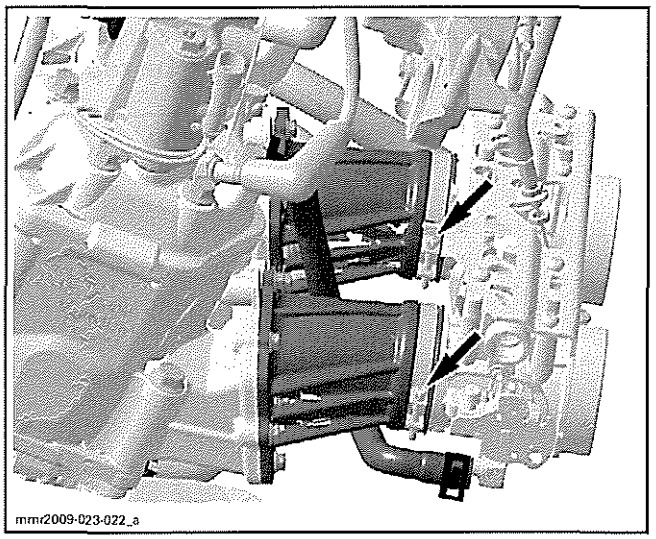
1. *Cable adjustment nut*
2. *Adjuster lock nut*

10. Loosen throttle body clamps.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11. Pull out throttle body enough to unhook throttle cable end.

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12. Remove throttle cable.

Throttle Cable Installation

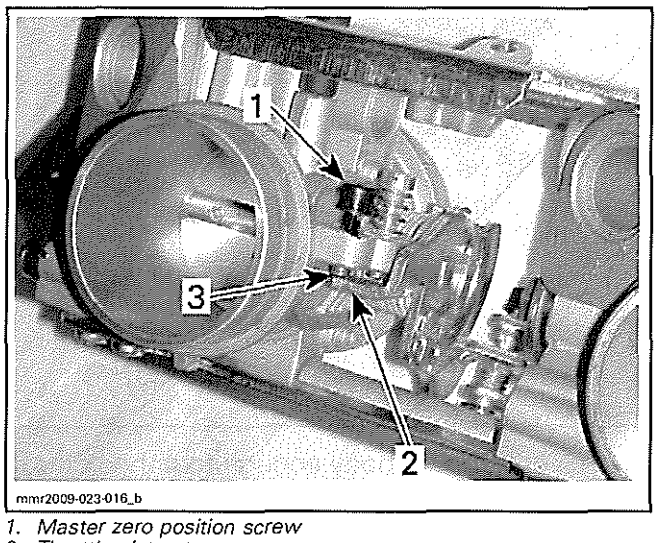
1. Reverse removal procedure but pay attention to the following.
2. Route cable as noted before removal.
3. Ensure that cable ends are properly secured in their levers.
4. Proceed with throttle cable adjustment.

Throttle Cable Adjustment

NOTICE Do not alter throttle cable routing. It may cause poor startability and erratic idling.

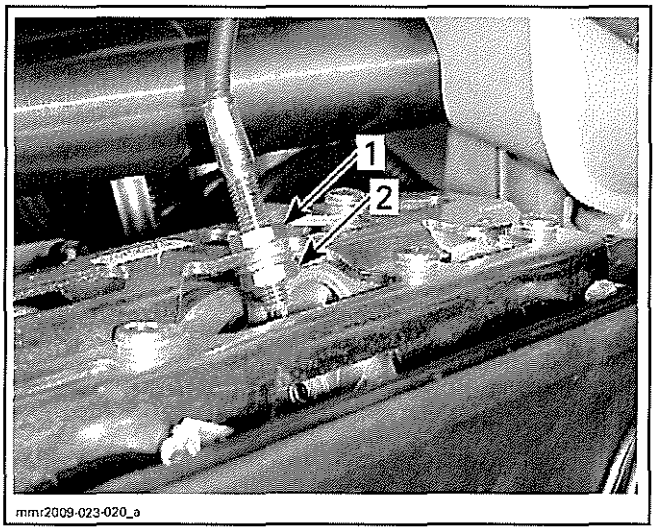
1. With throttle lever released, ensure there is some free-play in throttle cable to allow a contact between master zero position screw end and throttle plate stopper.

NOTICE Do not tamper with any screw. Otherwise, throttle body may have to be replaced.



1. *Master zero position screw*
2. *Throttle plate stopper*
3. *Contact here*

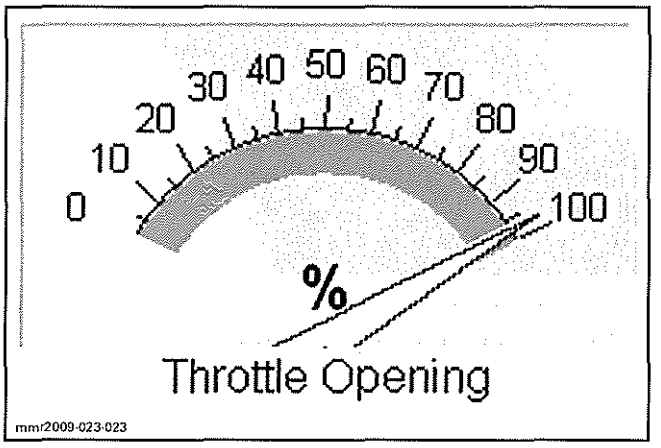
2. If there is no free-play, loosen throttle cable lock nut.



1. *Adjustment nut*
2. *Adjuster lock nut*

3. Set cable adjuster accordingly, then tighten lock nut.
4. Push throttle lever approximately one quarter travel, then quickly release. Repeat 2 - 3 times to settle throttle plate. Recheck adjustment.
5. Connect to applicable B.U.D.S. software. Refer to *COMMUNICATION TOOLS/B.U.D.S.* subsection.
6. On the **Monitoring** page of B.U.D.S., look for the **Throttle Opening** indication.
7. Fully depress throttle lever and hold.
8. Look at the throttle opening indication. Displayed value must be within the following specification.

THROTTLE OPENING (WIDE OPEN THROTTLE)
95 - 100%

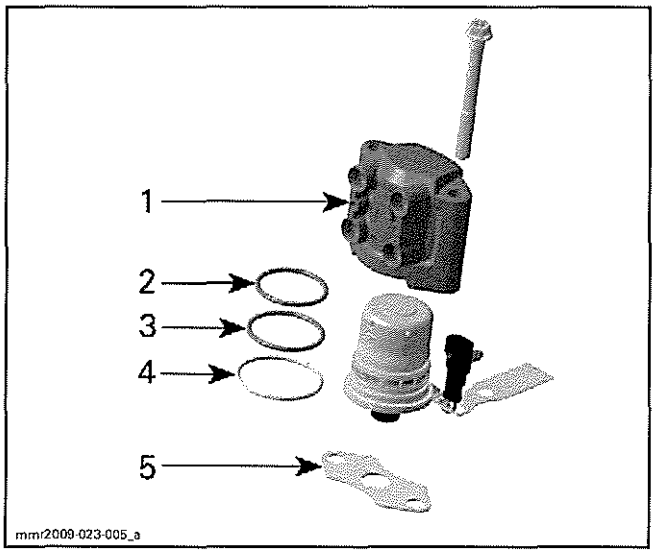


9. If throttle opening indication is not within specification, re-adjust throttle cable.

NOTE: If value is below the minimum, tighten throttle cable. If value is above maximum value, loosen throttle cable.

FUEL INJECTOR

General Information



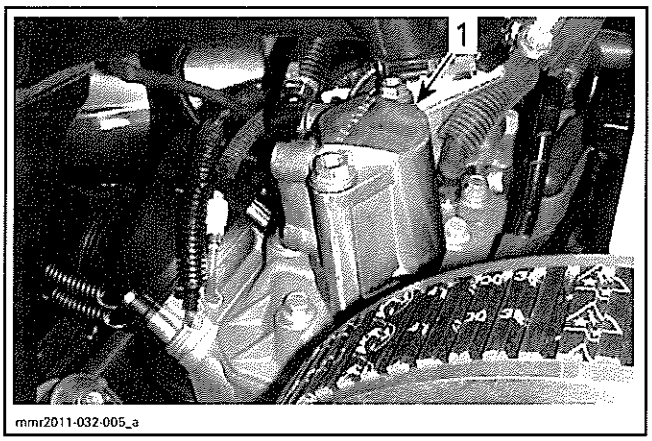
1. *Fuel injector housing*
2. *Top O-ring*
3. *Bottom O-ring*
4. *Crush ring*
5. *Thermal insulator*

Every fuel injector is bench tested. Its electrical and flow characteristics are registered throughout all its operating range in a calibration file.

When a fuel injector is replaced, the matching calibrated file must be loaded in the ECM using B.U.D.S. so that the ECM properly controls the fuel injector.

Fuel Injector Visual Inspection

1. Open LH panel.
2. Remove drive belt guard. Refer to *DRIVE BELT* subsection.
3. Observe the fuel injector area.



1. Fuel injector

If a fuel leak is noticed in the area of the hoses, inspect hoses and connections.

If a fuel leak is noticed in the fuel injector base area, it indicates a leak of the lower fuel injector O-ring.

If a dark carbon area is noticed in the fuel injector base area, it indicates a leak between the fuel injector nozzle and the cylinder head. The fuel injector retaining screws may not be tight enough.

Fuel Injector Troubleshooting Tips

Most of the time, a faulty fuel injector will lead to a poor engine idle and a low RPM around 800 RPM and below. It may also lead to engine misfiring.

Ensure the correct fuel injector is installed on the proper cylinder. Refer to *FUEL INJECTOR POSITION VALIDATION* in this subsection.

While engine is running, try unplugging a fuel injector connector:

⚠ WARNING

Be careful while working close to rotating parts.

- If engine RPM does not change, the disconnected fuel injector could be faulty.
- If engine RPM decreases, the other fuel injector could be faulty.

If one injector is thought to be faulty, proceed with the injector tests.

Fuel Injector Leak Test

Preparation

1. First make sure fuel system pressure is within specifications. Refer to *FUEL TANK AND FUEL PUMP* section.

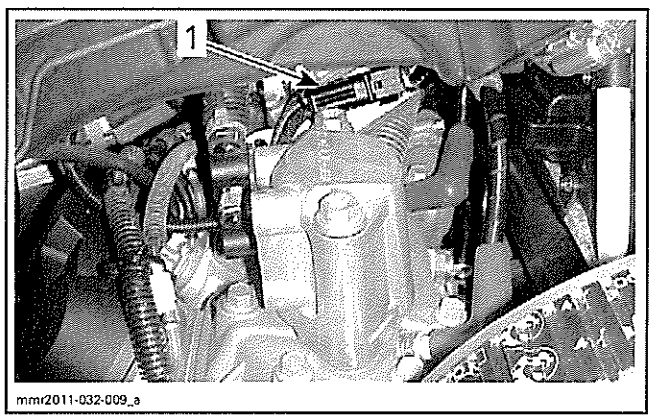
NOTE: Keep the pressure test gauge installed for the leak test.

2. Disconnect magneto connector. Refer to *MAGNETO SYSTEM* subsection.

⚠ WARNING

The magneto connector must be disconnected to prevent any spark in the engine compartment should the engine be cranked. Fuel vapors may ignite in presence of a spark creating a fire hazard.

3. Disconnect injector connector.



TYPICAL
1. Fuel injector connector

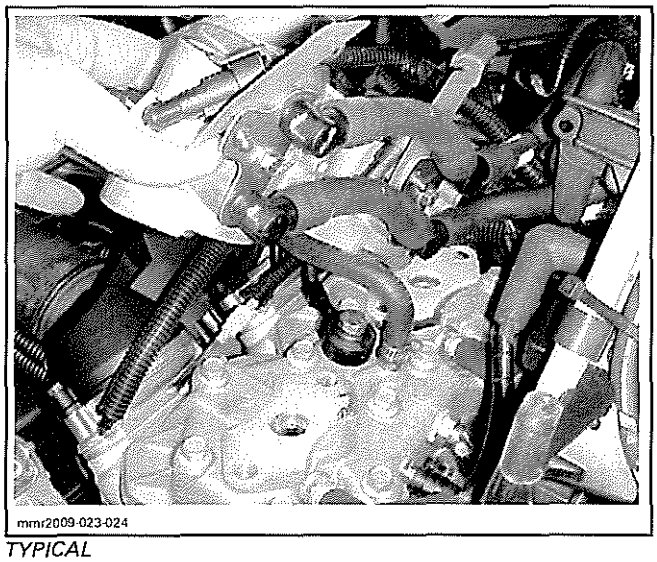
4. Release fuel pressure. Refer to *FUEL TANK AND FUEL PUMP* subsection.

NOTICE If fuel pressure is not released, pressure will push the fuel injector out of its housing when removing the fuel injector. This could damage the fuel injector and lead to an important fuel spill.

5. Remove drive belt guard. Refer to *DRIVE BELT* subsection.
6. Remove secondary air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.
7. Unlock ECM support to move ECM as required to lift fuel injectors.

NOTE: Fuel injector leak test can be carried out on one injector at a time or on both injectors simultaneously.

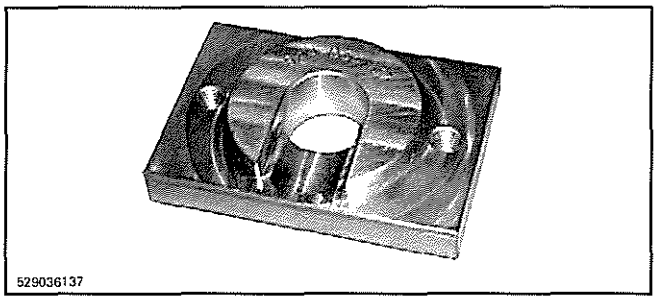
8. Remove both fuel injectors. Refer to *FUEL INJECTOR REMOVAL* in this subsection.
9. Carefully lift both fuel injectors. Be careful not to pry hoses against their plastic fittings.

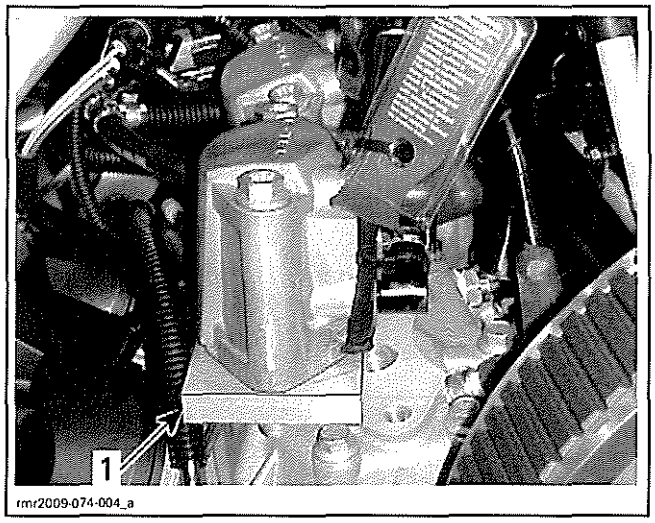

mmr2009-023-024

TYPICAL

NOTE: Do not install the thermal insulators against fuel injectors.

10. Secure each fuel injector to an INJECTOR RETAINER PLATE (P/N 529 036 137).


529036137

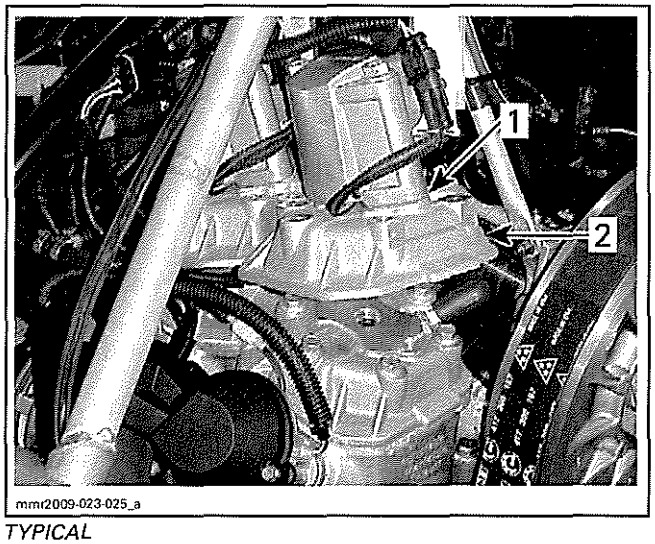


rmr2009-074-004_a

TYPICAL
1. Fuel injector retainer plate

NOTICE Be sure to position the opening in the retainer plate on the wire cable side of the fuel injector.

NOTE: As an alternate method for this test, fuel injectors can be installed on an E-TEC cylinder head.



mmr2009-023-025_a

TYPICAL
1. Thermal insulator
2. E-TEC cylinder head

⚠ WARNING

Fuel injector must be secured during the leak test to avoid the fuel injector to be projected.

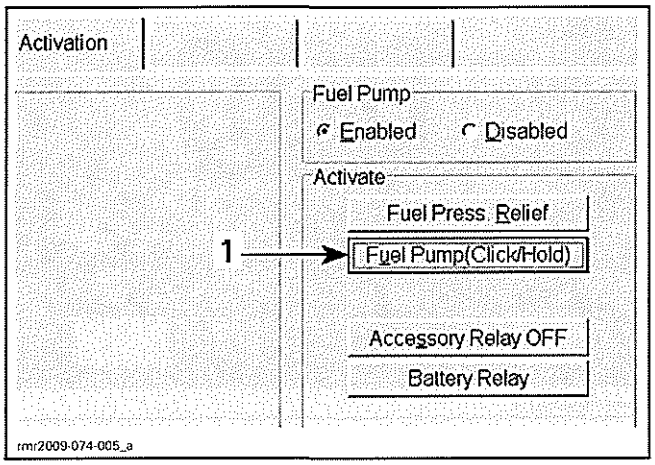
11. Place an appropriate container under the fuel injectors.
12. Ensure spark plug caps are installed on spark plugs.
13. Ensure there is enough fuel in fuel tank.

14. Connect B.U.D.S. Refer to *COMMUNICATION TOOLS/B.U.D.S.* subsection.

Leak Test

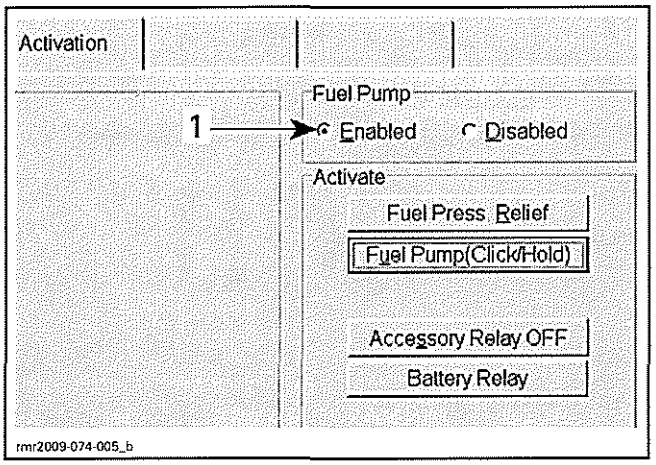
1. In B.U.D.S., select the **Activation** page tab.
2. Click and hold the **Fuel Pump** button.

NOTE: Fuel pump will operate as long as button is held depressed.



ACTIVATION PAGE
1. Fuel Pump (Click hold) button

NOTE: Ensure fuel pump is enabled in B.U.D.S.



ACTIVATION PAGE
1. Pump enabled

3. Check for fuel leakage from the fuel injector nozzle.
4. Monitor fuel pressure at fuel pressure gauge. If pressure drops below 275 kPa (40 PSI) during the test, reactivate fuel pump as necessary.

FUEL INJECTOR LEAKAGE	
TEST DURATION	SPECIFICATION
2 minutes	2 drops per minute maximum

If test is not within specification, replace the faulty fuel injector.

5. Properly reinstall fuel injectors. Refer to *FUEL INJECTOR INSTALLATION* in this subsection.
6. Reinstall remaining removed components.
7. Connect magneto connector.

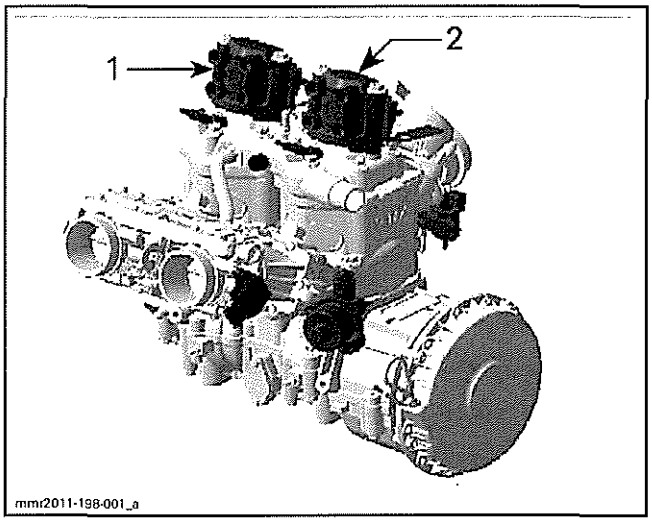
⚠ WARNING

Wipe up any spilled fuel.

Fuel Injector Functional Test

This test is valid if one of the fuel injectors works.

1. Connect vehicle to applicable B.U.D.S.
2. In B.U.D.S., select the **ECM** and **Activation** page tabs.
3. Activate the fuel injector by clicking on it in B.U.D.S. The fuel injector action should be felt.



ECM, ACTIVATION PAGE
1. PTO injector activation
2. MAG injector activation

4. If the fuel injector does not react, connect the opposite fuel injector connector to the suspected faulty injector, then click on the opposite injector in B.U.D.S. to test the suspected faulty injector again.

If the suspected fuel injector works with the opposite fuel injector connector, carry out the *FUEL INJECTOR INPUT VOLTAGE TEST* in this subsection.

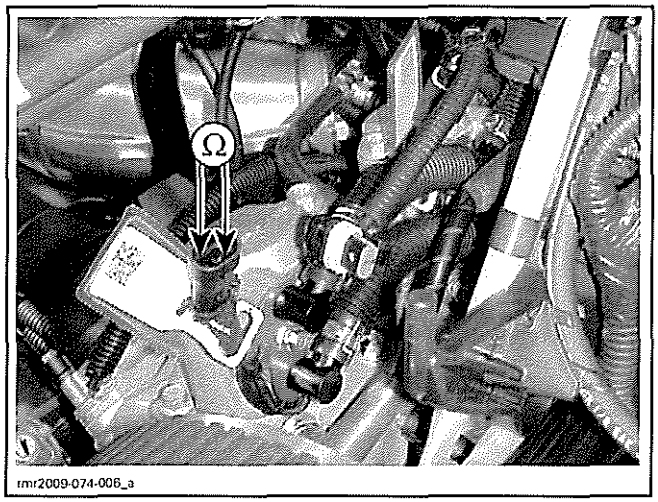
If the fuel injector still does not work, carry out the *FUEL INJECTOR RESISTANCE TEST.*

Fuel Injector Resistance Test

1. Remove drive belt guard. Refer to *DRIVE BELT* subsection.

2. Disconnect the fuel injector connector and measure fuel injector resistance directly on its terminals.

FUEL INJECTOR		MEASUREMENT @ 22°C (72°F)
Pin 1	Pin 2	Below 2.7 Ω



TYPICAL

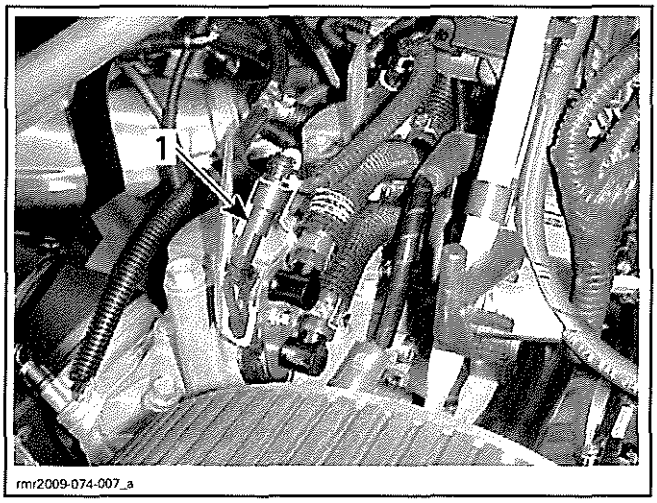
If measurement is out of specification, replace fuel injector.

Fuel Injector Input Voltage Test

1. Set engine stop switch to STOP to disable ignition and injection.

NOTE: Ensure magneto connector is connected.

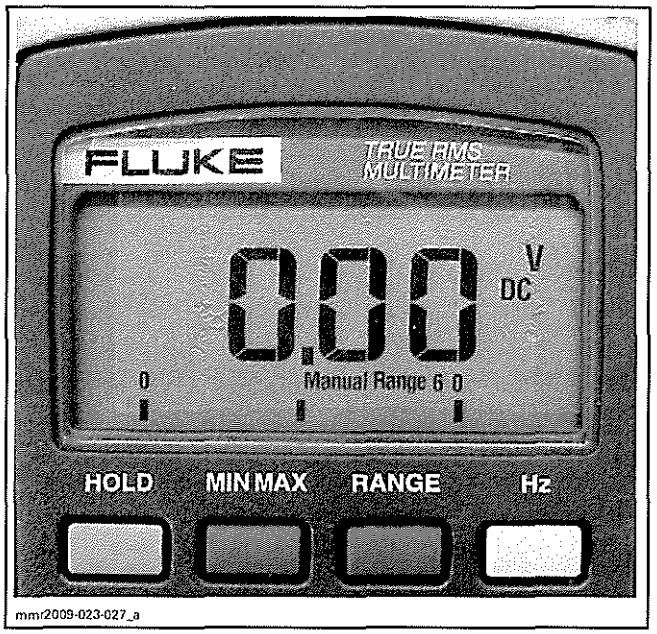
2. Disconnect the electrical connector from the faulty fuel injector.



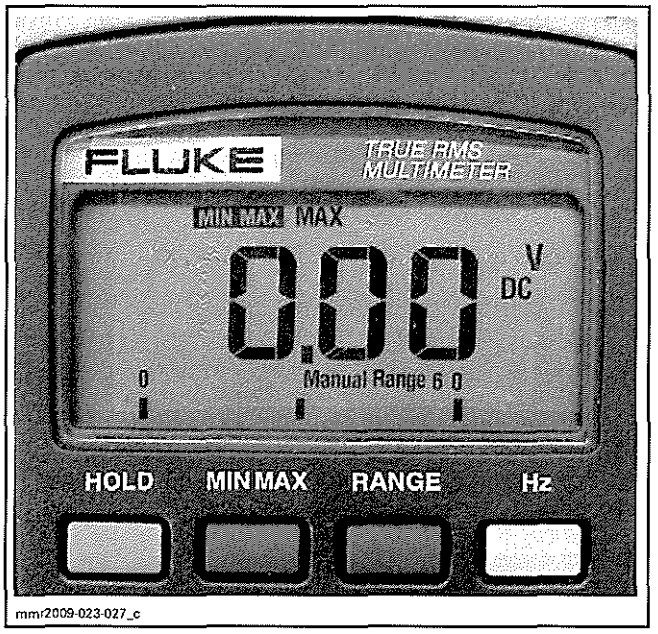
TYPICAL
1. Fuel Injector connector

3. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and set it to Vdc.

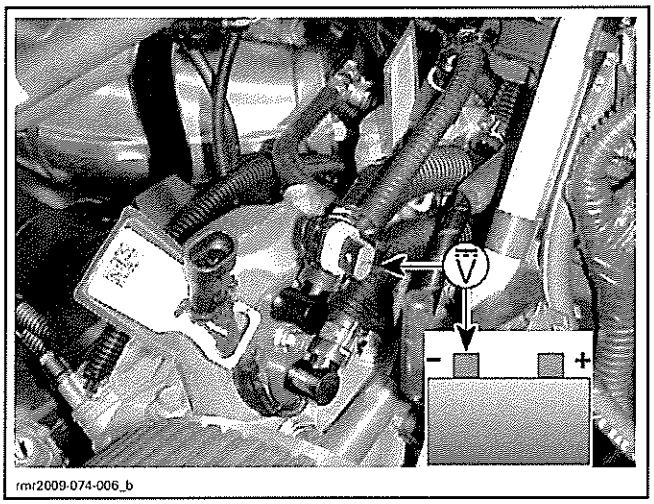
4. Repeatedly press the RANGE button until the display shows Manual Range 6 0.



5. Press the MIN MAX button so that the display shows MIN MAX.



6. Measure voltage while cranking engine.



TYPICAL

7. Read the MAX value.

FUEL INJECTOR CONNECTOR		MEASUREMENT
Pin 1	Battery ground	30 Vdc minimun

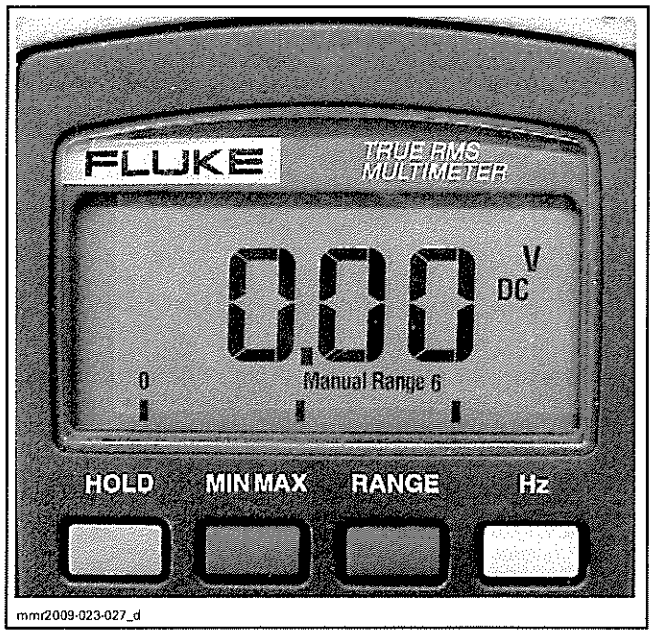
NOTE: Reset multimeter by pressing and holding MIN MAX button until meter beeps.

If voltage test is as per specification, carry out the *FUEL INJECTOR CONTROL CIRCUIT SIGNAL TEST.*

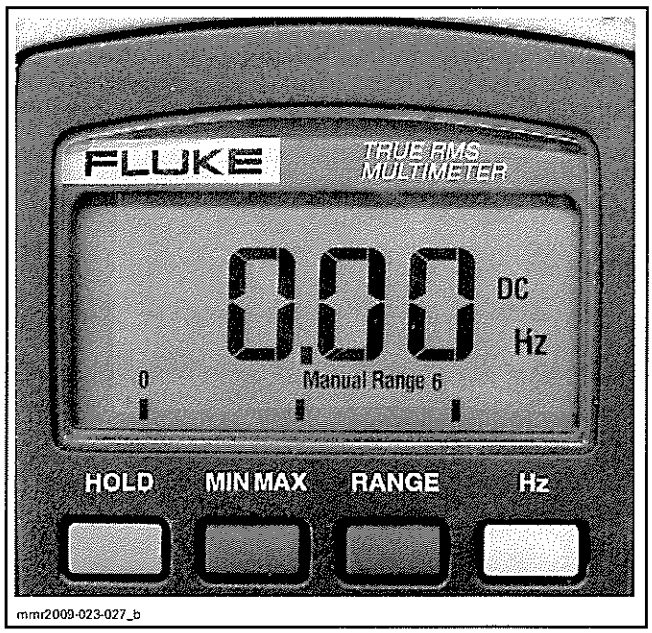
If voltage test is not as per specification, check wire continuity between ECM and fuel injector connector.

Fuel Injector Control Circuit Signal Test

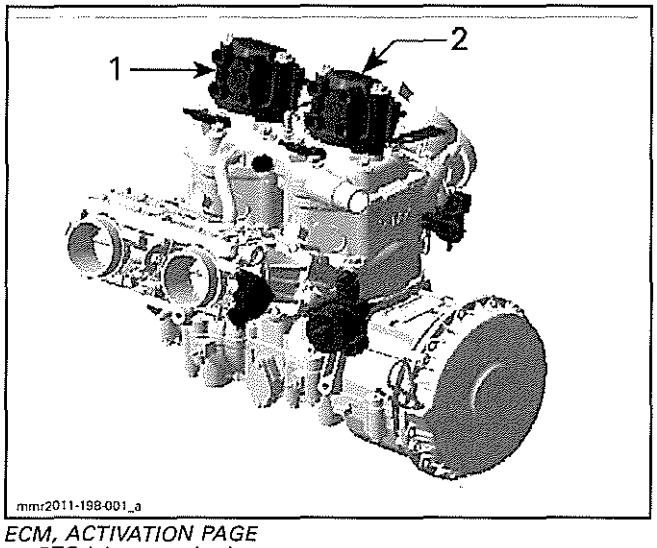
1. Connect B.U.D.S. Refer to *COMMUNICATION TOOLS/B.U.D.S.* subsection.
2. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and set it to Vdc (Hz).
3. Repeatedly press the RANGE button until the display shows Manual Range 6.



4. Press the Hz button so that the display shows Hz.



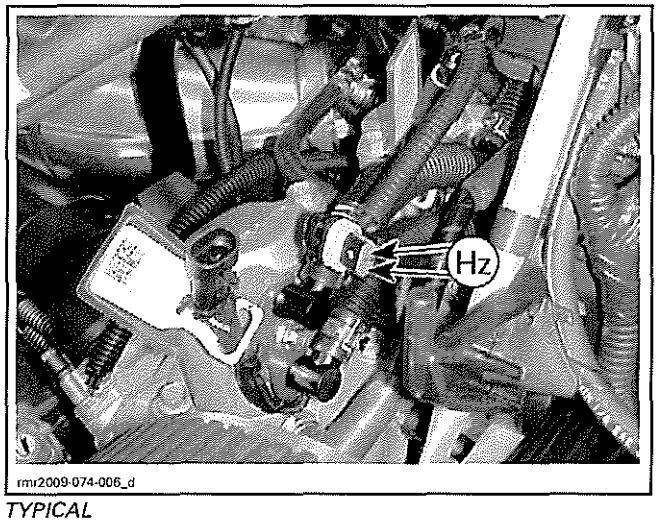
5. In B.U.D.S., select the Activation and ECM page tabs.
6. Activate the fuel injector and read the frequency on the multimeter.



ECM, ACTIVATION PAGE
1. *PTO injector activation*
2. *MAG injector activation*

NOTE: The multimeter counts the current pulses per minute (Hertz) of the ECM sends to the fuel injector.

FUEL INJECTOR CONNECTOR		MEASUREMENT
Pin 1	Pin 2	Approximately 2 Hz



TYPICAL

If there is no reading, check continuity of wiring between ECM and fuel injector connector.

If reading is good, the control circuit is functional.

Fuel Injector Removal

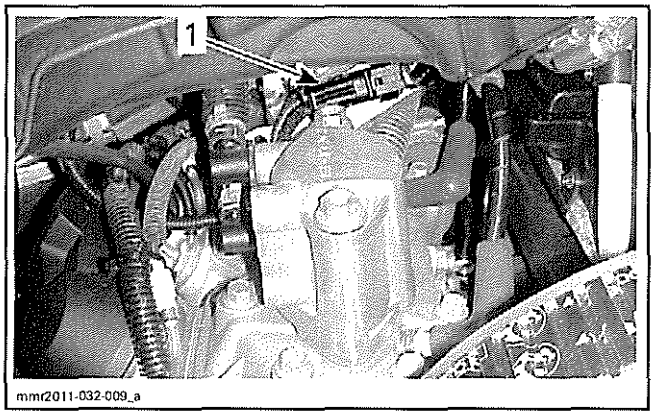
IMPORTANT: NEW O-rings and crush ring must be installed if fuel injector is removed (fuel injector disassembly required). Otherwise, leakage or damage to fuel injector/cylinder head might occur.

1. Remove drive belt guard. Refer to *DRIVE BELT* subsection.
2. Remove primary and secondary air intake silencers. Refer to *AIR INTAKE SYSTEM* subsection.
3. Disconnect magneto connector, refer to *MAGNETO SYSTEM* subsection.

⚠ WARNING

The magneto connector must be disconnected to prevent any spark in the engine compartment should the engine be cranked. Fuel vapors may ignite in presence of a spark creating a fire hazard.

4. Disconnect fuel injector connector.



1. *Fuel injector connector*

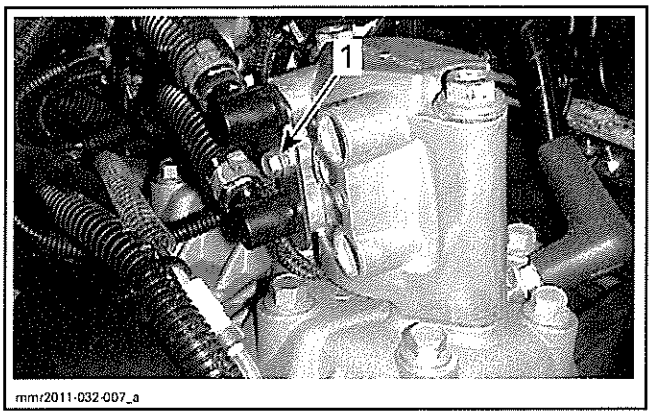
5. Clean fuel injector area.
6. Release the fuel pressure in the system using B.U.D.S. Refer to *FUEL TANK AND FUEL PUMP* subsection.

NOTICE If fuel pressure is not released, pressure will push fuel injector out of its housing when removing fuel injector. This could damage the fuel injector and lead to an important fuel spill.

⚠ WARNING

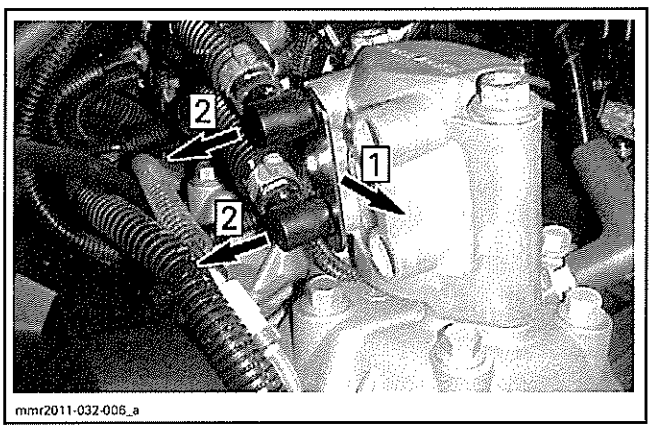
Fuel vapors in the engine compartment could be lit by a spark. This might create a fire.

7. Place a rag under the hose ends to catch fuel spillage.
8. Remove fuel hose retainer screw, then slide the retainer out.



1. Fuel hose retainer screw

9. Disconnect fuel hoses from fuel injector.



Step 1: Remove fuel hose retainer
Step 2: Remove fuel hoses

⚠ WARNING

More fuel will flow out than from usual fuel injector system. Work in a well ventilated area and wipe up spilled fuel.

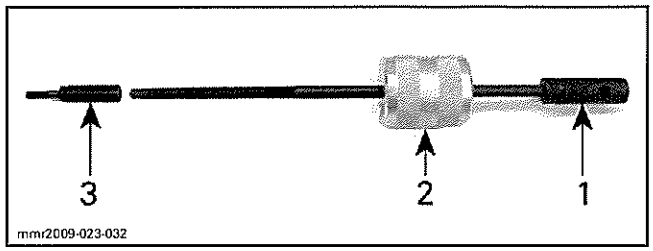
10. Remove fuel injector screws.
11. Gently pull the fuel injector up.

NOTE: If fuel injector is to be reinstalled, mark it for reinstallation on the same cylinder.

NOTICE Use caution when handling fuel injector. Never hold injector by its electrical wires. Prevent dirt and debris from entering fuel inlet and outlet ports of fuel injectors or fuel hoses. Cover the fuel injector nozzle port in cylinder head to prevent contamination of combustion chamber.

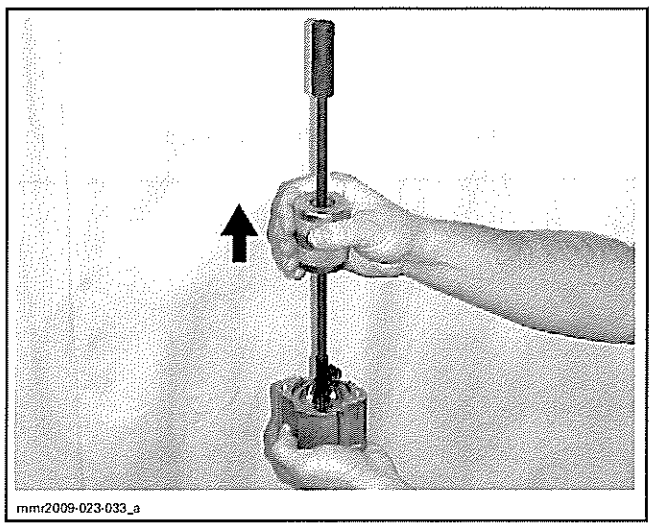
Fuel Injector Disassembly

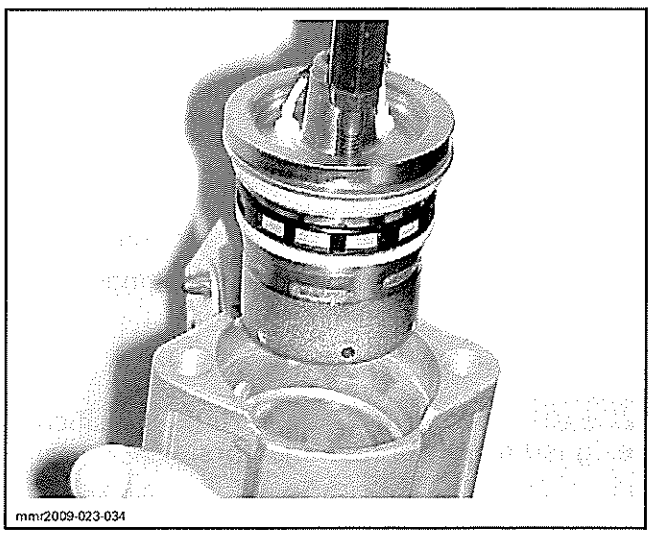
1. To remove fuel injector from its housing, use a Snap-on slide hammer puller including:
   - SNAP-ON SCREW (P/N CJ93-1)
   - SNAP-ON HAMMER (P/N CJ125-6).
2. Install the EXTRACTOR ADAPTOR (P/N 529 036 136) on the Snap-on screw.



1. Snap-on screw
2. Snap-on hammer
3. Extractor adapter (P/N 529 036 136)

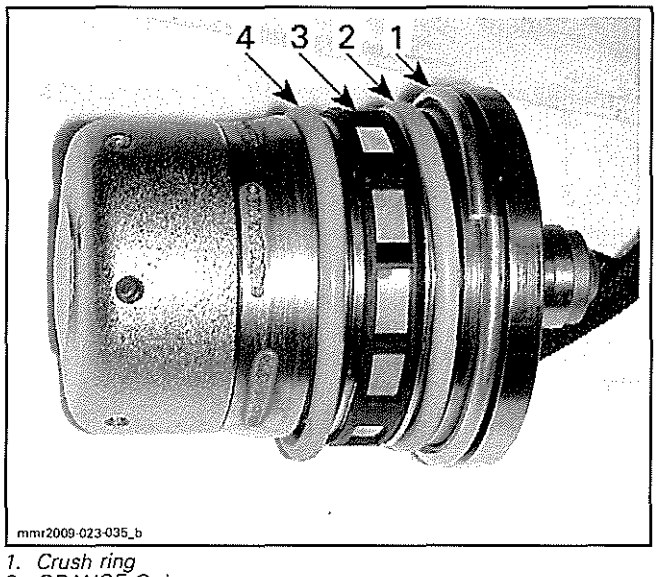
3. Thread the extractor adapter into the fuel injector.
4. Securely hold the fuel injector housing upside down to avoid dropping it.
5. Work slide hammer to pull the fuel injector out.





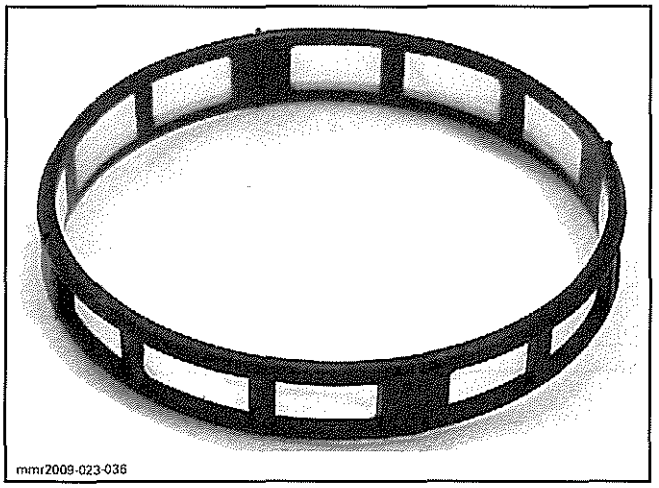
6. Remove the extractor adaptor from the fuel injector.

7. Remove O-rings, crush ring and filter from the fuel injector.



1. Crush ring
2. ORANGE O-ring
3. Filter
4. BLUE O-ring

8. Inspect and clean fuel injector filter.



Fuel Injector Assembly

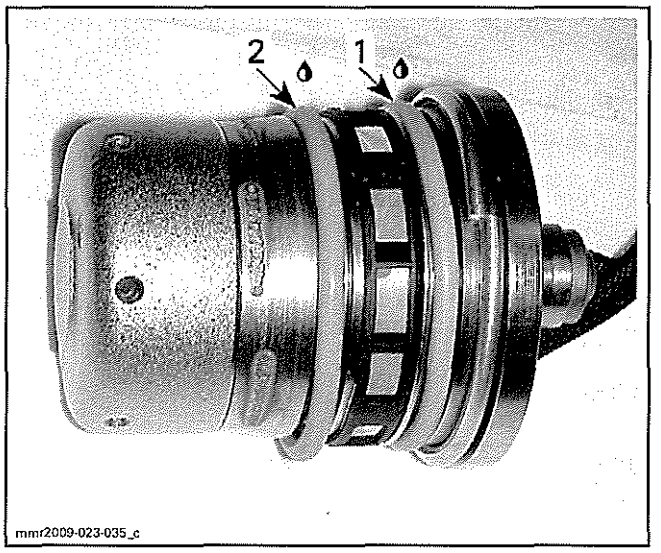
The assembly procedure is the reverse of disassembly. However, pay attention to the following:

IMPORTANT: Apply oil injection to O-rings.

1. Install a new crush ring.
2. Install a new orange O-ring on top.

NOTICE Always use the O-rings specifically designed for these fuel injectors.

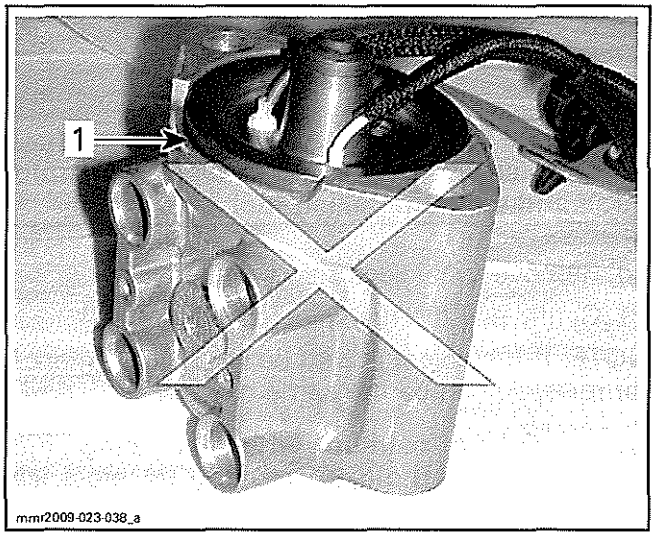
3. Install filter. Ensure filter is retained firmly on fuel injector. Otherwise, remove it, invert it half a turn, then reinstall. If it is still not retained securely, install a new one.
4. Install a new blue O-ring at bottom.



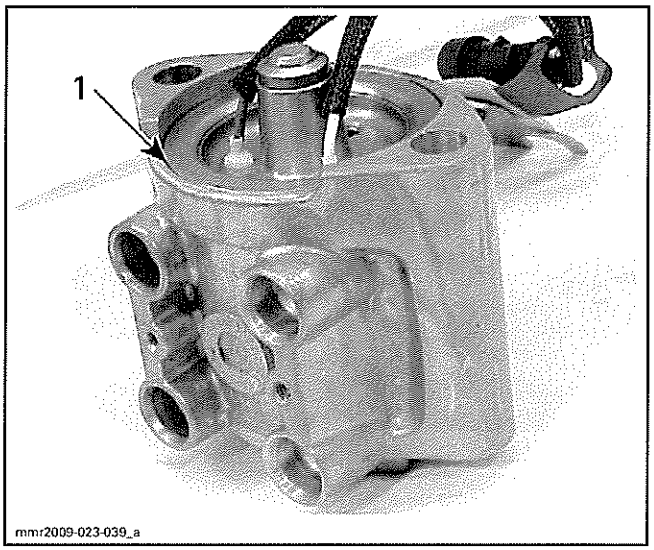
OIL INJECTION ON O-RINGS
1. ORANGE
2. BLUE

5. Reinstall fuel injector in its housing.
6. Fully insert fuel injector in the housing with the wire outlets towards the fuel ports.

NOTICE Never press or tap the fuel injector tip.



INCORRECT INSTALLATION
1. Fuel injector not fully inserted in its housing



CORRECT INSTALLATION
1. Fuel injector fully inserted in its housing

Fuel Injector Installation

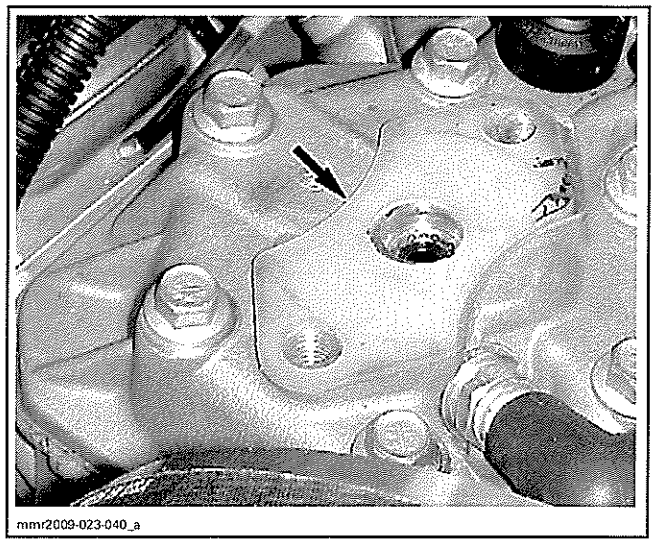
The following items and their mating surfaces must be cleaned and inspected prior to assembly:

- Fuel Injector
- Cylinder head: fuel injector housing base and fuel injector tip contact area
- Fuel injector screw threads and cylinder head threads (must be dry).

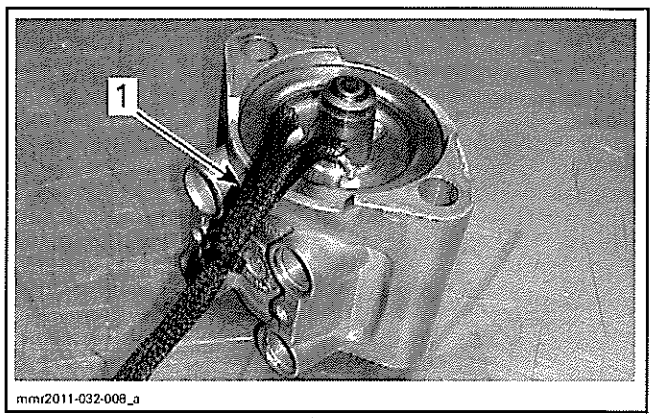
NOTICE All fuel injector components must be clean to ensure correct torque tightening specifications and to avoid leakage. Carefully follow the installation instructions.

NOTE: When installing a **used** fuel injector, re-install the fuel injector at the same location. If it was not marked at removal, verify the correct fuel injector-cylinder match using B.U.D.S. Refer to *FUEL INJECTOR POSITION VALIDATION* in this subsection.

1. Position the thermal insulator on cylinder head.



2. Route the fuel injector wires towards the fuel ports.

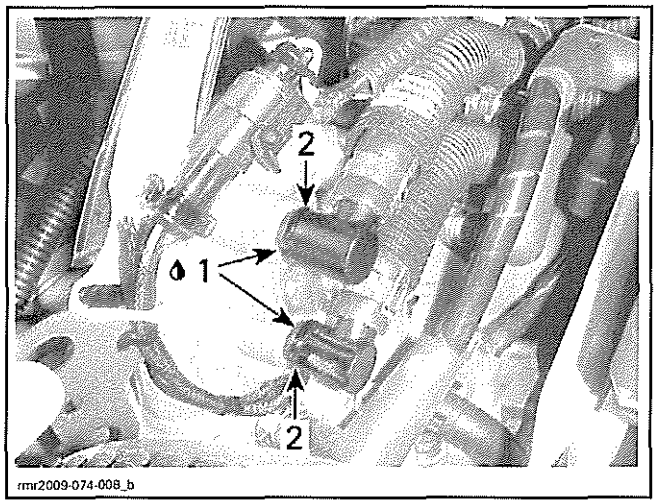


1. Fuel injector wires towards fuel ports

3. Place the fuel injector on the cylinder head, then thread NEW screws with washers.

NOTICE Torque fuel injector retaining screws prior to installing fuel hoses.

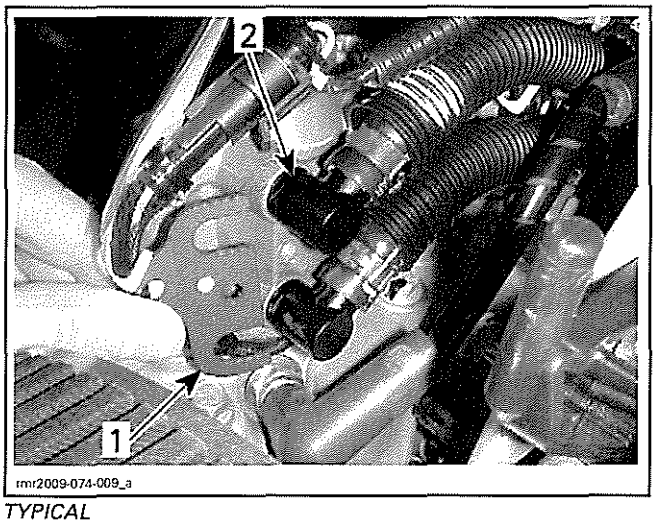
4. Tighten both screws alternately in the following sequence:
   - 4.1 Hand tighten until the screw heads contact the fuel injector housing
   - 4.2 5 N•m (44 lbf•**in**)
   - 4.3 25 N•m (18 lbf•ft)
   - 4.4 60 N•m (44 lbf•ft).
5. Check condition of fuel hose O-rings and plastic flange on hose fittings.
6. Apply injection oil to O-rings.
7. Insert fuel hoses into fuel injector housing.



TYPICAL
1. *Injection oil on O-rings*
2. *Ensure plastic flange is in good condition*

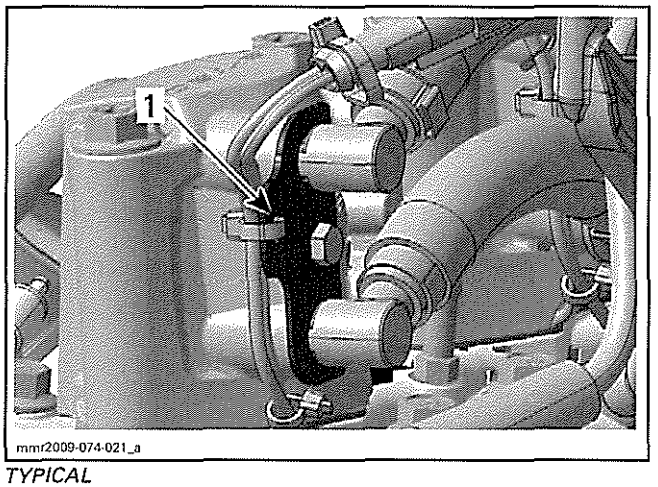
NOTE: Both hose fittings must be fully seated into fuel injector housing.

8. Hose retainer must engage the outer groove of the fuel injector housing fittings.



TYPICAL
1. *Retainer*
2. *Outer groove of fuel injector*

NOTE: Make sure the hole on the hose retainer for attaching the wiring harness is on top.

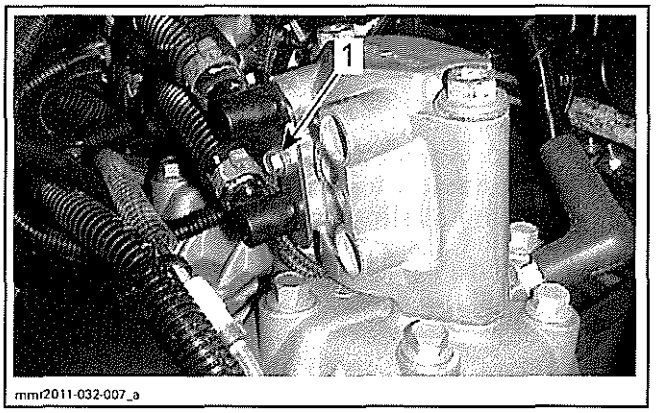


TYPICAL
1. *Hose retainer hole on top*

9. Install a NEW screw to secure hose retainer.

NOTICE **The screw features a threadlocker coating that is destroyed when loosening the screw. Always replace screw with a new one each time it is loosened.**

10. Torque fuel hose retainer screw to 5 N•m (44 lbf•**in**).



1. *Fuel hose retainer screw*

11. Apply some DIELECTRIC GREASE (P/N 293 550 004) in fuel injector connector.
12. Reconnect fuel injector connector.

NOTICE **Never fasten the electrical connector to the fuel injector. The connector must be "floating".**

13. When installing a NEW fuel injector, use B.U.D.S. to configure it in the ECM. Refer to *SETTING A FUEL INJECTOR TO A CYLINDER* in this subsection.

NOTE: The engine will be able to run with an improperly matched fuel injector. However, the engine may misfire, run rough at idle, have poor fuel economy or run lean.

⚠ WARNING

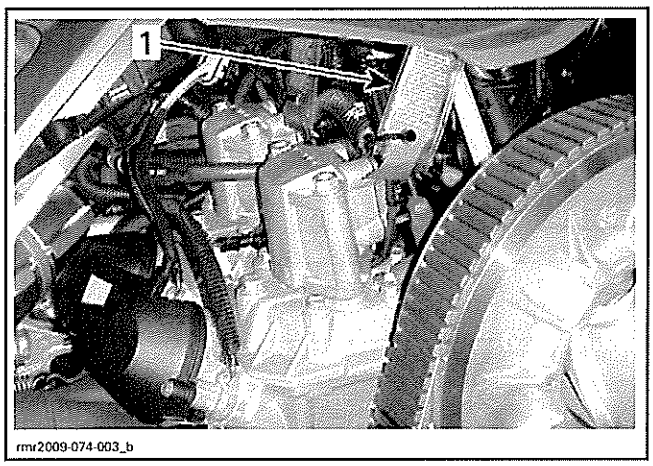
Perform a fuel pressure test and make sure there is no leak.

Fuel Injector Position Validation

When troubleshooting or reinstalling a fuel injector, the right match between the fuel injector and cylinder must be confirmed using B.U.D.S. An incorrect match between the fuel injector and cylinder would lead to engine miss, improper idling or poor fuel economy.

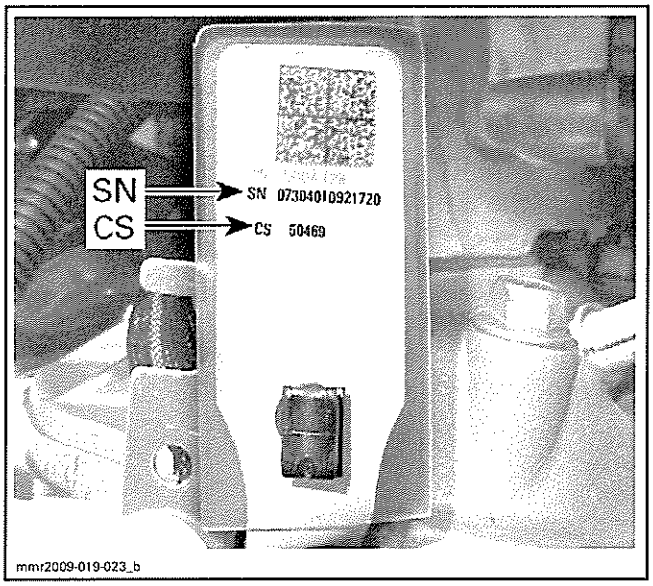
NOTE: To configure a new fuel injector at the installation, refer to *SETTING A FUEL INJECTOR TO A CYLINDER* in this subsection.

Look for a tag besides the fuel injector.



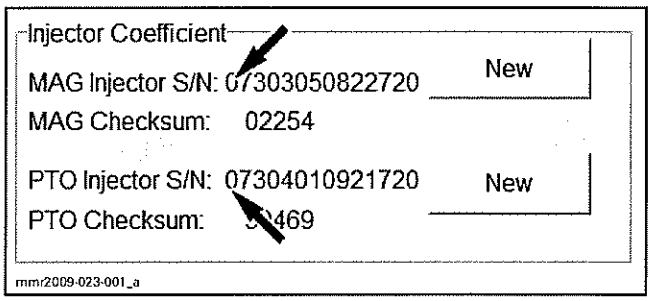
TYPICAL
1. Fuel injector tag

1. Note the fuel injector serial number (SN) on the tag of the fuel injector you wish to validate.



SN: Serial number
CS: Checksum number

2. In B.U.D.S., select Setting and ECM tabs.
3. In the Injector Coefficient box, see the fuel injector registered in the ECM (injector S/N).



PTO AND MAG INJECTOR S/N

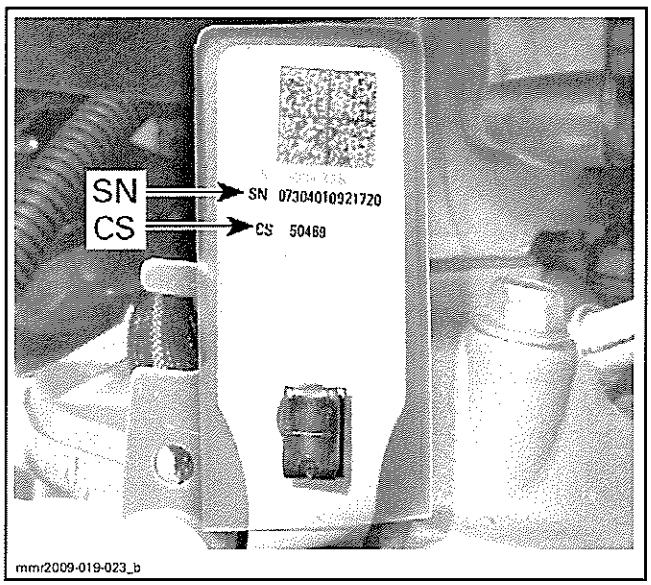
4. Compare the MAG or PTO Injector S/N that is configured in the ECM with the fuel injector SN installed on the engine.

The actual fuel injector number (SN) must match the number seen in B.U.D.S. (Injector S/N). If not, check if fuel injectors are mixed up.

If numbers do not match, configure the fuel injector in B.U.D.S. Refer to *SETTING A FUEL INJECTOR TO A CYLINDER.*

Setting a Fuel Injector to a Cylinder

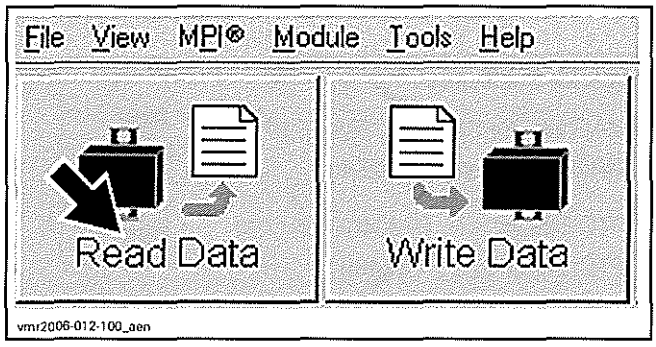
1. Note the serial number (SN) and the checksum (CS) on the fuel injector tag.



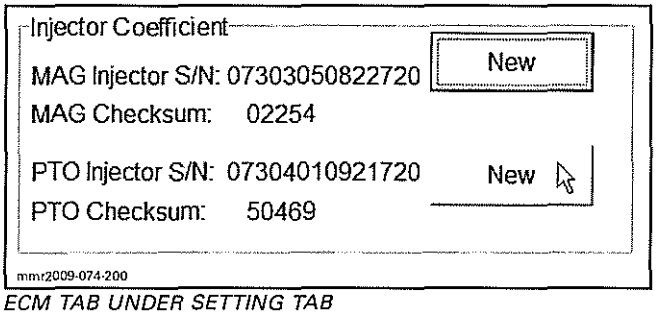
SN: Serial number
CS: Checksum number

2. Use BOSSWeb to get the matching calibration file.
3. Save the calibration file to your PC computer in the folder: C:\Program Files\BRP\BUDSCommon\ InjectorCoefficients.

4. Start B.U.D.S. and click on the **Read Data** button.



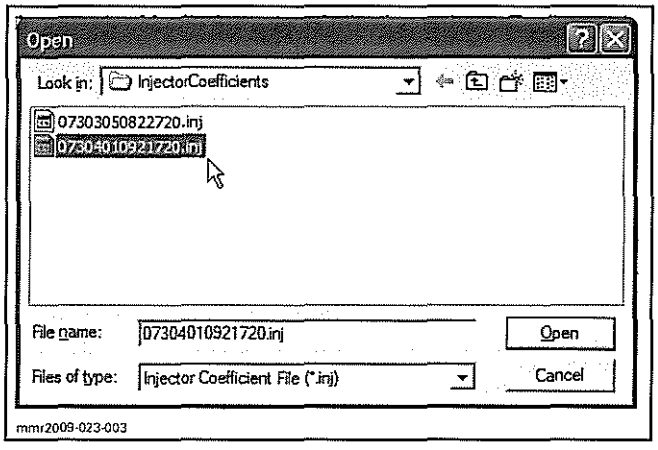
5. Select **Setting** and **ECM** page tabs.
6. In the **Injector Coefficient** box, click on the **New** button of the fuel injector you want to replace (MAG or PTO).



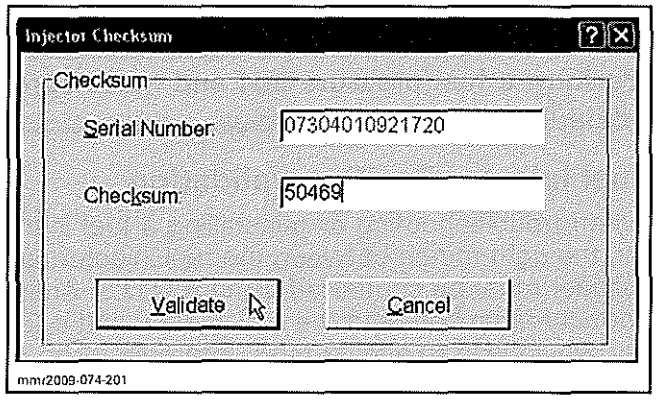
ECM TAB UNDER SETTING TAB

NOTE: Every time the **New** button is clicked, B.U.D.S. will automatically go in the **Injector Coefficients** folder.

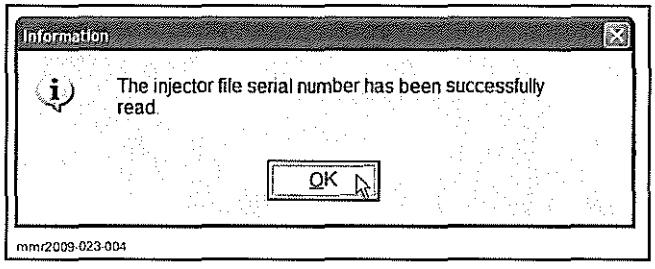
7. Select the fuel injector serial number file that matches the fuel injector installed on the engine.



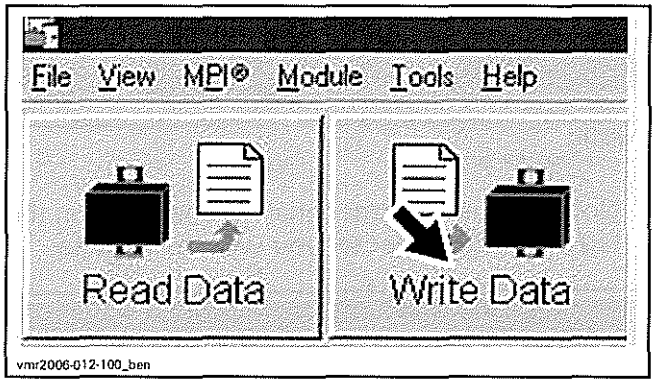
8. Enter the checksum noted earlier.



9. The file will be quickly read and loaded in B.U.D.S.
10. Then, click the **OK** button when the confirmation box appears.

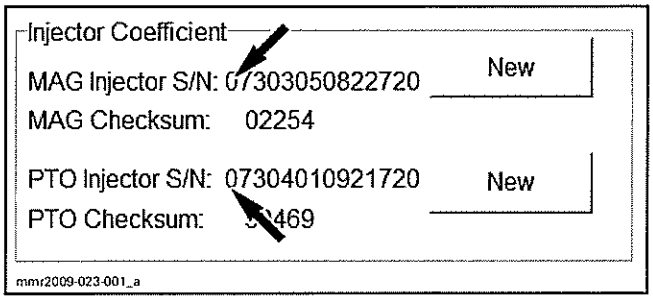


11. Click on the **Write Data** button.



IMPORTANT: To make sure the proper file has been set into the ECM, do the following:

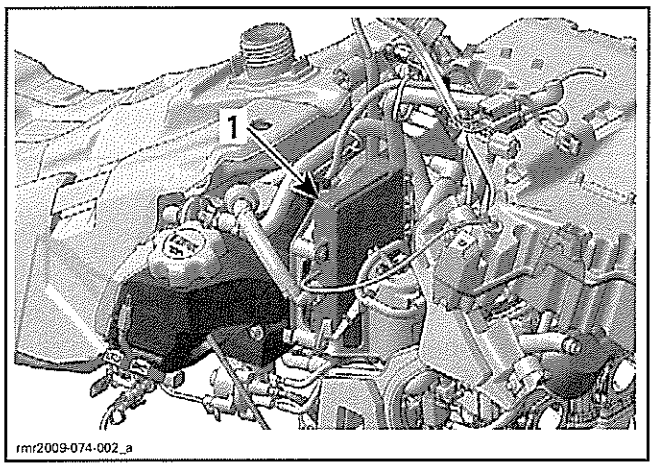
12. Read the data again in B.U.D.S.
13. In B.U.D.S., select the **Setting** page tab.
14. In the **Coefficient** field, ensure the S/N in B.U.D.S. matches the SN of the fuel injector installed on the engine and the PTO/MAG numbers are not inverted.



If there is a mismatch, reload the proper configuration file, click on **Write data** and read it again to recheck the S/N matching.

NOTE
Every time an ECM is read or when a **.mpem** file is opened, the fuel injector calibration files (example: 07303050822720 and 07304010921720.inj) are automatically stored on your PC computer under a folder that will be common to all versions of B.U.D.S.: C:\Program Files\BRP\BUDSCommon\InjectorCoefficients. If B.U.D.S. is uninstalled, the files won't be deleted. If you ever replace an ECM from which you were not able to read the data, you could load its latest **.mpem** file to look at the fuel injector serial numbers stored in the ECM to then read the matching calibration files from the common files without the need to download the file from BOSSWeb.

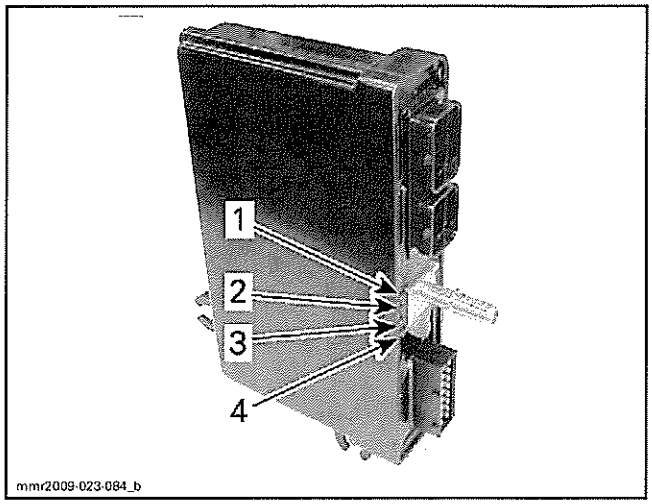
ECM (ENGINE CONTROL MODULE)



1. ECM

NOTE: Prior to replacing an ECM, ensure to conduct all testing procedures.

ECM Self Diagnostic LEDs



SELF DIAGNOSTIC LED
1. LED 1
2. LED 2
3. LED 3
4. LED 4

LED ON	ENGINE STARTING	ENGINE RUNNING
1	Charging OK	Charging fault
2	CPS signal OK	Fuel injection or ignition fault
3	Sensors OK	Sensor fault
4	Emergency and engine cut-off switch OK	No oil or engine overheat

ECM Wire Identification

CONNECTOR J1A		
FUNCTION	PIN	COLOR
RAVE position signal	1	WHITE/BLUE
D.E.S.S. ground	5	GREEN/BLACK
CPS	6	YELLOW
CPS	7	WHITE/YELLOW
Emergency engine stop switch	9	YELLOW/BLACK
TPS/RAVE position sensor +	10	BROWN/BLACK
D.E.S.S. signal	11	WHITE/GRAY
EGTS signal	12	GRAY/BROWN
CAN LO	13	WHITE/BLACK
CAN HI	14	WHITE/GREEN
ECM 12-volt power	15	WHITE/PINK

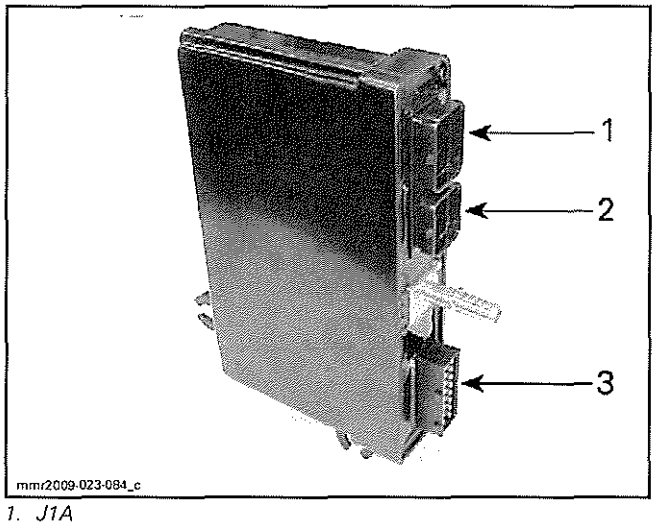
CONNECTOR J1A		
FUNCTION	PIN	COLOR
TPS signal	18	WHITE/BROWN
CTS signal	19	ORANGE/BROWN
ATS signal	20	WHITE/VIOLET
D.E.S.S. switch	23	WHITE/BLACK
TPS/RAVE position sensor ground	26	GRAY/BLACK
ATS/CTS/EGTS ground	27	RED/BLACK
START/RER switch signal	28	GREEN/RED
Oil level sensor +	29	LIGHT BLUE
Knock sensor +	33	BLUE/YELLOW
Knock sensor ground	34	BLUE/BROWN

CONNECTOR J1B		
FUNCTION	PIN	COLOR
PTO fuel injector control	1	GREEN
Relay control	5	ORANGE/WHITE
MAG fuel injector control	8	BLUE
Starter solenoid control	9	ORANGE/BLACK
ECM 12-volt power from diagnostic connector	10	BLUE/RED
Ground (fuel injectors)	14	BLACK
PTO ignition coil control	19	ORANGE/GREEN
Ground (fuel injectors)	20	BLACK
Ground (fuel injectors)	21	BLACK
E-RAVE solenoid control	22	GREEN/BROWN
Oil injection pump control	23	GREEN/YELLOW
MAG ignition coil control	26	ORANGE/BLUE

CONNECTOR J2		
FUNCTION	PIN	COLOR
Magneto winding	1	YELLOW
Magneto winding	2	BROWN
Magneto winding	3	ORANGE
Fuel pump control	4	PINK/BROWN
Ground	5	BLACK

CONNECTOR J2		
FUNCTION	PIN	COLOR
Secondary 12-volt supply	6	YELLOW/RED
Ground	7	BLACK
Ground	8	BLACK
Magneto winding	9	WHITE/YELLOW
Magneto winding	10	WHITE/BROWN
Magneto winding	11	ORANGE/WHITE
Fuel pump/oil injection pump 12-volt power	12	WHITE/RED
55/60-volt power	13	WHITE/RED
Secondary 12-volt supply	14	YELLOW/RED
Primary 12-volt supply	15	WHITE/PINK
Primary 12-volt supply	16	WHITE/PINK

ECM Connector Identification

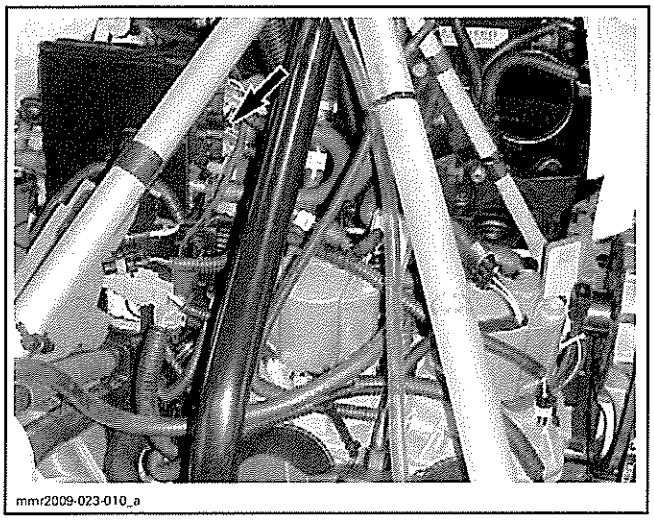


1. *J1A*
2. *J1B*
3. *J2*

ECM Connector Access

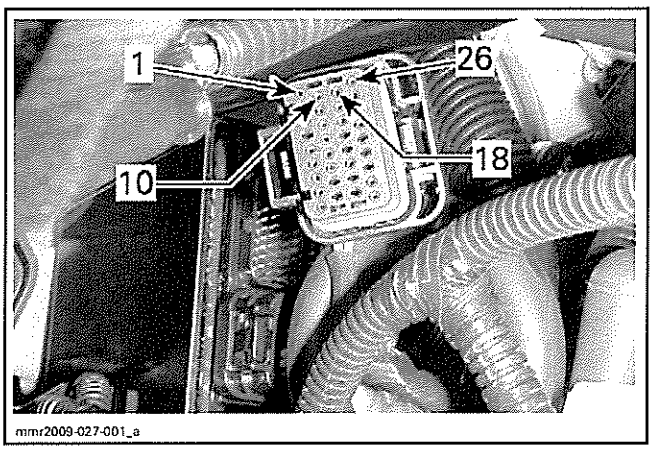
To access ECM connectors:

1. Open LH panel.
2. Remove secondary air intake silencer. Refer to *AIR INTAKE SYSTEM.*
3. Unlock ECM support to move ECM as necessary.

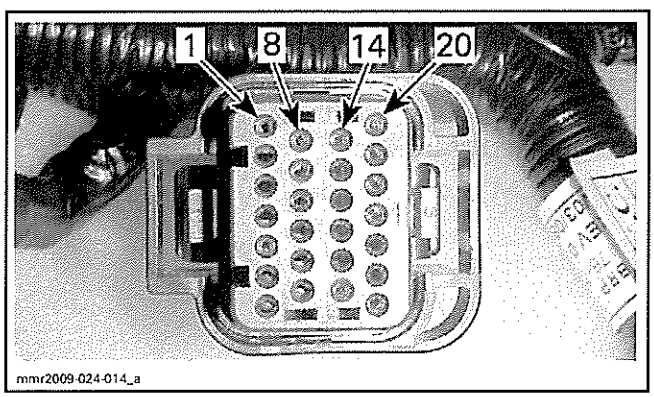


ECM CONNECTORS

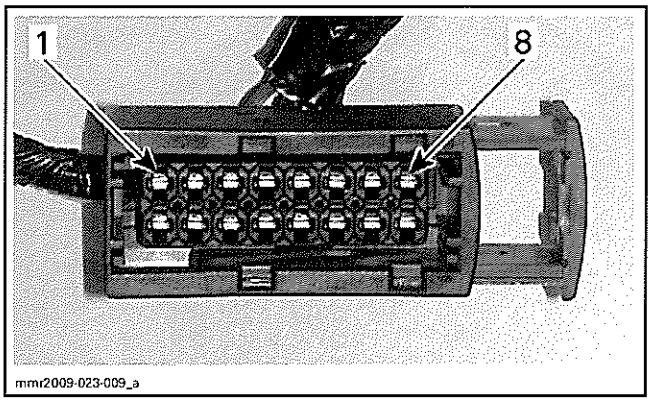
ECM Connector Pin-outs



J1A PIN-OUT



J1B PIN-OUT

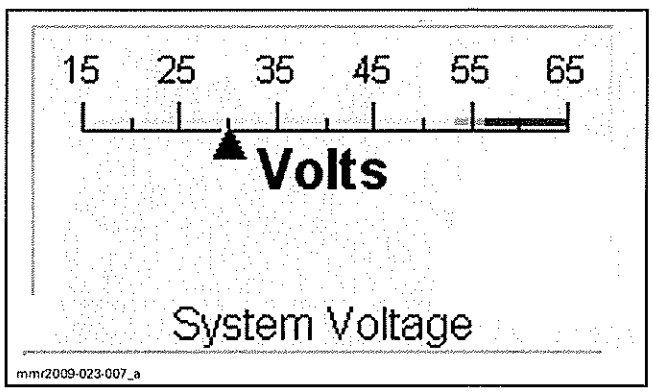


J2 PIN-OUT

ECM Power Supply Troubleshooting

System Voltage Verification

1. Connect vehicle to applicable B.U.D.S. Refer to *COMMUNICATION TOOLS/B.U.D.S.* subsection.
2. In B.U.D.S., select ECM page tab on the **Monitoring** page.
3. Crank engine while viewing **System Voltage** in B.U.D.S.



TEST CONDITION	VOLTAGE
Manual crank speed	30 Vdc min.

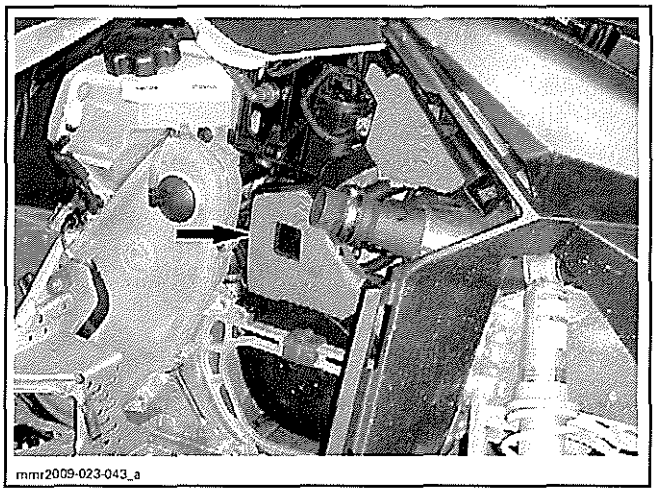
If voltage is as per specification, ECM is properly powered.

If voltage is out of specification, refer to *CHARGING SYSTEM.*

ECM Removal

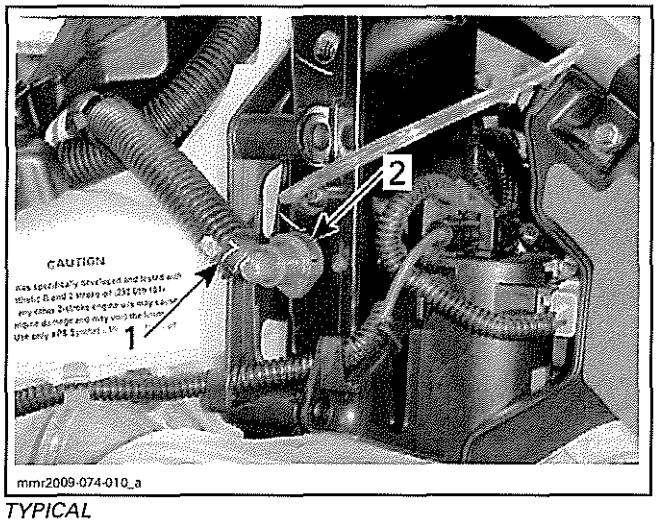
NOTE: If a new ECM is to be installed, read *ECM REPLACEMENT* in this subsection **before** removing ECM.

1. Remove tether cord cap (D.E.S.S. key).
2. Remove muffler. Refer to *EXHAUST SYSTEM* subsection.
3. Remove the acoustic panel.


mmr2009-023-043_a

TYPICAL

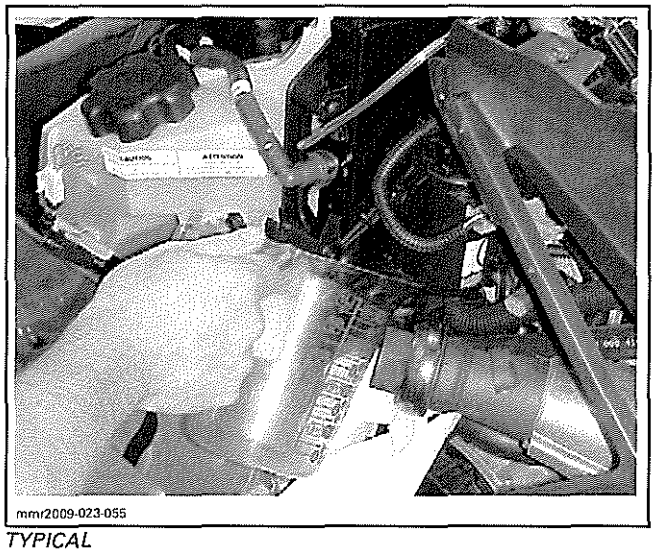
4. Remove console. Refer to *BODY.*
5. Set engine stop switch to STOP.
6. Install a rag under the ECM hose quick connect to catch fuel spillage.
7. Disconnect fuel supply hose from ECM.



mmr2009-074-010_a

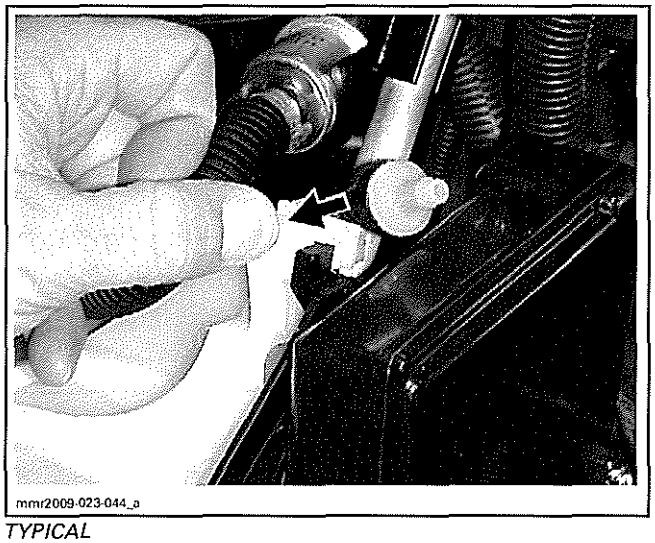
TYPICAL
1. Fuel supply hose
2. Release button

8. Place a container under the hose connector to recover fuel.


mmr2009-023-055

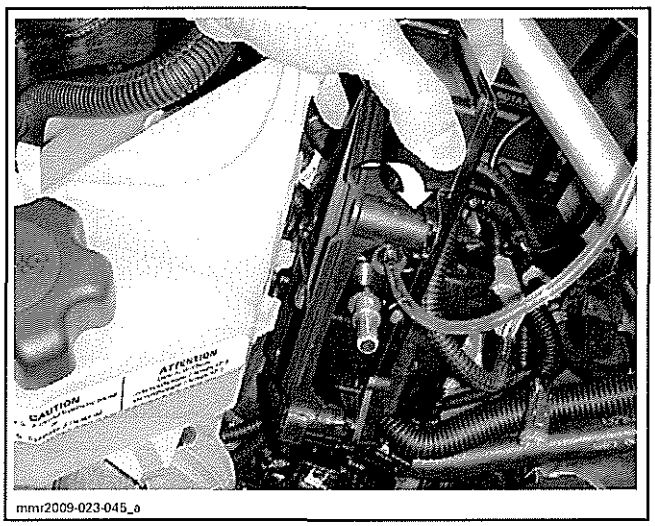
TYPICAL

9. Slowly disconnect fuel hose and drain fuel.
10. Unlock the ECM.

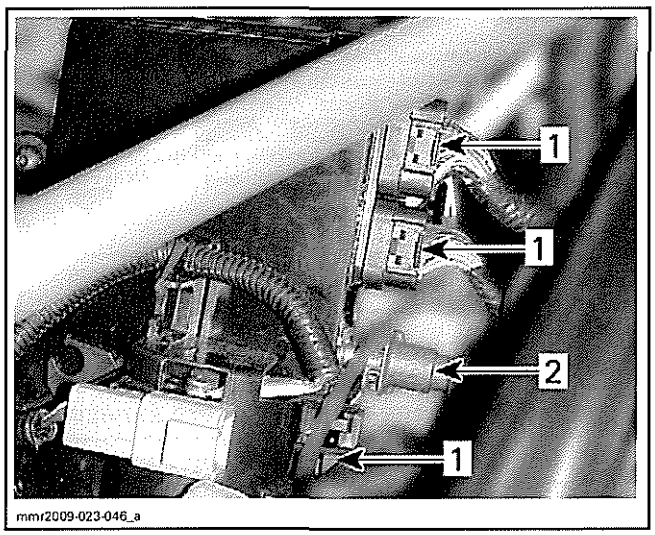

mmr2009-023-044_a

TYPICAL

11. Slightly pull ECM out.
12. Tilt ECM in order to drain fuel from ECM.

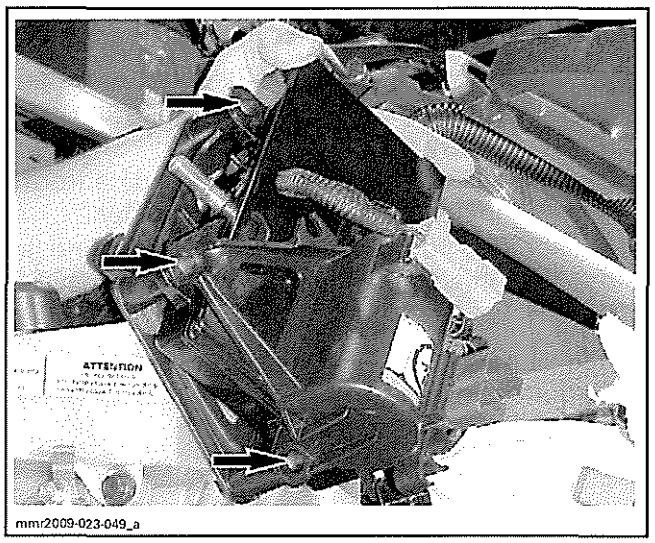


13. Disconnect APS tube from the ECM.
14. Disconnect ECM connectors.
15. Disconnect capacitor connector.
16. Disconnect remaining fuel hose from ECM.



1. ECM connectors
2. Fuel hose

17. Detach ECM from its support.

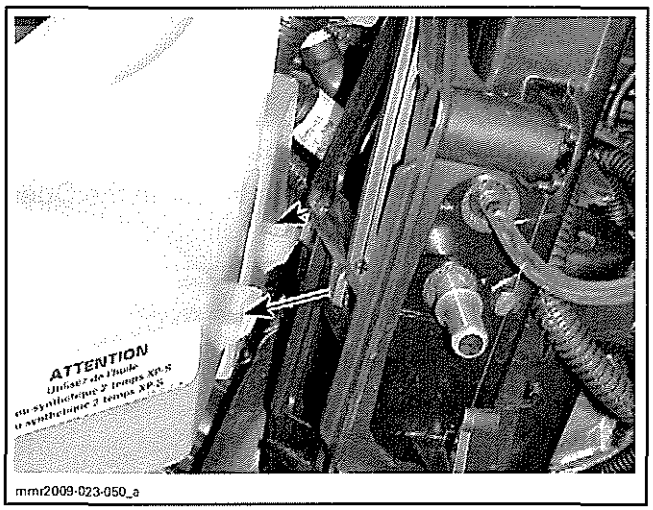


ECM Installation

Reverse removal procedure however, pay attention to the following.

Set engine stop switch to STOP.

Ensure to engage the ECM tabs of oil injection reservoir lugs.



⚠ WARNING

Wipe up all spilled fuel.

ECM Replacement

When installing a new ECM, data must be entered and several resets are required.

To enter data to the new ECM, refer to *ECM MANUAL DATA ENTRY* in this subsection.

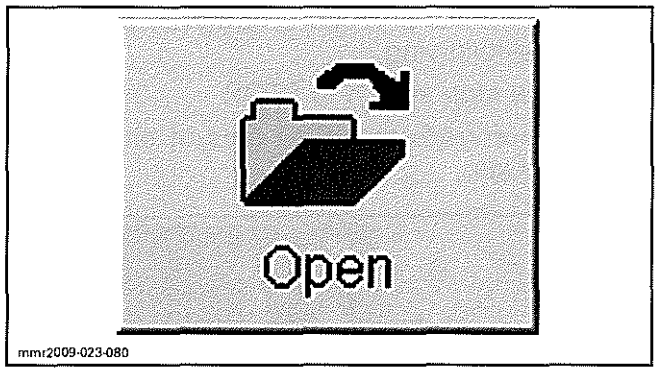
ECM Manual Data Entry

There are 2 possible methods used for collecting the required information. The 1st being the easiest.

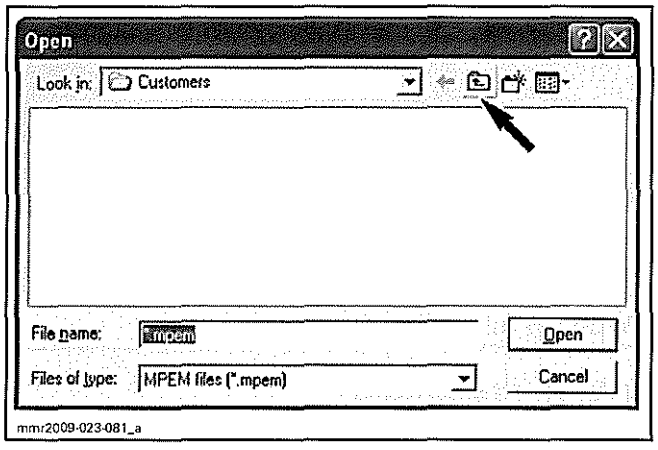
- Use B.U.D.S. software and get the data from a saved .mpem file on your PC computer.
- Collect the information from the vehicle and get the fuel injector coefficient files from BOSS-Web.

1st Collecting Method: Get the Data from a Saved .mpem File

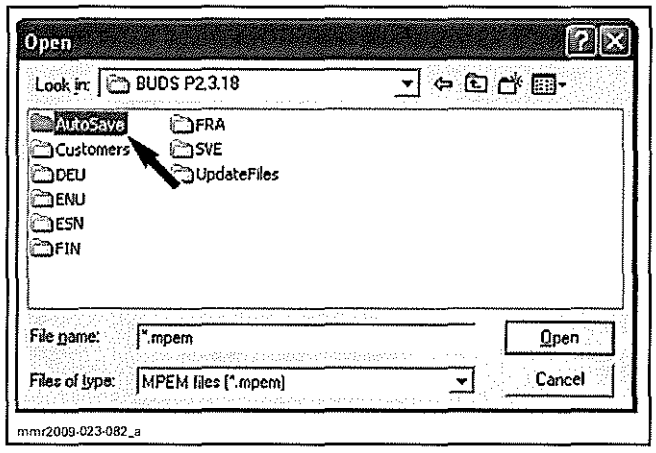
1. Remove the faulty ECM.
2. Install and connect the new ECM.
3. Connect to applicable B.U.D.S. software.
4. Click on the **Open** button.



5. Click once on the **Folder Up** button in the **Open** box.

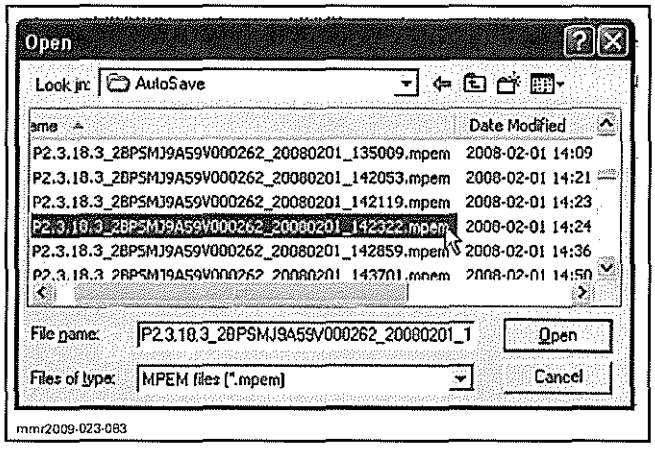


6. Double click on the **AutoSave** folder.



NOTE: You may have to go to another **AutoSave** folder from a previous version of B.U.D.S.

7. Choose the latest file saved for this specific vehicle.



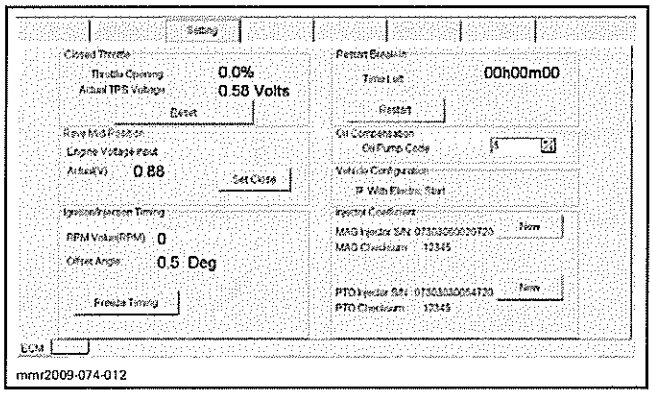
8. IMPORTANT: Ensure to use the file that specifically matches the vehicle you are servicing.

NOTE: The file name structure is as follows:
BUDS version_VIN_date read (yyyymmdd)_hour read (hhmmss).mpem
Example: P2.3.18.3_2BPSMJ9A59V000262_20080201_142322.mpem

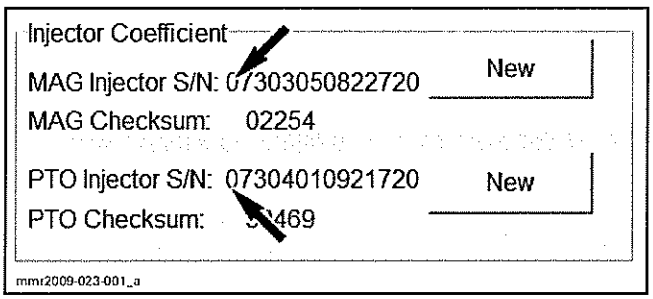
9. On the **Vehicle** page of B.U.D.S., record the following information:
   - Engine number (without the leading "M")
   - Customer name.

NOTE: It is not necessary to record the vehicle (VIN) and model numbers. They will be transferred later.

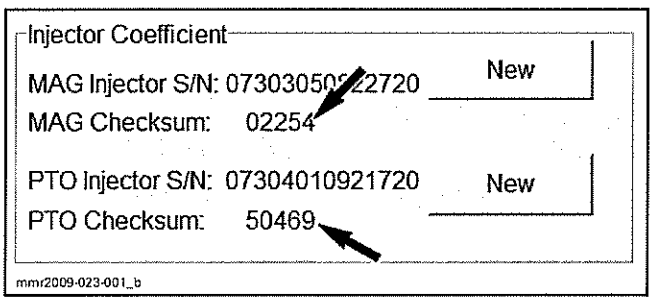
10. Select the **ECM** and **Setting** page tabs, then record the following information
    - Ignition/Injection timing: Offset angle
    - Oil compensation: Oil pump code.



11. Also record the Fuel injector coefficients: MAG/PTO injectors S/N and Checksums.



FUEL INJECTOR SERIAL NUMBER (S/N)

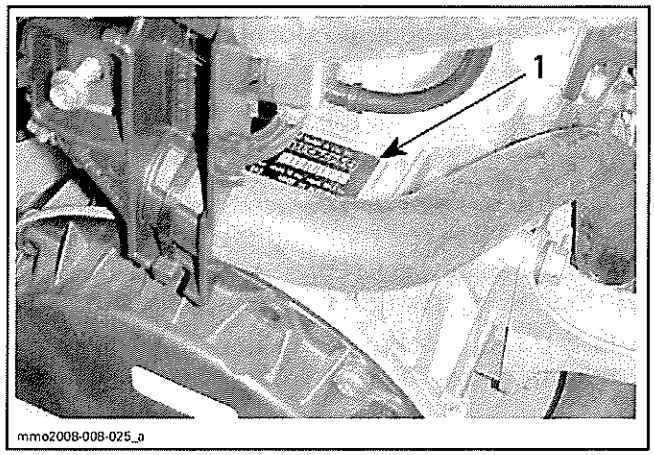


FUEL INJECTOR CHECKSUM (CS)

12. Enter collected data in new ECM as detailed in *ENTERING THE COLLECTED INFORMATION IN THE ECM.*

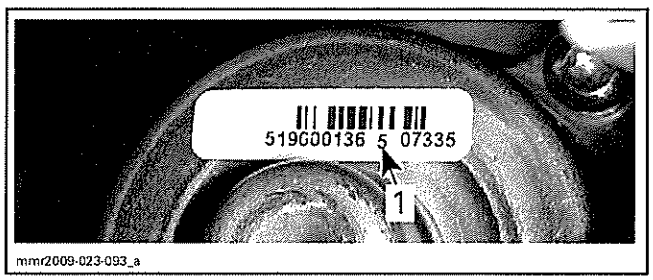
2nd Collecting Method: Collect the Information from the Vehicle

1. Record engine serial number.



RH SIDE OF ENGINE COMPARTMENT
1. Engine serial number

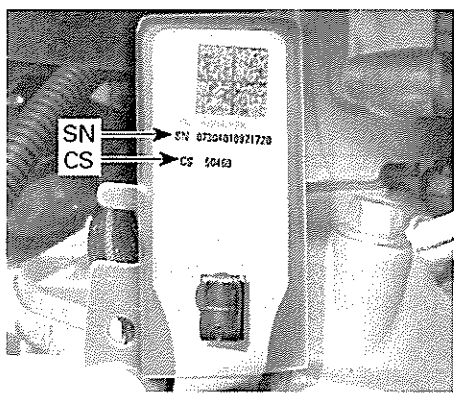
2. Record oil injection pump code.



BACK OF OIL INJECTION PUMP
1. Oil pump code (0 to 9)

3. Record MAG/PTO injectors S/N.

Record the serial number (SN) and the checksum (CS) on the fuel injector tag.



SN: Serial number
CS: Checksum number

Use BOSSWeb to get the matching calibration file.

Save the calibration file to your PC computer in the folder:

C:\Program Files\BRP\BUDSCommon\InjectorCoefficients.

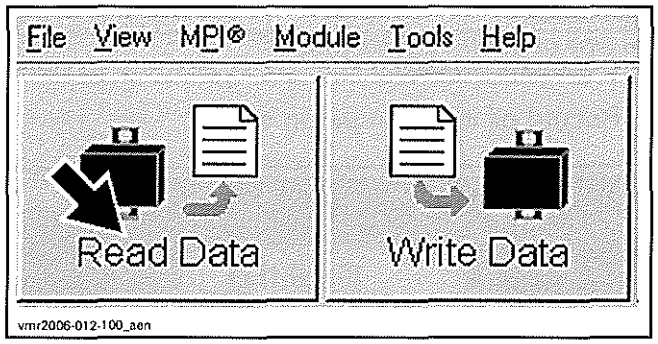
Enter collected data in new ECM as detailed in *ENTERING THE COLLECTED INFORMATION IN THE ECM.*

Entering the Collected Information In the ECM

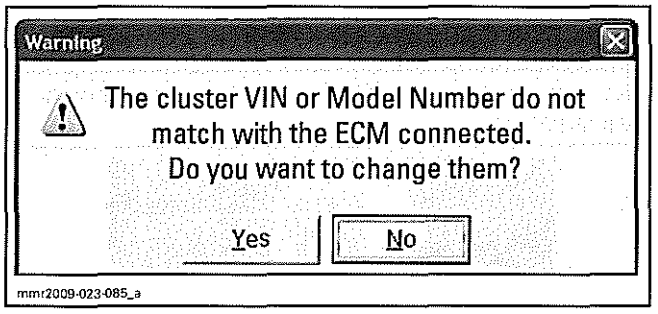
1. Remove the faulty ECM.
2. Install and connect the new ECM.
3. Use B.U.D.S. to enter the data in the new ECM.

NOTE: The beeper will continuously sound a sequence of 11 beeps meaning that the tether cord cap (D.E.S.S. key) is not programmed in the ECM. To stop the beeps, remove tether cord cap.

4. In B.U.D.S., click on the **Read Data** button to read the new "empty" ECM.



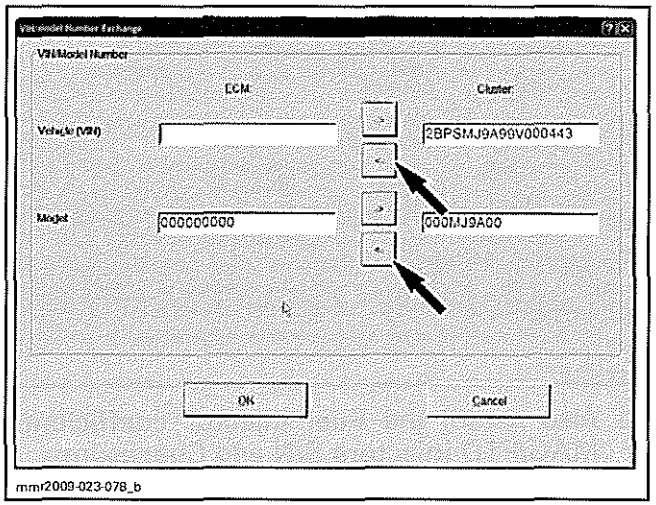
NOTE: A message will appear stating that the cluster (multifunction gauge) does not recognize the ECM.



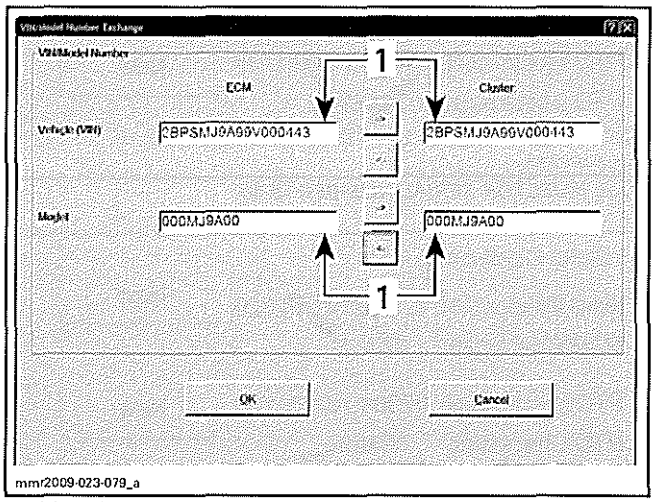
5. Click **Yes** to enable matching.

NOTE: If the numbers are not matched, the gauge will stop operating within 10 seconds of engine operation. Only its D.E.S.S. LED will be turned ON.

6. Click on the arrows to transfer the numbers from the **Cluster** column to the **ECM** column.

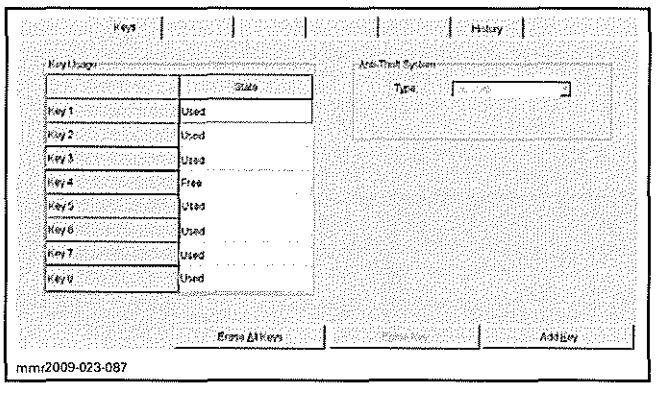


The **VIN** and **Model** number between ECM and cluster are now properly matched.

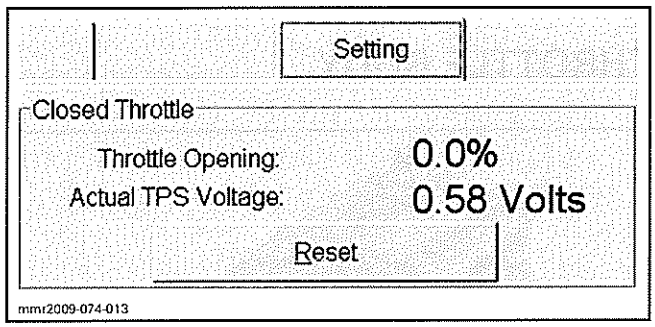


1. Matching numbers

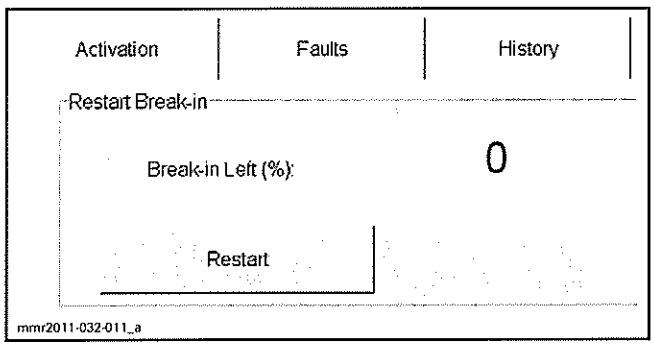
7. In B.U.D.S., select the **Vehicle** page tab and enter the information you recorded previously.
   - Engine number (do not enter the leading "M")
   - Customer name.
8. Select the **Keys** tab and click on **Erase All Keys**.



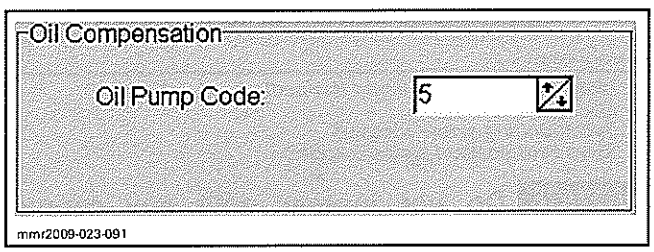
9. Program the desired key(s). Refer to *D.E.S.S. SYSTEM*.
10. Select the **ECM** and **Setting** page tabs.
11. Reset the **Closed Throttle**. Refer to *CLOSED THROTTLE RESET (TPS)*.



12. Carry out the **3D Rave Valves Position Sensor Setting**. Refer to *RAVE (E-TEC)* subsection.
13. Set the **Ignition/Injection Timing**. Refer to *IGNITION SYSTEM*.
14. In the **Restart Break-In** field, click **Restart** button if the real engine hours are less than 5 hours.



15. In the **Oil Compensation** field, enter the previously recorded **Oil Pump Code**.



16. For MAG and PTO fuel injector S/N, refer to the following.
    - 16.1 If you obtained the data from a saved .mpem file, refer to table A.
    - 16.2 If you obtained the fuel injector calibration file from BOSSWeb, refer to table B.

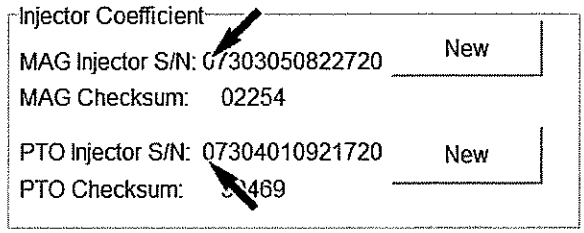
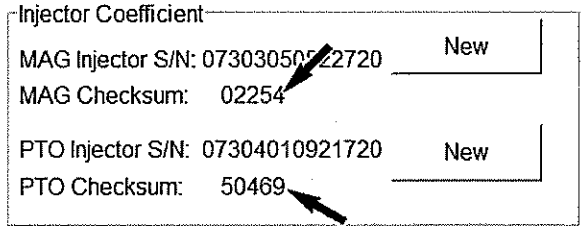
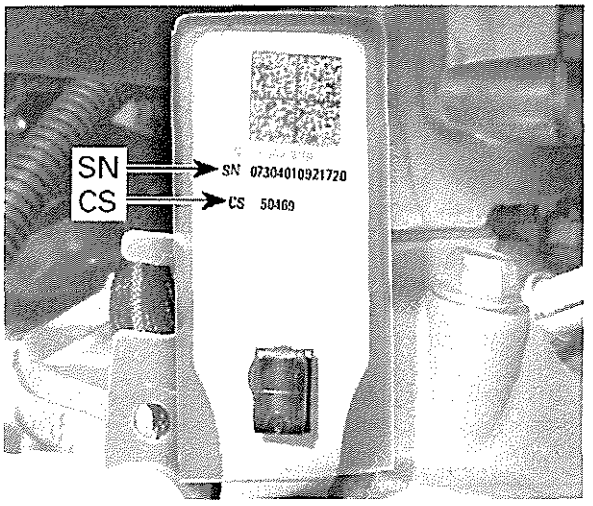
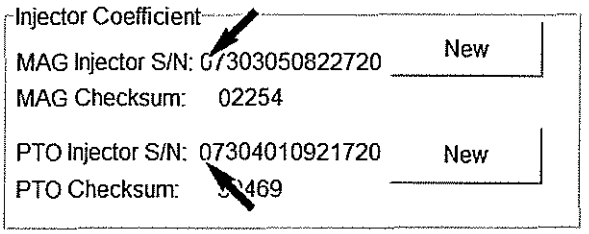
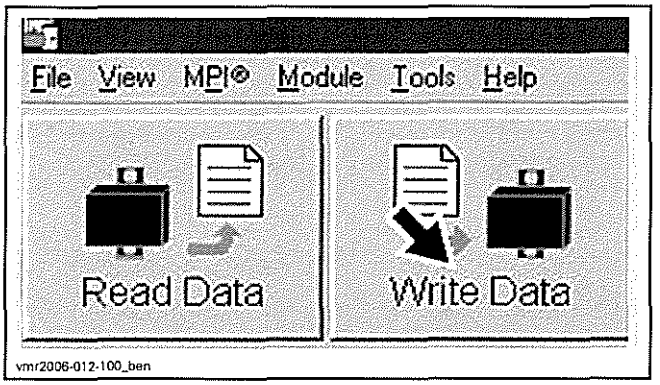
TABLE A (DATA FROM A SAVED .MPEM FILE)
Click on the New button and open the file that matches the previously recorded serial number.

Ensure to match PTO and MAG sides.
Once the file has been read, ensure the checksum number (CS) shown in B.U.D.S. matches the CS you previously recorded.

Otherwise, you read a wrong file. Read the file again until you get the appropriate file.

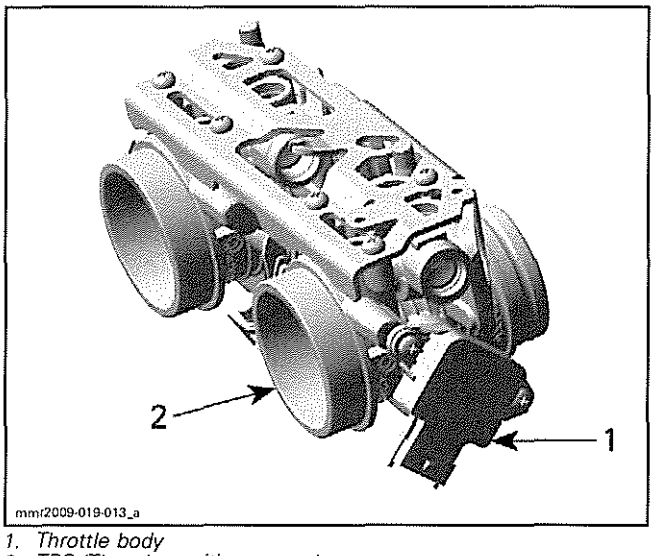
TABLE B (CALIBRATION FILE FROM BOSSWEB)
Click on the New button and open the file that you previously saved on your PC computer in the folder: C:\Program Files\BRP\BUDSCommon\InjectorCoefficient
Ensure to match PTO and MAG sides.
Once the file has been read, ensure the fuel injector tag SN matches the S/N shown in B.U.D.S.
 SN: Serial Number

Otherwise, you read a wrong file. Read the file again until you get the appropriate file.

17. Click on the Write Data button.



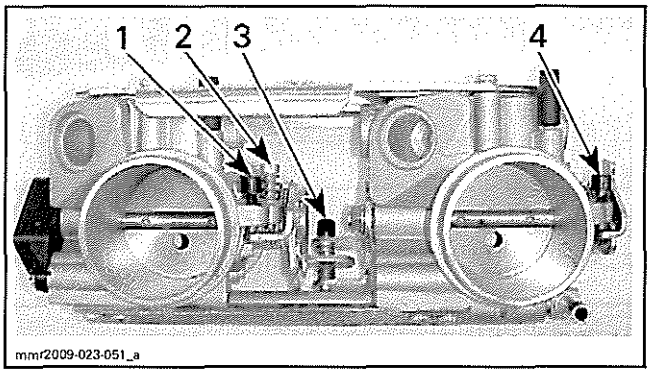
18. Lift rear of vehicle and safely support.
19. Start the engine and increase engine speed above 6000 RPM to be sure no fault codes appear.
20. Let engine idle to ensure idle is adequate.
21. If engine does not run as expected, ensure that the fuel injector calibration files are valid. Check with the tag of the fuel injectors installed on the engine.
22. Reinstall remaining removed parts.

THROTTLE BODY



1. Throttle body
2. TPS (Throttle position sensor)

Throttle Body Screw Identification



1. Master zero position screw (capped)
2. Idle screw
3. Synchronizing screw (capped)
4. Slave zero position screw (capped)

NOTICE Do not tamper with any capped screw, otherwise the throttle body may have to be replaced.

Throttle Body Inspection

Carry out the following:

1. Check that the throttle plates move freely and smoothly when depressing throttle lever.
2. Check if throttle body master zero position screw is loose. If so, replace throttle body.

3. Check if TPS is loose.
4. Check for corroded or damaged wiring or connectors.

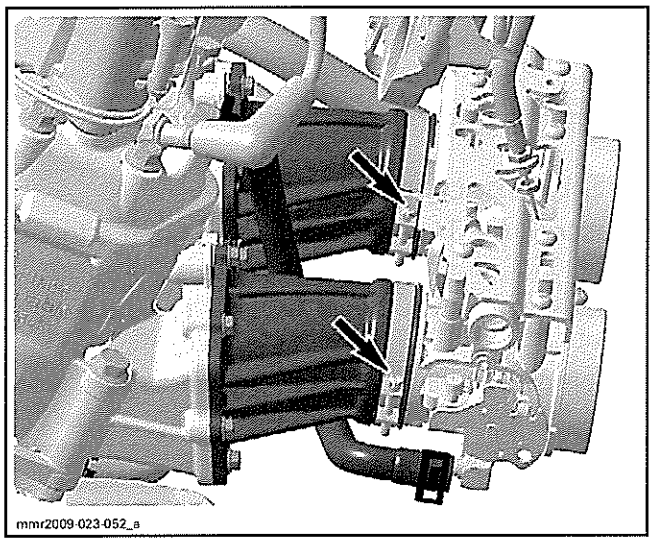
Throttle Body Removal

⚠ WARNING

Always remove tether cord cap (D.E.S.S. key) and disconnect battery before removing the throttle body.

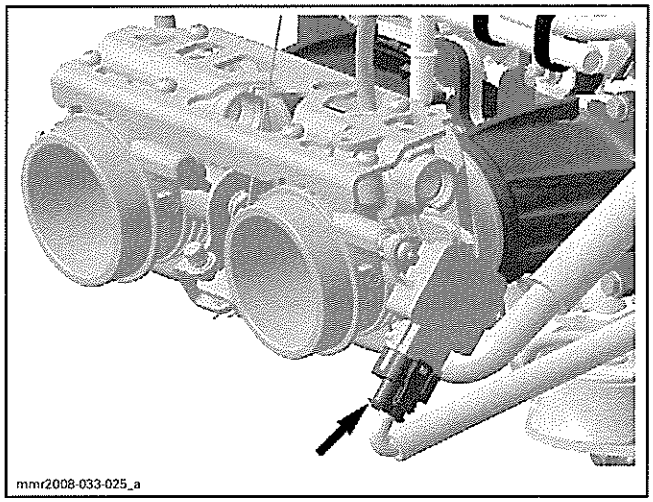
To remove the throttle body from engine, proceed as follows:

1. Remove drive belt guard. Refer to *DRIVE BELT* subsection.
2. Remove primary air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.
3. Loosen retaining clamps of throttle body.

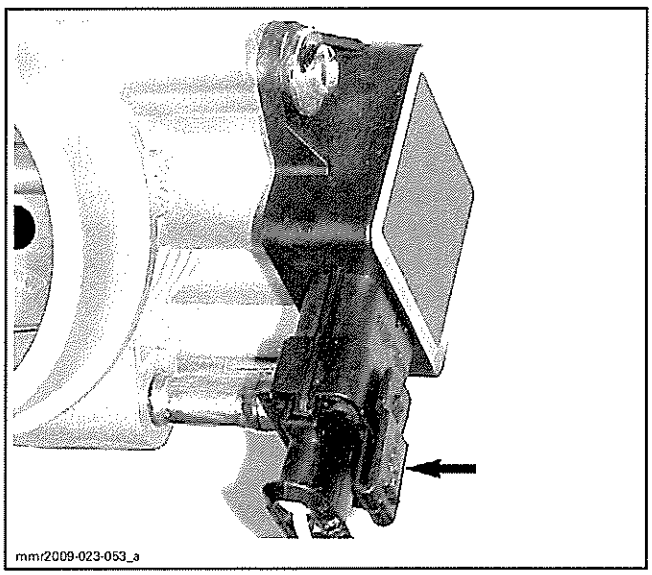


4. Pull out throttle body sufficiently to access coolant hoses and TPS connector.
5. Detach brake hose from air intake silencer adapter.
6. Remove air intake silencer adapter.
7. Disconnect TPS connector.

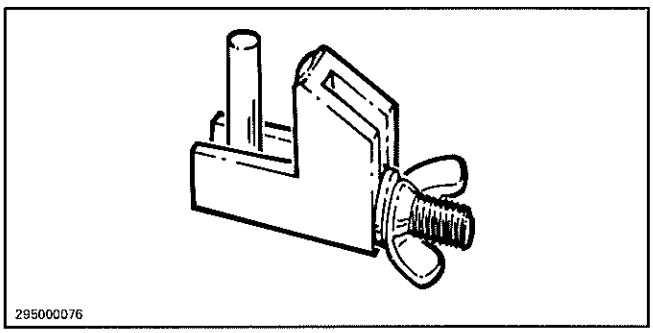
NOTE: Pull the secondary lock off the connector if applicable.

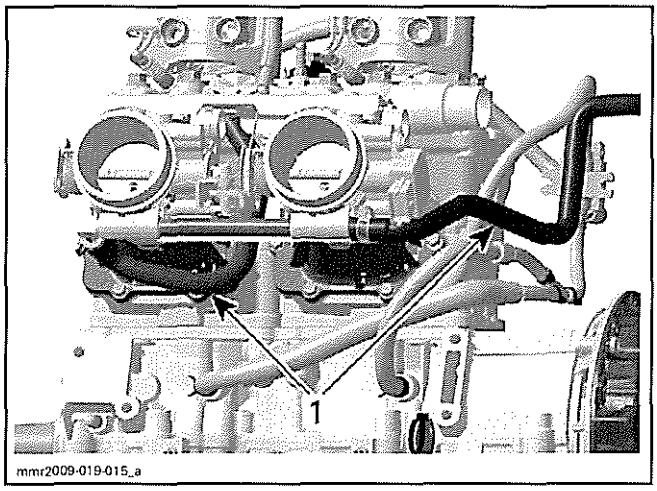


TPS CONNECTOR



8. Install SMALL HOSE PINCHER (P/N 295 000 076) on coolant hoses connected to throttle body.





1. Hose pinchers here

9. Detach coolant hoses for throttle body.
10. Disconnect throttle cable.
11. Pull throttle body out of vehicle.

Throttle Body Installation

Installation of the throttle body is the reverse of the removal procedure however, pay attention to the following details.

Before installation, clean throttle plates and bores with PULLEY FLANGE CLEANER (P/N 413 711 809).

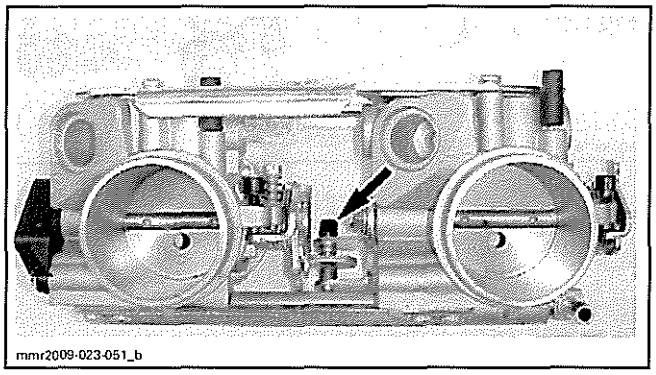
If a new throttle body is installed, carry out the *CLOSED THROTTLE RESET (TPS)* as detailed in this section.

Refill engine coolant. If an important quantity of coolant was spilled, bleed cooling system. Refer to *COOLING SYSTEM* section.

Throttle Body Synchronization

No synchronization is required as it has already been done at the factory.

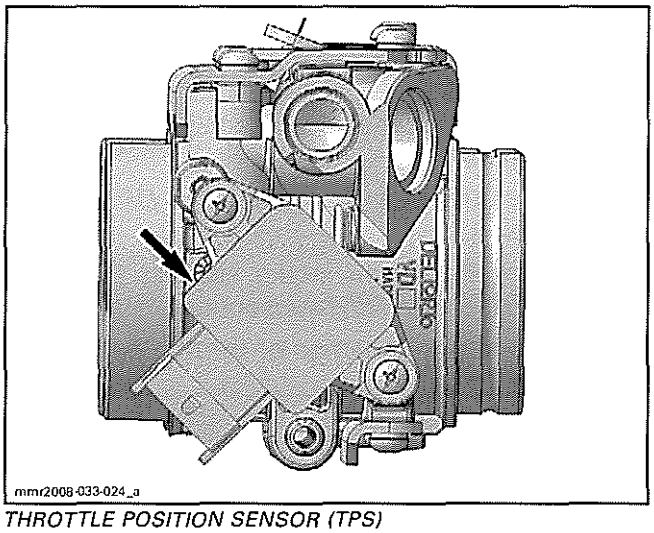
NOTICE **Do not alter setting synchronization screw, otherwise the throttle body must be replaced.**



THROTTLE POSITION SENSOR (TPS)

Description

The throttle position sensor (TPS) is a potentiometer that sends a signal to the ECM that is proportional to the throttle plate angle.



THROTTLE POSITION SENSOR (TPS)

TPS Connector Access

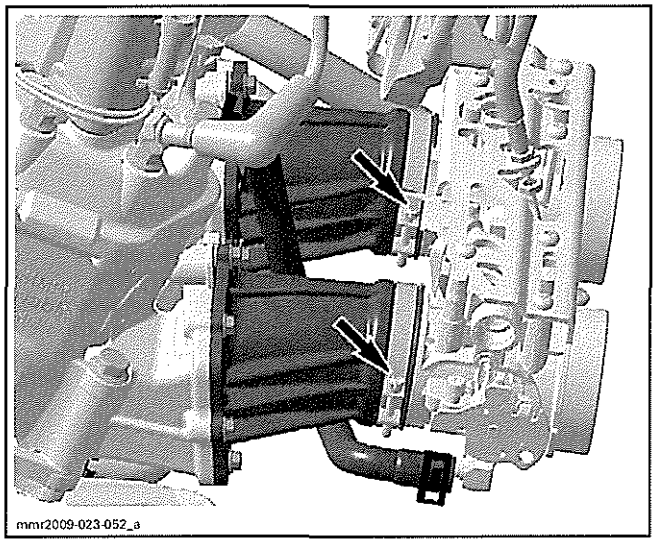
To access the TPS connector, perform the following:

1. Remove drive belt guard. Refer to *DRIVE BELT* subsection.
2. Remove primary air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.

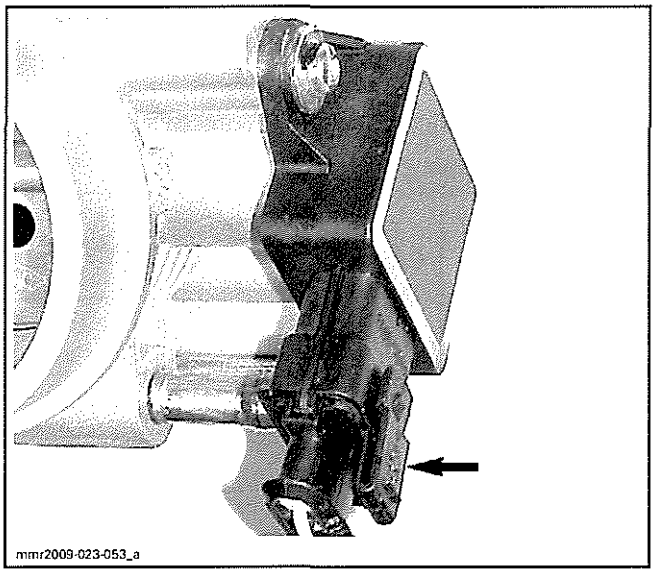
⚠ WARNING

Always remove tether cord cap (D.E.S.S. key) and disconnect battery before removing the throttle body.

3. Loosen retaining clamps of throttle body.

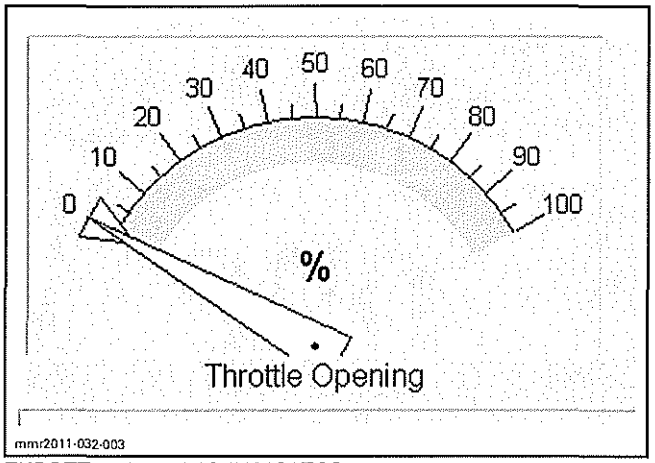


4. Pull out throttle body to access TPS connector.
5. Disconnect TPS connector.



TPS Wear Test

1. Ensure TPS connector is properly connected.
2. While engine is not running, activate throttle and pay attention for smooth operation without physical stops of the cable.
3. Connect vehicle to the applicable B.U.D.S. software.
4. Select the **Monitoring** and **ECM** page tabs.
5. Monitor the TPS using the **Throttle Opening** indicator.



THROTTLE OPENING INDICATOR

6. Slowly and regularly depress the throttle and observe the needle movement. It must change gradually and regularly as you move the throttle.

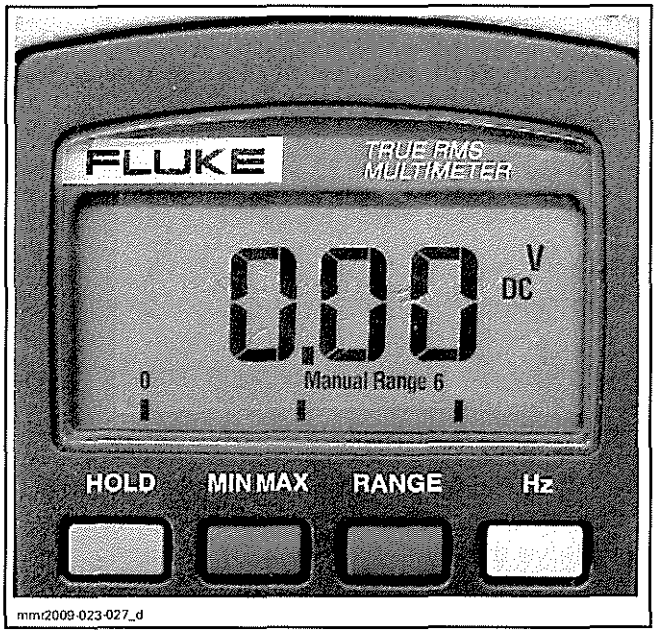
NOTE: If the needle "sticks", bounces, suddenly drops off, or if any discrepancy between the throttle movement and the needle movement is noticed, it indicates a worn TPS that needs to be replaced.

TPS Reset (Closed Throttle)

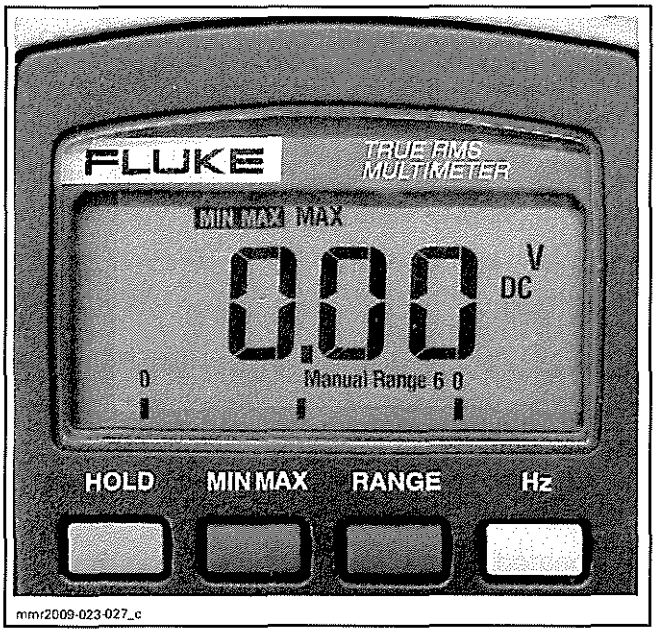
Refer to *CLOSED THROTTLE RESET (TPS)* in this subsection.

TPS Input Voltage Test

1. Remove parts required for access to the TPS connector, refer to *TPS CONNECTOR ACCESS* in this subsection.
2. Check the voltage output from the ECM to the throttle position sensor.
3. Disconnect TPS connector.
4. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and set it to Vdc.
5. Repeatedly press the **RANGE** button until the display shows Manual Range 6.

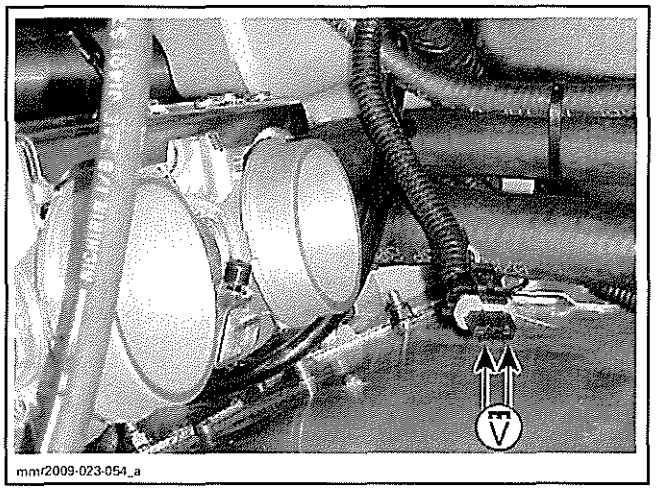


6. Press the MIN MAX button so that the display shows MIN MAX.



7. Crank engine.
8. Read voltage at TPS harness connector as follows.

TPS HARNESS CONNECTOR		VOLTAGE
Pin 1	Pin 2	5.0 Vdc



9. Read the MAX value.

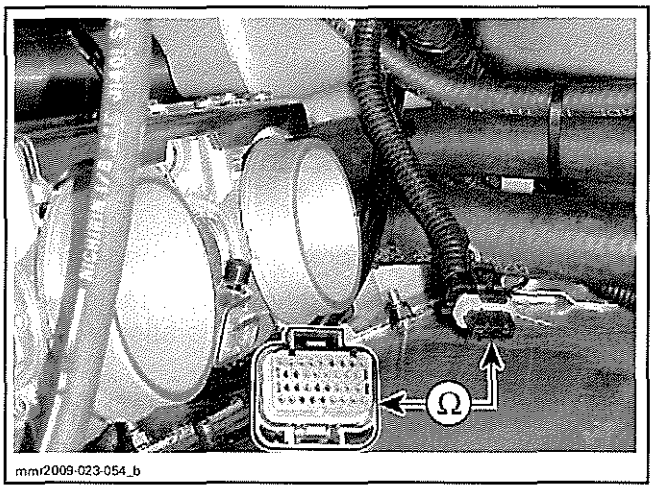
NOTE: Reset multimeter by pressing and holding MIN MAX button until meter beeps.

If voltage is good, carry out the *TPS SIGNAL WIRE TEST*.

TPS Signal Wire Test

1. Disconnect J1A connector from ECM.
2. Check the wiring continuity as follows.

TPS HARNESS CONNECTOR	ECM J1A CONNECTOR	RESISTANCE
Pin 3	Pin 18	Close to 0 Ω (continuity)



If tests are good, replace the TPS.

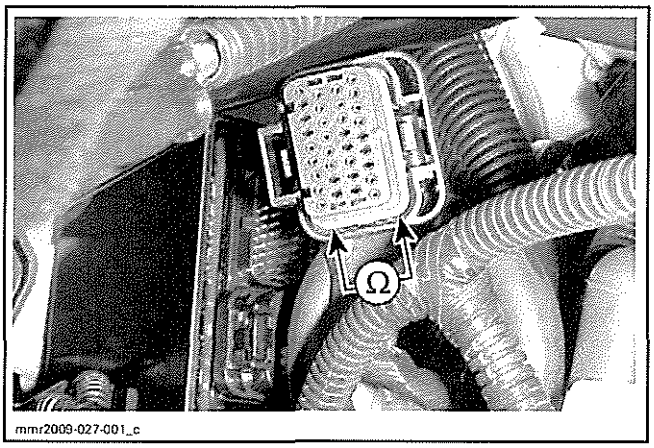
If tests are not good, continue to check the resistance of the rest of the TPS circuit.

TPS Resistance Test

1. Reconnect the TPS connector.
2. Disconnect the J1A connector from the ECM.

3. Using the FLUKE 115 MULTIMETER (P/N 529 035 868), check resistance value as per following table.

ECM CONNECTOR		THROTTLE IDLE POSITION	WIDE OPEN THROTTLE POSITION
PIN		RESISTANCE Ω	
J1A-18	J1A-26	1000	2500
J1A-26	J1A-10	1600 - 2400	1600 - 2400
J1A-18	J1A-10	2500	1000



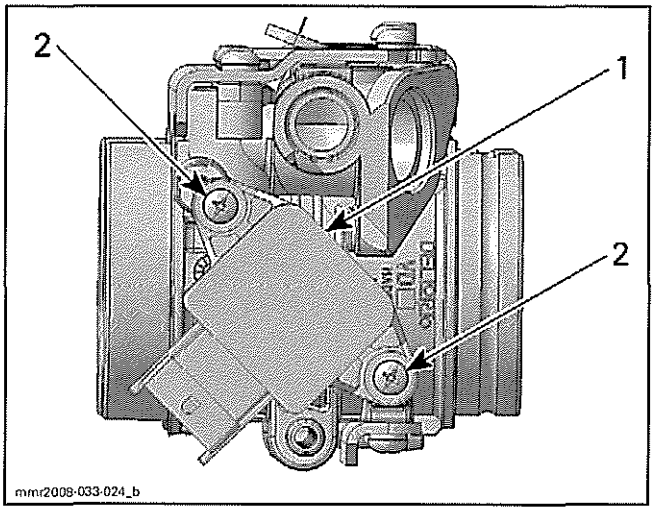
NOTE: The resistive value should change smoothly and proportionally to the throttle movement. Otherwise, replace TPS.

If resistive values are correct, try a new ECM. Refer to *ENGINE CONTROL MODULE (ECM)* elsewhere in this section.

If resistive values are incorrect, repair/replace wiring/connectors. If they are good, replace TPS.

TPS Replacement

1. Remove the throttle body as described previously in this subsection.
2. Remove TPS retaining screws.
3. Remove TPS.



1. Throttle position sensor (TPS)
2. Screws

4. Install the new TPS.

TPS SCREW INSTALLATION
LOCTITE 243 (BLUE) (P/N 293 800 060)
3 N•m (27 lbf•**in**)

5. Reinstall remaining removed parts.
6. Reset TPS, refer to *CLOSED THROTTLE RESET (TPS)* in this subsection.

CPS (CRANKSHAFT POSITION SENSOR)

CPS Test with B.U.D.S.

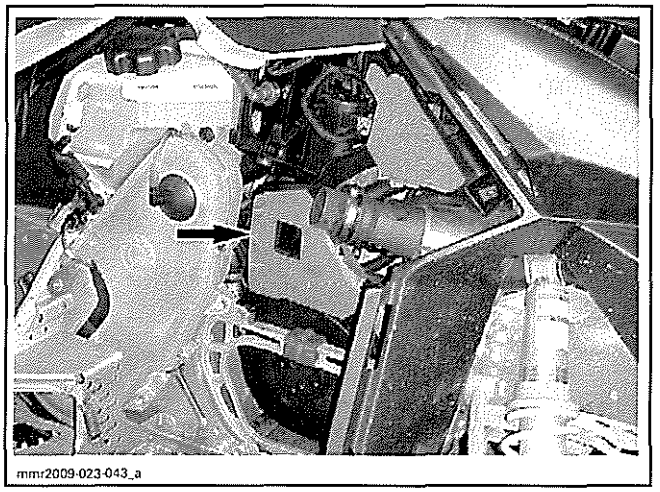
1. Connect vehicle to the applicable B.U.D.S. version.
2. Select the **ECM** and **Monitoring** tabs.
3. Monitor the **Engine Speed** (RPM) indicator while cranking engine.

The needle should move proportionally to the cranking RPM. If no needle movement is observed, carry out the *CPS OUTPUT VOLTAGE TEST.*

NOTE: A loose CPS or CPS connector can send an intermittent signal that can prevent the engine from starting.

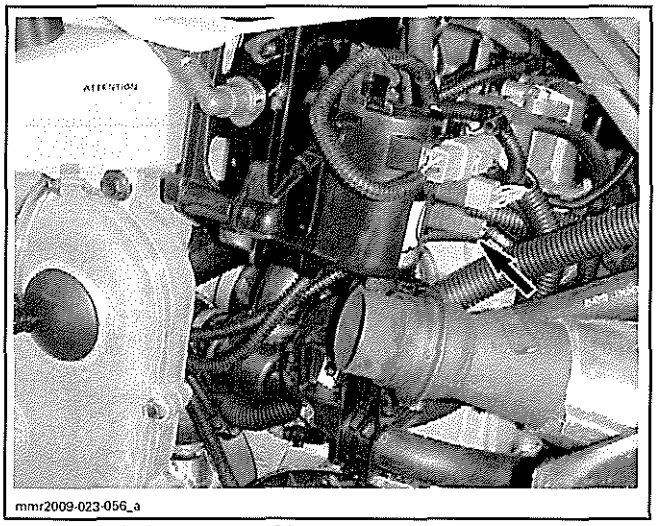
CPS Output Voltage Test

1. Remove muffler. Refer to *EXHAUST SYSTEM* subsection.
2. Remove the acoustic panel.



TYPICAL

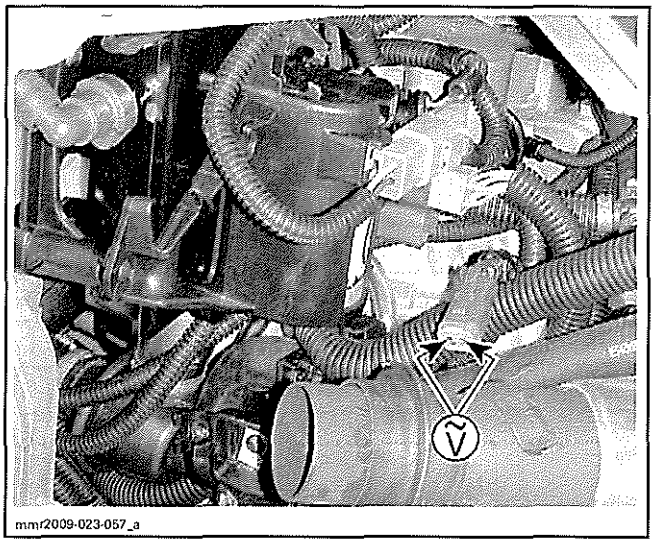
3. Disconnect CPS connector.



TYPICAL - CPS CONNECTOR

4. Probe terminals coming from CPS while cranking engine.

CPS CONNECTOR		VOLTAGE
Pin 1	Pin 2	1 - 2 Vac min.

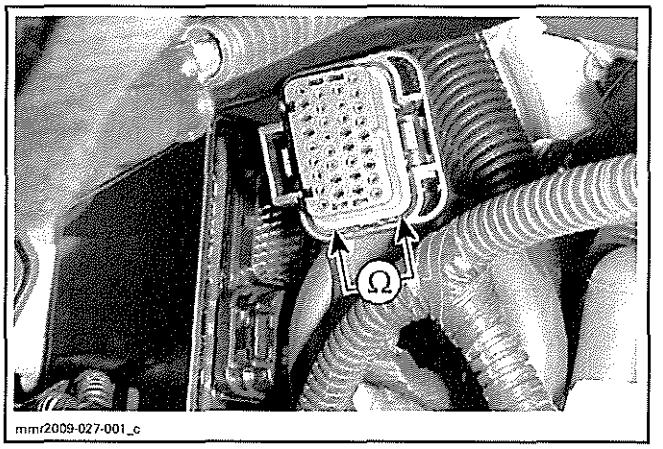


If voltage is out of specification, inspect wiring/connectors. Replace CPS if wiring is good.

CPS Resistance Test

1. Disconnect connector J1A from ECM.
2. Measure the resistance of the sensor itself.

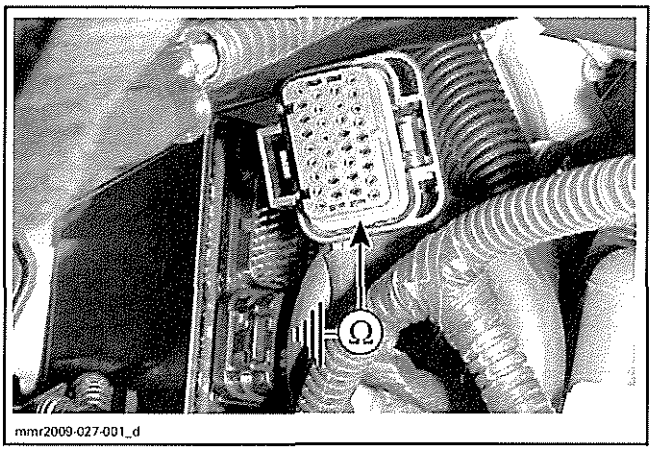
ECM J1A CONNECTOR		RESISTANCE @ 20°C (68°F)
Pin 6	Pin 7	190 - 290 Ω



If measurement is out of specification, check wiring continuity between ECM and CPS. If continuity is good, replace CPS.

3. Check for a bad ground connection as follows.

ECM J1A CONNECTOR		RESISTANCE @ 20°C (68°F)
Pin 6	Engine ground	Open circuit (OL)
Pin 7	Engine ground	

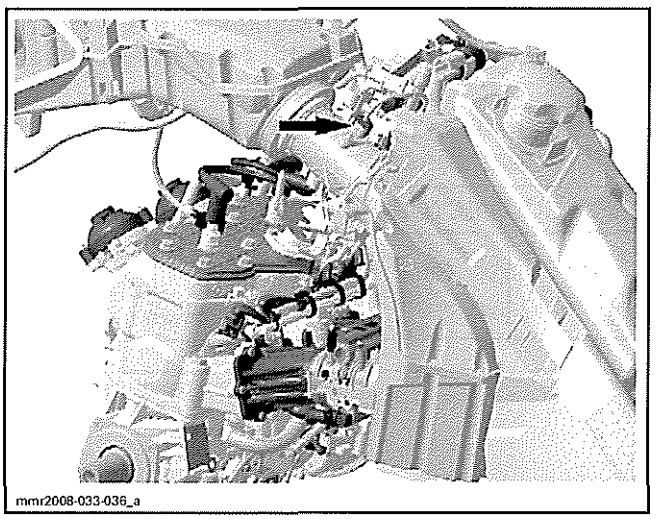


If measurement is out of specification, check wiring between ECM and CPS.

CPS Replacement

Refer to *MAGNETO SYSTEM* subsection.

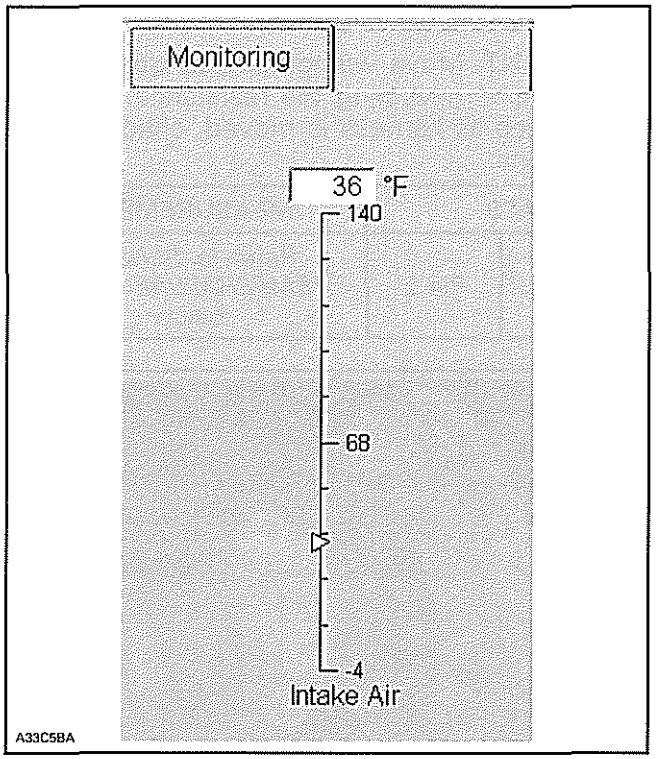
AIR TEMPERATURE SENSOR (ATS)



TYPICAL

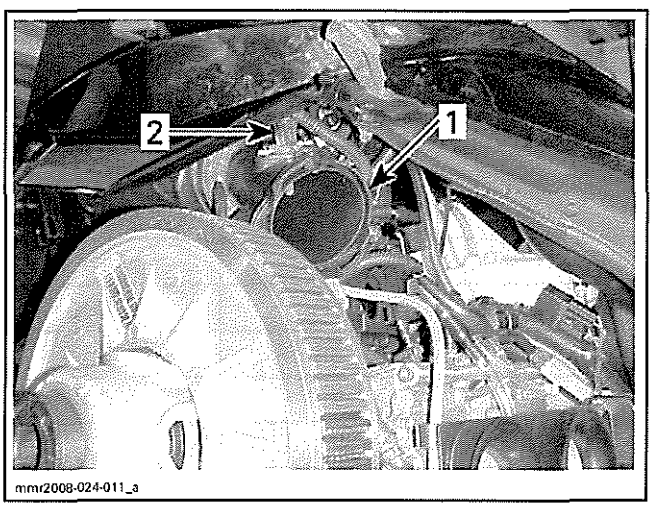
ATS Test with B.U.D.S.

1. Connect vehicle to applicable B.U.D.S.
2. Select the ECM and **Monitoring** page tabs.
3. Monitor the **Intake Air** indicator. It should show the ambient temperature. Otherwise, refer to *ATS RESISTANCE TEST*.



ATS Connector Access

1. Remove drive belt guard. Refer to *DRIVE BELT* subsection.
2. Remove primary air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.
3. Rotate intake adapter to disconnect ATS sensor connector.



TYPICAL
1. Rotate intake adapter
2. Disconnect sensor connector

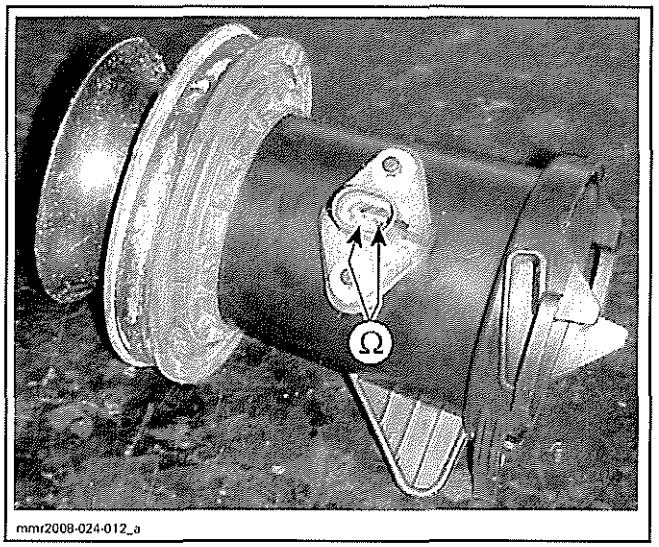
ATS Resistance Test

1. Remove parts required to access ATS connector. Refer to *ATS CONNECTOR ACCESS* in this subsection.

2. Measure sensor resistance.

IMPORTANT: Move wiring harness close to the sensor while measuring the resistance. If resistance varies as harness is moved, check sensor connections.

ATS		MEASUREMENT
Pin 1	Pin 2	Refer to *SENSOR TEMPERATURE TABLE* below



INTAKE ADAPTER REMOVED FOR CLARITY PURPOSE ONLY

SENSOR TEMPERATURE TABLE		
TEMPERATURE		RESISTANCE (ohms)
°C	°F	ATS
- 40	- 40	43610
- 30	- 22	25090
- 20	- 4	14900
- 10	14	9102
0	32	5705
10	50	3680
20	68	2436
25	77	2000
30	86	1651
40	104	1144
50	122	808
60	140	580
70	158	424
80	176	316
90	194	238

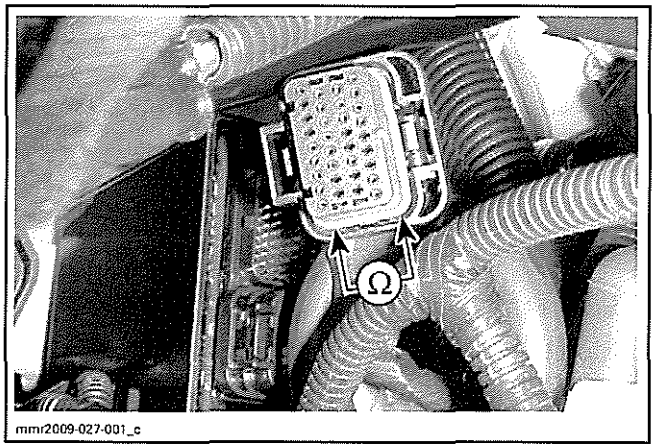
SENSOR TEMPERATURE TABLE		
TEMPERATURE		RESISTANCE (ohms)
°C	°F	ATS
100	212	182
110	230	141
120	248	111
130	266	88
140	284	70
150	302	57
160	320	47
170	338	39
180	356	32
190	374	27
200	392	23

If resistance is out of specifications, replace sensor.

If resistance tests good, reconnect the ATS and disconnect the J1A connector from ECM connector.

3. Using the FLUKE 115 MULTIMETER (P/N 529 035 868), measure resistance value as follows.

J1A CONNECTOR		MEASUREMENT
Pin J1A-20	Pin J1A-27	Refer to *SENSOR TEMPERATURE TABLE* above

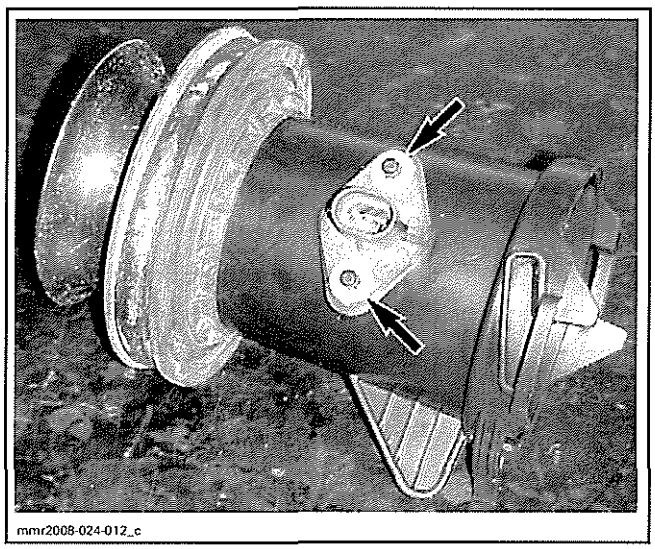


If resistance value is incorrect, repair the connectors or replace the wiring harness between ECM connector and the ATS.

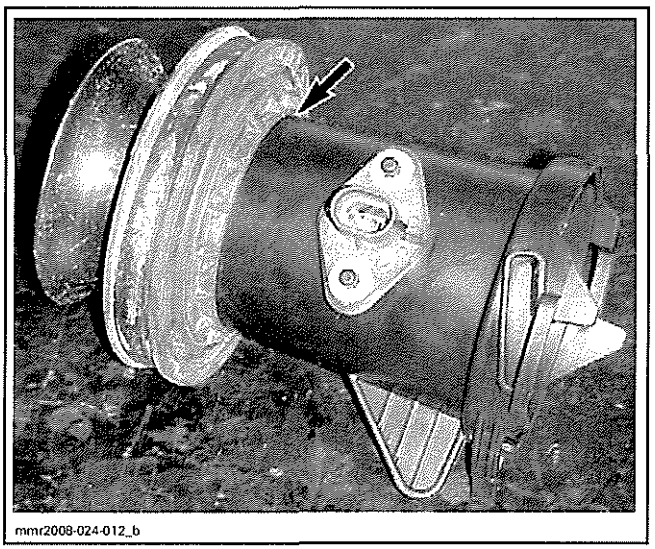
4. Reinstall removed parts. Ensure intake adapter boot is properly installed on the adapter. See below in *ATS REPLACEMENT.*

ATS Replacement

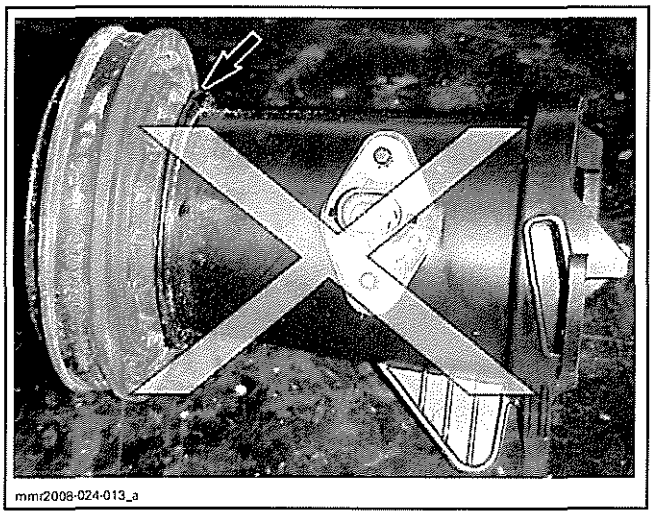
1. Remove parts required to access ATS connector. Refer to *ATS CONNECTOR ACCESS* in this subsection.
2. Unplug ATS connector.
3. Pull out intake adapter.
4. Remove sensor push nuts.



5. Pull out sensor.
6. Use new push nuts and secure the new sensor to adapter.
7. Reconnect ATS.
8. Ensure adapter boot is properly installed as shown.



CORRECT BOOT INSTALLATION



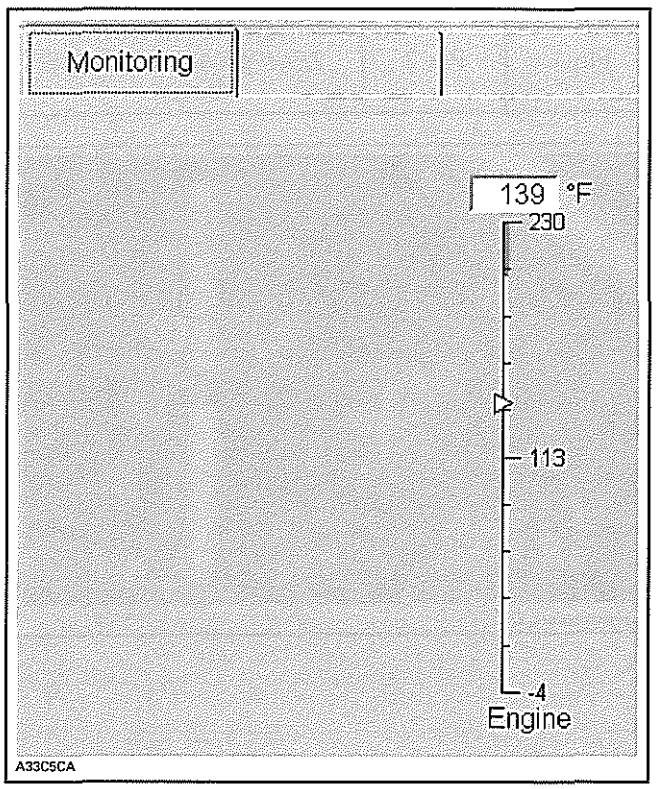
WRONG BOOT INSTALLATION

9. Reinstall remaining removed parts.

COOLANT TEMPERATURE SENSOR (CTS)

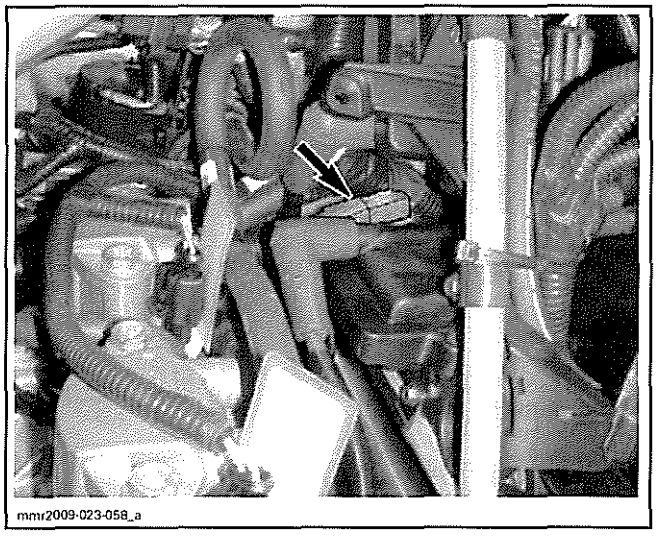
CTS Test with B.U.D.S.

1. Connect vehicle to applicable B.U.D.S.
2. Select the **ECM** and **Monitoring** page tabs.
3. Monitor the **Engine** indicator. It should show the coolant temperature. Otherwise, perform the *CTS RESISTANCE TEST*.



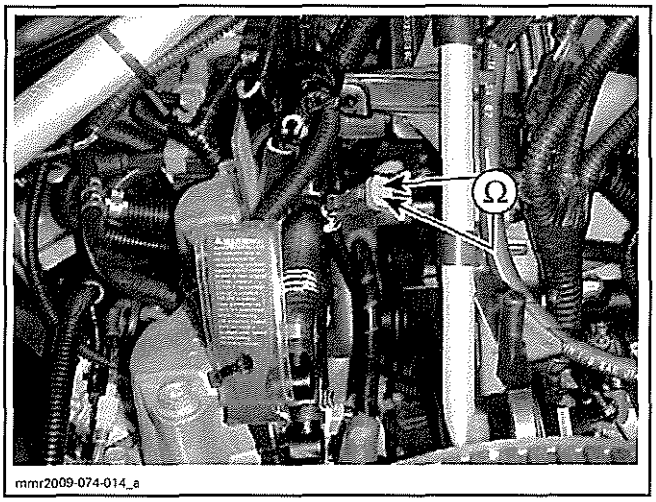
CTS Resistance Test

1. Remove drive belt guard. Refer to *DRIVE BELT* subsection.
2. Remove primary air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.
3. Disconnect CTS sensor connector.


mmr2009-023-058_a

4. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and set it to Ω.
5. Measure resistance between sensor terminals.

CTS		MEASUREMENT
Pin 1	Pin 2	Refer to *SENSOR TEMPERATURE TABLE* below



mmr2009-074-014_a

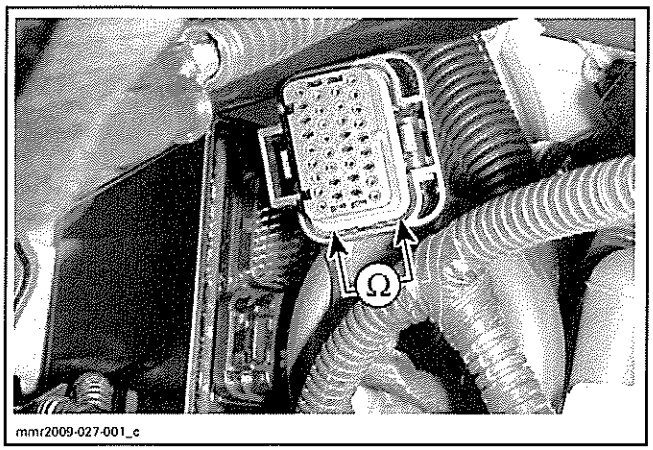
SENSOR TEMPERATURE TABLE (E-TEC)		
TEMPERATURE		RESISTANCE (ohms)
°C	°F	CTS
- 40	- 40	72412
- 30	- 22	38681
- 20	- 4	21529
- 10	14	12431
0	32	7418
10	50	4582
20	68	2919
30	86	1912
40	104	1284
50	122	883
60	140	622
70	158	448
80	176	328
90	194	245
100	212	186
110	230	143
120	248	112
130	266	88
135	275	79
140	284	71
145	293	64
150	302	57

If resistance is out of specifications, replace CTS.

If resistance tests good, reconnect the CTS.

6. Disconnect the J1A connector from ECM.
7. Measure resistance as follows.

J1A CONNECTOR		MEASUREMENT
Pin 19	Pin 27	Refer to *SENSOR TEMPERATURE TABLE* above



If resistance value is correct, sensor and wiring/connectors are good.

If resistance value is incorrect, repair/replace wiring/connectors between ECM and CTS.

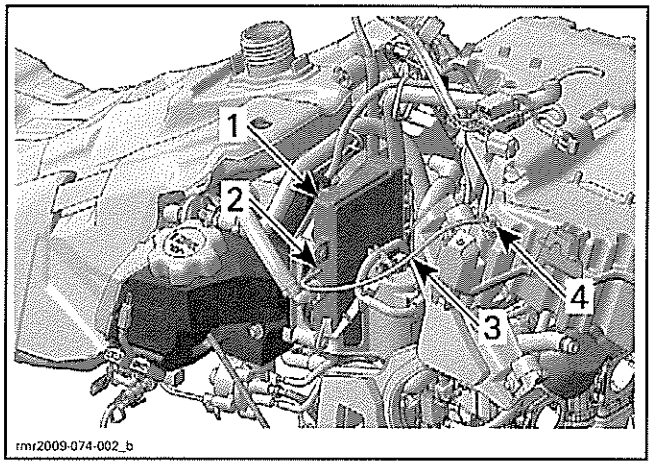
CTS Replacement

1. Remove drive belt guard. Refer to *DRIVE BELT* subsection.
2. Lift rear of vehicle to minimize coolant spillage.
3. Disconnect CTS connector.
4. Remove CTS.
5. Install new CTS.

CTS INSTALLATION
12 N•m (106 lbf•**in**)

6. Reinstall remaining removed parts.
7. Refill engine coolant. If an important quantity of coolant spilled, bleed cooling system. Refer to *COOLING SYSTEM* subsection.

AIR PRESSURE SENSOR (APS)



1. *ECM*
2. *APS*
3. *APS tube*
4. *APS fitting in secondary air intake silencer*

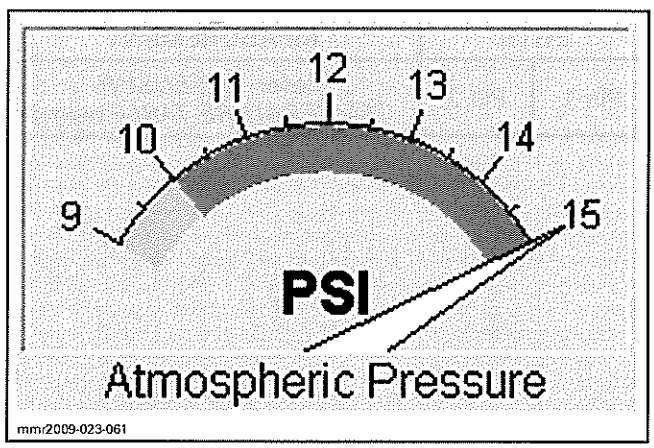
APS Inspection

1. Open RH side panel.
2. Ensure sensor hose is correctly connected on secondary air intake silencer and on ECM.
3. Check hose for cleanliness, water, ice. Ensure it is not bent, kinked or burnt.

Connect B.U.D.S. Refer to *COMMUNICATION TOOLS/B.U.D.S.* subsection.

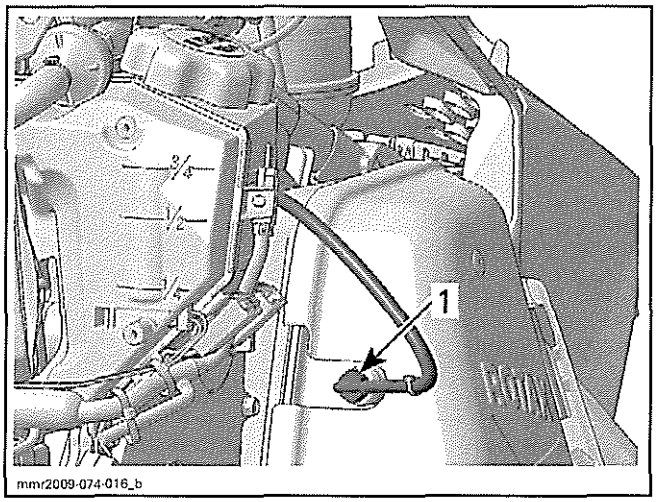
4. Select the **ECM** and **Monitoring** tabs.
5. Monitor the **Atmospheric Pressure** indicator.

APS READING AT SEA LEVEL
101.3 kPa (14.7 PSI)



Otherwise, replace ECM.

EXHAUST GAS TEMPERATURE SENSOR (EGTS)



600 HO E-TEC
1. EGTS

EGTS Test using B.U.D.S.

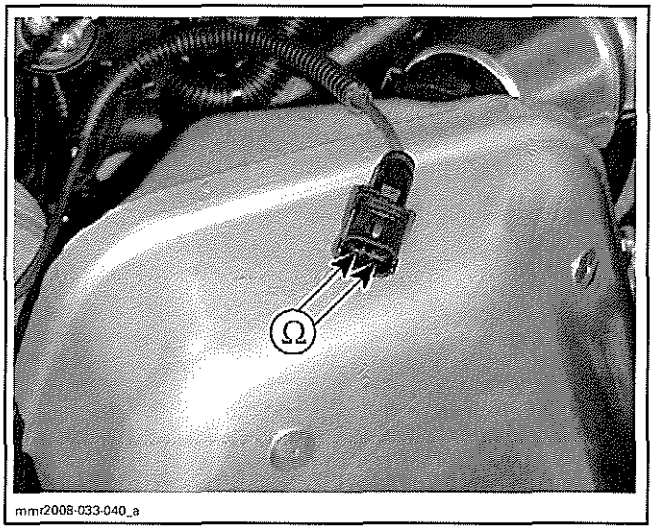
1. Connect vehicle to applicable B.U.D.S.
2. Select the **ECM** and **Monitoring** page tabs.
3. Monitor the **Exhaust** indicator. It should show the exhaust temperature, otherwise carry out the *EGTS RESISTANCE TEST.*

NOTE: If engine runs with the EGTS connected but not installed on the muffler, the reading will be 720°C (1,328°F) steady.

EGTS Resistance Test

1. Disconnect EGTS connector.
2. Measure sensor resistance as follows.

EGTS		MEASUREMENT
Pin 1	Pin 2	Refer to *SENSOR TEMPERATURE TABLE* below



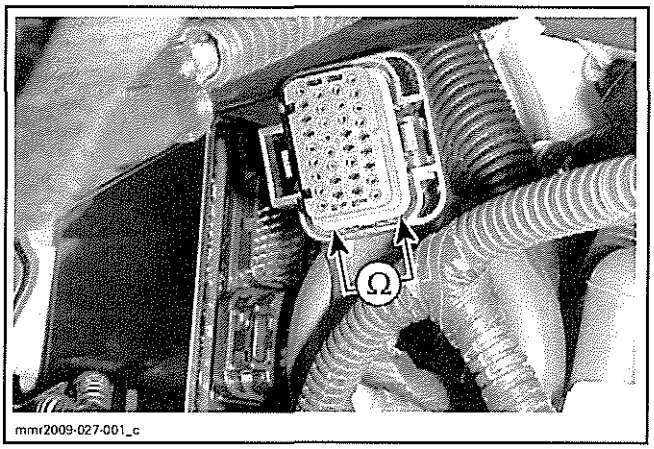
SENSOR TEMPERATURE TABLE		
TEMPERATURE		RESISTANCE (ohms)
°C	°F	EGTS
- 40	- 40	170
- 20	- 4	185
0	32	201
25	77	220
50	122	239
100	212	276
150	302	313
200	392	349
250	482	385
300	572	420
350	662	454
400	752	488
450	842	521
500	932	554
600	1112	618
700	1292	679
800	1472	738
900	1652	795
1000	1832	849

If resistance is out of specification, replace the sensor.

If resistance is as per specification, reconnect the EGTS.

3. Disconnect the J1A connector from ECM.
4. Measure resistance as follows.

J1A CONNECTOR		MEASUREMENT
Pin 12	Pin 27	Refer to *SENSOR TEMPERATURE TABLE* above



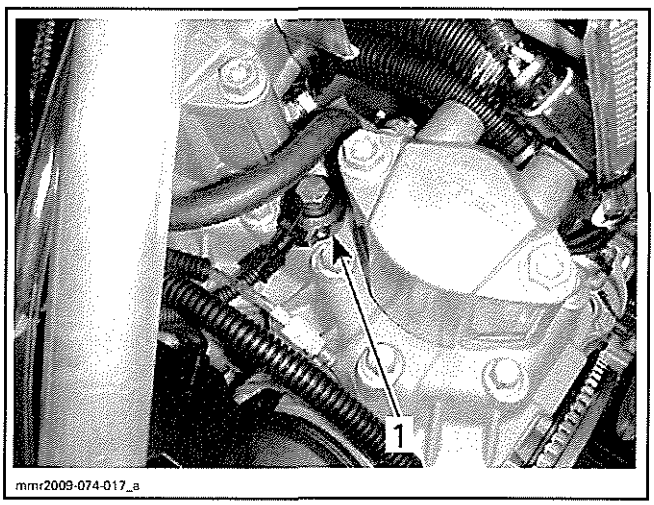
If resistance value is correct, try a new ECM. Refer to *ENGINE CONTROL MODULE (ECM)* elsewhere in this section.

If resistance value is incorrect, repair the connector or replace the wiring harness between ECM connector and the EGTS.

EGTS Replacement

Refer to *EXHAUST SYSTEM* subsection.

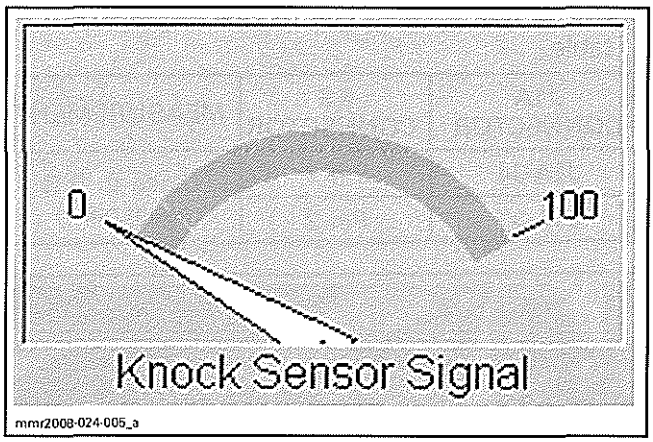
KNOCK SENSOR (KS)



TYPICAL
1. Knock sensor

KS Test with B.U.D.S.

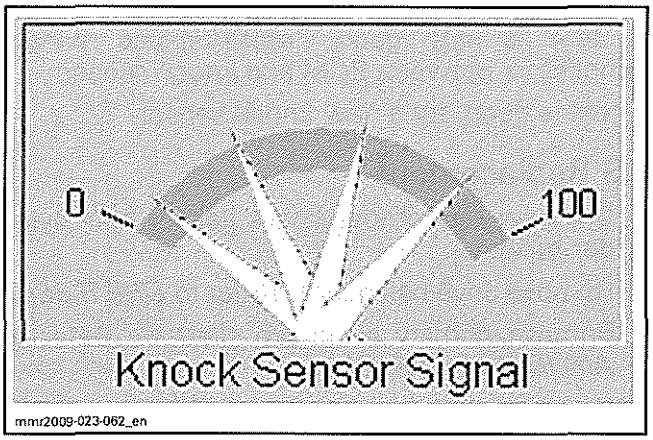
1. Lift rear of vehicle off the ground and support it with a wide-base mechanical stand.
2. Use B.U.D.S. software.
3. Monitor the knock sensor using the **Knock Sensor Signal** in **Monitoring** section in B.U.D.S.



MONITORING TAB

4. Start the engine.
5. Bring engine speed above 5200 RPM and vary engine RPM above 5200 RPM.

Needle of knock sensor signal should move between 0 and 100. The needle movement pattern is of no importance as long as it moves indicating the engine vibrations the knock sensor senses. If needle sticks either to 0 or 100, there is a problem.



If needle moves as described, the knock sensor should be good.

NOTE: Ensure ignition coil cables are not close to knock sensor harness. This might generate a false fault code.

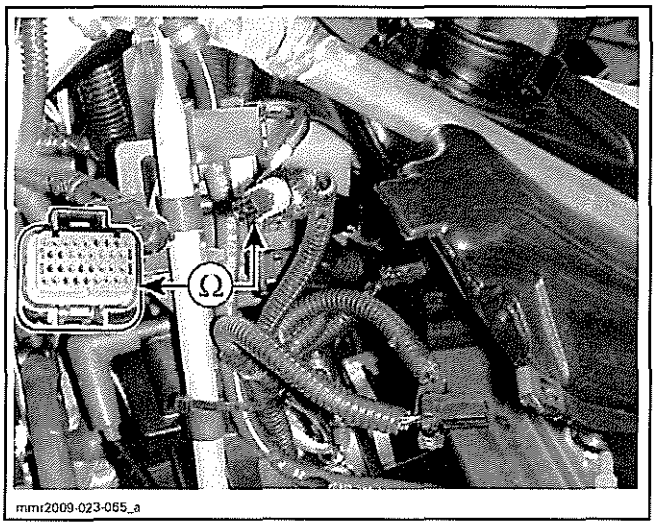
6. Verify knock sensor circuit as follows.
7. Carry out the *KS CIRCUIT CONTINUITY TEST.*

KS Circuit Continuity Test

1. Ensure sensor and head contact surfaces are clean and mounting bolt and washer are correct and properly torqued down.

2. Disconnect knock sensor connector. Refer to *KNOCK SENSOR REPLACEMENT.*
3. Disconnect J1A connector from ECM.
4. Check wire continuity of circuit as per following table.

J1A CONNECTOR	KS CONNECTOR	MEASUREMENT
J1A-34	Pin 1	Close to 0 Ω (continuity)
J1A-33	Pin 2	



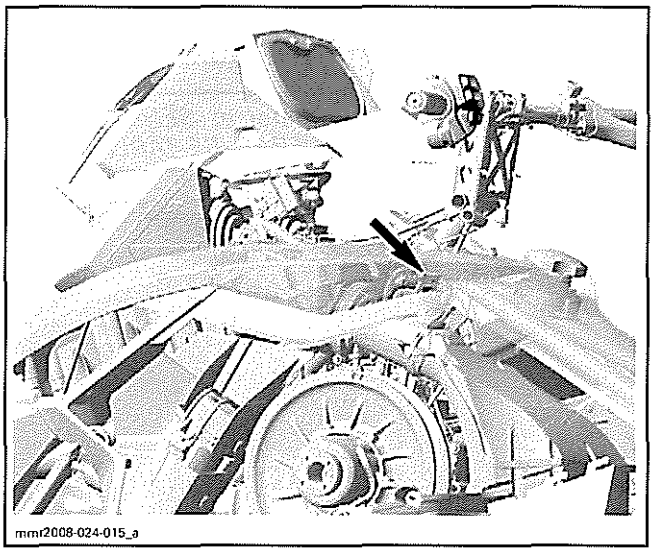
ECM CONNECTORS

If test is not good, repair/replace wiring/connectors between ECM and knock sensor.

If test is good, try a new knock sensor.

KS Replacement

1. Unscrew and remove knock sensor from cylinder head.
2. Remove drive belt guard. Refer to *DRIVE BELT.*
3. Remove primary air intake silencer. Refer to *AIR INTAKE SYSTEM.*
4. Unplug knock sensor connector above ATS.



5. Clean contact surface, then install the new knock sensor.

KNOCK SENSOR INSTALLATION
29 N•m (21 lbf•ft)

NOTICE Improper torque might prevent sensor to work properly and lead engine to severe damage of internal components.

6. Reconnect connector.
7. Reinstall remaining parts.

ELECTRONIC FUEL INJECTION (600 ACE)

SERVICE TOOLS

Description	Part Number	Page
ECM ADAPTER TOOL	529 036 166	510–511, 530, 532, 534, 537–538, 540
FLUKE 115 MULTIMETER	529 035 868	511, 519–520, 530, 534, 537–538
FUEL HOSE DISCONNECT TOOL	529 036 037	521
SMALL HOSE PINCHER	295 000 076	527
T-HARNESS	529 035 869	517, 530

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 243 (BLUE)	293 800 060	531, 533

GENERAL

⚠ WARNING

When electrically disconnecting or removing the throttle body from the intake manifold, or the idle air control valve (IACV) from the throttle body, always remove the tether cord from the engine cut-off switch and disconnect the battery.

⚠ WARNING

Fuel is flammable and explosive under certain conditions. Wear safety glasses and work in a well ventilated area. Do not smoke or allow open flames or sparks in the vicinity.

Release fuel pressure prior to removing fuel system components. Refer to *FUEL PRESSURE RELEASE* in *FUEL TANK AND FUEL PUMP* subsection.

⚠ WARNING

Always release fuel pressure prior to removing a fuel system component, proceed with care and use appropriate safety equipment when working on the fuel system. Wipe off any fuel spillage in the engine compartment. Do not allow fuel to spill on hot engine parts and/or on electrical connectors.

⚠ WARNING

Replace any damaged, leaking or deteriorated fuel lines or connections. After working on the fuel system, always pressurize the fuel system and check for fuel leaks. Refer to *FUEL SYSTEM PRESSURIZATION* in *FUEL TANK AND FUEL PUMP* subsection.

SYSTEM DESCRIPTION

The electronic fuel injection system (EFI) is comprised of various sensors used for detecting ongoing operating conditions of the engine and vehicle, and includes all the components that perform the required adjustments to the engine.

Electrical System

ECM (Electronic Control Module)

The ECM reads input signals that it receives from the various sensors. Through calculation of several variables which it compares to stored parameters (fuel maps), the ECM controls the injection system to meet driver demands and to ensure safe engine operation.

Through its management of the engine systems, the ECM ensures the engine is delivering optimum performance and fuel economy. The ECM also controls idle RPM by modulating the idle air control valve (IACV) and, limits maximum engine speed through the ignition and fuel injection systems.

EFI Sensors

To control the injection system, the engine management uses input signals from the following sensors:

- Crankshaft position sensor (CPS)
- Manifold absolute pressure and temperature sensor (MAPTS)
- Throttle position sensor (TPS).

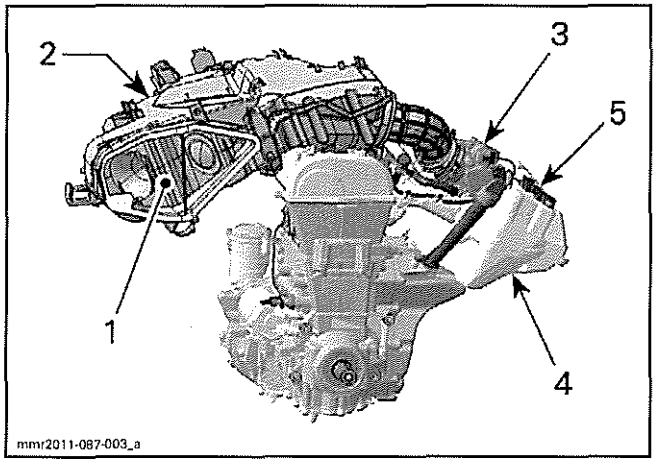
Air Intake System

Air Filter

Air flows through a mesh screen filter in the air intake silencer mounted over the engine. The mesh filter prevents snow from being drawn into the engine.

Air is then drawn in through the throttle body, the air intake manifold and into the engine.

Manifold absolute pressure and temperature are measured in the intake manifold.



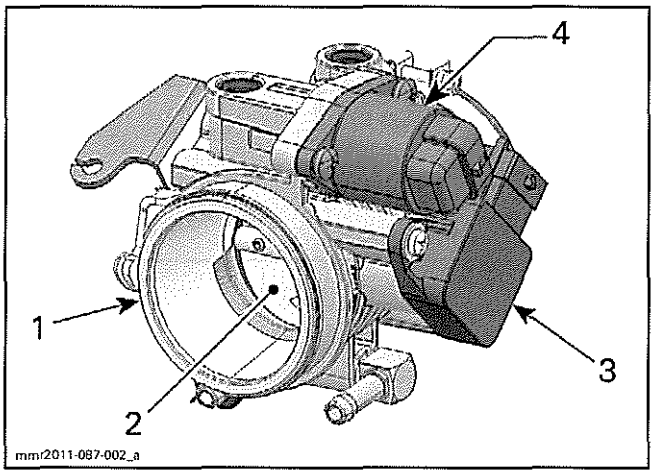
TYPICAL
1. *Mesh screen filter*
2. *Air intake system*
3. *Throttle body*
4. *Intake manifold*
5. *Manifold absolute pressure and temperature sensor*

Throttle Body

The heated single 46 mm throttle body is mounted on intake manifold.

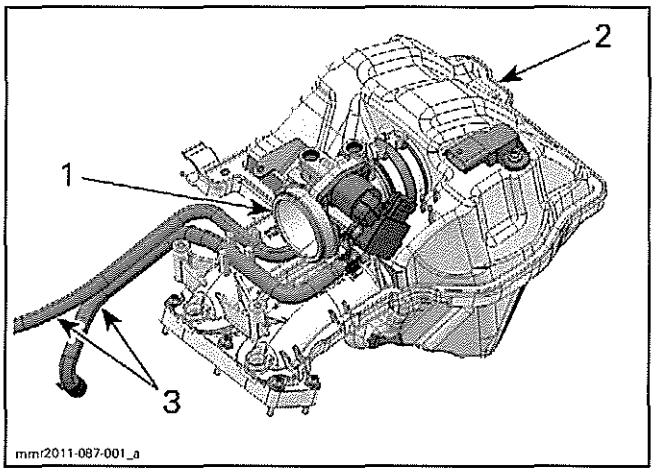
The TPS (Throttle Position Sensor) is fitted on the throttle body. The TPS sends throttle plate angle position to the ECM.

The IACV, also mounted on the throttle body, is used by the ECM to control idle RPM.



TYPICAL
1. *Throttle body*
2. *Throttle plate*
3. *TPS (Throttle Position Sensor)*
4. *IACV (Inlet Air Control Valve)*

Engine coolant flows through the throttle body to prevent potential freezing of the throttle plate.

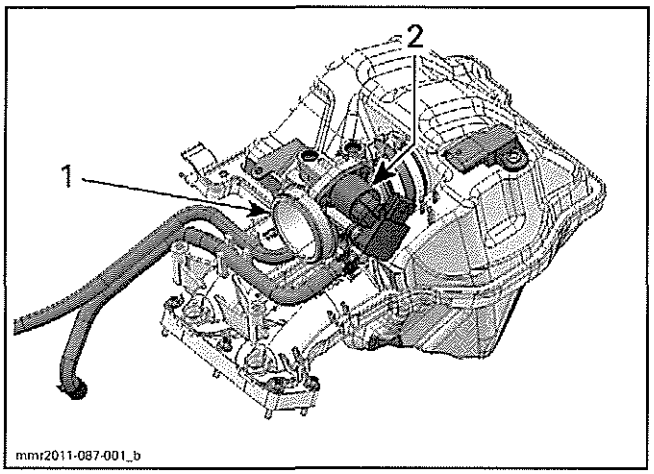


TYPICAL
1. *Throttle body*
2. *Intake manifold*
3. *Coolant-heated lines*

Idle Air Control Valve (IACV)

Since the throttle plate is closed when engine is idling, an idle air control valve (IACV) is used to allow air to bypass the throttle plate through a port in the throttle body.

Idle control is required to satisfy the varying conditions such as air temperature, altitude, engine load, etc.



1. *Throttle body*
2. *IACV (Idle air control valve)*

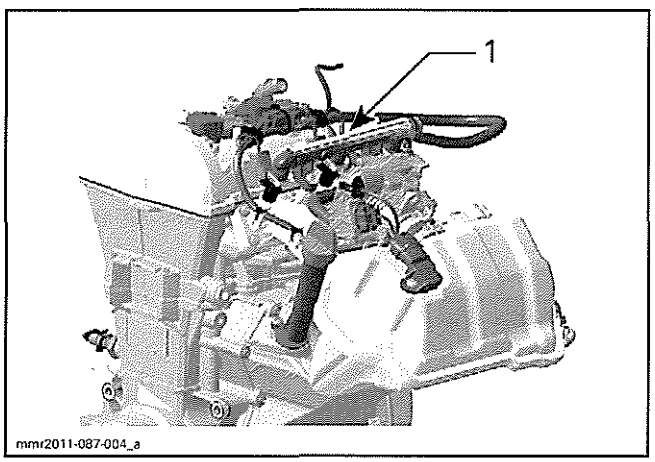
The amount of opening or closing of the IACV is controlled by the ECM. As the IACV opening is increased, more air is bypassed resulting in an increased idle speed.

Fuel System

Fuel Rail

A fuel rail is mounted on the intake manifold. The fuel rail, which is used to secure the injectors to the manifold, also provides to the injectors the fuel pressure that it receives from the fuel pump.

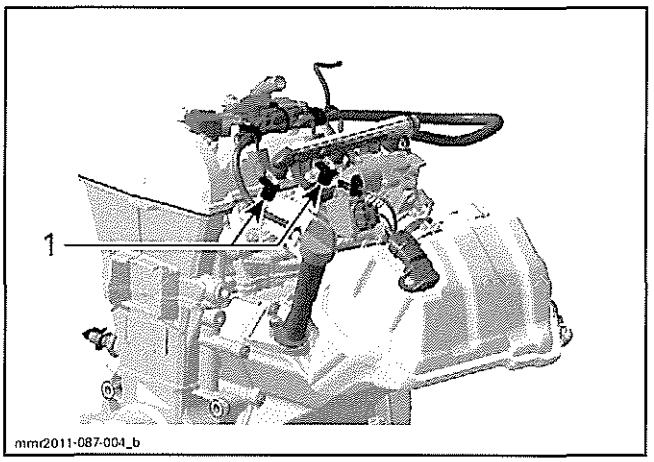
The fuel pressure applied to the fuel rail is regulated by the fuel pressure regulator located in the fuel pump module.



1. *Fuel rail*

Fuel Injectors

Two fuel injectors are used to inject fuel into the intake ports of the cylinder head. One injector is used per cylinder.



1. *Fuel injectors*

Fuel is injected in accordance with injection signals received from the ECM.

Fuel Pump

An electric fuel pump with an integrated pressure regulator and fuel system filters is used. For more details on the fuel pump unit, refer to *FUEL TANK AND FUEL PUMP* subsection.

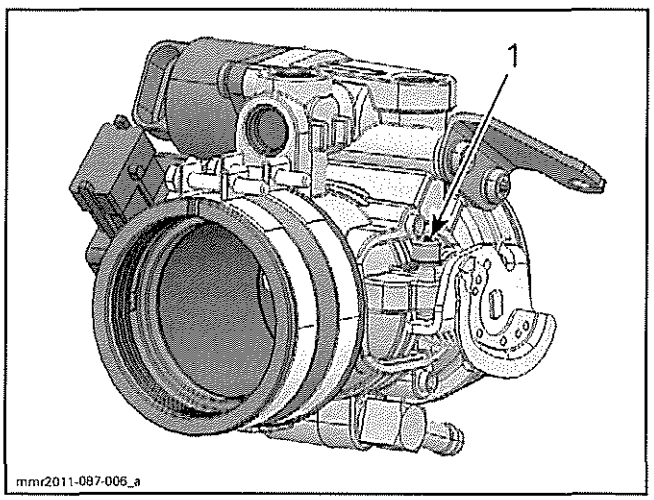
ADJUSTMENT

IDLE SPEED

Idle speed (RPM) is controlled by the EMS (Engine Management System) and is not adjustable.

If idle RPM is not as per specification (see *TECHNICAL SPECIFICATIONS*), perform the *CLOSED THROTTLE RESET (TPS)* as described in this subsection.

NOTICE Never attempt to adjust the capped idle stop screw. It is calibrated at the factory. If the screw adjustment is changed, the throttle body must be replaced.

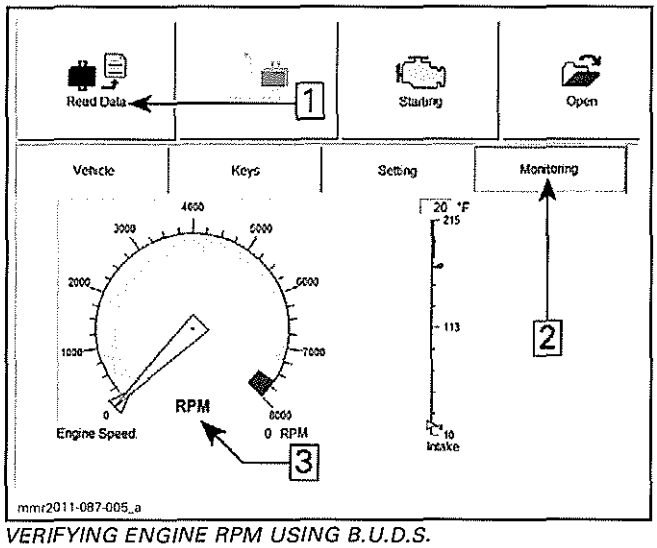


1. *Capped screw (DO NOT TAMPER)*

The vehicle multifunction gauge can provide a readout of the engine's idle RPM.

Indicated engine RPM may be verified using the applicable B.U.D.S. software version, refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.

In B.U.D.S., select the following:



VERIFYING ENGINE RPM USING B.U.D.S.
Step 1: Click on the Read Data *button*
Step 2: Select the Monitoring *page tab*
Step 3: Read the engine RPM *indication*

NOTE: The vehicle gauge and B.U.D.S. use the same signal to provide the engine RPM indication.

TROUBLESHOOTING

DIAGNOSTIC TIPS

Engine problems are not necessarily related to the fuel injection system.

It is important to ensure that the engine and propulsion system, fuel delivery and electrical systems are functioning normally.

For diagnostics purposes, use B.U.D.S. software. See *COMMUNICATION TOOLS AND B.U.D.S.* subsection.

After a problem has been solved, be sure to clear the fault(s) recorded in the ECM using the B.U.D.S. software.

⚠ WARNING

Electrical actuators and electronic modules may be powered up as soon as the START/RER button is depressed. Always disconnect the battery prior to disconnecting any electrical or electronic parts.

Never use a battery charger to temporarily substitute the battery as it may cause the ECM to function erratically, or not at all.

Check related-circuit fuse solidity and condition with an ohmmeter. A visual inspection could lead to a false diagnosis.

Poor Idling

If poor idling is experienced, check the following:
- Throttle cable adjustment or routing.
- IACV operation, cleanliness, leaking or clogged air passages.
- Throttle body cleanliness and idle stop screw.
- Engine leaks or other mechanical problem.

Electrical Related Problems

It is important to check the following in the electrical system:
- Battery voltage
- Fuses
- Ground connections
- Wiring and connectors.

Ensure that all electronic components are original BRP recommended components. Any modification to the wiring harness may lead to poor system operation or generate fault codes.

Electrical Connections

Pay particular attention to ensure that terminals and pins are not out of their connectors, corroded, or out of shape.

When probing terminals, pay attention not to deform the terminals as this could cause a loose or intermittent connection that would be difficult to troubleshoot.

NOTE: Do not apply dielectric grease or other lubricants on the ECM connectors.

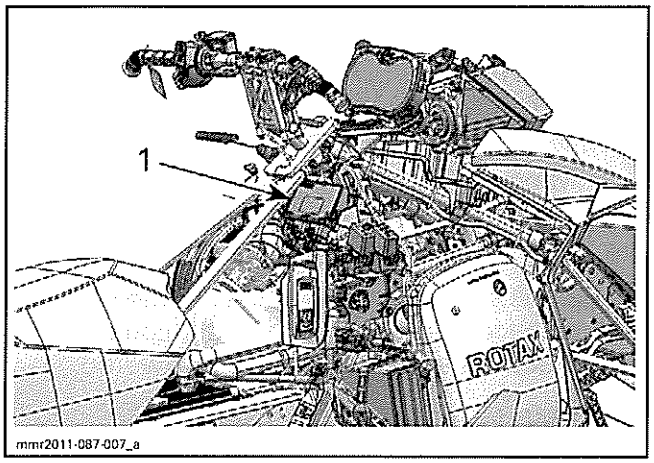
PROCEDURES

ENGINE CONTROL MODULE (ECM)

NOTE: As a first troubleshooting step, always check for applicable fault codes using B.U.D.S. software.

ECM Location

The ECM is located above the air intake manifold.

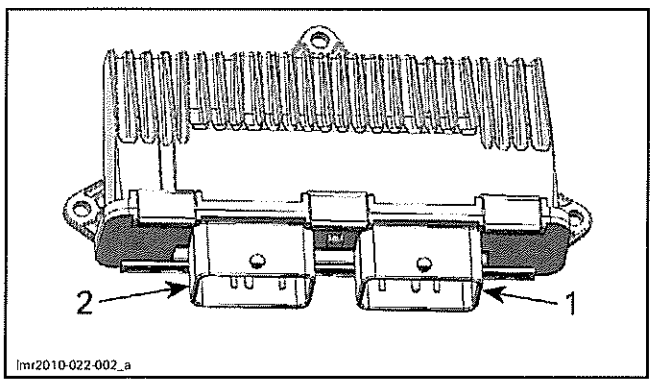


TYPICAL - ECM LOCATION
(FUEL TANK REMOVED FOR CLARITY)
1. ECM

ECM Connector Identification

There are 2 connectors connected to the ECM:

- Engine harness connected to ECM-A
- Vehicle system control harness connected to ECM-B.



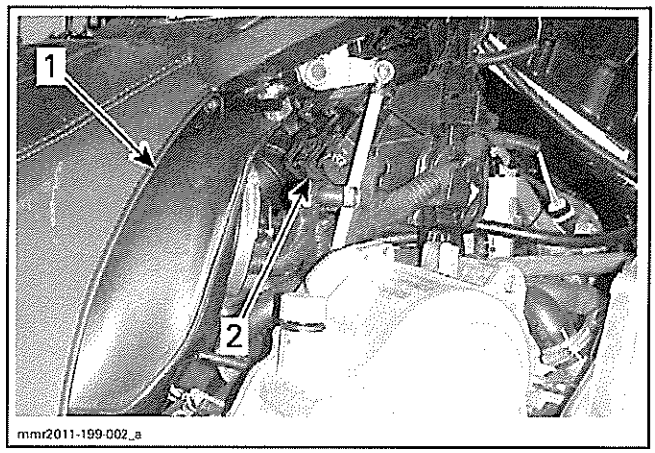
ECM CONNECTOR IDENTIFICATION - COOLING FINS FACING OUT
1. Connector A
2. Connector B

The ECM connectors have 48 pins.

NOTE: For connector information, cleaning and probing, refer to *CONNECTOR INFORMATION* subsection.

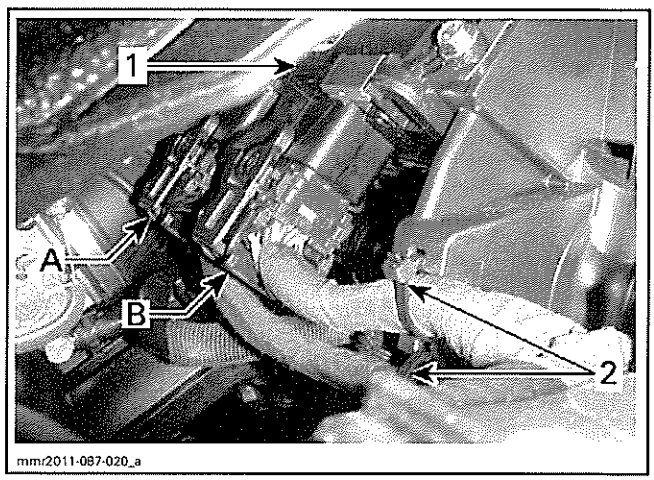
ECM Connector Access

1. Refer to *BODY* subsection and remove the RH side panel.
2. Reach in above the gearbox, between the fuel tank and shift rod.



ECM CONNECTOR ACCESS
1. Fuel tank
2. ECM connectors

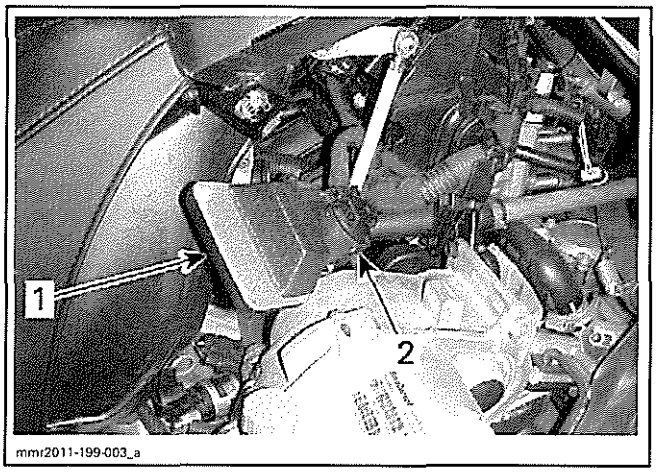
3. Cut the locking tie(s) that secure the ECM connector harnesses to the ECM support.



ECM CONNECTOR ACCESS
1. ECM
2. Harness locking ties
A. ECM-A connector
B. ECM-B connector

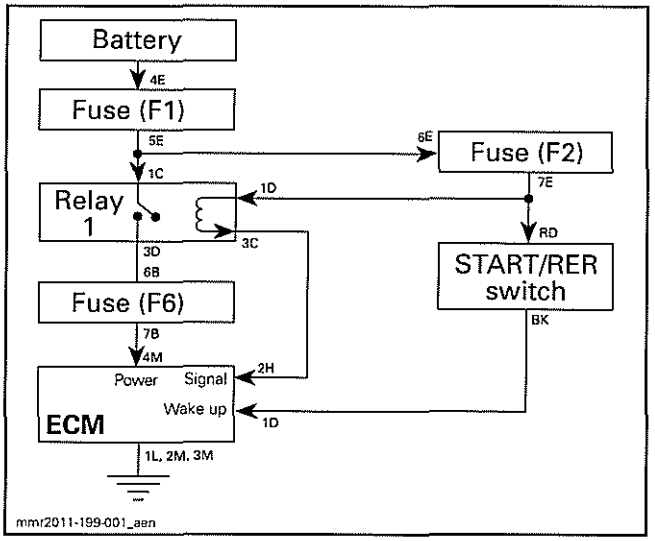
NOTE: The ECM is mounted with the cooling fins facing forward. Therefore, ECM A connector is on the LH side of the vehicle, and ECM B connector is on the RH side.

4. Disconnect the ECM connector(s) and pull them outwards for installation on the ECM adapter tool.



1. *ECM adapter tool*
2. *ECM connector*

ECM Power Circuit Diagram



ECM Power Circuit Validation

Briefly press START/RER button.

This should wake up the ECM. The ECM will then activate relay R1 for approximately 12 seconds after which it will turn off all power. If the tether cord is installed when the START/RER button is pressed, the power will stay on for approximately 40 seconds.

QUICK INDICATION THAT ECM IS POWERED (ASSUMING THE OBSERVED COMPONENT IS WORKING)
Multifunction gauge comes ON.
Fuel pump turns on for approx. 2 seconds (if tether cord installed).

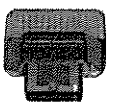
If ECM does not turn on, check the following:
- Fuse F1, F2 and F6.
- Battery voltage. Refer to *CHARGING SYSTEM.*
- Relay R1.
- START/RER switch. Refer to *STARTING SYSTEM.*
- ECM power circuit wires and ground wires.

For testing of fuses and relay R1, refer to *POWER DISTRIBUTION* subsection.

NOTE: When relay 1 is not working, the EMS (engine management system) and the complete vehicle electrical system will not be powered.

ECM Wake Up Circuit Test

1. Disconnect "B" connector from ECM, refer to *ECM CONNECTOR ACCESS* in this subsection.
2. Install ECM connector "B" on the ECM adapter tool.

ECM ADAPTER TOOL (P/N 529 036 166)	

3. Use a multimeter and select Vdc.
4. While pressing START/RER button, read voltage as follows.

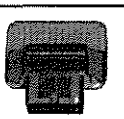
ECM ADAPTER	BATTERY	MEASUREMENT
1D	Battery ground	Battery voltage

If voltage is as per specification, refer to *ECM POWER CIRCUIT TEST.*

If voltage is out of specification:
- Test the START/RER switch, refer to *STARTING SYSTEM* subsection.
- If START/RER switch tests good, test wiring and connectors from battery to ECM. Refer to *WIRING DIAGRAM.*

ECM Power Circuit Test

1. Connect ECM connector "B" on the ECM adapter tool.

ECM ADAPTER TOOL (P/N 529 036 166)	

2. Install an appropriate fused jumper wire between the following terminals on the ECM adapter tool.

JUMPER WIRE COORDINATES ON ECM ADAPTER	
2H	2M, 3M or 1L

NOTE: When the jumper is installed, the multifunction gauge should come on.

If the multifunction gauge did not come on, check the following:
- Fuses F1, F2 and F6
- Relay R1
- Wiring between ECM-B contact 2H and fuse F2, refer to the *WIRING DIAGRAM* subsection
- ECM ground circuit, refer to *CONTINUITY TEST OF ECM GROUND CIRCUITS* in this subsection.

For testing of fuses and relay R1, refer to *POWER DISTRIBUTION* subsection.

If gauge came on, carry on with the following step.

3. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and select Vdc.
4. Check for voltage as follows.

ECM ADAPTER	BATTERY	VOLTAGE
B-4M	Negative post	Battery voltage

If voltage is not measured, check the wiring and connections between ECM and fuse F6, refer to the *WIRING DIAGRAM* subsection.

If all items mentioned in this test and in *ECM WAKE UP CIRCUIT TEST* tested good, try a new ECM.

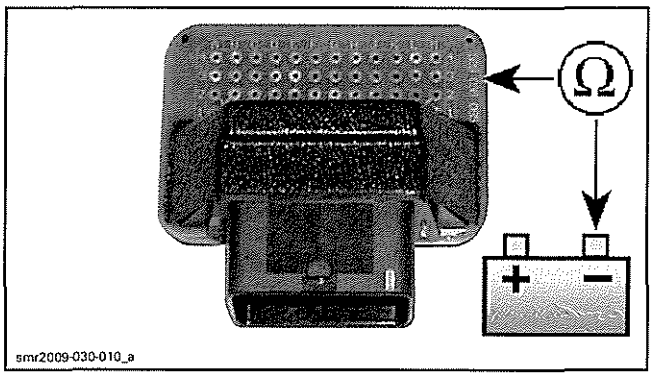
Continuity Test of ECM Ground Circuits

1. Connect ECM connector "B" on the ECM adapter tool.

ECM ADAPTER TOOL (P/N 529 036 166)	

2. Select the FLUKE 115 MULTIMETER (P/N 529 035 868) to Ω and probe adapter terminals as per following table.

ECM ADAPTER	BATTERY POST	RESISTANCE
Pins 1L, 2M and 3M	Ground	Close to 0 Ω (continuity)



If any measurement is out of specification refer to *POWER DISTRIBUTION* subsection and check the following:
- Wiring and connections
- Engine ground
- Battery ground
- Frame ground.

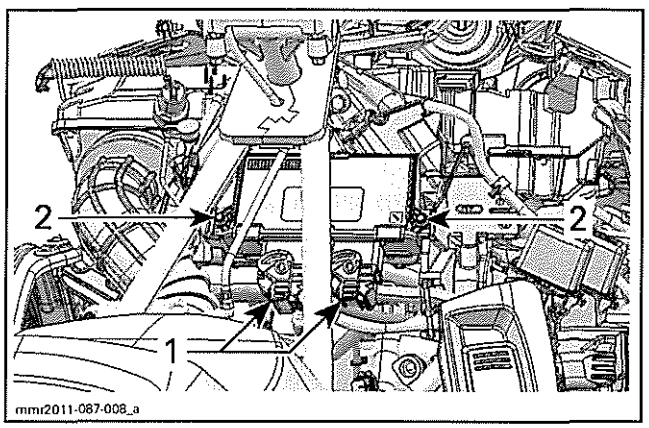
ECM Removal

NOTE: If a new ECM is to be installed, first read the procedures in *ECM REPLACEMENT* in this subsection.

1. Disconnect battery cables.

NOTICE Always disconnect the BLACK negative (–) battery cable first, then disconnect RED positive (+) cable.

2. Refer to *BODY* subsection and remove the LH and RH side panels.
3. Remove the air intake silencer and gauge support as a unit, refer to *AIR INTAKE SYSTEM* subsection.
4. Disconnect both ECM connectors from ECM.
5. Remove ECM retaining screws and remove the ECM from its support.



TYPICAL - ECM REMOVAL
1. ECM connectors
2. ECM retaining screws

ECM Installation

1. Reverse removal procedure however, pay attention to the following.

ECM INSTALLATION	
TORQUE	2.5 N•m (22 lbf•**in**)

2. Reconnect ECM connectors.
3. Reconnect battery cables.

⚠ WARNING

Always reconnect the RED positive (+) battery cable first, then reconnect BLACK negative (–) cable.

4. If a new ECM is installed, refer to *ECM REPLACEMENT* in this subsection.

ECM Replacement

NOTE: Prior to replacing an ECM, ensure that all the recommendations in the general introduction of this section have been followed and all applicable testing procedures have been carried out.

When the ECM is replaced, data must be entered into the new ECM. Refer to *ECM MANUAL DATA ENTRY FOR ECM REPLACEMENT* further in this subsection.

ECM Manual Data Entry for ECM Replacement

Use one of the following 2 methods to collect the required information. The 1st being the easiest:

1. Use B.U.D.S. to obtain the data from a saved .mpem file on your PC computer.
2. Collect the information from the vehicle and BOSSWeb.

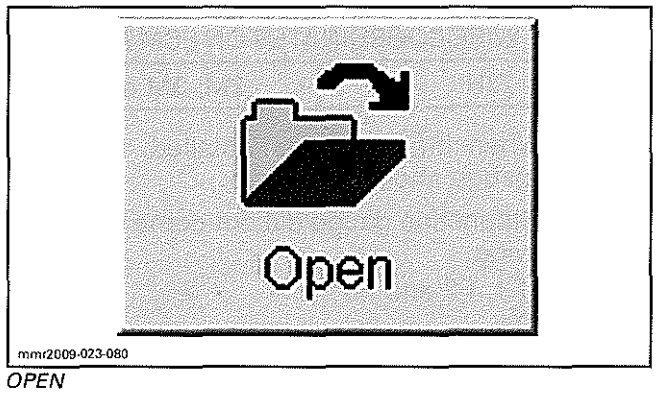
Once the required information has been collected, refer to *ENTERING THE COLLECTED INFORMATION INTO THE ECM.*

1st Collecting Method: Obtaining the Data from a Saved .mpem File

1. Start B.U.D.S.

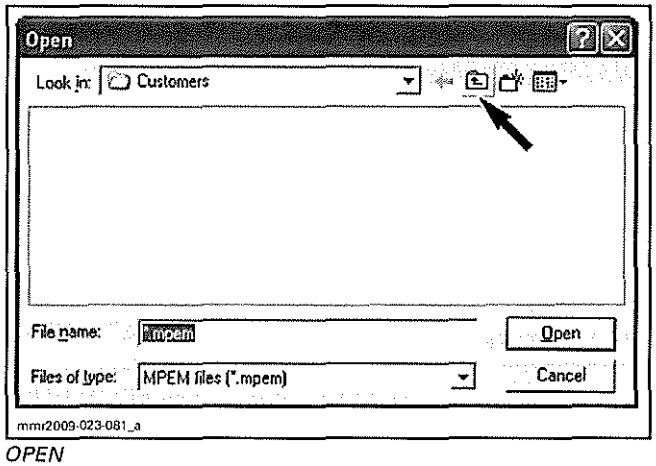
NOTE: It is not necessary to perform any connection. The PC computer can be used alone.

2. In B.U.D.S., click on the **Open** button.



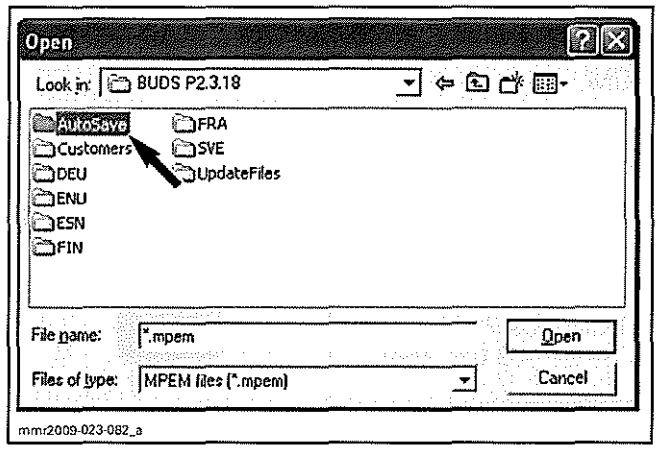
OPEN

3. Click once on the **Folder Up** button in the Open box.



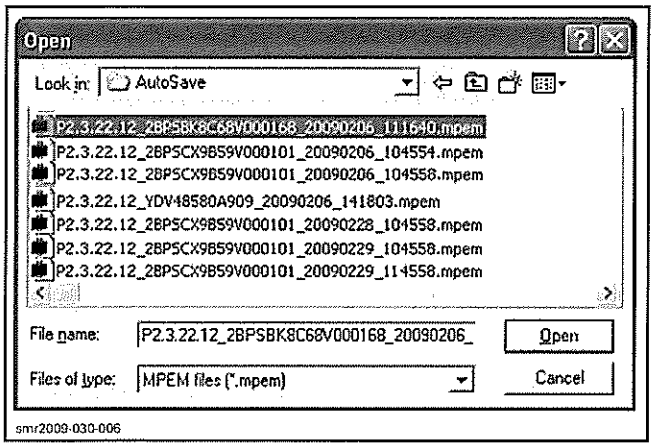
OPEN

Double click on the **AutoSave** folder.



NOTE: You may have to go to another AutoSave folder from a previous version of B.U.D.S.

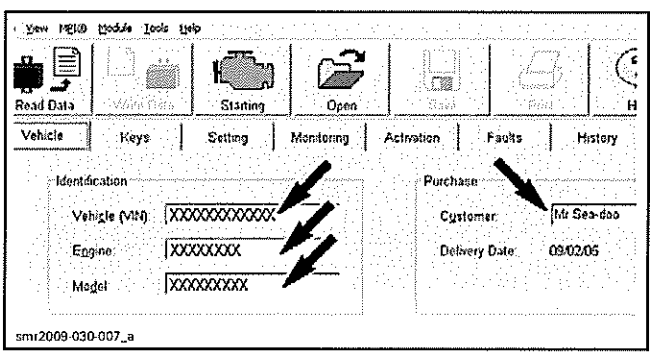
4. Choose the latest file saved for this specific vehicle.



IMPORTANT: Be sure to use the file that specifically matches the vehicle you are servicing.

NOTE: The file name structure is as follows:
B.U.D.S. version_VIN_date read (yyyymmdd)_hour read (hhmmss).mpem
Example: P2.3.22.12_2BPSBK8C68V000168_20090206_111640.mpem Therefore: B.U.D.S. version: P2.3.22.12 VIN: 2BPSBK8C68V000168 Date: 2009 02 06 Hour: 11h 16m 40s

5. Select the **Vehicle** page tab and record (write down) the following information.
   1. Vehicle serial number
   2. Engine serial number (without the leading "M")
   3. Vehicle model number
   4. Customer name.

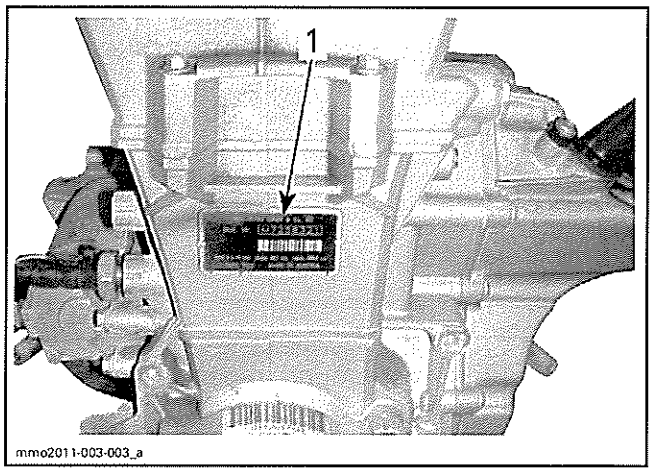


VEHICLE TAB

6. Enter recorded data in ECM as detailed in *ENTERING THE COLLECTED INFORMATION INTO THE ECM.*

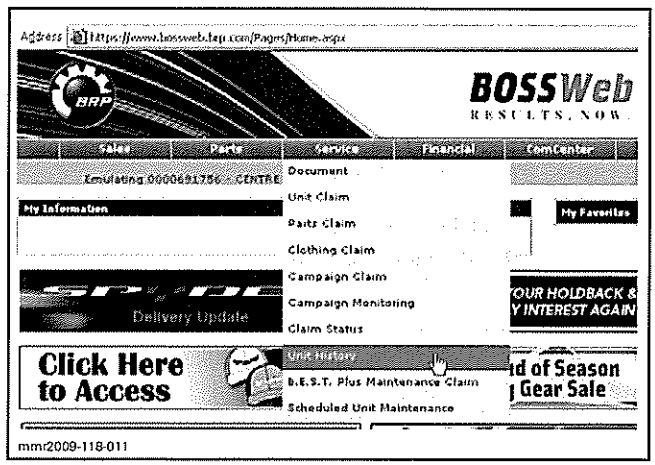
2nd Collecting Method: Collect the Information from the Vehicle and BOSSWeb

1. Record engine serial number.



TYPICAL - LH SIDE OF ENGINE
1. Engine serial number

2. Record the following numbers using BOSSWeb. Look in **Service** menu and choose Unit history.
   1. Vehicle serial number
   2. Vehicle model number
   3. Customer name.

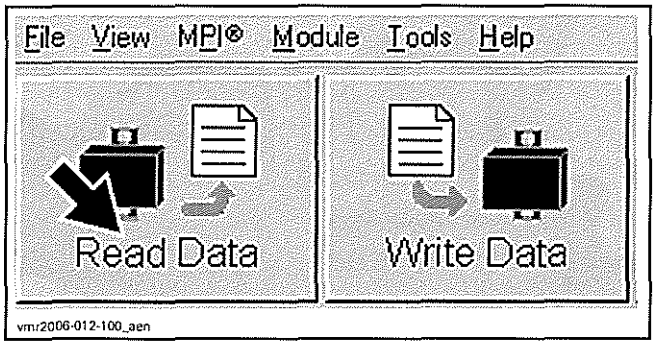


SERVICE, UNIT HISTORY

3. Enter the recorded data in the new ECM as detailed in *ENTERING THE COLLECTED INFORMATION INTO THE ECM.*

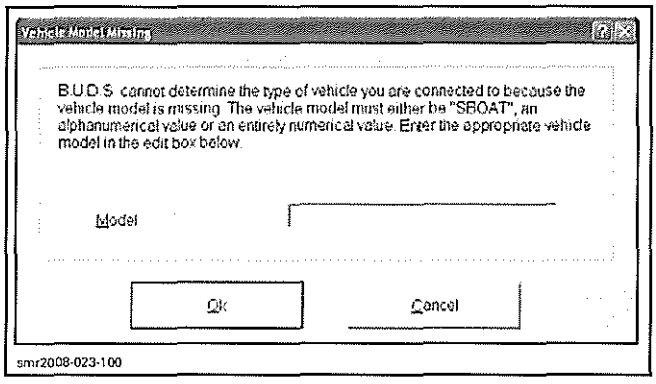
Entering the Collected Information Into the ECM

1. Use the applicable B.U.D.S. version. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. In B.U.D.S., click the **Read Data** button to read the new ECM.



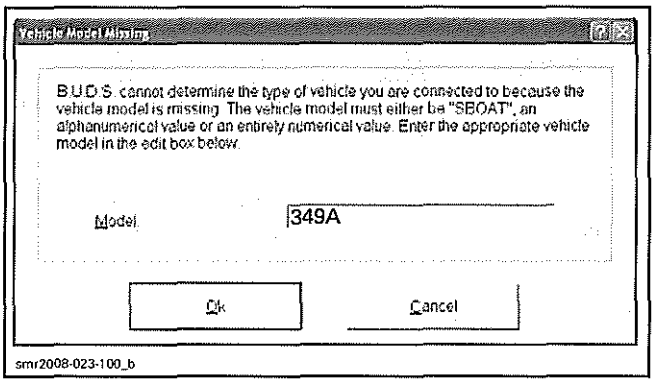
NOTE: A BEEP will sound repeatedly until the tether cord cap (D.E.S.S. key) is programmed into the new ECM.

The following screen window will pop up.

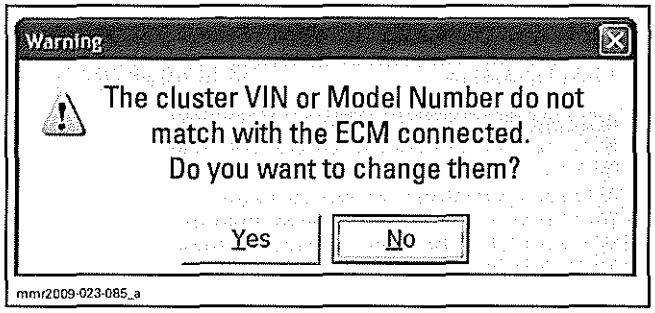


3. Enter the vehicle model number.

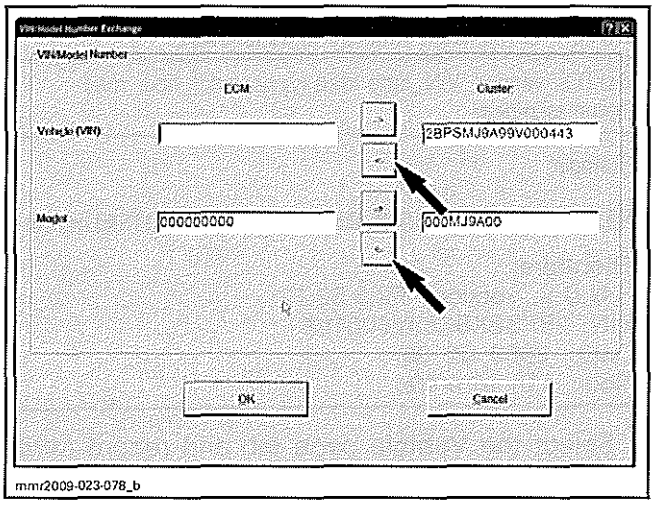
NOTICE Enter only the appropriate product model number as obtained when gathering the information.

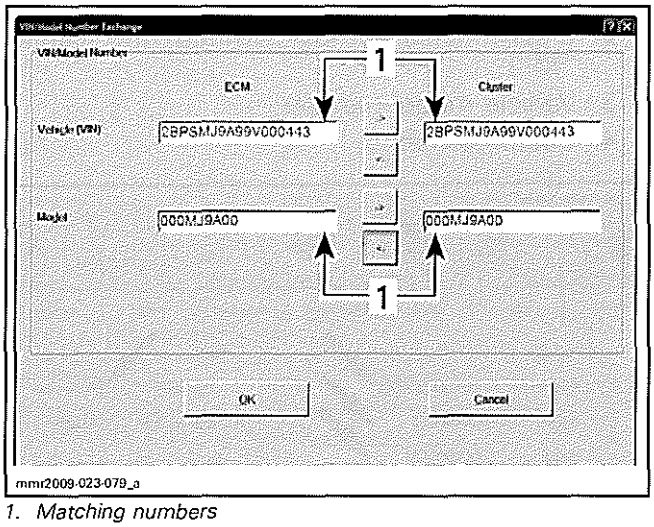


4. Click Ok once the required data has been entered.
5. The following message will appear on B.U.D.S. screen.



6. Click Yes to match ECM and gauge.
7. The serial numbers are purposely missing as seen in B.U.D.S. Click the arrows indicated in the following illustration to transfer the gauge numbers into the ECM.

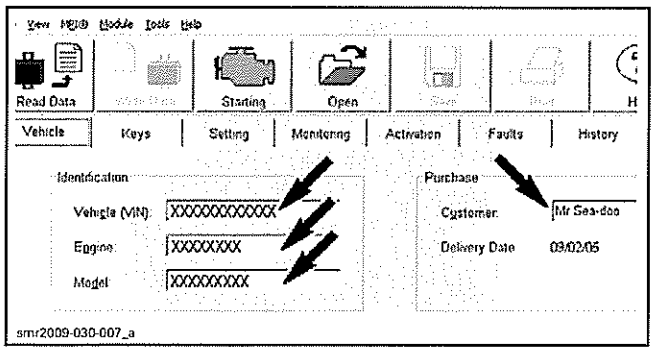




1. Matching numbers

8. Click the OK button to complete the procedure.
9. Select the Vehicle page tab and ensure all of the following information you recorded previously is precisely entered in the new ECM.
   1. Vehicle serial number (VIN)
   2. Engine serial number (do not enter the "M" at the beginning of the engine number)

3. Vehicle model number
4. Customer name.

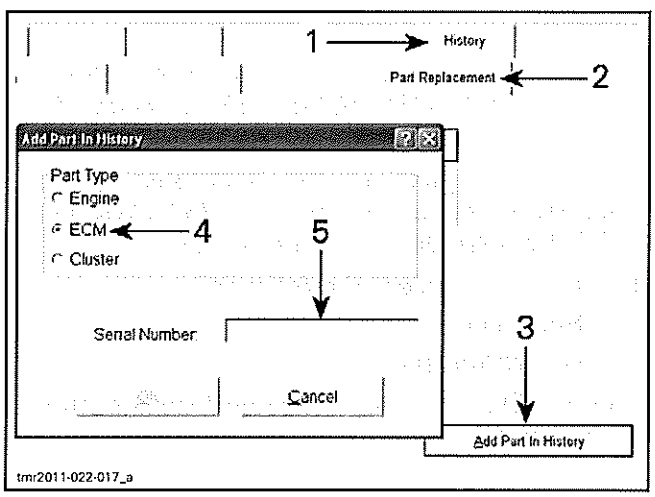


VEHICLE TAB

10. Enter all missing information.

NOTICE Pay particular attention when typing the V.I.N. and model numbers. Once **Write Data** button is pressed, the data cannot be modified.

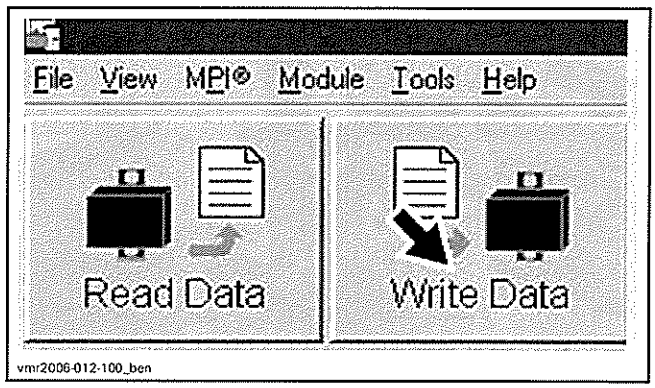
11. Click on the following tabs:
    - History
    - Part Replacement
    - Add Part in History.
12. Enter the old ECM serial number in the Add Part In History window.



TYPICAL - ADDING PART IN HISTORY
1. History *page tab*
2. Part Replacement *tab*
3. Add part in history *button*
4. ECM *selection*
5. *Add ECM serial number here*

NOTE: The ECM serial number can be found on the ECM sticker that also identifies the part number.

13. Click on the OK button.
14. Click on the Write Data button.



15. Perform the *CLOSED THROTTLE RESET (TPS)* procedure, refer to *THROTTLE POSITION SENSOR (TPS)* further in this subsection.
16. Program the tether cord cap (D.E.S.S. key(s)) into the new ECM, refer to *DIGITAL ENCODED SECURITY SYSTEM (D.E.S.S.)* subsection.
17. Set the gauge units of display. Refer to *LIGHTS, GAUGE AND ACCESSORIES* subsection.
18. Start the engine and ensure proper operation.

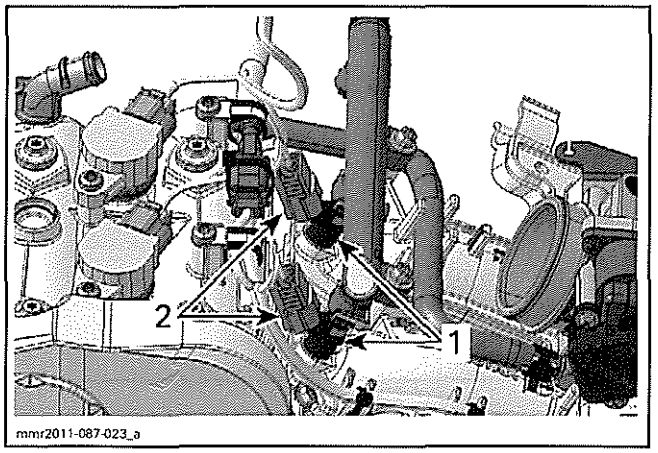
NOTE: If the engine will not idle, or idles very roughly, refer to *IACV AUTO RESET* in this subsection.

19. Reinstall any remaining removed parts.

FUEL INJECTOR

Fuel Injector Access

1. Refer to *BODY* subsection and remove both side body panels.
2. Refer to *AIR INTAKE SYSTEM* subsection and remove the following parts:
   - Air intake silencer and gauge support as a unit
   - Air intake hose from throttle body.

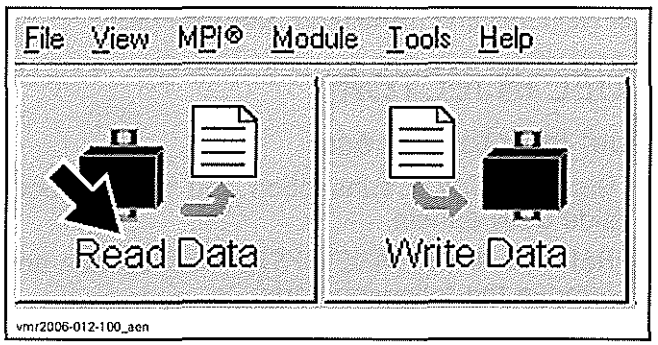


TYPICAL
1. *Fuel Injectors*
2. *Fuel Injector connectors*

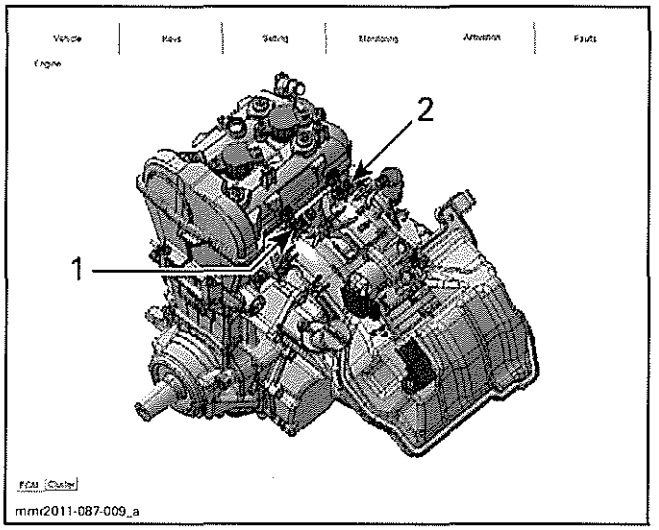
3. If removing injectors, also disconnect the ECM connectors. Refer to *ECM CONNECTOR ACCESS* in this subsection.

Fuel Injector Activation Test Using B.U.D.S.

1. Connect vehicle to the applicable B.U.D.S. version. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. In B.U.D.S., click the **Read Data** button to read the new ECM.



3. On the **Activation** page of B.U.D.S. software, energize the fuel injector to be tested.



INJECTOR ACTIVATION IN B.U.D.S.
1. *Click on PTO injector to activate*
2. *Click on MAG injector to activate*

You should hear the injector functioning.

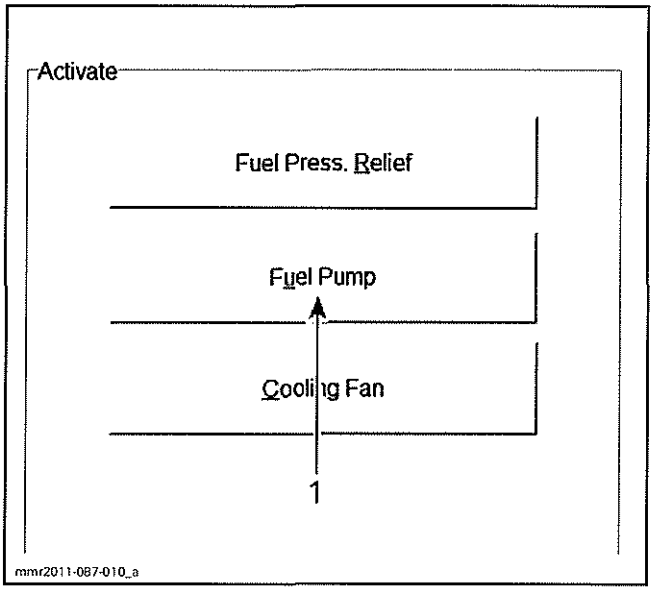
This will validate the injector mechanical and electrical operation.

If the injector does not function, carry out the *FUEL INJECTOR RESISTANCE TEST.*

Fuel Injector Balance Test

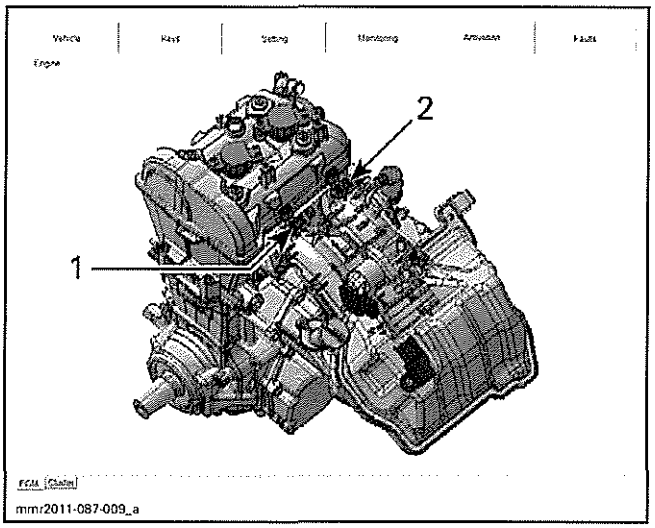
NOTICE **After fuel injector activation using B.U.D.S., always crank engine in drowned mode to ventilate the engine of fuel.**

1. Install a fuel pressure gauge as described in *FUEL PUMP PRESSURE TEST* of *FUEL TANK AND FUEL PUMP* subsection.
2. Connect vehicle to the applicable B.U.D.S. software version. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
3. In B.U.D.S., select the following:
   - **Read Data** button
   - **Activation** page tab.
4. In B.U.D.S., click on the **Fuel Pump** button to activate fuel pump.



1. Fuel Pump activation button

5. Fuel pressure must be within specification. Refer to *FUEL TANK AND FUEL PUMP* subsection. Re-activate fuel pump as necessary.
6. In B.U.D.S., energize fuel injector **no. 1**.



INJECTOR ACTIVATION IN B.U.D.S.
1. Click on PTO injector to activate
2. Click on MAG injector to activate

7. Record the fuel pressure drop for injector **no. 1**.
8. In B.U.D.S., click on the Fuel Pump button to activate fuel pump.
9. Repeat the procedure for fuel injector **no. 2** and record the pressure drop for each injector.
10. The maximum fuel pressure drop between injectors should not exceed the following specification:

MAXIMUM FUEL PRESSURE DROP ALLOWED BETWEEN FUEL INJECTORS
10 kPa (1.5 PSI)

If the pressure drop between fuel injectors is greater than the specification, replace the injector with the least pressure drop, then repeat the test.

11. Using the valve on the fuel pressure gauge, release the pressure in the system (if so equipped).
12. Remove fuel pressure gauge and reinstall removed parts.
13. Set engine emergency shut off switch to OFF.
14. Crank engine in drowned mode (accelerator held all the way in) to ventilate the engine of the fuel that was injected during the test.

⚠ WARNING

Always crank engine in drowned mode to ventilate all fuel that was injected during the test. Failure to do so may result in severe engine damage and injury.

Fuel Injector Leak Test

Test Setup

1. Ensure there is enough fuel in fuel tank.
2. Ensure fuel pressure from fuel pump is within specification. Refer to *FUEL TANK AND FUEL PUMP* subsection.

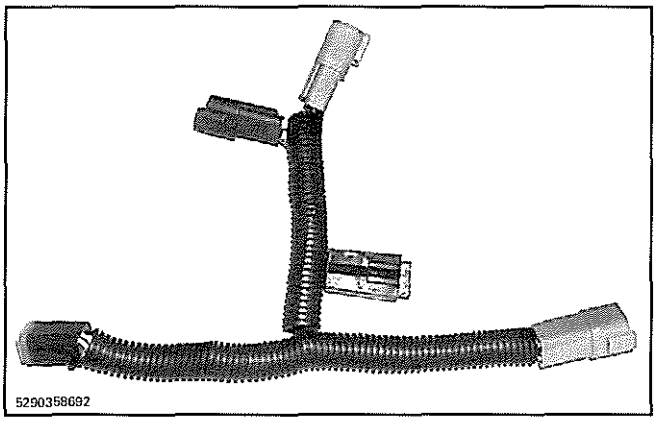
NOTE: Keep the pressure gauge installed for the leakage test.

3. Remove tether cord from engine cut-off switch.
4. Set engine emergency stop switch to STOP.

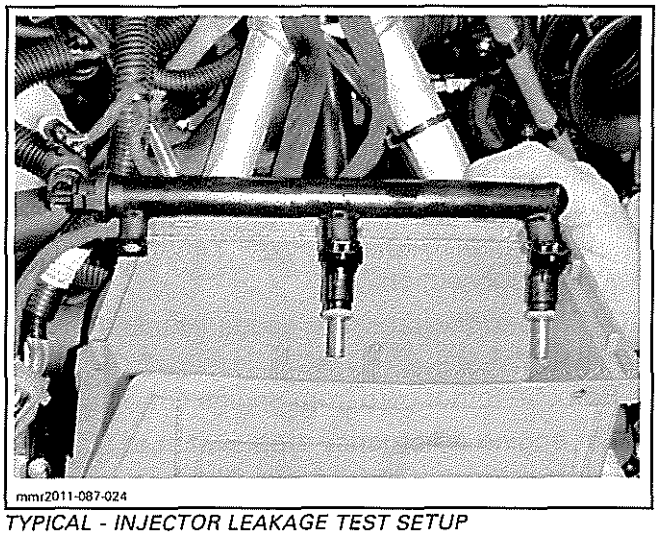
⚠ WARNING

The engine emergency stop switch is set to STOP to prevent any spark in the engine compartment should the engine be cranked. Fuel vapors may ignite in presence of a spark creating a fire hazard.

5. Disconnect the vehicle from B.U.D.S. by disconnecting the T-HARNESS (P/N 529 035 869) from the vehicle diagnostic connector.



6. Wait for vehicle electrical power to shut off; the multifunction gauge will turn off.
7. Remove fuel rail with injectors from engine however, **do not** disconnect fuel pump pressure hose from fuel rail. Refer to *FUEL INJECTORS* in this subsection.
8. Position fuel rail so that an appropriate container may be placed under the injectors to collect any fuel leakage.

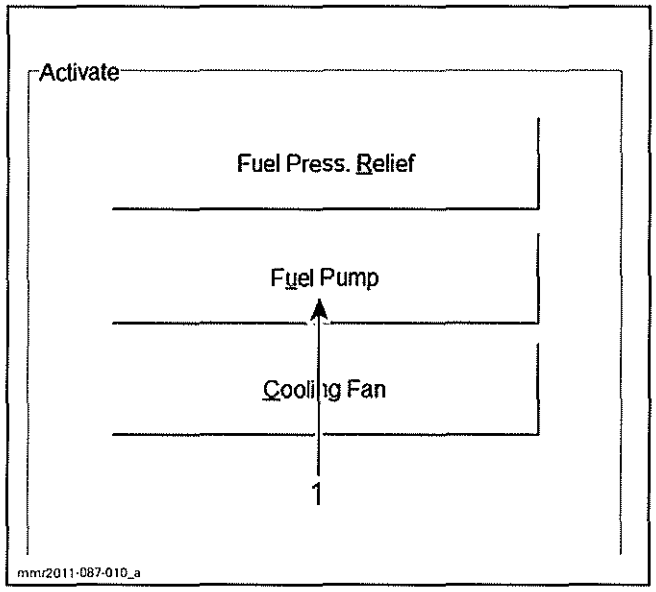


TYPICAL - INJECTOR LEAKAGE TEST SETUP

9. Install tether cord on engine cut-off switch.
10. Connect vehicle to the applicable B.U.D.S. software, refer to *COMMUNICATION TOOLS AND B.U.D.S.*

Leak Test

1. In B.U.D.S., select the following:
   - **Activation** page tab
   - **ECM** page.
2. Click on the **Fuel Pump** button to activate fuel pump for a few seconds.



ACTIVATION AND ECM TABS
1. Click here

3. Check for fuel leakage from the injector nozzles.
4. Monitor fuel pressure at fuel pressure gauge. If pressure drops below 372 kPa (54 PSI) during the test, re-activate fuel pump as necessary.

FUEL INJECTOR LEAK TEST	
TEST DURATION	SPECIFICATION
2 minutes	1 drop per minute maximum

If test is not within specification, replace the faulty fuel injector.

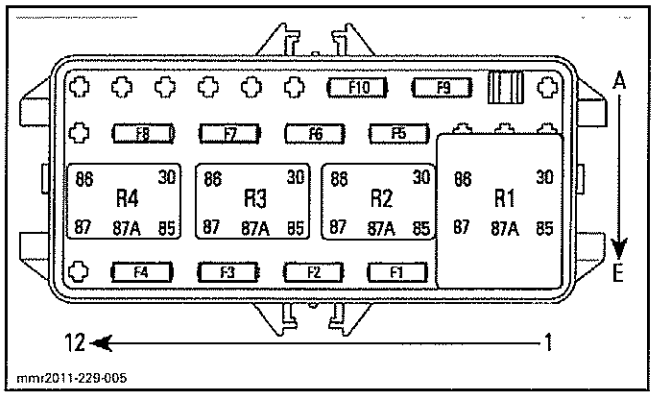
5. Properly reinstall fuel rail. Refer to *FUEL RAIL* in this subsection.
6. Reinstall remaining removed components.

⚠ WARNING

Wipe up any spilled fuel.

Fuel Injector and Circuit Resistance Test

1. Ensure vehicle electrical power is off.
2. Disconnect connector "A" from the ECM, refer to *ECM CONNECTOR ACCESS* in this subsection.
3. Remove cover from the fuse box and locate fuse F5 (HIC fuse).



FUSE BOX COORDINATES

4. Using a FLUKE 115 MULTIMETER (P/N 529 035 868), check resistance value between fuse box and ECM connector terminals as follows.

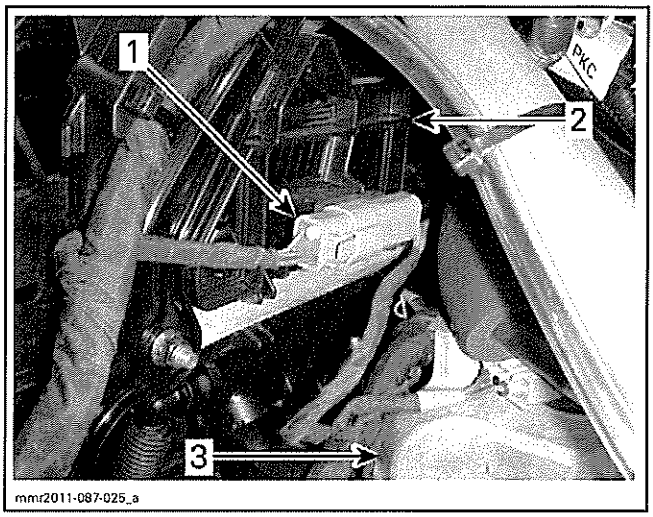
NOTE: It is not necessary to remove the fuse. Refer to *POWER DISTRIBUTION* subsection for fuse box information.

FUEL INJECTOR RESISTANCE TEST AT FUSE BOX			
INJECTOR	**FUSE CONTACT**	**ECM CONNECTOR "A"**	**RESISTANCE @ 20°C (68°F)**
PTO	5B	A-J1	12 ± 0.6 Ω
MAG		A-K1	

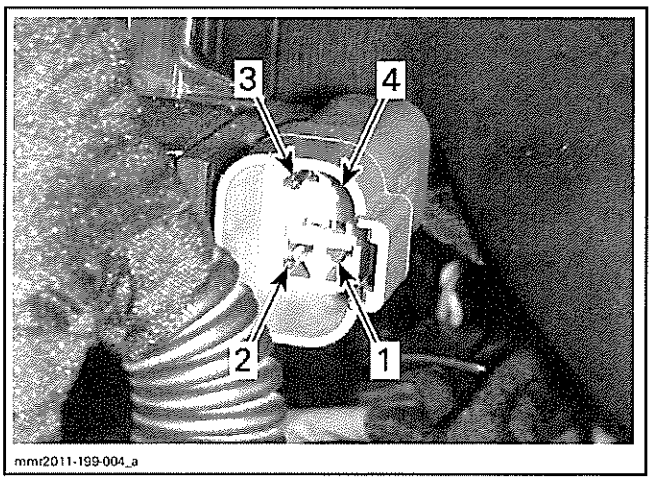
If resistance value obtained is correct, carry out a *FUEL INJECTOR INPUT VOLTAGE TEST.*

If resistance value obtained is incorrect, repeat test at HIC connector located on front side of ECM support.

FUEL INJECTOR RESISTANCE TEST AT HIC CONNECTOR			
INJECTOR	**HIC CONNECTOR**	**ECM CONNECTOR "A"**	**RESISTANCE @ 20°C (68°F)**
PTO	Pin 2	A-J1	12 ± 0.6 Ω
MAG	Pin 3	A-K1	



HIC CONNECTOR LOCATION
1. *HIC connector*
2. *ECM support*
3. *Engine valve cover*



HIC CONNECTOR PIN-OUT

If resistance value obtained is incorrect, carry out a *FUEL INJECTOR RESISTANCE TEST AT COMPONENT.*

Fuel Injector Resistance Test at Component

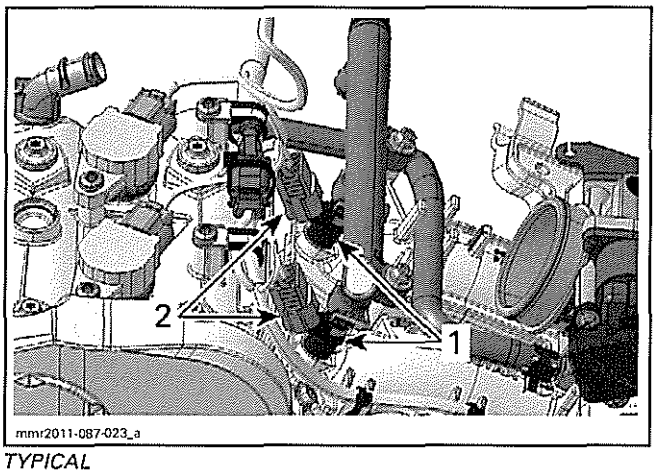
1. Remove injector connector, refer to *FUEL INJECTOR ACCESS* in this subsection.
2. Check resistance value between injector pins as follows.

FUEL INJECTOR RESISTANCE TEST AT INJECTOR		
INJECTOR PIN		RESISTANCE @ 20°C (68°F)
1	2	12 ± 0.6 Ω

If readings are out of specifications, replace injector.

Fuel Injector Input Voltage Test

1. Ensure both ECM connectors are properly connected.
2. Ensure the HIC connector is properly connected.
3. Disconnect the fuel injector connector. Refer to *FUEL INJECTOR ACCESS* in this subsection.



TYPICAL
1. Fuel Injectors
2. Fuel Injector connectors

NOTE: If the connector is hard to unlock, gently use a screwdriver to release connector locking tab.

4. Ensure fuse F5 (HIC fuse) is properly installed.
5. Set engine emergency stop switch to STOP to prevent engine starting.
6. Install tether cord on engine cut-off switch.

NOTE: With tether cord installed on engine cut-off switch, vehicle electrical power will stay on for approximately 20 seconds.

7. Momentarily press the START/RER button to wake up the ECM.

NOTE: It is not necessary to activate the injector since it is continuously powered when the ECM is awake.

8. Use a multimeter and set it to Vdc. Read voltage.

CYLINDER	INJECTOR CONNECTOR		MEASUREMENT
	WIRE		
PTO	VIOLET/ BLUE	Battery ground	Approximately 12 Vdc
MAG			

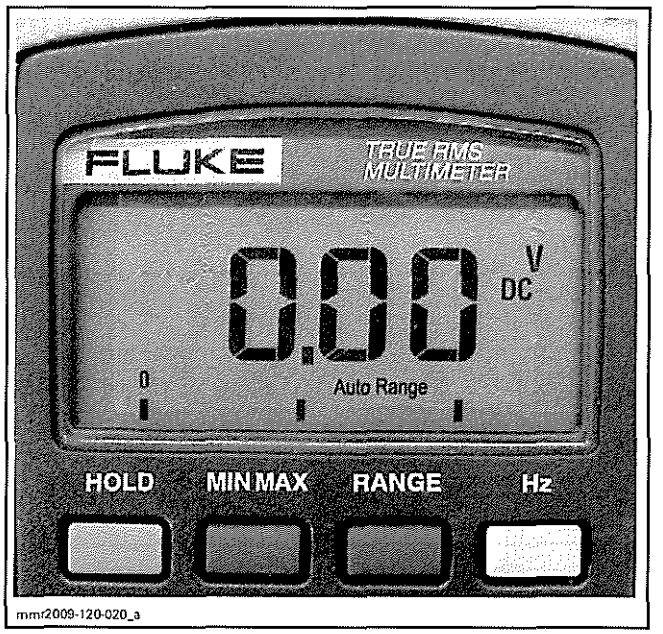
If injector input voltage is good, carry out the following:
- Circuit continuity test between injector and ECM, refer to *WIRING DIAGRAM* subsection.
- *FUEL INJECTOR SIGNAL TEST* further in this subsection.

If injector input voltage is not good, check the following:
- Fuse F5 (HIC fuse)
- Circuit continuity between fuse F5 and injector. Refer to *POWER DISTRIBUTION* and *WIRING DIAGRAM* subsections.

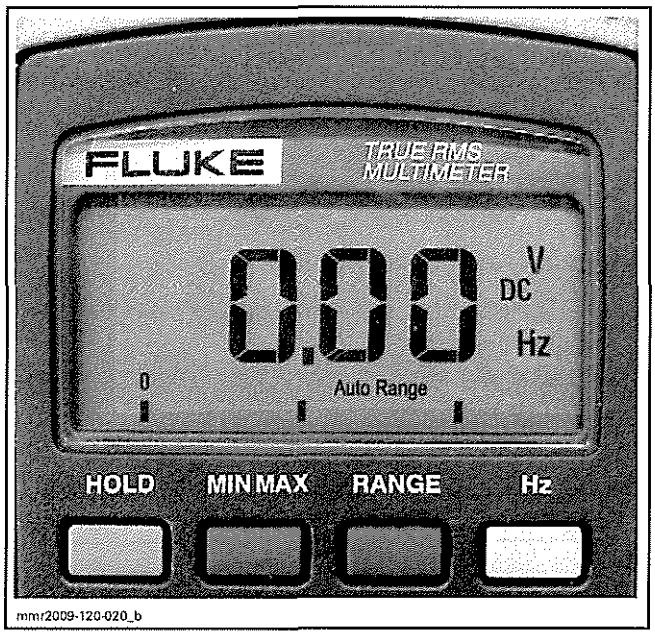
Fuel Injector Signal Test

1. Connect vehicle to the applicable B.U.D.S. version. Refer to *COMMUNICATION TOOLS AND B.U.D.S. SOFTWARE.*
2. In B.U.D.S., select the **Activation** page tab.
3. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and set it to Vdc.

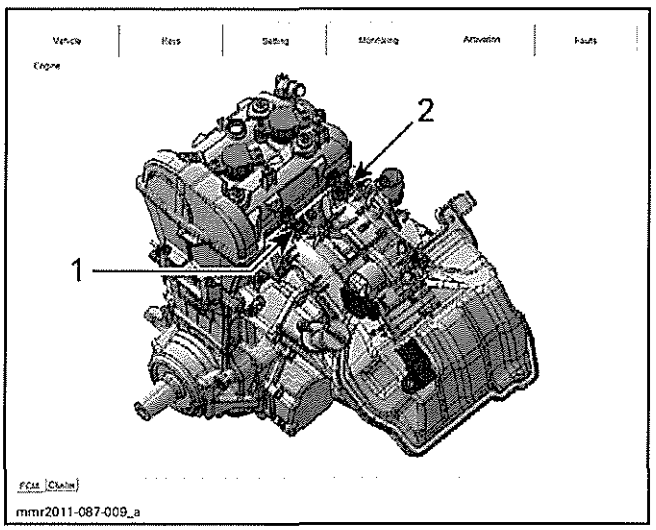
NOTE: Make sure multimeter is in the **Auto Range** mode.



4. Press the **Hz** button so that the display shows Hz.



5. Connect the multimeter probes as indicated in the following table and using the B.U.D.S. software, activate each injector and read the frequency on the multimeter.



INJECTOR ACTIVATION IN B.U.D.S.
1. Click on PTO injector to activate
2. Click on MAG injector to activate

NOTE: The multimeter counts the pulses per seconds (Hertz) of current the ECM sends to the injector.

INJECTOR	INJECTOR CONNECTOR CONTACT	BATTERY	MEASUREMENT
PTO	BROWN/RED wire	Battery ground	Approximately 9 Hz
MAG	BROWN/BLUE wire		

If reading is good, the control circuit is functional.

If there is no reading, check continuity of control circuit (ECM to injectors). Refer to *WIRING DIAGRAM* for circuit details.

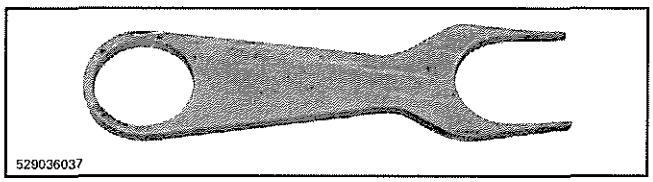
Fuel Injector Removal

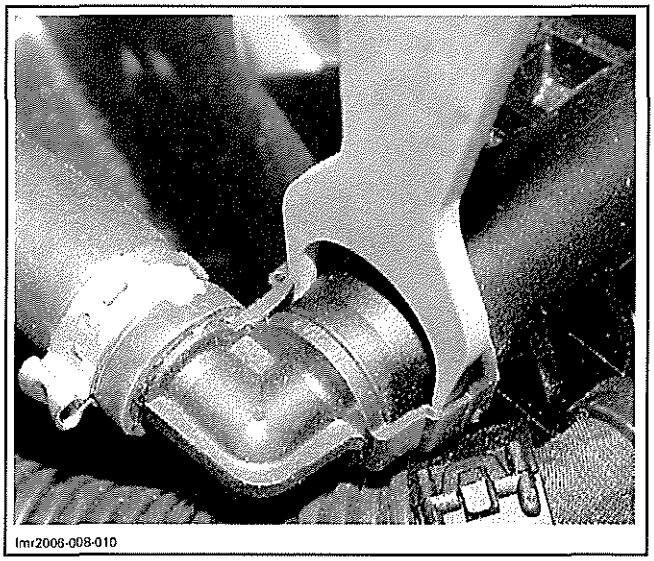
1. Disconnect fuel pump electrical connector, refer to *FUEL TANK AND FUEL PUMP* subsection.
2. Start engine and let run until it runs out of fuel.
3. Disconnect the battery, refer to *CHARGING SYSTEM* subsection.

⚠ WARNING

When removing or disconnecting the fuel injectors, always remove the tether cord from the engine cut-off switch and disconnect the battery.

4. Remove parts required for access to the fuel rail and fuel injectors, refer to *FUEL INJECTOR ACCESS.*
5. Disconnect the fuel injector electrical connectors.
6. Disconnect the fuel pressure hose from the fuel rail using the FUEL HOSE DISCONNECT TOOL (P/N 529 036 037).

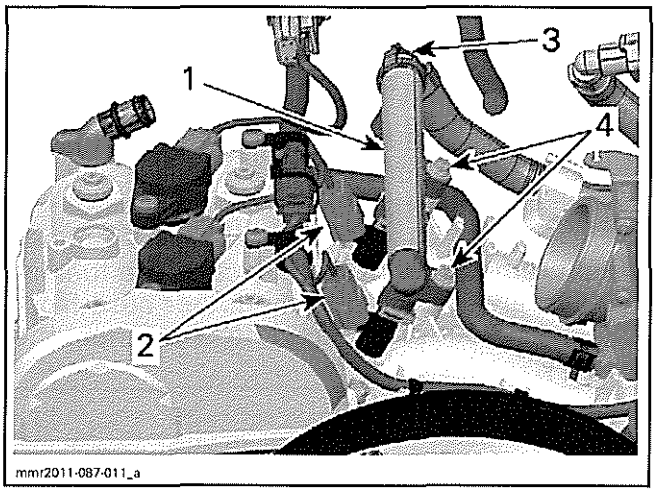




NOTE: It may be necessary to rotate fuel hose fitting to align the tool ends with the openings of the locking mechanism.

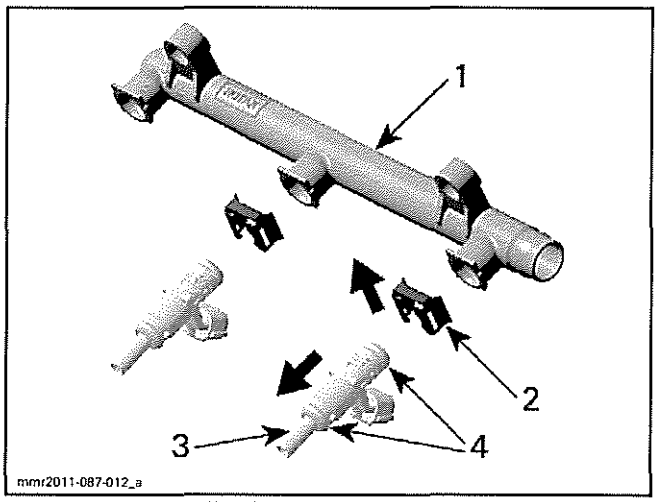
NOTE: Wrap a rag around the hose end to catch any fuel leakage.

7. Remove the fuel rail mounting screws (2).



TYPICAL
1. *Fuel rail*
2. *Injector connectors*
3. *Fuel pressure hose disconnect*
4. *Fuel rail mounting screws*

8. Pull on fuel rail to remove the fuel rail and injectors from the engine.
9. Remove the fuel injector retaining clips (2) from the fuel rail.



TYPICAL - FUEL RAIL ASS'Y
1. *Fuel rail*
2. *Fuel injector retaining clip*
3. *Injector*
4. *Injector O-rings*

10. Pull the fuel injector(s) out of the fuel rail.

Fuel Injector Installation

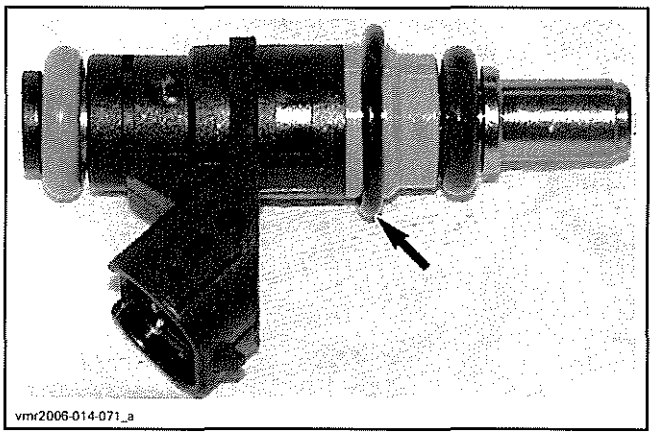
For the installation, reverse the removal procedure however, pay attention to the following details.

NOTICE If installing the removed injector(s), ensure injector O-rings are in good condition. Replace O-rings as required.

1. Apply a thin film of engine oil to O-rings to ease insertion in rail.
2. Install fuel injector with your hand. Do not use any tool.

FUEL INJECTOR INSTALLATION		
O-RINGS	New	Lubricate with engine oil

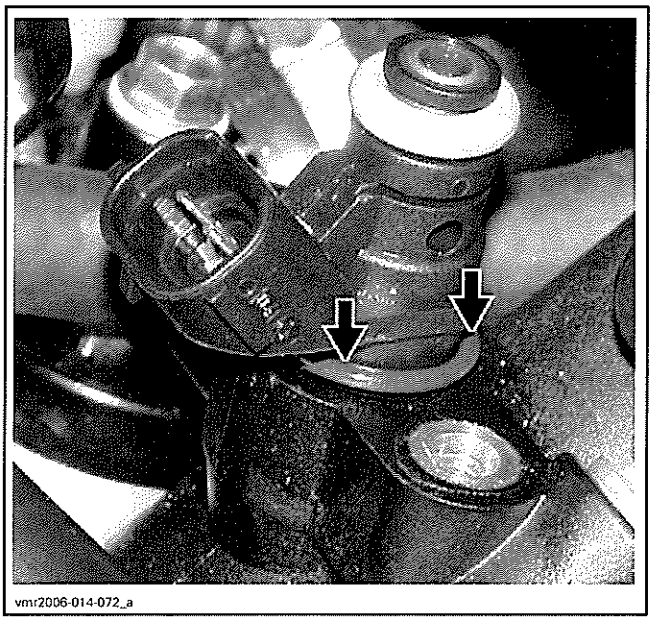
3. Ensure proper positioning of the intake manifold O-ring on injector as in following illustration.



TYPICAL - INTAKE MANIFOLD O-RING POSITION

4. Carefully insert injector in air intake manifold paying attention to the manifold O-ring.

NOTICE Gently push O-ring in evenly all around while inserting injector. O-ring must be completely inserted and not visible, before completing the insertion of the injector.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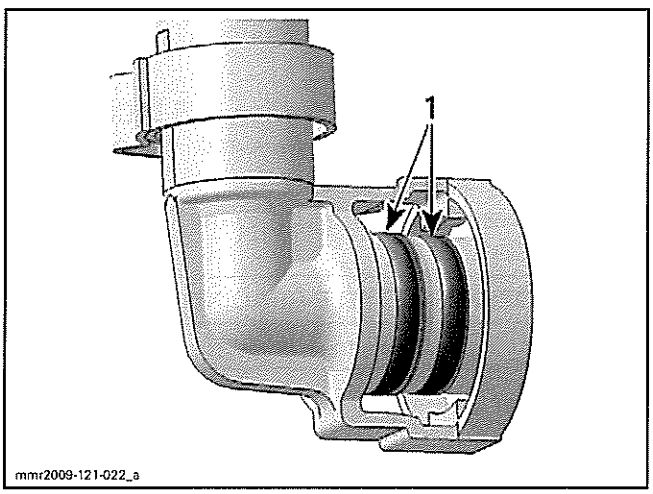
TYPICAL

5. Firmly push injector until it bottoms out.
6. Install fuel rail.

FUEL RAIL RETAINING SCREW TORQUE
11 N•m (97 lbf•**in**)

7. Apply engine oil on O-rings of fuel pressure hose fitting.



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FUEL PRESSURE HOSE FITTING
1. Apply oil on O-rings

8. Connect fuel pressure hose to fuel rail.

IMPORTANT: Push fuel hose fitting on fuel rail until you hear a "click". Try pulling on fuel hose fitting to ensure it is properly locked.

Pressurize the fuel system and check for fuel leaks. Refer to *FUEL SYSTEM PRESSURIZATION* in *FUEL TANK AND FUEL PUMP* subsection.

⚠ WARNING

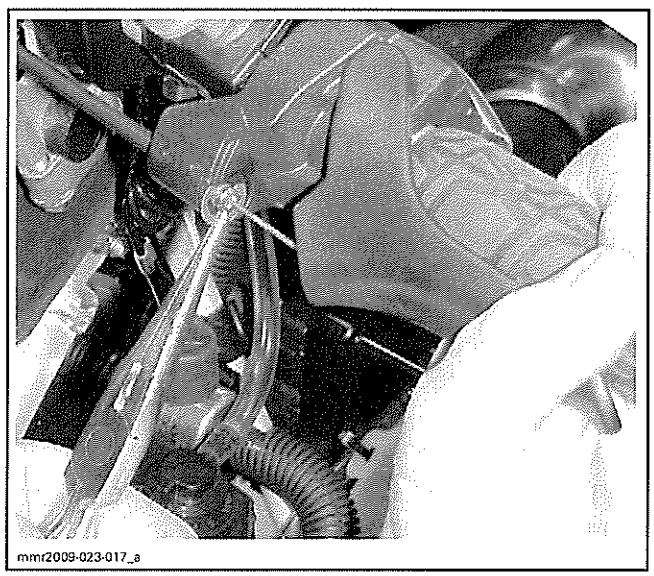
Failure to pressurize the fuel system and checking for fuel leaks may result in severe injury or a life threatening situation should a leak occur.

9. Reinstall all remaining removed parts.

THROTTLE CABLE

Throttle Cable Removal

1. Remove handlebar cover.
2. Depress and hold throttle lever.
3. Pull out circlip using long nose pliers. Keep circlip for re-use.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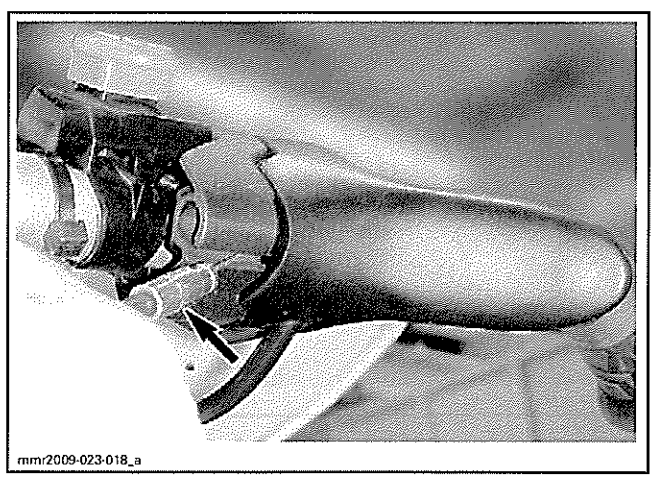
4. Pull throttle cable out of throttle lever housing.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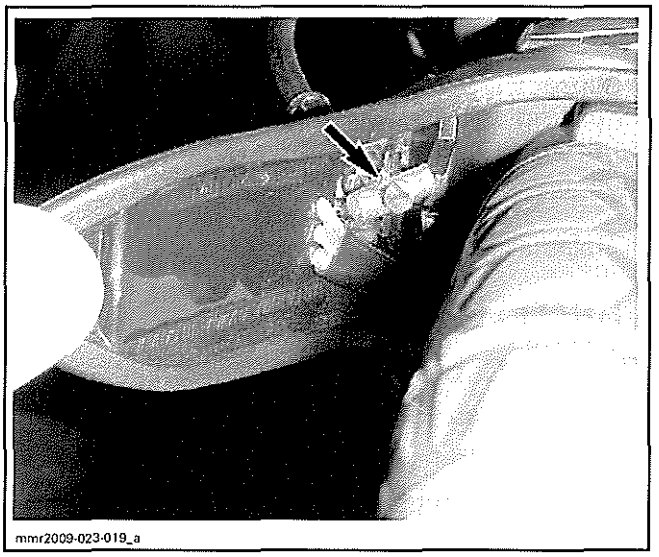
5. Unhook cable barrel end from throttle lever and remove cable from throttle lever.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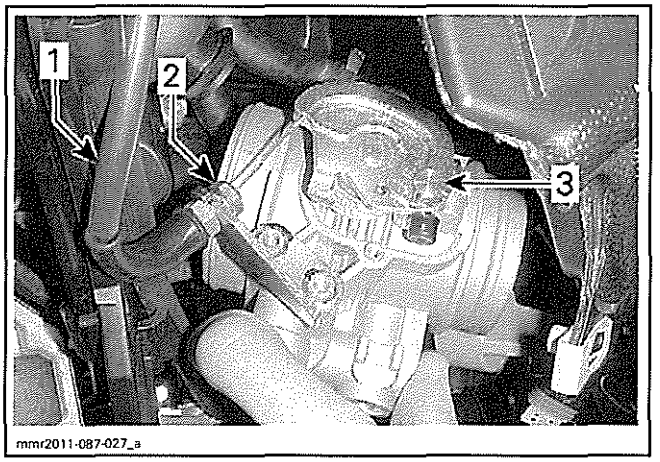
6. Note throttle cable routing before removal.
7. Refer to *THROTTLE BODY REMOVAL* and remove the throttle body from the intake manifold.

NOTE: DO NOT disconnect the coolant hoses from the throttle body.

8. Pull out and turn throttle body towards you for access to throttle cable attachment. See following illustration.
9. Remove throttle cable retaining nut and pull cable out through the slot in the cable support.
10. Detach throttle cable from the throttle plate actuating cam.

NOTE: Be careful not to drop the throttle cable retainer when removing it from the throttle plate actuating cam.



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1. Throttle cable
2. Throttle cable retaining nut
3. Throttle cable retainer

11. Remove throttle cable from vehicle.

Throttle Cable Installation

For throttle cable installation, reverse removal procedure however, pay attention to the following.

1. Route cable as per factory installation as noted before removal.

NOTICE Do not alter throttle cable routing. Incorrect cable routing may cause the engine to be difficult to start or to idle erratically.

2. Ensure cable ends are properly secured in the throttle lever and throttle plate actuating cam.

THROTTLE CABLE RETAINING NUT TORQUE (AT THROTTLE BODY)
4.5 N•m (40 lbf•**in**)

3. Proceed with a *THROTTLE CABLE ADJUSTMENT* as described in this subsection.

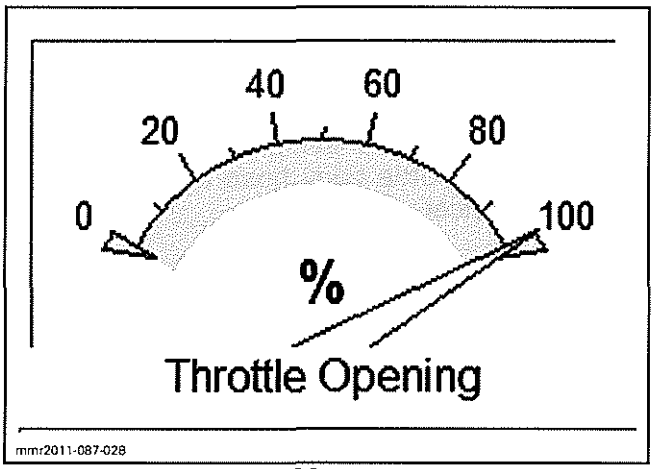
Throttle Cable Adjustment

Wide Open Throttle Adjustment

1. Position handlebar in the straight ahead position.
2. Connect vehicle to the applicable B.U.D.S. software. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
3. In B.U.D.S., select the following:
   - Monitoring page tab
   - ECM page.
4. Observe the throttle opening in B.U.D.S. while holding throttle lever at wide open throttle (WOT).

The displayed value must be within the following specification.

WIDE OPEN THROTTLE READING IN B.U.D.S.
95 to 100%

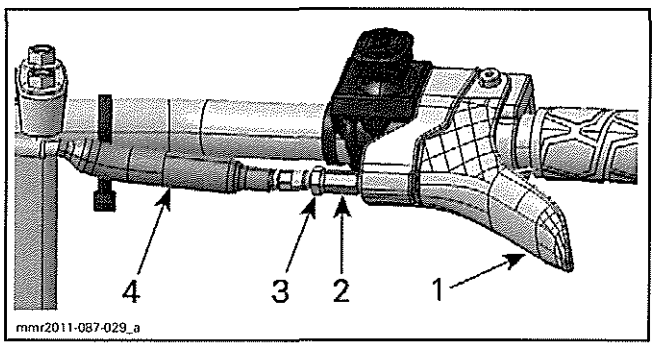


MONITORING AND ECM TABS

NOTE: There will be no performance loss as long as the throttle opening is within the specification.

If reading is not within specification, adjust throttle cable.

5. Pull protector back from throttle cable adjuster.
6. Loosen lock nut on the cable adjuster.



1. *Throttle lever*
2. *Cable adjuster*
3. *Adjuster lock nut*
4. *Adjuster protector*

7. Set cable adjuster as required to obtain specified throttle opening in B.U.D.S., then tighten lock nut.

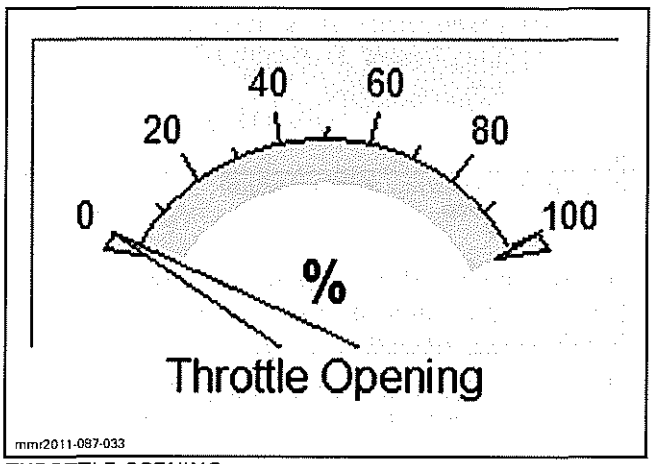
NOTE: If value is below the minimum, tighten throttle cable adjuster. If value is above the maximum value, loosen throttle cable adjuster.

LOCK NUT TORQUE (THROTTLE CABLE ADJUSTER)
2.5 N•m (22 lbf•**in**)

8. Turn handlebar side to side and ensure adjustment is still within the specification in each position while at WOT.
9. Carry out the *IDLE POSITION VERIFICATION.*

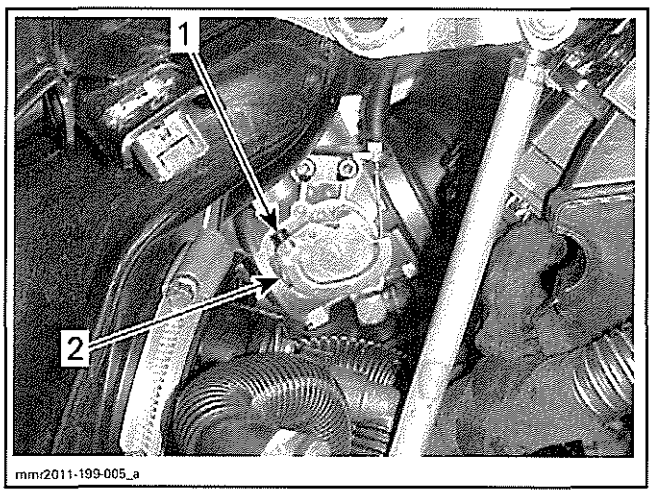
Idle Position Verification

1. Apply and release throttle lever a few times.
2. While throttle is released, ensure the following:
   - Throttle cam idle stop rests against the idle stop screw
   - No tension on throttle cable
   - There is some throttle free-play between throttle lever and housing.
   - The throttle opening indicated in B.U.D.S. is zero (0).

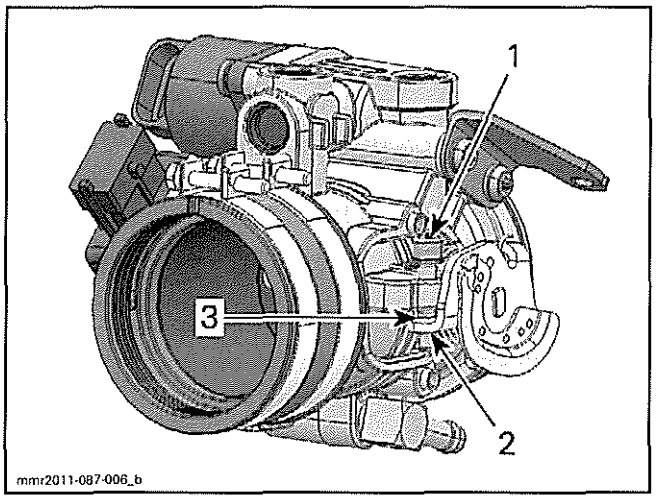


THROTTLE OPENING

NOTE: To see the throttle cam and the idle stop screw contact, look in from the RH side of the vehicle using a flashlight and a mechanics mirror.



ACCESS TO IDLE STOP
1. *Capped idle stop screw (NOT adjustable)*
2. *Look for idle stop screw contact here*



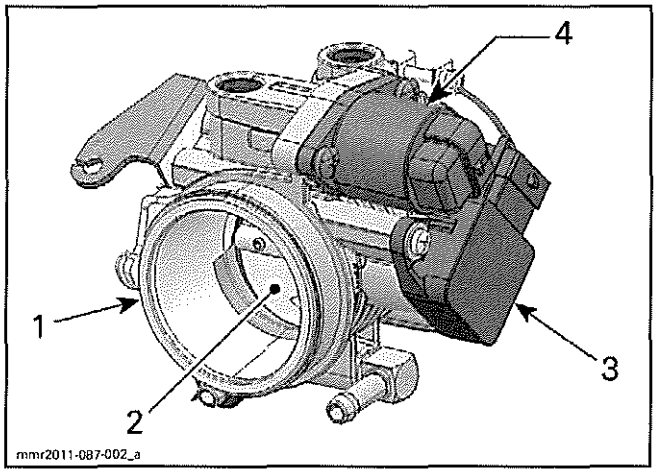
1. Capped idle stop screw (NOT adjustable)
2. Throttle cam stop
3. Contact here

3. If the specified conditions are not met, adjust throttle cable as detailed in *WIDE OPEN THROTTLE ADJUSTMENT*.
4. If all conditions are met except for the throttle opening indication in B.U.D.S., carry out the *CLOSED THROTTLE RESET* procedure as described in this subsection.

NOTICE If there is no free-play at the idle position, it may cause the engine to be difficult to start, or to idle erratically.

THROTTLE BODY

Throttle Body Description



1. Throttle body
2. Throttle plate
3. Throttle position sensor (TPS) (inside)
4. Idle air control valve (IACV)

Throttle Body Access

1. Refer to *BODY* subsection and remove the LH side body panel.
2. Remove the drive belt guard, refer to *DRIVE SYSTEM AND BRAKE* subsection.
3. If removing, inspecting or cleaning throttle body, refer to *AIR INTAKE SYSTEM* and remove the throttle body hose adapter from air intake silencer.

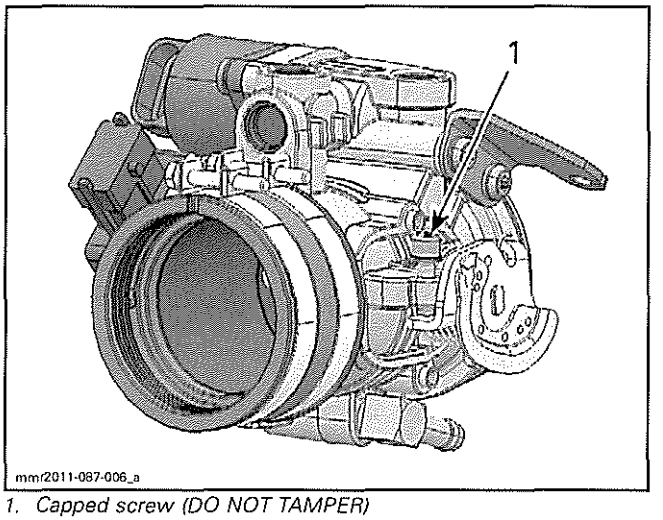
Throttle Body Lubrication

No lubrication is required.

Throttle Body Inspection

1. Remove parts required to access throttle body, refer to *THROTTLE BODY ACCESS*.

NOTICE Never attempt to adjust the capped idle stop screw. It is calibrated at the factory. If the screw adjustment is changed, the throttle body must be replaced.



1. Capped screw (DO NOT TAMPER)

2. Carry out the following:
   - Inspect throttle body for cleanliness.
   - Ensure throttle plate opens fully and smoothly.
   - Check if throttle body idle stop screw is loose or worn. If so, throttle body must be replaced.
   - Check if TPS (throttle position sensor) is loose).
   - Check for a dirty or loose IACV (idle air control valve).
   - Check for corroded or damaged wiring or connectors on TPS and IACV.

Throttle Body Cleaning

1. Remove parts required to access throttle body, refer to *THROTTLE BODY ACCESS*.

2. Check throttle body cleanliness using a flashlight. Fully open throttle plate and verify:
- Throttle body bore
- Throttle plate edge.

Look for:
- Dirt
- Oily surfaces
- Carbon and salt deposits on throttle plate and the surrounding bore.

3. Clean as necessary.
4. To clean throttle body, remove throttle body from intake manifold without disconnecting the throttle cable and hoses. Refer to *THROTTLE BODY REMOVAL* further in this subsection.
5. Use a throttle body cleaner such as GUNK INTAKE MEDIC or an equivalent.

NOTICE Only use an appropriate throttle body cleaner that will not damage O-rings and EFI sensors.

⚠ CAUTION Use the product in a well ventilated area. Refer to product manufacturer's warnings.

6. To avoid getting dirt into engine, spray cleaner on a clean rag then rub rag against throttle plate and bore. A toothbrush may also be used.
7. Gently open throttle plate and hold fully open to clean all surfaces.
8. To remove residual dirt, spray cleaner on throttle plate and and throttle bore.

NOTE: If the engine idle speed is not stable, also remove and clean the IACV. Refer to *IDLE AIR CONTROL VALVE (IACV)* further in this subsection.

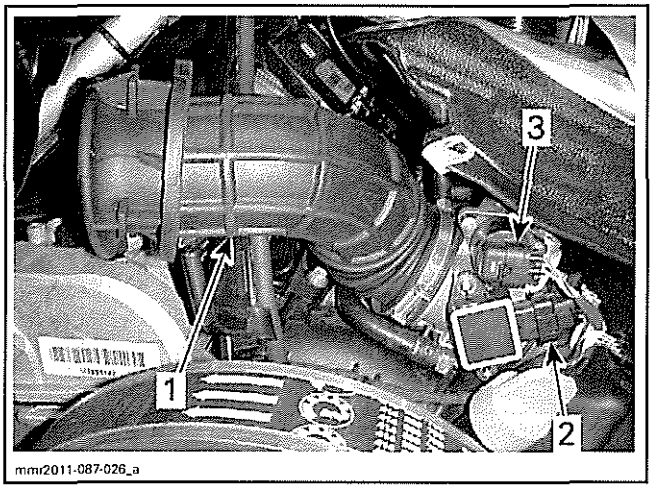
9. Reinstall all removed parts.

Throttle Body Removal

⚠ WARNING

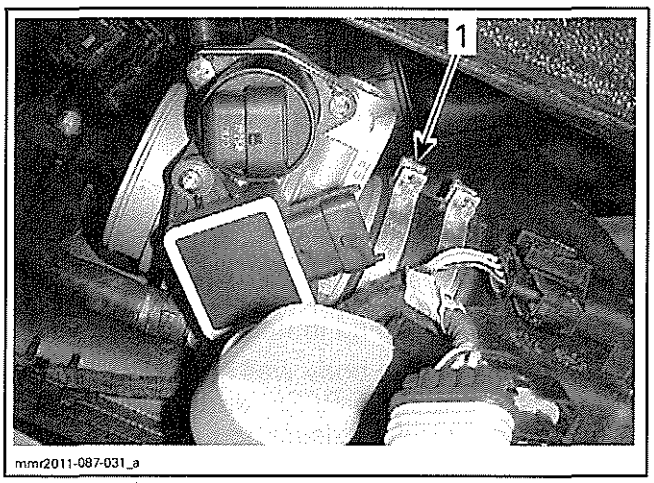
When electrically disconnecting or removing the throttle body from the intake manifold, or the idle air control valve (IACV) from the throttle body, always remove the tether cord from the engine cut-off switch and disconnect the battery.

1. Remove parts required to access throttle body, refer to *THROTTLE BODY ACCESS*.
2. Disconnect TPS connector (throttle position sensor).
3. Disconnect IACV connector (idle air control valve).



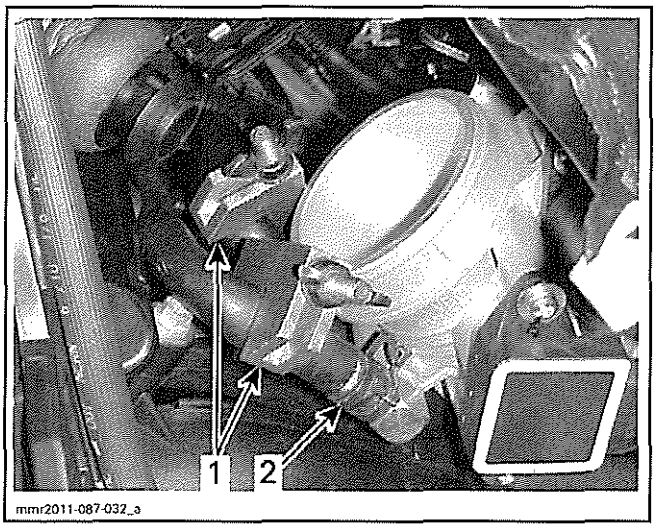
1. Adapter hose from air intake silencer (removed)
2. TPS connector
3. IACV connector

4. Loosen gear clamp and remove throttle body from intake manifold adapter.



1. Loosen this gear clamp to remove throttle body

5. Disconnect throttle cable from throttle body, refer to *THROTTLE CABLE REMOVAL* in this subsection.
6. Install a SMALL HOSE PINCHER (P/N 295 000 076) on each coolant hose connected to throttle body.
7. Disconnect coolant hoses from throttle body.



1. Small hose pinchers on coolant hoses
2. Disconnect hoses here (2)

Throttle Body Installation

Installation of the throttle body is the reverse of the removal procedure. However, pay attention for the following details.

1. Install throttle cable on throttle body, refer to *THROTTLE CABLE INSTALLATION*.
2. Install throttle body on intake manifold.
3. Install coolant hoses on throttle body; replace clamps as required.
4. Refill and bleed cooling system as required. Refer to *COOLING SYSTEM*.
5. Carry out the *WIDE OPEN THROTTLE ADJUSTMENT* and *IDLE POSITION VERIFICATION* procedures as described in this subsection.

NOTE: If the throttle body was replaced, perform a *CLOSED THROTTLE RESET* and an *IACV AUTO RESET* procedures as described in this subsection.

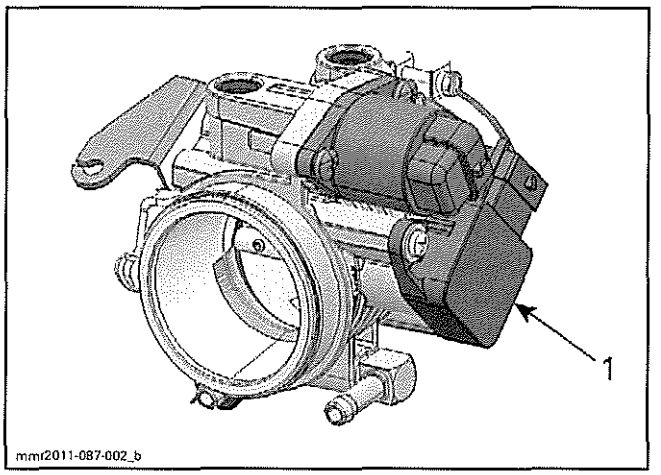
6. Install all remaining removed parts, refer to applicable subsections.
7. Start engine and ensure proper idle and throttle control.

THROTTLE POSITION SENSOR (TPS)

TPS Description

The throttle position sensor (TPS) is a potentiometer that sends a signal to the ECM that is proportional to the throttle plate angle.

The TPS is attached to the side of the throttle body.



THROTTLE BODY
1. Throttle position sensor (TPS)

NOTE: As a first troubleshooting step, always check for applicable fault codes using B.U.D.S. software.

Throttle Position Sensor Access

Open the LH side body panel, refer to *BODY* subsection.

Closed Throttle Reset

General Information

This operation performs a reset of the basic TPS (throttle position sensor) values stored in the ECM when the throttle is closed. This reset is very important as the setting of the TPS will determine the basic parameters for all fuel mapping and several ECM calculations for idle speed control of the engine.

A closed throttle reset must be carried out if the :
- TPS is loosened, removed or replaced
- Throttle body is replaced
- ECM is replaced.

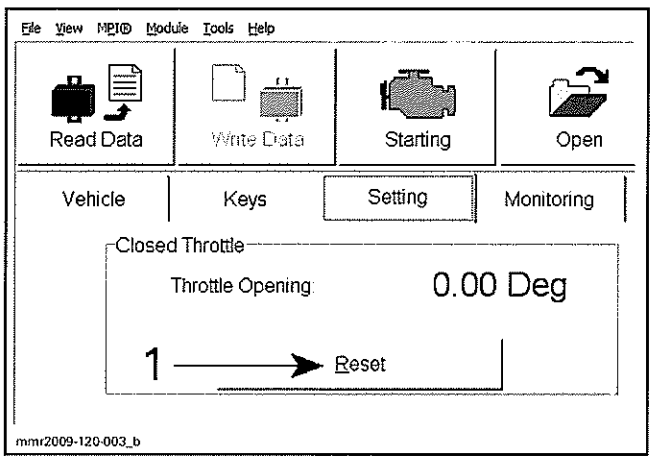
NOTICE A *CLOSED THROTTLE RESET* must be carried out anytime the TPS has been loosened, removed or replaced. An improperly set TPS may lead to poor engine performance, engine stalls, fault codes and possible engine damage. Emission compliance may also be affected.

Closed Throttle Reset Procedure

1. Remove the LH and RH side body panels, refer to *BODY* subsection.
2. Connect vehicle to the applicable B.U.D.S. software version, refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
3. Open throttle approximately one quarter travel, then quickly release.

NOTE: Repeat 2 - 3 times to settle throttle plate.

4. Ensure the throttle cam stop rests against the idle stop screw without any tension in the cable. Refer to the *IDLE POSITION VERIFICATION* procedure in this subsection.
5. If the throttle cam stop does not contact the idle stop screw, perform the *WIDE OPEN THROTTLE CABLE ADJUSTMENT* and the *IDLE POSITION VERIFICATION* procedures. Refer to *THROTTLE CABLE ADJUSTMENT* in this subsection.
6. In B.U.D.S., click on the **Reset** button.



SETTING AND ECM TABS
1. Click Reset

A message will be displayed if the operation is successful.

IMPORTANT: If the TPS is not within the allowed range when the **Closed Throttle Reset** is carried out, B.U.D.S. will display a message box and will not accept the setting.

7. If a fault message box is displayed:
   - Follow the instructions in the message box(s).
   - Check throttle cable adjustment.
   - Check for fault codes, refer to *DIAGNOSTIC AND FAULT CODES*.
   - Carry out the service actions.
   - Reset the fault.
   - Repeat the closed throttle reset procedure.

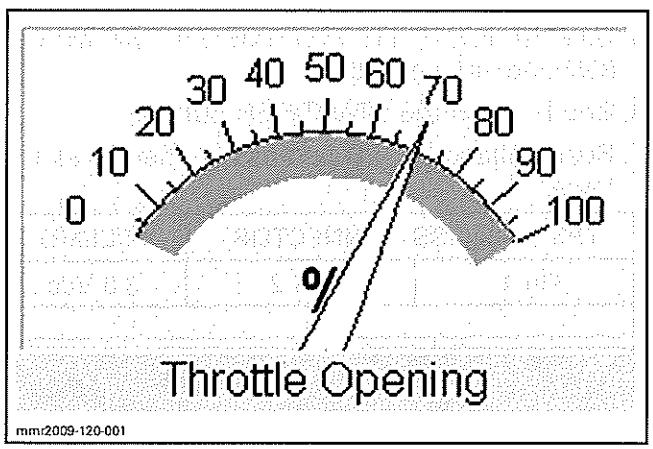
If all of the previous steps have been carried out and the closed throttle reset cannot be carried out successfully, the engine will not start or will not idle properly, carry out the following:

- Exit B.U.D.S.
- Remove the tether cord from engine cut-off switch.
- Wait for the ECM to shut down.
- Perform an *IACV AUTO RESET* procedure as described in this subsection.
- Connect vehicle to the applicable B.U.D.S. software version, refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
- Perform another *CLOSED THROTTLE RESET* procedure.

8. Start engine and make sure it operates normally throughout its full RPM range.

TPS Wear Test

1. Ensure TPS connector is properly connected.
2. With the engine **turned off**, slowly apply throttle and pay attention for smooth operation without physical stops.
3. Connect vehicle to the applicable B.U.D.S. software version. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
4. In B.U.D.S., select the following:
   - **Monitoring** page tab
   - **ECM** page tab.
5. Slowly and regularly apply and release the throttle while observing the **Throttle Opening** indication in B.U.D.S.



MONITORING AND ECM TABS

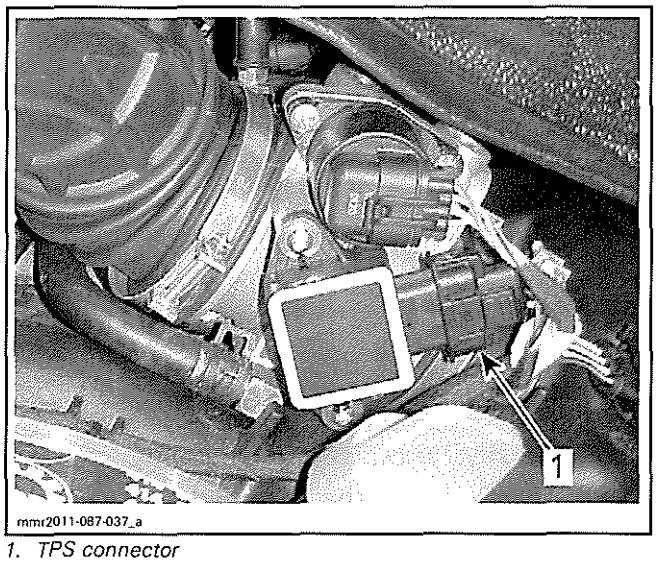
NOTE: The needle should move gradually and regularly as you move the throttle. If the TPS indication is erratic or suddenly drops off, it may indicate a worn TPS that needs to be replaced. An initial slight delay after the throttle is applied and before the needle starts to move is normal.

If the indication does not move as expected, perform the *TPS INPUT VOLTAGE TEST*.

TPS Input Voltage Test

1. Remove parts required to access throttle body, refer to *THROTTLE BODY ACCESS* in this subsection.

2. If connected to B.U.D.S., disconnect the T-HARNESS (P/N 529 035 869) from the vehicle diagnostic connector.
3. Disconnect the TPS connector.



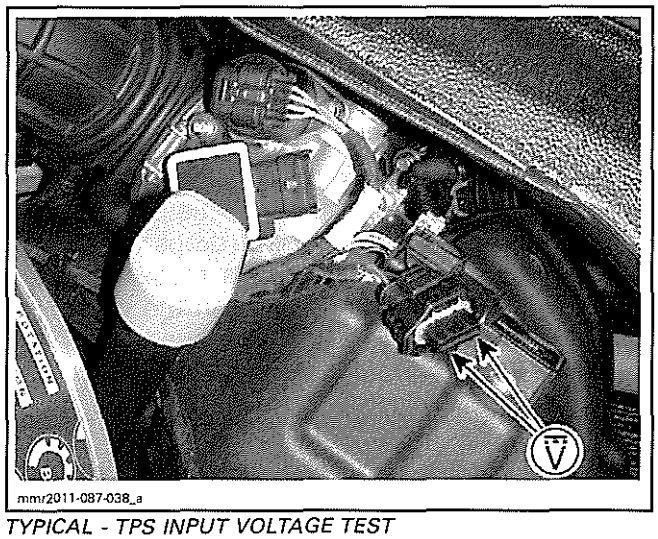
1. TPS connector

4. Install the tether cord on the engine cut-off switch.

NOTE: Installing the tether cord allows electrical power to stay on for approximately 40 seconds.

5. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and set it to Vdc.
6. Briefly press the START/RER button.
7. Read voltage at TPS harness connector as follows.

TPS HARNESS CONNECTOR		VOLTAGE
Pin 1	Pin 2	3.3 Vdc



TYPICAL - TPS INPUT VOLTAGE TEST

If voltage is good, carry out the *TPS SIGNAL WIRE TEST*.

TPS Signal Wire Test

1. Remove parts required to access the ECM connectors, refer to *ECM CONNECTOR ACCESS* in this subsection.
2. Disconnect the "A" connector from the ECM and install it on the ECM ADAPTER TOOL (P/N 529 036 166).
3. Test for continuity as follows.

TPS HARNESS CONNECTOR	ECM A CONNECTOR	RESISTANCE
Pin 3	Pin 3F	Close to 0 Ω (continuity)

If the TPS signal wire tests good, carry out the *TPS RESISTANCE TEST* before assuming the TPS is at fault.

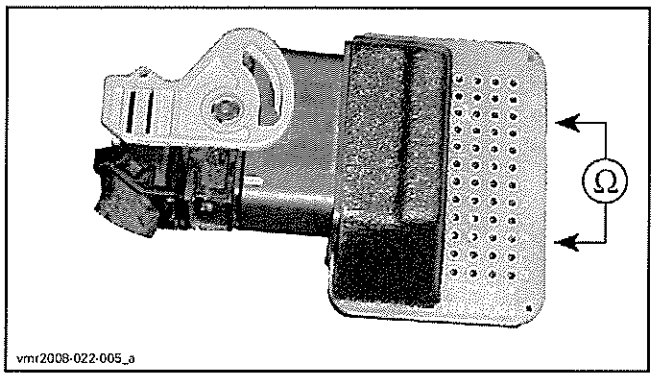
If the TPS signal wire does not test good, repair or replace wiring and connectors.

TPS Resistance Test

1. Remove parts required to fully access the throttle body, refer to *THROTTLE BODY ACCESS* in this subsection.
2. Ensure the TPS connector is properly connected.
3. Ensure ECM connector A is properly installed on the ECM ADAPTER TOOL (P/N 529 036 166).
4. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and select Ω.
5. Probe circuit as per following table while using your hand to manually move throttle plate.

IMPORTANT: For the WOT measurement, manually open the throttle plate until the throttle cam touches its stopper. Using the throttle lever on the handlebar will not fully open the throttle plate.

ECM ADAPTER		THROTTLE IDLE POSITION	WIDE OPEN THROTTLE POSITION
PIN		RESISTANCE Ω	
3F	4K	2390 - 2810	880 - 1300
4K	2A	1600 - 2400	1600 - 2460
3F	2A	880 - 1300	2390 - 2810

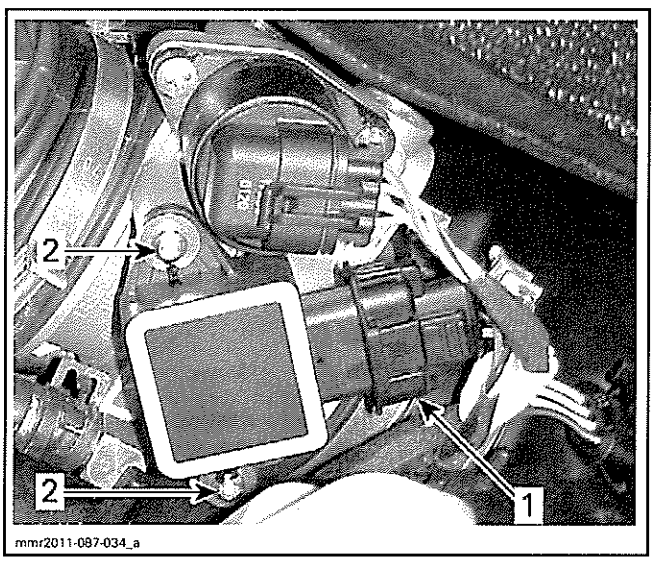


If resistance values are correct, try a new ECM. Refer to *ENGINE CONTROL MODULE (ECM)* in this subsection.

If any resistance value is incorrect, replace the TPS.

TPS Removal

1. Remove parts required to access the LH side of the throttle body, refer to *THROTTLE BODY ACCESS* in this subsection.
2. Disconnect the TPS connector.
3. Remove the TPS retaining screws (2).



1. TPS connector
2. TPS retaining screws

4. Pull the TPS from the throttle body.

TPS Installation

Installation is the reverse of removal however, pay attention to the following.

TPS INSTALLATION	
O-RING	SERVICE PRODUCT
	APPLY ENGINE OIL ON O-RING
MOUNTING SCREWS	SERVICE PRODUCT
	LOCTITE 243 (BLUE) (P/N 293 800 060)
	TORQUE
	3 N•m (27 lbf•**in**)

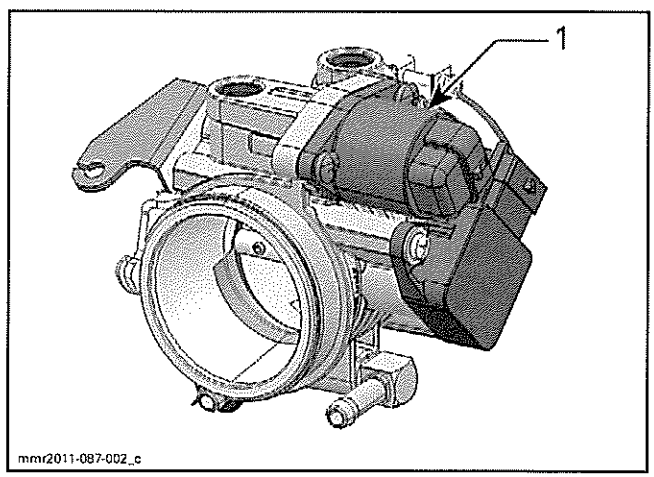
Carry out a *CLOSED THROTTLE RESET* as described in this subsection.

NOTICE A closed throttle reset must be carried out anytime the TPS has been loosened, removed or replaced. An improperly set TPS may lead to poor engine performance, engine stalls, fault codes and possible engine damage. Emission compliance may also be affected.

IDLE AIR CONTROL VALVE (IACV)

If the IACV is to be removed, refer to *IACV REMOVAL* in this subsection. Important instructions are given to prevent damaging the IACV.

NOTICE Do not perform any test on the IACV when it is disassembled, otherwise it will be damaged.



THROTTLE BODY
1. Idle air control valve (IACV)

IACV Auto Reset

When the engine is shut down, just before the ECM turns off, the IACV will completely close to find its zero position. It will then back out a number of steps and park to this reference position.

If idle speed is not stable or is inaccurate, reset the IACV as follows:

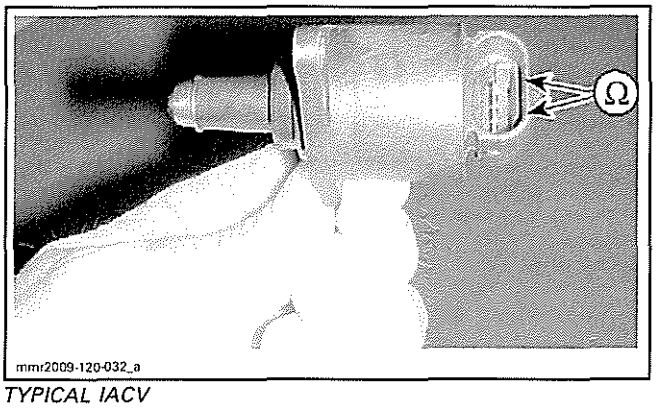
1. Power the ECM by briefly by pressing the START/RER button.
2. Remove the tether cord from engine cut-off switch.
3. Wait until multifunction gauge turns off.
4. Repeat the procedure 2 - 3 times.

IACV Resistance Test (at Component)

NOTE: An idle air control valve with good resistance measurements can still be faulty. A mechanical failure may occur which, may not detectable without measuring the air flow. Replacing the IACV may be necessary as a test.

1. Remove LH side body panel, refer to *BODY* subsection.
2. Disconnect IACV connector.
3. Remove IACV from intake manifold.
4. Check the resistance between pins as follows.

IACV		MEASUREMENT
PIN		RESISTANCE @ 20°C (68°F)
1	4	Approximately 50 Ω
2	3	



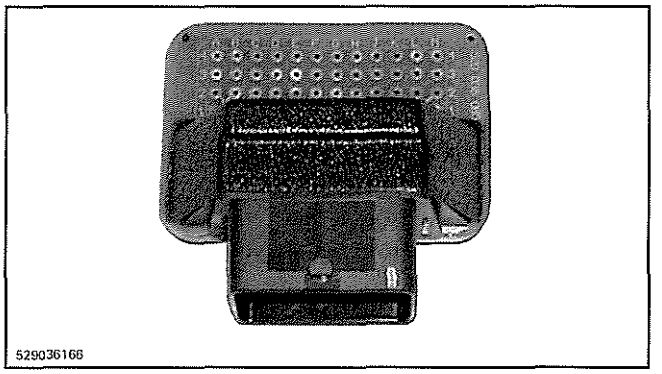
TYPICAL IACV

If the resistance is not as specified, replace the IACV.

If resistance test is good, refer to *IACV RESISTANCE TEST (AT ECM CONNECTOR.*

IACV Resistance Test (at ECM Connector)

1. Reconnect IACV connector.
2. Remove parts required to access ECM connectors, refer to *ECM CONNECTOR ACCESS* in this subsection.
3. Disconnect ECM A connector and connect it to the ECM ADAPTER TOOL (P/N 529 036 166).



4. Set multimeter to Ω and read resistance as follows.

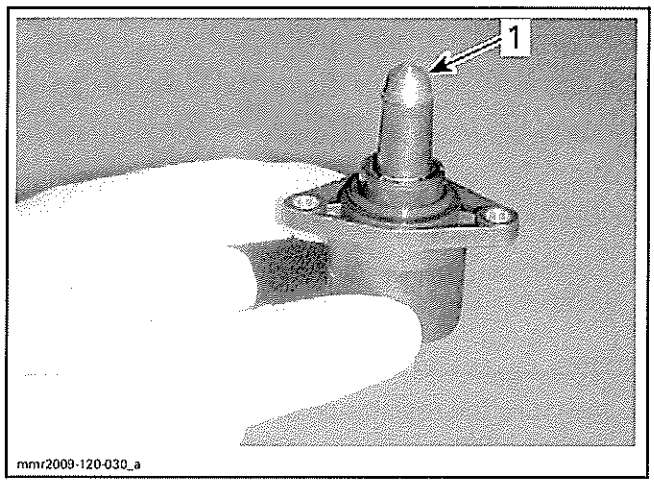
ECM ADAPTER		MEASUREMENT
PIN		RESISTANCE @ 20°C (68°F)
1C	2C	Approximately 50 Ω
2B	4A	

If any resistance test failed, repair/replace wiring/connectors between IACV and ECM.

If resistance tests are good and all valve maintenance and reset procedures have been carried out, check ECM. Refer to *ECM.* in this subsection.

IACV Visual Inspection and Cleaning

1. Refer to *IACV REMOVAL* in this subsection and remove IACV from throttle body. **Important safety instructions** are given.
2. Check the piston and idle air bypass ports in throttle body for dirt or deposits which can cause the piston to stick.



TYPICAL
1. Piston

3. Using a parts cleaner, clean idle bypass port in throttle body of any contamination, then use an air gun to dry it.
4. Install ACV on throttle body.
5. Reconnect the battery.

IACV Removal

NOTICE Do not remove the IACV unless absolutely necessary.

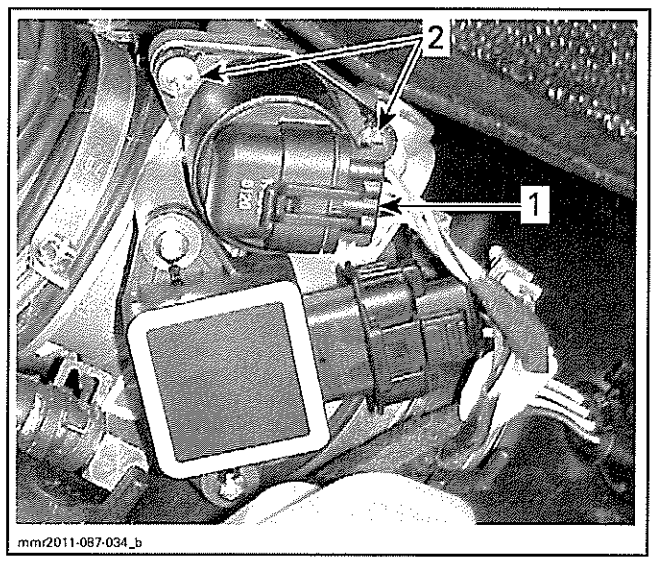
1. Remove tether cord from engine cut-off switch and disconnect the battery.

⚠ WARNING

When electrically disconnecting or removing the throttle body from the intake manifold, or the idle air control valve (IACV) from the throttle body, always remove the tether cord from the engine cut-off switch and disconnect the battery.

NOTICE Do not attempt to operate the piston of the IACV when it is removed from the throttle body. Also do not move the piston by hand. The screw drive is very sensitive and will be damaged.

2. Disconnect IACV connector.
3. Remove IACV retaining screws.

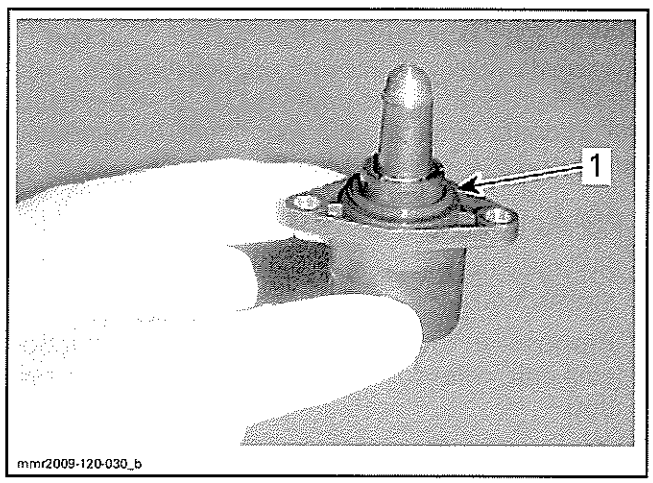


1. IACV connector
2. IACV retaining screws

4. Pull IACV out of throttle body.

IACV Installation

1. Inspect IACV O-ring condition. Replace as necessary.



TYPICAL
1. O-ring

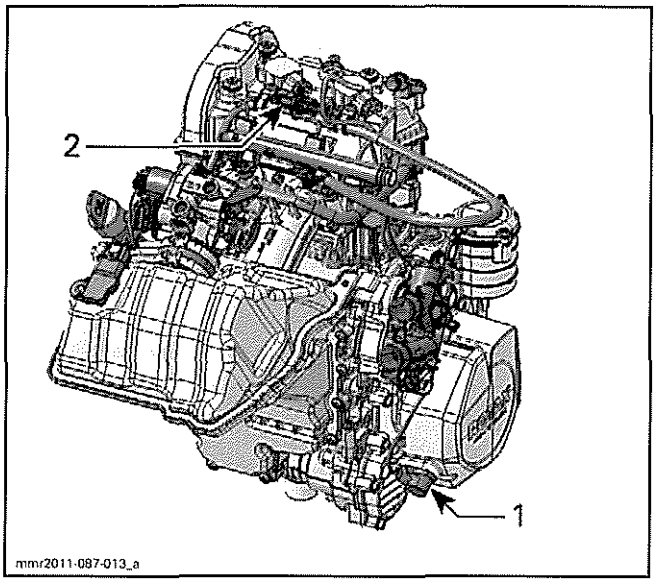
2. Install IACV.

IACV INSTALLATION	
O-RING	SERVICE PRODUCT
	APPLY ENGINE OIL ON O-RING
MOUNTING SCREW	SERVICE PRODUCT
	LOCTITE 243 (BLUE) (P/N 293 800 060)
	TORQUE
	4.5 N•m (40 lbf•**in**)

3. Carry out an *IACV AUTO RESET.*

CRANKSHAFT POSITION SENSOR (CPS)

CPS and CPS Connector Location



TYPICAL - RH SIDE OF ENGINE
1. *CPS location*
2. *CPS connector location*

NOTE: Take into account that a CPS fault can be triggered by bent or missing encoder wheel teeth. First check fault codes using B.U.D.S., then check the encoder wheel teeth condition if necessary (refer to *MAGNETO SYSTEM*).

CPS Access

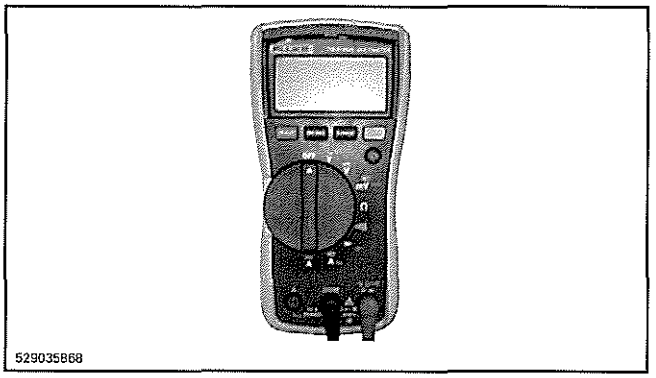
1. Remove both side body panels, refer to *BODY* subsection.
2. Remove air intake silencer and gauge support as a unit, refer to *AIR INTAKE SYSTEM* subsection.
3. Remove muffler, refer to *EXHAUST SYSTEM* subsection.

CPS Resistance Test

1. Remove parts required to access ECM connector, refer to *ECM CONNECTOR ACCESS* in this subsection.
2. Disconnect ECM-A connector, refer to *ECM CONNECTOR ACCESS*.
3. Connect ECM-A connector to the ECM adapter.

ECM ADAPTER TOOL (P/N 529 036 166)	

4. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Ω.



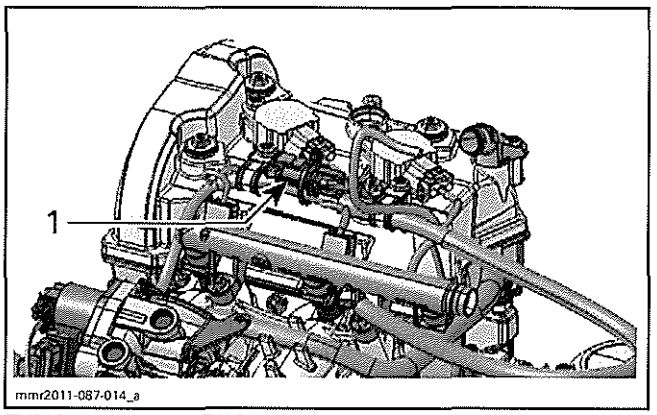
5. Measure the resistance of the sensor as per following table.

ECM A CONNECTOR		RESISTANCE @ 20°C (68°F)
Pin 1-H	Pin 2-K	775 - 950 Ω

If resistance is as specified, test continuity of wiring between ECM-A and CPS connectors. Refer to *WIRING DIAGRAM* subsection.

If resistance value is not as specified, reconnect ECM-A connector to the ECM and carry on with the following steps.

6. Remove air intake silencer and gauge support assembly, refer to *AIR INTAKE SYSTEM* subsection.
7. Disconnect CPS wiring harness connector.



TYPICAL - TOP OF ENGINE
1. *CPS connector location*

8. Probe CPS connector terminals as per following table.

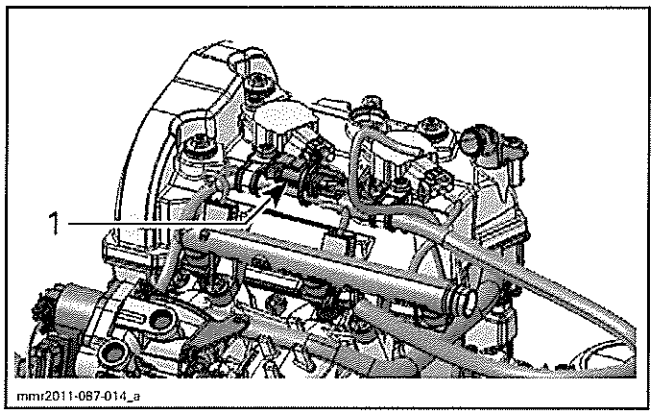
CPS CONNECTOR		MEASUREMENT
PIN		RESISTANCE Ω @ 20°C (68°F)
1	2	775 - 950 Ω

If resistance is not within specifications, replace the CPS.

If resistance tests good, carry out a *CPS OUTPUT VOLTAGE TEST.*

CPS Output Voltage Test

1. Remove fuse F5 (Ignition/Injection fuse), refer to *POWER DISTRIBUTION* subsection.
2. Disconnect the CPS connector.



TOP OF ENGINE LH SIDE
1. CPS connector location

3. Probe CPS connector terminals while cranking engine as per following table.

CPS CONNECTOR		VOLTAGE
Pin 1	Pin 2	1 - 2 Vac min.

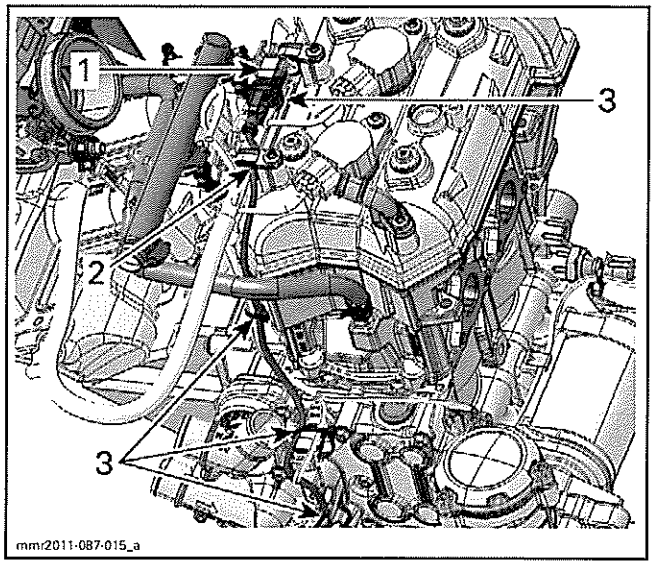
If voltage is out of specification, inspect wiring/connectors. Replace CPS if wiring is good.

If voltage is within specification, the problem may be related to the ECM.

4. Reconnect CPS connector and install all removed parts.

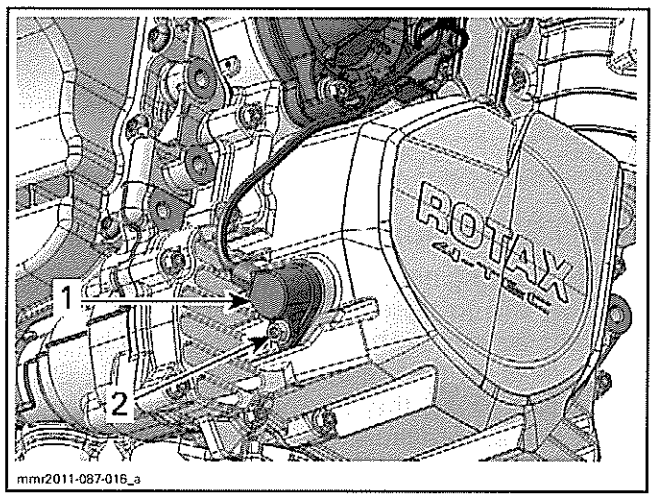
CPS Replacement

1. Remove parts required to access the CPS, refer to *CPS ACCESS* in this subsection.
2. Take note of factory CPS wire harness routing for reinstallation.
3. Remove CPS wire harness retaining clamp on top of engine.
4. Disconnect CPS connector and cut harness locking ties (4).



TYPICAL
1. CPS connector
2. Retaining clamp
3. Locking ties (4)

5. Remove CPS retaining screw and pull on CPS to remove it.



TYPICAL
1. CPS
2. Retaining screw

6. Install new CPS.

CPS INSTALLATION	
O-RING	SERVICE PRODUCT
	APPLY ENGINE OIL ON O-RING
RETAINING SCREW	TORQUE
	10 N•m ± 1 N•m (89 lbf•**in** ± 9 lbf•**in**)

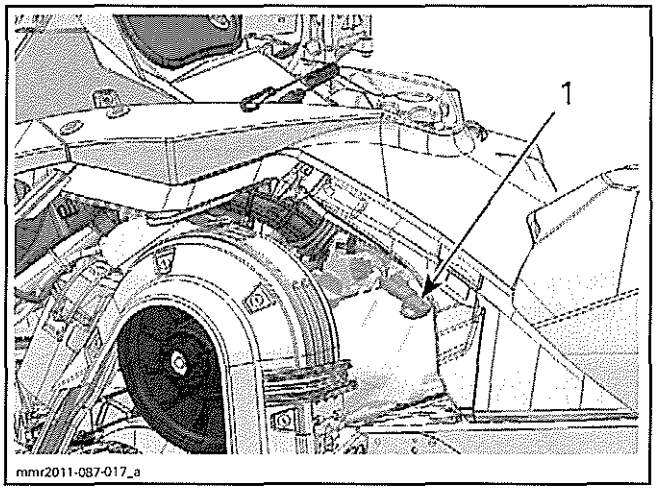
7. Route and secure CPS harness using harness clamp and locking ties as noted prior to removal.

MANIFOLD ABSOLUTE PRESSURE AND TEMPERATURE SENSOR (MAPTS)

NOTE: This sensor is a multifunction device. It measures manifold absolute pressure and intake temperature for air flow calculations.

MAPTS Access

To access the MAPTS, remove the LH side body panel.



TYPICAL - MAPTS LOCATION
1. Manifold air pressure and temperature sensor (MAPTS)

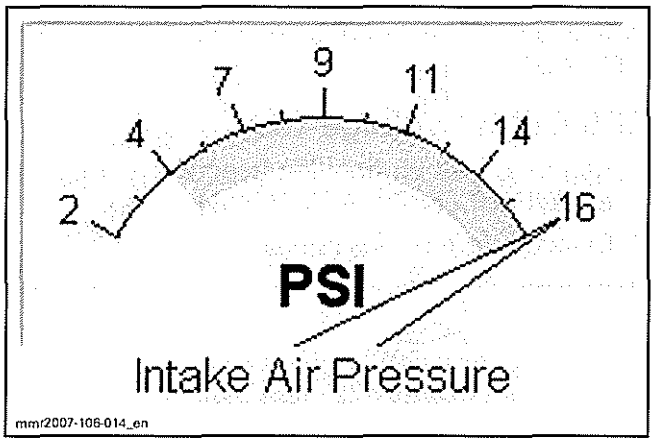
MAPTS Pressure Function

Before the engine is started, when power is applied to the system, the sensor measures the ambient air atmospheric pressure. The ambient pressure is, at that moment, stored in the ECM. Thereafter, once the engine is started, it measures the air pressure in the intake manifold at operating RPMs.

The sensor must be correctly installed on the intake manifold. Otherwise, the MAPTS could generate a fault code for an unexpected sensor range at idle when it reads the atmospheric pressure. If this is the case, remove sensor and check for oil or dirt on its end and if problem persists, check throttle plate condition/position and the wiring harness. Perform the following tests.

MAPTS Quick Test (Pressure Function)

1. Connect vehicle to the applicable B.U.D.S. software version.
2. In B.U.D.S., select the following:
   - Read Data
   - Monitoring page tab
   - ECM page.



TYPICAL - MAPTS PRESSURE READING IN B.U.D.S.

3. Look for and take note of the MAPTS pressure reading while the engine is stopped.

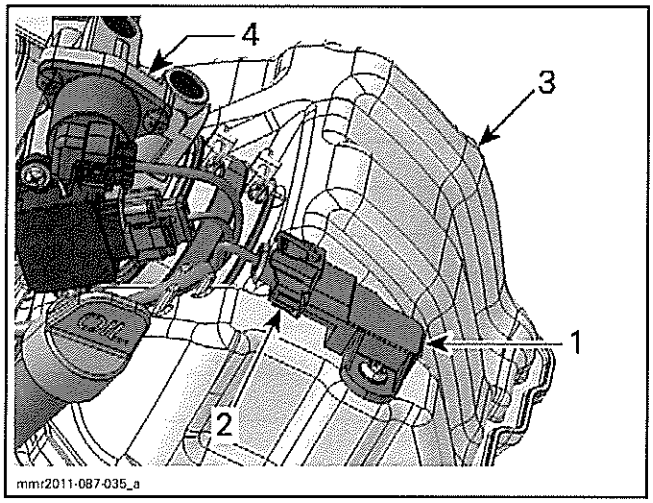
NOTE: The indicated intake air pressure in B.U.D.S. must be within 3.4 kPa (.5 PSI) of local atmospheric pressure when the engine is stopped.

MAPTS PRESSURE FUNCTION QUICK TEST			
RESULT	SERVICE ACTION		
NO READING	Circuit Continuity Test of MAPTS Pressure Function	MAPTS Input Voltage Test	Repair or replace wiring
VALUE IS OUT OF RANGE	Replace MAPTS		

4. Perform the same test with a new MAPTS and compare both readings.

MAPTS Input Voltage Test

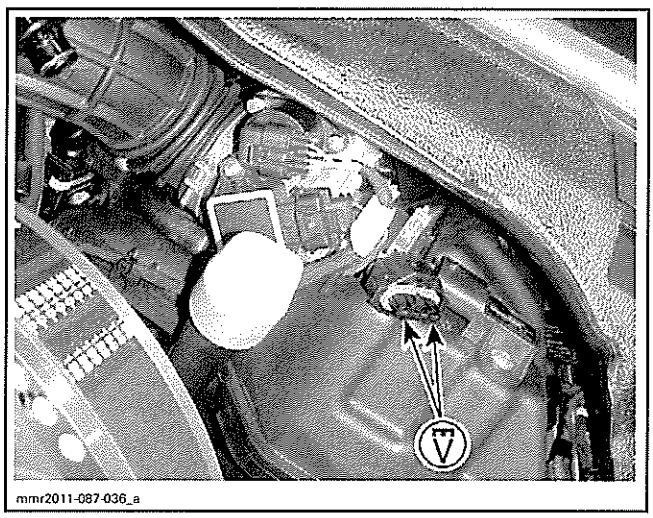
1. Remove parts required to access the MAPTS, refer to *MAPTS ACCESS*.
2. Remove electrical connector from MAPTS.



1. *MAPTS*
2. *MAPTS connector to remove*
3. *Air intake*
4. *Throttle body*

3. Briefly push START/RER button.
4. Using a FLUKE 115 MULTIMETER (P/N 529 035 868) set to Vdc, measure for MAPTS input voltage as per following table.

MAPTS CONNECTOR		MEASUREMENT
PIN		VOLTAGE
1	3	5 Vdc



If voltage test is good, replace the MAPTS.

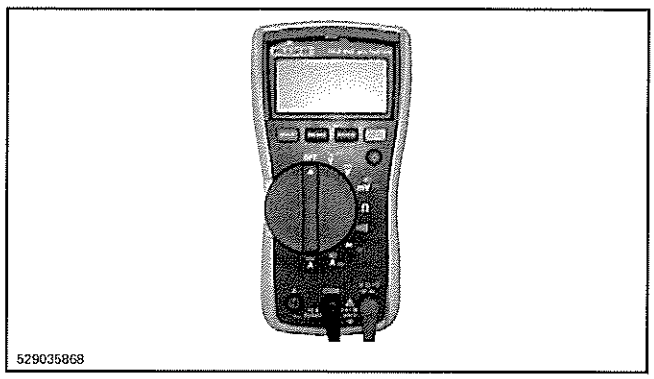
If voltage test is not good, carry out the *MAPTS CIRCUIT CONTINUITY TEST (PRESSURE FUNCTION).*

MAPTS Circuit Continuity Test (Pressure Function)

1. Remove parts required to access ECM connectors, refer to *ECM CONNECTOR ACCESS* in this subsection.
2. Disconnect the ECM-A connector from the ECM and connect it to the ECM adapter tool.

ECM ADAPTER TOOL (P/N 529 036 166)	

3. Using a FLUKE 115 MULTIMETER (P/N 529 035 868) set to Ω, check continuity of the following circuits.



MAPTS CIRCUIT CONTINUITY TEST (PRESSURE FUNCTION)		
ECM-A	MAPTS CONNECTOR	RESISTANCE VALUE
Pin 4B	Pin 3	Close to 0 Ω
Pin 4G	Pin 4	
Pin 2H	Pin 1	

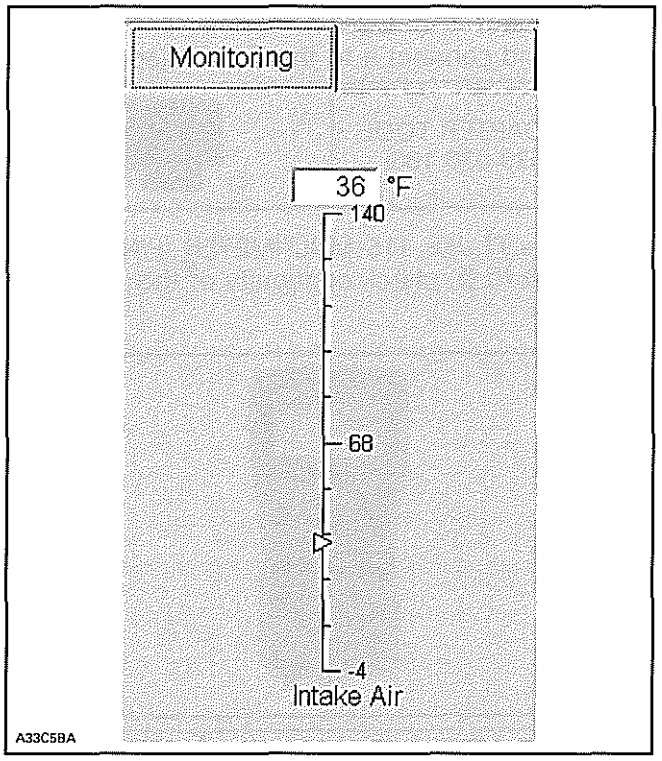
If resistance is not within specification, repair or replace the wiring harness between ECM connector and the MAPTS. Refer to *WIRING DIAGRAM.*

MAPTS Temperature Function

The MAPTS also monitors the temperature of the air in the intake manifold.

MAPTS Quick Test (Temperature Function)

1. Connect vehicle to the applicable B.U.D.S. software version.
2. In B.U.D.S., select the following:
   - Read Data
   - Monitoring page tab
   - ECM page.
3. Look for the Intake Air temperature reading while the engine is stopped.



TYPICAL - MONITORING PAGE TAB, ECM

NOTE: If the complete vehicle is at room temperature, B.U.D.S. should display the ambient air temperature at the intake manifold.

4. Perform the same test with a new MAPTS and compare both readings.

If the engine's MAPTS temperature reading is significantly different than the new MAPTS, replace it.

NOTE: Both sensors must feel same ambient air temperature.

If there is no reading, carry out a *MAPTS RESISTANCE TEST (TEMPERATURE FUNCTION).*

MAPTS Resistance Test (Temperature Function)

1. Disconnect the MAPTS connector.
2. Using the FLUKE 115 MULTIMETER (P/N 529 035 868) set to Ω, test MAPTS resistance at the sensor as per following tables.

MAPTS		MEASUREMENT
PIN		Refer to MAPTS TEMPERATURE SENSOR TABLE
1	2	

MAPTS TEMPERATURE SENSOR TABLE		
TEMPERATURE		RESISTANCE (ohms)
°C	°F	MAPTS
- 40	- 40	—
- 30	- 22	28000
- 20	- 4	15000
0	32	5500
20	68	2500
40	104	1200
60	140	600
80	176	320
100	212	180
130	266	90

If resistance is not within specification, replace the MAPTS.

If resistance tests good, **reconnect** the MAPTS and proceed with the following steps.

3. Disconnect the ECM-A connector.
4. Install ECM-A connector on the ECM adapter tool.

ECM ADAPTER TOOL (P/N 529 036 166)	

5. Using a multimeter, recheck resistance value as per following table.

ECM CONNECTOR		MEASUREMENT
PIN		Refer to MAPTS TEMPERATURE SENSOR TABLE
A-2H	A-3H	

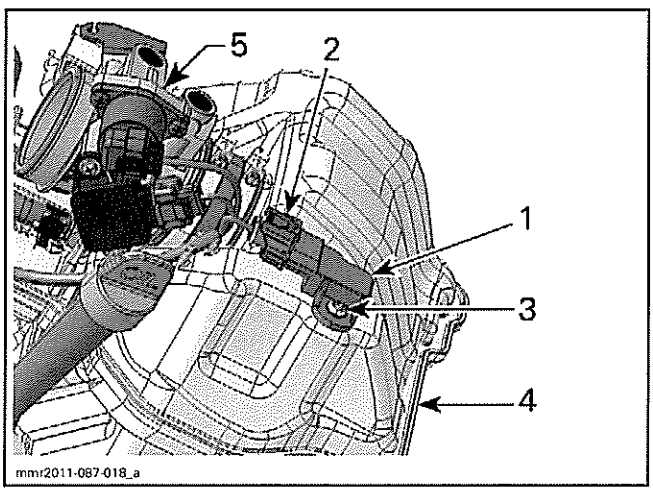
MAPTS TEMPERATURE SENSOR TEST RESULTS			
RESULT	SERVICE ACTION		
NO READING	Circuit Continuity Test of MAPTS Temperature Function	MAPTS Input Voltage Test	Repair or replace wiring
INCORRECT RESISTANCE VALUE	Replace MAPTS		
CORRECT RESISTANCE VALUE	Try a new ECM		

MAPTS Circuit Continuity Test (Temperature Function)

MAPTS CIRCUIT CONTINUITY TEST (TEMPERATURE FUNCTION)		
ECM-A	MAPTS CONNECTOR	RESISTANCE VALUE
Pin 2H	Pin 1	Close to 0 Ω
Pin 3H	Pin 2	

Repair or replace wiring as required.

MAPTS Replacement



1. MAPTS
2. MAPTS connector
3. Retaining screw
4. Intake manifold
5. Throttle body

1. Disconnect MAPTS connector and remove the MAPTS from the intake manifold.
2. Install new MAPTS as per following table.

RETAINING SCREW TORQUE
6 N•m ± 0.7 N•m (53 lbf•**in** ± 6 lbf•**in**)

COOLANT TEMPERATURE SENSOR (CTS)

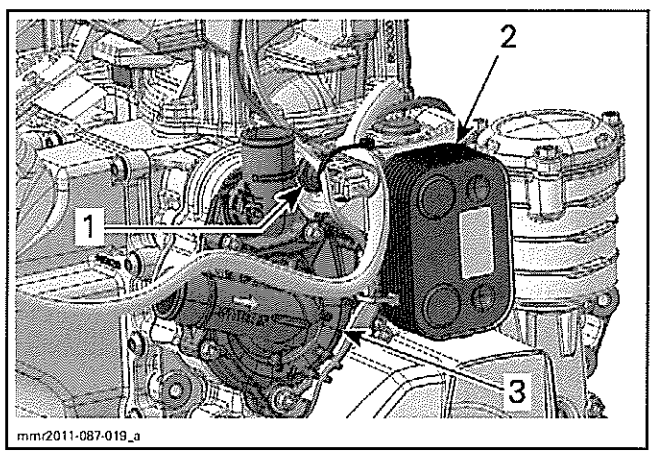
Overheat Warning

The CTS will cause the engine overheat warning to come on when the coolant temperature is above 110°C (230°F).

CTS Access

The CTS is located on the RH side of the engine, between the water pump and oil cooler.

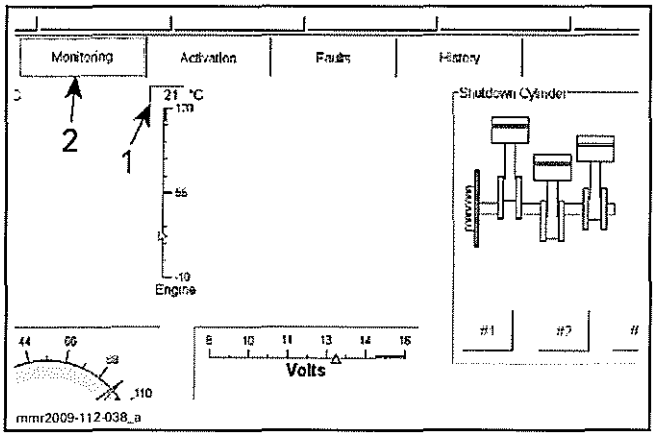
To access the CTS, remove the RH side body panel.



TYPICAL - RH SIDE OF THE ENGINE
1. Coolant temperature sensor (CTS)
2. Oil cooler
3. Water pump

CTS Quick Test

1. Connect the vehicle to the applicable B.U.D.S. software.
2. In B.U.D.S., select the following:
   - **Read Data** button
   - **Monitoring** page tab
   - **ECM** page.
3. Look for the engine temperature indication.



TYPICAL
1. Engine temperature
2. Monitoring tab

The engine temperature gauge in B.U.D.S. should provide an indication of the actual engine coolant temperature. Otherwise, perform the *CTS RESISTANCE TEST*.

CTS Resistance Test

1. Disconnect the CTS connector.
2. Test the resistance of the sensor as per following tables.

CTS SENSOR		MEASUREMENT
PIN		Refer to CTS TEMPERATURE SENSOR TABLE
1	2	

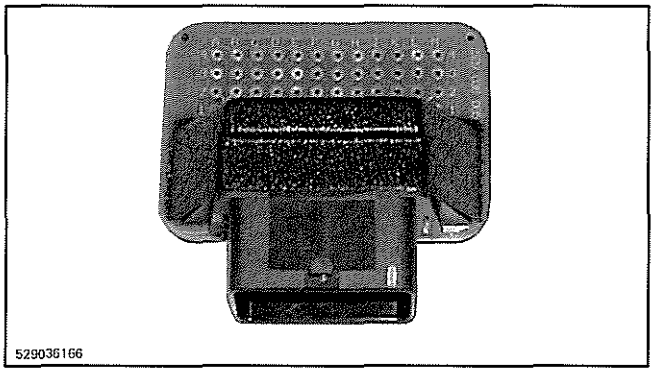
CTS TEMPERATURE SENSOR TABLE				
TEMPERATURE		RESISTANCE (OHMS)		
°C	°F	NOMINAL	LOW	HIGH
- 30	- 22	12600	11800	13400
- 20	- 4	11400	11000	11800
- 10	14	9500	8000	11,000
0	32	5900	4900	6900
10	50	3800	3100	4500
20	68	2500	2200	2800
30	86	1700	1500	1900
40	104	1200	1080	1320
50	122	840	750	930
60	140	630	510	750
70	158	440	370	510
80	176	325	280	370
90	194	245	210	280
100	212	195	160	210
110	230	145	125	160
120	248	115	100	125

NOTE: To test sensor at various temperatures, remove sensor and use a heat gun, ice and a thermometer.

If resistance is out of specification, replace the CTS.

If resistance test is good, proceed with the following steps.

3. Reconnect the CTS connector.
4. Remove parts required to access ECM connectors, refer to *ECM CONNECTOR ACCESS* in this subsection.
5. Disconnect the ECM-A connector.
6. Install ECM-A connector on ECM ADAPTER TOOL (P/N 529 036 166).



7. Using a multimeter, recheck resistance from the ECM connector as per following table.

ECM "A CONNECTOR		MEASUREMENT
PIN		Refer to CTS TEMPERATURE SENSOR TABLE
A1	J2	

If resistance value is correct, refer to *ECM REPLACEMENT*.

If resistance value is incorrect, repair the connectors or replace the wiring harness between ECM connector and the CTS.

CTS Replacement

1. Disconnect CTS connector.
2. Remove CTS from engine.
3. Install new CTS and torque as specified.

CTS TORQUE
16 N•m ± 2 N•m (142 lbf•**in** ± 18 lbf•**in**)

4. Reinstall remaining removed parts.
5. Refill and bleed the cooling system, refer to *COOLING SYSTEM* subsection.

ELECTRONIC FUEL INJECTION (1200 4-TEC)

SERVICE TOOLS

Description	Part Number	Page
ECM ADAPTER TOOL	420 277 010	545–546, 558–559, 567, 569, 572, 576–577, 579
FLUKE 115 MULTIMETER	529 035 868	556–559, 567, 574, 579
FUEL HOSE DISCONNECT TOOL	529 036 037	551
OETIKER PLIERS	295 000 070	565
SMALL HOSE PINCHER	295 000 076	564
T-HARNESS	529 035 869	566

SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
FLUKE RIGID BACK PROBE	TP88	574

SERVICE PRODUCTS

Description	Part Number	Page
DEOXIT LUBRICANT	293 550 034	545
LOCTITE 243 (BLUE)	293 800 060	568
XPS SYNTHETIC GREASE	293 550 010	573

GENERAL

⚠ WARNING

When electrically disconnecting or removing the throttle body or the idle air control valve (IACV) from the intake manifold, always remove the tether cord from the engine cut-off switch and disconnect the battery.

⚠ WARNING

Fuel is flammable and explosive under certain conditions. Wear safety glasses and work in a well ventilated area. Do not smoke or allow open flames or sparks in the vicinity.

Release fuel pressure prior to removing fuel system components. Refer to *FUEL PRESSURE RELEASE* in *FUEL TANK AND FUEL PUMP* subsection.

⚠ WARNING

Always release fuel pressure prior to removing a fuel system component, proceed with care and use appropriate safety equipment when working on the fuel system. Wipe off any fuel spillage in the engine compartment. Do not allow fuel to spill on hot engine parts and/or on electrical connectors.

⚠ WARNING

Replace any damaged, leaking or deteriorated fuel lines or connections. After working on the fuel system, pressurize the fuel system to check for leaks. Refer to *FUEL SYSTEM PRESSURIZATION* in *FUEL TANK AND FUEL PUMP* subsection.

SYSTEM DESCRIPTION

The ECM reads input signals from different sensors which provide an indication of the engine operating conditions at micro-second intervals.

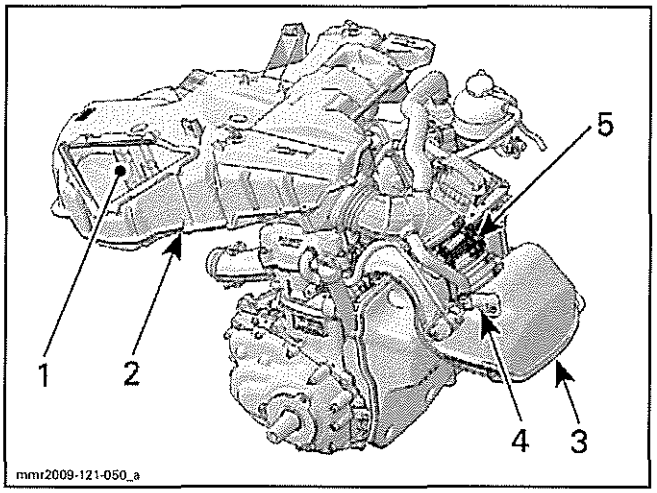
The signals from the sensors are used by the ECM to determine the injection parameters by comparing them to stored fuel maps. The engine

management system then calculates the proper air/fuel ratio and activates the output to the injectors to meet driver demands and to ensure safe engine operation.

Through its management of the engine systems, the ECM ensures the engine is delivering optimum performance and fuel economy.

To control the injection, the engine management system uses inputs from the following sensor:
- Crankshaft position sensor (CPS)
- Manifold absolute pressure and temperature sensor (MAPTS)
- Throttle position sensor (TPS).

Air Induction



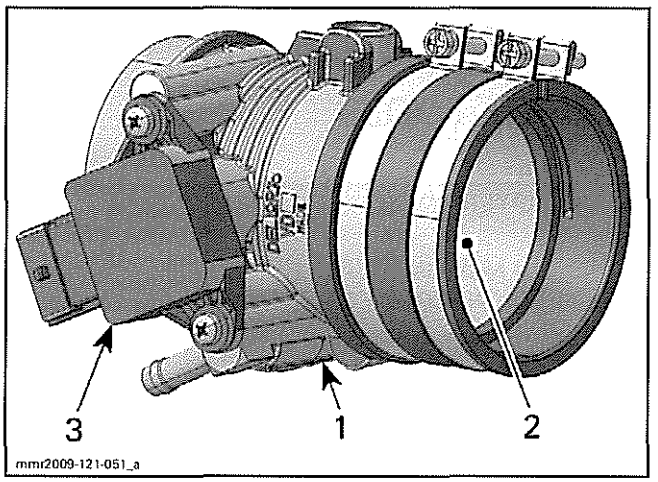
TYPICAL
1. *Mesh screen filter*
2. *Air intake silencer*
3. *Intake manifold*
4. *Manifold absolute pressure and temperature sensor*
5. *Throttle body*

Air flows through a mesh screen filter in the air intake silencer mounted over the engine. The mesh filter prevents snow from being drawn into the engine.

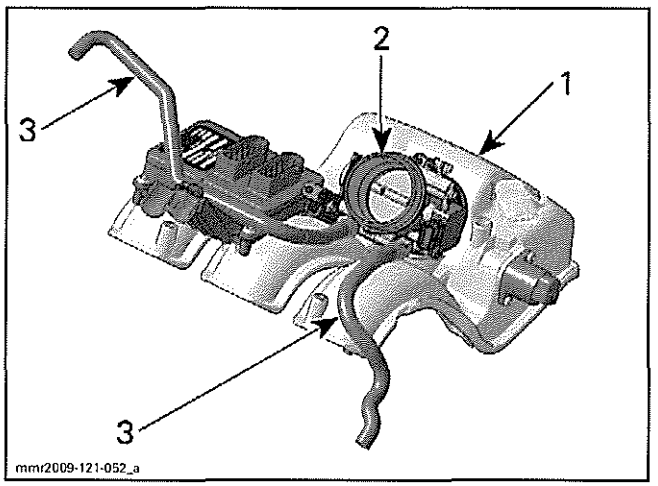
Air is then drawn in through the throttle body, the air intake manifold and into the engine.

Manifold absolute pressure and temperature are measured in the intake manifold.

Throttle Body



1. *Throttle body*
2. *Throttle plate*
3. *TPS (Throttle Position Sensor)*



1. *Intake manifold*
2. *Throttle body*
3. *Coolant-heated lines*

The heated single 52 mm throttle body is mounted on the intake manifold.

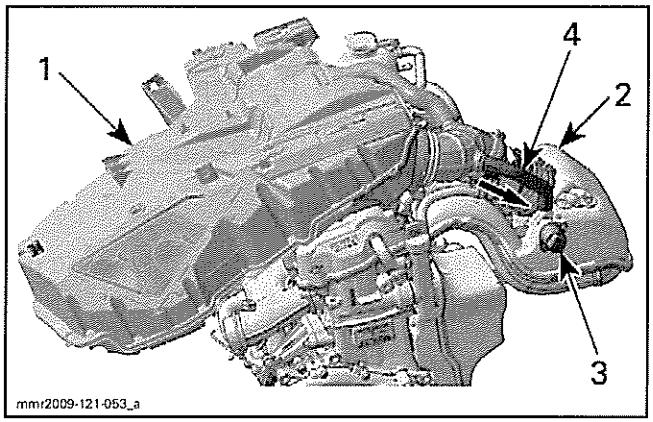
The TPS (Throttle Position Sensor) is fitted on the throttle body. The TPS sends throttle angle position to the ECM.

Engine coolant flows through throttle body to prevent potential freezing of the throttle plate.

Idle Air Control Valve (IACV)

Since the throttle plate is closed when the engine is idling, an idle air control valve (IACV) is used to allow air to bypass the throttle plate through a hose linking the intake air to the intake manifold.

Idle control is required to satisfy the varying conditions such as air temperature, altitude, engine load, etc.



1. *Air intake silencer*
2. *Intake manifold*
3. *IACV (Idle air control valve)*
4. *Bypass hose*

The amount of opening or closing of the IACV is controlled by the ECM. As the IACV opening is increased, more air is bypassed resulting in an increased idle speed.

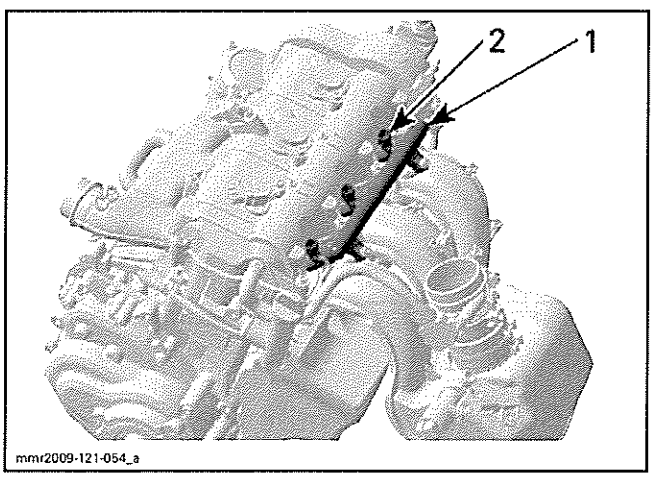
Intake Manifold

The intake manifold is mounted to the cylinder head inlet ports.

The air flows through the intake manifold to the intake valves to finally reach the combustion chamber.

The intake manifold also provides a support for the ECM.

Fuel Rail



1. *Fuel rail*
2. *Fuel injector*

The fuel rail is mounted on the intake manifold. It delivers fuel to the fuel injectors. The fuel rail is fed by the fuel pump with the properly regulated fuel pressure.

Fuel Injectors

Three fuel injectors are used to inject fuel into the intake ports of the cylinder head.

One injector is used per cylinder.

Fuel is injected in accordance with injection signals received from the ECM.

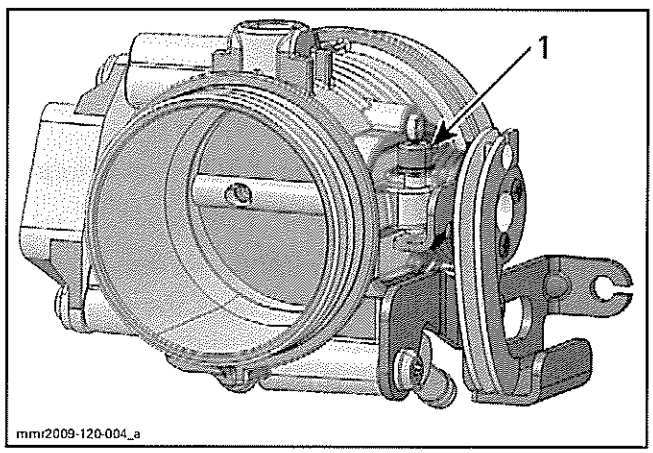
ADJUSTMENT

IDLE SPEED

Idle speed (RPM) is controlled by the EMS (Engine Management System) and is not adjustable.

If idle RPM is not as per specification (see *TECHNICAL SPECIFICATIONS*), perform the *CLOSED THROTTLE RESET (TPS)* as described in this subsection.

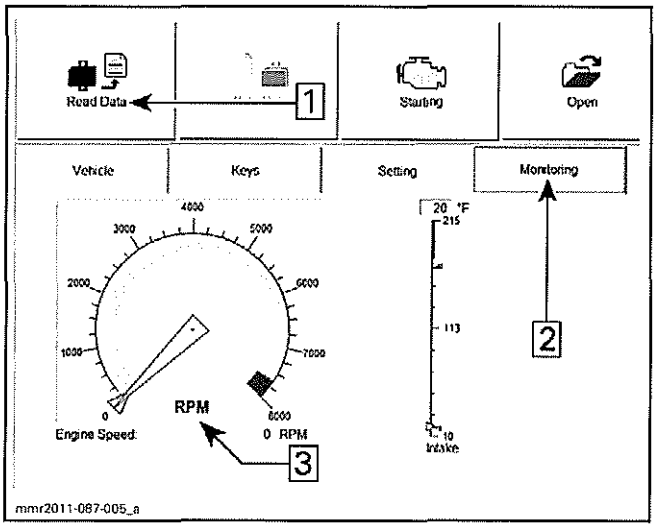
NOTICE **Never attempt to adjust the capped idle stop screw. It is calibrated at the factory. If the screw adjustment is changed, the throttle body must be replaced.**



1. *Capped screw (DO NOT TAMPER)*

Indicated engine RPM may be verified using the applicable B.U.D.S. software version, refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.

In B.U.D.S., select the following:



VERIFYING ENGINE RPM USING B.U.D.S.
Step 1: Click on the Read Data button
Step 2: Select the Monitoring *page tab*
Step 3: Read the engine RPM *indication*

NOTE: The gauge and B.U.D.S. use the same signal to provide the engine RPM indication.

TROUBLESHOOTING

DIAGNOSTIC TIPS

Engine problems are not necessarily related to the injection system.

It is important to ensure the mechanical integrity of the engine is intact.

Poor Idling

If poor idling is experienced, check the following:
- Throttle cable adjustment or routing.
- IACV operation, cleanliness, leaking or clogged air passages.
- Throttle body cleanliness and idle stop screw.
- Engine leaks or other mechanical problem.

Electrical Related Problems

It is important to check the following in the electrical system:
- Battery voltage
- Ground connections
- Wiring connectors.

Ensure that all electronic components are original BRP recommended components.

Any modification on the wiring harness may lead to generate fault codes or bad operation.

⚠ WARNING

All electrical actuators (example: injectors, fuel pump and ignition coils) are powered as soon as the START button is depressed.

Electrical Connections

Pay particular attention to ensure that pins are not out of their connectors or out of shape.

Make sure that connections are very tight and they make good contact, they are corrosion-free and show no signs of moisture. Particularly check ECM ground connections.

NOTE: Do not apply dielectric grease or other lubricant on the ECM connectors.

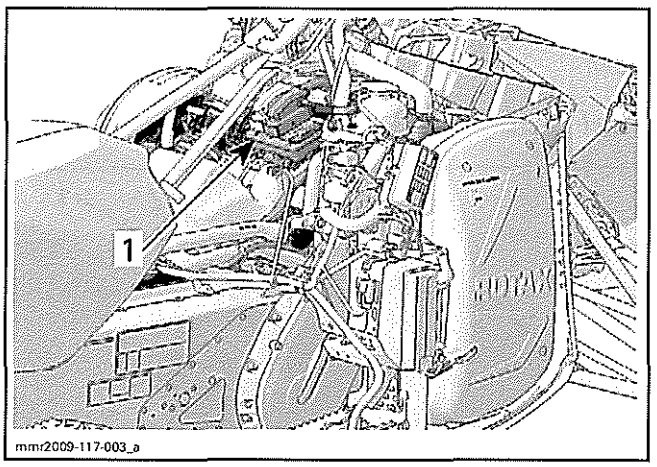
Check if wiring harness shows any signs of scoring.

PROCEDURES

ENGINE CONTROL MODULE (ECM)

ECM Location

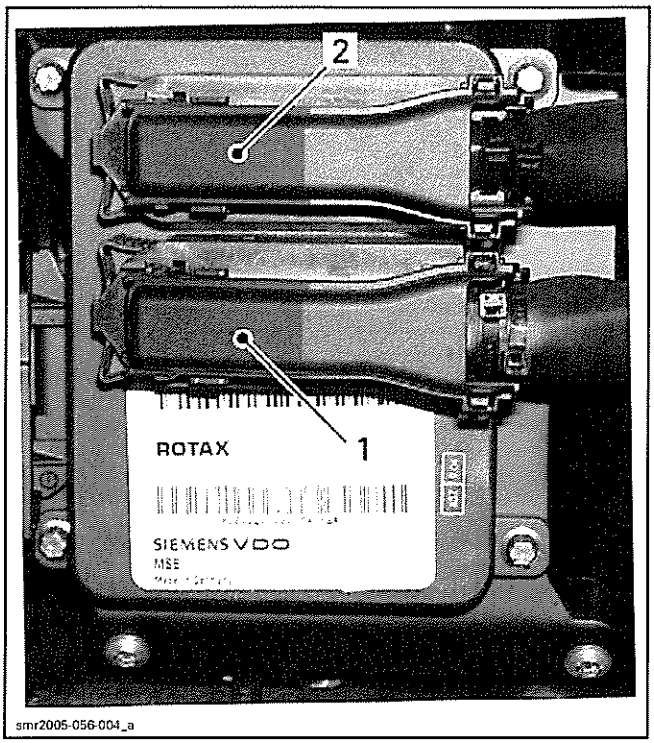
The ECM is located above the air intake manifold.



TYPICAL - ECM LOCATION, FUEL TANK REMOVED FOR CLARITY
1. ECM

ECM Connector Identification

There are two Kostal connectors used and they are connected on the ECM. The engine harness female connector is connected on the module male connector A and the vehicle system control harness female connector is connected to the module male connector B. The ECM connectors have 41 pins.

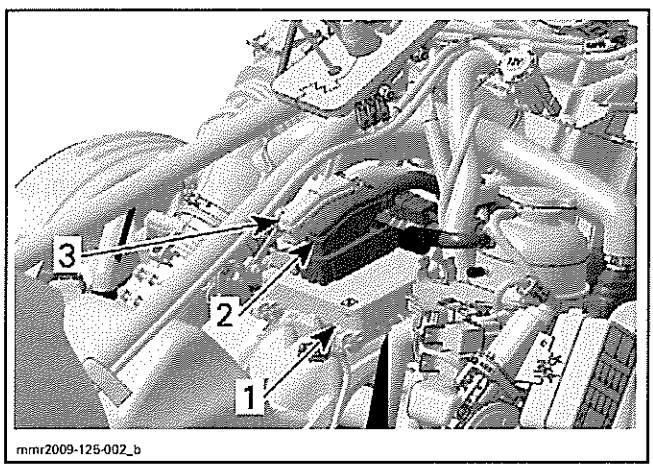


ECM
1. *Connector A (engine harness)*
2. *Connector B (vehicle harness)*

NOTICE Do not disconnect the ECM connectors needlessly. They are not designed to be disconnected/reconnected frequently.

ECM Access

1. Remove gauge support and air intake silencer as a unit, refer to *AIR INTAKE SYSTEM* subsection.
2. Remove drive pulley guard.



TYPICAL - SOME PARTS REMOVED FOR CLARITY
1. *ECM*
2. *A connector*
3. *B connector*

ECM Connector Cleaning

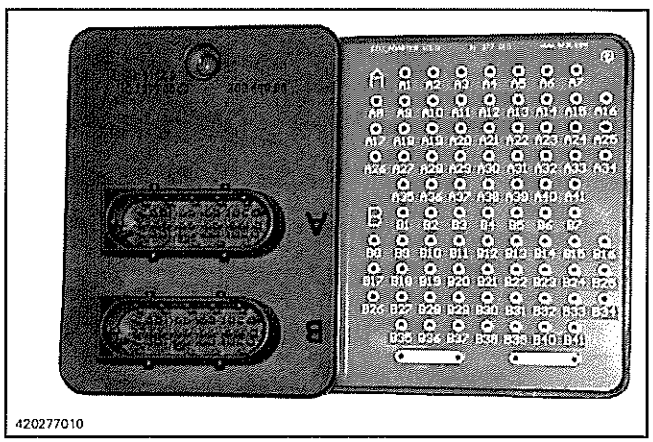
To clean oxidized ECM terminals, use a contact cleaner such as DEOXIT LUBRICANT (P/N 293 550 034).

NOTICE Remove connector seal prior to applying the product. Otherwise, the seal will swell and will let water enter inside connector. Dry out connector with compressed air prior to reinstalling the seal.

Do not apply any lubricant product to the pins of the connector on the ECM.

ECM Connector Probing

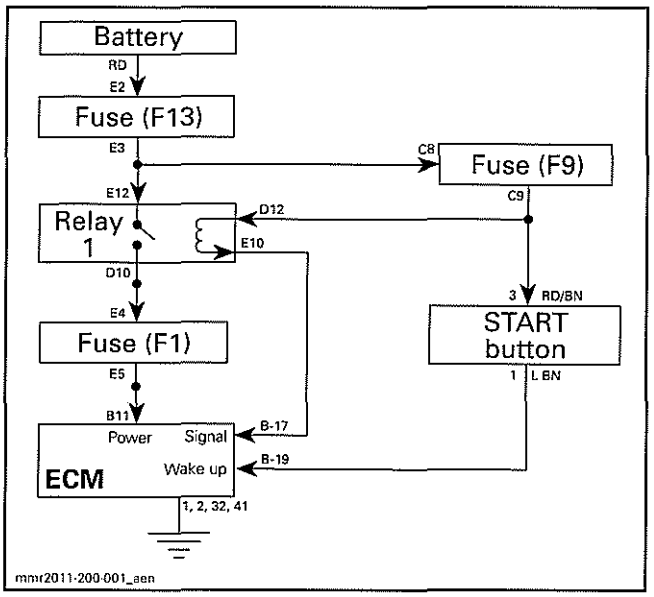
The most recommended and safest method to probe ECM connector terminals is to use the ECM ADAPTER TOOL (P/N 420 277 010). This tool will prevent deforming or enlarging terminals which would lead to bad ECM terminal contact creating intermittent or permanent problems.



Disconnect the desired connector (A or B) from ECM and reconnect on the matching tool connector. Probe required terminals directly in the tool pins.

ECM Power Circuit Troubleshooting

ECM Power Circuit Diagram



ECM Power Circuit Validation

Briefly press START button.

This should wake up the ECM and continuously activate the R1 relay.

QUICK INDICATION THAT ECM IS POWERED (ASSUMING THE OBSERVED COMPONENT IS WORKING)
Multifunction gauge comes ON.
Fuel pump comes ON for approx. 2 seconds.
Engine cranking occurs when pressing and holding START button.

If ECM does not turn on, check the following:

- Fuse F1, F13 and F9.
- Battery voltage. Refer to *CHARGING SYSTEM* subsection.
- Relay R1.
- START button switch. Refer to *STARTING SYSTEM* subsection.
- ECM power circuit wires and ground wires.

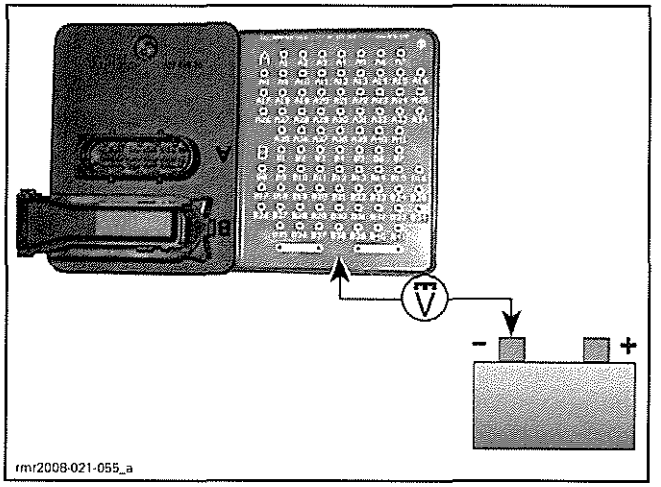
For testing of fuses and relay R1, refer to *POWER DISTRIBUTION (1200 4-TEC)* subsection.

NOTE: When relay R1 is not functioning, the EMS (engine management system) and the complete vehicle electrical system will not be powered.

ECM Wake Up Circuit Test

1. Remove parts required to access ECM connectors, refer to *ECM CONNECTOR ACCESS* in this subsection.
2. Disconnect ECM-B connector.
3. Use a multimeter and select Vdc.
4. While pressing START button, read voltage as follows.

ECM ADAPTER	BATTERY	MEASUREMENT
B-19	Battery ground	Battery voltage

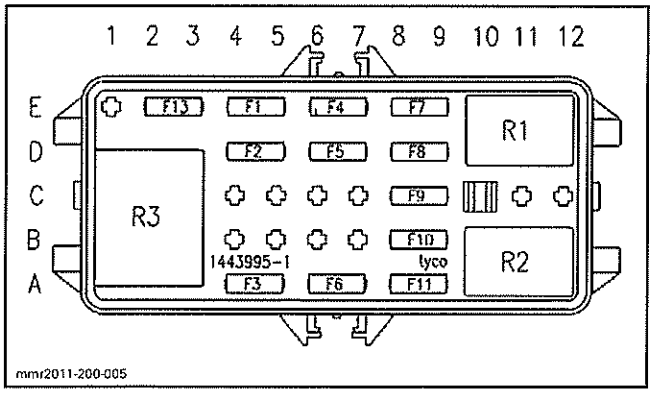


If voltage is out of specification, check START switch (refer to *STARTING SYSTEM*). If switch tested good, check wiring and connectors from battery to ECM. Refer to *WIRING DIAGRAM*.

If voltage is as per specification, check the power circuit test.

ECM Power Circuit Test

1. Disconnect ECM-B connector.
2. Install ECM ADAPTER TOOL (P/N 420 277 010) on ECM connector.
3. Remove relay R1 from fuse box.

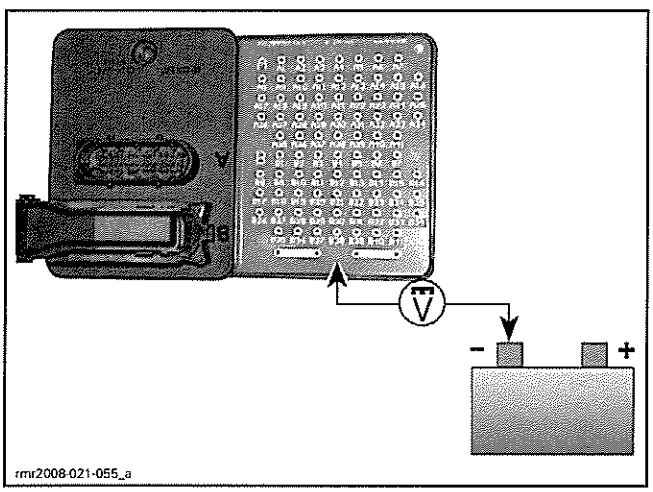


4. Temporarily install an appropriate fused jumper between terminals as per table.

FUSE BOX TERMINAL COORDINATES	
10D	12E

5. Use a multimeter and select Vdc.
6. Read voltage.

ECM ADAPTER	BATTERY	MEASUREMENT
Pin B-11	Battery ground	Battery voltage



If voltage is out of specification, test the following. Refer to *WIRING DIAGRAM* subsection.

- Fuse F1
- Fuse F13 (Battery charging fuse (Main)
- wiring and connectors from battery to ECM.

If voltage is as per specification, test the following:

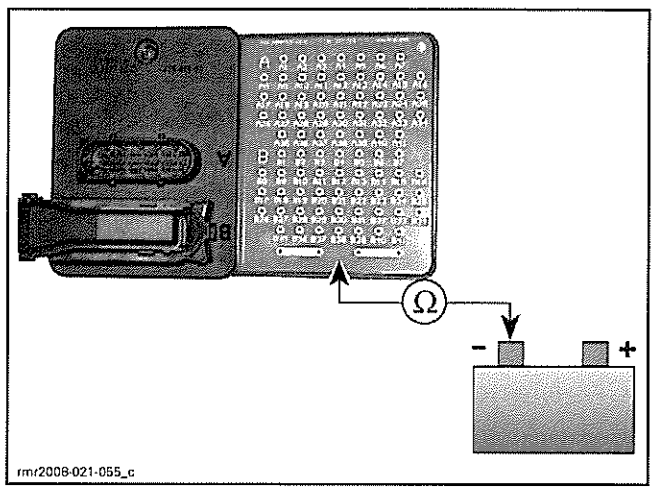
- Fuse F9 Relay/Gauge fuse
- ECM grounds, refer to *ECM GROUND CIRCUIT TEST* in this subsection
- Relay R1, refer to *POWER DISTRIBUTION (1200 4-TEC)* subsection.

7. Remove jumper and reinstall relay.

ECM Ground Circuit Test

1. Disconnect ECM-B connector.
2. Use a multimeter and select Ω.
3. Check continuity of wiring as follows.

ECM ADAPTER	BATTERY	MEASUREMENT
B-1	Battery ground	Close to 0 Ω (continuity)
B-2		
B-32		
B-41		



If test succeeded, ECM grounds are adequate.

If test failed, refer to *POWER DISTRIBUTION (1200 4-TEC)* subsection and check and check the following:

- Wiring and connections
- Engine ground
- Battery ground
- Frame ground.

ECM Removal

NOTE: If a new ECM is to be installed, first read the procedures in the *ECM REPLACEMENT.*

1. Disconnect battery cables.

⚠ WARNING

Battery BLACK (-) cable must always be disconnected first and connected last.

2. Remove parts required to access the ECM, refer to *ECM ACCESS* in this subsection.
3. Disconnect ECM connectors.
4. Cut locking ties and move ECM harnesses away from ECM support.

5. Remove ECM retaining screws.
6. Pull ECM from vehicle.

ECM Installation

Reverse removal procedure and pay attention to the following.

1. Reconnect ECM connectors.
2. Reconnect battery cables.

⚠ WARNING

Always reconnect BLACK (-) battery cable last.

NOTE: If a new ECM has been installed, refer to *ECM REPLACEMENT* below.

ECM Replacement

NOTE: Before replacing an ECM, ensure all applicable testing procedures have been carried out.

When the ECM is replaced, data must be entered in the new ECM. Refer to *ECM MANUAL DATA ENTRY FOR ECM REPLACEMENT* further in this subsection.

ECM Manual Data Entry for ECM Replacement

Use one one of the following 2 methods to collect the required information. The 1st being the easiest

1. Use B.U.D.S. to obtain the data from a saved .mpem file on your PC computer.
2. Collect the information from the vehicle and BOSSWeb.

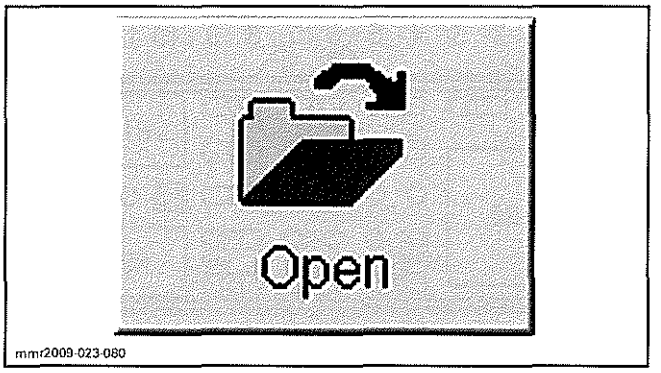
Once the required information has been collected, refer to *ENTERING THE COLLECTED INFORMATION INTO THE ECM*

1st Collecting Method: Obtaining the Data from a Saved .mpem File

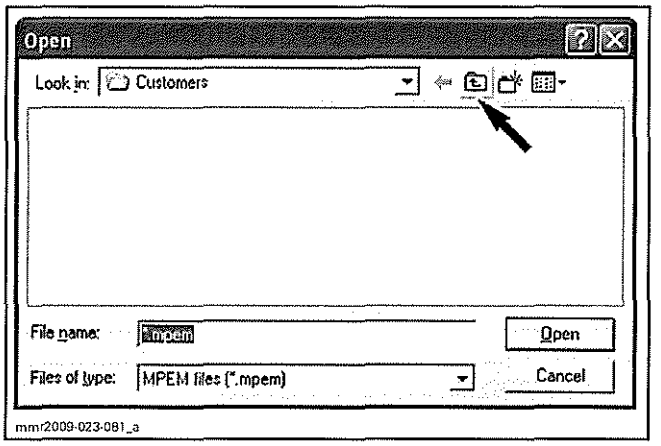
1. Start B.U.D.S.

NOTE: It is not necessary to perform any connection. The PC computer can be used alone.

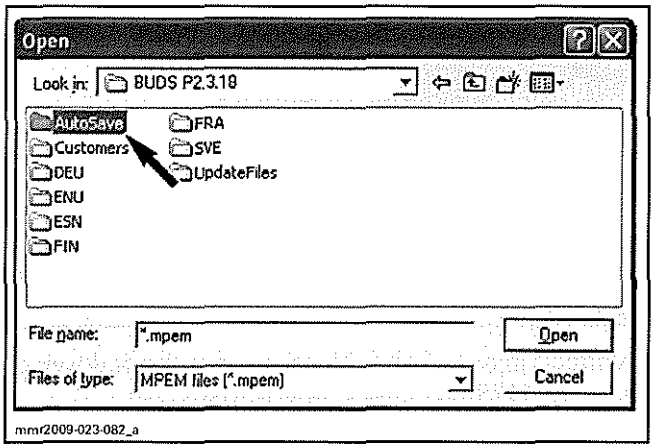
2. In B.U.D.S., click on the **Open** button.



3. Click once on the **Folder Up** button in the Open box.

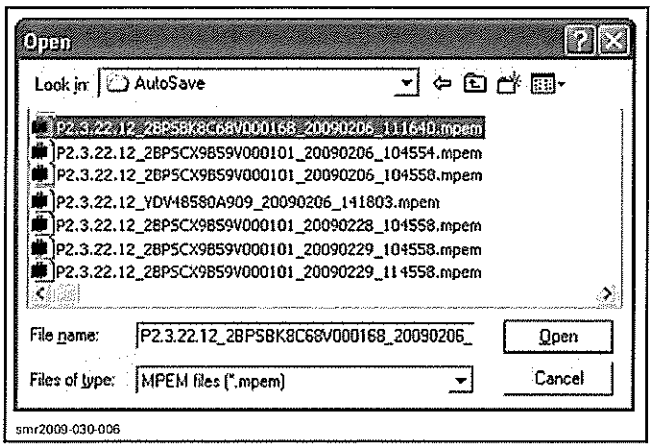


Double click on the **AutoSave** folder.



NOTE: You may have to go to another AutoSave folder from a previous version of B.U.D.S.

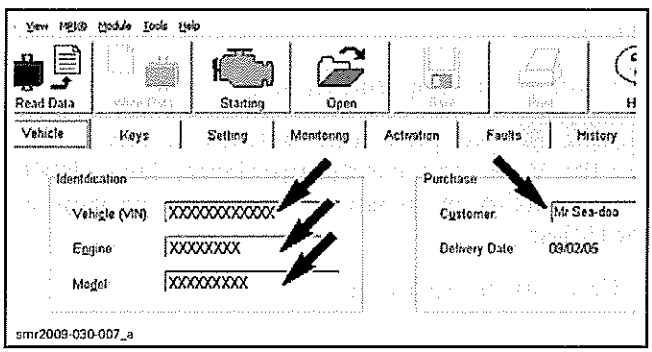
4. Choose the latest file saved for this specific vehicle.



IMPORTANT: Be sure to use the file that specifically matches the vehicle you are servicing.

NOTE: The file name structure is as follows:
BUDS version_VIN_date read (yyyymmdd)_hour read (hhmmss).mpem
Example: P2.3.22.12_2BPSBK8C68V000168_20090206_111640.mpem Therefore: B.U.D.S. version: P2.3.22.12 VIN: 2BPSBK8C68V000168 Date: 2009 02 06 Hour: 11h 16m 40s

5. Select the **Vehicle** page tab and record (write down) the following information.
   1. Vehicle serial number
   2. Engine serial number (without the leading "M")
   3. Vehicle model number
   4. Customer name.

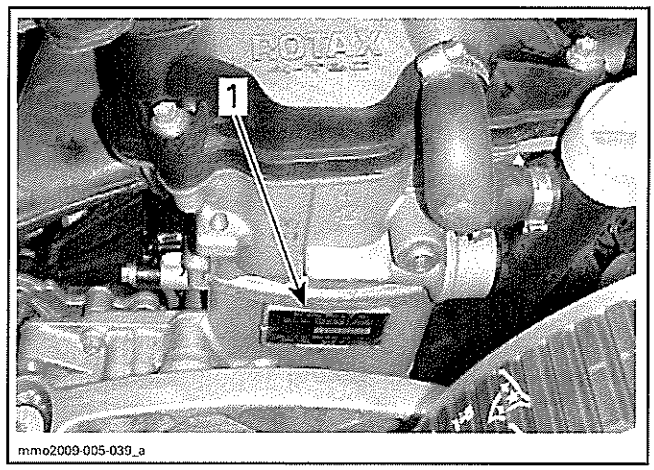


VEHICLE TAB

6. Enter recorded data in ECM as detailed in *ENTERING THE COLLECTED INFORMATION INTO THE ECM.*

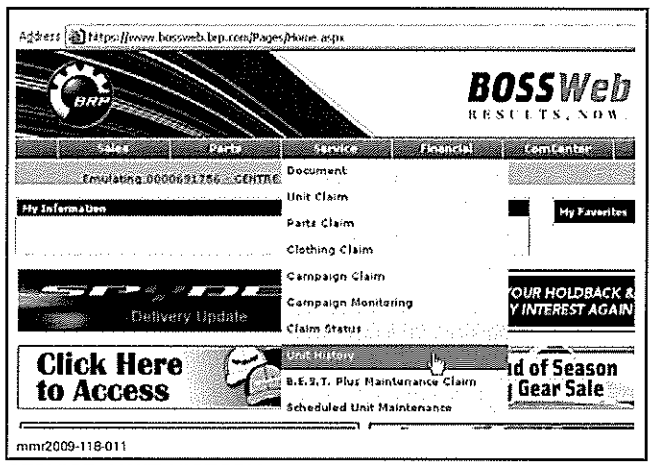
2nd Collecting Method: Collect the Information from the Vehicle and BOSSWeb

1. Record engine serial number.



TYPICAL - LH SIDE OF ENGINE
1. Engine serial number

2. Record the following numbers using BOSSWeb. Look in **Service** menu and choose Unit history.
   1. Vehicle serial number
   2. Vehicle model number
   3. Customer name.

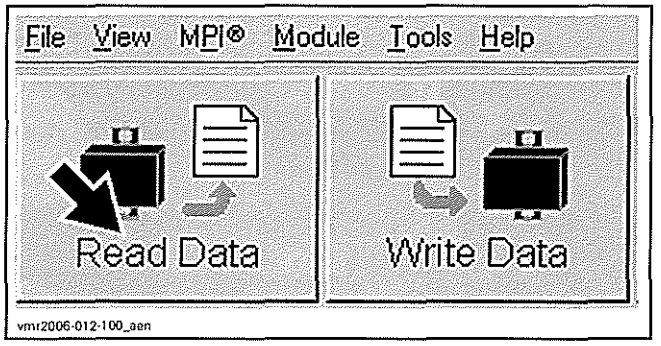


SERVICE, UNIT HISTORY

3. Enter the recorded data in the new ECM as detailed in *ENTERING THE COLLECTED INFORMATION INTO THE ECM.*

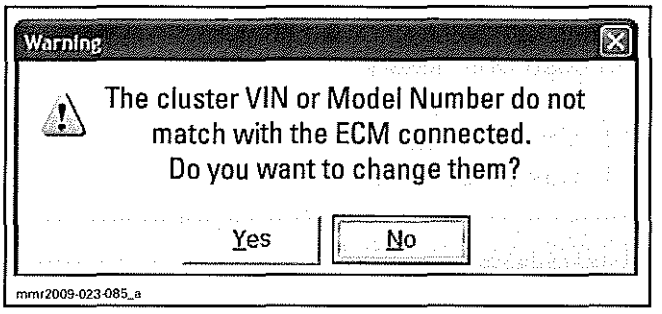
Entering the Collected Information Into the ECM

1. In B.U.D.S., Click on the **Read Data** button to read the new "empty" ECM.

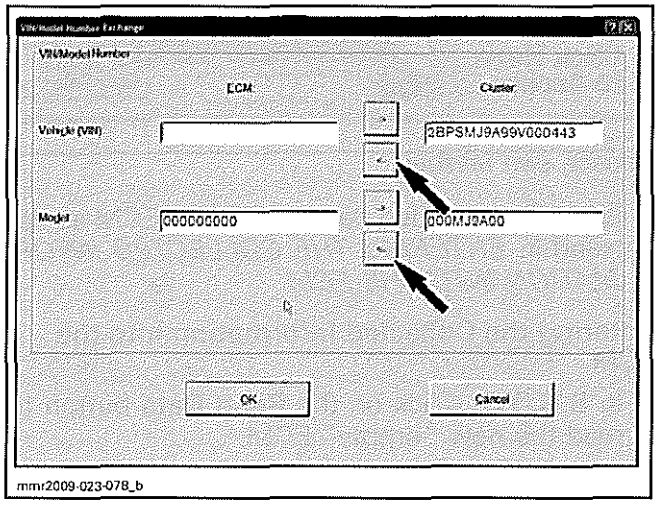


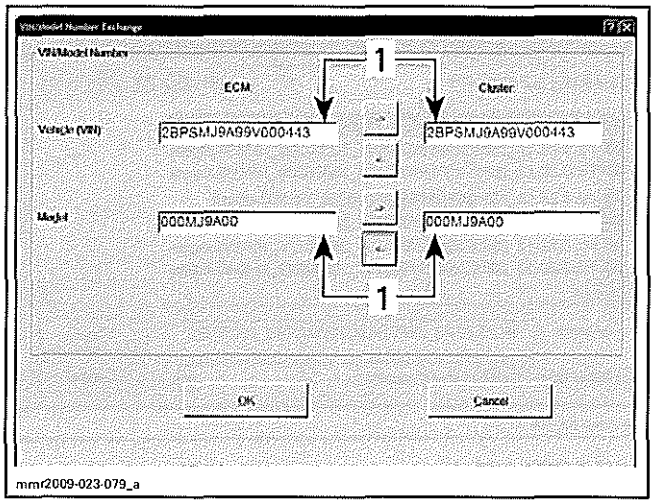
NOTE: A BEEP will sound repeatedly until the tether cord cap (D.E.S.S. key) is programmed into the new ECM.

2. The following message will appear on B.U.D.S. screen.



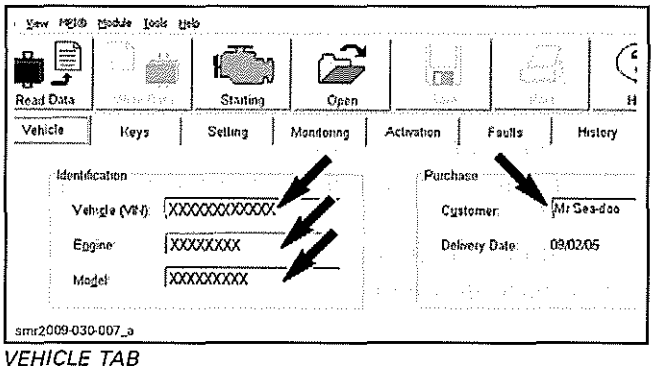
3. Click **Yes** to match ECM and gauge.
4. The serial numbers are purposely missing as seen in B.U.D.S. Click the arrows indicated in the following illustration to transfer the gauge numbers into the ECM.





1. Matching numbers

5. Click the **OK** button to complete the procedure.
6. Select the **Vehicle** page tab and ensure all of the following information is precisely entered in the new ECM.
   1. Vehicle serial number (VIN)
   2. Engine serial number (without the leading "M")
   3. Vehicle model number
   4. Customer name.

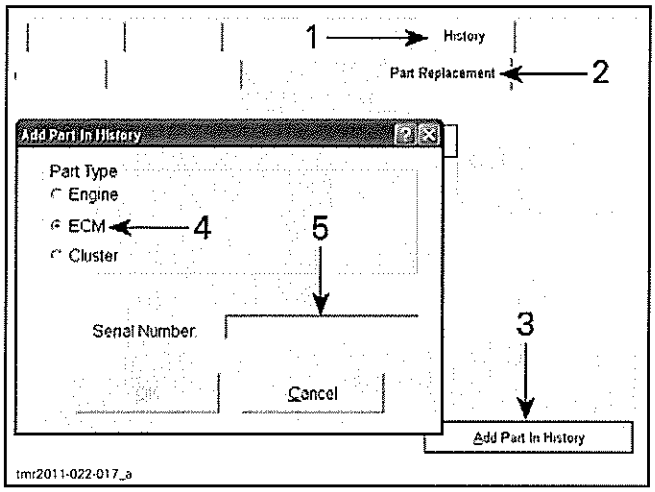


VEHICLE TAB

7. Enter all missing information.

NOTICE Pay particular attention when typing the V.I.N. and model numbers. Once **Write Data** button is pressed, the data cannot be modified.

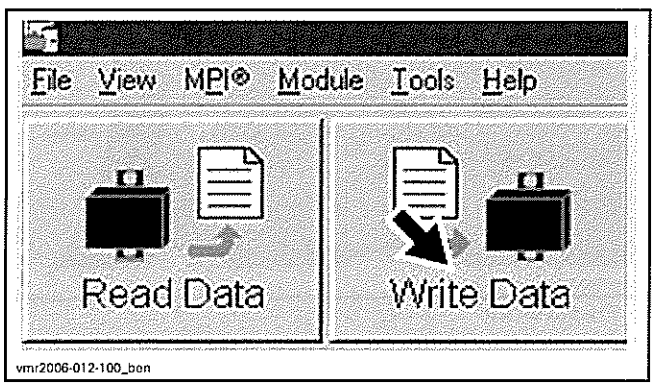
8. Click on the following tabs:
   - History
   - Part Replacement
   - Add Part in History.
9. Enter the **old** ECM serial number in the Add Part In History window.



TYPICAL - ADDING PART IN HISTORY
1. History *page tab*
2. Part Replacement *tab*
3. Add part in history *button*
4. ECM *selection*
5. *Add ECM serial number here*

NOTE: The ECM serial number can be found on the ECM sticker that also identifies the part number.

10. Click on the OK button.
11. Click on the Write Data button.



12. Program the tether cord cap (D.E.S.S. key(s)). Refer to *DE.S.S. SYSTEM* subsection.
13. Perform the *CLOSED THROTTLE RESET PROCEDURE*. Refer to *THROTTLE POSITION SENSOR (TPS)* in this subsection.
14. Set the gauge units of display. Refer to *LIGHTS, GAUGE AND ACCESSORIES* subsection.
15. Start the engine and increase engine speed above 6000 RPM to ensure no fault appears.

NOTE: If the engine will not idle, or idles very roughly, refer to *IACV AUTO RESET* in this subsection.

16. Reinstall any remaining removed parts.

FUEL RAIL

Fuel Rail Access

1. Remove air intake silencer and gauge support assembly. Refer to *AIR INTAKE SYSTEM* subsection.
2. Remove drive belt guard. Refer to *DRIVE BELT* subsection.

Fuel Rail Removal

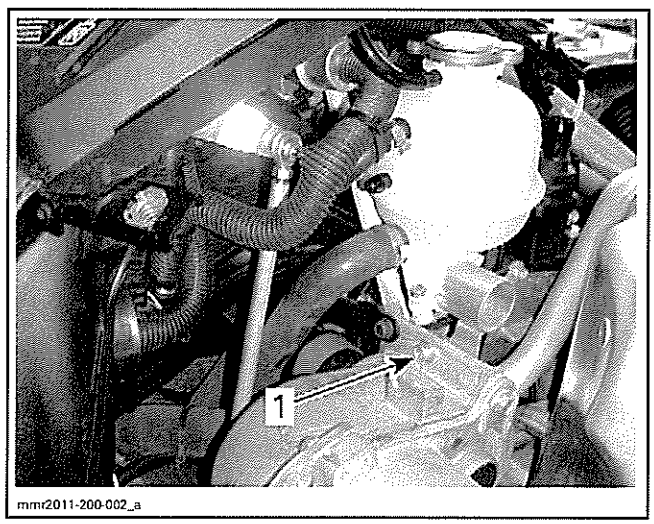
Fuel Rail Hose Disconnect

1. Release fuel pressure in the system using the fuel pressure relief function in B.U.D.S. Refer to *FUEL PUMP* in *FUEL TANK AND FUEL PUMP* subsection.
2. Disconnect the battery, refer to *CHARGING SYSTEM* subsection.

⚠ WARNING

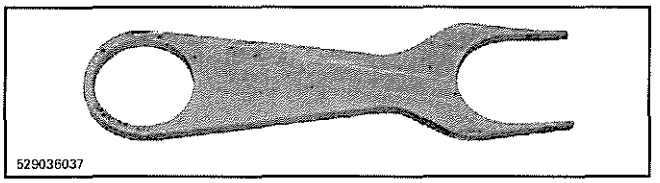
When removing or disconnecting the fuel injectors, always remove the tether cord from the engine cut-off switch and disconnect the battery.

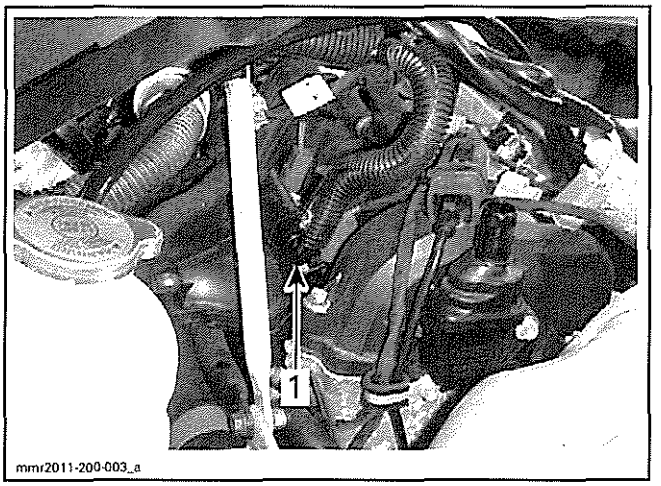
3. Remove both side panels, refer to *BODY* subsection.
4. Remove the coolant tank support retaining screw and move coolant tank rearward.



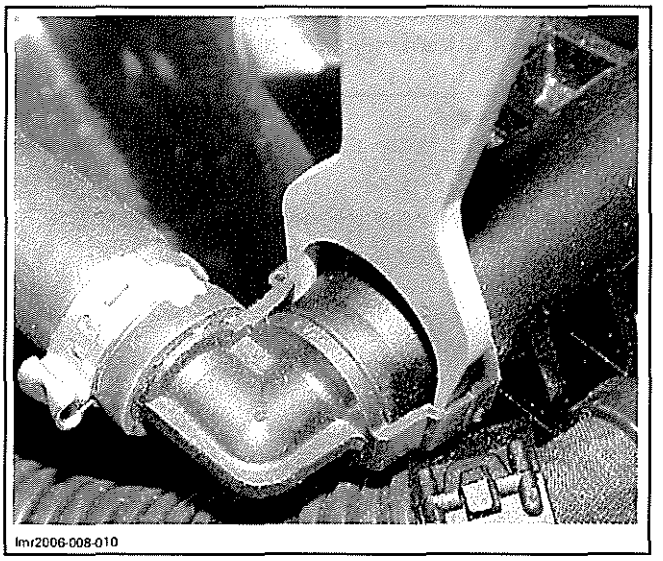
1. *Coolant tank support retaining screw*

5. Disconnect fuel hose from fuel rail using the FUEL HOSE DISCONNECT TOOL (P/N 529 036 037).





1. Fuel rail hose disconnect location

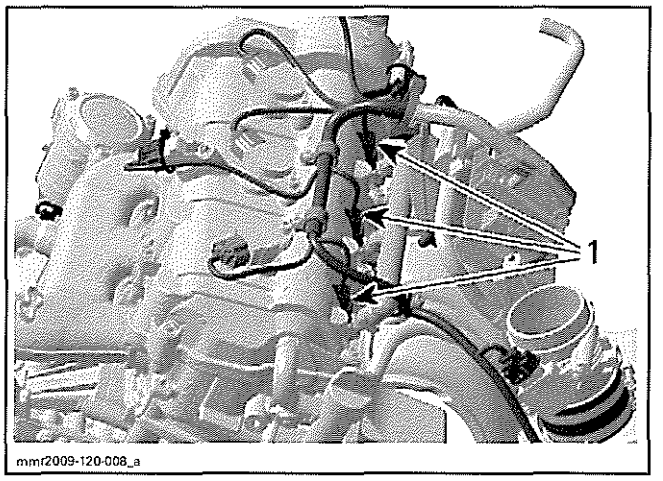


NOTE: It may be necessary to rotate fuel hose fitting to align the tool ends with the openings of the locking mechanism.

NOTE: Wrap a rag around the hose end to catch fuel leakage.

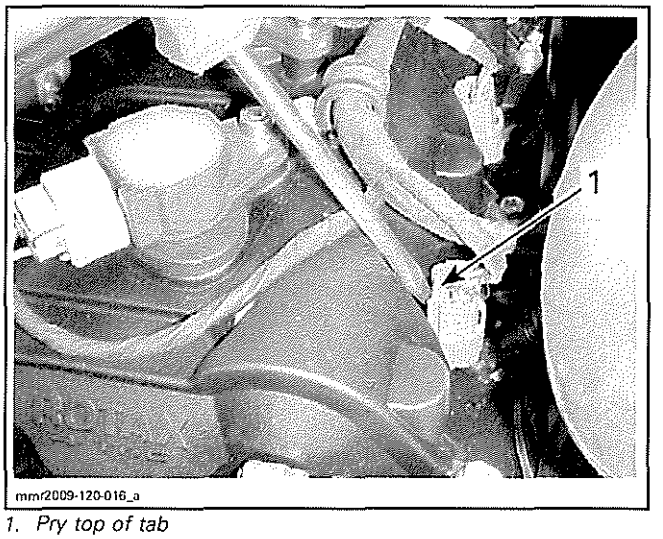
Fuel Rail Removal

1. Disconnect electrical connectors from all injectors.



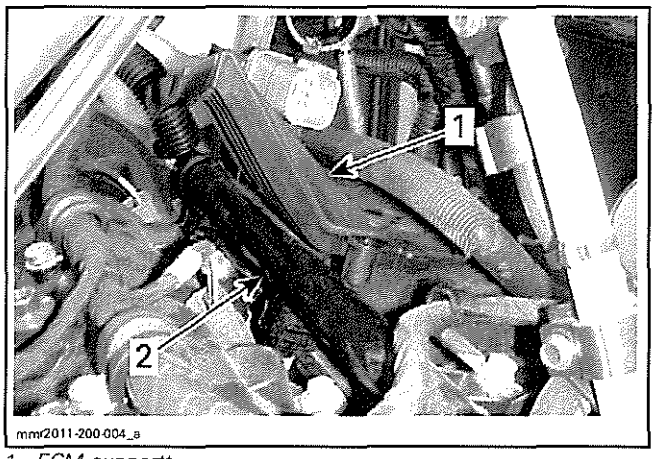
TYPICAL
1. Injector connectors

NOTE: Using a screwdriver, gently pry the top of the connector tab to unlock it.



1. Pry top of tab

2. Remove ECM, refer to *ECM REMOVAL* in this subsection.
3. Remove ECM support.



1. ECM supportt
2. Fuel rail

4. Remove retaining screws from fuel rail.
5. Gently pull fuel rail side to side (wiggle).
6. Pull fuel rail and fuel injectors out of engine.

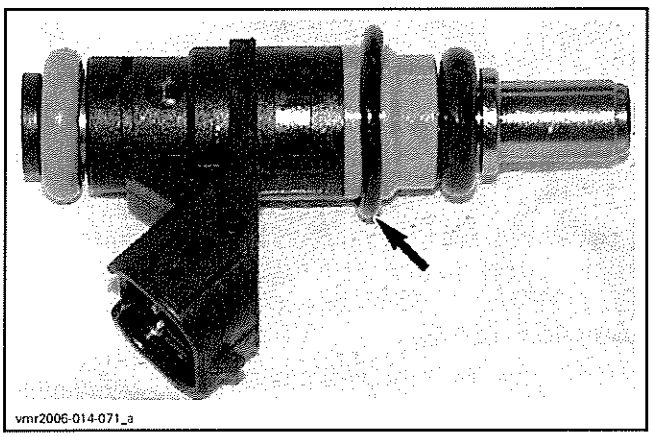
Fuel Rail Installation

For the installation, reverse the removal procedure. However, pay attention to the following.

1. Apply a thin film of engine oil to O-rings to ease insertion in rail.
2. Install fuel injector with your hand. Do not use any tool.

FUEL INJECTOR INSTALLATION		
O-RINGS	New	Lubricate with engine oil

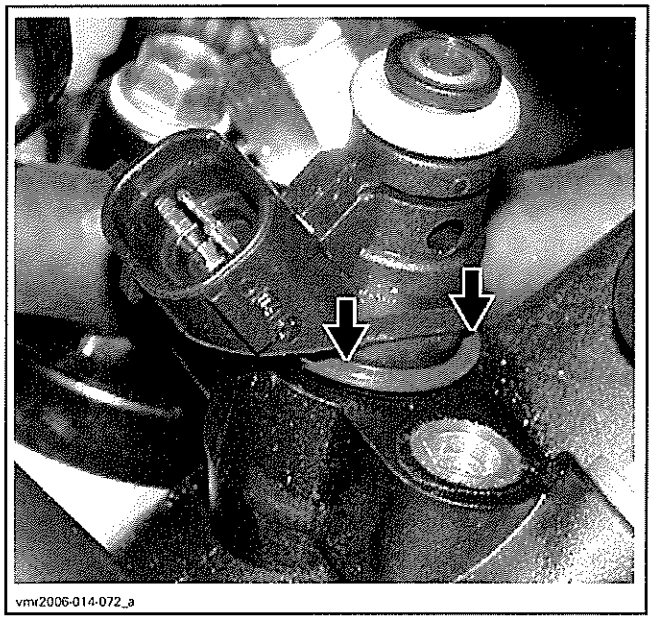
3. Ensure proper positioning of the intake manifold O-ring on injector as in following illustration.



TYPICAL - INTAKE MANIFOLD O-RING POSITION

4. Carefully insert injector in air intake manifold paying attention to the manifold O-ring.

NOTICE Gently push O-ring in evenly all around while inserting injector. O-ring must be completely inserted and not visible, before completing the insertion of the injector.



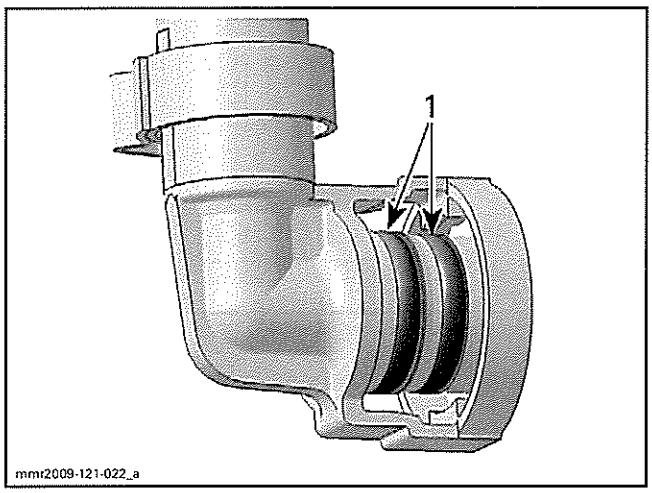
TYPICAL

5. Firmly push injector until it bottoms out.

FUEL RAIL RETAINING SCREW TORQUE
11 N•m (97 lbf•**in**)

Fuel Rail Hose Connection

1. Apply engine oil on O-rings of fitting.



1. Apply oil on O-rings

2. Connect fuel pressure hose to fuel rail.

IMPORTANT: Push fuel hose fitting on fuel rail until you hear a "click". Try pulling on fuel hose fitting to ensure it is properly locked.

Pressurize the fuel system and check for fuel leaks. Refer to *FUEL SYSTEM PRESSURIZATION* in *FUEL TANK AND FUEL PUMP* subsection.

⚠ WARNING

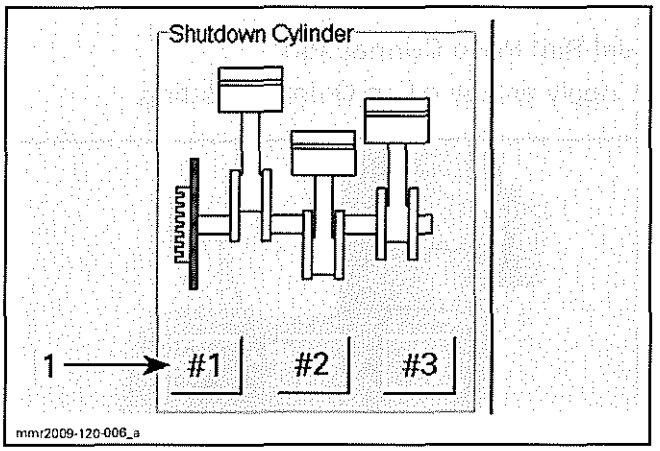
Failure to pressurize the fuel system and checking for fuel leaks may result in severe injury or a life threatening situation should a leak occur.

3. Reinstall all remaining removed parts.

FUEL INJECTOR

Fuel Injector Operation Test (Dynamic)

1. Connect vehicle to the applicable B.U.D.S. version. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. Start engine.
3. In B.U.D.S., select the following:
   - Read Data button
   - Monitoring page tab
   - ECM page.
4. Using B.U.D.S., shut down each engine cylinder, one at a time.



1. Click on the desired cylinder number

If the engine RPM drops when clicking on a cylinder, the injector and the ignition of this cylinder are working.

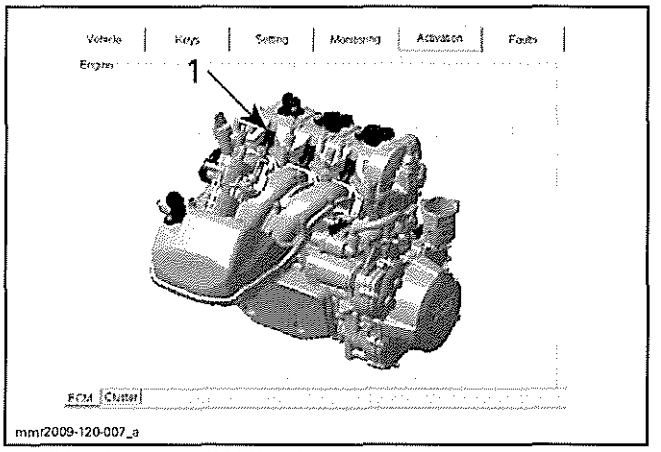
If the engine RPM does not drop when clicking on a cylinder, this cylinder is not working properly. Check the following:

- Fuel injector operation. Refer to *FUEL INJECTOR OPERATION TEST.*
- Spark plug and ignition coil. Refer to *IGNITION SYSTEM.*
- Engine condition.

Fuel Injector Operation Test (Static)

NOTICE After fuel injector activation using B.U.D.S., always crank engine in drowned mode to ventilate engine to prevent a potential backfire due to fuel accumulation in engine.

1. Stop engine.
2. In B.U.D.S., energize the desired fuel injector.



ACTIVATION AND ECM TABS
1. Injector of cylinder no. 1 shown

3. Listen to the injector.

If you can hear the injector, it validates its operation. Carry out the *FUEL INJECTOR BALANCE TEST WITH B.U.D.S.* and the *FUEL INJECTOR LEAKAGE TEST.*

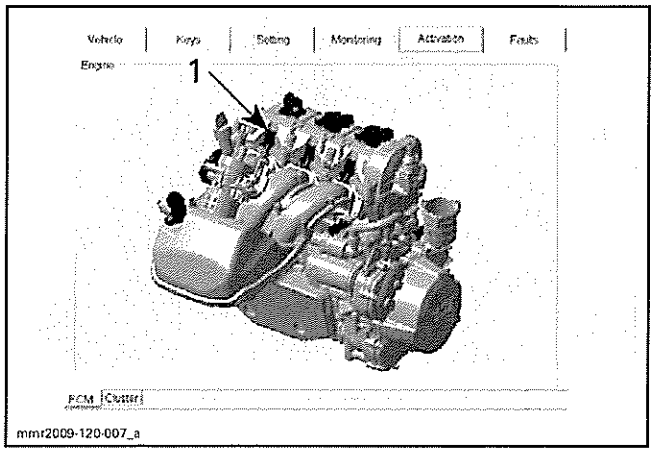
If you do not hear the injector, carry out the *INJECTOR INPUT VOLTAGE TEST.*

Fuel Injector Balance Test

NOTICE After fuel injector activation using B.U.D.S., always crank engine in drowned mode to ventilate engine to prevent a potential backfire due to fuel accumulation in engine.

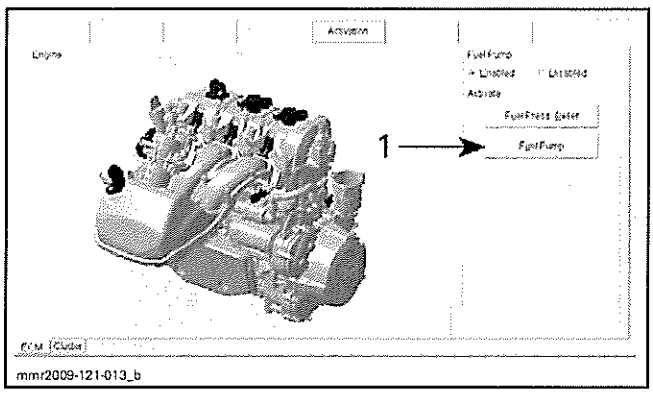
1. Install a fuel pressure gauge as described in *FUEL PUMP PRESSURE TEST* of *FUEL TANK AND FUEL PUMP* subsection.
2. Connect vehicle to applicable B.U.D.S. version. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
3. Install tether cord on the engine cut-off switch.
4. Set engine emergency stop switch to STOP to prevent engine starting.
5. In B.U.D.S., click the Fuel Pump button to activate fuel pump.
6. Fuel pressure must be within specification. Refer to *FUEL TANK AND FUEL PUMP* subsection. Reactivate fuel pump as necessary.

7. In B.U.D.S., energize the fuel injector **no. 1**.



ACTIVATION AND ECM TABS
1. Injector of cylinder no. 1

8. Record the fuel pressure drop for injector **no. 1**.
9. In B.U.D.S., click the **Fuel Pump** button to activate fuel pump.



ACTIVATION AND ECM TABS
1. Click here

10. Repeat the procedure for fuel injectors **no. 2** and **no. 3** and record their pressure drops.
11. The maximum fuel pressure drop between injectors should not exceed the following specification:

MAXIMUM FUEL PRESSURE DROP ALLOWED BETWEEN FUEL INJECTORS
10 kPa (1.5 PSI)

12. If the pressure drop of any fuel injector is greater than the specification, replace that injector then repeat the test.
13. Using the valve on the fuel pressure gauge, release the pressure in the system (if so equipped).
14. Remove fuel pressure gauge and reinstall removed parts.
15. Set engine emergency shut off switch to OFF.
16. Crank engine in drowned mode (accelerator held all the way in) to vent the engine of the fuel that was injected during the test.

⚠ WARNING

Always crank engine in drowned mode to ventilate all fuel that was injected during the test.

Fuel Injector Leak Test

Test Setup

1. First make sure fuel pressure is within specification. Refer to *FUEL TANK AND FUEL PUMP* subsection.

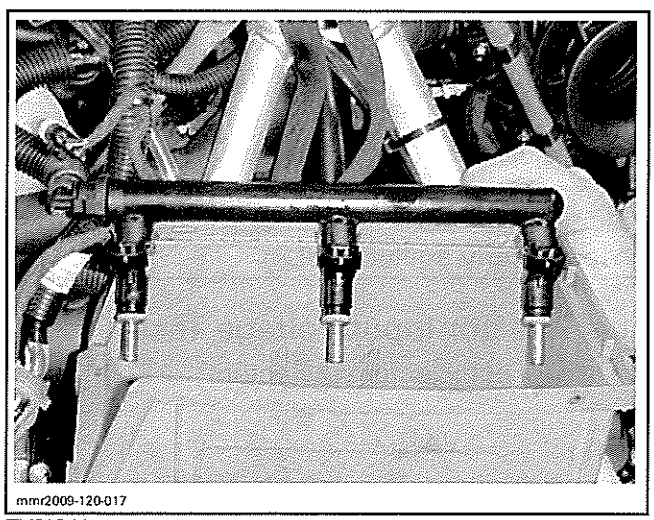
NOTE: Keep the pressure gauge installed for the leakage test.

2. Install tether cord on engine cut-off switch.
3. Set engine emergency stop switch to STOP.

⚠ WARNING

The engine emergency stop switch is set to STOP to prevent any spark in the engine compartment should the engine be cranked. Fuel vapors may ignite in presence of a spark creating a fire hazard.

4. Withdraw fuel rail and keep it connected. Refer to *FUEL RAIL* in this subsection.
5. Carefully lift fuel rail.
6. Place an appropriate container under injectors.

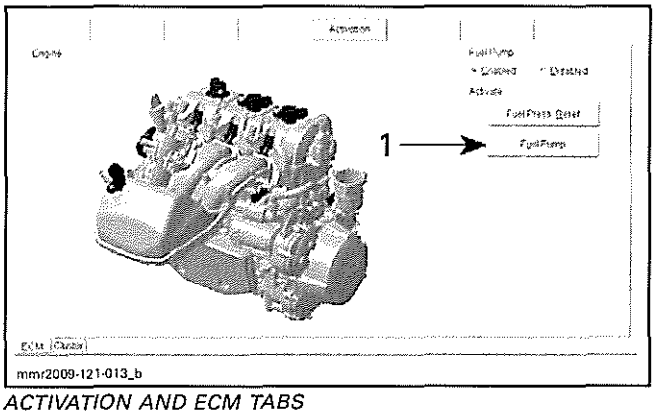


TYPICAL

7. Ensure there is enough fuel in fuel tank.

Leak Test

1. In B.U.D.S., select the following:
   - Activation page tab
   - ECM page.
2. In B.U.D.S., click on the **Fuel Pump** button to activate fuel pump for a few seconds.



ACTIVATION AND ECM TABS
1. Click here

3. Check for fuel leakage from the injector nozzles.
4. Monitor fuel pressure at fuel pressure gauge. If pressure drops below 372 kPa (54 PSI) during the test, re-activate fuel pump as necessary.

FUEL INJECTOR LEAKAGE	
TEST DURATION	SPECIFICATION
2 minutes	1 drop per minute maximum

If test is not within specification, replace the faulty fuel injector.

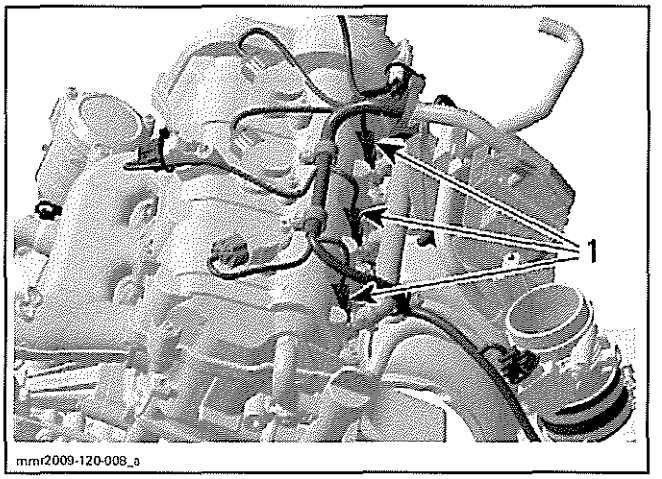
5. Properly reinstall fuel rail. Refer to *FUEL RAIL* in this subsection.
6. Reinstall remaining removed components.

⚠ WARNING

Wipe up any spilled fuel.

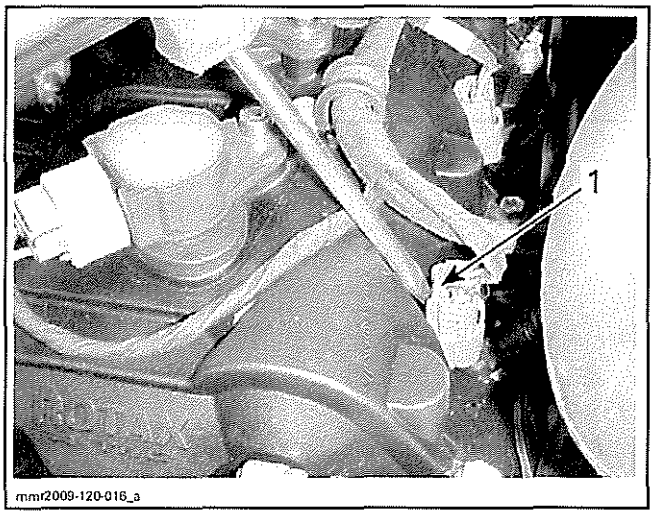
Fuel Injector Input Voltage Test

1. Disconnect injector connectors.



1. Injector connectors

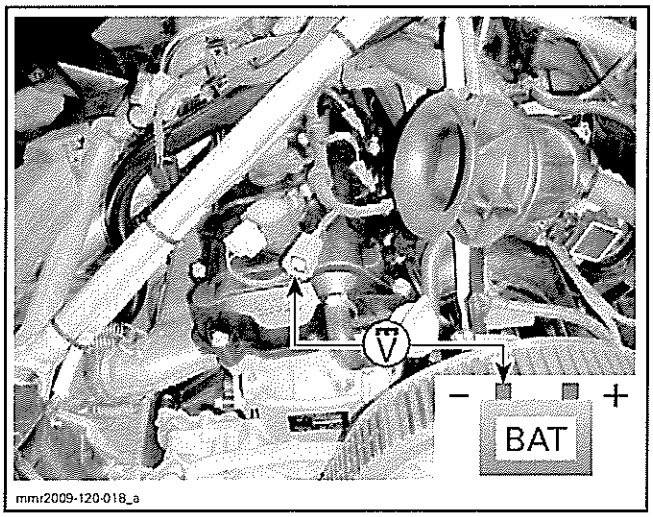
NOTE: Using a screwdriver, gently pry the top of the connector tab to unlock it.



1. Pry top of tab

2. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and select Vdc.
3. Briefly press the START button to wake up ECM.
4. Read voltage of the desired injector.

INJECTOR NO.	INJECTOR CONNECTOR	BATTERY	MEASUREMENT
1	VIOLET/BLUE	Ground terminal	Battery voltage
2	VIOLET/GREEN		
3	VIOLET/ORANGE		



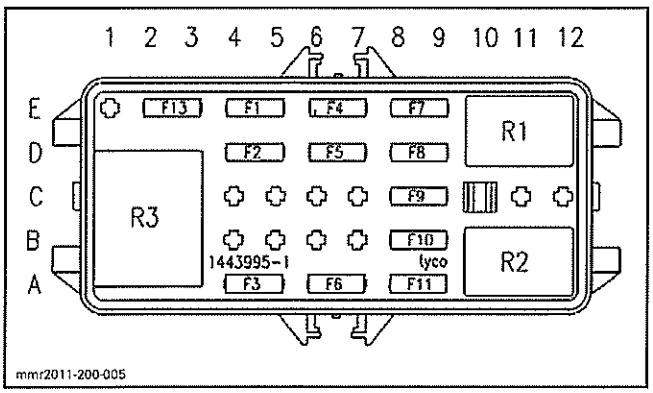
TYPICAL

If input voltage is good, carry out the *FUEL INJECTOR CONTROL CIRCUIT TEST.*

If input voltage is not good, carry out a *CONTINUITY TEST OF FUEL INJECTOR POWER CIRCUIT.*

Continuity Test of Fuel Injector Power Circuit

1. Remove relay R1 from fuse box.



2. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and select Ω.
3. Read the resistance of the desired injector circuit.

INJECTOR NO.	INJECTOR CONNECTOR	FUSE BOX	MEASUREMENT
1	VIOLET/BLUE	Terminal 10D	Close to 0 Ω
2	VIOLET/GREEN		
3	VIOLET/ORANGE		

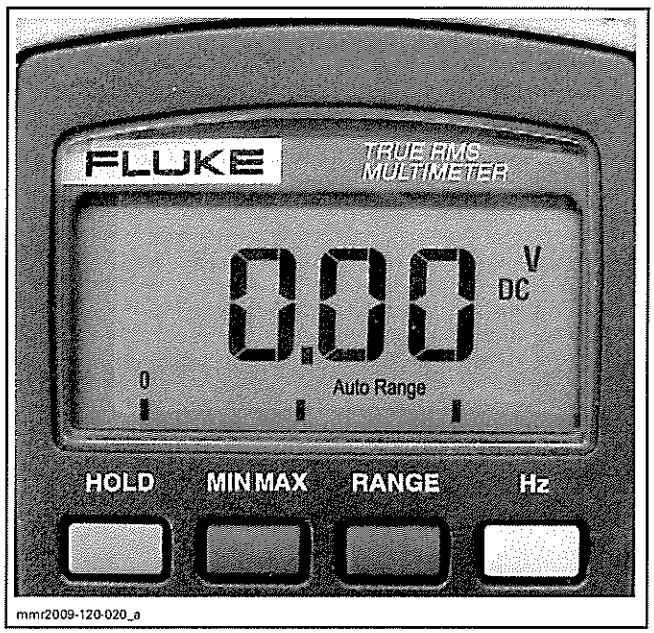
If continuity is faulty:
- Check applicable injector fuse.
- Repair or replace wiring from fuse box to injector.

If continuity is good:
- Check fuse F9 (Relay/Gauge fuse).
- Check fuse F13 (Battery/Charging fuse).
- Check relay R1, refer to *POWER DISTRIBUTION (1200 4-TEC)* subsection.
- Repair or replace wiring from battery to fuse box, refer to *WIRING DIAGRAM* subsection.

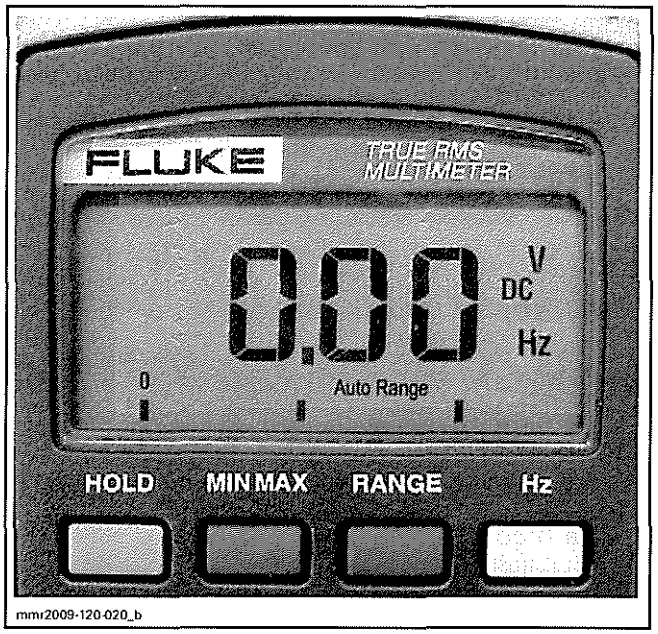
Fuel Injector Signal Test

1. Connect B.U.D.S. Refer to *COMMUNICATION TOOLS AND B.U.D.S. SOFTWARE.*
2. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and set it to Vdc.

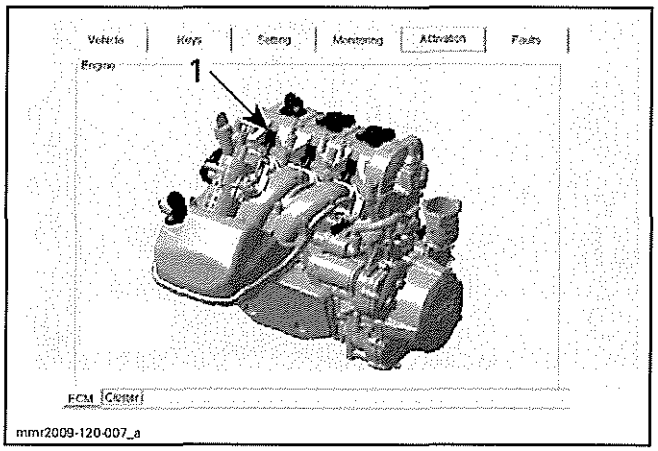
NOTE: Make sure multimeter is in the **Auto Range** mode.



3. Press the **Hz** button so that the display shows Hz.



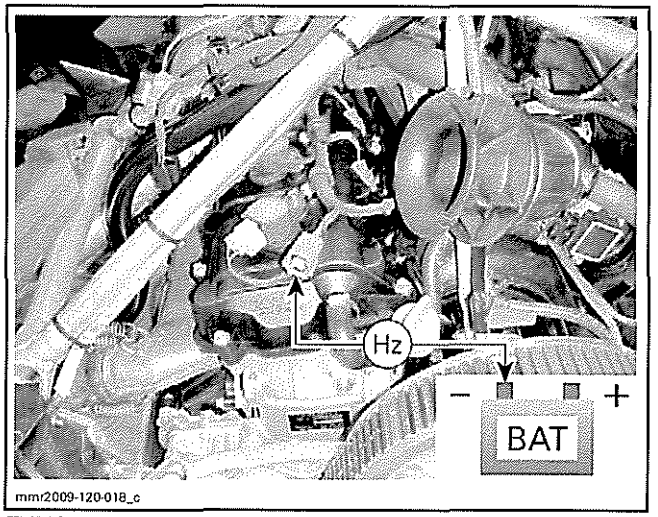
4. Connect the multimeter probes as indicated in the following table and using the B.U.D.S. software, activate each injector and read the frequency on the multimeter.



ACTIVATION AND ECM TABS
1. Injector of cylinder no. 1

NOTE: The multimeter counts the pulses per minute (Hertz) of current the ECM sends to the injector.

INJECTOR NO.	INJECTOR CONNECTOR CONTACT	BATTERY	MEASUREMENT
1	BROWN/RED wire	Battery ground	Approximately 60 Hz (2 short pulses)
2	BROWN/BLUE wire		
3	BROWN/GRAY wire		



TYPICAL

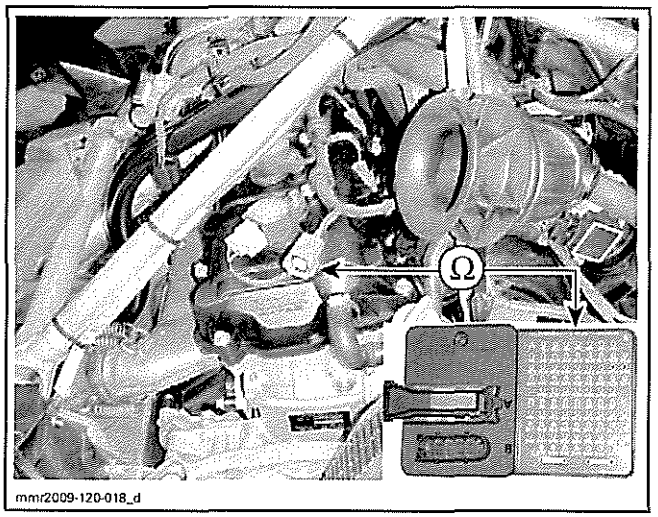
If reading is good, the control circuit is functional.

If there is no reading, refer to *FUEL INJECTOR CONTROL CIRCUIT TEST.*

Fuel Injector Control Circuit Test

1. Disconnect ECM A connector. Refer to *ECM* in this subsection.
2. Install ECM ADAPTER TOOL (P/N 420 277 010) on ECM connector.
3. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and select Ω.
4. Probe terminals as follows.

INJECTOR NO.	ECM ADAPTER	INJECTOR CONNECTOR	MEASUREMENT
1	A-15	BROWN/RED	Close to 0 Ω
2	A-33	BROWN/BLUE	
3	A-14	BROWN/GRAY	



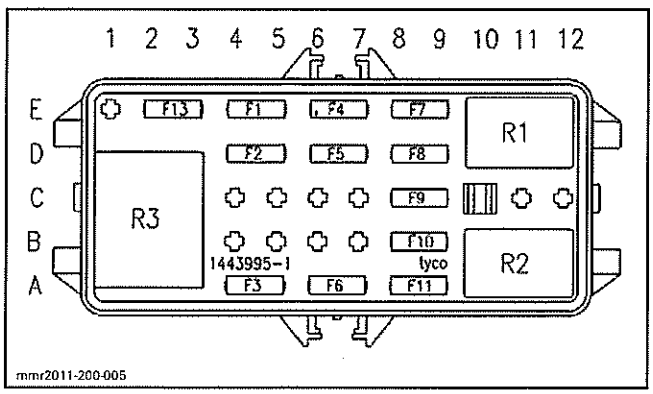
TYPICAL

If control circuit is faulty, repair/replace wiring/connectors.

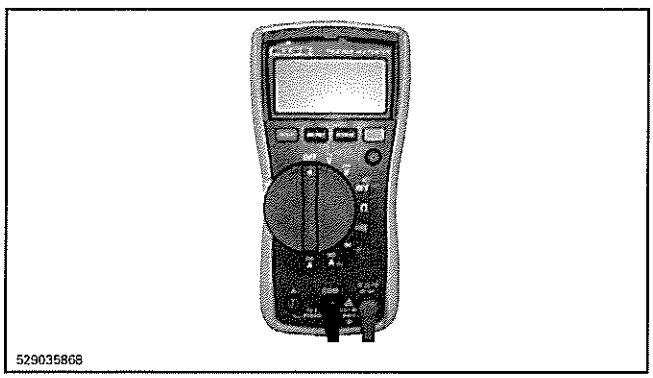
If control circuit and all tests applicable to the injector are good, try a new ECM. Refer to *ECM* in this subsection.

Fuel Injector Resistance Test (at ECM Connector)

1. Reconnect the injector connector.
2. Disconnect the ECM-A connector.
3. Install ECM ADAPTER TOOL (P/N 420 277 010) on ECM connector.
4. Remove relay R1 from fuse box.



5. Use the FLUKE 115 MULTIMETER (P/N 529 035 868).



6. Set multimeter to Ω.
7. Check resistance value between terminals as follows.

INJECTOR	FUSE BOX	ECM ADAPTER	RESISTANCE @ 20°C (68°F)
1	Terminal 10D	A-15	12 ± 0.6 Ω
2		A-33	
3		A-14	

If resistance value is correct, applicable injector fuse, injector coil, and wiring are in good condition.

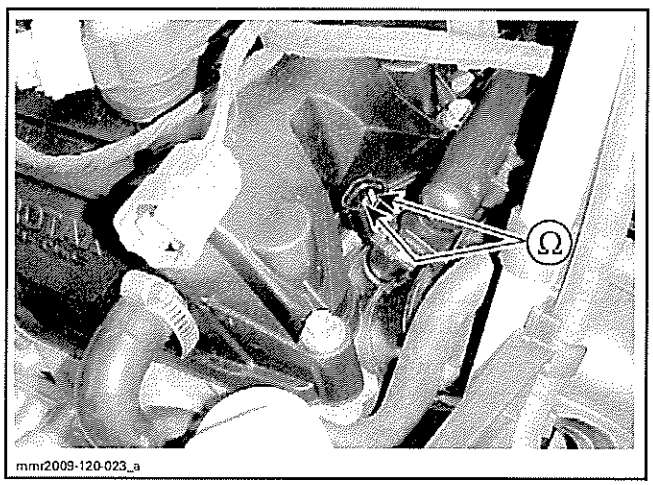
If resistance value is incorrect:
- Test applicable injector fuse.
- Repeat test at injector if fuses are good.

8. Reinstall relay R1.

Fuel Injector Resistance Test (at Component)

1. Remove injector connector and check resistance value between injector pins as follows.

INJECTOR PIN		RESISTANCE @ 20°C (68°F)
1	2	12 ± 0.6 Ω



TYPICAL

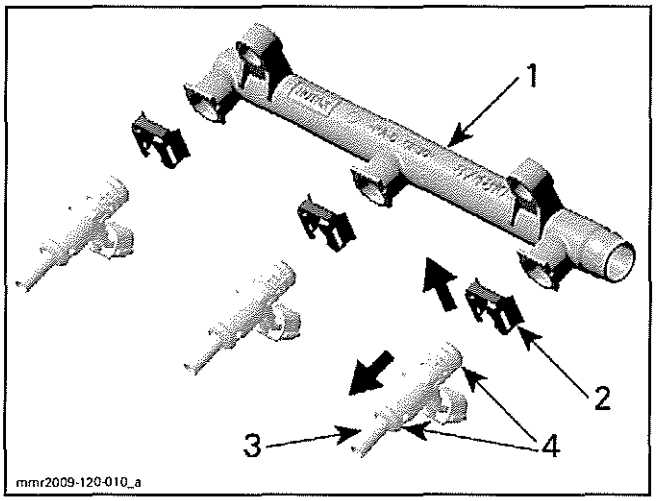
If reading is out of specification, replace injector.

If reading is good but the test failed at ECM, repair/replace wiring/connectors from fuse box to injector.

2. Reinstall relay R1 and remaining removed parts.

Fuel Injector Removal

1. Remove fuel rail with injectors still installed in the fuel rail. Refer to *FUEL RAIL* in this subsection.
2. Remove the fuel injector clip (see illustration).
3. Pull fuel injector out from fuel rail.



1. *Fuel rail*
2. *Fuel injector clip*
3. *Fuel injector*
4. *O-ring*

Fuel Injector Installation

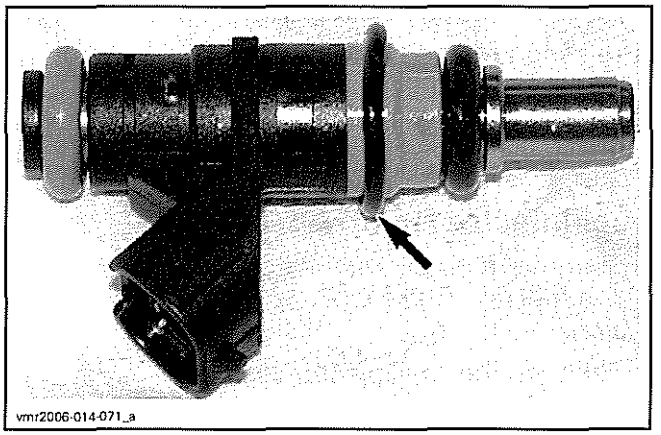
1. For the installation, reverse the removal procedure. However, pay attention to the following.

NOTICE If installing the removed injector(s), ensure injector O-rings are in good condition. Replace O-rings as required.

2. Apply a thin film of engine oil to O-ring.

FUEL INJECTOR INSTALLATION		
O-RINGS	New	Lubricate with engine oil

3. Ensure proper positioning of the intake manifold O-ring on each injector as in following illustration.



TYPICAL - INTAKE MANIFOLD O-RING POSITION

4. Carefully insert and secure the fuel injector in the fuel with your hand.

⚠ WARNING

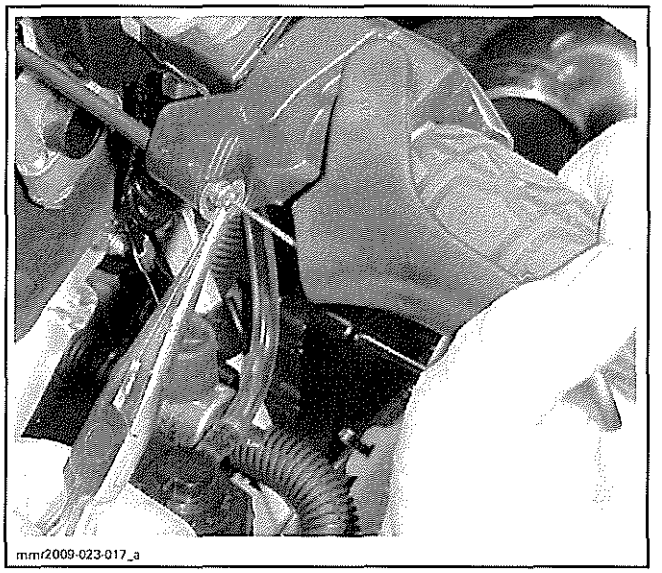
Ensure to properly lock fuel injectors in the fuel rail with their clips.

5. Reinstall fuel rail with the injectors in the manifold. Refer to *FUEL RAIL* in this subsection.

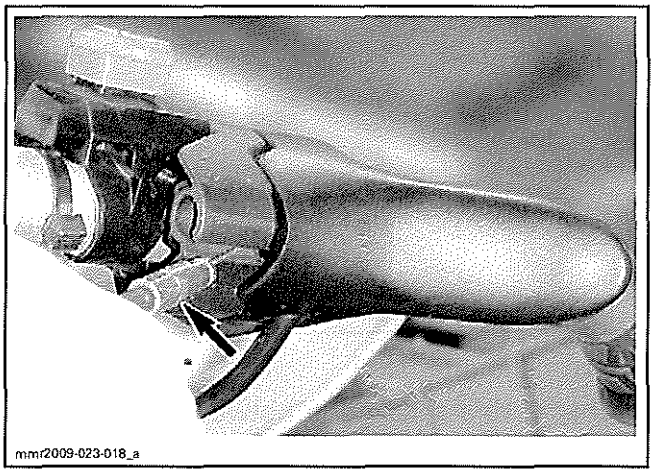
THROTTLE CABLE

Throttle Cable Removal

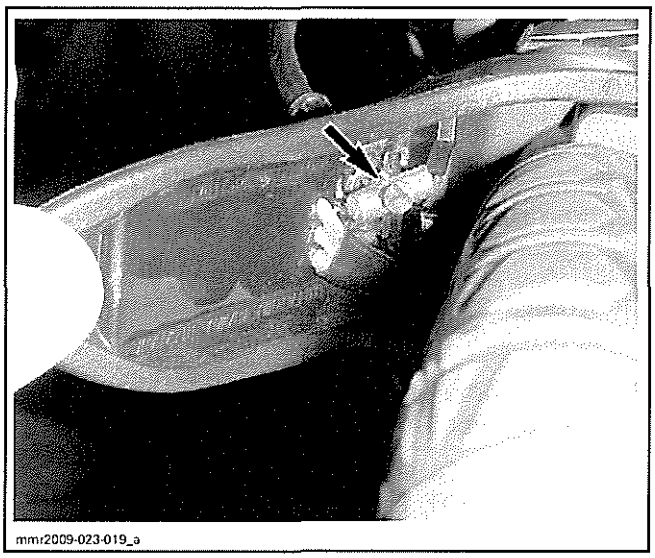
1. Remove handlebar cover.
2. Depress and hold throttle lever.
3. Pull out circlip using long nose pliers. Keep circlip for re-use.



4. Pull throttle cable out of throttle lever housing.



5. Unhook cable barrel end from throttle lever and remove cable from throttle lever.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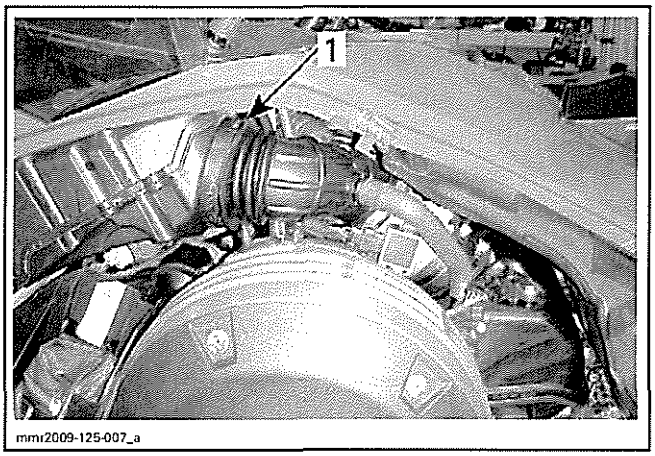
6. Take note of factory cable routing before removal.
7. Remove drive belt guard. Refer to *DRIVE BELT* subsection.
8. Remove air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.
9. Disconnect intake adapter from air intake silencer and both hoses connected to it.



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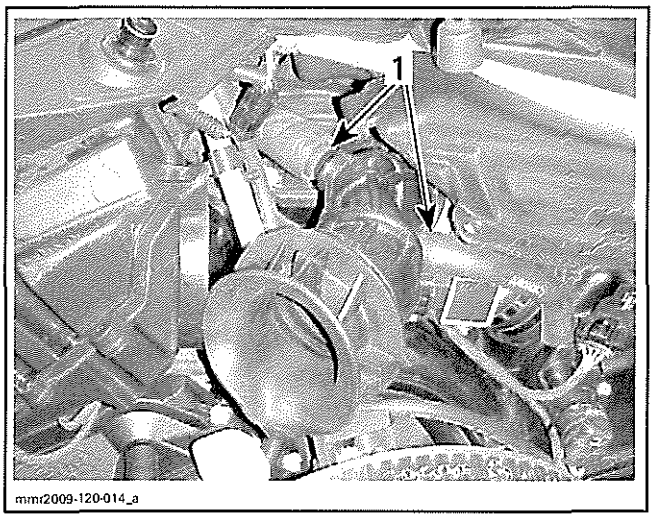
TYPICAL
1. Disconnect here



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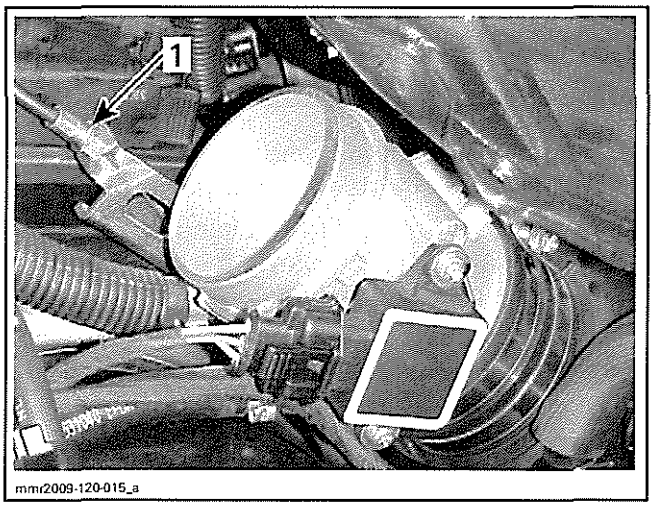
TYPICAL
1. Disconnect both hoses

10. Pull out adapter from throttle body.
11. At throttle body, unlock top nut.



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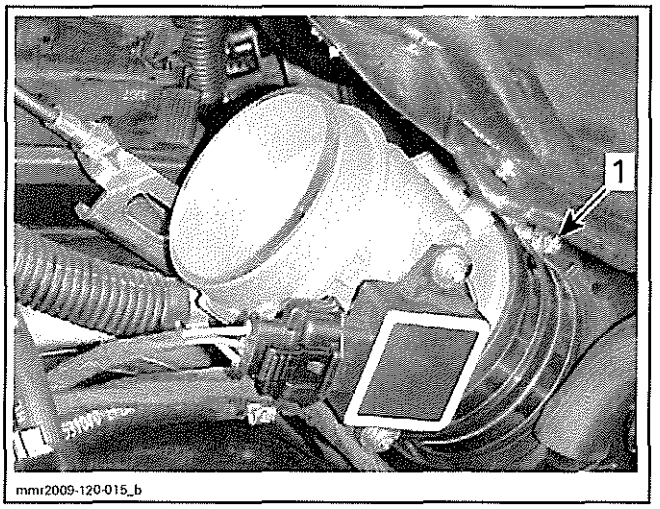
TYPICAL
1. Top nut

12. Loosen throttle body clamp.



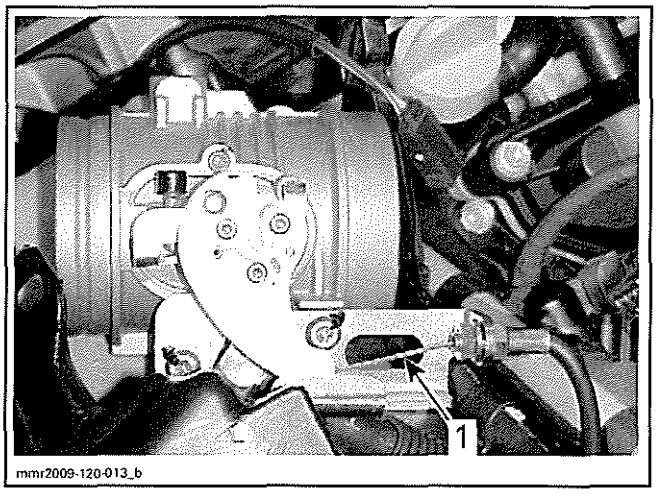
TYPICAL
1. Clamp

⚠ WARNING

When electrically disconnecting or removing the throttle body or the idle air control valve (IACV) from the intake manifold, always remove the tether cord from the engine cut-off switch and disconnect the battery.

13. Pull throttle body out and turn it towards you for access to throttle cable attachment.
14. Remove throttle cable retaining nut and pull cable out through the slot in the cable support.
15. Detach throttle cable from the throttle plate actuating cam.

NOTE: Be careful not to drop the throttle cable retainer when removing it from the throttle plate actuating cam.



TYPICAL
1. Throttle cable

16. Remove throttle cable from vehicle.

Throttle Cable Installation

For throttle cable installation, reverse the removal procedure however, pay attention to the following.

1. Route throttle cable as per factory installation noted before removal.

NOTICE **Do not alter throttle cable routing. Incorrect cable routing may cause the engine to be difficult to start or to idle erratically.**

2. Ensure cable ends are properly secured in the throttle lever and throttle plate actuating cam.

THROTTLE CABLE RETAINING NUT TORQUE (AT THROTTLE BODY)
4.5 N•m (40 lbf•**in**)

3. Proceed with *THROTTLE CABLE ADJUSTMENT* as described in this subsection.

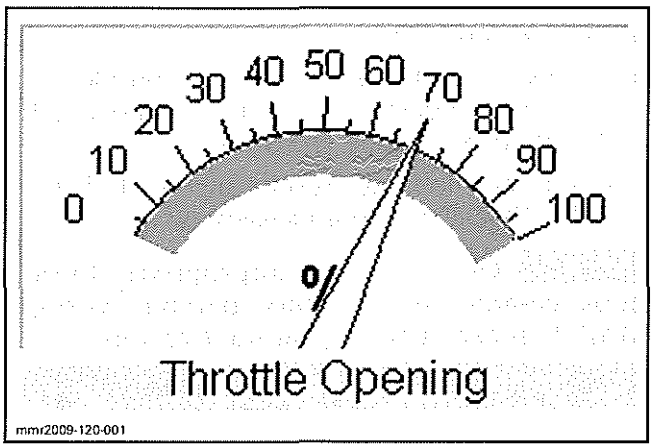
Throttle Cable Adjustment

Wide Open Throttle Position Adjustment

1. Position handlebar in the straight ahead position.
2. Connect vehicle to applicable B.U.D.S. version. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
3. In B.U.D.S., select the following:
   - **Monitoring** page tab
   - **ECM** page.
4. Observe the throttle opening in B.U.D.S. while holding throttle lever at wide open throttle (WOT).

The displayed value must be within the following specification.

THROTTLE OPENING (WIDE OPEN THROTTLE)
68 - 72%

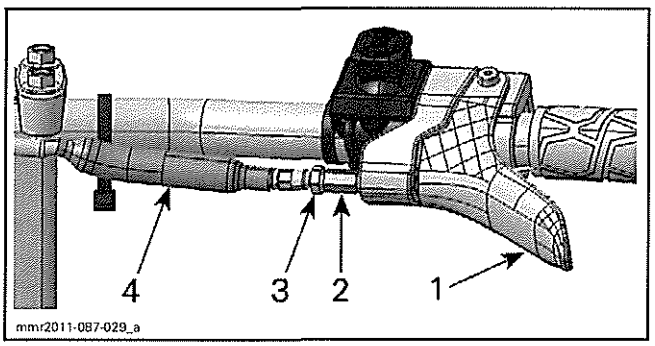


MONITORING AND ECM TABS

NOTE: , There will be no performance loss as long as the throttle opening is within the specification, even if it is not fully opened.

If reading is not within specification, adjust throttle cable.

5. Pull protector back from throttle cable adjuster.
6. Loosen lock nut on the cable adjuster.



1. *Throttle lever*
2. *Cable adjuster*
3. *Adjuster lock nut*
4. *Adjuster protector*

7. Set cable adjuster as required then tighten lock nut.

NOTE: If value is below the minimum, tighten throttle cable adjuster. If value is above the maximum value, loosen throttle cable adjuster.

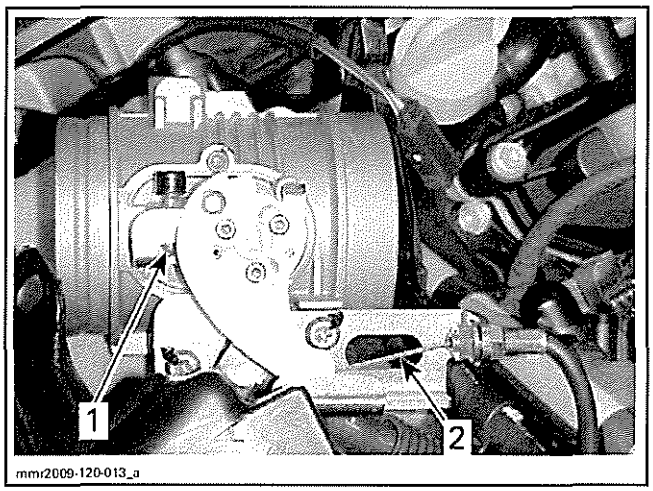
LOCK NUT TORQUE (THROTTLE CABLE ADJUSTER)
2.5 N•m (22 lbf•**in**)

8. Turn handlebar side to side and ensure adjustment is still within the specification in each position while at WOT.
9. Carry out the *IDLE POSITION VERIFICATION.*

Idle Position Verification

1. Apply and release throttle lever a few times.
2. While throttle is released, ensure the following:
   - Throttle cam idle stop rests against the idle stop screw
   - No tension on throttle cable
   - There is some throttle free-play between throttle lever and housing.
   - The throttle opening indicated in B.U.D.S. is zero (0).

NOTE: Use a flashlight and look at the throttle body from the RH side to see the throttle cam and the idle stop screw.



TYPICAL
1. *Contact here*
2. *Free-play here*

3. If the above conditions are not met, adjust throttle cable as detailed in *WIDE OPEN THROTTLE POSITION ADJUSTMENT.*

NOTICE If there is no free-play at idle position, it may cause the engine to be difficult to start, or to idle erratically.

4. If all conditions are met except for the throttle opening indication in B.U.D.S., carry out the *CLOSED THROTTLE RESET* procedure as described in this subsection.

THROTTLE BODY

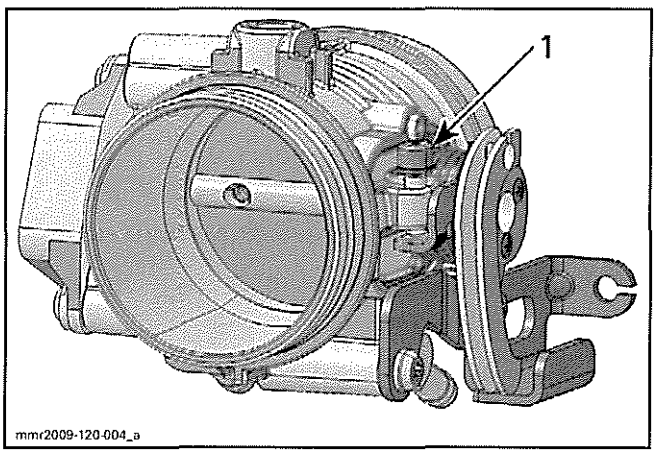
Throttle Body Access

Remove the following parts:
- LH side panel (refer to *BODY* subsection)
- Drive belt guard (refer to *DRIVE SYSTEM AND BRAKE* subsection)
- Gauge support and intake silencer as a unit (refer to *AIR INTAKE SYSTEM* subsection).

Throttle Body Inspection

1. Remove parts required to access throttle body, refer to *THROTTLE BODY ACCESS*.

NOTICE Never attempt to adjust the capped idle stop screw. It is calibrated at the factory. If the screw adjustment is changed, the throttle body must be replaced.



1. Capped screw (DO NOT TAMPER)

2. Carry out the following:
   - Inspect throttle body for cleanliness.
   - Ensure throttle plate opens fully and smoothly.
   - Check if throttle body idle stop screw is loose or worn. If so, throttle body must be replaced.
   - Check if TPS (throttle position sensor) is loose.
   - Check for corroded or damaged wiring or connectors on TPS.

Throttle Body Lubrication

No lubrication is required.

Throttle Body Cleaning

1. Remove parts required to access throttle body, refer to *THROTTLE BODY ACCESS*.
2. Check throttle body cleanliness using a flashlight. Fully open throttle plate and inspect:
   - Throttle body bore
   - Throttle plate edge
   - Air orifice.

Look for:
- Dirt
- Oily surfaces
- Carbon deposits on throttle plate and the surrounding bore.

3. Clean as necessary.
4. To clean throttle body, remove throttle body from intake manifold without disconnecting the throttle cable, hoses and wires.
5. Use a throttle body cleaner such as GUNK INTAKE MEDIC or the equivalent.

NOTICE Only use an appropriate throttle body cleaner that will not damage O-rings, MAPTS sensor and idle air control valve.

⚠ WARNING

Use the product in well ventilated area. Refer to product manufacturer's warnings.

6. To avoid getting dirt into engine, spray cleaner on a clean rag then rub rag against throttle plate and bore. A toothbrush works well too.
7. Fully open throttle and hold to reach all surfaces.
8. To remove residual dirt, spray cleaner on throttle plate and on bore.
9. Reinstall all removed parts.

Throttle Body Removal

⚠ WARNING

When electrically disconnecting or removing the throttle body or the idle air control valve (IACV) from the intake manifold, always remove the tether cord from the engine cut-off switch and disconnect the battery.

1. Remove parts required to access throttle body, refer to *THROTTLE BODY ACCESS*.
2. Disconnect TPS connector.
3. Detach throttle body from intake manifold.
4. Disconnect throttle cable from throttle body.
5. Install a SMALL HOSE PINCHER (P/N 295 000 076) on each coolant hose connected to the throttle body.
6. Disconnect coolant hoses from throttle body.
7. Remove throttle body.

Throttle Body Installation

Installation of the throttle body is the reverse of the removal procedure. However, pay attention for the following details.

1. Install throttle cable on throttle body, refer to *THROTTLE CABLE INSTALLATION*.
2. Install throttle body on intake manifold.

3. Ensure throttle cable is properly locked. Activate throttle lever several times.
4. Check throttle cable adjustment.
5. Install new clamps on coolant hoses connected to throttle body using OETIKER PLIERS (P/N 295 000 070).
6. Refill and bleed cooling system if necessary. Refer to *COOLING SYSTEM.*
7. Carry out the *WIDE OPEN THROTTLE ADJUSTMENT* and *IDLE POSITION VERIFICATION* procedures as described in this subsection.

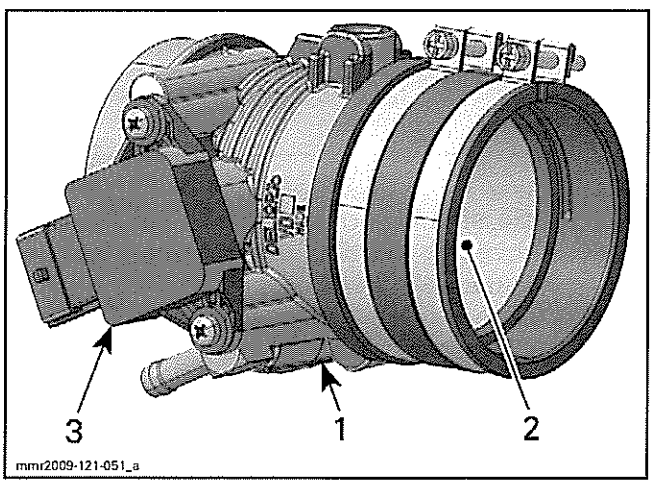
NOTE: If the throttle body was replaced, perform a *CLOSED THROTTLE RESET* and an *IACV AUTO RESET* procedures as described in this subsection.

8. Install all remaining removed parts, refer to applicable subsections.
9. Start engine and ensure proper idle and throttle control.

THROTTLE POSITION SENSOR (TPS)

TPS Description

The throttle position sensor (TPS) is a potentiometer that sends a signal to the ECM that is proportional to the throttle plate angle.



1. *Throttle body*
2. *Throttle plate*
3. *TPS (Throttle Position Sensor)*

TPS Access

1. Open the LH side body panel.
2. Remove the drive belt guard, refer to *DRIVE BELT* subsection.

TPS Closed Throttle Reset

General Information

This operation performs a reset of the TPS (throttle position sensor) values in the ECM when the throttle is closed. This reset is very important as the setting of the TPS will determine the basic parameters for all fuel mapping and several ECM calculations for idle speed control of the engine.

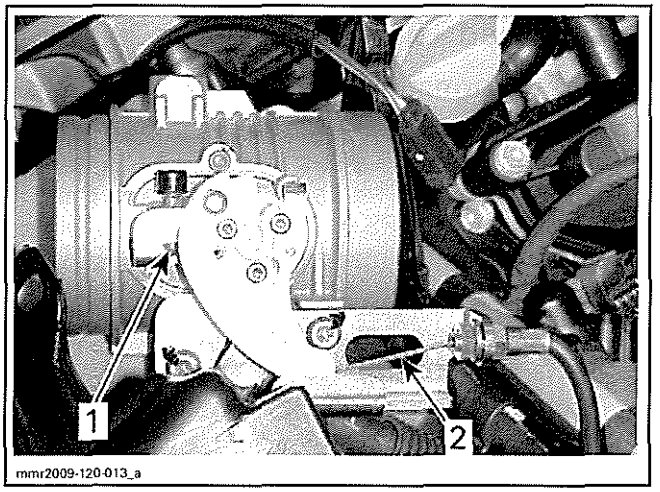
A closed throttle reset must be carried out if the :
- TPS is loosened, removed or replaced.
- Throttle body is replaced.
- ECM is replaced.

NOTICE A *CLOSED THROTTLE RESET* must be carried out anytime the TPS has been loosened, removed or replaced. An improperly set TPS may lead to poor engine performance, engine stalls, fault codes and possible engine damage. Emission compliance may also be affected.

Closed Throttle Reset Procedure (TPS)

1. Remove the LH and RH side body panels.
2. Connect vehicle to the applicable B.U.D.S. software version to perform this adjustment. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
3. Open throttle approximately one quarter travel then quickly release.
4. Repeat 2 - 3 times to settle throttle plate.
5. Ensure the throttle cam of throttle body rests against idle stop screw without any tension in the cable. Otherwise, perform the throttle cable adjustment. Refer to *THROTTLE CABLE ADJUSTMENT* in this subsection.

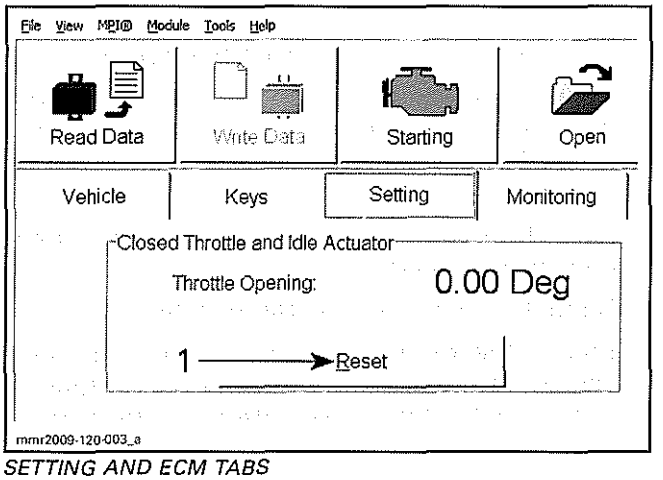
NOTE: Use a flashlight and look from the RH side to see the throttle cam and the idle stop screw.



1. Contact here
2. Free-play here

NOTICE Do not alter the setting of the capped screw, otherwise throttle body must be replaced.

6. In B.U.D.S., click on the **Reset** button.



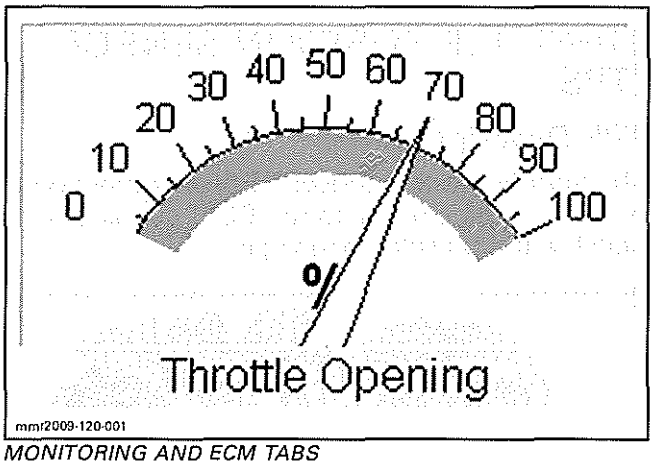
SETTING AND ECM TABS
1. Click Reset

IMPORTANT: If TPS is not within the allowed range when the **Closed Throttle Reset** is carried out, B.U.D.S. will display a message box and will not accept the setting. Exit B.U.D.S., remove tether cord from engine cut-off switch and wait for the ECM to shut down. Check throttle cable adjustment and repeat the reset.

7. If a fault message box is displayed:
   - Follow the instructions in the message box(es)
   - Check throttle cable adjustment
   - Check for fault codes, refer to *DIAGNOSTIC AND FAULT CODES*
   - Carry out the service actions
   - Reset the fault
   - Repeat the reset procedure.
8. Start engine and make sure it operates normally through its full engine RPM range. If fault codes appear, refer to *DIAGNOSTIC AND FAULT CODES* subsection.

TPS Wear Test

1. Ensure TPS connector is properly connected.
2. With the engine **turned off**, apply throttle and pay attention for smooth throttle operation without physical stops of the cable.
3. Connect vehicle to the applicable B.U.D.S. software version. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
4. In B.U.D.S., select the following:
   - **Monitoring** page tab
   - **ECM** page tab.
5. Slowly and regularly apply and release the throttle while observing the **Throttle Opening** indication in B.U.D.S.



MONITORING AND ECM TABS

The needle should move gradually and regularly as you move the throttle. If the needle "sticks", bounces, suddenly drops off or if any discrepancy between the throttle movement and the needle movement is noticed, it may indicate a worn TPS that needs to be replaced.

If the indication does not move as expected, perform the *TPS INPUT VOLTAGE TEST* in this subsection.

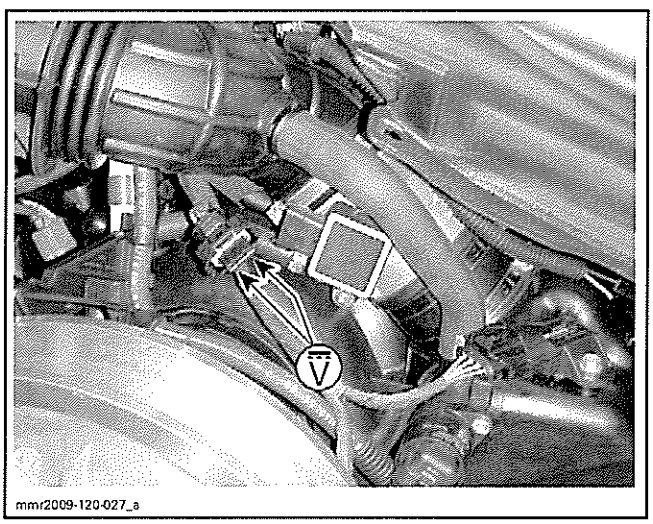
TPS Input Voltage Test

1. Remove parts required to access throttle body, refer to *THROTTLE BODY ACCESS* in this subsection.
2. If connected to B.U.D.S., **disconnect** the T-HARNESS (P/N 529 035 869) from the vehicle diagnostic connector.
3. Disconnect TPS connector.

4. Use theFLUKE 115 MULTIMETER (P/N 529 035 868) and set it to Vdc.

5. Briefly press the START button.
6. Read voltage at TPS harness connector as follows.

TPS HARNESS CONNECTOR		VOLTAGE
Pin 1	Pin 2	5.0 Vdc

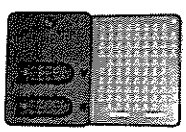


TYPICAL

If voltage is good, carry out the *TPS SIGNAL WIRE TEST.*

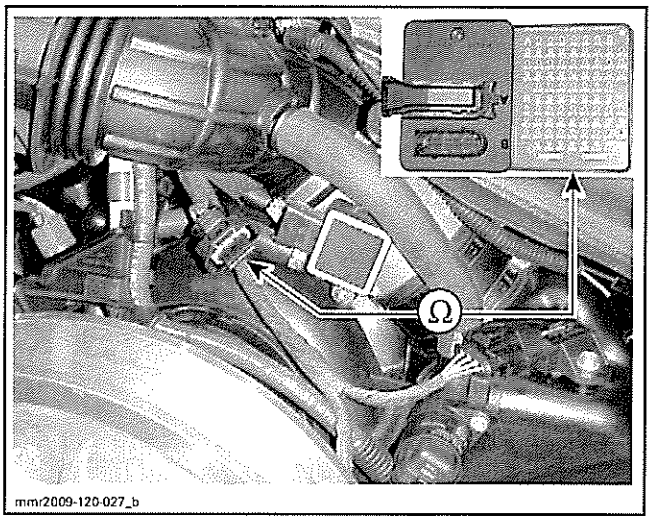
TPS Signal Wire Test

1. Remove parts required to access the ECM connectors, refer to *ECM CONNECTOR ACCESS* in this subsection.
2. Disconnect ECM A connector from the ECM and install it on the ECM adapter tool.

ECM ADAPTER TOOL (P/N 420 277 010)	

3. Test for continuity as follows

TPS HARNESS CONNECTOR	ECM A CONNECTOR	RESISTANCE
Pin 3	Pin A-24	Close to 0 Ω (continuity)



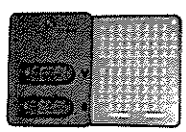
TYPICAL

If the TPS signal wire tests good, carry out the *TPS RESISTANCE TEST* before assuming the TPS is at fault.

If the TPS signal wire does not test good, repair or replace wiring and connectors.

TPS Resistance Test

1. Remove parts required to fully access the throttle body, refer to *THROTTLE BODY ACCESS* in this subsection.
2. Ensure the TPS connector is properly connected.
3. Ensure ECM connector A is properly installed on the ECM adapter tool.

ECM ADAPTER TOOL (P/N 420 277 010)	

4. Using the FLUKE 115 MULTIMETER (P/N 529 035 868), check resistive value as per the following table.

IMPORTANT: For the WOT measurement, manually open the throttle plate until the throttle cam touches its stopper. Using the throttle lever on the handlebar will not fully open the throttle plate.

ECM ADAPTER		THROTTLE IDLE POSITION	WIDE OPEN THROTTLE POSITION
PIN		RESISTANCE Ω	
A-24	A-25	880 - 1300	2390 - 2810
A-25	A-39	1600 - 2400	1600 - 2460
A-24	A-39	2390 - 2810	880 - 1300

NOTE: The resistance value should change smoothly and proportionally to the throttle movement. Otherwise, replace TPS.

If resistance values are correct, try a new ECM. Refer to *ENGINE CONTROL MODULE (ECM)* in this subsection.

If resistance values are incorrect, replace the TPS.

TPS Removal

1. Remove parts required to access the LH side of the throttle body, refer to *THROTTLE BODY ACCESS* in this subsection.
2. Disconnect the TPS connector.
3. Remove TPS retaining screws.
4. Remove TPS from throttle body.

TPS Installation

Installation is the reverse of removal however, pay attention to the following.

TPS INSTALLATION	
O-RING	SERVICE PRODUCT
	APPLY ENGINE OIL ON O-RING
MOUNTING SCREWS	SERVICE PRODUCT
	LOCTITE 243 (BLUE) (P/N 293 800 060)
	TORQUE
	3 N•m (27 lbf•**in**)

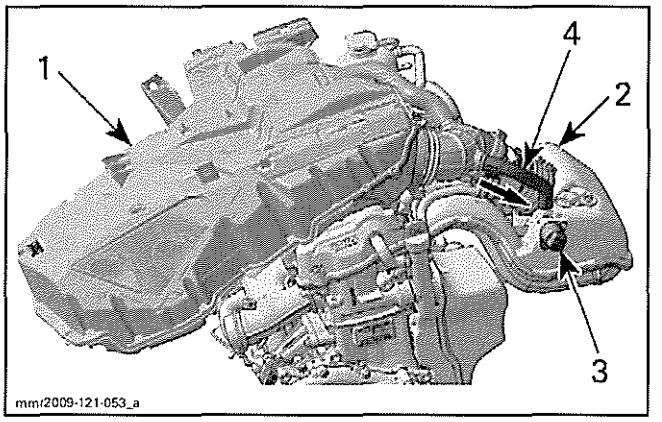
Carry out a *CLOSED THROTTLE RESET* as described in this subsection.

NOTICE A closed throttle reset must be carried out anytime the TPS has been loosened, removed or replaced. An improperly set TPS may lead to poor engine performance, engine stalls, fault codes and possible engine damage. Emission compliance may also be affected.

IDLE AIR CONTROL VALVE (IACV)

If IACV is to be removed, refer to *IACV REMOVAL* in this subsection. Important instructions are given to prevent damaging the IACV.

NOTICE Do not perform any test on the IACV when it is disassembled, otherwise it will be damaged.



TYPICAL
1. *Air intake silencer*
2. *Intake manifold*
3. *IACV (Idle air control valve)*
4. *Bypass hose*

IACV Auto Reset

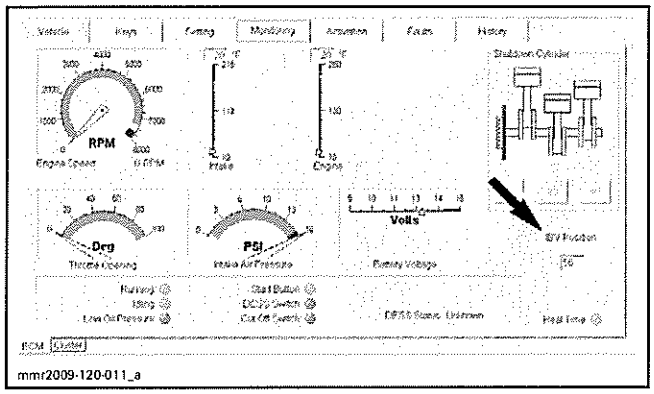
When the engine is shut down, just before the ECM turns off, the IACV will completely close to find its zero position. It will then back out a number of steps and park to this reference position.

If idle speed is not stable or is inaccurate, reset the IACV as follows:

1. Power the ECM by briefly pressing the START button.
2. Remove tether cord from engine cut-off switch.
3. Wait until multifunction gauge turns off.
4. Repeat steps 1 - 3 two to three times.
5. Start the engine and let it warm up.
6. Stop the engine.
7. Start engine and let it idle for a few seconds.
8. Stop the engine.
9. Repeat steps 5 - 8 four to five times.

IACV Information in B.U.D.S. Software

1. Start engine and let warm up.
2. Use B.U.D.S. and read IACV position while engine is idling.



MONITORING AND ECM TABS - IBV INFORMATION

NOTE: The IACV Position is displayed for information purposes only.

The IACV is controlled by a stepper motor (via the ECM) and the value given is the position of the stepper motor.

The value is given in steps. See chart.

IACV STEPS IN B.U.D.S.	VALVE POSITION
0	Fully closed
Typical values: 15 - 50 (1)	Partially open
150	Fully open

(1) Typical IACV values at idle are given for a warm engine and vary depending on altitude, air temperature, throttle body and production tolerances.

The ECM constantly controls the IACV to maintain engine idle target speed when the throttle is closed.

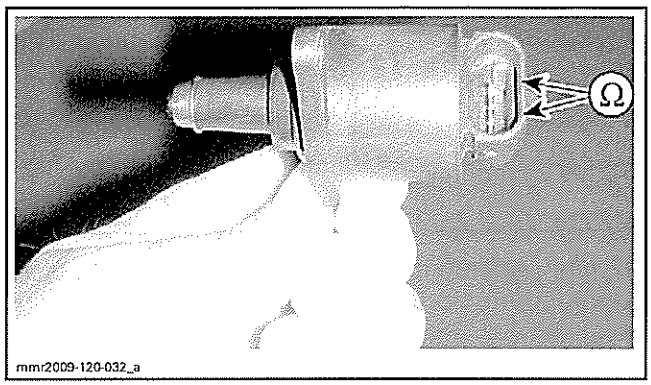
NOTE: An engine giving an IACV position outside of this range is not necessarily faulty. It may only provide clues if poor idle or light throttle behavior is experienced. Lower values may indicate a leakage in the air intake system or in the idle air control system. Higher values may suggest a dirty throttle body, obstructed idle bypass passages etc.

IACV Resistance Test (at Component)

NOTE: An idle air control valve with good resistance measurement can still be faulty. IA mechanical failure may occur which, may not detectable without measuring the air flow. Replacing the IACV may be necessary as a test.

1. Disconnect IACV connector.
2. Remove IACV from intake manifold.
3. Check the resistance between pins as follows.

IACV		MEASUREMENT
PIN		RESISTANCE @ 20°C (68°F)
A	D	Approximately 50 Ω
C	B	



TYPICAL IACV

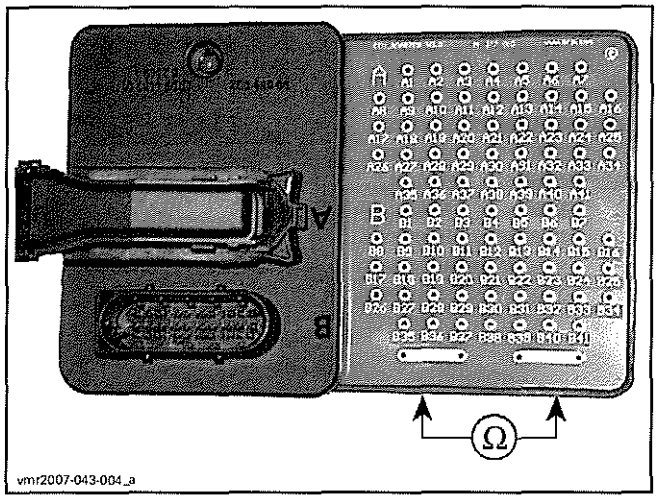
If the resistance is not as specified, replace the IACV.

If resistance test is good, refer to *IACV RESISTANCE TEST (AT ECM CONNECTOR.*

IACV Resistance Test (at ECM Connector)

1. Reconnect IACV connector.
2. Remove parts required to access ECM connector, refer to *ECM CONNECTOR ACCESS* in this subsection.
3. Disconnect ECM A connector and connect it to the ECM ADAPTER TOOL (P/N 420 277 010).
4. Set multimeter to Ω and read resistance as follows.

ECM ADAPTER		MEASUREMENT
PIN		RESISTANCE @ 20°C (68°F)
A-35	A-36	Approximately 50 Ω
A-37	A-38	

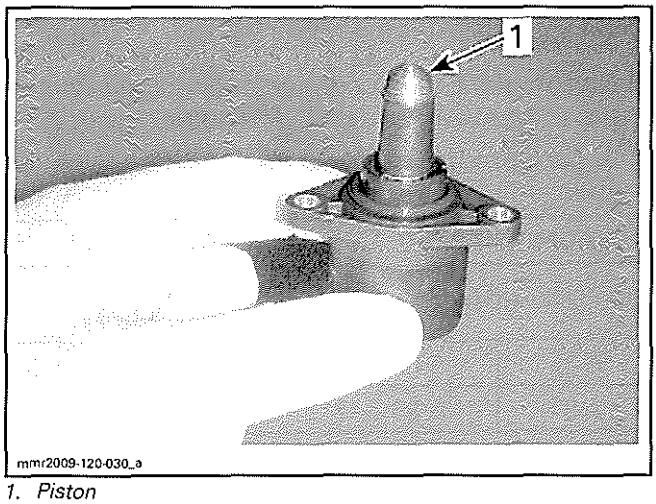


If any resistance test failed, repair/replace wiring/connectors between IACV and ECM.

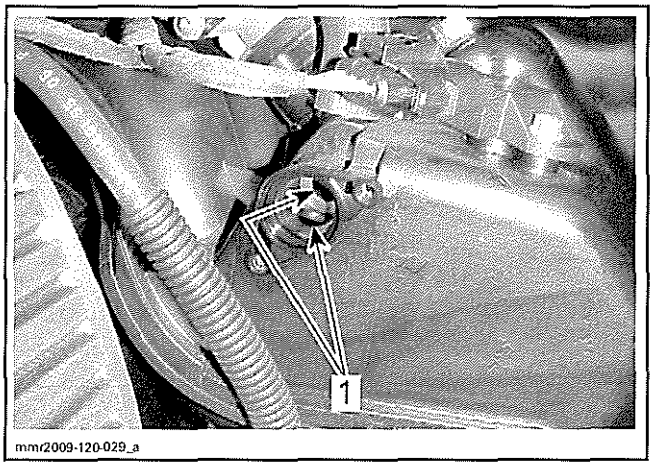
If resistance test are good and all valve maintenance and reset procedures have been carried out, check ECM. Refer to *ECM.* in this subsection.

IACV Visual Inspection and Cleaning

1. Refer to *IACV REMOVAL* in this subsection and remove IACV from throttle body. **Important safety instructions** are given.
2. Check the piston and idle air bypass ports in intake manifold for dirt or deposits which can cause the piston to stick.



1. Piston



1. Air passages

3. Using a parts cleaner, clean idle bypass channel in intake manifold and bypass hose from contamination, then use an air gun to dry them.
4. Install IACV on the intake manifold.
5. Reconnect the battery.

IACV Removal

1. Remove tether cord from engine cut-off switch and disconnect the battery.

⚠ WARNING

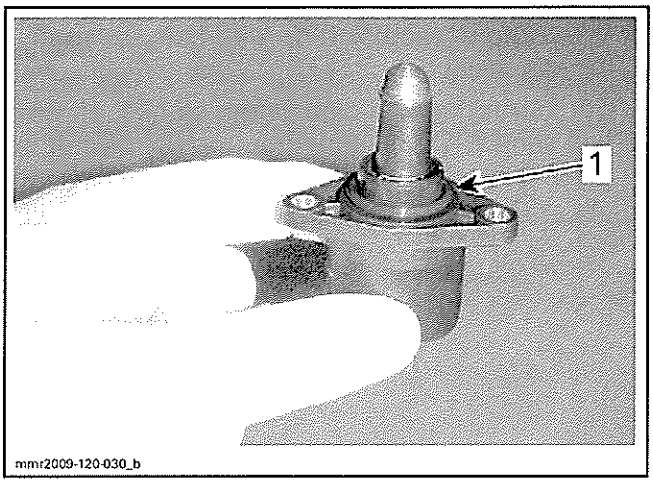
When electrically disconnecting or removing the throttle body or the idle air control valve (IACV) from the intake manifold, always remove the tether cord from the engine cut-off switch and disconnect the battery.

NOTICE Do not attempt to operate the piston of the IACV when it is removed from the intake manifold. Also do not move the piston by hand. The screw drive is very sensitive and will be damaged.

2. Disconnect IACV connector.
3. Remove retaining screw.
4. Pull IACV out of intake manifold.

IACV Installation

1. Inspect IACV O-ring condition. Replace as necessary.



TYPICAL
1. O-ring

2. Install IACV.

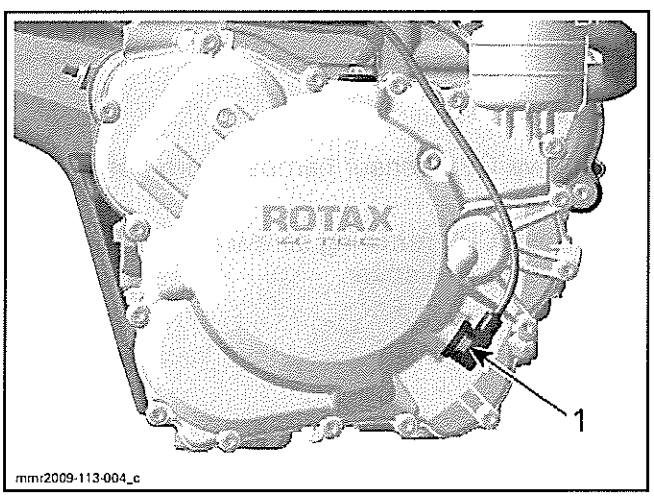
IACV RETAINING SCREW TORQUE
2.5 N•m (22 lbf•**in**)

CRANKSHAFT POSITION SENSOR (CPS)

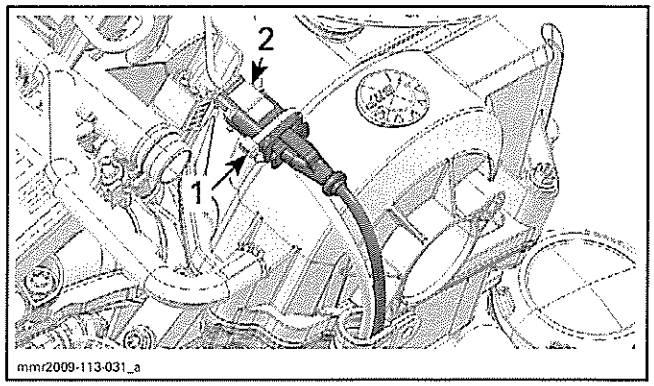
NOTE: If fault code P0339 is present and CPS succeeded to all tests below, refer to *DIAGNOSTIC AND FAULT CODES.*

CPS Access

1. Remove RH side body panel, refer to *BODY* subsection.
2. Remove muffler, refer to *EXHAUST SYSTEM* subsection.



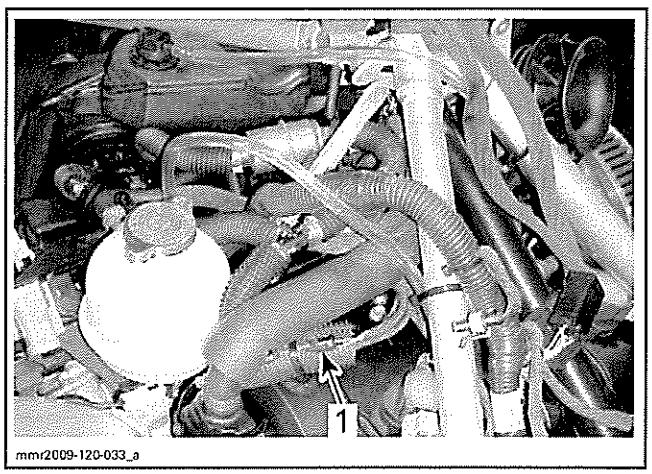
1. CPS



TYPICAL - TOP RH SIDE OF ENGINE
1. Locking tie
2. CPS sensor connector

CPS Output Voltage Test

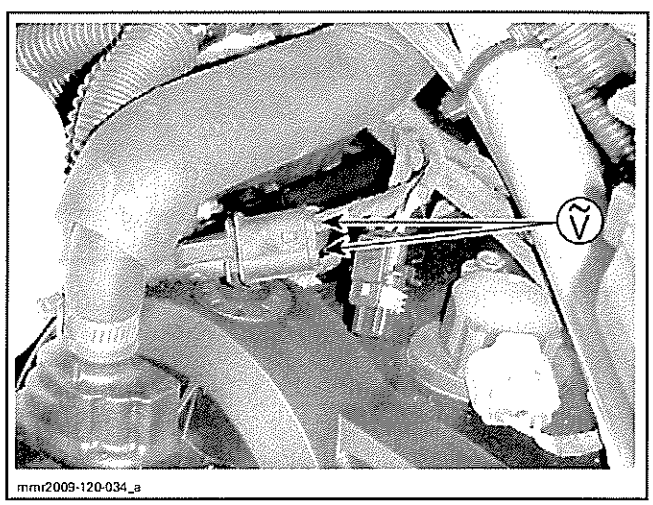
1. Disconnect CPS connector.



TYPICAL
1. CPS connector

2. Probe terminals coming from CPS while cranking engine.

CPS CONNECTOR		VOLTAGE
Pin 1	Pin 2	1 - 2 Vac min.

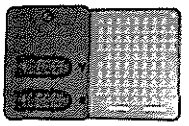


TYPICAL

If voltage is out of specification, inspect wiring/connectors. Replace CPS if wiring is good.

CPS Resistance Test

1. Remove parts required to access ECM connector, refer to *ECM CONNECTOR ACCESS* in this subsection.
2. Disconnect ECM-A connector and install it on the ECM adapter tool.

ECM ADAPTER TOOL (P/N 420 277 010)	

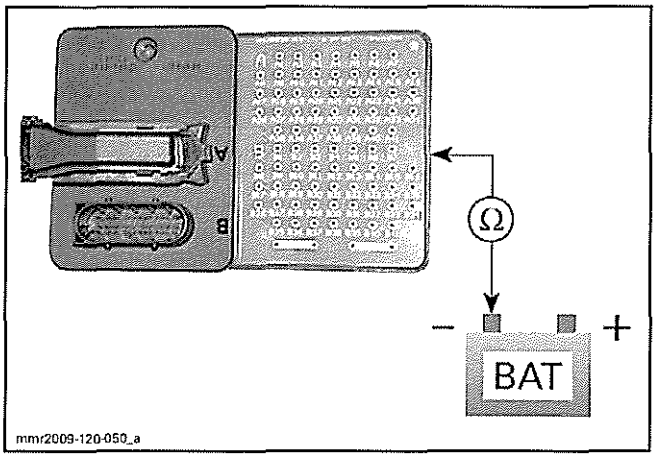
3. Reconnect CPS connector.
4. Measure the resistance of the sensor as per following table.

ECM A CONNECTOR		RESISTANCE @ 20°C (68°F)
Pin A-5	Pin A-19	775 - 950 Ω

If measurement is out of specification, check wiring continuity between ECM and CPS. Refer to *WIRING DIAGRAM* subsection.

Also check for a short circuit to ground as follows.

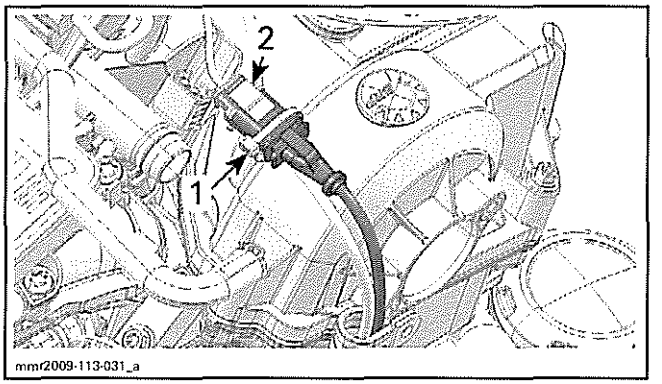
ECM A CONNECTOR		RESISTANCE @ 20°C (68°F)
Pin A-5	Engine ground	Open circuit (OL)
Pin A-19	Engine ground	



If measurement is out of specification, carry out a continuity test of the wiring between ECM and CPS.

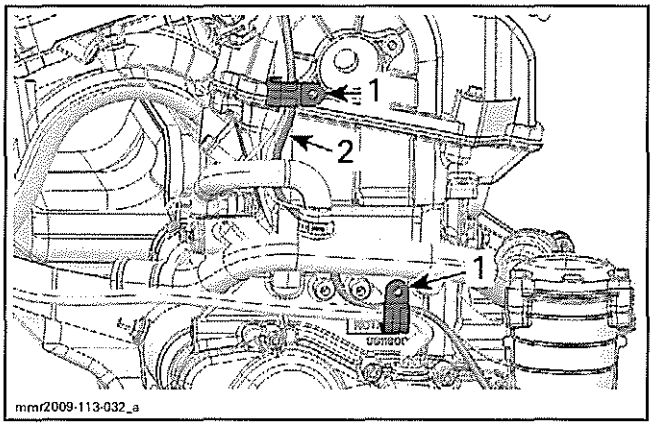
CPS Replacement

1. Remove parts required to access the CPS, refer to *CPS ACCESS* in this subsection.
2. Take note of factory CPS wire harness routing for reinstallation.
3. Cut locking tie and disconnect crankshaft position sensor (CPS) connector (top RH side of engine).



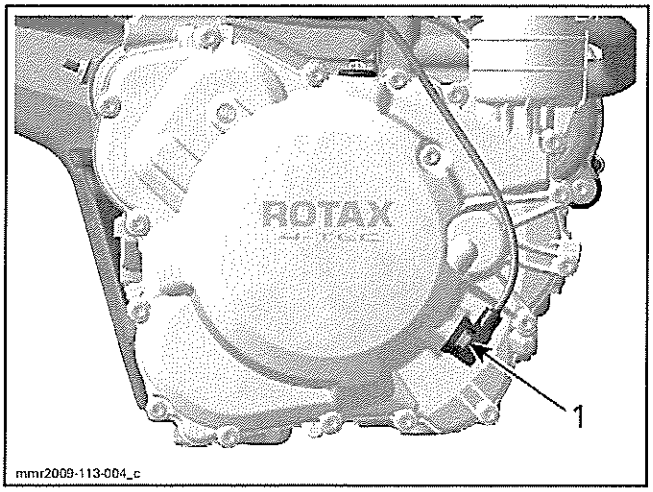
TYPICAL
1. *Locking tie*
2. *CPS sensor connector*

4. Remove retaining screw and open CPS harness retaining clamps (2).



TYPICAL
1. *CPS harness clamps*
2. *CPS sensor wire*

5. Remove CPS sensor harness from both retaining clamps.
6. Remove CPS retaining screw and remove CPS from magneto cover.



TYPICAL
1. CPS retaining screw

7. Install new CPS.

CPS INSTALLATION	
O-RING	SERVICE PRODUCT
	XPS SYNTHETIC GREASE (P/N 293 550 010)
SENSOR SCREW	TORQUE
	11 N•m ± 1 N•m (97 lbf•**in** ± 9 lbf•**in**)

8. Route and secure CPS harness using harness clamps and locking tie as noted prior to removal.

CAMSHAFT POSITION SENSOR (CAPS)

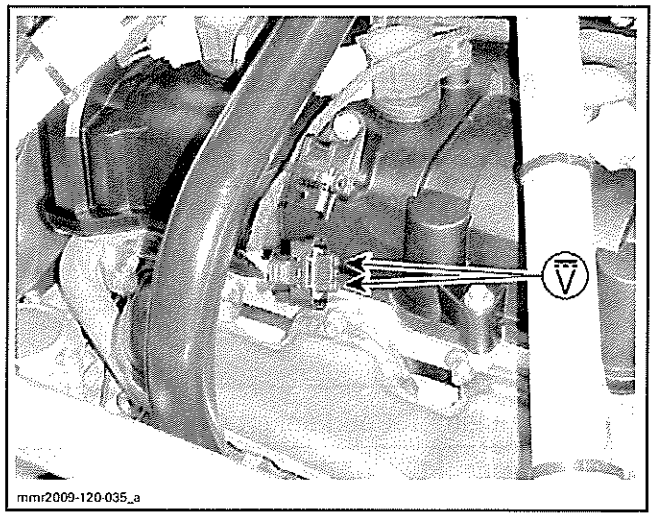
CAPS Voltage Test (Harness Side)

1. Remove air intake silencer and gauge support as a unit. Refer to *AIR INTAKE SYSTEM*.
2. Disconnect CAPS connector.
3. Briefly press START button.

NOTE: Do not install tether cord.

4. Use a multimeter and select Vdc.
5. Probe terminals as per following table.

CAPS CONNECTOR		MEASUREMENT
PIN		VOLTAGE
1	3	Battery voltage

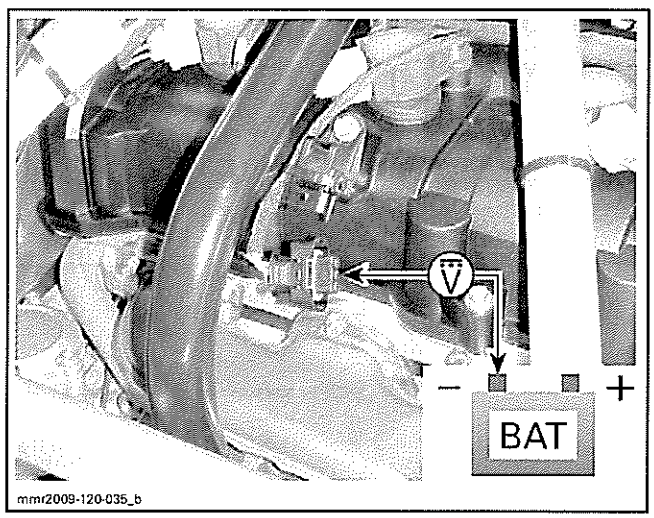


TYPICAL

If battery voltage is read, proceed with *CAPS DYNAMIC TEST* further in this subsection.

If battery voltage is not read, probe circuit as per following table.

CAPS CONNECTOR		MEASUREMENT
PIN		VOLTAGE
3	Battery ground	Battery voltage



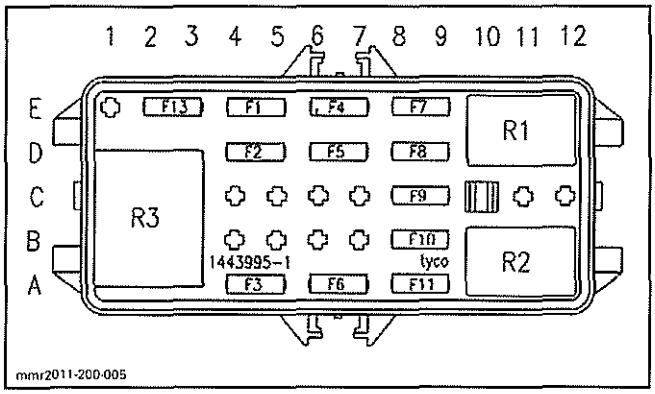
TYPICAL

If battery voltage is read, test ground circuit for continuity. Repair wire/connector if defective.

If voltage is not read, carry out a *CAPS POWER CIRCUIT CONTINUITY TEST*.

CAPS Power Circuit Continuity Test

1. Remove fuse F1 from fuse box.



2. Use a multimeter and select Ω.

FUSE BOX	CAPS CONNECTOR	RESISTANCE
TERMINAL	PIN	Ω
5E	3	Close to 0 Ω (continuity)

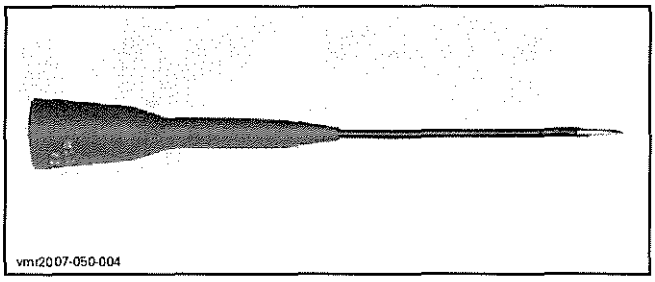
If resistance is not as specified, repair wire/connector between fuse box and CAPS.

If resistance is as specified, power circuit is functional.

3. Reinstall fuse F1.

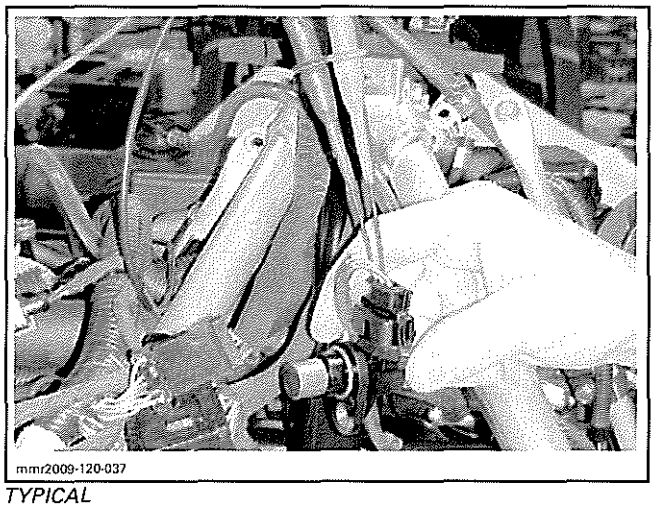
CAPS Dynamic Test

1. Remove CAPS sensor from engine.
2. Use the FLUKE 115 MULTIMETER (P/N 529 035 868).
3. Back-probe connector using FLUKE RIGID BACK PROBE (P/N TP88) or the equivalent.



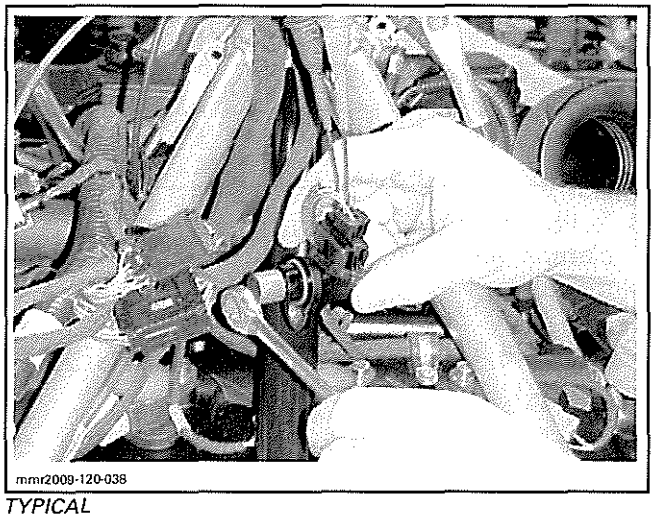
4. Set multimeter to Vdc and read voltage.

CAPS CONDITION	CAPS CONNECTOR		VOLTAGE
Free	2	3	Close to 0 Vdc



TYPICAL

CAPS CONDITION	CAPS CONNECTOR		VOLTAGE
Metallic object on sensor	2	3	Battery voltage



TYPICAL

If voltage is as specified, check/repair wiring/connector between sensor and ECM. If wiring and connectors are good, check ECM. Refer to *ENGINE CONTROL MODULE (ECM).*

If voltage is wrong, try a new CAPS.

CAPS Removal

Remove retaining screw and pull CAPS out.

CAPS Installation

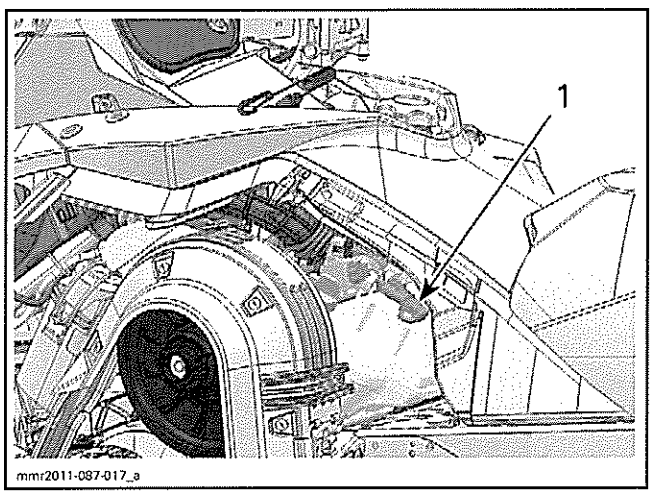
CAPS INSTALLATION	
O-RING	SERVICE PRODUCT
	APPLY ENGINE OIL ON O-RING SEAL
SENSOR SCREW	TORQUE
	11 N•m ± 1 N•m (97 lbf•**in** ± 9 lbf•**in**)

MANIFOLD ABSOLUTE PRESSURE AND TEMPERATURE SENSOR (MAPTS)

NOTE: This sensor is a multifunction device. It measures manifold absolute pressure and intake temperature for air flow calculations.

MAPTS Access

To access the MAPTS, remove the:
- LH side body panel, refer to *BODY* subsection
- Drive belt guard, refer to *DRIVE BELT* subsection.



TYPICAL - MAPTS LOCATION
1. Manifold air pressure and temperature sensor (MAPTS)

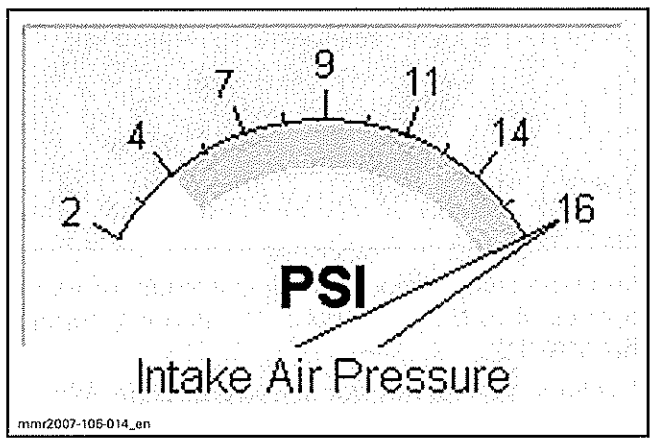
MAPTS Pressure Function

Before the engine is started, when power is applied to the system, the sensor measures the ambient air atmospheric pressure. The ambient pressure is, at that moment, stored in the ECM. Thereafter, once the engine is started, it measures the air pressure in the intake manifold at operating RPMs.

The sensor must be correctly installed on the intake manifold. Otherwise, the MAPTS could generate a fault code for an unexpected sensor range at idle when it reads the atmospheric pressure. If this is the case, remove sensor and check for oil or dirt on its end and if problem persists, check throttle plate condition/position and the wiring harness. Perform the following tests.

MAPTS Quick Test (Pressure Function)

1. Connect vehicle to the applicable B.U.D.S. software, refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. In B.U.D.S., select the following:
   - Read Data button
   - Monitoring page tab
   - ECM page.
3. On the monitoring page, read the Intake Air Pressure indication.



MONITORING AND ECM TABS

The indicated intake air pressure in B.U.D.S. must be within 3.4 kPa (.5 PSI) of local atmospheric pressure when the engine is stopped.

MAPTS PRESSURE FUNCTION QUICK TEST			
RESULT	SERVICE ACTION		
NO READING	Circuit Continuity Test of MAPTS Pressure Function	MAPTS Input Voltage Test	Repair or replace wiring
VALUE IS OUT OF RANGE	Replace MAPTS		

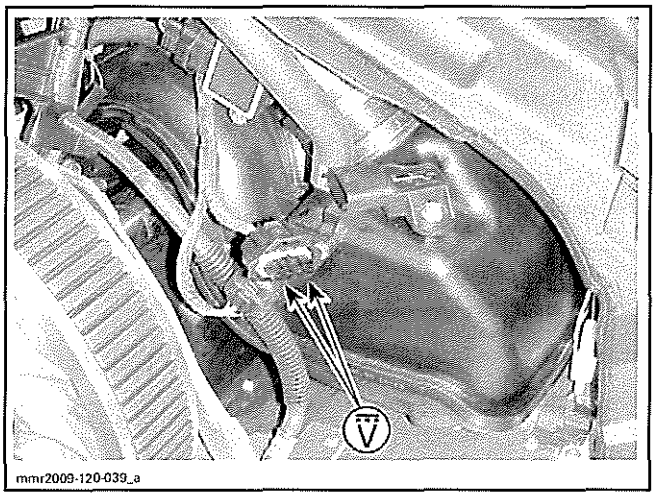
4. Perform the same test with a new MAPTS and compare both readings.

MAPTS Input Voltage Test

1. Remove parts required to access the MAPTS, refer to *MAPTS ACCESS*.
2. Remove electrical connector from MAPTS.

3. Use a multimeter and select Vdc.
4. Briefly press START button.
5. Read voltage as follows.

MAPTS CONNECTOR		MEASUREMENT
PIN		VOLTAGE
1	3	5 Vdc



If voltage test is good, Check continuity of wiring from pin 4 to ECM A pin 12. If it is good, replace the MAPTS.

If voltage test is not good, carry out the *MAPTS CIRCUIT CONTINUITY TEST (PRESSURE FUNCTION).*

MAPTS Circuit Continuity Test (Pressure Function)

1. Remove parts required to access ECM connectors, refer to *ECM CONNECTOR ACCESS* in this subsection.
2. Disconnect connector A from the ECM.
3. Install ECM ADAPTER TOOL (P/N 420 277 010) on ECM-A connector.
4. Using a multimeter set to Ω, check continuity of the following circuits.

MAPTS CIRCUIT CONTINUITY TEST (PRESSURE FUNCTION)		
ECM-A	MAPTS CONNECTOR	RESISTANCE VALUE
Pin 40	Pin 3	Close to 0 Ω
Pin 12	Pin 4	
Pin 28	Pin 1	

If wiring harness is good, try a new ECM. Refer to *ECM.*

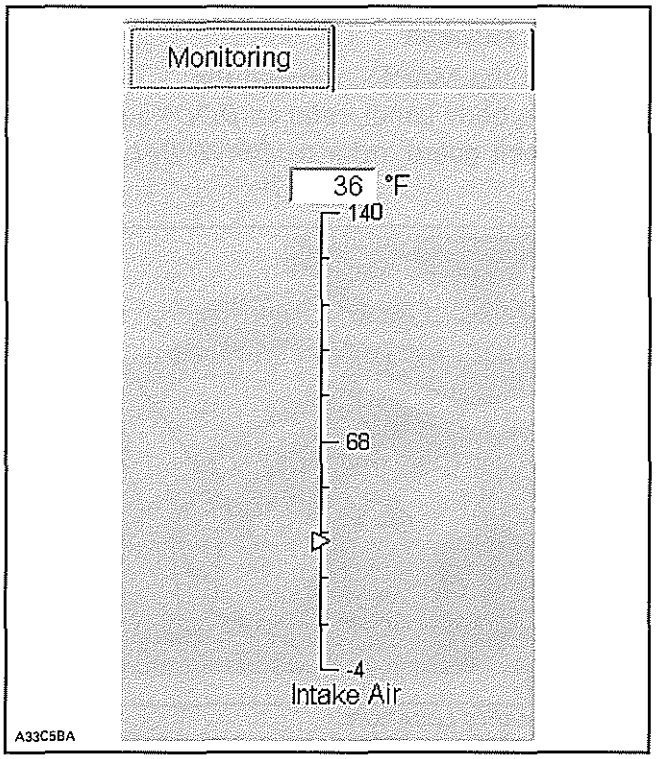
Otherwise, repair or replace wiring harness between ECM and MAPTS. Refer to *WIRING DIAGRAM.*

MAPTS Temperature Function

The MAPTS also monitors the temperature of the air in the intake manifold.

MAPTS Quick Test (Temperature Function)

1. Connect vehicle to the applicable B.U.D.S. software version.
2. In B.U.D.S., select the following:
   - Read Data
   - Monitoring page tab
   - ECM page.
3. Look for the Intake Air temperature reading while the engine is stopped.



MONITORING AND ECM TABS

NOTE: If the complete vehicle is at room temperature, B.U.D.S. should display the ambient temperature at the intake manifold.

4. Perform the same test with a new MAPTS and compare both readings.

If the engine's MAPTS temperature reading is significantly different than the new MAPTS, replace it.

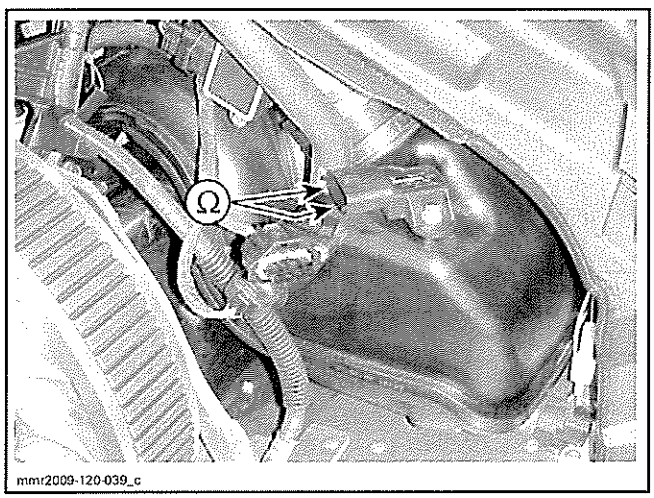
NOTE: Both sensors must feel same ambient air temperature.

If there is no reading, carry out a *MAPTS RESISTANCE TEST (TEMPERATURE FUNCTION).*

MAPTS Resistance Test (Temperature Function)

1. Disconnect the MAPTS connector.
2. Use a multimeter and select Ω.
3. Test MAPTS resistance at the sensor as per following tables.

MAPTS		MEASUREMENT
PIN		Refer to *MAPTS TEMPERATURE SENSOR TABLE*
1	2	



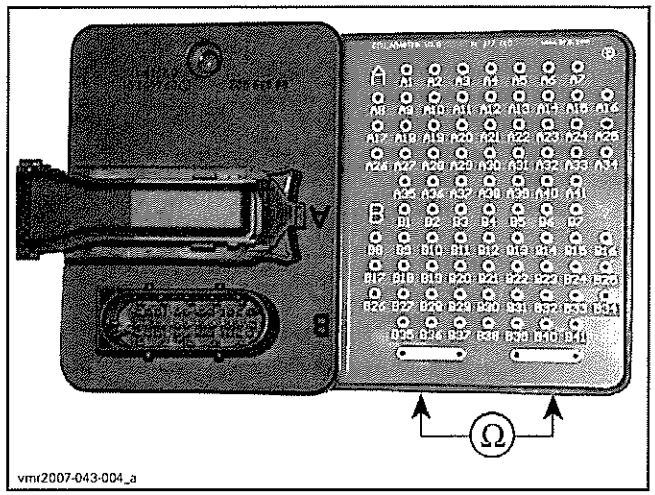
MAPTS TEMPERATURE SENSOR TABLE		
TEMPERATURE		RESISTANCE (ohms)
°C	°F	MAPTS
- 40	- 40	—
- 30	- 22	28000
- 20	- 4	15000
0	32	5500
20	68	2500
40	104	1200
60	140	600
80	176	320
100	212	180
130	266	90

If resistance is not within specification, replace the MAPTS.

If resistance tests good, reconnect the MAPTS and proceed with the following steps.

4. Disconnect the ECM-A connector.
5. Install ECM ADAPTER TOOL (P/N 420 277 010) on ECM-A connector.
6. Use a multimeter and select Ω.
7. Check resistance value as per following table.

ECM ADAPTER		MEASUREMENT
PIN		Refer to *MAPTS TEMPERATURE SENSOR TABLE*
A-7	A-28	



MAPTS TEMPERATURE SENSOR TEST RESULTS			
RESULT	SERVICE ACTION		
NO READING	Circuit Continuity Test of MAPTS Temperature Function	MAPTS Input Voltage Test	Repair or replace wiring
INCORRECT RESISTANCE VALUE	Replace MAPTS		
CORRECT RESISTANCE VALUE	Try a new ECM		

MAPTS Circuit Continuity Test (Temperature Function)

MAPTS CIRCUIT CONTINUITY TEST (TEMPERATURE FUNCTION)		
ECM-A	MAPTS CONNECTOR	RESISTANCE VALUE
Pin 28	Pin 1	Close to 0 Ω
Pin 7	Pin 2	

Repair or replace wiring as required.

MAPTS Removal

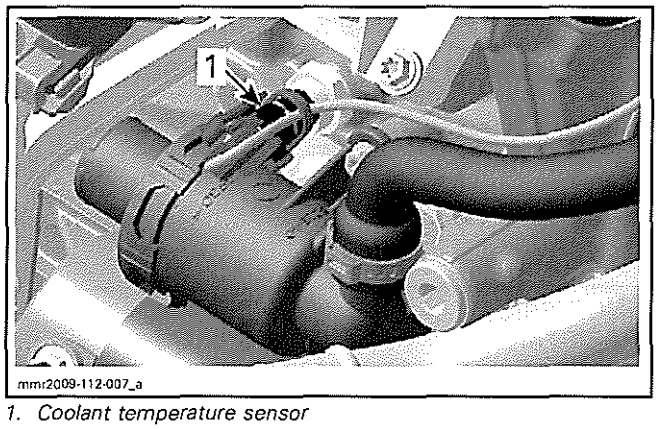
Disconnect MAPTS connector and remove the MAPTS from the intake manifold.

MAPTS Installation

RETAINING SCREW TORQUE
5.5 N•m ± 0.7 N•m (49 lbf•**in** ± 6 lbf•**in**)

COOLANT TEMPERATURE SENSOR (CTS)

The coolant temperature sensor is located on rear side of the cylinder head.



1. Coolant temperature sensor

NOTE: Overheat signals will appear when coolant temperature reaches 110°C (230°F).

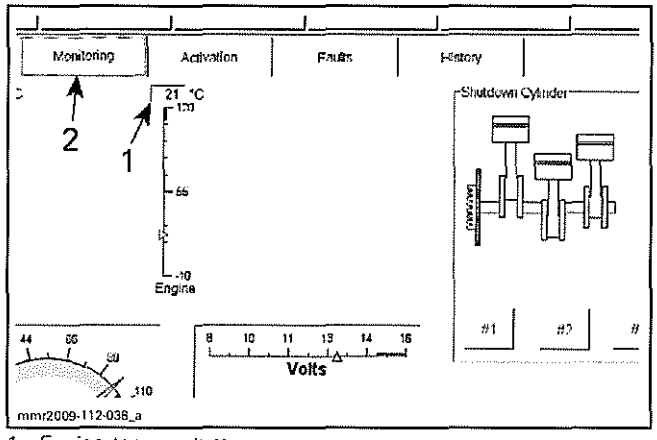
CTS Access

To access the CTS:

– Remove the driven pulley and countershaft. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 HO E-TEC AND 1200 4-TEC)* subsection.

CTS Quick Test

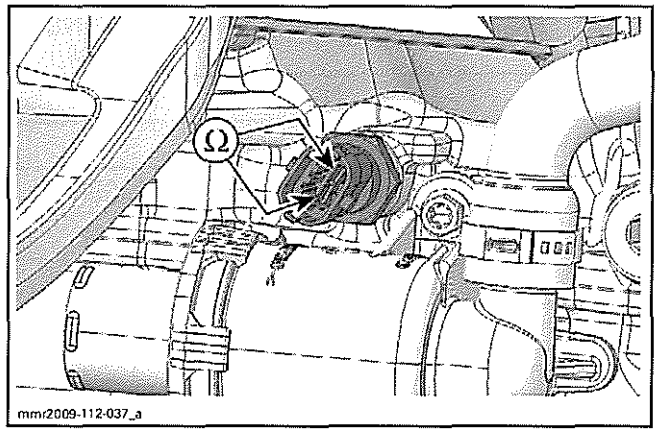
1. Connect the vehicle to the applicable B.U.D.S. software.
2. In B.U.D.S., select the following:
   – Read Data button
   – Monitoring page tab
   – ECM page.
3. Look for the engine temperature indication. The engine temperature gauge in B.U.D.S. should provide an indication of the actual engine coolant temperature. Otherwise, perform the *CTS RESISTANCE TEST.*



1. Engine temperature
2. Monitoring tab

CTS Resistance Test

1. Remove parts required to access CTS. Refer to *CTS ACCESS* in this subsection.
2. Disconnect the connector from the CTS sensor and check the resistance of the sensor itself.



CTS SENSOR		MEASUREMENT
PIN		Refer to *CTS TEMPERATURE SENSOR TABLE*
1	2	

Test the resistance of the sensor as per following tables.

CTS TEMPERATURE SENSOR TABLE				
TEMPERATURE		RESISTANCE (OHMS)		
°C	°F	NOMINAL	LOW	HIGH
- 30	- 22	12600	11800	13400
- 20	- 4	11400	11000	11800
- 10	14	9500	8000	11,000
0	32	5900	4900	6900
10	50	3800	3100	4500
20	68	2500	2200	2800
30	86	1700	1500	1900
40	104	1200	1080	1320
50	122	840	750	930
60	140	630	510	750
70	158	440	370	510
80	176	325	280	370
90	194	245	210	280
100	212	195	160	210
110	230	145	125	160
120	248	115	100	125

NOTE: To test sensor at various temperatures, remove sensor and use a heat gun, ice and a thermometer.

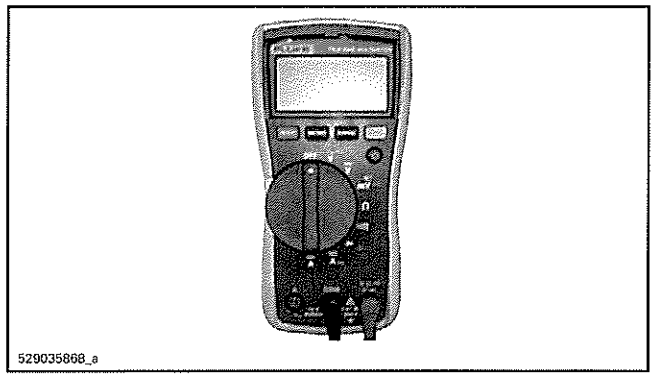
If resistance is out of specification, replace the CTS sensor.

If resistance tests good, check the *CTS CIRCUIT CONTINUITY TEST (WITH SENSOR).*

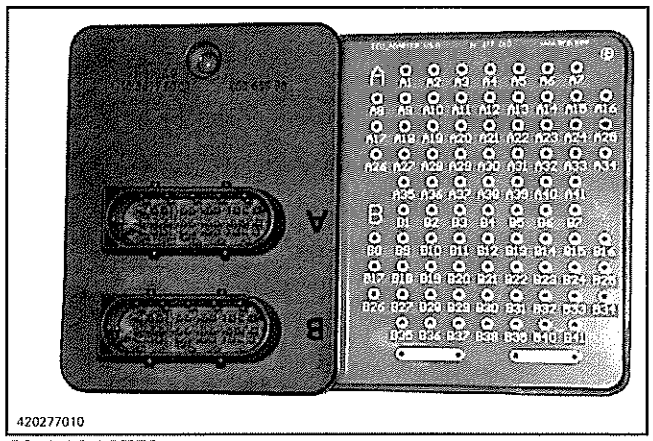
CTS Circuit Continuity Test (with Sensor)

1. Connect the CTS sensor.
2. Remove parts required to access the ECM connectors, refer to *ECM CONNECTOR ACCESS* in this subsection.
3. Remove the air intake silencer and gauge support as a unit, refer to *AIR INTAKE SYSTEM* subsection.
4. Disconnect the ECM-A connector.
5. Using the FLUKE 115 MULTIMETER (P/N 529 035 868) and the ECM ADAPTER TOOL (P/N 420 277 010), check the circuit resistance as per the following table.

ECM ADAPTER		MEASUREMENT
PIN		Refer to *CTS TEMPERATURE SENSOR TABLE*
A-11	A-27	



FLUKE 115 MULTIMETER



ECM ADAPTER

If resistance value is correct, check ECM. See procedure in this subsection.

If resistance value is incorrect, repair the connectors or replace the wiring harness between ECM connector and the CTS sensor.

CTS Replacement

1. Remove the driven pulley and countershaft. Refer to *DRIVEN PULLEY AND COUNTERSHAFT (600 HO E-TEC AND 1200 4-TEC)* subsection.
2. Disconnect the CTS connector.
3. Remove the CTS from engine.
4. Install new CTS and torque as specified.

CTS TORQUE
16 N•m ± 2 N•m (142 lbf•**in** ± 18 lbf•**in**)

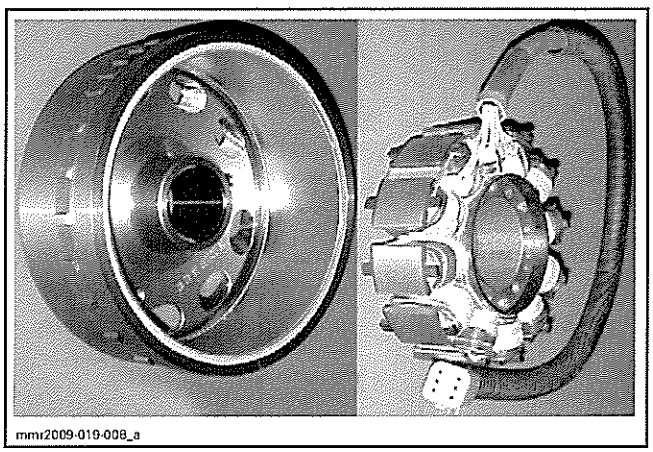
5. Reinstall removed parts.
6. Refill engine coolant. If an important quantity of coolant is spilled, bleed cooling system. Refer to *COOLING SYSTEM* subsection.

POWER DISTRIBUTION (600 HO E-TEC)

GENERAL

OVERVIEW

The E-TEC technology is a batteryless system, no battery is needed for its operation but it can accommodate an electric start.

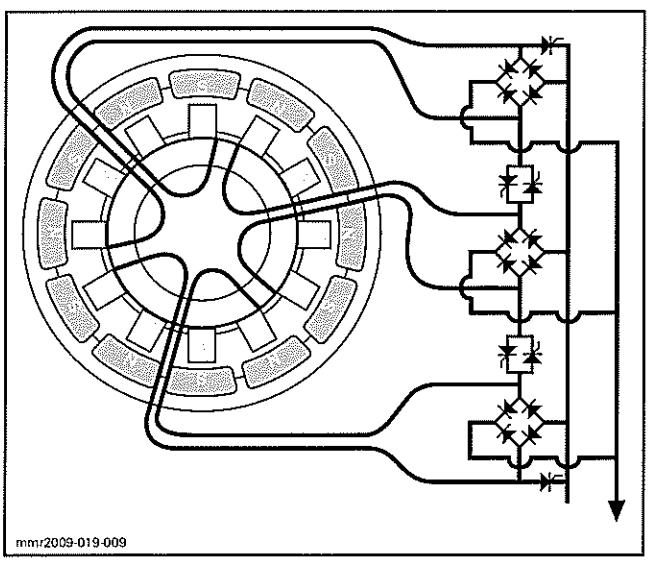


FLYWHEEL AND STATOR

A 1200 W magneto is used.

The flywheel is ventilated to cool down the temperature generated by the high power stator.

The stator is wired with 3 independent windings that works in phase. Each winding is separately wound, they are not connected, so 6 wires go to the ECM.



The vehicle requires the highest possible voltage at low RPM (to properly supply the fuel pump, injectors and ignition coils) and the highest possible current at higher RPM (to properly supply the RAVES, gauge, lights, heaters and other accessories). To achieve this, the stator windings are connected in series at low RPM to meet the voltage requirements and then connected in parallel at higher RPM to meet the current requirements. This series-parallel switch is done in the ECM. Therefore, the electrical requirements of the vehicle can be satisfied.

The series to parallel switching occurs at approximately 1500 RPM.

At high RPM if the magneto power is greater than the loads, the ECM will shunt the stator windings to regulate its power as necessary.

The voltage regulator/rectifier is part of the ECM.

The ECM receives the energy produced by the magneto, rectifies the alternating current (AC) to direct current (DC) and regulates the voltage as per the following chart.

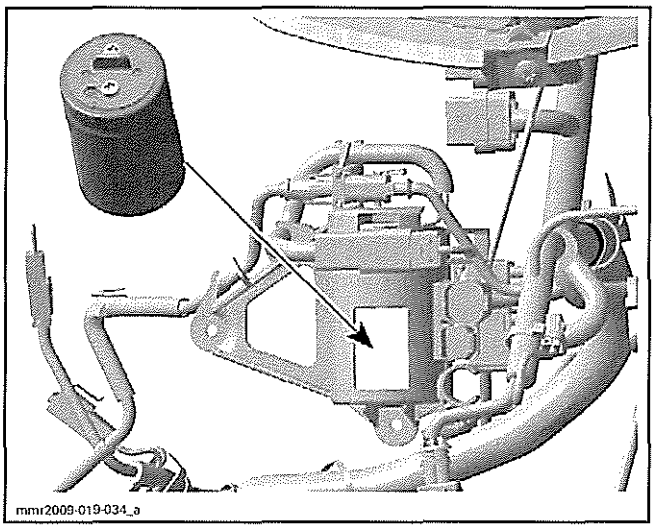
MODEL	VOLTAGE
600 HO E-TEC	55 Vdc

SYSTEM VOLTAGE (55 VDC)

Since the available power is low when cranking, the ECM first supplies 55 Vdc to the components that mandatory need voltage for the starting and the basic operation of the engine:

- ECM (internally powered to a lower voltage)
- Fuel pump
- Fuel injectors
- Ignition coils
- Electronic oil injection pump.

A large capacitor is used to stabilize the 55 Vdc system to provide a constant power to the injectors.



CAPACITOR

SYSTEM VOLTAGE (12 VDC)

A DC-DC converter, in the ECM, steps down the 55 DC voltage to 12 Vdc when the engine reaches 800 RPM.

The 12 Vdc voltage is then divided in a primary and a secondary system.

Below 2000 RPM, the total available current is limited to reduce the load on the system voltage. Above 2000 RPM, the 12 Vdc system have a maximum of 25 A available. In all running conditions, the system voltage must be kept at 55 Vdc.

Primary Voltage (12 Vdc)

Since the available power is not at its maximum at the early stage of engine starting, the ECM supplies 12 Vdc to the components that are critical for the engine and vehicle when engine reaches 800 RPM.

- RAVE solenoid
- Lighting system
- Multifunction gauge.

When the conditions indicated in the chart are met, the charging system relay (R1) closes and battery charging can take place.

MODEL	CHARGING RELAY ACTIVATION
600 HO E-TEC	1900 RPM + 2 second delay

Secondary Voltage (12 Vdc)

When the conditions indicated in the chart are met, the accessory relay inside the ECM closes and power is delivered to the vehicle accessories (handle grip/lever heaters, 12 V power outlet and other accessories).

MODEL	ACCESSORY RELAY ACTIVATION
600 HO E-TEC	1900 RPM + 2 second delay

POWER DISTRIBUTION SUMMARY

ENGINE OPERATION	VOLTAGE DELIVERED	COMPONENT SUPPLIED
All RPM's	55 Vdc	– ECM (internally powered) – Fuel pump – Fuel injectors – Ignition coils – Electronic oil injection pump
When engine reaches 800 RPM	12 Vdc	– RAVE solenoid – Lighting system – Multifunction gauge – Handle grip/lever heaters (premium gauge)
1900 RPM + 2 second delay	12 Vdc	– Battery charging
1900 RPM + 2 second delay	12 Vdc	– Handle grip/lever heaters (standard gauge) – 12 V power outlet – Other accessories

POWER DISTRIBUTION (600 ACE)

SERVICE TOOLS

Description	Part Number	Page
ECM ADAPTER TOOL	529 036 166	586
FLUKE 115 MULTIMETER	529 035 868	585

GENERAL

OVERVIEW

All the electrical system is powered by DC current supplied by a 12 V battery. The battery charge is maintained by the charging system.

Electrical system is protected by fuses located in one fuse box.

The system uses 3 relays that control different electrical components.

Relay 1 Activation

When the START/RER button is briefly pressed or held, it wakes up the ECM that in turn, powers the relay 1 and its contacts close to deliver power.

The relay supplies the following components:
- ECM power (B 4M)
- Fuel pump
- Starter solenoid
- Injectors
- Ignition coils
- Gauge
- Diagnostic connector.

Relay 2 Activation

When engine reaches approximately 800 RPM, the ECM activates the relay 2 and its contacts close to deliver power.

The relay supplies the following components:
- Lights.

Relay 3 Activation

When engine runs, the ECM activates the relay 3 and its contacts close to deliver power.

The relay supplies the following components:
- Thumb heater
- Front grip heaters
- Front power outlet.

The following actions will be taken by the ECM to preserve electrical power for the most important functions.

CONDITION	ECM CORRECTIVE ACTION
If battery voltage is lower than 12 V for 10 seconds	Relay 3 is disabled.
If battery voltage is lower than 11.5 V	Engine speed is increased to idle speed.
If battery voltage is lower than 11 V	Low battery pilot lamp turns on.

Automatic Power Cut-Off

The ECM features an automatic power cut-off that will completely turn off the ECM (after engine was running) and thus cutting all power to components. All the vehicle electrical loads will be turned off (except the clock in the multifunction gauge). This feature prevents the battery from discharging if the tether cord cap is left on engine cut-off switch when the engine is not running.

The cut-off time is as follows.

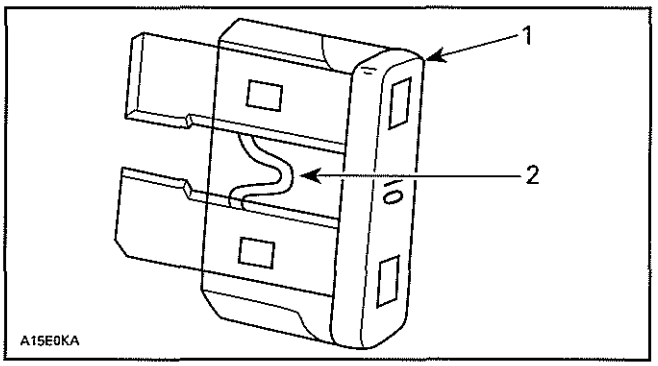
ACTION	POWER CUT-OFF TIME
Removing tether cord cap	Approximately 15 seconds
Setting emergency engine stop switch to STOP (tether cord cap connected)	Approximately 20 seconds

NOTE: The ECM will remain off until the START/RER button is pressed.

FUSES

Fuse Inspection

Check if filament is melted. Replace as necessary.



1. Fuse
2. Check if melted

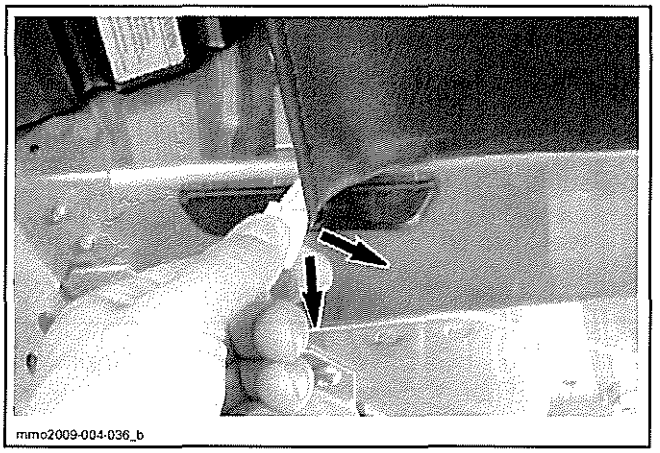
⚠ WARNING

Do not use a higher rated fuse as this can cause severe damage to electric components and/or a fire. If fuse has burnt out, the cause of the malfunction should be determined and corrected before restarting.

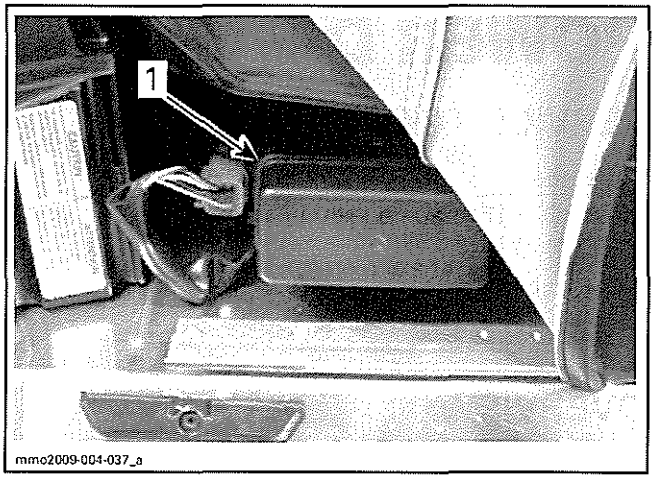
Fuse Box

The fuse box is located behind the front seat upholstery at the LH front lower portion of seat.

To access the fuse box, carefully pull seat upholstery out of the aluminum extrusion by pulling the plastic strip downwards and sideways at the same time.



TYPICAL - PULL STRIP

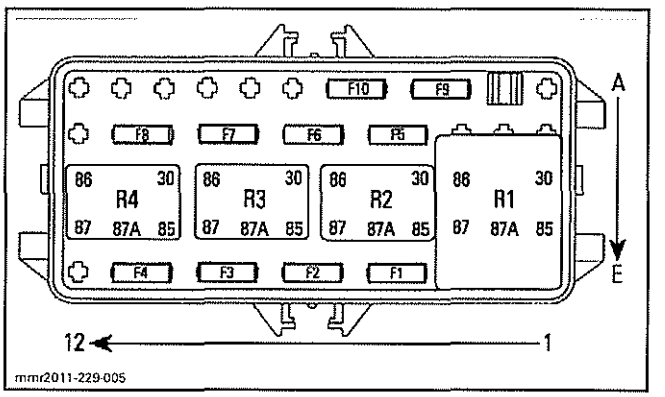


1. Fuse box

Refer to the decal inside the fuse box cover for fuse identification.

Close upholstery by pushing the strip back in the aluminum extrusion when finished.

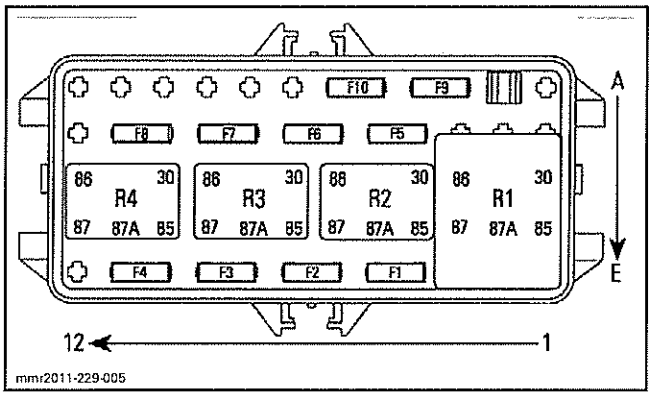
Fuse box contacts are identified with letters to identify rows and numbers to identify columns. The combined letter and number identify the coordinate of a contact that is used in the procedures.



RELAYS

Relay Location

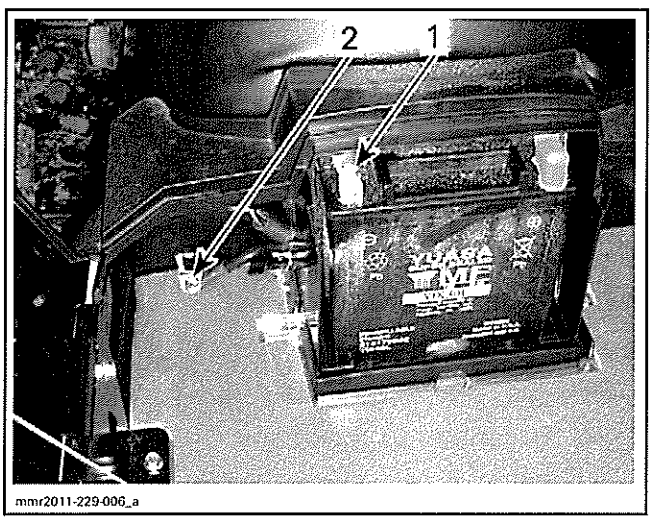
Relays are in the fuse box.



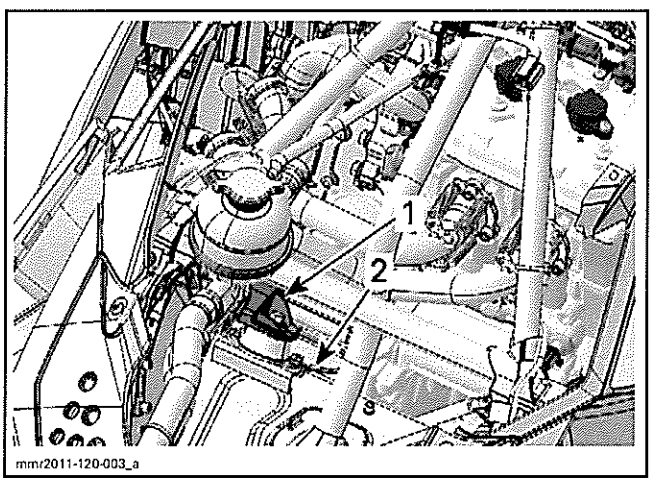
RELAYS ARE IDENTIFIED BY THE LETTER R FOLLOWED BY A DIGIT

GROUNDS

Ground Location



BATTERY AND FRAME GROUNDS
1. *Battery ground*
2. *Frame ground*



TYPICAL — ENGINE GROUND
1. *Engine mount*
2. *Ground*

PROCEDURES

RELAYS

Relay Input Voltage Test

Remove relay from fuse box.

Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Vdc and measure voltage between fuse box terminals and ground.

RELAY 1 (R1)		
PROBES		VOLTAGE
Winding input: Fuse box pin 1 D	Battery Ground	Battery voltage
Contact input: Fuse box pin 1 C	Battery Ground	

RELAY 2 (R2)		
PROBES		VOLTAGE
Winding input: Fuse box pin 4 D	Battery Ground	Battery voltage
Contact input: Fuse box pin 4 C	Battery Ground	

RELAY 3 (R3)		
PROBES		VOLTAGE
Winding input: Fuse box pin 7 D	Battery Ground	Battery voltage
Contact input: Fuse box pin 7 C	Battery Ground	

If input voltages are good, check the following:
- Relay, refer to *RELAY CONTINUITY TEST* in this subsection.
- ECM ground signal. Refer to *RELAY 1 (R1) GROUND SIGNAL TEST* or *RELAY 2 (R2) GROUND SIGNAL TEST* or *RELAY 3 (R3) GROUND SIGNAL TEST*.
- ECM ground signal wire, refer to *GROUND WIRE CONTINUITY TEST (R1, R2 AND R3)* in this subsection.
- Accessory supply wire for an open circuit. Refer to *WIRING DIAGRAM*.

If input voltages are not good, refer to *WIRING DIAGRAM* and check for an open circuit on the applicable relay winding supply wire.

Relay 1 (R1) Ground Signal Test

1. Remove relays 1 and 2.
2. Temporarily install relay 2 into relay 1 location.
3. Check if functions related to relay 1 work.

If functions work, replace relay 1 by a new one and install in its original location.

If functions do not work, reinstall relay 2 into its original location then perform *GROUND SIGNAL WIRE CONTINUITY TEST* for relay 1.

Relay 2 (R2) Ground Signal Test

1. Remove relay 2.
2. Set multimeter to Vdc.
3. Start engine.
4. Measure voltage as follows to confirm ground signal:

RELAY 2 (R2)		
PROBES		VOLTAGE
Fuse box pin 6 C	Battery positive terminal (+)	Approximately battery voltage

If test fails, perform *GROUND SIGNAL WIRE CONTINUITY TEST.*

Relay 3 (R3) Ground Signal Test

1. Remove relay 3.
2. Set multimeter to Vdc.
3. Start engine.
4. Measure voltage as follows to confirm ground signal:

RELAY 3 (R3)		
PROBES		VOLTAGE
Fuse box pin 9 C	Battery positive terminal (+)	Approximately battery voltage

If test fails, perform *GROUND SIGNAL WIRE CONTINUITY TEST.*

Ground Wire Continuity Test (R1, R2 and R3)

1. Disconnect ECM connector B and install it on the ECM ADAPTER TOOL (P/N 529 036 166). Refer to *ELECTRONIC FUEL INJECTION* section.
2. Remove applicable relay.
3. Set the multimeter to Ω.
4. Measure resistance as per the following table.

RELAY 1 (R1)		
PROBES		RESISTANCE
Fuse box pin 3 C	ECM pin B 2H	Close to 0 Ω

RELAY 2 (R2)		
PROBES		RESISTANCE
Fuse box pin 6 C	ECM pin B 1G	Close to 0 Ω

RELAY 3 (R3)		
PROBES		RESISTANCE
Fuse box pin 9 C	ECM pin B 2J	Close to 0 Ω

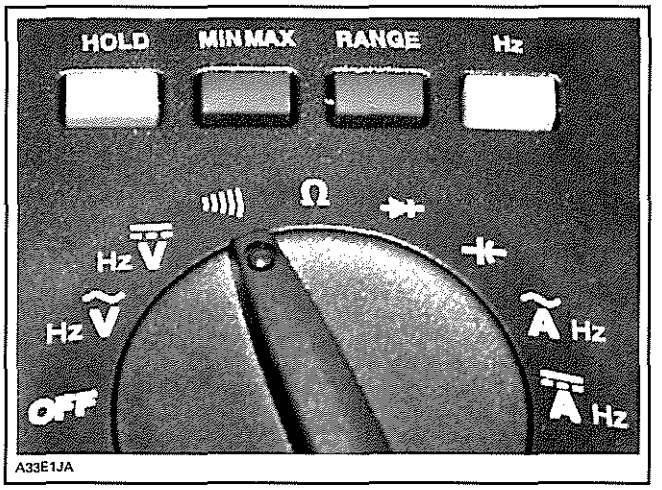
Relay Test

Substitution Test

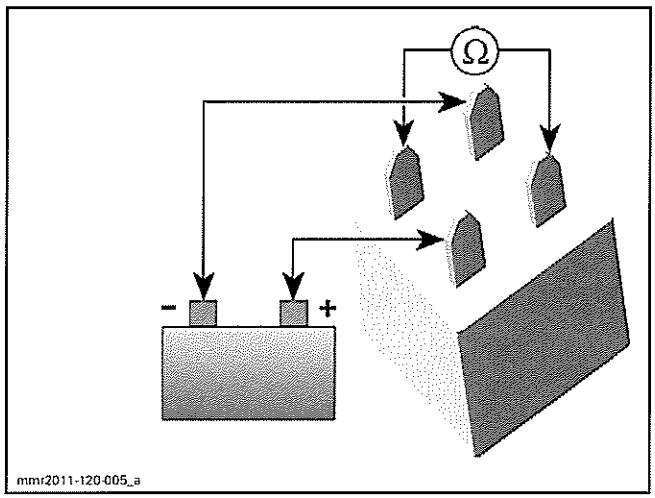
1. Remove the suspected relay.
2. Remove another relay from fuse box.
3. Replace it by the suspected relay.
4. Check if the relay related functions work.
   - 4.1 If the functions work, the suspected relay is good.
   - 4.2 If the functions do not work, the suspected relay is bad. Replace by a new one.
5. Reinstall the removed relays.

Continuity Test

1. Remove relay to be tested from fuse box.
2. Set multimeter to the beeper position.



3. Connect a jumper from the positive post of a 12 V battery to terminals 85 and 86 of relay then place the multimeter probe on terminal 30 and the other probe on the terminal 87.



The audible signal should be continuous. If not, replace the relay.

POWER DISTRIBUTION (1200 4-TEC)

SERVICE TOOLS

Description	Part Number	Page
ECM ADAPTER TOOL	420 277 010	591
FLUKE 115 MULTIMETER	529 035 868	591
T-HARNESS	529 035 869	591

GENERAL

OVERVIEW

All the electrical system is powered by DC current supplied by a 12 V battery. The battery charge is maintained by the charging system.

Electrical system is protected by fuses located in fuse box.

The system uses 2 relays that control different electrical components.

Relay 1 Activation

When the START/RER button is briefly pressed or held, it wakes up the ECM that in turn, activate the relay 1 and its contacts close to deliver power.

The relay supplies the following components:
- ECM power (B 4M)
- Fuel pump
- Starter solenoid
- CAPS (camshaft position sensor)
- Injectors
- Ignition coils
- Gauge
- Speed sensor.

Relay 3 Activation

When engine reaches approximately 800 RPM, the ECM activates the relay 3 and its contacts close to deliver power.

The relay supplies the following components:
- Lights
- Front power outlet
- Rear power outlet.

Automatic Power Cut-Off

The ECM features an automatic power cut-off that will completely turn off the ECM (after engine was running) and thus cutting all power to components. All the vehicle electrical loads will be turned off (except the clock in the multifunction gauge). This feature prevents the battery from discharging if the tether cord cap is left on the engine cut-off switch when the engine is not running.

The cut-off time is as follows.

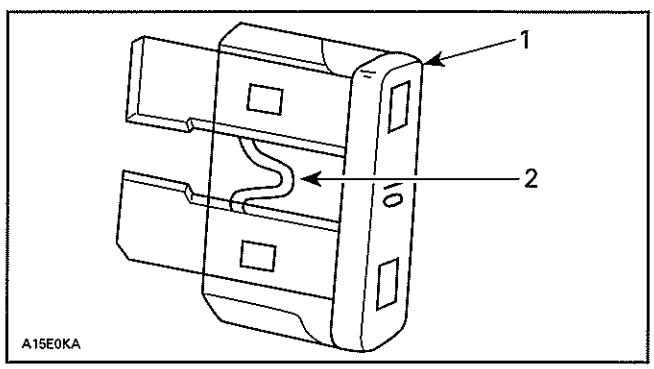
ACTION	POWER CUT-OFF TIME
Removing tether cord cap	5 seconds
Setting emergency engine stop switch to STOP (tether cord cap connected)	30 seconds (after 5 seconds, headlamp will turn off)

NOTE: The ECM will remain off until the START/RER button is pressed.

FUSES

Fuse Inspection

Check if filament is melted. Replace as necessary.



1. Fuse
2. Check if melted

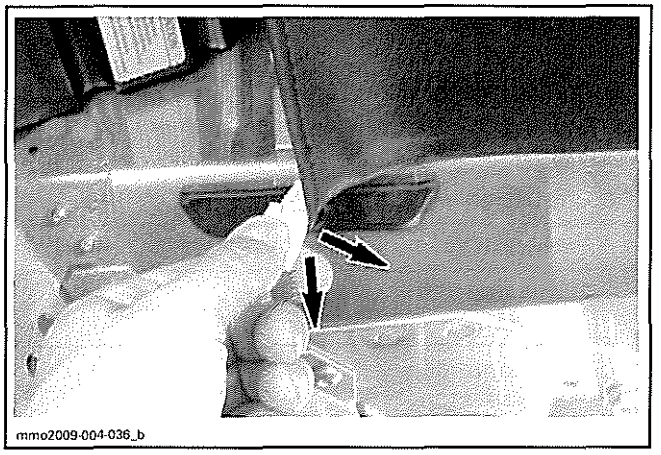
⚠ WARNING

Do not use a higher rated fuse as this can cause severe damage to electric components and/or a fire. If fuse has burnt out, the cause of the malfunction should be determined and corrected before restarting.

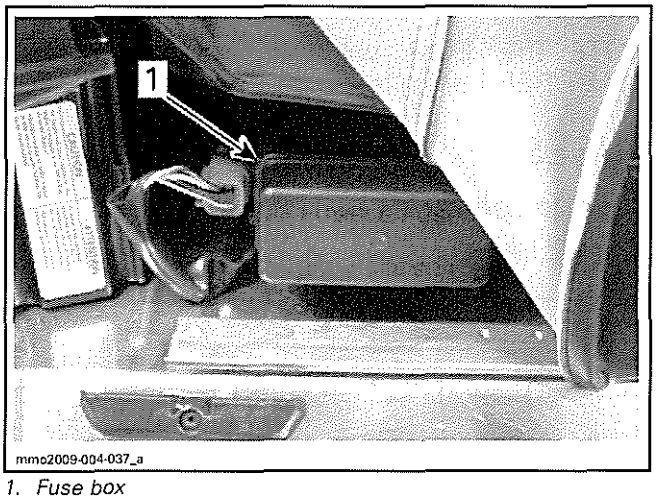
Fuse Box

The fuse box is located behind the front seat upholstery at the LH front lower portion of seat.

To access the fuse box, carefully pull seat upholstery out of the aluminum extrusion by pulling the plastic strip downwards and sideways at the same time.



TYPICAL - PULL STRIP

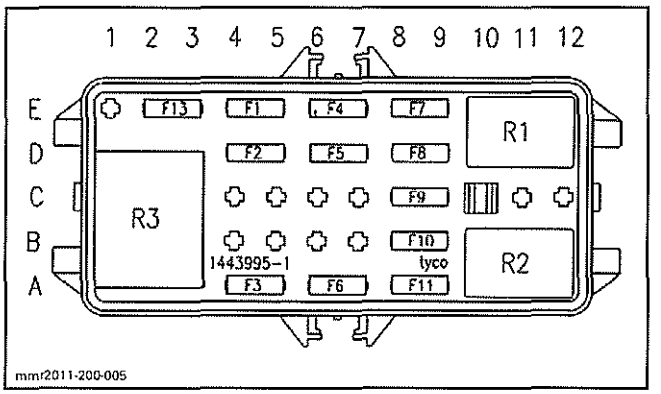


1. Fuse box

Refer to the decal inside the fuse box cover for fuse identification.

Close upholstery by pushing the strip back in the aluminum extrusion when finished.

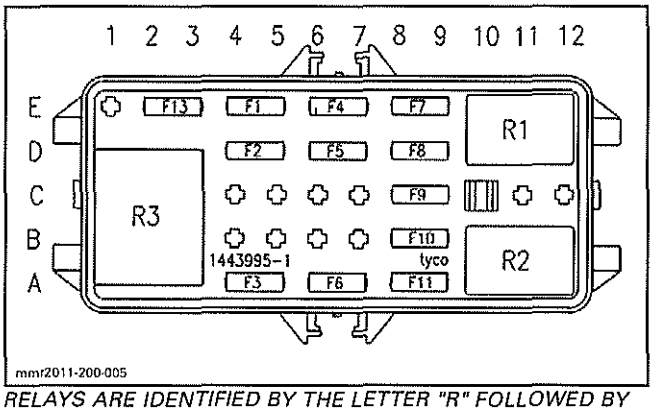
Fuse box contacts are identified with letters to identify rows and numbers to identify columns. The combined letter and number identify the coordinate of a contact that is used in the procedures.



RELAYS

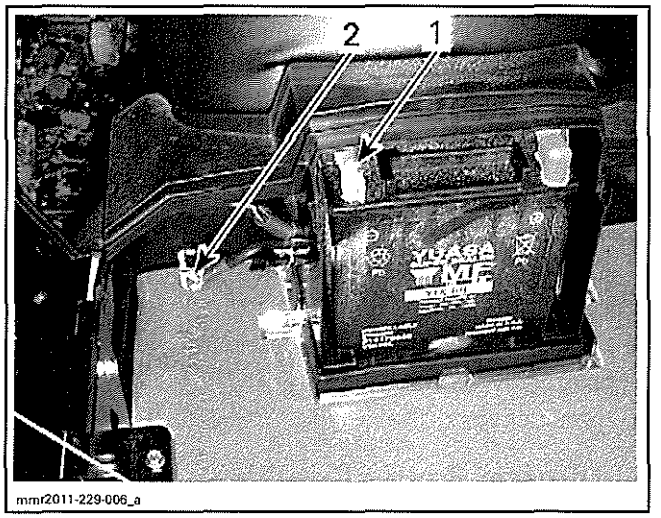
Relay Location

Relays are in the fuse box.

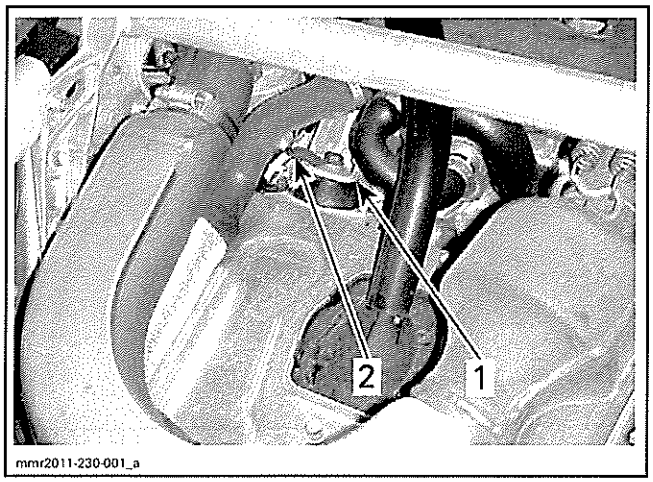


RELAYS ARE IDENTIFIED BY THE LETTER "R" FOLLOWED BY A DIGIT

GROUNDS



TYPICAL — BATTERY AND FRAME GROUNDS
1. Battery ground
2. Frame ground



TYPICAL — ENGINE GROUND
1. *Engine mount*
2. *Ground*

PROCEDURES

RELAYS

Relay Input Voltage Test

Remove relay from fuse box.

Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Vdc and measure voltage between fuse box terminals and ground.

RELAY 1 (R1)		
PROBES		VOLTAGE
Winding input: Fuse box pin 12 D	Battery ground	Approximately battery voltage
Contact input: Fuse box pin 12 E	Battery ground	

Install T-HARNESS (P/N 529 035 869) on diagnostic connector.

RELAY 3 (R3)		
PROBES		VOLTAGE
Winding input: Fuse box pin 3 B	Battery ground	Approximately battery voltage
Contact input: Fuse box pin 1 B	Battery ground	

If input voltages are good, check the following:
- Relay, refer to *RELAY CONTINUITY TEST* in this subsection.
- ECM ground signal. Refer to *RELAY 1 (R1) GROUND SIGNAL TEST* or *RELAY 3 (R3) GROUND SIGNAL TEST*.
- ECM ground signal wire, refer to *GROUND WIRE CONTINUITY TEST (R1 AND R3)* in this subsection.
- Accessory supply wire for an open circuit. Refer to *WIRING DIAGRAM*.

If input voltages are not good, refer to *WIRING DIAGRAM* and check for an open circuit on the applicable relay winding supply wire.

Relay 1 (R1) Ground Signal Test

1. Remove relays 1 and 3.
2. Temporarily install relay 3 into relay 1 location.
3. Check if functions related to relay 1 work.

If functions work, replace relay 1 by a new one and install in its original location.

If functions do not work, reinstall relay 3 into its original location then perform *GROUND SIGNAL WIRE CONTINUITY TEST* for relay 1.

Relay 3 (R3) Ground Signal Test

1. Remove relay 3.
2. Set multimeter to Vdc.
3. Start engine.
4. Measure voltage as follows to confirm ground signal:

RELAY 3 (R3)		
PROBES		VOLTAGE
Fuse box pin 1 C	Battery positive terminal (+)	Approximately battery voltage

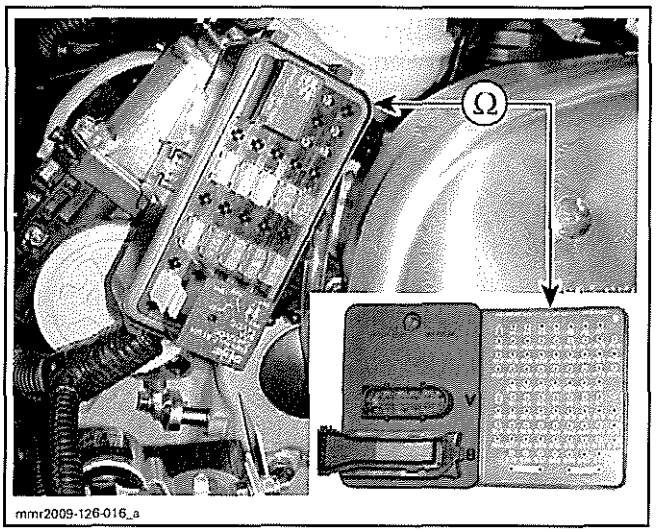
If test fails, perform *GROUND SIGNAL WIRE CONTINUITY TEST*.

Ground Wire Continuity Test (R1 and R3)

1. Disconnect ECM connector B and install it on the ECM ADAPTER TOOL (P/N 420 277 010). Refer to *ELECTRONIC FUEL INJECTION* section.
2. Remove applicable relay.
3. Set the multimeter to Ω.
4. Measure resistance as per the following table.

RELAY 1 (R1)		
PROBES		RESISTANCE
Fuse box pin 10 E	ECM pin B 17	Close to 0 Ω

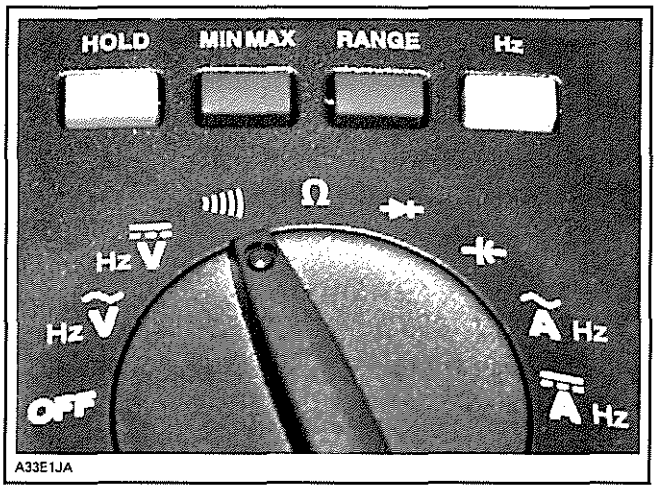
RELAY 3 (R3)		
PROBES		RESISTANCE
Fuse box pin 1 C	ECM pin B 16	Close to 0 Ω



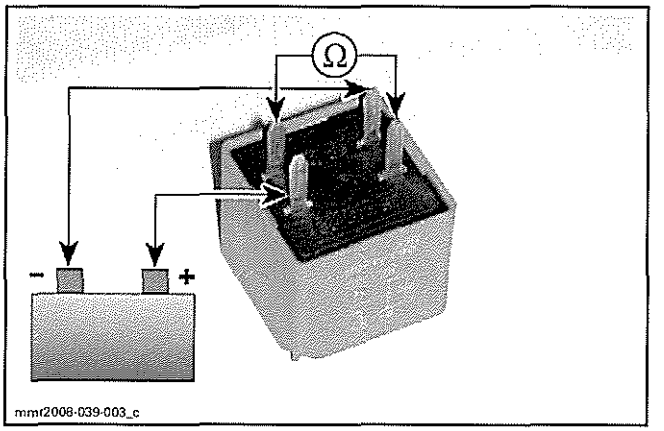
TYPICAL

Relay Continuity Test

1. Remove relay to be tested from fuse box.
2. Set multimeter to the beeper position.



3. Connect a jumper from the positive post of a 12 V battery to terminals 85 and 86 of relay then place the a multimeter probe on terminal 30 and the other probe on the terminal 87.



TYPICAL

The audible signal should be continuous. If not, replace the relay.

COMMUNICATION PROTOCOLS

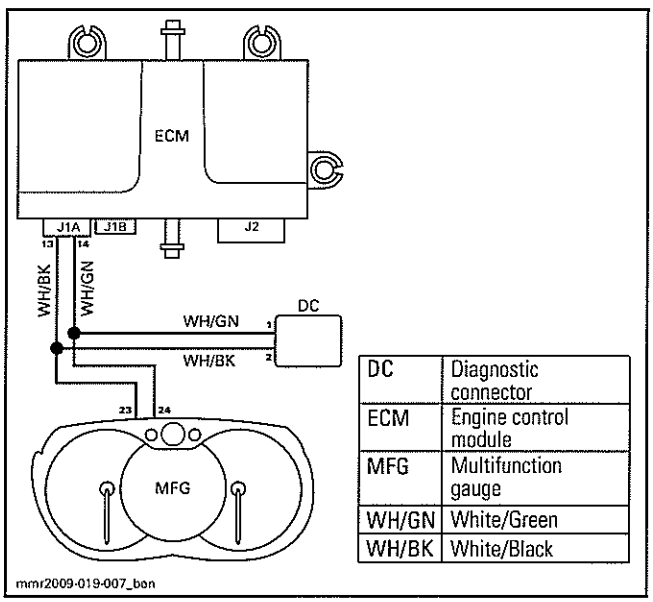
SERVICE TOOLS

Description	Part Number	Page
ECM ADAPTER TOOL	420 277 010	595
ECM ADAPTER TOOL	529 036 166	595
FLUKE 115 MULTIMETER	529 035 868	595–596

GENERAL

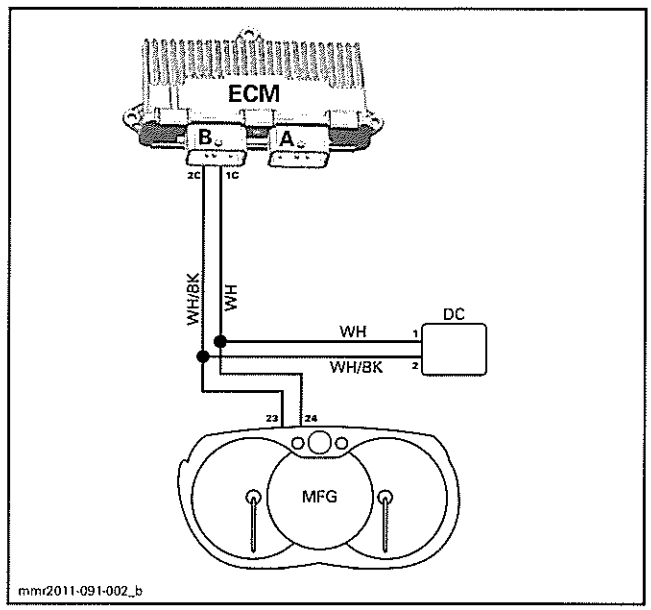
CONTROLLER AREA NETWORK (CAN)

The CAN protocol is an ISO standard for serial data communication. The CAN bus links the ECM and the multifunction gauge. Two wires connect each component and they are in constant communication with each other. CAN lines consist of a pair of wires as illustrated.

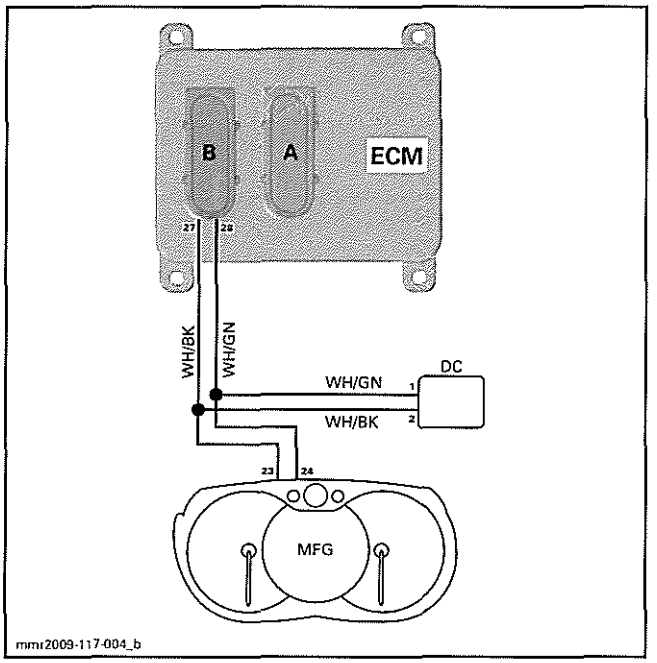


DC	Diagnostic connector
ECM	Engine control module
MFG	Multifunction gauge
WH/GN	White/Green
WH/BK	White/Black

600 HO E-TEC MODELS



600 ACE MODELS
WH: WHITE
WH/BK: WHITE/BLACK
MFG (multifunction gauge)
ECM (electronic control module)
DC (diagnostic connector)



1200 4-TEC MODELS
WH/GN: WHITE/GREEN
WH/BK: WHITE/BLACK
MFG (multifunction gauge)
ECM (electronic control module)
DC (diagnostic connector)

Fault codes are broadcasted to the CAN bus and can be displayed in B.U.D.S. or in the premium multifunction gauge.

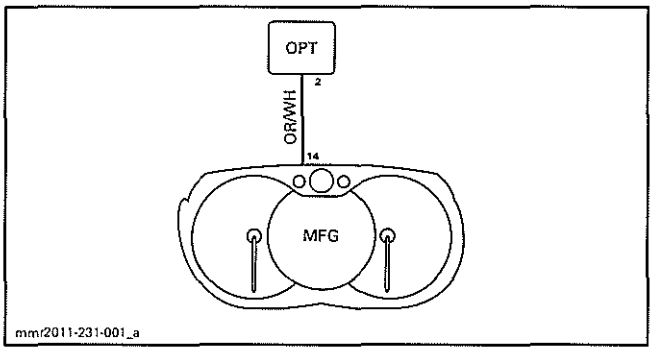
LOCAL INTERCONNECT NETWORK (LIN)

The LIN bus is a simple broadcast serial network comprising one master and up to 16 slaves. It is used as a complement to the CAN network to integrate the following devices.

MASTER	SLAVES
Multifunction gauge	Optional premium module (compass, engine temperature, lap recorder)
	Optional engine temperature module

The master communicates to one slave at a time which supplies the requested information. The gauge can then display the related data (engine temperature for example).

One wire connects each component. The LIN line consists of an ORANGE/WHITE wire.

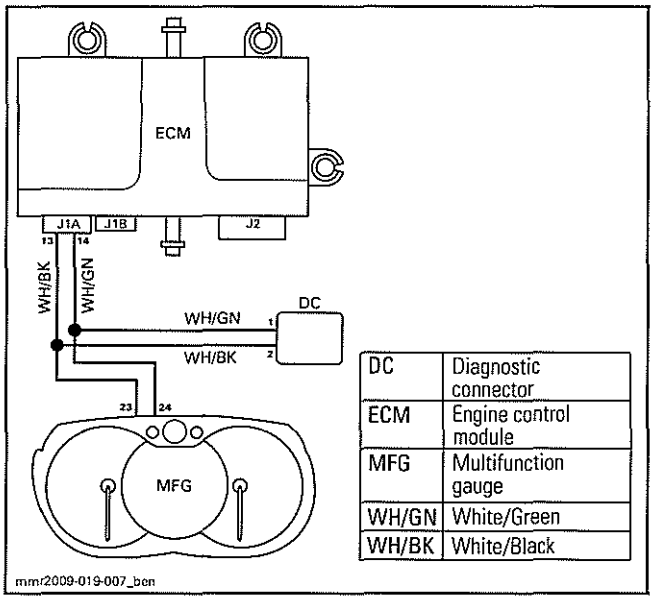


OR/WH: ORANGE/WHITE
MFG (multifunction gauge)
OPT (optional modules: compass, engine temperature, lap recorder)

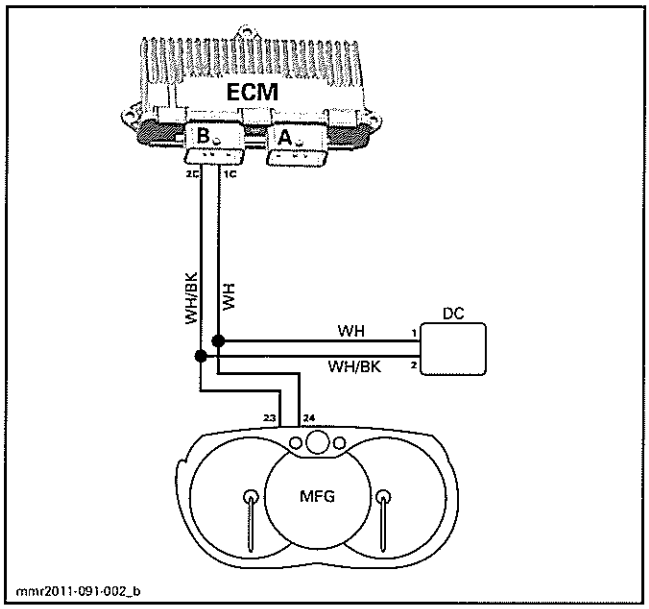
PROCEDURES

CAN LINE TEST

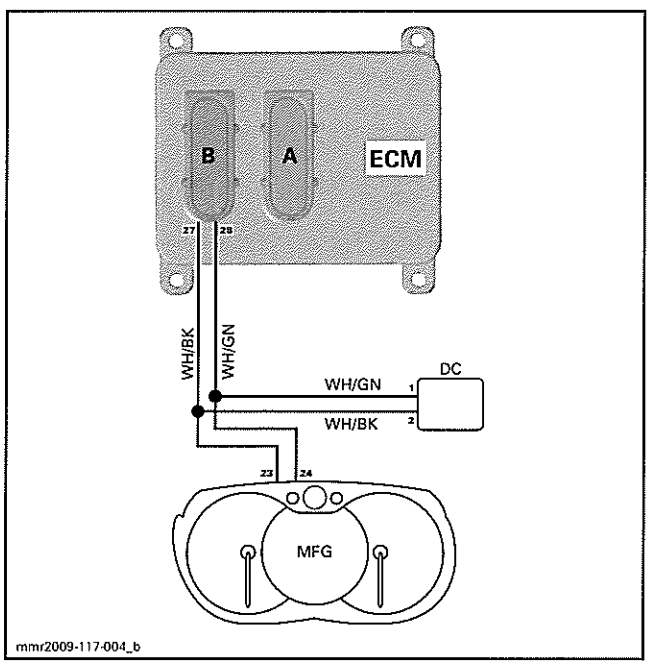
CAN lines link the ECM, multifunction gauge and vehicle diagnostic connector.



600 HO E-TEC MODELS



600 ACE MODELS
WH: WHITE
WH/BK: WHITE/BLACK
MFG (multifunction gauge)
ECM (electronic control module)
DC (diagnostic connector)



1200 4-TEC MODELS
WH/GN: WHITE/GREEN
WH/BK: WHITE/BLACK
MFG (multifunction gauge)
ECM (electronic control module)
DC (diagnostic connector)

Test CAN wires continuity as follows.

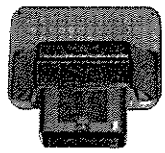
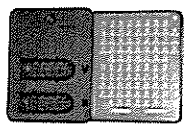
600 HO E-TEC Models

Disconnect ECM connector "J1A".

600 ACE and 1200 4-TEC Models

Disconnect ECM connector "B".

Install the proper adapter on ECM connector.

MODEL	TOOL	TOOL VIEW
600 ACE	ECM ADAPTER TOOL (P/N 529 036 166)	
1200 4-TEC	ECM ADAPTER TOOL (P/N 420 277 010)	

All Models

Disconnect multifunction gauge connector. Refer to *LIGHTS, GAUGE AND ACCESSORIES.*

Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and select Ω.

Read wire resistance as follows.

600 HO E-TEC Models

ECM ADAPTER	GAUGE CONNECTOR	MEASUREMENT
Pin 13	Pin 23	Close to 0 Ω
Pin 14	Pin 24	

600 ACE Models

ECM ADAPTER	GAUGE CONNECTOR	MEASUREMENT
Pin 2C	Pin 23	Close to 0 Ω
Pin 1C	Pin 24	

1200 4-TEC Models

ECM ADAPTER	GAUGE CONNECTOR	MEASUREMENT
Pin B-27	Pin 23	Close to 0 Ω
Pin B-28	Pin 24	

If continuity is out of specification, repair or replace wiring harness between ECM and multi-function gauge.

If continuity is as per specification, carry out the following test.

Disconnect vehicle diagnostic connector from its protective cap.

Read wire resistance as follows.

DIAGNOSTIC CONNECTOR	GAUGE CONNECTOR	MEASUREMENT
Pin 2	Pin 23	Close to 0 Ω
Pin 1	Pin 24	

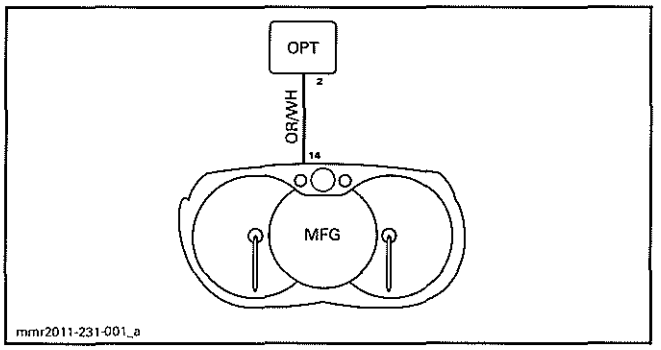
If continuity is out of specification, repair or replace wiring harness between diagnostic connector and multifunction gauge.

If continuity is as per specification, CAN lines are functional.

Reconnect connectors and reinstall removed parts.

LIN LINE TEST

LIN line links the multifunction gauge with the OPT connector (connector used to connect options to the gauge).



OR/WH: ORANGE/WHITE
MFG (multifunction gauge)
OPT (optional modules: compass, engine temperature, lap recorder)

Test LIN wire continuity as follows.

Disconnect OPT connector.

Disconnect multifunction gauge connector. Refer to *LIGHTS, GAUGE AND ACCESSORIES*.

Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and select Ω.

Read wire resistance as follows.

OPT CONNECTOR	GAUGE CONNECTOR	MEASUREMENT
Pin 2	Pin 14	Close to 0 Ω

If continuity is out of specification, repair or replace wiring harness between OPT connector and multifunction gauge.

If continuity is as per specification, LIN line is functional. Check power and ground circuits of the devices.

CIRCUIT	OPT CONNECTOR
Power	pin 3
Ground	pin 1

Reconnect connectors and reinstall removed parts.

IGNITION SYSTEM (600 HO E-TEC)

SERVICE TOOLS

Description	Part Number	Page
DIAL INDICATOR ADAPTER	529 036 132	599–600
FLUKE 115 MULTIMETER	529 035 868	605
IGNITION TIMING TOOL	529 036 129	599
TDC DIAL INDICATOR	295 000 143	599
TDC DIAL INDICATOR	414 104 700	599

SERVICE PRODUCTS

Description	Part Number	Page
DIELECTRIC GREASE	293 550 004	604

GENERAL

⚠ WARNING

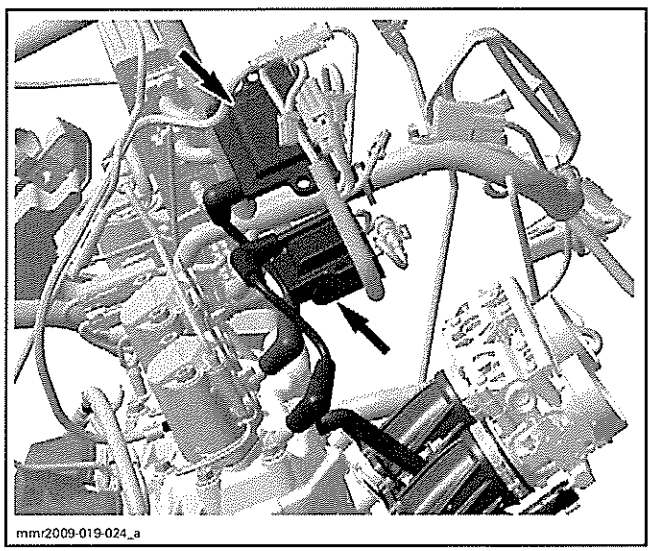
Always electrically disconnect both fuel injectors prior to testing for ignition spark. Otherwise, fuel vapors may ignite in presence of a spark creating a fire hazard.

SYSTEM DESCRIPTION

This ignition system is an inductive type specifically designed for the E-TEC engine with a rapid rise time to prevent spark plug fouling. It provides a quick spark similar to a CDI system but with a longer duration.

The ignition system is fully managed by the ECM which controls the ignition system parameters such as spark timing, dwell time, and firing order.

The system uses two separate ignition coils which induce voltage to a high level in their secondary winding to produce a spark at each spark plug independently.



TYPICAL — IGNITION COILS

The ignition coils receive power from the 55 Vdc system. Their operating voltage varies from 20 to 55 Vdc.

Ignition System Basic Operation

A 3-wire connector is connected to the primary winding of each coil.

The ignition coils are powered by the 55 Vdc system voltage through the WHITE/RED wire. The BLACK wire is connected to a ground circuit.

Each ignition coil uses an active circuitry to energize the primary winding when it receive a pulse from the ECM via the following wires.

CYLINDER	WIRE COLOR
PTO	OR/GN
MAG	OR/BU

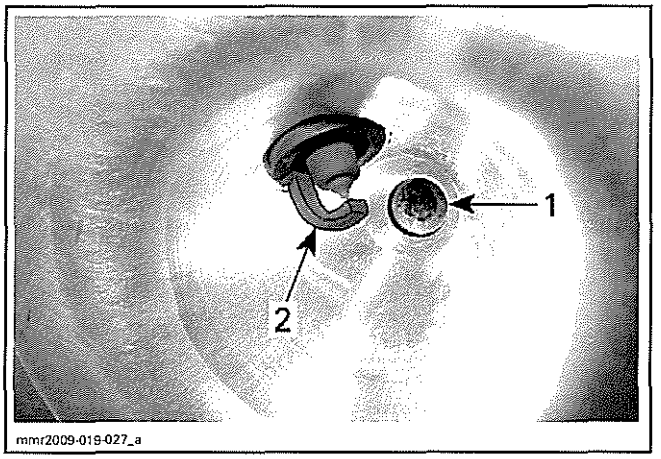
The dwell time has an amplitude of approximately 10 volts. At the end of the dwell time, the power is released from the primary winding which induces a current that produces a high voltage in the secondary winding. This high voltage is then fed to the spark plug.

A resistive core spark plug cable is used to prevent the RFI (Radio Frequency Interference). There is no resistor in the spark plug cap.

Spark Plugs

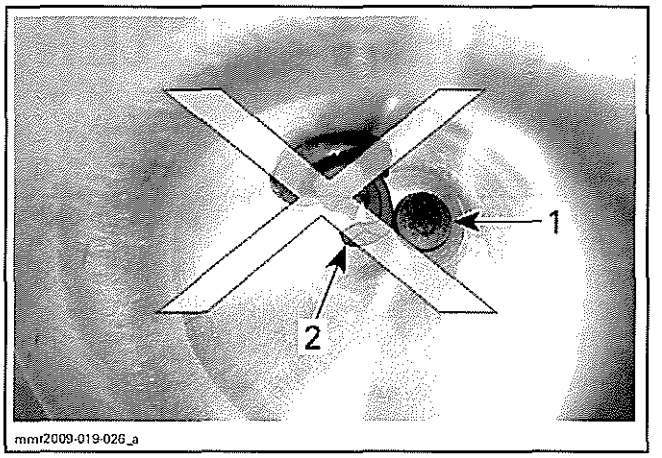
The OEM spark plug used in the E-TEC engine is specially indexed for optimum engine operation and efficiency.

The threads on the spark plug and in the cylinder head are indexed so that when the plug is installed, the open end of the negative electrode will be facing the injection spray, within ± 90°.This ensures the negative electrode does not deviate the injection spray and ensures proper ignition.



CORRECTLY INDEXED
1. Injector nozzle
2. Ground electrode

NOTE: Using an incorrectly indexed spark plug will result in poor idle and increased emissions.



INCORRECTLY INDEXED
1. Injector nozzle
2. Ground electrode

If using a non OEM spark plug, a specific installation procedure must be followed. Refer to *SPARK PLUG INSTALLATION* in this section.

Ignition Timing

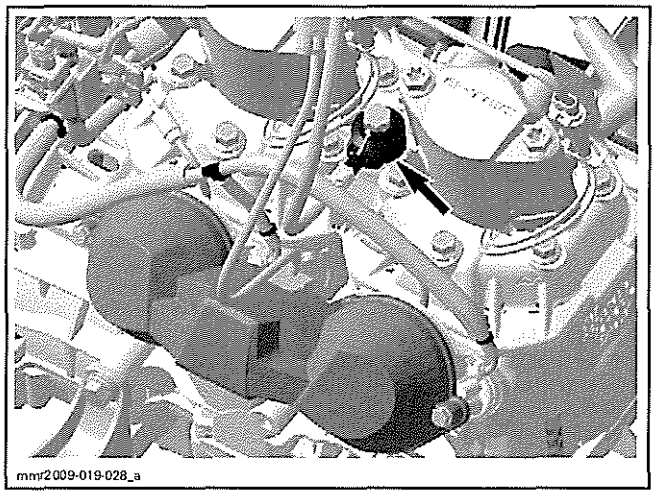
The crankshaft position sensor (CPS), the air pressure sensor (APS) and the throttle position sensor (TPS) are the primary sensors used to control the ignition timing.

The ECM is programmed with data (ignition mappings). Using engine operating parameters provided by the sensors, the ECM controls the ignition timing for optimum engine operation under all operating conditions.

Ignition timing can be adjusted using the B.U.D.S. software with the proper procedure.

Knock Detection

A knock sensor is mounted on top of the cylinder head. It detects specific vibration that would be typically generated by engine detonation.



TYPICAL

If detonation occurs, the ECMs retards the ignition and increases the fuel injected temporarily (it goes into a specific operating mode) until detonation stops.

ADJUSTMENT

IGNITION TIMING

Normally, ignition timing adjustments should not be required. It has been set at the factory and should remain correctly adjusted as every component is fixed and non adjustable.

The only time the ignition timing may require adjustment is when replacing the crankshaft, the magneto flywheel, a CPS or the ECM.

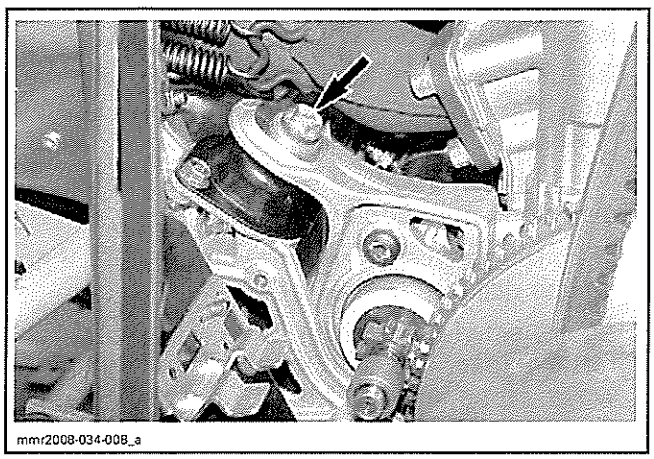
If the ignition timing is found incorrect, first check for proper crankshaft alignment. This might be an indication of a twisted crankshaft. Refer to *ENGINE MEASUREMENT* section.

Ignition Timing Tool Installation

⚠ WARNING

Ensure tether cord is removed from engine cut-off switch and emergency engine stop switch is in the STOP position.

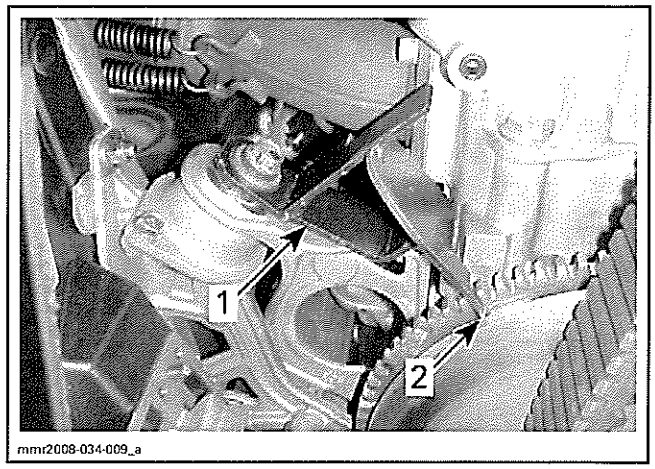
1. Remove the LH front engine mounting screw.



LH FRONT ENGINE MOUNT SCREW

NOTE: Note position of washers for installation.

2. Install the IGNITION TIMING TOOL (P/N 529 036 129) on the LH front engine mount and torque mounting bolt to 25 N•m (18 lbf•ft).



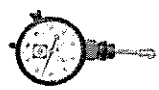
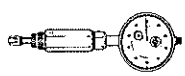
1. Ignition timing tool
2. Pointer

TDC Gauge Installation

⚠ WARNING

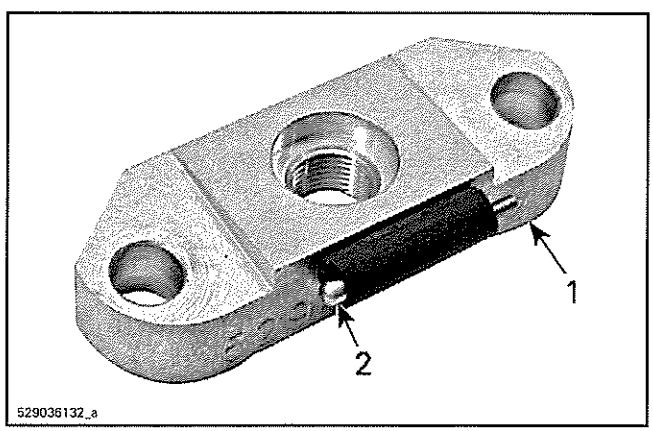
Ensure tether cord is removed from engine cut-off switch and emergency engine stop switch is in the STOP position.

Two TDC gauges can be used:

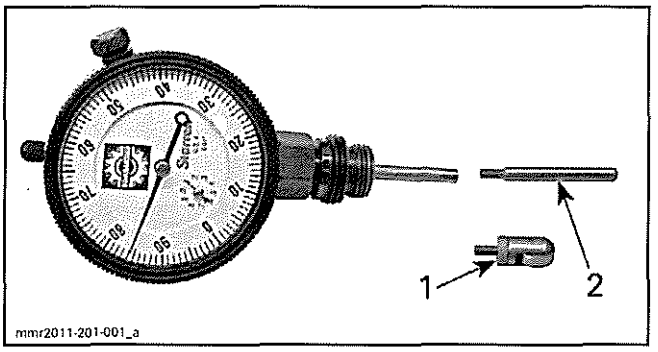
TDC GAUGES	
TDC DIAL INDICATOR (P/N 295 000 143) **(short reach)**	
TDC DIAL INDICATOR (P/N 414 104 700) **(long reach)**	

Short Reach Gauge Preparation (Preferred Gauge)

1. Remove the roller tip from the gauge.
2. Use the rounded tip from the DIAL INDICATOR ADAPTER (P/N 529 036 132).



1. Dial indicator adaptor
2. Rounded tip



1. Roller tip removed
2. Rounded tip to install

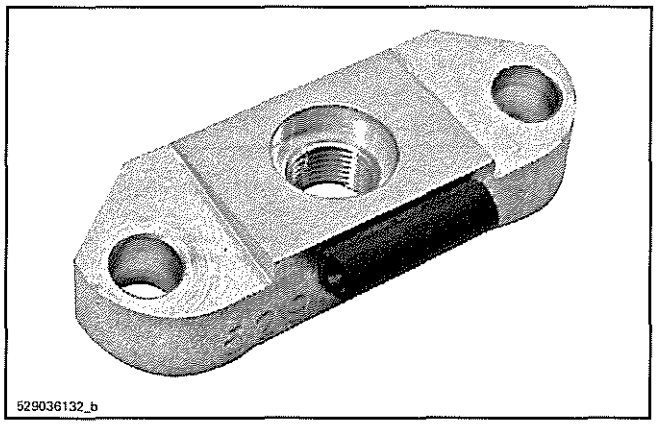
3. Install the rounded tip on the gauge.

Long Reach Gauge Preparation

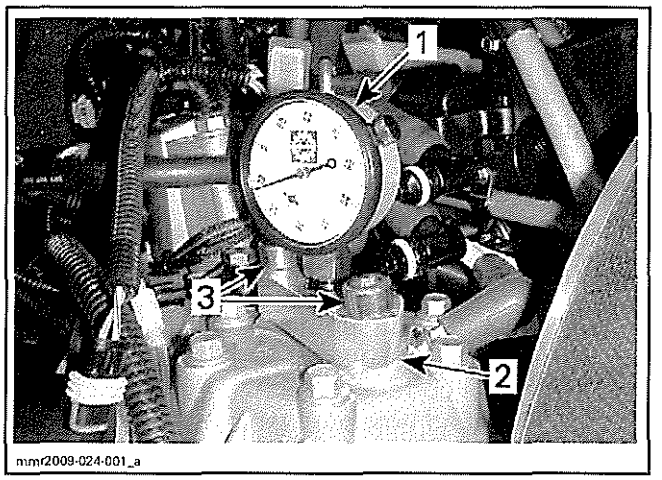
1. Loosen and lift the console, gauge support and secondary air intake silencer to provide clearance for the long reach gauge.
2. Replace the roller tip by the rounded tip as described in the *SHORT REACH GAUGE PREPARATION.*

Gauge Installation (both gauges)

1. Remove the PTO injector, refer to *E-TEC DIRECT INJECTION* section.
2. Install the DIAL INDICATOR ADAPTER (P/N 529 036 132) over the PTO injector hole.



3. Use two screws M10 x 1.5 x 35 to secure the adaptor.
4. Carefully insert the TDC gauge through the dial indicator adapter hole.



1. TDC gauge
2. Dial indicator adaptor
3. Screws

5. Screw the gauge into the adapter plate with the dial face towards the PTO and tighten it enough to prevent movement.

Locating Piston TDC

NOTE: Normal engine rotation as seen from the PTO side is counterclockwise.

1. Slowly rotate the drive pulley counterclockwise while observing the TDC gauge needle.
2. Rotate pulley until the gauge needle starts reversing its movement. This indicates the piston is changing direction at the top of its stroke.
3. Rotate the dial face so the "0" is in line with the needle when it stops moving.
4. Resume rotating the enginecounterclockwise until the gauge needle has rotated approximately 1/4 turn past TDC.
5. Then, slowly rotate the engine in a clockwise direction until needle stops moving.

NOTE: The needle should stop on the "0". If not, reset the dial "0" to the needle.

6. Again, slowly rotate the drive pulley back and forth across TDC and confirm the needle always stops exactly at "0" before changing direction. "0" now indicates exact TDC.
7. Lock the dial face with the dial lock screw.

NOTE: If a difference in "0" setting the dial in each direction of rotation is easily noticeable, the engine components may suffer from excessive wear. The engine may require further inspection and maintenance.

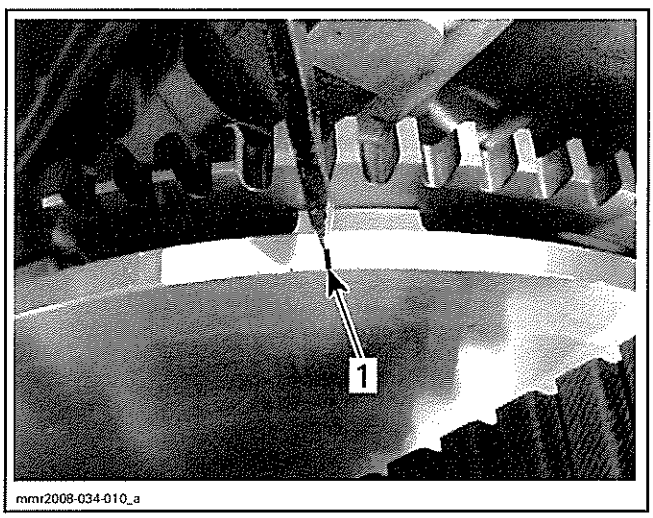
Scribing the Timing Mark

1. From the "0" (TDC), rotate the drive pulley clockwise until the dial needle rotates one-quarter turn past the required BTDC measurement (see table below).
2. Then carefully rotate it counterclockwise until the needle indicates precisely the measurement as specified in the following table.

NOTE: Final setting must always be made counterclockwise (normal engine rotation).

IGNITION TIMING BTDC		
ENGINE	MEASUREMENT BTDC	DEGREE SETTING BTDC
600 HO E-TEC	5.39 mm (.212 in)	28°

3. With the TDC gauge indicating specified timing, use a permanent marker to draw a line on the drive pulley fixed sheave directly in line with pointer end.



TYPICAL
1. Timing mark in line with pointer end

4. Repeat the procedure to ascertain the mark is exactly in line with the pointer.
5. Remove the TDC gauge and dial indicator adapter.
6. Reinstall the fuel injector. Refer to *E-TEC DIRECT INJECTION* section.
7. Check ignition timing as per applicable procedure in this section.

Checking Ignition Timing

The ignition timing can be checked with either the engine hot or cold at the specified RPM.

ENGINE SPEED FOR IGNITION TIMING CHECK	
MODEL	ENGINE RPM
600 HO E-TEC	2500 to 4000 (1)
(1) In this range, the spark advance does not change during the procedure.	

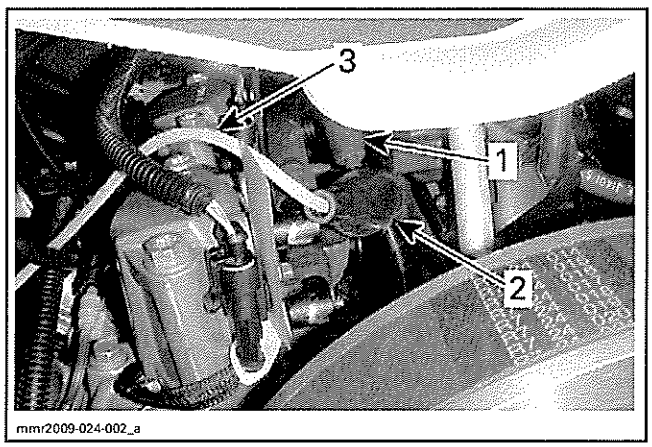
To check the ignition timing proceed as follows:

⚠ WARNING

Place ski tips against a wall, raise rear of vehicle on a stand, so that track does not contact the ground. Do not allow anyone in front of or behind the vehicle while engine is running. Keep clear of track and do not wear loose clothing which can get caught in moving parts.

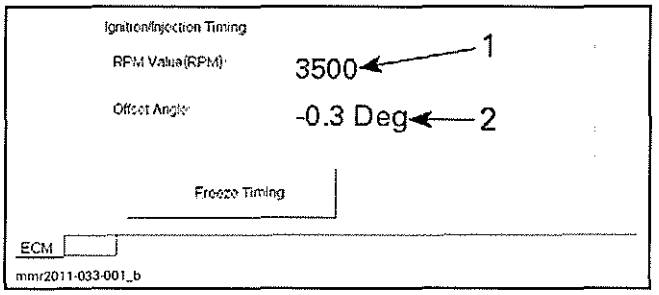
1. Connect the timing light pick-up to the PTO spark plug cable.

NOTICE Be careful to route timing light cable away from drive belt and pulleys.



TYPICAL — TIMING LIGHT CONNECTION
1. PTO spark plug cable
2. Timing light connection to PTO plug cable
3. Timing light wire routing

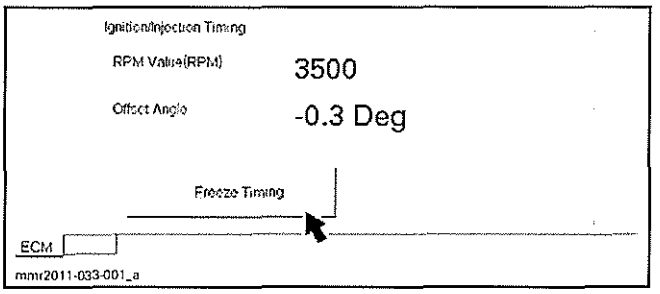
2. Connect to the B.U.D.S. software version applicable to the E-TEC from BOSSWeb. Refer to *COMMUNICATION TOOLS AND B.U.D.S. SOFTWARE* section.
3. Start engine and let idle.
4. In B.U.D.S., select **Read Data**.
5. Select the **Setting** tab.
6. At the bottom of the setting page, select the **ECM** tab.
7. At the bottom left hand corner of the page, you will be able to read the **RPM Value** and the **Offset Angle** in the **Ignition/Injection Timing** field.



TYPICAL
1. *RPM Value*
2. *Timing Offset Angle*

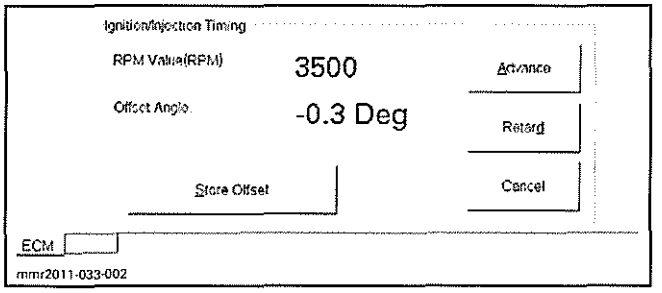
8. In the **Ignition/Injection Timing** field, select **Freeze timing**.

NOTE: Selecting **Freeze timing** will freeze the timing to the proper advance. Timing will be frozen on the PTO cylinder only for RPM stability. RPM will be limited to 4000 RPM.



TYPICAL — SELECTING FREEZE TIMING

Note how the available buttons in the **Ignition/Injection Timing** field have changed.



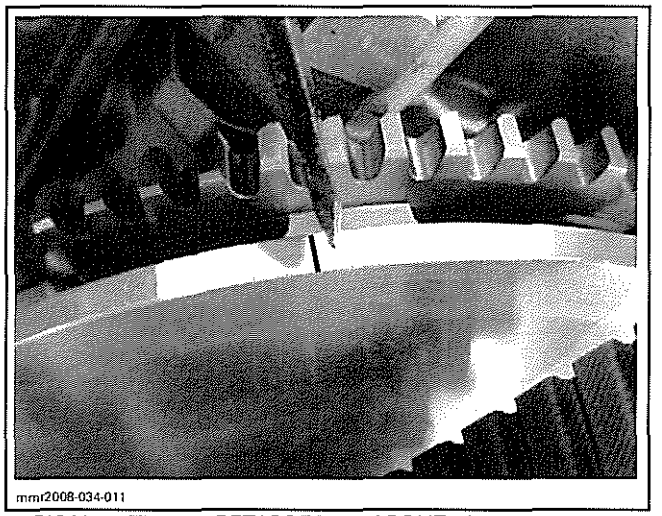
TYPICAL

9. Point the timing light on the timing mark and increase engine to the specified engine speed for a brief instant.
10. The timing mark must be aligned with the pointer end within the specified tolerance.

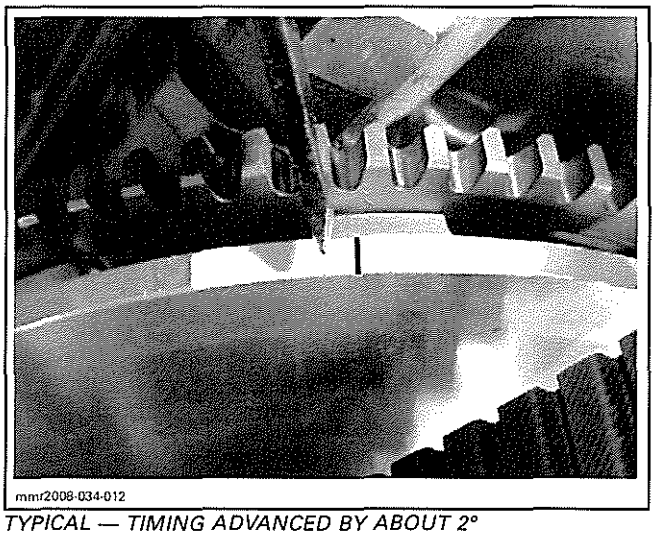
MODEL	TOLERANCE
600 HO E-TEC	± 0.5°

If timing mark and pointer are aligned, no adjustment is required.

If they are not aligned, note if timing is retarded or advanced, see following illustrations. Then, adjust timing as described in *ADJUSTING TIMING (E-TEC)* further in this section.



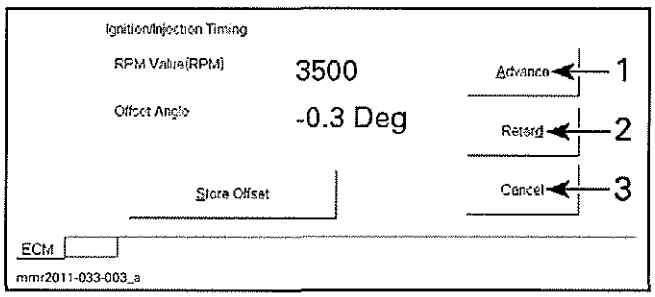
TYPICAL — TIMING RETARDED BY ABOUT 1°



TYPICAL — TIMING ADVANCED BY ABOUT 2°

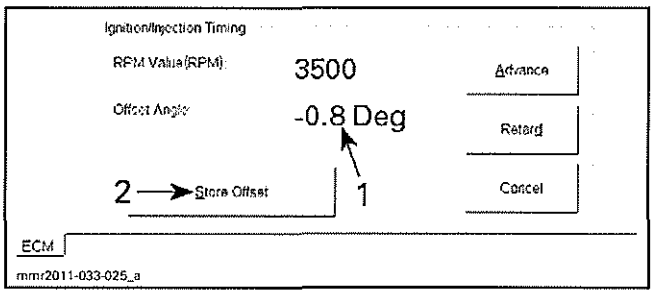
Adjusting Timing

1. In the **Ignition/Injection Timing** field on the **Setting** page, select **Advance** or **Retard** to change the ignition timing in 0.5° increments. Select **Cancel** to erase the last change.



TYPICAL
1. *Advance timing button*
2. *Retard timing button*
3. *Cancel timing change*

2. Adjust the timing using the appropriate button until the timing mark is in line with the pointer. Then select **Store Offset** to store the ignition timing correction.



TYPICAL
1. *Timing angle changed in 0.5° increments*
2. *Store Offset button*

3. Shut down engine.
4. Restart engine and select **Read Data** in B.U.D.S.
5. Recheck timing to ensure ignition timing adjustment was properly stored in the ECM.
6. Increase engine RPM past 4000 RPM to ascertain the **Freeze Timing** function is no longer active.
7. Remove all tools.

TROUBLESHOOTING

IGNITION SYSTEM TESTING SEQUENCE

NOTE: It is good practice to check for fault codes using the B.U.D.S. software as a first troubleshooting step. Refer to the *DIAGNOSTIC AND FAULT CODES* section.

In the case of ignition problems, check the following in the prescribed order until the problem can be solved:

1. Spark plugs
2. Spark plug cables
3. Wiring harness/electrical connectors
4. Emergency engine stop switch
5. Ignition cut-off switch
6. Ignition coil(s)
7. CPS
8. ECM (Engine Control Module).

If engine idles roughly or shows signs of increased emissions, the spark plugs may be incorrectly indexed. Refer to *SPARK PLUG INSTALLATION* in this section.

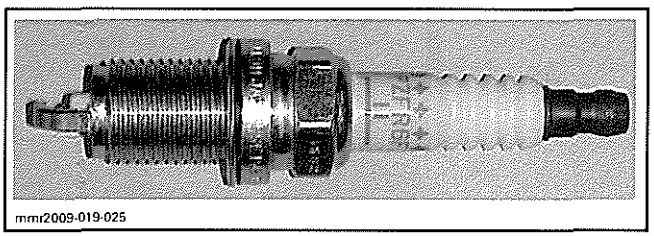
PROCEDURES

SPARK PLUGS

Spark Plug Application

A platinum NGK spark plug is used, one per cylinder.

MODEL	NGK SPARK PLUG NUMBER
600 HO E-TEC	PZFR6F



TYPICAL

Spark Testing

NOTE: Use ONLY an approved inductive spark plug tester or a new spark plug to test for ignition spark. In-line (series connected) spark testers must not be used. Radio frequency interference (RFI) generated by the arcing current may cause erratic behavior in the ECM.

⚠ WARNING

Always electrically disconnect both fuel injectors prior to testing for ignition spark. Otherwise, fuel vapors may ignite in presence of a spark, creating a fire hazard.

1. Install the inductive spark tester (or a new spark plug) on the spark plug cable.

⚠ WARNING

Do not remove spark plugs installed on engine.

2. Bring the new spark plug into contact with the engine.

3. Press START/RER button to crank engine.
4. If no spark is produced, refer to *IGNITION SYSTEM TESTING SEQUENCE* in this section.
5. If a spark is produced, install new spark plugs in the engine and repeat the test to assure the new spark plugs are in good condition and functioning correctly.

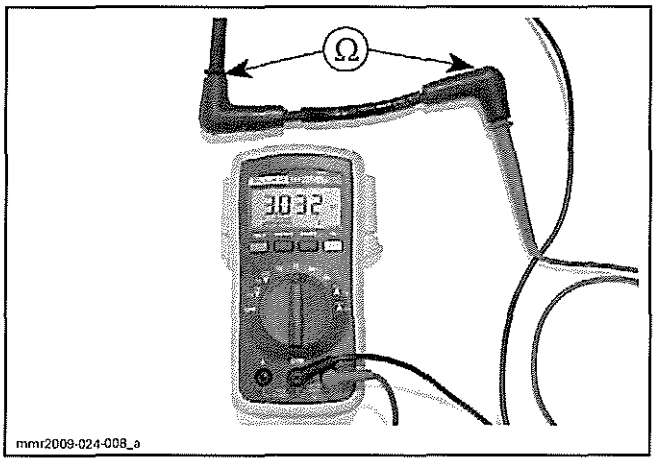
SPARK PLUG CABLES

Spark Plug Cable Resistance Test

If the spark plug cables are in good condition, carry out the following resistance test.

1. Remove each spark plug cable from its ignition coil and spark plug.
2. Set multimeter to Ω.
3. Insert a probe in each cable end and measure the resistance.

SPARK PLUG CABLE RESISTANCE
1283 – 4083 Ω



SPARK PLUG CABLE RESISTANCE TEST

If resistance is not as specified, replace spark plug cable.

NOTE: Apply DIELECTRIC GREASE (P/N 293 550 004) on contact in spark plug cap before reinstalling cable.

NOTICE Do not interchange spark plug cables. The lower LH coil must be matched to the PTO spark plug.

EMERGENCY ENGINE STOP SWITCH

Emergency Engine Stop Switch Operation

The emergency engine stop switch provides a ground signal to the ECM when STOP is selected.

The ground signal is applied to ECM connector J1A pin 9, through the emergency engine stop switch (STOP position).

Refer to applicable *WIRING DIAGRAM* for details.

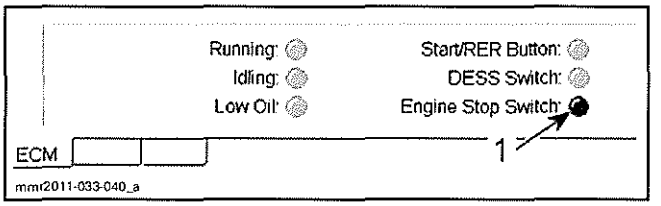
Emergency Engine Stop Switch Troubleshooting

Engine Will Not Start, No Spark

If the engine will not start and you do not have ignition spark at the plugs, the emergency engine stop switch or its wiring to the ECM may be shorted to ground.

Provide power to the electrical system using the T-harness and connect as described in *COMMUNICATION TOOLS AND B.U.D.S. SOFTWARE*.

1. Using the B.U.D.S. software, select the **Monitoring** tab.
2. On the lower LH side of the page, choose the **ECM** tab.
3. Press and hold the vehicle emergency engine stop switch.
4. In B.U.D.S., look for the engine stop switch indicator light at the bottom of the page to turn GREEN. If it does, the switch is functioning correctly.



1. Engine stop switch light indication

5. If the indicator light did not turn green, carry out an *EMERGENCY ENGINE STOP SWITCH CONTINUITY TEST* as per procedures in this section.

Engine Will Not Stop

The emergency engine stop switch and wiring may be open-circuit (no ground available).

Carry out an *EMERGENCY ENGINE STOP SWITCH CONTINUITY TEST* as per procedures in this section.

Emergency Engine Stop Switch Continuity Test

To test the emergency engine stop switch, carry out the following steps.

1. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) multimeter to Ω.
2. Measure the resistance through the switch and its wiring as follows.

EMERGENCY ENGINE STOP SWITCH CONTINUITY TEST			
SWITCH POSITION	**TEST PROBES**		**RESISTANCE**
RUN	BK wire	YE/BK wire	Infinite (OL)
STOP			0 to 0.5 Ω

If readings are not as specified in table, replace switch or repair wiring/connector.

If readings are as specified, refer to *WIRING DIAGRAM* and check the circuit wiring.

ENGINE CUT-OFF SWITCH

Engine Cut-off Switch Continuity Test

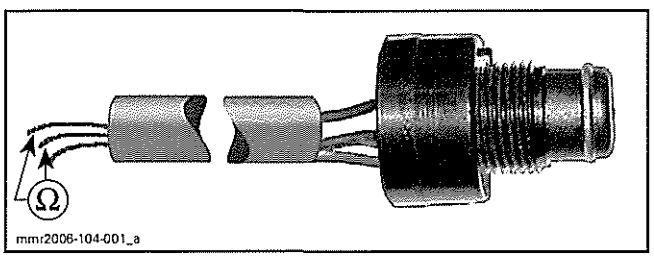
Use the FLUKE 115 MULTIMETER (P/N 529 035 868).

Tether Cord Cap Removed from Switch

Set multimeter to Ω.

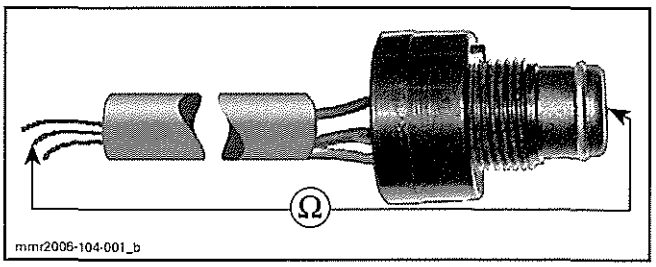
Connect test probes to engine cut-off switch and its connector as per tables and measure resistance.

ENGINE CUT-OFF SWITCH		RESISTANCE Ω @ 20°C (68°F)
WIRE		
GREEN/BLACK	WHITE/BLACK	Open circuit



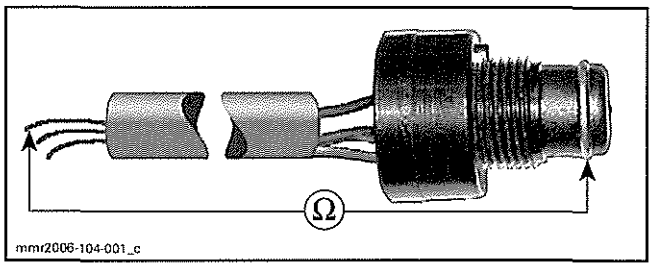
TYPICAL

ENGINE CUT-OFF SWITCH		RESISTANCE Ω @ 20°C (68°F)
WIRE		
WHITE/GRAY	Switch terminal	Close to 0 Ω



TYPICAL

ENGINE CUT-OFF SWITCH		RESISTANCE Ω @ 20°C (68°F)
WIRE		
GREEN/BLACK	Switch ring	Close to 0 Ω

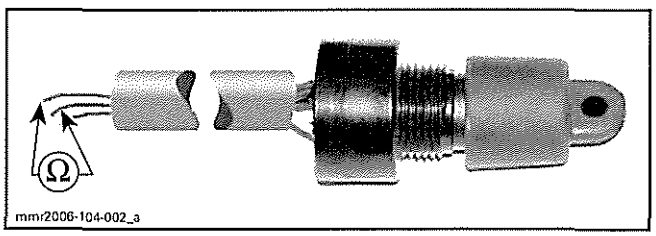


TYPICAL

Tether Cord Cap on Switch

Connect test probes to engine cut-off switch connector as per table and measure resistance.

ENGINE CUT-OFF SWITCH		RESISTANCE Ω @ 20°C (68°F)
WIRE		
GREEN/BLACK	WHITE/BLACK	Close to 0 Ω



TYPICAL

If any resistance test fails, replace engine cut-off switch.

If readings are as specified, refer to *WIRING DIAGRAM* and check the circuit wiring.

IGNITION COILS

Ignition Coil Testing Sequence

NOTE: A resistance test of the ignition coil primary and secondary windings cannot be carried out due to internal circuits.

Before replacing an ignition coil, carry out the following in this order:

– Ignition coil test with B.U.D.S.

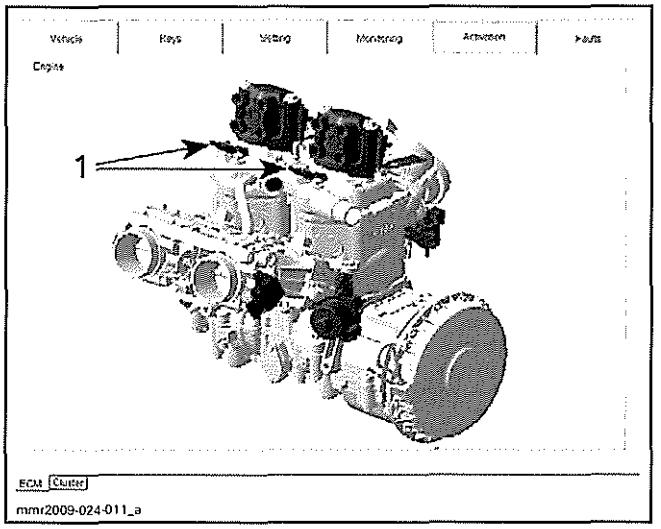
- Ignition coil input voltage test
- Ignition control signal test with B.U.D.S.
- Ignition coil control circuit test
- Ignition coil ground circuit test
- Spark plug cable test
- Spark plug replacement.

Ignition Coil Test with B.U.D.S.

NOTE: The battery must be fully charged. The test with B.U.D.S. will fail if the battery voltage is less than 11 Vdc.

NOTE: The ECM energizes and sends a trigger signal to each ignition coil individually. It can detect if each ignition coil is connected, display a trouble code in the multifunction display, and a CHECK ENGINE upon engine starting.

1. Use the B.U.D.S. software version applicable to the E-TEC from BOSSWeb. Refer to *COMMUNICATION TOOLS AND B.U.D.S. SOFTWARE* section.
2. Connect B.U.D.S. to the vehicle and select **Read Data**.
3. Select the **Activation** tab.
4. At the bottom LH corner of the activation page, select the **ECM** tab.
5. Energize each ignition coil separately.



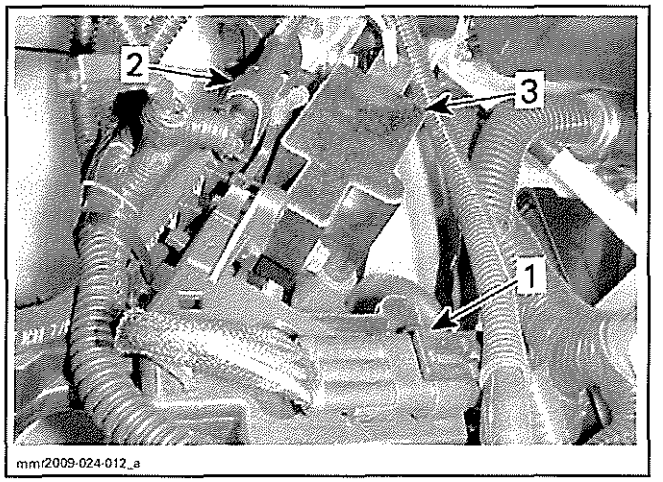
1. Activate here

You should hear the spark occurring. If in doubt, use an inductive spark tester.

If there is no spark, carry out an *IGNITION COIL INPUT VOLTAGE TEST*.

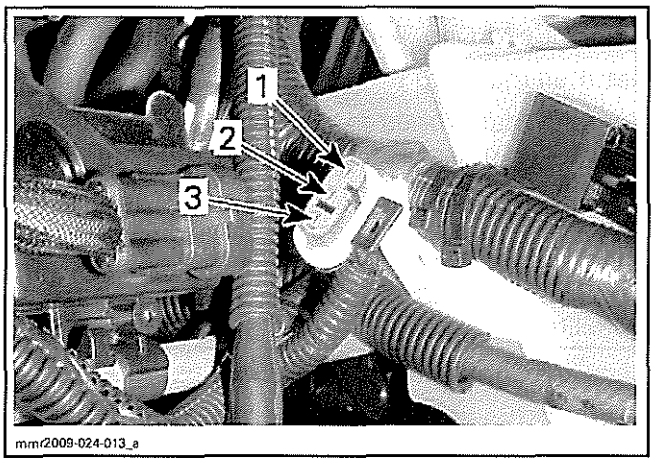
Ignition Coil Input Voltage Test

1. Disconnect the connector from each ignition coil.



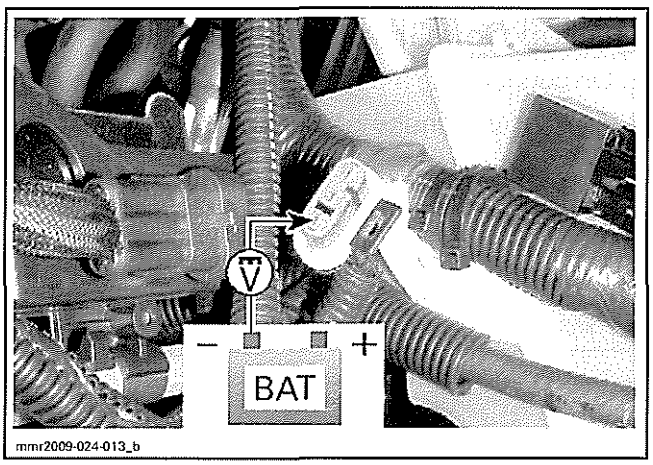
IGNITION COIL CONNECTORS, REAR VIEW
1. PTO coil connector
2. MAG coil connector
3. MAG ignition coil

2. Provide power to the electrical system for testing. Refer to *LIGHTING AND ACCESSORIES SYSTEM TESTING* in the *TROUBLESHOOTING* topic at the beginning of the subsection for proper procedure.
3. Set multimeter to Vdc and measure supply battery voltage.
4. Check ignition coil input voltage as follows.



IGNITION COIL CONNECTOR PIN-OUT

IGNITION COIL WIRE		VOLTAGE (VDC)
WH/RD	Battery ground	Battery voltage minus 0.7 Vdc



INPUT VOLTAGE TEST (PRIMARY COIL WINDING)

If voltage is NOT as specified, carry out the following. Refer to applicable *WIRING DIAGRAM* for details.

- Check continuity of wire between WH/RD wire of ignition coil and pin 13 of the ECM J2 connector.
- Test for supply battery voltage at pins 15 and 16 of ECM J2 connector.
- Test continuity of all ECM ground circuits, refer to *E-TEC DIRECT INJECTION* section.
- Repair or replace wiring as required.

If battery voltage is read at coil input, carry out the following. Refer to applicable *WIRING DIAGRAM* for details.

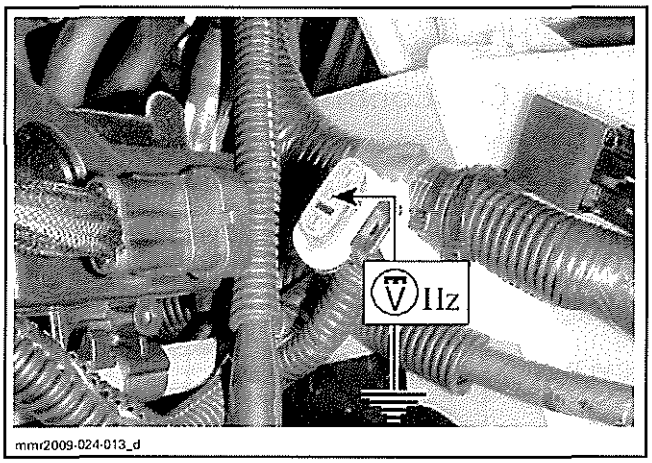
- Ignition control signal test with B.U.D.S.
- Spark plug cable resistance test
- Continuity test of ignition coil control circuit
- Continuity test of coil ground circuit, BK wire to chassis ground
- Replace coil
- Replace ECM.

Ignition Coil Control Signal Test with B.U.D.S.

1. Disconnect the affected ignition coil connector.
2. Set multimeter to Vdc, then select the frequency function (Hz), and manually set the scale to 6 Hz.

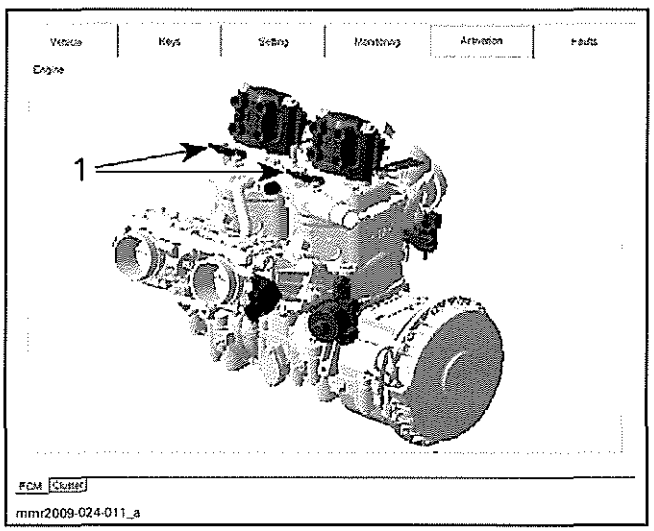
NOTE: If the meter is left in automatic range mode, you will not obtain a reading as the ignition control signal is too fast and far too short a period of time for the meter to adjust and take the reading. The meter must be in a low manual Hz range.

3. Set multimeter to a low manual Hz range.
4. Select the MAX. function on the multimeter to record the maximum reading detected.
5. Install an alligator clip adapter to the BLACK (–) probe, and a thin rigid back probe to the RED multimeter probe.



IGNITION SIGNAL TEST AT COIL CONNECTOR

6. Insert the RED probe in OR/GN wire (PTO) and OR/BU wire (MAG) of the coil connector, and clip the BLACK probe to engine ground.
7. In B.U.D.S., energize the affected ignition coil separately.



1. Activate here

METER SELECTION	TEST PROBES		READING
Vdc Hz manual range	Coil wire	Engine	Approximately 2 Hz
	PTO: OR/GN	Ground	
	MAG: OR/BU	Ground	

Frequency of ignition signal should be consistentl.

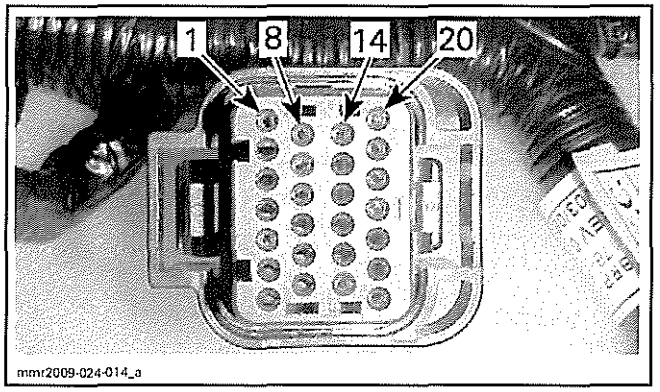
If signal is not present, refer to *IGNITION COIL CONTROL CIRCUIT*.

If the ignition coil control signal test was good, test the following before installing a new coil.
- Ignition coil ground circuit test
- Spark plug cable resistance test
- Spark plugs.

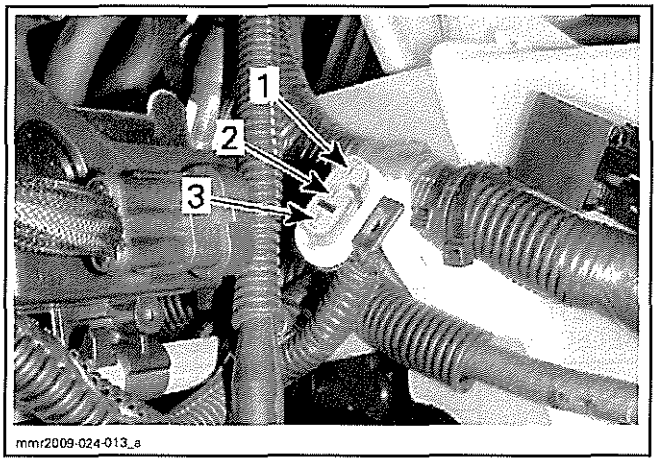
Ignition Coil Control Circuit Test

1. Disconnect connector J1B from ECM.
2. Test for continuity of the circuit between ECM connector and ignition coil connector as follows.

CONNECTOR PIN			
CYLINDER	ECM J1B	IGNITION COIL WIRE	RESISTANCE
PTO	19	OR/GN	Close to 0 Ω (continuity)
MAG	26	OR/BU	



J1B PIN-OUT



IGNITION COIL CONNECTOR PIN-OUT

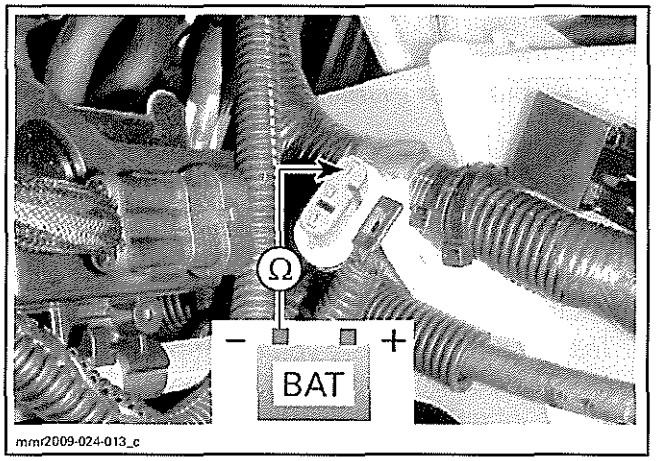
If wiring harness is defective, repair the connector or replace the wiring harness between ECM connector and the ignition coil.

If wiring harness tested good, refer to *IGNITION COIL GROUND CIRCUIT TEST.*

Ignition Coil Ground Circuit Test

1. Disconnect the input connector from both coils.
2. Test for continuity of the coil ground circuit as follows.

CYLINDER	IGNITION COIL CONNECTOR		RESISTANCE
PTO	BK	Chassis ground	Close to 0 Ω (continuity)
MAG			



IGNITION COIL GROUND CIRCUIT TEST (PIN 1)

If wiring harness is defective, repair or replace the wiring and connectors.

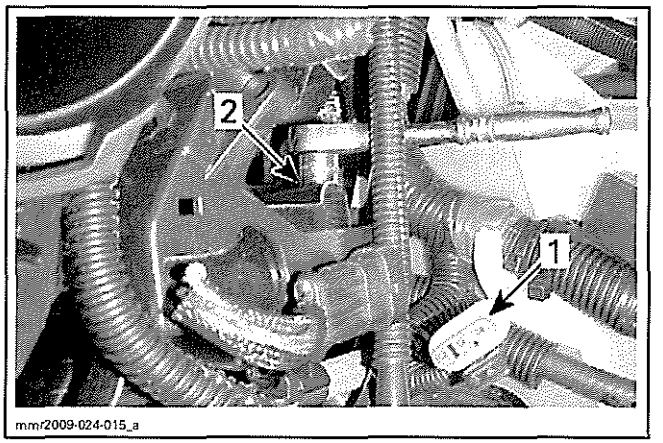
If the ground circuit tested good, replace the ignition coil.

Ignition Coil Removal

1. Note position of spark plug cables and remove them from the spark plugs.

PTO Coil Removal

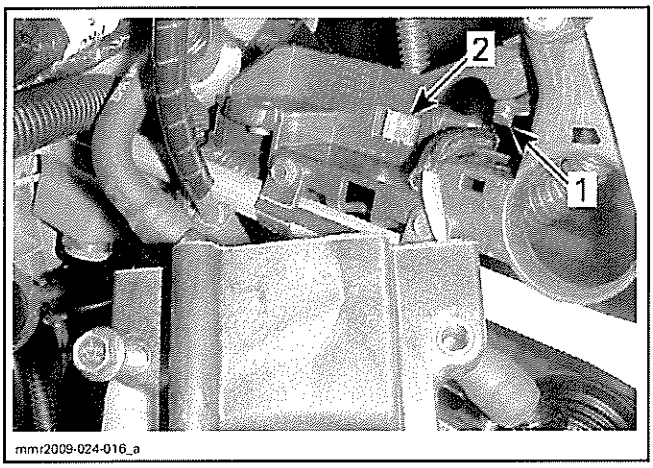
1. Disconnect the ignition coil connector.
2. Remove the coil retaining screw.



PTO IGNITION COIL (REAR VIEW)
1. Disconnect coil connector
2. Remove coil retaining screw

NOTE: PTO coil connector is mounted to the support with a retaining clip. Coil must be off support to access clip for removal.

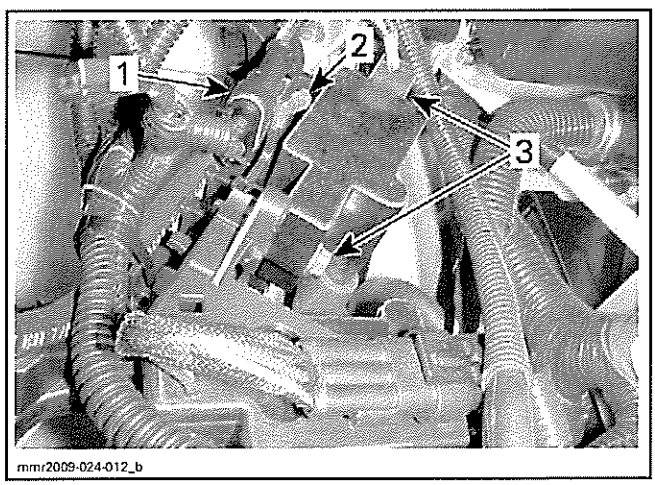
3. Using a screwdriver, lift the retaining tab out of the second coil mounting hole to release coil from support. Do not pull coil away from support.
4. Using a small screwdriver, remove spring clip retaining coil connector to support and pull connector through support opening.



1. Lift to release coil from support
2. Remove connector retaining clip from support

MAG Coil Removal

1. Disconnect the ignition coil connector.
2. Using a small screwdriver, remove connector retaining clip from support.
3. Remove the two coil retaining screws.

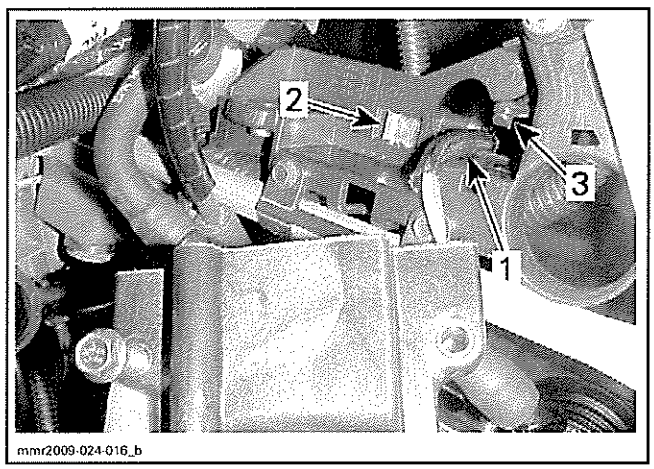


1. Disconnect coil connector
2. Remove connector retaining clip
3. Remove two mounting screws

Ignition Coil Installation

Reverse the removal procedures but pay attention to the following:

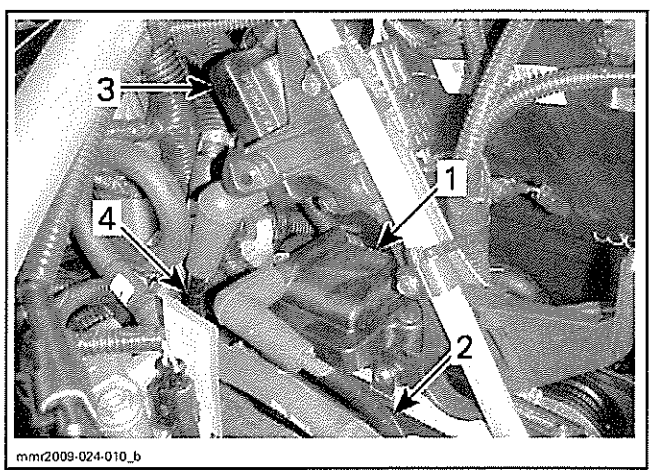
1. On the PTO coil, insert the coil connector through the coil support and install its retaining clip on the support before installing the coil.
2. Insert the PTO coil under the coil support retaining tab and slide it onto the support until the tab drops into the coil mounting hole.



1. Insert coil connector through support
2. Install connector retaining clip
3. Lift tab and insert coil

3. Install the retaining screw(s) and torque to 10 N•m (89 lbf•**in**) (both coils).
4. Reconnect the primary winding connectors and the spark plug cables.

NOTE: Pay attention to the position of the spark plug cables when connecting them. Lower coil connects to the PTO spark plug. Apply dielectric grease, refer to *SPARK PLUG CABLE.*



1. PTO ignition coil
2. Cable To PTO spark plug
3. MAG ignition coil
4. To MAG spark plug

⚠ WARNING

Always reconnect ignition coil cables to the same spark plugs they were disconnected from. Otherwise, severe backfire may occur with possible damage to exhaust system components.

IGNITION SYSTEM (600 ACE AND 1200 4-TEC)

SERVICE TOOLS

Description	Part Number	Page
ECM ADAPTER TOOL	420 277 010	614, 616
ECM ADAPTER TOOL	529 036 166	614, 616
FLUKE 115 MULTIMETER	529 035 868	612, 615

GENERAL

Cables and locking ties removed during a procedure must be reinstalled as per factory standards.

NOTICE Never force a multimeter probe into an electrical terminal.

SYSTEM DESCRIPTION

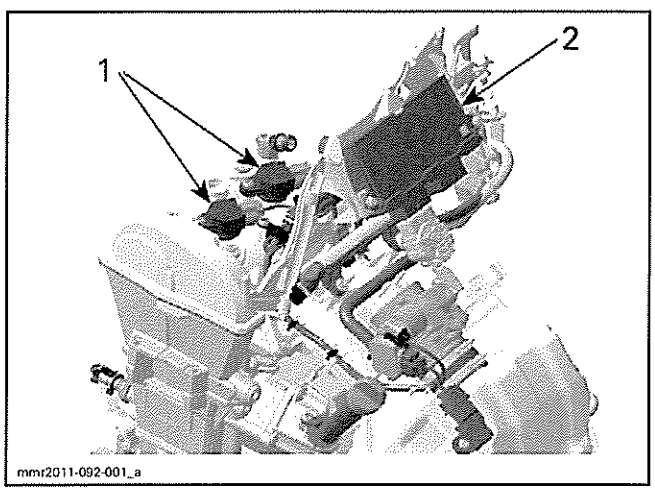
The ignition system is a digital inductive type (IDI) system.

Ignition system parameters such as ignition timing, spark duration, and firing order, are controlled by the ECM in order to meet engine operational requirements.

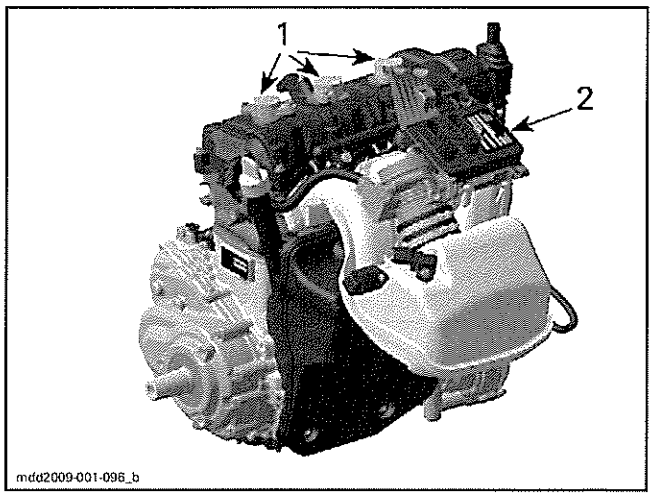
Direct ignition coils (stick coils) are used for each cylinder.

When a ground signal is provided by the ECM to an ignition coil primary winding, a high voltage is induced in the ignition coil secondary winding that is used to produce a spark at the spark plug electrode.

Cylinder 1 is on the PTO side of engine.



600 ACE ENGINE
1. Ignition coils
2. ECM



1200 4-TEC ENGINE
1. Ignition coils
2. ECM

Ignition Timing

Ignition timing is not adjustable.

The ECM is programmed with data (ignition mappings), used along with data received from a variety of sensors to establish optimum ignition timing under all engine operating conditions.

The firing of each spark plug is independent of the other(s).

TROUBLESHOOTING

DIAGNOSTIC TIPS

No Spark when Cranking Engine with both Spark Plugs Removed and Grounded on Cylinder Head

600 ACE Models

At least one spark plug must be installed in a cylinder. Otherwise, there will be no spark at any spark plug.

IGNITION SYSTEM TESTING

The ECM controls the ignition system.

If a fault is detected by the ECM, the check engine light will turn on.

On a premium gauge, a check engine message will be displayed and beep code will be emitted. Refer to *DIAGNOSTIC AND FAULT CODES* section for details.

The ECM can detect a problem on the primary winding or circuit of the ignition coils.

The secondary winding of the ignition coils is not monitored by the ECM.

Other sensors in relation with the ignition system are also monitored by the ECM.

Ignition System Testing Sequence

Check for fault codes using B.U.D.S. software as a first troubleshooting step. Refer to *DIAGNOSTIC AND FAULT CODES* section.

Check the following fuses:

600 ACE MODEL	1200 4-TEC MODEL
Fuse 5	Fuse 3
	Fuse 4
	Fuse 5

If a fuse is burnt, test for a short circuit or faulty component on that fuse circuit before replacing the fuse. Refer to *POWER DISTRIBUTION*.

Check ignition spark, refer to *IGNITION COIL QUICK TEST USING B.U.D.S.* in this subsection.

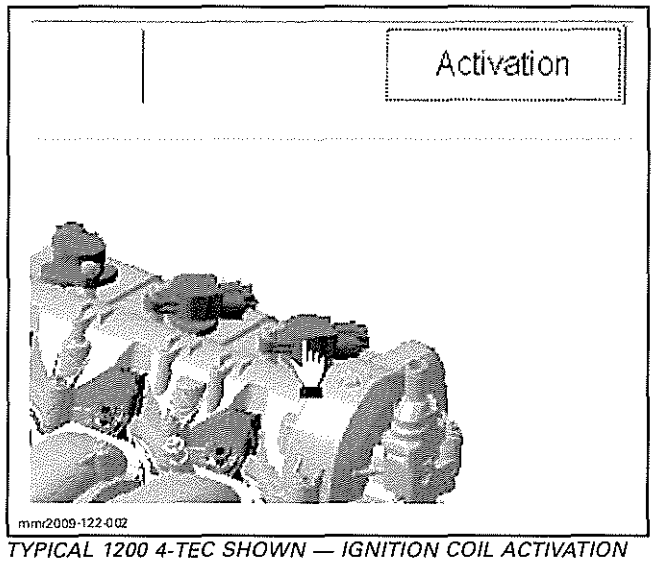
PROCEDURES

IGNITION COILS

Ignition Coil Quick Test using B.U.D.S.

This test confirms the working condition of the ignition circuit and ignition coil for the cylinder tested.

1. Remove ignition coil, refer to *IGNITION COIL REMOVAL* in this subsection.
2. Install a spark tester on the ignition coil.
3. Connect to the proper B.U.D.S. version software, refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
4. In B.U.D.S., select **Read Data**.
5. Select the **Activation** tab.
6. Energize the **ignition** coil by selecting it on the engine illustration.



TYPICAL 1200 4-TEC SHOWN — IGNITION COIL ACTIVATION

If there is no spark, carry out the following tests.

Ignition Coil Input Voltage Test

1. Disconnect the ignition coil connector.
2. Install tether cord cap on engine cut-off switch.
3. Set emergency engine stop switch to RUN.
4. Quickly press on START/RER switch to wake up ECM.
5. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and set it to Vdc.
6. Measure voltage as per following table.

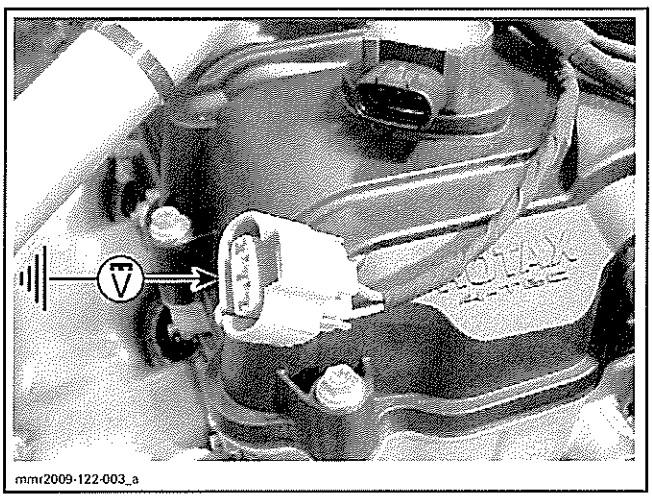
NOTE: Test is valid only if ECM is active (gauge will be on).

600 ACE Models

IGNITION COIL INPUT VOLTAGE TEST		
TEST PROBES		VOLTAGE
PTO coil VIOLET/BLUE wire	Battery ground	Battery voltage
MAG coil VIOLET/GREEN wire		

1200 4-TEC Models

IGNITION COIL INPUT VOLTAGE TEST		
TEST PROBES		VOLTAGE
Ignition coil 1 VIOLET/BLUE wire	Battery ground	Battery voltage
Ignition coil 2 VIOLET/GREEN wire		
Ignition coil 3 connector pin 1 (VIOLET/ORANGE)		



TYPICAL 1200 4-TEC SHOWN — IGNITION COIL INPUT VOLTAGE TEST

If battery voltage is read, test ignition coil ground signal. Refer to *IGNITION COIL CIRCUIT CONTINUITY TEST.*

If battery voltage is NOT read, test ignition coil power input wire. Refer to *IGNITION COIL CIRCUIT CONTINUITY TEST.*

7. Remove tether cord cap from engine cut-off switch.

Ignition Coil Circuit Continuity Test

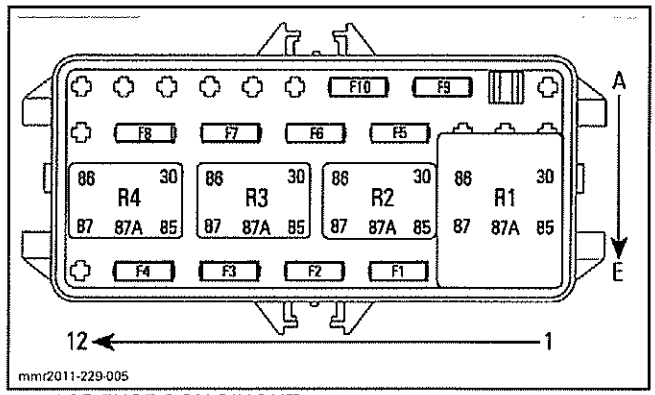
Power Input Wire (Ignition Coil)

1. Make sure that tether cord cap is removed from engine cut-off switch and emergency engine stop switch is set to STOP.
2. Locate the applicable ignition/injector fuse located in the fuse box. Refer to *POWER DISTRIBUTION.*
3. Disconnect ignition coil connector.
4. Remove applicable fuse.
5. Test for continuity of circuit as per following table.

NOTE: Probe the metallic part on top of the fuse.

600 ACE Models

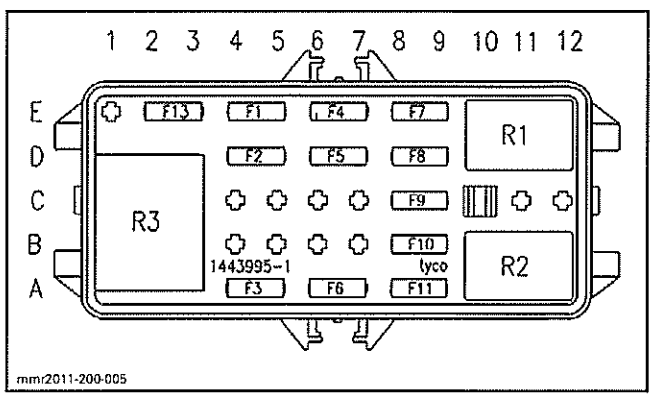
POWER INPUT WIRE CONTINUITY TEST (IGNITION COIL) FUSE BOX			
IGNITION COIL	IGNITION COIL CONNECTOR WIRE	FUSE BOX CONTACT	RESISTANCE
PTO	VIOLET/BLUE	5B (fuse 5)	Close to 0 Ω (continuity)
MAG	VIOLET/GREEN		



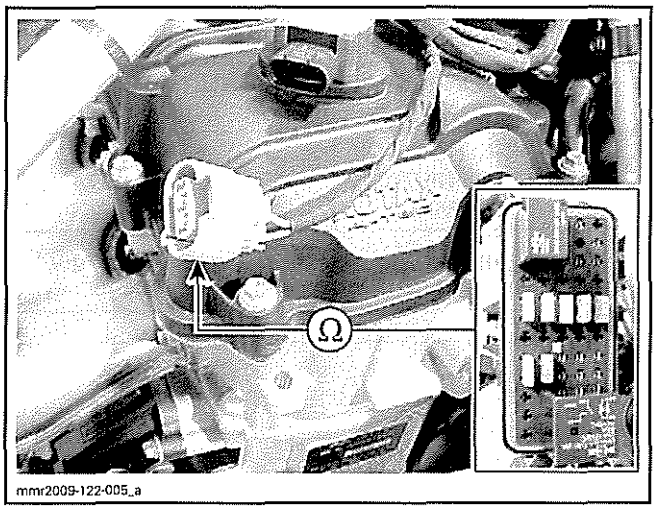
600 ACE FUSE BOX PINOUT

1200 4-TEC Models

POWER INPUT WIRE CONTINUITY TEST (IGNITION COIL)			
IGNITION COIL	IGNITION COIL CONNECTOR WIRE	FUSE BOX CONTACT	RESISTANCE
Cylinder 1	VIOLET/BLUE	7D (fuse 5)	Close to 0 Ω (continuity)
Cylinder 2	VIOLET/GREEN	7E (fuse 4)	
Cylinder 3	VIOLET/ORANGE	5A (fuse 3)	



1200 4-TEC FUSE BOX PINOUT

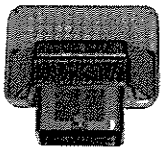
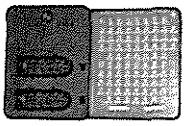


TYPICAL 1200 4-TEC SHOWN — POWER INPUT WIRE CONTINUITY TEST (IGNITION COIL)

If continuity is not measured as specified, test the engine and vehicle harnesses.

Ground Signal Wire (Ignition Coil)

1. Disconnect ECM connector A. Refer to *ELECTRONIC FUEL INJECTION* subsection.
2. Install connector on the following tool according to model.

MODEL	TOOL	TOOL VIEW
600 ACE	ECM ADAPTER TOOL (P/N 529 036 166)	
1200 4-TEC	ECM ADAPTER TOOL (P/N 420 277 010)	

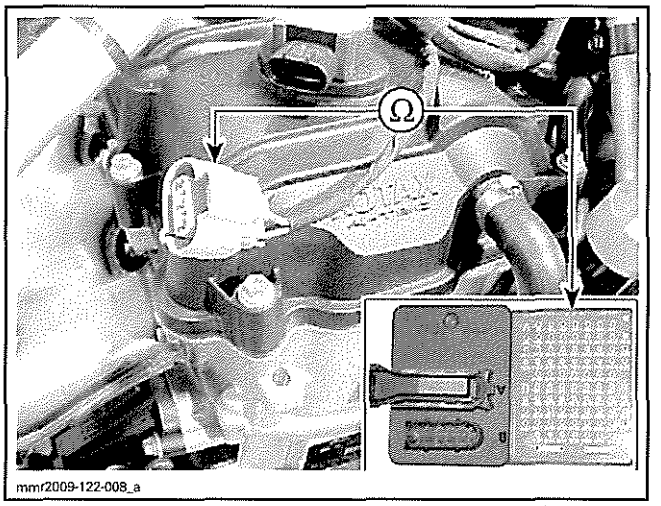
3. Disconnect ignition coil connector.
4. Test for continuity of ignition coil ground signal circuit as per following table.

600 ACE Models

GROUND WIRE CONTINUITY TEST (IGNITION COIL)			
IGNITION COIL	IGNITION COIL CONNECTOR WIRE	ECM PIN	RESISTANCE
PTO	BROWN/BLACK	M1	Close to 0 Ω (continuity)
MAG	BROWN/ORANGE	M2	

1200 4-TEC Models

GROUND WIRE CONTINUITY TEST (IGNITION COIL)			
IGNITION COIL	IGNITION COIL CONNECTOR WIRE	ECM PIN	RESISTANCE
Cylinder 1	BROWN/BLACK	A-41	Close to 0 Ω (continuity)
Cylinder 2	BROWN/ORANGE	A-1	
Cylinder 3	BROWN/YELLOW	A-29	



TYPICAL 1200 4-TEC SHOWN — IGNITION COIL GROUND SIGNAL WIRE CONTINUITY TEST

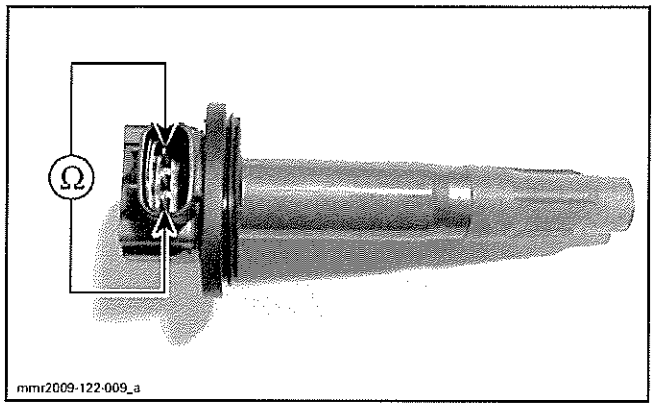
If continuity is not measured as specified, repair the connector or replace the engine wiring harness.

Ignition Coil Resistance Test

An ignition coil with a good resistance measurement can still be faulty. Current leakage can occur at high voltage levels which is not detectable with an ohmmeter. Replacing the ignition coil may be necessary as a test.

Primary Winding

1. Remove ignition coil. Refer to *IGNITION COIL REMOVAL* in this subsection.
2. Set the multimeter to Ω and measure primary winding resistance as specified.



MODEL	CIRCUIT	PIN	RESISTANCE @ 20°C (68°F)
600 ACE 1200 4-TEC	Primary	1 and 3	0.8 - 0.97 Ω

If resistance is not within specification, replace ignition coil.

Secondary Winding

The secondary winding on this type of ignition coil cannot be tested.

Ignition Coil Removal

1. Disconnect ignition coil connector.
2. Remove ignition coil retaining screw.

NOTICE Do not pry on ignition coil with a tool.

3. Remove ignition coil from spark plug by rotating coil side to side as you pull up.

NOTE: For cylinder 2, turn steering column to ease ignition coil removal.

Ignition Coil Installation

1. Align the retaining screw hole of the ignition coil with the threaded hole on the valve cover.
2. Install the ignition coil on the spark plug and push it all the way down until it rests on the valve cover.
3. Install the retaining screw an tighten to 11 N•m (97 lbf•**in**).
4. Connect ignition coil connector.

SPARK PLUGS

Spark Plug Application

ENGINE	SPARK PLUG
600 ACE	CR7EB
1200 4-TEC	NGK CR8EKB

EMERGENCY ENGINE STOP SWITCH

Emergency Engine Stop Switch Operation

The emergency engine stop switch provides a ground signal to the ECM when STOP is selected.

The ground signal is applied to ECM connector as per table, through the emergency engine stop switch (STOP position).

MODEL	ECM PIN
600 ACE	B-4C
1200 4-TEC	B-21

Refer to applicable *WIRING DIAGRAM* for details.

Emergency Engine Stop Switch Continuity Test

Remove gauge.

Check switch continuity as per following table using the FLUKE 115 MULTIMETER (P/N 529 035 868).

EMERGENCY ENGINE STOP SWITCH CONTINUITY TEST			
SWITCH POSITION	TEST PROBES		RESISTANCE
RUN	BK wire	YE/BK wire	Infinite (OL)
STOP			Close to 0 Ω

If readings are not as specified in table, check wiring and connections going to switch. If good, replace switch.

ENGINE CUT-OFF SWITCH

Engine Cut-Off Switch Continuity Test

Disconnect engine cut-off switch connector.

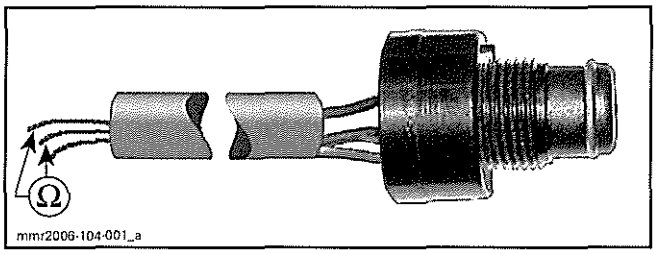
The following continuity tests can be performed using the FLUKE 115 MULTIMETER (P/N 529 035 868).

Tether Cord Cap Removed from Engine Cut-Off Switch

Set multimeter to Ω.

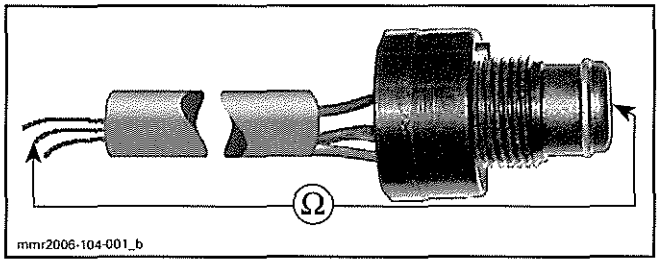
Connect test probes to engine cut-off switch and its connector as per tables and measure resistance.

ENGINE CUT-OFF SWITCH		RESISTANCE Ω @ 20°C (68°F)
WIRE		
GREEN/BLACK	WHITE/BLACK	Open circuit



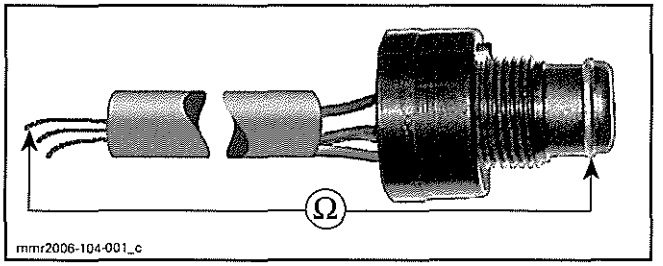
TYPICAL

ENGINE CUT-OFF SWITCH		RESISTANCE Ω @ 20°C (68°F)
WIRE		
WHITE/ GRAY	Switch terminal	Close to 0 Ω



TYPICAL

ENGINE CUT-OFF SWITCH		RESISTANCE Ω @ 20°C (68°F)
WIRE		
GREEN/BLACK	Switch ring	Close to 0 Ω

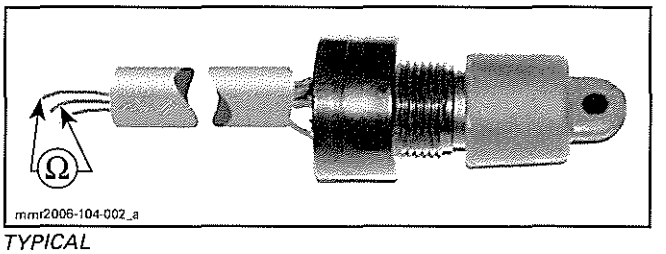


TYPICAL

Tether Cord Cap on Engine Cut-Off Switch

Connect test probes to engine cut-off switch connector as per table and measure resistance.

ENGINE CUT-OFF SWITCH		RESISTANCE Ω @ 20°C (68°F)
WIRE		
GREEN/BLACK	WHITE/BLACK	Close to 0 Ω



TYPICAL

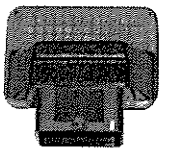
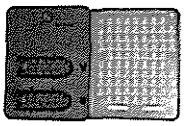
If any resistance test fails, replace engine cut-off switch.

Engine Cut-Off Switch Vehicle Harness Continuity Test

Disconnect engine cut-off switch connector.

Disconnect ECM connector B. Refer to *ELECTRONIC FUEL INJECTION* subsection.

Install connector on the following tool according to model.

MODEL	TOOL	TOOL VIEW
600 ACE	ECM ADAPTER TOOL (P/N 529 036 166)	
1200 4-TEC	ECM ADAPTER TOOL (P/N 420 277 010)	

Set multimeter to Ω.

Check wire continuity between engine cut-off switch connector of main wiring harness and ECM as follows.

600 ACE Models

ENGINE CUT-OFF SWITCH CONNECTOR (MAIN WIRING HARNESS SIDE)	ECM ADAPTER	RESISTANCE Ω @ 20°C (68°F)
WIRE	PIN	
WHITE/GRAY	B-B2	Close to 0 Ω
WHITE/BLACK	B-E4	
GREEN/BLACK	B-F2	

1200 4-TEC Models

ENGINE CUT-OFF SWITCH CONNECTOR (MAIN WIRING HARNESS SIDE)	ECM ADAPTER	RESISTANCE Ω @ 20°C (68°F)
WIRE	PIN	
WHITE/GRAY	B-38	Close to 0 Ω
WHITE/BLACK	B-26	
GREEN/BLACK	B-39	

- If any continuity test failed, repair or replace wiring connectors/terminals.
- If problem persists and all tests have been performed, try a new ECM. Refer to *ECM REPLACEMENT.*

CHARGING SYSTEM (600 HO E-TEC)

SERVICE TOOLS

Description	Part Number	Page
FLUKE 115 MULTIMETER	529 035 868	623–624

SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
FLUKE RIGID BACK PROBES	TP88	624
NAPA ULTRA PRO BATTERY LOAD TESTER	95260	629

SERVICE PRODUCTS

Description	Part Number	Page
DIELECTRIC GREASE	293 550 004	630–631

GENERAL

⚠ WARNING

Unless otherwise specified, always disconnect the magneto connector and ensure spark plugs are installed in the engine before carrying out electrical system checks. Should the engine be made to rotate with magneto connected, a spark may occur resulting in electrical shock, a fire, or an explosion.

SYSTEM DESCRIPTION

Magneto

A magneto provides the primary source of electrical energy. It transforms a magnetic field into an alternating current (AC).

The magneto is comprised of a 3 winding, single phase wound stator that has a capacity of 1200 watts.

AC current is rectified and regulated by a voltage regulator/rectifier circuit, and a DC to DC converter, both integrated within the ECM.

The charging system provides 3 outputs to the vehicle electrical system, one 55 Vdc and two 12 Vdc outputs.

Battery

A battery is installed on as a secondary power source. It is primarily used for energizing the starter. It provides power to instantly power the ECM when the START/RER button is pressed.

On vehicles equipped with a high end multifunction gauge, it also provides power to maintain the clock function within the gauge.

NOTE: Never use a battery charger to temporarily substitute the battery as it may cause the ECM (engine control module) to function erratically or not at all.

TROUBLESHOOTING

NOTE: It is good practice to check for fault codes using B.U.D.S. software as a first troubleshooting step. Refer to *DIAGNOSTIC AND FAULT CODES*.

TROUBLESHOOTING GUIDELINES

Weak or Discharged Battery

If the battery is weak or discharged, check the following items:

- Battery charging fuse (F1)
- Battery charging relay (R1)
- Charging system voltage, see *PRIMARY 12 VDC CIRCUIT TEST WITH B.U.D.S.* in this section
- Battery
- Wiring and connections.

NOTE: If there is no primary 12 Vdc circuit output voltage, the lights and gauge will not function.

Charging System Voltages (Engine May Not Start)

The engine cannot start without having a minimum voltage to the 55 V power circuit. If the engine does not start, see *VOLTAGE REGULATOR/RECTIFIER* in this section and carry out the 55 Vdc voltage output test with B.U.D.S.

If voltage is not as specified, check the following items in the recommended order until you find the fault:

- Stator (refer to *MAGNETO* section)
- Capacitor (see procedure in this section).

NOTE: The 55 Vdc may be unstable or unobtainable if the capacitor is faulty, not connected, or incorrectly connected.

If the above mentioned checks were good, isolate each of the following components by disconnecting them individually, and repeating the voltage test after each one.

- Each injector
- Each ignition coil
- Fuel pump
- Oil injection pump.

NOTE: When the 55 Vdc test good after a component is disconnected, replace that component and repeat the test.

PROCEDURES

BATTERY CHARGING FUSE

Fuse Location

The battery charging fuse (F1) is located in fuse box.

Fuse Information

The voltage regulator could be the culprit of a blown battery charging fuse.

To check for this, carry out the *PRIMARY 12 VDC CIRCUIT TEST WITH B.U.D.S.* in this section. Also check for an applicable fault code, refer to *DIAGNOSTIC AND FAULT CODES.*

BATTERY CHARGING RELAY (R1)

A battery charging relay (R1), completes the charging circuit between the voltage regulator output and the battery. It receives its ground control signal from the ECM. Refer to *WIRING DIAGRAM* for more details.

The ECM provides the ground to activate the relay at approximately at the following engine speed:

MODEL	CHARGING RELAY ACTIVATION
600 HO E-TEC	1900 RPM

Battery charging Relay Location

The battery charging relay is located in fuse box.

VOLTAGE REGULATOR/RECTIFIER

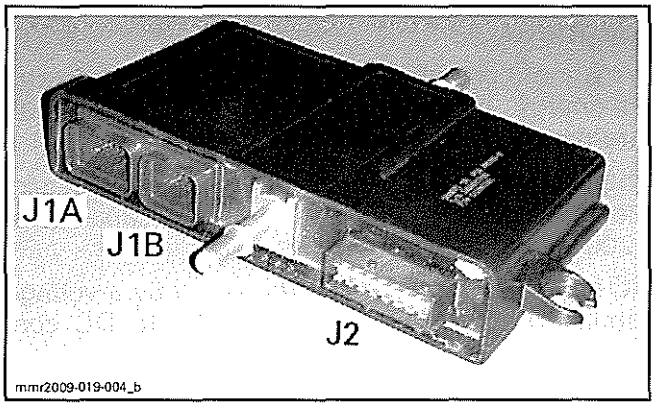
Description

The voltage regulator/rectifier is integrated within the ECM. It receives three single phase alternating current (AC) inputs from the magneto which it rectifies and regulates to 55 Vdc.

On a single pull start with the engine between 250 and 500 RPM, the magneto, combined with an ingenious series/parallel switching capability of the voltage regulator/rectifier, is capable of producing 55 Vdc.

55 Vdc Output Path

ECM CONNECTOR	TO
J2 (pin 13)	Capacitor Fuel Injectors Ignition coils Fuel pump Oil injection pump J2 (pin 12) (ECM internal protection)



Continuity Test (Voltage Regulator/Rectifier)

Due to internal circuitry, there is no static test available to check continuity.

55 Vdc Voltage Output Test with B.U.D.S. (Voltage Regulator/Rectifier)

1. Raise vehicle so that the track is off the ground and can turn freely.

⚠ WARNING

Ensure vehicle track is completely raised off ground. If the track should come into contact with the ground when the engine is at 5000 RPM, equipment damage and severe injury may result.

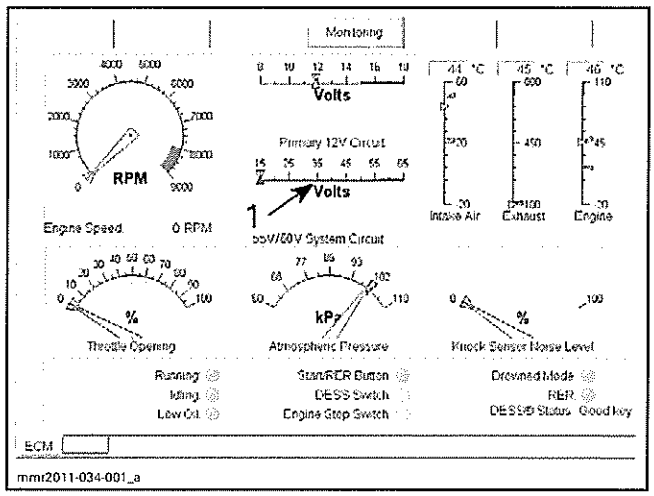
2. Make proper connections and use the applicable B.U.D.S. software version. Refer to *COMMUNICATION TOOLS/B.U.D.S. SOFTWARE* section.

Procedure when Engine Cannot be Started

NOTE: Pressing the START/RER button momentarily will power the ECM to allow B.U.D.S. to read the ECM prior to engine cranking for the test.

1. In B.U.D.S., select **Read Data**.
2. Select the **Monitoring** tab.
3. At the bottom of the monitoring page, select the **ECM** tab.
4. Crank the engine over by pressing and holding the START/RER button for a few seconds.
5. Read the voltage on the **55V System Circuit** meter in B.U.D.S. as the engine is being cranked.

NOTICE **Do not hold the START/RER button more than 10 seconds. A rest period should be observed between the cranking cycles to let the starter cool down. Holding the START/RER button for extended periods could overheat and permanently damage the starter.**



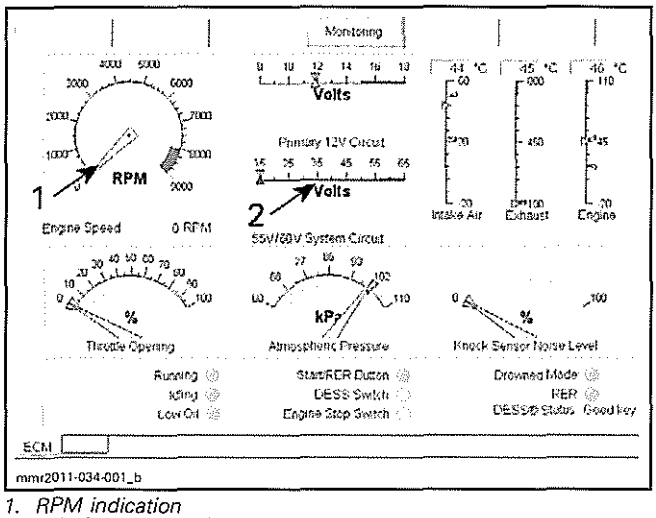
1. 55V System circuit

6. Refer to the *55 VDC VOLTAGE OUTPUT TEST* table in the previous *MANUAL START MODELS* for specifications.

Procedure With Engine Running

1. Make proper connections and use the applicable B.U.D.S. software version. Refer to *COMMUNICATION TOOLS AND B.U.D.S. SOFTWARE* section.
2. Start engine.
3. In B.U.D.S., select **Read Data**.
4. Select the **Monitoring** tab.
5. At the bottom of the **Monitoring** page, select the **ECM** tab.
6. Read the voltage on the **55V System Circuit** meter in B.U.D.S.

55 VDC VOLTAGE OUTPUT TEST (ENGINE RUNNING)		
MODEL	TEST ENGINE SPEED	VOLTAGE
600 HO E-TEC	Any RPM from idle and above	55 Vdc ± 2



1. RPM indication
2. 55V System circuit indication

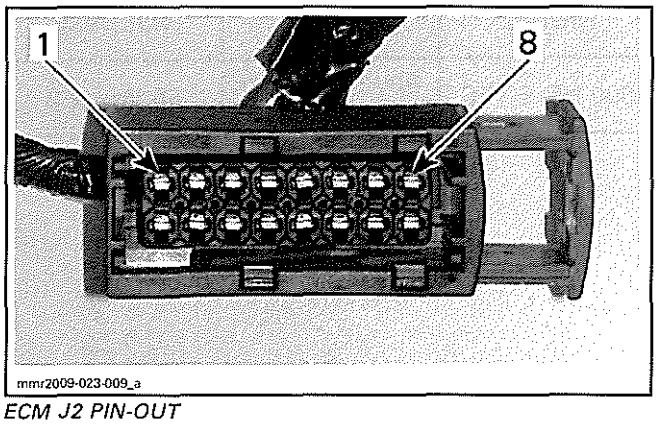
If voltage is not within specification, refer to *TROUBLESHOOTING* in this section and carry out the required tests.

Also carry out the *VOLTAGE REGULATOR/RECTIFIER GROUND CIRCUIT TEST.*

Ground Circuit Test (Voltage Regulator/Rectifier)

1. Disconnect the ECM J2 connector.
2. Test ground circuit continuity as follows.

VOLTAGE REGULATOR/RECTIFIER GROUND CIRCUIT TEST	
ECM J2 CONNECTOR	Chassis ground
Pin 5	
Pin 7	
Pin 8	



ECM J2 PIN-OUT

DC-DC CONVERTER

Description

The DC-DC converter is integrated within the ECM. It receives 55 Vdc from the voltage regulator/rectifier which, it steps down to 12 Vdc. This 12 Vdc power is then split into two separate circuits, a primary and a secondary 12 Vdc output.

Primary 12 Vdc Output

From approximately 800 RPM and 50/55 V from the voltage regulator, the primary 12 Vdc output provides power to the following:

- Multifunction gauge
- 3D RAVE valve solenoid
- Lighting system.

NOTICE **The 12 Vdc primary circuit is not to be used to power accessory loads. All accessories are to be powered from the secondary 12 Vdc circuit.**

Secondary 12 Vdc Output

The secondary 12 Vdc output provides power to the accessories when the engine reaches the following conditions.

MODEL	SECONDARY 12 VDC ACTIVATION
600 HO E-TEC	1900 RPM + 2 second delay

NOTE: Should the 12 Vdc outputs fail, the engine will still run on the 55 Vdc supply voltage.

12 Vdc Output Voltage Tests (DC-DC Converter)

The primary 12 volts is supplied through ECM connector J2 pins 15 and 16.

The secondary 12 volts is supplied through ECM connector J2 pins 6 and 14.

ECM connector J2 is not easily accessible. To carry out 12 Vdc output tests, carry out the following procedures.

Primary 12 Vdc Circuit Test with B.U.D.S.

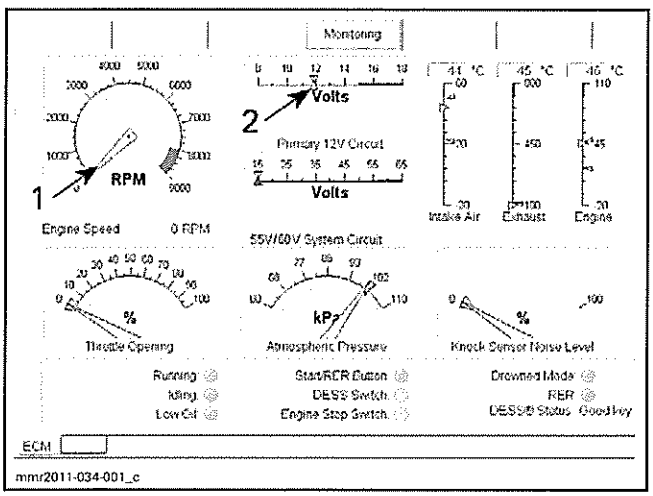
1. Make proper connections and use the applicable B.U.D.S. software version. Refer to *COMMUNICATION TOOLS/B.U.D.S. SOFTWARE* section.
2. Raise vehicle so that the track is off the ground and can turn freely.

⚠ WARNING

Ensure vehicle track is completely raised off ground. If the track should come into contact with the ground when the engine is at 5000 RPM, equipment damage and severe injury may result.

3. Start engine.
4. In B.U.D.S., select Read Data.
5. Select the Monitoring tab.
6. At the bottom of the Monitoring page, select the ECM tab.
7. Read the primary 12 Vdc system voltage on the Primary 12V Circuit meter in B.U.D.S.

PRIMARY 12 VDC CIRCUIT TEST WITH B.U.D.S.		
ENGINE	TEST ENGINE SPEED	VOLTAGE
600 HO E-TEC	Any RPM above 1100 RPM	14.75 ± 0.5 Vdc



1. *RPM indication*
2. *Primary 12V circuit indication (battery)*

If voltage is above specification, replace ECM.

If voltage is below specification, check the 55 Vdc. Refer to *VOLTAGE REGULATOR/RECTIFIER.*

Also carry out the *VOLTAGE REGULATOR/RECTIFIER GROUND CIRCUIT TEST* in this section.

Install all removed parts and connectors.

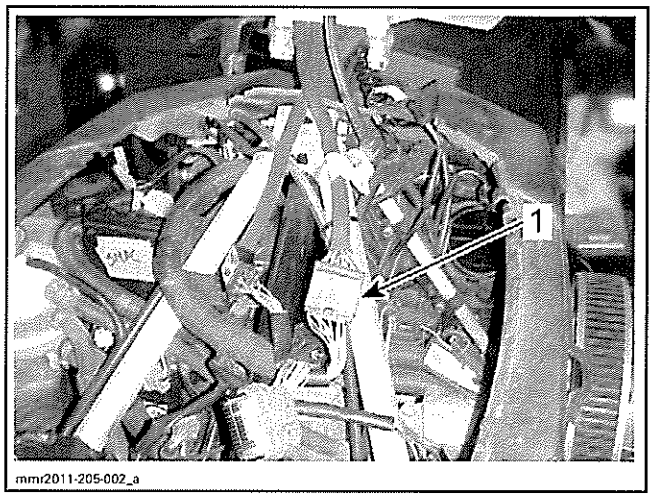
Secondary 12 Vdc Circuit Test

The secondary 12 Vdc system is not monitored in B.U.D.S.

To test the secondary 12 Vdc system, carry out the following procedure.

1. Remove multifunction gauge to access the 10-pin connector.

NOTE: Do not disconnect gauge or the 10-pin connector.



TYPICAL
1. *10-pin connector*

2. Raise vehicle so that the track is off the ground and can turn freely.

⚠ WARNING

Ensure vehicle track is completely raised off ground. If the track should come into contact with the ground when the engine is at 5000 RPM, equipment damage and severe injury may result.

3. Set FLUKE 115 MULTIMETER (P/N 529 035 868) to Vdc scale.
4. Start the engine.
5. Accelerate the engine above 1900 RPM and hold for at least 2 seconds.
6. To measure the secondary 12 Vdc, back-probe the HG connector as follows.

ENGINE SPEED	BACK-PROBE 10-PIN CONNECTOR		VOLTAGE
	RED TEST PROBE	BLACK TEST PROBE	
Over 1900 RPM + 2 sec.	YL/RD	Chassis ground	14.75 ± 0.5 Vdc
	YL/RD	BK	

If the secondary 12 Vdc voltage is as specified to chassis ground, but not present when measuring between YELLOW/RED and BLACK wires, test continuity of BLACK wire to ground.

If voltage cannot be measured, test continuity of YELLOW/RED wire from the 10-pin connector to pins 6 and 14 of ECM J2 connector.

If the YELLOW/RED wire continuity is good and other voltages from ECM tested good, ECM may not output secondary 12 Vdc.

Carry out the *VOLTAGE REGULATOR/RECTIFIER GROUND CIRCUIT TEST*. If the ground circuit tests good, the ECM will need to be replaced.

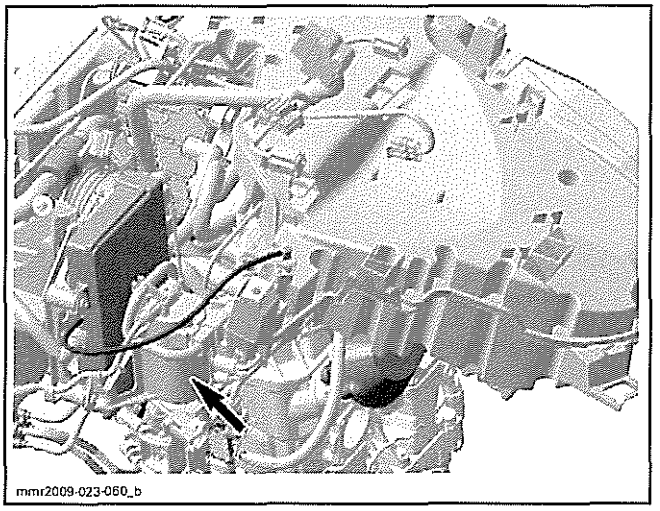
NOTE: Before replacing ECM, all ECM grounds, power output circuits, and input circuits from the magneto must be tested.

Repair or replace as applicable.

CAPACITOR

The engine fuel injectors, which require a stable 55 Vdc for their operation, are particularly sensitive to voltage variations. A capacitor is connected to the 55 Vdc electrical system to stabilize the system voltage.

The capacitor is located on the RH side of the vehicle, just ahead of the ECM.



CAPACITOR LOCATION

Quick Troubleshooting

A faulty capacitor will lead to the following symptoms:

- Unstable, low, or no system voltage (55 V).
- Engine will not start
- Engine hard to start
- Poor idling
- Engine misfiring.

NOTE: A defective capacitor is likely to give off a burn like odor.

Discharging Capacitor

⚠ WARNING

The capacitor remains charged approximately 10 seconds after engine is stopped. A high energy could suddenly be discharged if capacitor terminals were shorted. Always discharge capacitor before servicing.

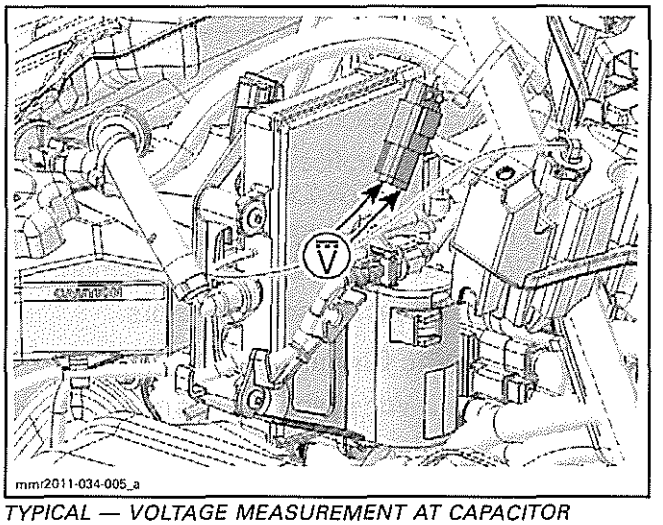
To properly discharge capacitor, leave it connected for at least 10 seconds after engine has been stopped, or after engine was last cranked before carrying out any maintenance procedure on the capacitor or 55 volt electrical system.

Capacitor Charge Hold Test

1. Use a FLUKE 115 MULTIMETER (P/N 529 035 868) set to Vdc to measure the capacitor charge voltage.

NOTE: Ensure to use the multimeter RED probe with the YELLOW/RED wire.

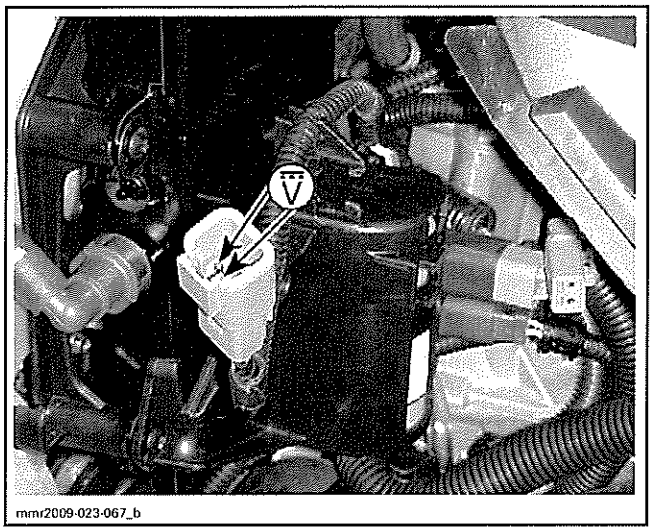
2. Back-probe capacitor connector using the FLUKE RIGID BACK PROBES (P/N TP88).



TYPICAL — VOLTAGE MEASUREMENT AT CAPACITOR CONNECTOR

3. Start engine to charge capacitor.

4. Stop engine.
5. Read and note capacitor charge voltage.
6. Disconnect capacitor connector.
7. Wait 5 minutes.
8. Read capacitor charge voltage again.



TYPICAL

CAPACITOR CHARGE HOLD TEST
Capacitor Vdc must be within 1 Vdc of battery Vdc after 5 minutes

If voltage is out of specification, replace capacitor.

If in doubt, proceed with the following residual voltage test.

Capacitor Residual Voltage Test

⚠ WARNING

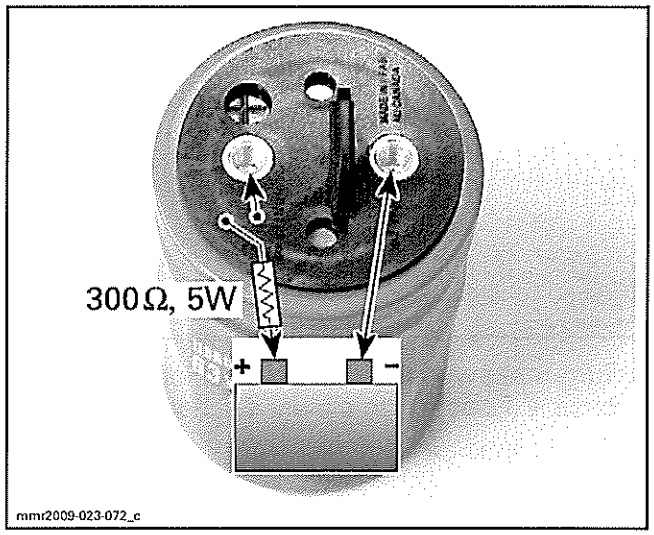
Disconnect the magneto connector. Should the engine be made to rotate with magneto connected, a spark may occur resulting in electrical shock, a fire or an explosion.

1. Disconnect magneto connector.
2. Remove capacitor from vehicle and carry out the following test on a non metallic workbench.
3. Connect the following items to the capacitor, see following illustration.
   - A switch
   - Resistor (300 Ω/5 W)
   - 12 V battery (fully charged).

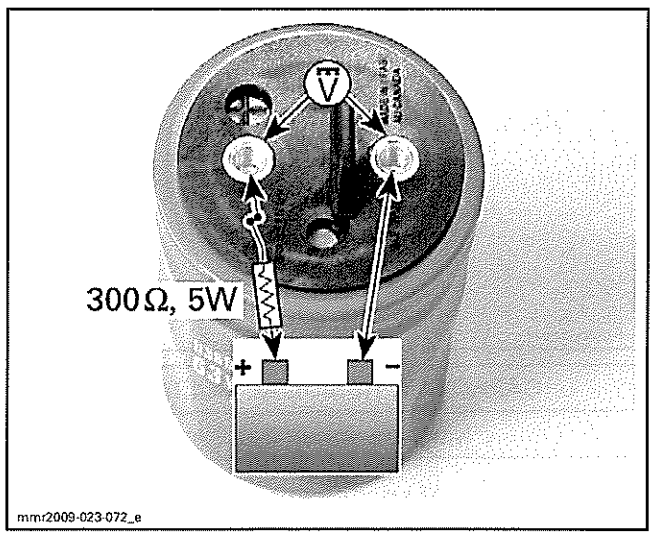
NOTICE **Ensure the test switch is in the OFF position when connecting the battery to the capacitor to prevent sparking or electrical shock.**

⚠ WARNING

Be sure to connect the battery POSITIVE post to the capacitor POSITIVE terminal.



4. Turn switch to ON and read capacitor voltage. Wait until voltage reaches 12 V to ensure the capacitor is fully charged.

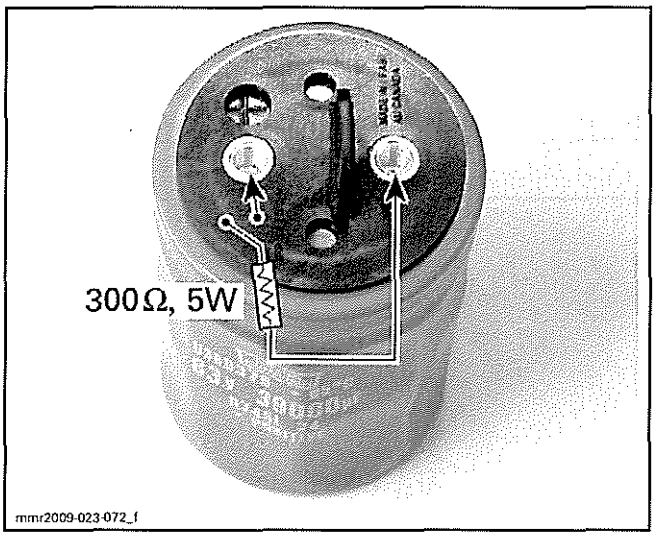


5. Turn test switch to OFF.

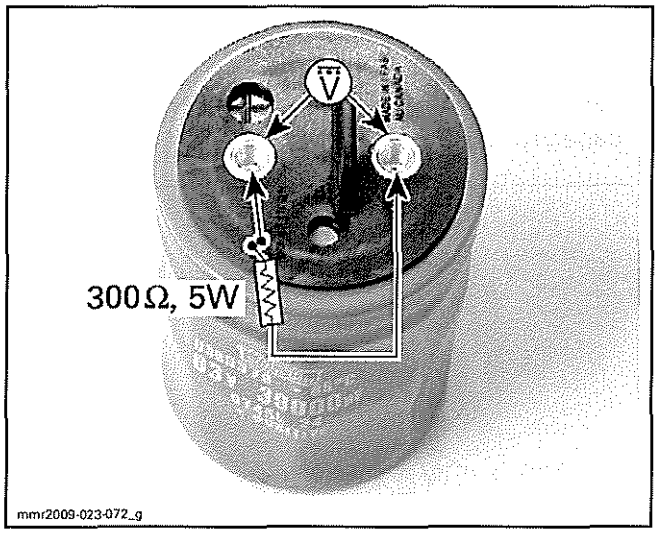
NOTE: Carry out the following steps within the following minute to ensure the capacitor does not begin to discharge before the test.

6. Remove battery from circuit and connect the resistor and switch across capacitor terminals.

NOTICE **Ensure test switch is in the OFF position during the circuit configuration change.**



7. Turn test switch to the ON position for 12 seconds ± 1 second to slowly discharge capacitor.
8. Read capacitor voltage.



CAPACITOR RESIDUAL VOLTAGE
Must be above 2.6 Vdc

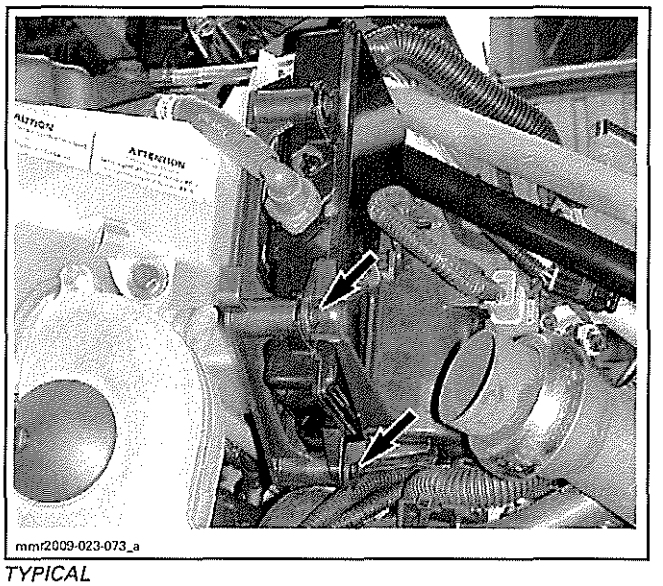
If voltage is out of specification, replace capacitor.

Capacitor Removal

⚠ WARNING

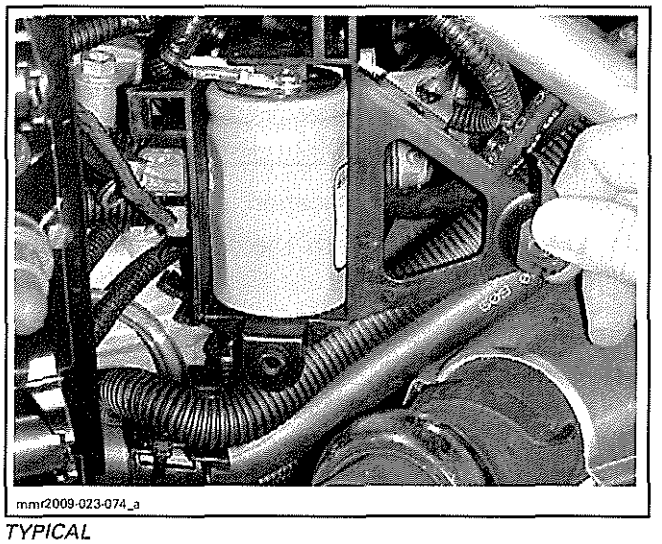
Disconnect the magneto connector. Should the engine be made to rotate with magneto connected, a spark may occur resulting in electrical shock, a fire or an explosion.

1. Ensure capacitor remained connected for at least 10 seconds after engine shut down, or after engine was last cranked. This ensures capacitor is fully discharged.
2. Remove retaining screws from capacitor support cover.



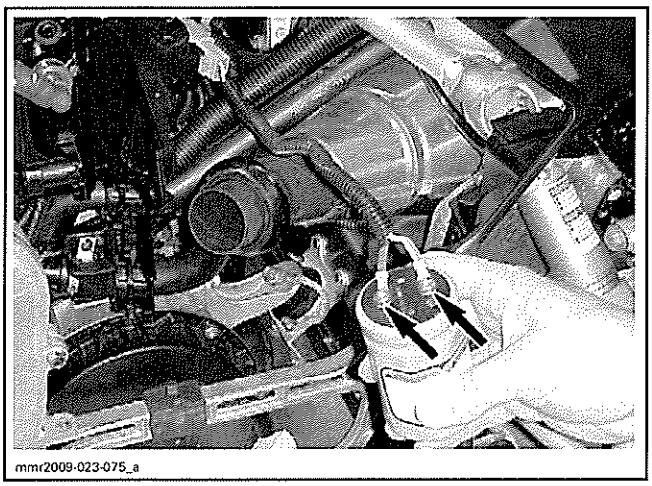
TYPICAL

3. Pull capacitor support cover open.



TYPICAL

4. Pull capacitor out of support and remove terminal screws.

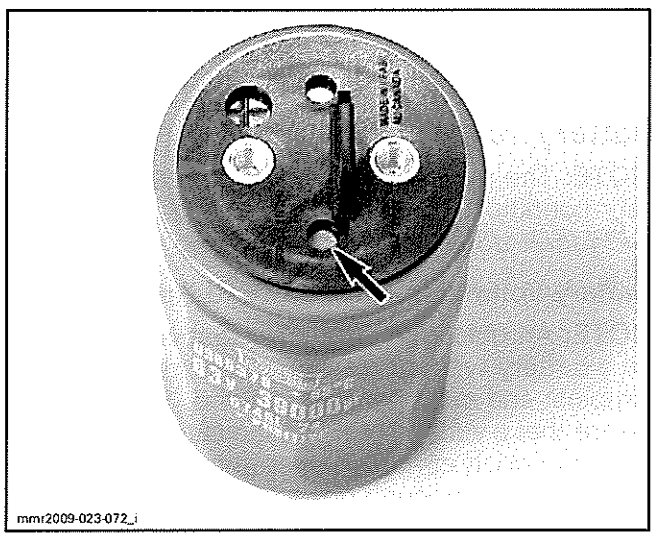


TYPICAL

⚠ WARNING

Do not remove plastic protector from top of capacitor unless the capacitor is to be replaced. The cover prevents the two capacitor contacts from being easily shorted together which may cause a spark, possibly resulting in a fire.

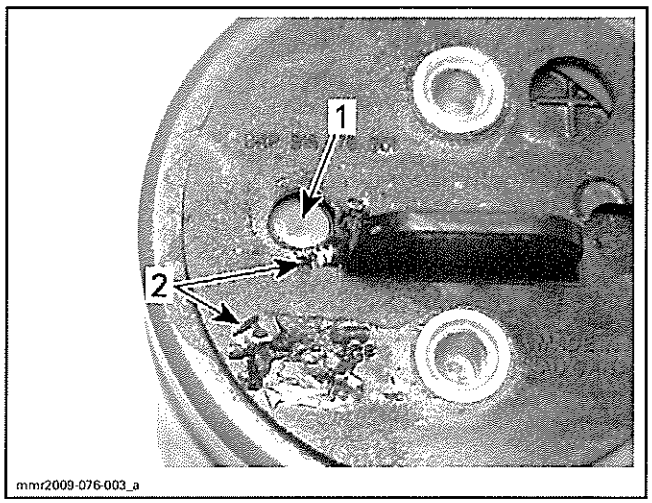
5. Check inspection hole on top of capacitor.



INSPECTION HOLE (SHIELD IS INTACT)

If the top shield is open (pierced), replace capacitor.

NOTE: The following illustration shows a perforated shield with capacitor fluid leakage. This capacitor was connected in reverse polarity.

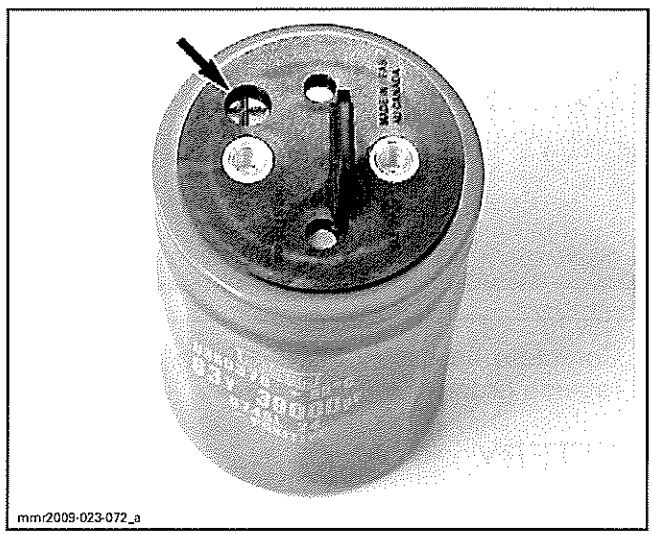


1. Perforated shield
2. Capacitor fluid leakage

Capacitor Installation

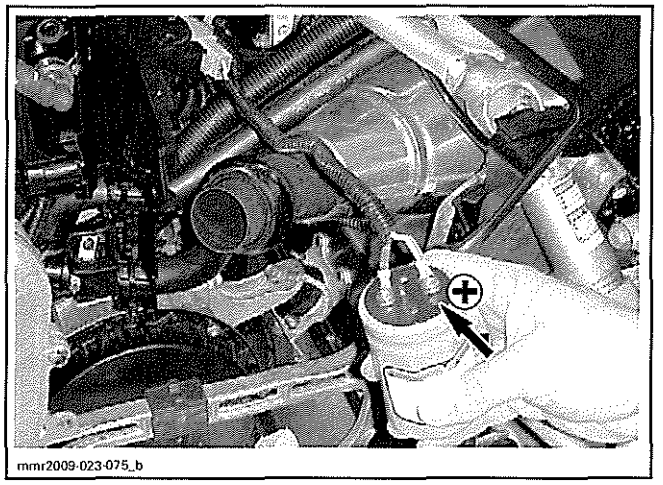
1. If capacitor was replaced, install a plastic protector cap on new capacitor.

NOTE: When reinstalling plastic protector, ensure the + sign on top of capacitor is visible through the hole in protector. If + sign is not visible, pull off protector, rotate it one half turn, then reinstall it.



2. Connect wire terminals to capacitor. Ensure to connect the YELLOW/RED wire to the + terminal on capacitor. Position wires so as to route them away of the + sign.

NOTICE **Improper polarity could destroy the capacitor while in operation.**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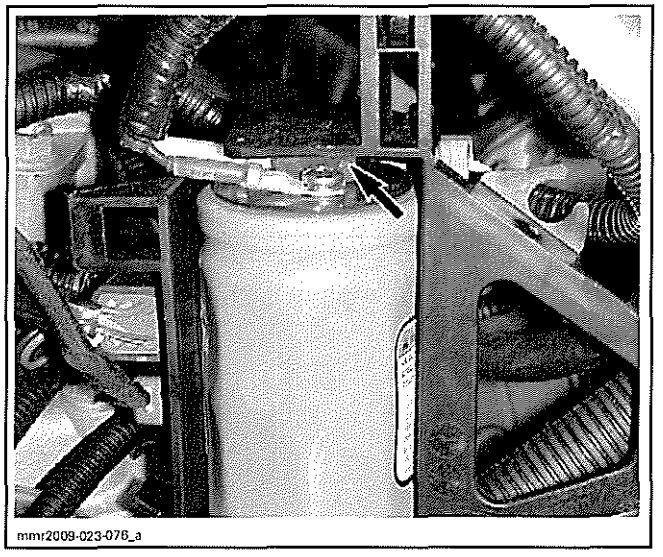
TYPICAL

3. Insert capacitor in its support ensuring it bottoms out completely.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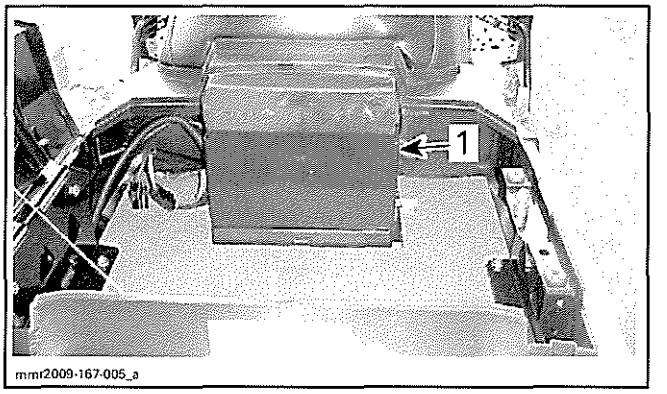
4. Complete assembly of remaining parts in the reverse order of removal.

BATTERY

Vehicles are equipped with a sealed valve regulated lead acid (VRLA) battery. It is a non-spillable, maintenance reduced type (no electrolyte level to be checked and readjusted). No ventilation tube is attached to the battery.

Battery is located in the rear storage compartment.



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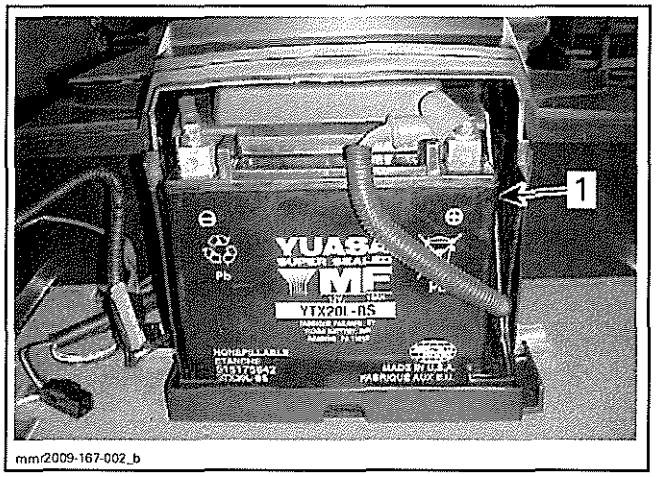
1. Battery cover



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1. Battery

Battery Testing

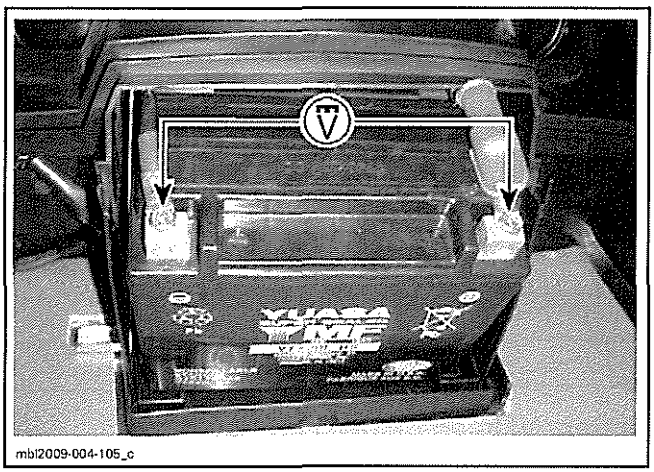
NOTE: The most accurate test to determine battery condition is the *BATTERY TESTING (LOAD APPLIED) USING A LOAD TESTER.*

Battery Voltmeter Test (No Load Applied)

NOTE: An unloaded voltmeter test is carried out on a battery without discharging current. It is the simplest and most commonly used. However, be aware that a voltage test can indicate that the battery is in good condition even though the battery does not have enough power to crank the engine. A voltage reading provides an instant indication of the state of charge of the battery, not of its current storage capacity. A battery load test gives a more accurate indication of the battery condition.

If the battery has just received a charge, allow it to rest for 1-2 hours before taking a voltage reading.

Set multimeter to Vdc and connect to battery terminals. Always respect polarity.



Batteries with a voltage above 12.8 V do not need to be charged.

Batteries with a voltage of 12.8 V and below need to be charged. Refer to *BATTERY CHARGING* in this section.

Battery Testing (Load Applied)

This is the best test used to determine the battery condition.

Using a load testing device such as the NAPA ULTRA PRO BATTERY LOAD TESTER (P/N 95260), test the storage capacity of the battery. It has a 500 A carbon pile adjustable load.

The battery should be fully charged before testing.

If battery has just been recharged, allow battery to rest for at least one hour.

Follow battery load tester instructions.

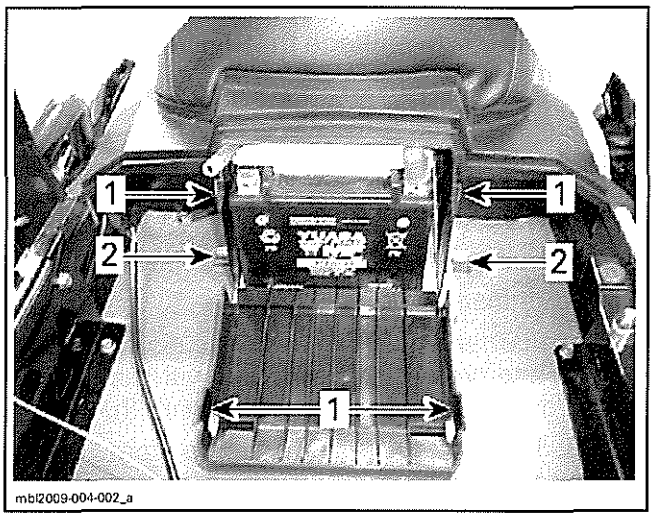
If battery voltage has dropped below 10 Vdc (or voltage indicated on battery temperature compensation chart), battery storage capacity has decreased appreciably and should be replaced.

Battery Removal

⚠ WARNING

The BLACK (-) battery cable must always be disconnected first and reconnected last. Never charge or boost a battery while installed on vehicle.

1. Open storage compartment cover.
2. Remove battery cover.
3. Disconnect BLACK (-) cable terminal from the negative battery post.
4. Slide the RED rubber protector off the (+) cable terminal and disconnect it from the battery post.
5. Remove 2 screws securing metal support and remove support.



1. Battery cover latches
2. Screws from metal support

6. Remove battery.

NOTICE Should any electrolyte spillage occur, immediately wash off with a solution of baking soda and water to prevent damage to vehicle components.

Battery Cleaning

Clean the battery, battery casing, cables and battery posts using a solution of baking soda and water.

Remove corrosion from battery cable terminals and battery posts using a firm wire brush. Battery top should be cleaned with a soft brush and any grease-cutting soap or baking soda solution.

Battery Inspection

Visually inspect battery casing for cracks, leaks or other possible damage.

Discoloration, warping or raised top, indicates that the battery has overheated or been overcharged.

If the casing is damaged, replace battery and thoroughly clean battery tray and surrounding area with a water and baking soda solution.

⚠ WARNING

Should the battery casing be damaged, wear a suitable pair of non-absorbent gloves when removing the battery by hand.

Inspect the battery posts for security of mounting.

Battery Storage

NOTICE A discharged battery will freeze and may damage its casing. A damaged casing will allow electrolyte spillage that may damage surrounding parts.

1. Disconnect and remove battery from the vehicle.
2. Clean battery terminals and cable connections using a wire brush. Apply a light coat of DIELECTRIC GREASE (P/N 293 550 004) or petroleum jelly on terminals.
3. Clean battery casing using a solution of baking soda and water. Rinse battery with clear water and dry thoroughly using a clean cloth.

NOTE: The battery must always be stored in fully a charged state.

4. Charge the battery every month if stored at a temperature **below** 15°C (59°F).
5. Charge the battery every two week if stored at a temperature **above** 15°C (59°F).

NEW Battery Activation

Refer to the instructions provided with the battery.

Battery Charging

⚠ WARNING

Always wear safety glasses and charge the battery in a ventilated area. Never charge or boost a battery while installed on a vehicle. Do not open the sealed caps during charging. Do not place battery near an open flame.

NOTICE If the battery becomes hot to the touch, stop charging and allow it to cool before continuing.

NOTE: Sealed VRLA batteries have an internal safety valve. If battery pressure increases due to overcharging, the valve opens to release excess pressure, preventing battery damage.

Carry out a battery *UNLOADED VOLTMETER TEST* as described in this section, then proceed as described here.

An automatic charger is the fastest and most convenient way for error-proof charging.

When using a constant current charger, charge battery according to the chart below.

Battery Voltage Below 12.8 V and Above 11.5 V

STANDARD CHARGING (RECOMMENDED)	
TIME	CHARGE
4-9 hours	2 A

QUICK CHARGING	
TIME	CHARGE
50 minutes	10 A

Battery Voltage Below 11.5 V

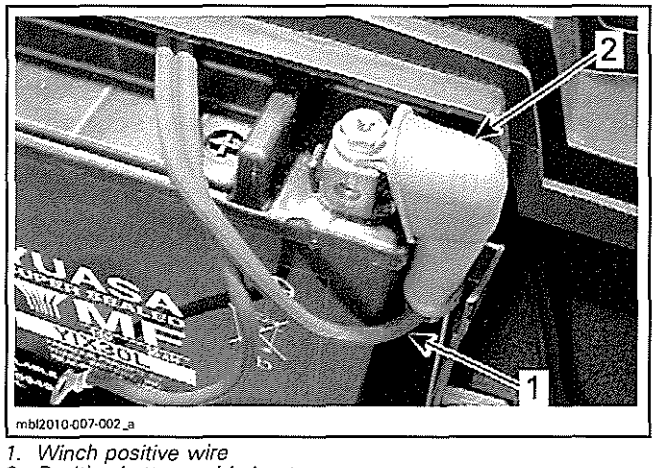
A battery with a voltage below 11.5 V requires a special procedure to recharge. In charging an over discharged battery, its internal resistance may be too high to charge at a normal charging rate.

Set charger to the 10 A charging rate and monitor charging current for approximately 30 minutes. If there is no change in charging current or battery becomes abnormally hot, the battery is most likely at the end of its service life and should be replaced.

Battery Installation

Models with a Winch

1. Install winch wiring.
   - 1.1 Position winch wires over the battery.
   - 1.2 Insert positive winch wire in the positive battery cable boot.



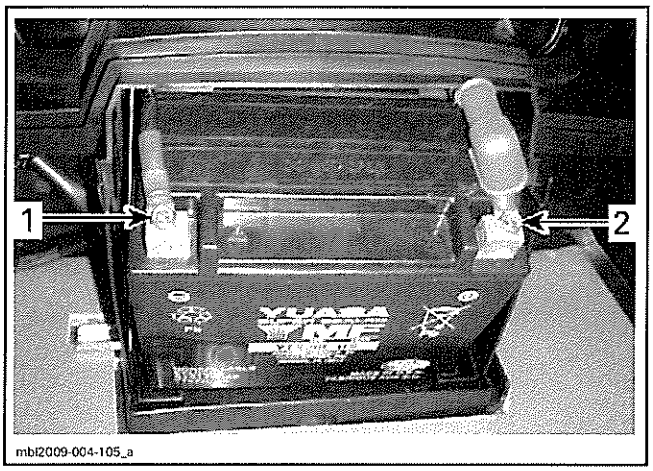
1. Winch positive wire
2. Positive battery cable boot

NOTE: Place the winch wire terminals over the battery cable terminals and connect winch wires to battery along with battery cables.

All Models

2. Connect RED (+) cable to battery positive post.

3. Connect BLACK (-) cable to battery negative post.



1. BLACK (-) cable
2. RED (+) cable

4. Apply DIELECTRIC GREASE (P/N 293 550 004) on battery posts.
5. Cover the RED (+) connection with the red rubber boot.
6. Push back the battery correctly into the battery box.
7. Reinstall metal support with the 2 previously removed screws.

NOTICE Do not tighten the metal support bolts too much as it may get warped.

8. Close battery cover.

CHARGING SYSTEM (600 ACE AND 1200 4-TEC)

SERVICE TOOLS

Description	Part Number	Page
FLUKE 115 MULTIMETER	529 035 868	634, 636–637

SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
EXTECH AMMETER	380941	634
FLUKE RIGID BACK PROBES	TP88	637
NAPA ULTRA PRO BATTERY LOAD TESTER	95260	639

SERVICE PRODUCTS

Description	Part Number	Page
DIELECTRIC GREASE	293 550 004	640–641

GENERAL

SYSTEM DESCRIPTION

Magneto

A magneto provides the primary source of electrical energy. It transforms a magnetic field into an alternating current (AC).

The magneto is comprised of a 3 phase delta wound stator.

AC current is rectified to DC current and regulated by a voltage regulator within 14-15 volts DC for primary power to the vehicle electrical system and to charge the battery.

Voltage Regulator

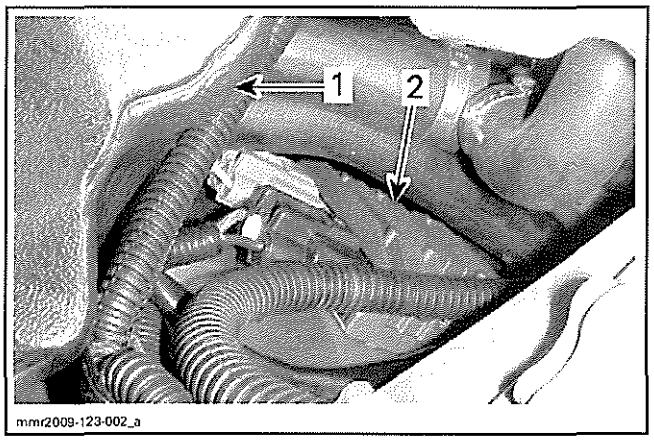
The voltage regulator has two connectors.

- An AC input connector coming from the magneto stator (YELLOW wires).
- A DC output connector that holds the supply wire (WHITE/RED) and the ground wire (BLACK).

The voltage regulator DC output supplies to all the vehicle needs in current when engine is running and charges the battery through the battery charging fuse (main).

The voltage regulator is grounded to the chassis through the black wire.

The voltage regulator is located on the RH side of tunnel in front of the fuel tank.



TYPICAL — 1200 4-TEC MODEL SHOWN
1. *Fuel tank*
2. *Voltage regulator*

Battery

A battery is installed as a power source. It is primarily used for energizing the ECM, gauge and starter.

The battery also provides a stable voltage to the voltage regulator to ensure the ECM operates normally.

On vehicles equipped with a premium gauge, it also provides continuous power to maintain the clock function within the gauge.

NOTE: Never use a battery charger to temporarily substitute the battery as it may cause the ECM (engine control module) to function erratically or not at all.

INSPECTION

CHARGING SYSTEM OUTPUT

DC Voltage Output Test

NOTE: The charging system can have an adequate voltage output while being unable to provide enough current for the vehicle needs. In doubt, perform the current output test.

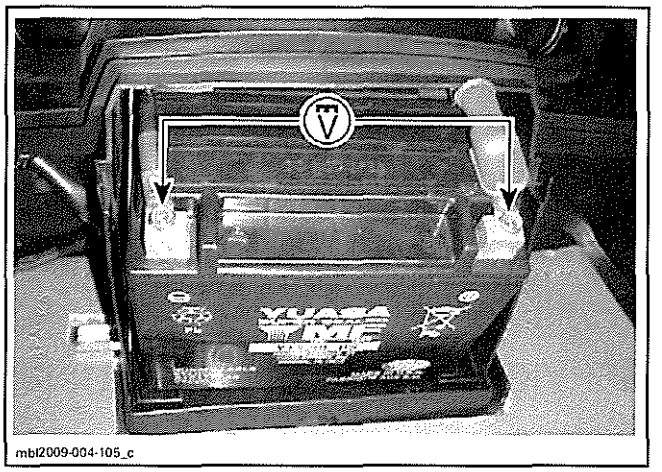
1. Raise vehicle and ensure the track is off the ground and can turn freely.

⚠ WARNING

Make sure vehicle track is completely raised off ground. If track should come into contact with ground when engine is at high RPM, equipment damage and severe injury may result.

2. Remove RED rubber boot protector from positive battery post.
3. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Vdc scale.
4. Connect multimeter to battery posts.
5. Start engine and read voltage as follows.

DC VOLTAGE OUTPUT TEST				
MAGNETO	TEST ENGINE SPEED	TEST PROBES		VOLTAGE (Vdc)
600 ACE 650 W	4000 RPM	Battery (+)	Battery (-)	14 - 15
1200 4-TEC 490 W				



If voltage is above specification, replace voltage regulator.

If voltage is below specification, check the following:

- Check stator wires (YELLOW) and terminals at voltage regulator for damage.
- Test stator, refer to *MAGNETO AND STARTER* subsection.
- Perform wiring tests. Refer to *VOLTAGE REGULATOR* in this subsection.

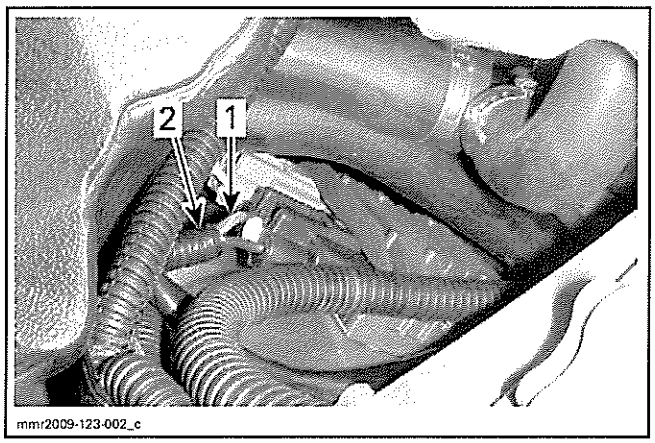
DC Current Output Test

1. Move fuel tank back, refer to *FUEL TANK AND FUEL PUMP* section.
2. Raise vehicle and ensure the track is off the ground and can turn freely.

⚠ WARNING

Make sure vehicle track is completely raised off ground. If track should come into contact with ground when engine is at high RPM, equipment damage and severe injury may result.

3. If necessary, carefully open the protective sheath covering the wires enough to allow ammeter clamp installation.
4. Measure current using an inductive ammeter such as the EXTECH AMMETER (P/N 380941).
   4.1 Install ammeter clamp over the WHITE/RED wire nearby the voltage regulator.



TYPICAL — 1200 4-TEC SHOWN
1. *Protective sheath*
2. *WHITE/RED wire*

4.2 Start engine.

4.3 Set the heated grips and throttle lever to the highest intensity and the headlights to high beam.

4.4 Rev engine at 4000 RPM and read ammeter.

DC CURRENT OUTPUT TEST	
TEST ENGINE SPEED	MINIMUM CURRENT
4000 RPM	25 A

If current reading is significantly below specification, do the following:
- Check battery connections.
- Check stator wires (YELLOW) and terminals at voltage regulator for damage.
- Test stator, refer to *MAGNETO AND STARTER* subsection.
- Perform wiring tests. Refer to *VOLTAGE REGULATOR* in this subsection.

TROUBLESHOOTING

NOTE: It is good practice to check for fault codes using B.U.D.S. software as a first troubleshooting step. Refer to *DIAGNOSTIC AND FAULT CODES*.

DIAGNOSTIC TIPS

Weak or Discharged Battery

If the battery is weak or discharged, check the following:
- Check battery. Refer to *BATTERY* in this subsection.
- Check items in *LOW OR NO CHARGING SYSTEM VOLTAGE*.
- Check charging current output, refer to *INSPECTION* in this subsection.

Low or No Charging System Voltage

If charging system voltage is low, the engine may be unstable, or stall.

Test the following items:
- Charging system voltage, refer to *INSPECTION* in this subsection
- Test stator, refer to *MAGNETO AND STARTER* subsection
- Wiring and connections, refer to *VOLTAGE REGULATOR* in this subsection.

Engine Stalls

- Check battery charging fuse (main).

Battery Charging Fuse (main) Continuously Burns

A defective voltage regulator, loose connection, damaged wires or terminals can cause the fuse to blow.

1. Disconnect voltage regulator connectors and inspect wires and terminals for damage.
2. Keep the voltage regulator disconnected and install a new fuse.
3. Start and rev engine.
4. Stop engine and check fuse condition.

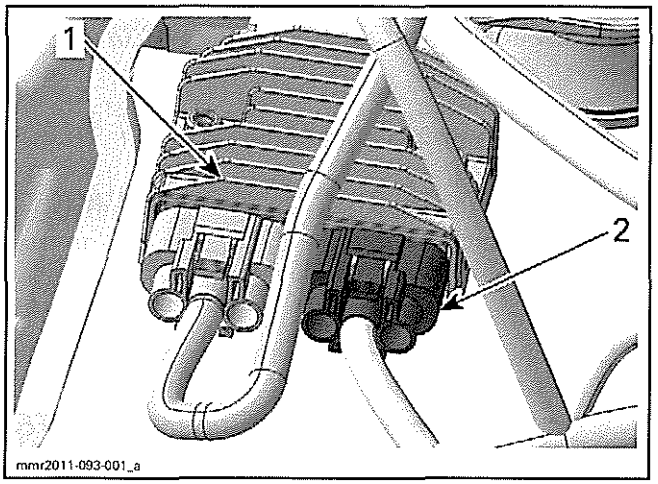
- If fuse does not burn, replace voltage regulator.
- If fuse still burns, the problem is in the wiring harness. Refer to *WIRING DIAGRAM* subsection.

PROCEDURES

VOLTAGE REGULATOR

Voltage Regulator Wiring Continuity Test

1. Disconnect battery.
2. Disconnect regulator DC connector.

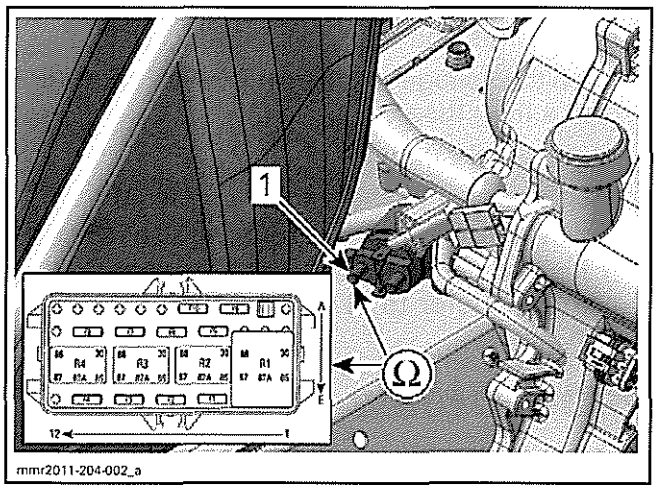


1. *Voltage regulator/rectifier*
2. *DC connector*

3. Remove the battery charging fuse (main).
4. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Ω and measure resistance as follows:

600 ACE Model

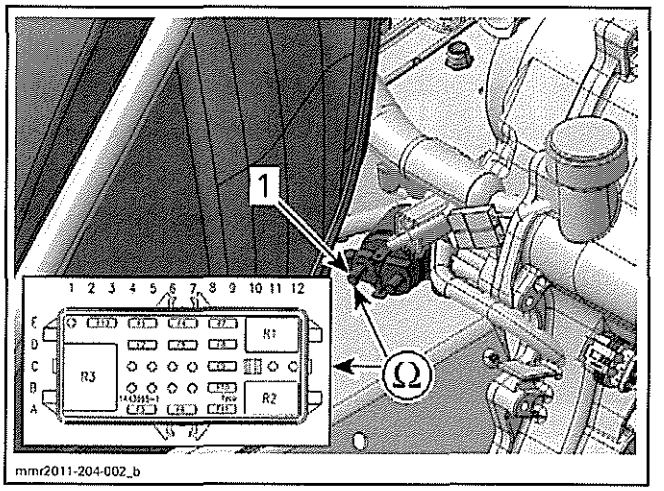
TEST PROBES		RESISTANCE
Charge wire (RED)	Fuse box, terminal 4E	Close to 0 Ω



SOME PARTS REMOVED FOR CLARITY PURPOSE
1. *Charge wire connected here*

1200 4-TEC Model

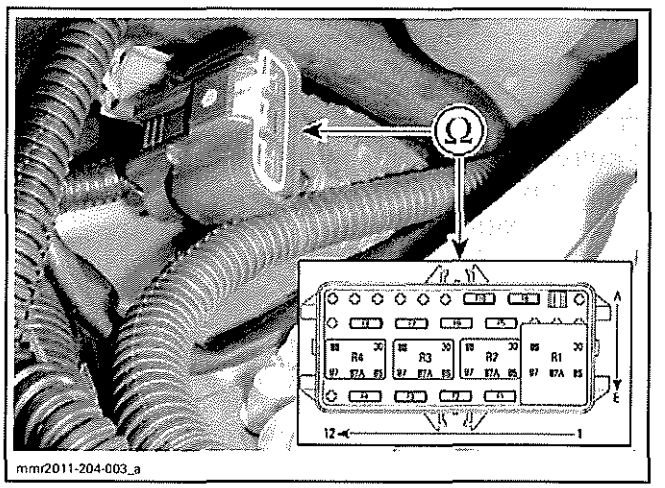
TEST PROBES		RESISTANCE
Charge wire (RED) at solenoid positive post	Fuse box terminal 2E	Close to 0 Ω



SOME PARTS REMOVED FOR CLARITY PURPOSE
1. *Charge wire connected here*

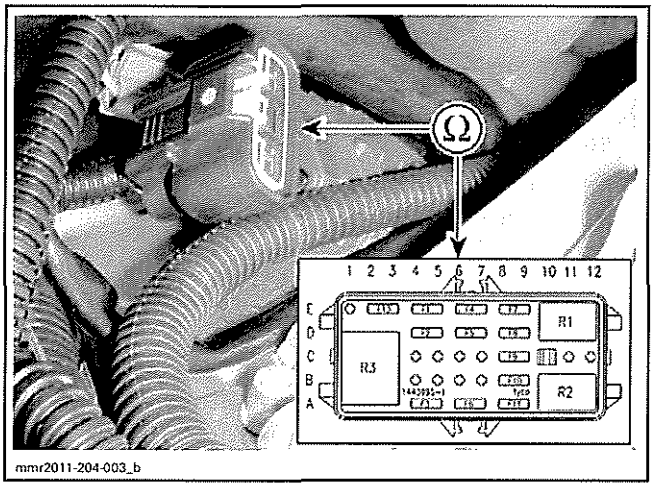
600 ACE Model

TEST PROBES		RESISTANCE
Regulator DC connector pin 1 (WHITE/RED wire)	Fuse box, terminal 5E	Close to 0 Ω



1200 4-TEC Model

TEST PROBES		RESISTANCE
Regulator DC connector pin 1 (WHITE/RED wire)	Fuse box terminal 3E	Close to 0 Ω



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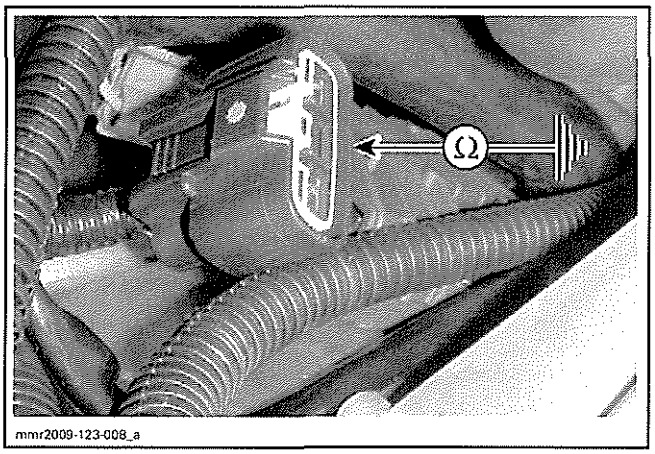
All Models

TEST PROBES		RESISTANCE
Regulator DC connector pin 3 (BLACK wire)	Chassis ground	Close to 0 Ω



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If a high resistance is read, check wire for corrosion or damage.

Reconnect voltage regulator connector.

Voltage Regulator Wiring Voltage Drop Test

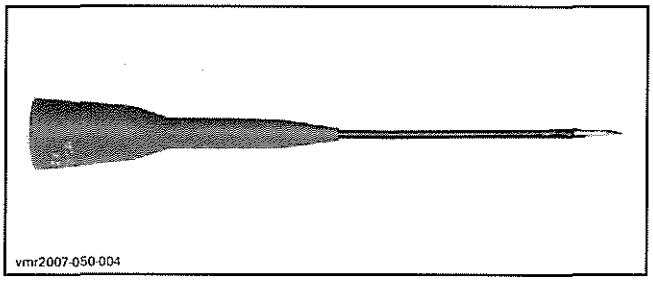
In some cases, even if the continuity tests good, a parasitic resistance may affect the circuit. In these cases, a voltage drop test is more accurate.

Supply Wire Voltage Drop Test

1. Move fuel tank back, refer to *FUEL TANK AND FUEL PUMP* subsection.

NOTE: Ensure the DC connector is connected to the voltage regulator.

2. Back probe pin 1 (WHITE/RED wire) of the DC connector at voltage regulator using the FLUKE RIGID BACK PROBES (P/N TP88).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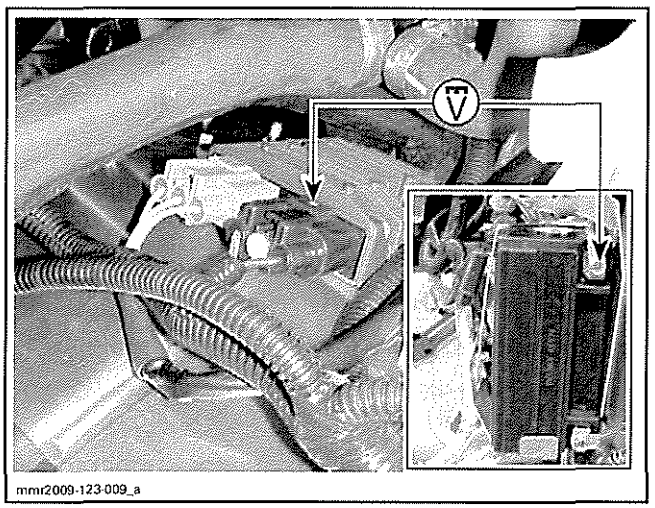
3. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Vdc.
4. Start engine and rev it above 2000 RPM.
5. Set the heated grips and throttle lever to the highest intensity and the headlights to high beam.
6. Measure voltage between the following points.

REGULATOR DC CONNECTOR	BATTERY	VOLTAGE DROP
Pin 1 (WHITE/RED wire)	Positive post (+)	Maximum 1 volt



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TYPICAL — 1200 4-TEC MODEL SHOWN

7. Stop engine.

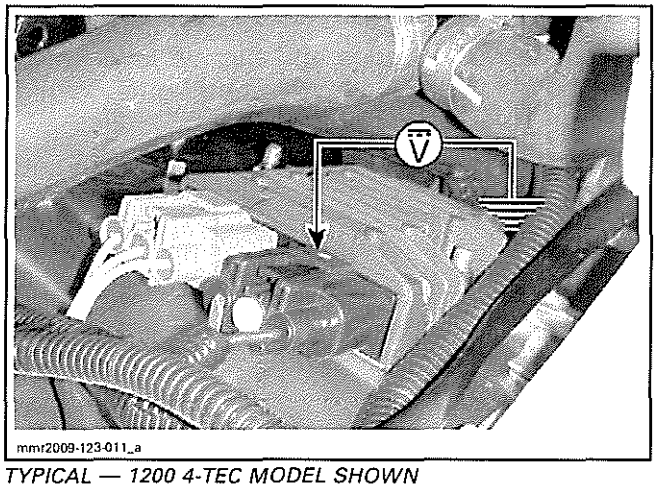
If reading is above specification, check battery connections, terminals at regulator DC connector, WHITE/RED wire and fuse holder for corrosion or damage.

Ground Circuit Voltage Drop Test

1. Back probe pin 3 (BLACK wire) of the DC connector at voltage regulator using the FLUKE RIGID BACK PROBES (P/N TP88).
2. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Vdc.
3. Start engine and rev it above 2000 RPM.

4. Set the heated grips and throttle lever to the highest intensity and the headlights to high beam.
5. Measure voltage between the following points.

REGULATOR DC CONNECTOR	CHARGING SYSTEM FUSE HOLDER (FA)	VOLTAGE DROP
Pin 3 (BLACK wire)	Chassis ground	Maximum 1 volt



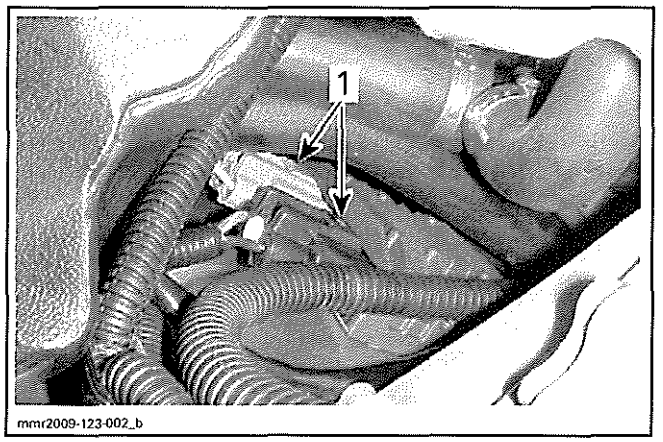
TYPICAL — 1200 4-TEC MODEL SHOWN

6. Stop engine.

If reading is above specification, check battery connections, terminal at regulator DC connector, battery ground, engine ground, chassis ground and BLACK wire for corrosion or damage.

Voltage Regulator Removal

1. Disconnect battery.
2. Move fuel tank back, refer to *FUEL TANK/FUEL PUMP* section.
3. Disconnect the voltage regulator connectors.



TYPICAL
1. Voltage regulator connectors

4. Remove both elastic nuts retaining the regulator to the tunnel.
5. Lift regulator up to free it from the LH mounting stud.
6. Pivot regulator counterclockwise, then free it from the RH mounting stud.

Voltage Regulator Installation

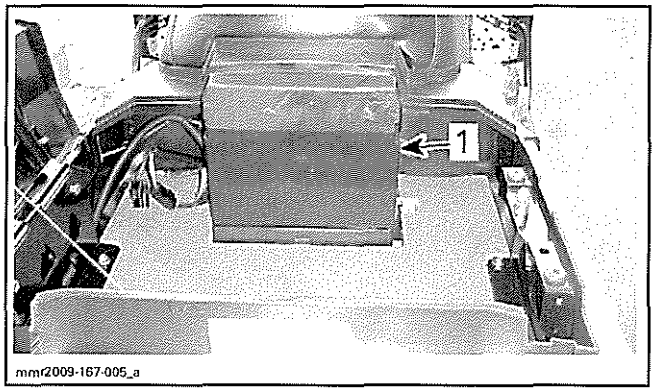
Installation is the reverse order of removal procedure.

Torque voltage regulator screws to 5 N•m (44 lbf•**in**).

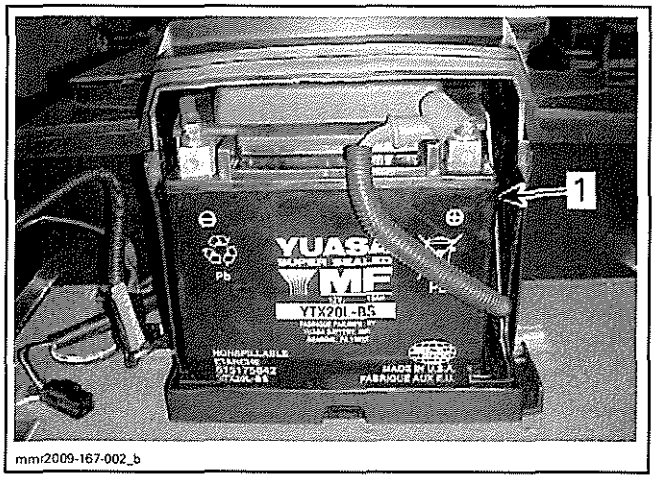
BATTERY

The battery type is a sealed valve regulated lead acid (VRLA). It a non-spillable, maintenance reduced type (no electrolyte level to be checked and readjusted). No ventilation tube is attached to the battery.

Battery is located in the rear storage compartment.



1. Battery cover



1. Battery

Battery Testing

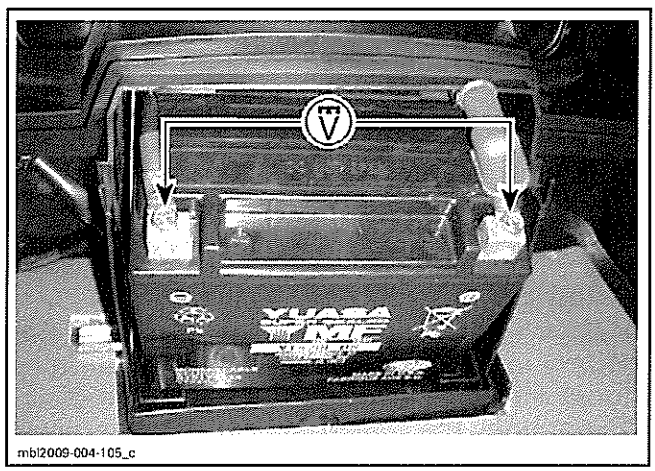
NOTE: The most accurate test to determine battery condition is the *BATTERY TESTING (LOAD APPLIED) USING A LOAD TESTER.*

Battery Voltmeter Test (No Load Applied)

NOTE: An unloaded voltmeter test is carried out on a battery without discharging current. It is the simplest and most commonly used. However, be aware that a voltage test can indicate that the battery is in good condition even though the battery does not have enough power to crank the engine. A voltage reading provides an instant indication of the state of charge of the battery, not of its current storage capacity. A battery load test gives a more accurate indication of the battery condition.

If the battery has just received a charge, allow it to rest for 1 - 2 hours before taking a voltage reading.

Set multimeter to Vdc and connect to battery terminals. Always respect polarity.



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Batteries with a voltage above 12.8 V do not need to be charged.

Batteries with a voltage of 12.8 V and below need to be charged. Refer to *BATTERY CHARGING* in this section.

Battery Testing (Load Applied) Quick Test

The battery must be fully charged before testing.

1. Disconnect the regulator DC connector.
2. Set the multimeter to Vdc.
3. Start engine and rev it above 2000 RPM.
4. Set the heated grips and throttle lever to the highest intensity and the headlights to high beam.
5. Measure voltage on the battery terminals.

The battery voltage should be more than 10 Vdc.

If battery voltage reading is below 10 Vdc, storage capacity has decreased appreciably and battery should be replaced.

Battery Testing (Load Applied) Using a Load Tester

This is the best test used to determine the battery condition.

Using a load testing device such as the NAPA ULTRA PRO BATTERY LOAD TESTER (P/N 95260), test the storage capacity of the battery. It has a 500 Amp carbon pile adjustable load.

The battery must be fully charged before testing.

If battery has just been recharged, allow battery to rest for at least one hour.

Follow battery load tester instructions.

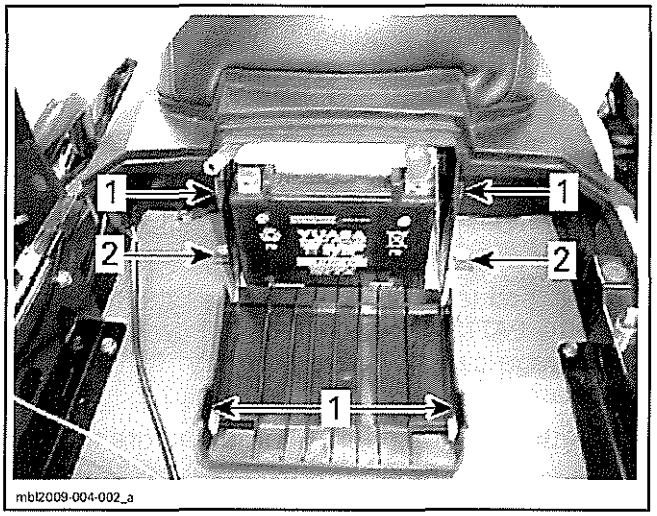
If battery voltage has dropped below 10 Vdc (or voltage indicated on battery temperature compensation chart), battery storage capacity has decreased appreciably and should be replaced.

Battery Removal

⚠ WARNING

The BLACK (–) battery cable must always be disconnected first and reconnected last. Never charge or boost a battery while installed on vehicle.

1. Open storage compartment cover.
2. Remove battery cover.
3. Disconnect BLACK (–) cable terminal from the negative battery post.
4. Slide the RED rubber protector off the (+) cable terminal and disconnect it from the battery post.
5. Remove 2 screws securing metal support and remove support.



1. Battery cover latches
2. Screws from metal support

6. Remove battery.

NOTICE Should any electrolyte spillage occur, immediately wash off with a solution of baking soda and water to prevent damage to vehicle components.

Battery Cleaning

Clean the battery, battery casing, cables and battery posts using a solution of baking soda and water.

Remove corrosion from battery cable terminals and battery posts using a firm wire brush. Battery top should be cleaned with a soft brush and any grease-cutting soap or baking soda solution.

Battery Inspection

Visually inspect battery casing for cracks, leaks or other possible damage.

Discoloration, warping or raised top, indicates that the battery has overheated or been overcharged.

If the casing is damaged, replace battery and thoroughly clean battery tray and surrounding area with a water and baking soda solution.

⚠ WARNING

Should the battery casing be damaged, wear a suitable pair of non-absorbent gloves when removing the battery by hand.

Inspect the battery posts for security of mounting.

Battery Storage

NOTICE A discharged battery will freeze when exposed to temperature below 0°C (32°F) and may damage its casing. A damaged casing will allow electrolyte spillage that may damage surrounding parts.

1. Disconnect and remove battery from the vehicle.
2. Clean battery terminals and cable connections using a wire brush. Apply a light coat of DIELECTRIC GREASE (P/N 293 550 004) or petroleum jelly on terminals.
3. Clean battery casing using a solution of baking soda and water. Rinse battery with clear water and dry thoroughly using a clean cloth.

NOTE: The battery must always be stored in fully charged condition.

4. Charge the battery every month if stored at a temperature below 15°C (60°F).
5. Charge the battery every two weeks if stored at a temperature above 15°C (60°F).

New Battery Activation

Refer to the instructions provided with the battery.

Battery Charging

⚠ WARNING

Always wear safety glasses and charge the battery in a ventilated area. Never charge or boost a battery while installed on a vehicle. Do not open the sealed caps during charging. Do not place battery near an open flame.

NOTICE If battery becomes hot to the touch, stop charging and allow it to cool before continuing.

NOTE: Sealed VRLA batteries have an internal safety valve. If battery pressure increases due to overcharging, the valve opens to release excess pressure, preventing battery damage.

Carry out a battery *BATTERY VOLTMETER TEST (NO LOAD APPLIED)* as described in this section, then proceed as described here.

An automatic charger is the fastest and most convenient way for error-proof charging.

When using a constant current charger, charge battery according to the chart below.

Battery Voltage Below 12.8 V and Above 11.5 V

STANDARD BATTERY CHARGING (RECOMMENDED)	
TIME	CHARGE
5 - 10 hours	2 A

QUICK BATTERY CHARGING	
TIME	CHARGE
50 minutes	10 A

Battery Voltage Below 11.5 V

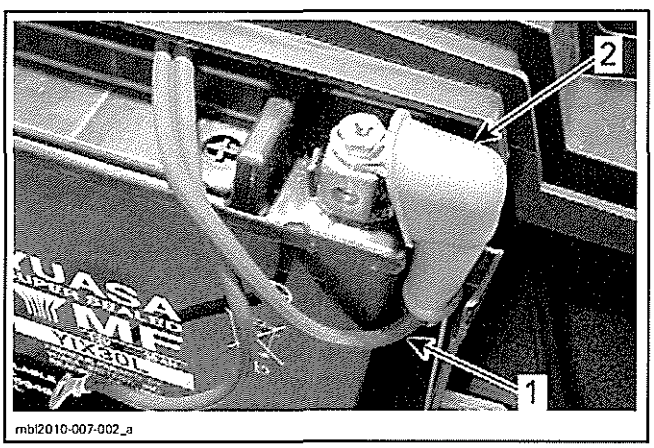
A battery with a voltage below 11.5 V requires a special procedure to recharge. In charging an over discharged battery, its internal resistance may be too high to charge at a normal charging rate.

Set charger to the 10 A charging rate and monitor charging current for approximately 30 minutes. If there is no change in charging current or battery becomes abnormally hot, the battery is most likely at the end of its service life and should be replaced.

Battery Installation

Models with a Winch

1. Install winch wiring.
   - 1.1 Position winch wires over the battery.
   - 1.2 Insert positive winch wire in the positive battery cable boot.

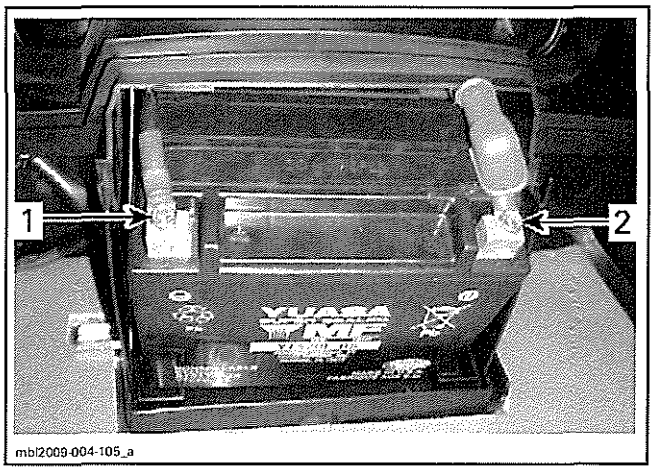


1. Winch positive wire
2. Positive battery cable boot

NOTE: Place the winch wire terminals over the battery cable terminals and connect winch wires to battery along with battery cables.

All Models

2. Connect RED (+) cable to battery positive post.
3. Connect BLACK (-) cable to battery negative post.



1. BLACK (-) cable
2. RED (+) cable

4. Apply DIELECTRIC GREASE (P/N 293 550 004) on battery posts.
5. Cover the RED (+) connection with the red rubber boot.
6. Push back the battery correctly into the battery box.
7. Reinstall metal support with the 2 previously removed screws.

NOTICE Do not tighten the metal support bolts too much as it may get warped.

8. Close battery cover.

STARTING SYSTEM (600 HO E-TEC)

GENERAL

BASIC STARTING SYSTEM OPERATION

When the START/RER button is pressed, a 12 Vdc signal is sent to the ECM, which completes the starter solenoid circuit by providing a ground. The battery then supplies current to the starter through the starter solenoid to crank the engine.

Conditions for Engine Cranking

- Engine stop switch set to RUN
- D.E.S.S. cap installed
- START/RER button depressed.

TROUBLESHOOTING

TROUBLESHOOTING TIPS

NOTE: It is good practice to check for fault codes using B.U.D.S. software as a first troubleshooting step. Refer to *DIAGNOSTIC AND FAULT CODES.*

In case of starter malfunction, first ensure the problem is not related to an engine mechanical component.

The engine is not equipped with a rewind starter. Carry out the following procedure to ensure engine can be rotated.

1. Set engine stop switch to STOP.
2. Ensure tether cord cap is **not installed** on the engine cut-off switch.
3. Manually rotate the engine using the drive pulley.

⚠ WARNING

When manually rotating engine, the emergency engine stop switch MUST BE set to STOP and tether cord cap MUST NOT be installed or severe injury may occur.

If the engine can be rotated, test starting system as per *STARTING SYSTEM TESTING SEQUENCE.*

If the engine cannot be rotated, check engine.

STARTING SYSTEM TESTING SEQUENCE

Test starting system in the following order:

- 30 A battery charging fuse (F1)
- 5 A START/RER fuse (F2)
- Battery connections and voltage test, refer to *CHARGING SYSTEM*
- Starter. Refer to *STARTER QUICK TEST*
- Starter solenoid. Refer to *STARTER SOLENOID QUICK TEST*
- Start switch. Refer to *START/RER SWITCH USING B.U.D.S.*
- Diode test (through GN/RD wire of starter solenoid and ECM connector J1B, pin 10). Refer to *WIRING DIAGRAM.*

PROCEDURES

START/RER FUSE

NOTE: When a burnt fuse is found, always identify the cause before replacing it.

Fuse Inspection

The ECM power circuit used for the starting system first passes through the 30 A battery charging fuse (F1).

Then it passes through a 5 A START/RER fuse (F2), to the starting system circuits.

If the starter does not crank the engine, test each fuse condition and replace it if necessary.

If fuses are good, try a starter solenoid quick test, refer to *STARTER SOLENOID QUICK TEST* in this section.

ELECTRIC STARTER

Starter Quick Test

1. Set engine cut-out switch to STOP or remove D.E.S.S. cap to prevent engine from starting.

⚠ WARNING

Do not touch spark plug or cables when cranking engine. High voltage can cause a powerful electrical shock if you touch them.

2. Connect one end of a battery booster cable to the positive (+) battery post.
3. Momentarily touch the other end of the booster cable to the starter cable terminal on the starter solenoid.

⚠ WARNING

A spark will be generated when making the final contact of the booster cables to power the starter directly. If there is a fuel or acid smell (fuel system or battery leak), or visible evidence of a leak, do not carry out this procedure as the spark generated may ignite the fuel or acid vapors. This would produce a fire or explosion possibly resulting in severe injury, or fatality.

NOTE: This procedure will bypass the starter solenoid and supply current from the battery directly to the starter through its power input cable.

If the starter does not turn, check for the following:

- Starter power cable/connections
- Starter.

If the starter rotated, carry out a *STARTER SOLENOID QUICK TEST*.

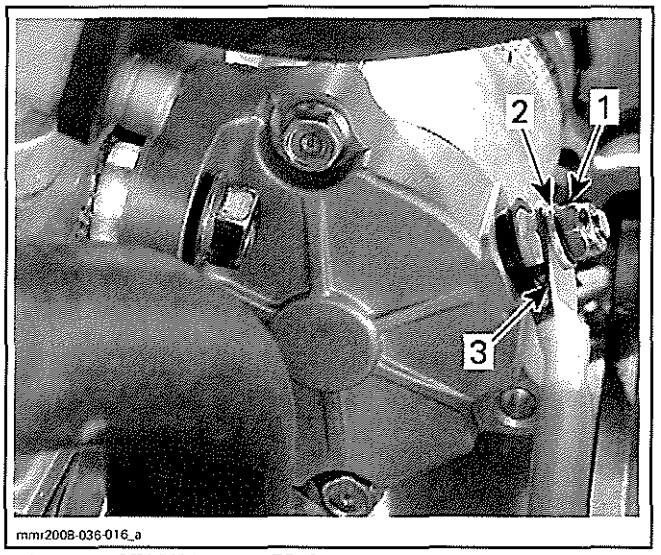
Starter Removal

1. Disconnect BLACK (-) cable from battery.
2. Disconnect RED (+) cable from battery.

⚠ WARNING

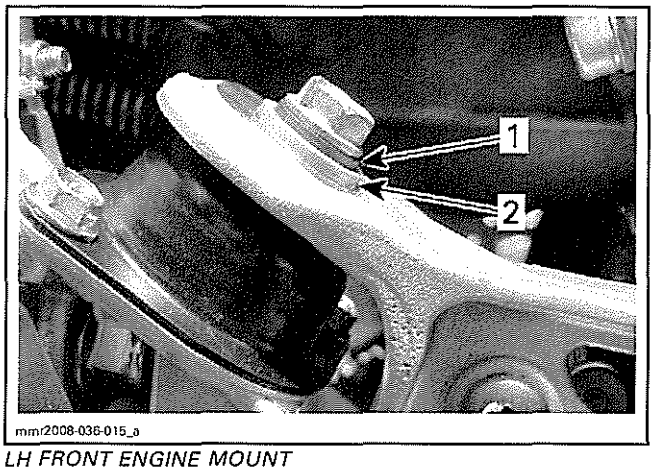
Always disconnect BLACK (-) cable first and reconnect last.

3. Disconnect RED power cable from starter.



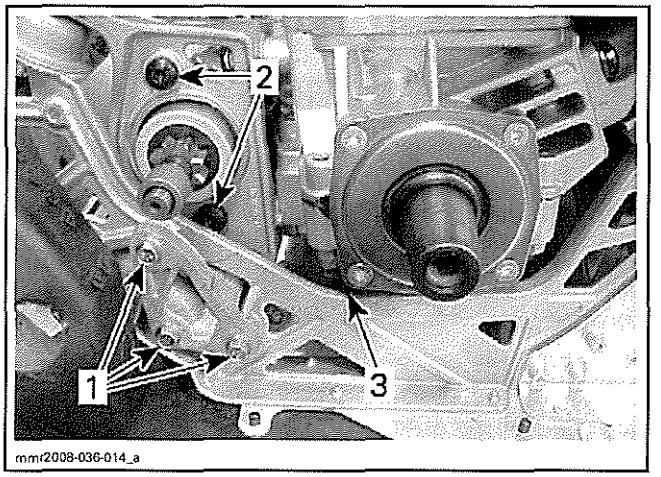
TYPICAL - STARTER POWER CABLE
1. *Elastic nut*
2. *Washer*
3. *Power cable*

4. Remove the LH front and rear engine mounting hex screws (PTO side). Discard the screws.



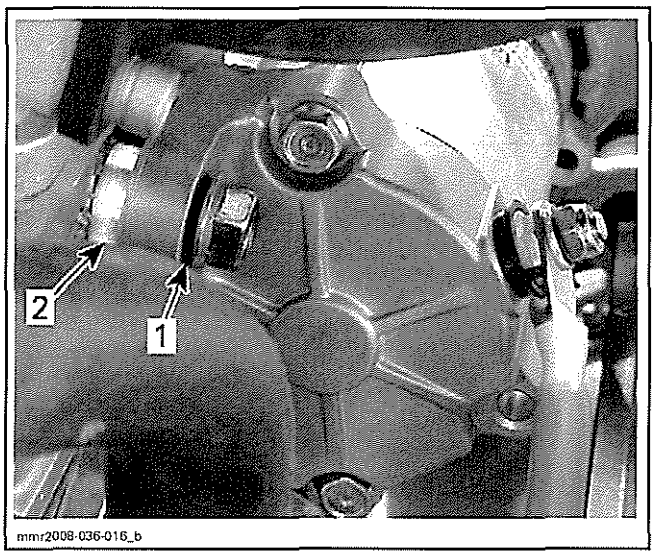
LH FRONT ENGINE MOUNT
1. *Conical washer*
2. *Flat washer*

5. Remove and discard the three bolts retaining the engine torque stopper support.



1. *Screws, torque stopper support*
2. *Starter screws*
3. *Pry bar position*

6. Insert a pry bar over the LH frame member and gently raise the engine just enough to access the lower mounting torx screw on the starter.
7. Remove and discard the lower mounting screw from the starter.
8. Remove the pry bar.
9. Remove and discard the upper mounting screw from the starter.
10. Remove and discard the RH starter mounting screw from the front of the engine.



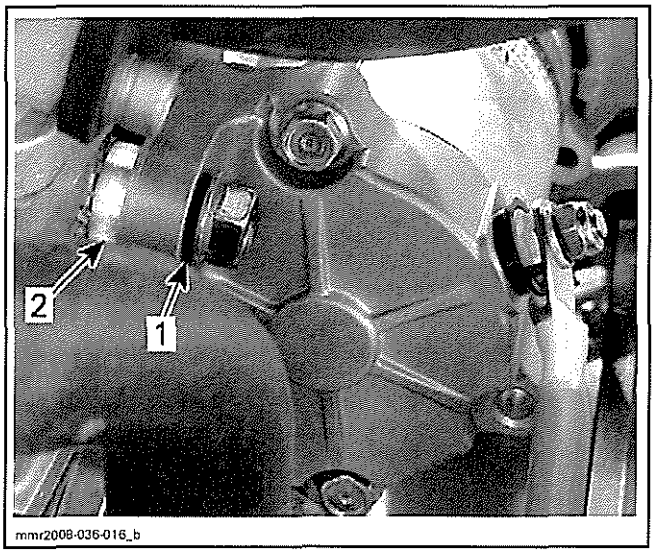
STARTER MOUNTING SCREW, RH
1. *Washer under screw head*
2. *Washer spacer between starter and engine*

Starter Installation

Install removed parts in the reverse order of removal, however, pay attention to the following.

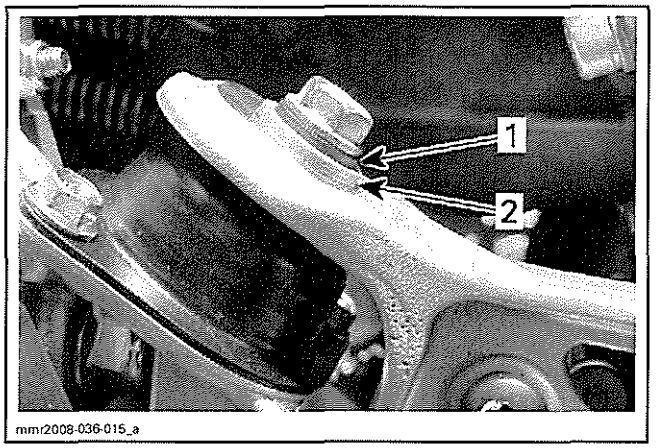
1. Ensure starter and engine mating surfaces are free of grime. Serious trouble may arise if starter is not properly aligned.
2. Replace all scotch grip screws.
3. For ease of installation, install the three new starter mounting screws loosely before torquing.
4. Install the washer and spacer as shown.

NOTICE **Be sure to install the washer and spacer as shown when installing the mounting screw on the RH side of the starter.**



STARTER MOUNTING SCREW, RH
1. *Washer under screw head*
2. *Washer spacer between starter and engine*

5. Torque the two starter mounting Torx screws first, then the hex screw to 28 N•m (21 lbf•ft).
6. Install the torque stopper support and two new engine mounting bolts, refer to *ENGINE REMOVAL AND INSTALLATION* section. Install washers under front mount bolt head as shown.

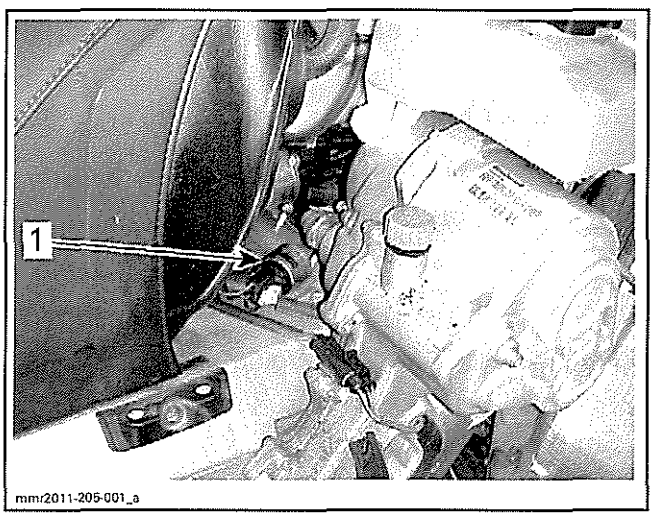


LH FRONT ENGINE MOUNT
1. *Conical washer*
2. *Flat washer*

7. Connect the RED wire to the large terminal on the starter.
8. Install the drive belt, refer to *DRIVE SYSTEM AND BRAKE* section.
9. Install the muffler and tune pipe, refer to *EXHAUST SYSTEM* section.
10. Reconnect the positive (+) RED battery cable, then the negative (-) BLACK cable.

STARTER SOLENOID

The starter solenoid is located on RH side of vehicle, between gearbox and fuel tank.



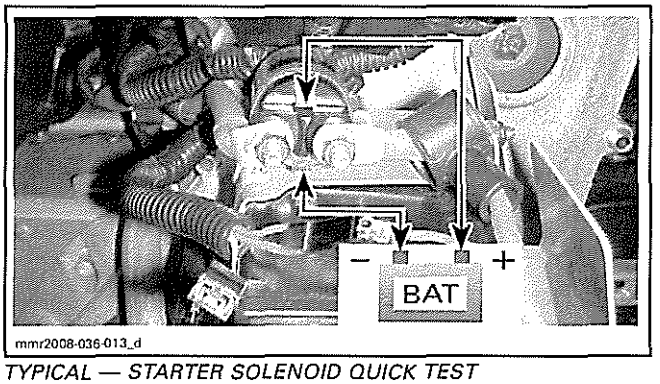
NOTE: In the following tests, a typical view is used.

Solenoid Quick Test

1. Test battery voltage, it should be approximately 12.8 Vdc for a fully charged battery.
2. Disconnect the small positive connector from the solenoid coil.

MODEL	POSITIVE TERMINAL
600 HO E-TEC	GREEN/RED

3. Install a jumper wire (with insulated clips) between the positive solenoid terminal and the positive battery terminal.
4. Disconnect the small negative connector (ORANGE/BLACK wire) from the starter solenoid.
5. Install a jumper wire on the negative solenoid terminal and momentarily touch the other end to battery ground.



TYPICAL — STARTER SOLENOID QUICK TEST

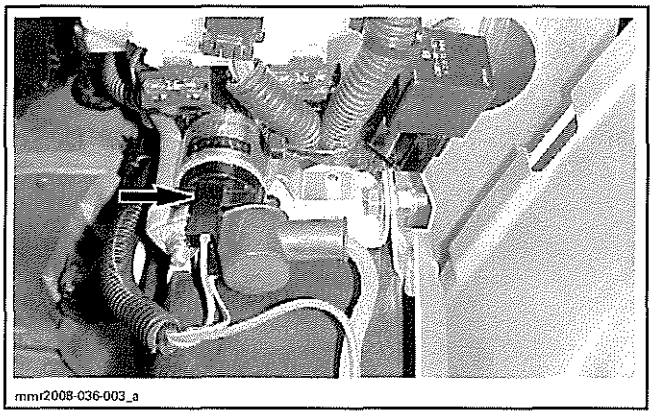
NOTICE The two small solenoid coil terminals are close to each other. When installing the two jumper wires, ensure the ends of the jumper wires are insulated and cannot come into contact with each other or a short circuit will occur.

If the starter engages, refer to *STARTER SOLENOID INPUT VOLTAGE TEST* .

If the starter did not engage, refer to *STARTER SOLENOID STATIC TEST*, or try a known good solenoid.

Starter Solenoid Input Voltage Test

1. Install D.E.S.S. cap on engine cut-off switch.
2. Set engine stop switch to RUN.
3. Set multimeter to Vdc.
4. Press and hold the START/RER button as you back-probe the solenoid coil 12 Vdc input connector.



TYPICAL — BACK-PROBE COIL 12 VDC INPUT WIRE

5. Measure the solenoid input voltage as per following table.

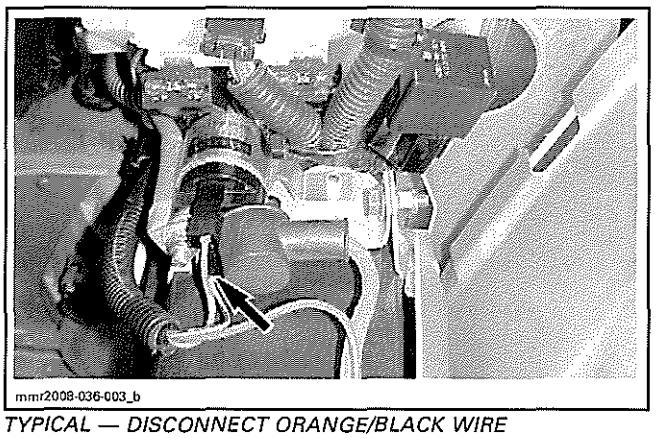
MODEL	PROBE		VOLTAGE
600 HO E-TEC	GREEN/RED	Battery ground	Battery voltage

If voltage is not as specified, refer to *WIRING DIAGRAM* and test for solenoid power wire continuity.

If the input voltage to the solenoid control winding is as specified, refer to *SOLENOID GROUND SIGNAL TEST.*

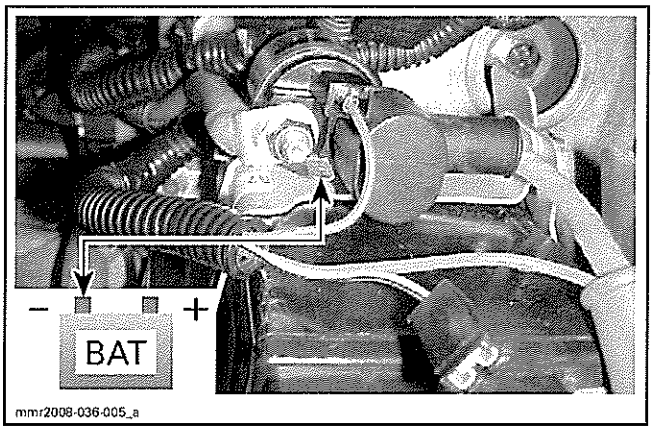
Solenoid Ground Signal Test

1. Reconnect the coil 12 Vdc input wire to the positive solenoid terminal.
2. Disconnect the small ORANGE/BLACK wire from the solenoid negative terminal (ground signal).



TYPICAL — DISCONNECT ORANGE/BLACK WIRE

3. Connect a jumper wire between solenoid negative terminal and battery ground.



TYPICAL — JUMPER NEGATIVE TO SOLENOID TERMINAL

4. Press START/RER button.

If solenoid does not function and starter solenoid input voltage test was good, carry out the following:

- *SOLENOID STATIC TEST*
- *SOLENOID DYNAMIC TEST.*

If solenoid functions normally, ECM may not be providing a ground signal, or the ground signal wire from ECM to starter solenoid may be open circuit.

Carry out the following:

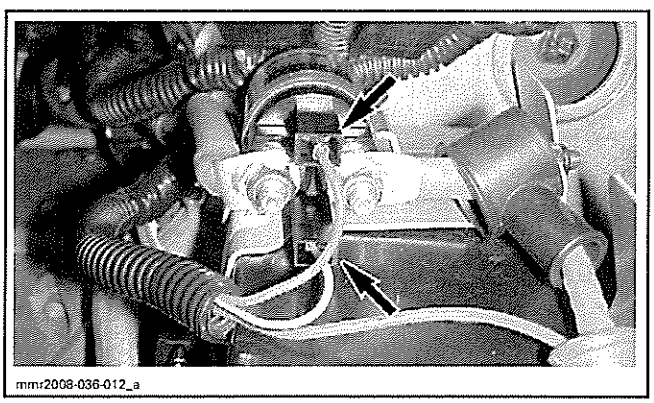
- *SOLENOID WIRING CONTINUITY TEST* (refer to *WIRING DIAGRAM*)
- *VEHICLE HARNESS CONTINUITY* (refer to *WIRING DIAGRAM*).

Repair or replace wiring/connectors.

NOTE: If ground signal wire tested good, and all other previous test were good, try a NEW ECM.

Solenoid Static Test

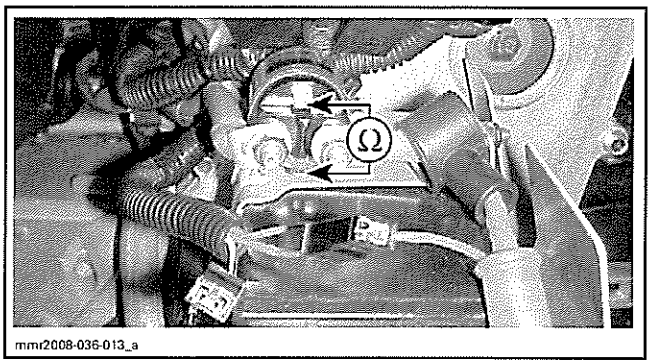
1. Disconnect the small terminals from the starter solenoid.



TYPICAL

2. With a multimeter set to Ω, test coil winding resistance as follows.

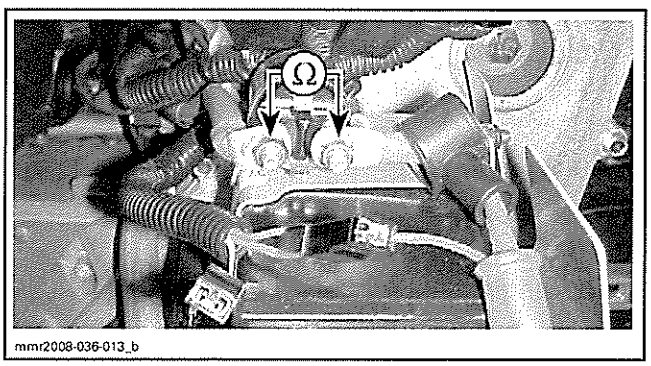
SOLENOID CONNECTOR		MEASUREMENT
TERMINAL		RESISTANCE @ 20°C (68°F)
A	B	Approximately 7.5 Ω



TYPICAL

3. Disconnect battery ground cable.
4. Check for a stuck solenoid plunger by measuring the resistance through the solenoid main contacts as follows.

SOLENOID CONNECTOR		MEASUREMENT
Battery post	Starter post	Open circuit



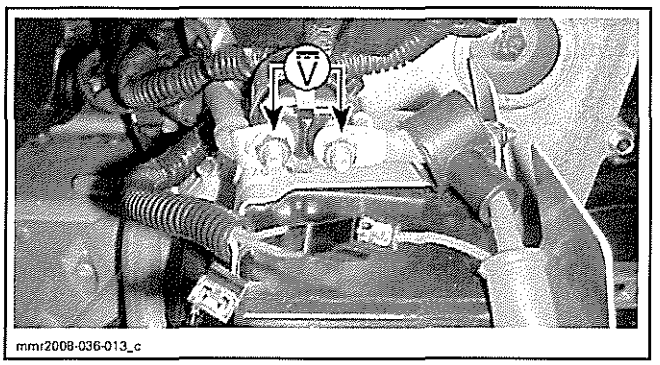
TYPICAL

If a reading other than an open circuit is measured, replace solenoid.

Solenoid Dynamic Test

1. Reconnect battery ground cable and solenoid connectors.
2. Disconnect the ignition coil(s) primary winding connector(s) to prevent engine from starting.
3. Press START/RER button and hold. While engine is cranking, measure the voltage drop across the solenoid main contacts as follows.

SOLENOID CONNECTOR		VOLTAGE
Post coming from battery	Post going to starter	0.2 Vdc max.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TYPICAL

4. Reconnect ignition coil connector(s).

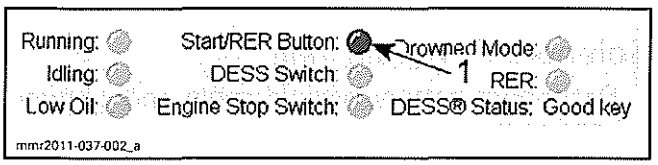
If voltage is out of specification, replace solenoid.

If solenoid tests good, refer to *ELECTRIC STARTER.*

START/RER SWITCH

START/RER Switch Test Using B.U.D.S.

1. Connect the vehicle to the applicable B.U.D.S. software available from BOSSWeb. Refer to *COMMUNICATION TOOLS/B.U.D.S. SOFTWARE* for proper connection instructions.
2. In B.U.D.S., select the **Read Data** button.
3. Select the **Monitoring** tab.
4. At the bottom LH corner of the **Monitoring** page, select the **ECM** tab.
5. Set engine stop switch to RUN and install D.E.S.S. cap on engine cut-off switch.
6. Press the **START/RER button** and look for the **START/RER Button** LED in the bottom field. It should come ON (turn GREEN).



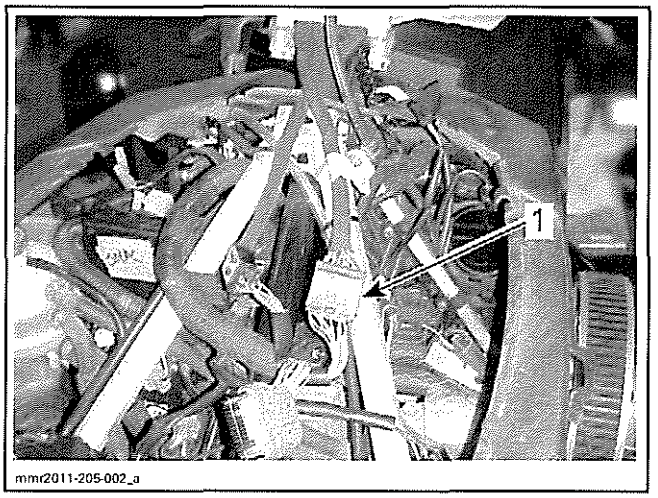
1. Should turn ON (green)

If the **START/RER button** LED comes on in B.U.D.S., the starting system is functional on the input side (START/RER button, ECM and circuit wiring to ECM). Test the output side of the starting system, refer to *WIRING DIAGRAM.*

If the LED does not come on, refer to *START/RER SWITCH INPUT VOLTAGE TEST .*

START/RER Switch Input Voltage Test

1. Set multimeter to Vdc.
2. Measure voltage at battery terminals. It should be approximately 12.8 Vdc for a fully charged battery.
3. Disconnect the 10-pin connector.



TYPICAL
1. 10-pin connector

4. Measure START/RER switch input voltage at the vehicle harness connector as per following table.

START/RER SWITCH INPUT VOLTAGE TEST		
PROBE		VOLTAGE
GRAY/RED	Battery ground	Battery voltage

If battery voltage is measured, refer to *CONTINUITY TEST START/RER SWITCH.*

If battery voltage is not measured, test the following in the recommended order:
- 30 A battery charging fuse (F1)
- 5 A START/RER fuse (F2)
- START/RER Switch Power Circuit Continuity (refer to *WIRING DIAGRAM.*

START/RER Switch Continuity Test

1. Set multimeter to Ω selection.
2. Measure start switch continuity as per following table.

CONTINUITY TEST START/RER SWITCH (SB CONNECTOR)			
SWITCH POSITION	3-PIN (SB) CONNECTOR		RESISTANCE
Released	BEIGE	BLACK	Continuity (close to 0 Ω)
	BEIGE	RED	High value or infinite (OL)
Pressed and held	BEIGE	BLACK	High value or infinite (OL)
	BEIGE	RED	Continuity (close to 0 Ω)

If continuity test failed, replace START/RER switch.

If continuity test of steering harness was good, test vehicle harness continuity. Refer to *WIRING DIAGRAM*.

STARTING SYSTEM (600 ACE AND 1200 4-TEC)

SERVICE TOOLS

Description	Part Number	Page
ECM ADAPTER TOOL	420 277 010	653, 656
ECM ADAPTER TOOL	529 036 166	653, 656
FLUKE 115 MULTIMETER	529 035 868	652, 655

SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
FLUKE RIGID BACK PROBES	TP88	655

GENERAL

BASIC STARTING SYSTEM OPERATION

When the START/RER button is pressed, a 12 Vdc signal is sent to the ECM, which completes the starter solenoid circuit by providing a ground. The battery then supplies current to the starter through the starter solenoid to crank the engine.

Conditions for Engine Cranking

- Emergency engine stop switch to RUN
- Tether cord cap installed
- Pressing START/RER button.

TROUBLESHOOTING

DIAGNOSTIC TIPS

Check for fault codes using B.U.D.S. software as a first troubleshooting step. Refer to *DIAGNOSTIC AND FAULT CODES*.

NOTE: Some tests require fuses removal which may lead to a fault code occurrence. Clear fault codes if needed.

Starter Does Not Turn

1. Check battery charging fuse (main).
2. Check starter solenoid fuse.
3. Ensure that the ring terminals are secured to negative and positive posts of battery.

Carry out the following procedure to check if engine can be rotated.

1. Set emergency engine stop switch to STOP.
2. Make sure tether cord is not installed.
3. Manually rotate the engine using the drive pulley.

⚠ WARNING

When manually rotating engine, the emergency engine stop switch MUST BE set to STOP and tether cord cap MUST NOT be installed or severe injury may occur.

If the engine can be rotated, test starting system as per *STARTING SYSTEM TESTING SEQUENCE*.

If the engine cannot be rotated, check engine.

Starter Turns Slowly

Check the following:

- Battery and connections condition. Refer to *CHARGING SYSTEM*.
- Starter operation. Refer to *MAGNETO AND STARTER*.
- Starter solenoid contacts. Refer to *SOLENOID VOLTAGE DROP TEST*.

STARTING SYSTEM TESTING SEQUENCE

600 ACE Models

Test starting system in the following order:

- Fuse 2 and 3 (in fuse box).
- Battery charging fuse (fuse 1, in fuse box). A blown main fuse cuts the current flow to the entire electrical system.
- Battery and connections condition, refer to *CHARGING SYSTEM*.
- Starter. Refer to *MAGNETO AND STARTER*.

– Starter solenoid. Refer to *SOLENOID QUICK TEST.*
– Start switch. Refer to *START/RER SWITCH TEST USING B.U.D.S.*

1200 4-TEC Models

Test starting system in the following order:
– Fuse 9 (in fuse box).
– Fuse 8 (in fuse box).
– Battery charging fuse (main) (fuse 13 in fuse box). A blown main fuse cuts the current flow to the entire electrical system.
– Battery and connections condition, refer to *CHARGING SYSTEM.*
– Starter. Refer to *MAGNETO AND STARTER.*
– Starter solenoid. Refer to *SOLENOID QUICK TEST.*
– Start switch. Refer to *START/RER SWITCH TEST USING B.U.D.S.*

PROCEDURES

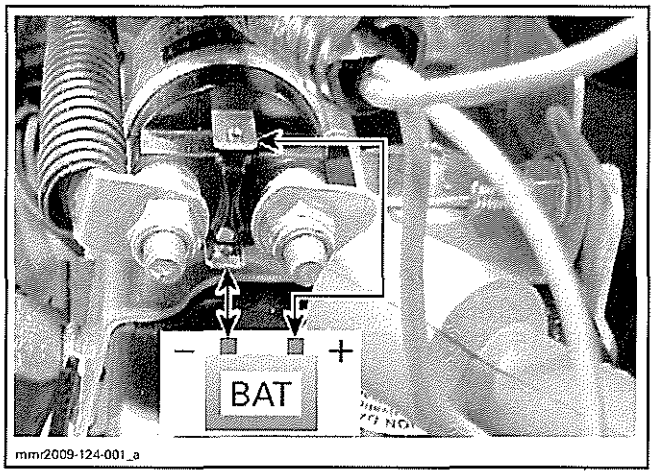
STARTER SOLENOID

Solenoid Quick Test

1. Remove tether cord cap from engine cut-off switch.
2. Disconnect the small positive connector from starter solenoid.

MODEL	SMALL POSITIVE CONNECTOR WIRE COLOR
600 ACE	GREEN/BLUE
1200 4-TEC	GRAY/RED

3. Install a jumper wire (with insulated clips) between the positive solenoid terminal and the positive battery terminal.
4. Disconnect the small negative connector (ORANGE/BLACK wire) from starter solenoid.
5. Install a jumper wire on the battery negative terminal and momentarily touch the negative solenoid terminal.



NOTICE The two small solenoid coil terminals are close to each other. When installing the jumper wires, ensure the ends of the jumper wires are insulated and cannot come into contact with each other or a short circuit will occur.

If the starter engages, test solenoid input voltage. Refer to *INPUT VOLTAGE TEST (STARTER SOLENOID).*

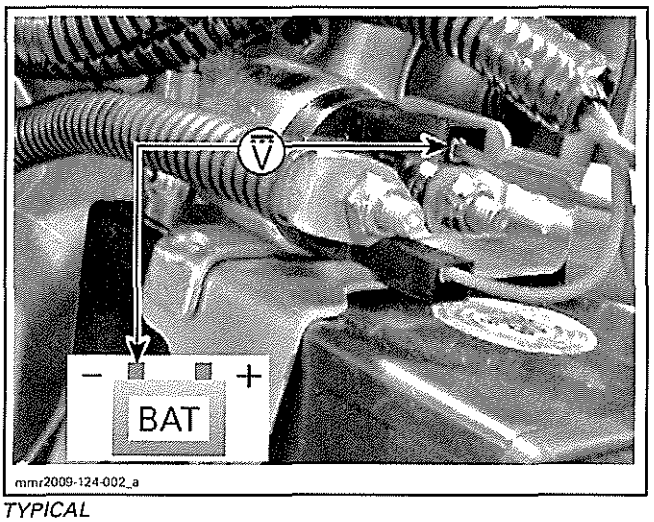
If the starter does not engage, refer to *STARTER SOLENOID STATIC TESTS*, or try a known good solenoid.

Input Voltage Test (Starter Solenoid)

1. Install tether cord cap on engine cut-off switch.
2. Set emergency engine stop switch to RUN.
3. Set FLUKE 115 MULTIMETER (P/N 529 035 868) to Vdc.
4. Quickly press on START/RER button to wake up the ECM.
5. Back probe the solenoid input terminal and measure voltage as per following table.

TEST PROBES		VOLTAGE
600 ACE: GREEN/BLUE wire	Battery ground	Battery voltage
1200 4-TEC: GRAY/RED wire	Battery ground	Battery voltage

NOTE: Test is valid only if the ECM is powered (gauge will turn on).



TYPICAL

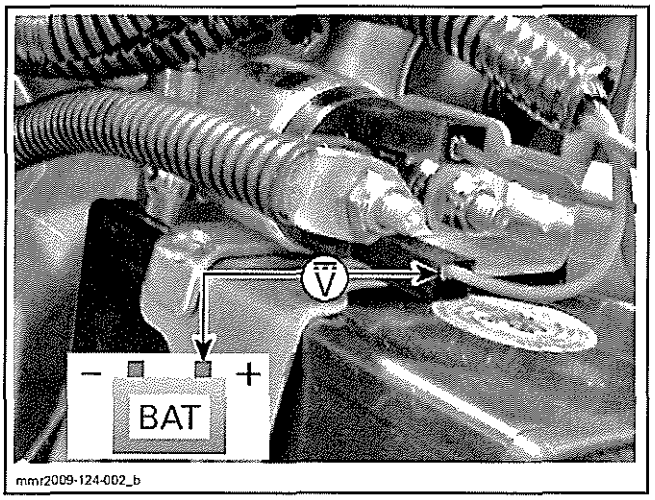
If voltage is not as specified, repair open circuit. Refer to *WIRING DIAGRAM* for details.

If the solenoid input voltage is as specified, refer to *SOLENOID GROUND SIGNAL TEST.*

Solenoid Ground Signal Test (Starter Solenoid)

1. Carry out steps 1 to 4 of *INPUT VOLTAGE TEST (STARTER SOLENOID).*
2. Back probe solenoid negative terminal (ORANGE/BLACK wire) and measure voltage as per following table.

TEST PROBES		VOLTAGE
OR/BK	Battery positive terminal	Battery voltage



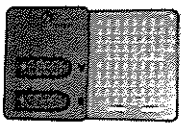
TYPICAL

If voltage is not as specified, carry out *GROUND WIRE CONTINUITY TEST.*

If voltage is as specified, carry out *START/RER SWITCH TESTS.*

Ground Wire Continuity Test (Starter Solenoid)

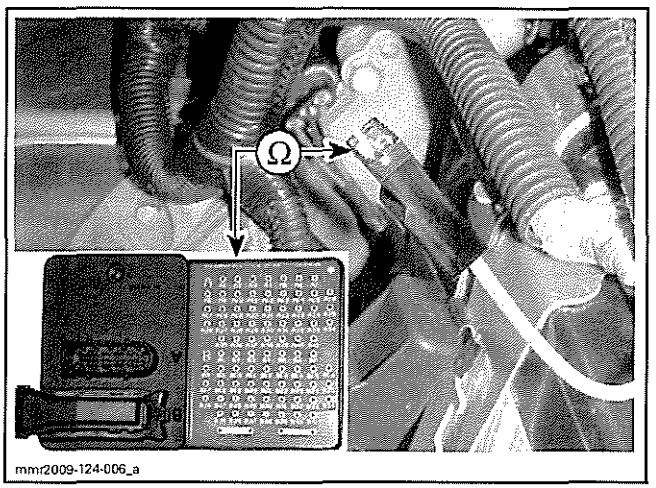
1. Disconnect battery negative terminal.
2. Disconnect ECM connector B, refer to *ELECTRONIC FUEL INJECTION.*
3. Install connector on the following tool according to model.

MODEL	TOOL	TOOL VIEW
600 ACE	ECM ADAPTER TOOL (P/N 529 036 166)	
1200 4-TEC	ECM ADAPTER TOOL (P/N 420 277 010)	

4. Disconnect ground signal wire (ORANGE/BLACK) from starter solenoid.
5. Set multimeter to Ω.
6. Measure wire continuity as follows:

600 ACE MODELS		
TEST PROBES		RESISTANCE
Ground wire (OR/BK)	ECM connector B pin 4L	Close to 0 Ω

1200 4-TEC MODELS		
TEST PROBES		RESISTANCE
Ground wire (OR/BK)	ECM connector B pin 31	Close to 0 Ω



TYPICAL — 1200 4-TEC SHOWN

If resistance is not as specified, repair open circuit. Refer to *WIRING DIAGRAM* for wiring and connector details.

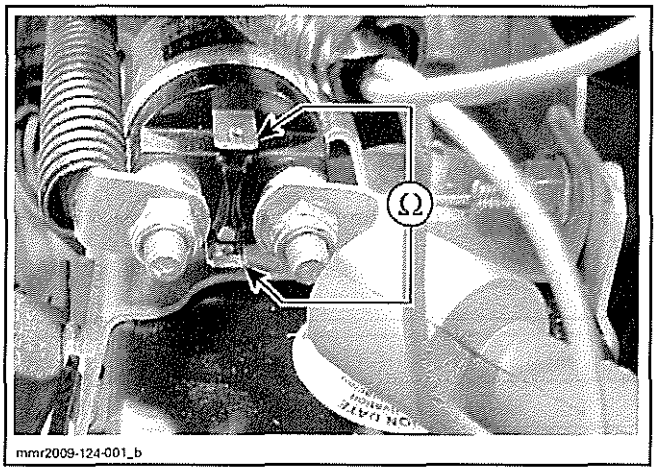
If resistance is as specified, test ECM grounds, refer to *ECM* in *ELECTRONIC FUEL INJECTION* subsection. If ECM grounds are good, try a new ECM.

Solenoid Static Tests

Solenoid Winding Resistance Verification

1. Disconnect the small terminals from the starter solenoid.
2. With a multimeter set to Ω, test coil winding resistance as follows.

TEST PROBES		MEASUREMENT
SOLENOID COIL TERMINALS		RESISTANCE @ 20°C (68°F)
A	B	Approximately 7.5 Ω



TYPICAL

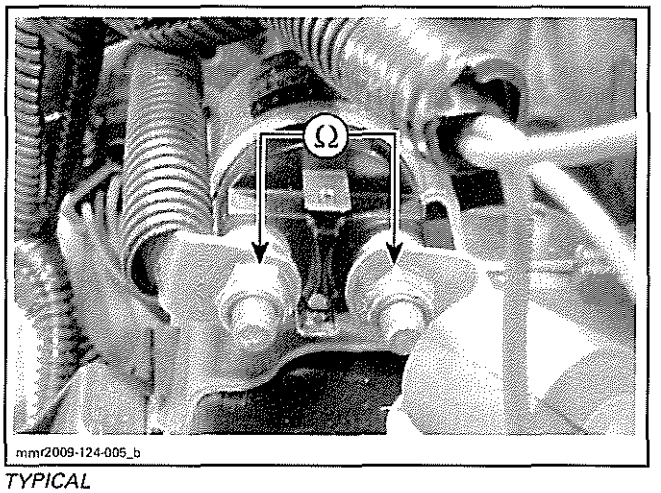
If resistance is not as specified, replace solenoid.

If resistance is as specified, carry out the *SOLENOID PLUNGER VERIFICATION.*

Solenoid Plunger Verification

1. Disconnect battery ground cable.
2. Check for a stuck solenoid plunger by measuring the resistance through the solenoid main contacts as follows.

SOLENOID CONNECTOR		MEASUREMENT
Battery post	Starter post	Open circuit



TYPICAL

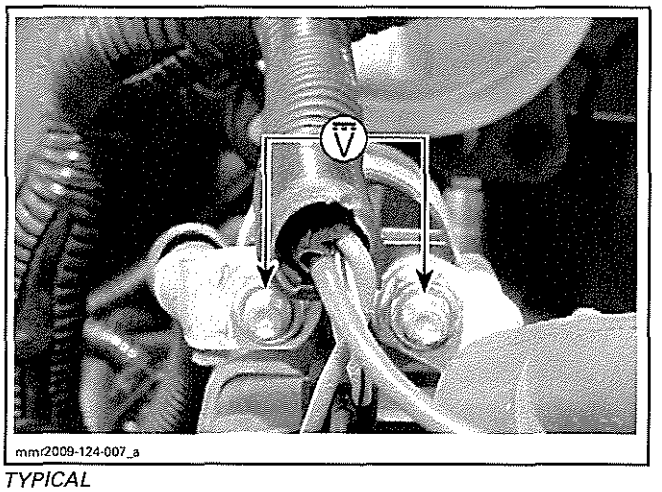
If a reading other than an open circuit is measured, replace solenoid.

If an open circuit is measured, carry out the *SOLENOID VOLTAGE DROP TEST.*

Solenoid Voltage Drop Test

1. Fully squeeze and hold throttle lever (to enter engine drown mode) to prevent engine from starting.
2. Press START/RER button and hold. While engine is cranking, measure the voltage drop across the solenoid main contacts as follows.

SOLENOID CONNECTOR		VOLTAGE
Post coming from battery	Post going to starter	0.2 Vdc max.



TYPICAL

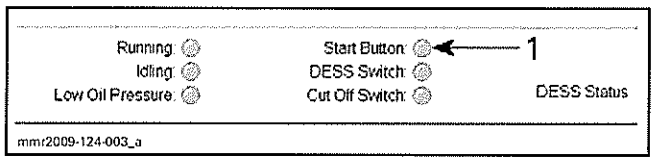
If voltage is out of specification, replace solenoid.

If solenoid tests good, test start/RER switch. Refer to *START/RER SWITCH.*

START/RER SWITCH

START/RER Switch Test Using B.U.D.S.

1. Connect the vehicle to the proper B.U.D.S. software version available from BOSSWeb. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* for proper connection instructions.
2. In B.U.D.S., select the **Read Data** button.
3. Select the **Monitoring** tab.
4. At the bottom LH corner of the **Monitoring** page, select the **ECM** tab.
5. Set emergency engine stop switch to RUN and install tether cord cap on engine cut-off switch.
6. Press the START/RER button and look for the **START Button** LED in the bottom section. It should come ON (turn GREEN).



TYPICAL
1. Should turn ON (GREEN)

If the START Button LED turns green, the ECM receives the START/RER positive signal. This confirms that:

– The voltage input reaches the START/RER switch.
– The START switch is good.
– The signal wiring is good.

Therefore, the tests are completed.

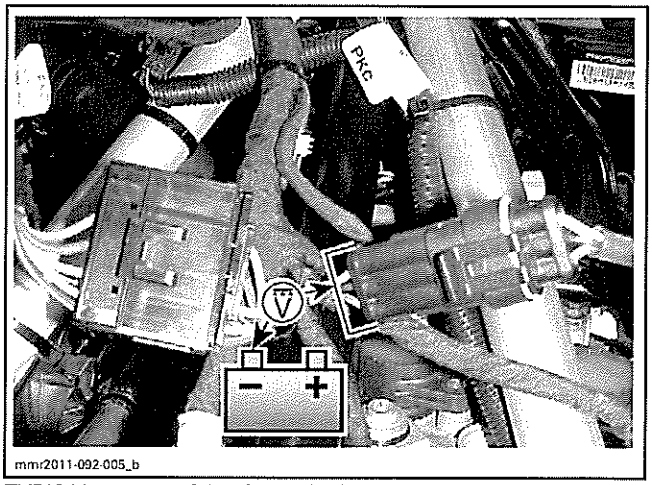
If the START/RER LED does not turn green refer to *START/RER INPUT VOLTAGE TEST.*

START/RER Switch Input Voltage Test

1. Set FLUKE 115 MULTIMETER (P/N 529 035 868) to Vdc.
2. Back probe switch input wire (RD/BN) at switch connector and measure voltage as per following table.

NOTE: Use the FLUKE RIGID BACK PROBES (P/N TP88) or equivalent to back probe wire.

INPUT VOLTAGE (SWITCH CONNECTOR)		
TEST PROBES		VOLTAGE
RD/BN	Battery ground	Battery voltage



TYPICAL — 600 ACE MODEL SHOWN

If voltage is as specified, refer to *START/RER SWITCH OUTPUT TEST.*

If voltage is not as specified, repair open circuit. Refer to *WIRING DIAGRAM* for wiring and connectors details.

START/RER Switch Output Voltage Test

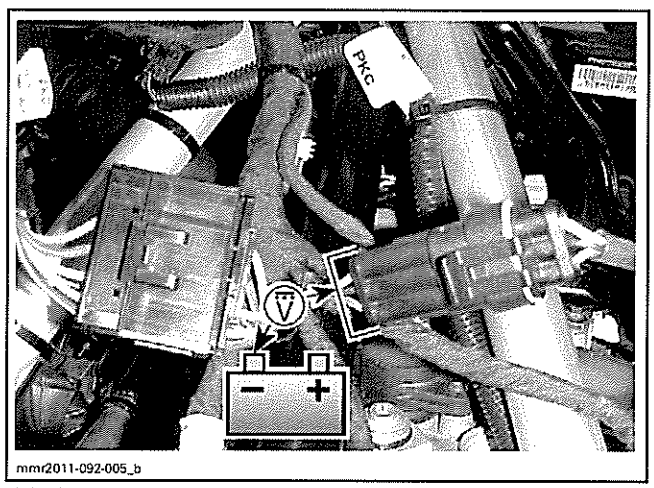
Make sure Input voltage reaches START/RER switch.

1. Set multimeter to Vdc.
2. Back probe switch output (signal) wire (LIGHT BROWN) at switch connector.

NOTE: Use the FLUKE RIGID BACK PROBES (P/N TP88) or equivalent to back probe wire.

3. Press and hold START/RER button while measuring voltage as per following table.

SWITCH OUTPUT VOLTAGE (SWITCH CONNECTOR)		
TEST PROBES		VOLTAGE
LIGHT BROWN	Battery ground	Battery voltage



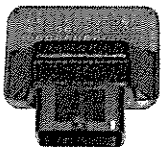
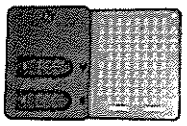
TYPICAL — 600 ACE MODEL SHOWN

If voltage is as specified, refer to *START/RER SIGNAL WIRE CONTINUITY TEST.*

If voltage is not as specified, replace switch.

START/RER Signal Wire Continuity Test

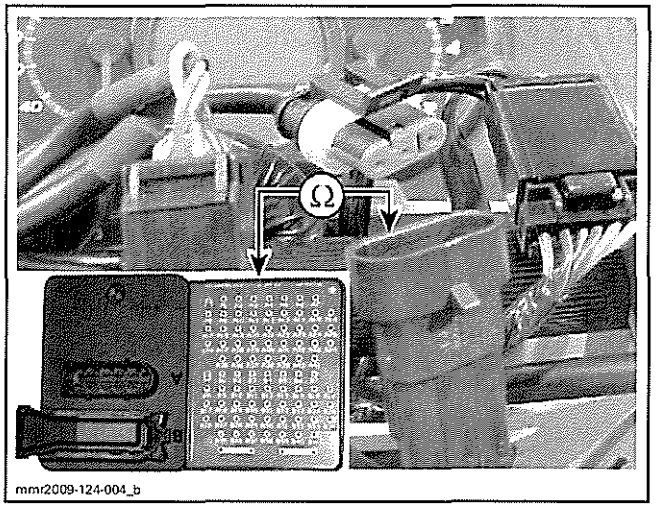
1. Disconnect battery negative terminal.
2. Disconnect ECM connector B, refer to *ELECTRONIC FUEL INJECTION* section.
3. Install connector on the following tool according to model.

MODEL	TOOL	TOOL VIEW
600 ACE	ECM ADAPTER TOOL (P/N 529 036 166)	
1200 4-TEC	ECM ADAPTER TOOL (P/N 420 277 010)	

4. Disconnect switch connector.
5. Set multimeter to Ω and measure resistance as per following table.

600 ACE MODELS		
TEST PROBES		RESISTANCE
Switch connector, LIGHT BROWN wire	ECM connector B pin 1D	Close to 0 Ω

1200 4-TEC MODELS		
TEST PROBES		RESISTANCE
Switch connector, LIGHT BROWN wire	ECM connector B pin 19	Close to 0 Ω



TYPICAL — 1200 4-TEC SHOWN

If resistance is as specified and switch input and output are good, carry out the *START/RER SWITCH GROUND TEST.*

If resistance is not as specified, repair open circuit. Refer to *WIRING DIAGRAM* for wiring and connector details.

START/RER Switch Ground Test

1. Set multimeter to Vdc.
2. Disconnect switch connector.
3. Measure voltage as per following table.

TEST PROBES		VOLTAGE
Switch connector, BK wire	Battery positive terminal	Battery voltage

If voltage is not as specified, repair open circuit. Refer to *WIRING DIAGRAM* for wiring and connector details.

If voltage is as specified, test ECM grounds. Refer to *ECM* in *ELECTRONIC FUEL INJECTION* subsection. If ECM grounds are good, try a new ECM.

DIGITALLY ENCODED SECURITY SYSTEM (D.E.S.S.)

SERVICE TOOLS

Description	Part Number	Page
D.E.S.S. POST INTERFACE	529 036 019	657, 659

GENERAL

SYSTEM DESCRIPTION

The following components are specially designed for this system: ECM, D.E.S.S. key (inside tether cord cap) and engine cut-off switch.

This system allows the engine to reach pulley engagement speed only if a D.E.S.S. key is installed on engine cut-off switch and the key is recognized as valid by the ECM.

The D.E.S.S. key contains a magnet and a ROM chip.

- The magnet closes the reed switch inside the engine cut-off switch. It is the equivalent of a rotary mechanical ignition switch.
- The ROM chip owns a unique digital code. It is the equivalent of the tooth-pattern cut on a conventional ignition key.

The D.E.S.S. system is quite flexible. Up to 8 D.E.S.S. keys may be programmed in the memory of the ECM using the B.U.D.S. software. The keys can also be erased individually.

NOTE: If desired, a D.E.S.S. key can be used on another vehicle equipped with the D.E.S.S. It only needs to be programmed on that vehicle.

D.E.S.S. Beeper Codes

When a tether cord cap is installed on the engine cut-off switch and the ECM wakes up, it identifies the D.E.S.S. key. The D.E.S.S. signals will be issued according to the key recognition. See table.

D.E.S.S. SIGNAL		DESCRIPTION	COMMENT
BEEPER	DISPLAYED MESSAGE (1)		
2 shorts beeps	SKI-DOO	Welcome message, good key	Working D.E.S.S. key. Vehicle can be driven. It allows engine to rev above 3000 RPM.
2 short beeps repeating slowly	CHECK KEY	Unable to read key (bad connection)	Make sure the tether cord cap contacts are free of dirt, snow or ice. Reinstall tether cap and restart engine. Vehicle can not be driven.
Short beeps repeating rapidly	BAD KEY	Invalid key or key not programmed	Use the proper key for this vehicle or have the key programmed. Vehicle can not be driven.
(1) Only available on premium gauge			

PROCEDURES

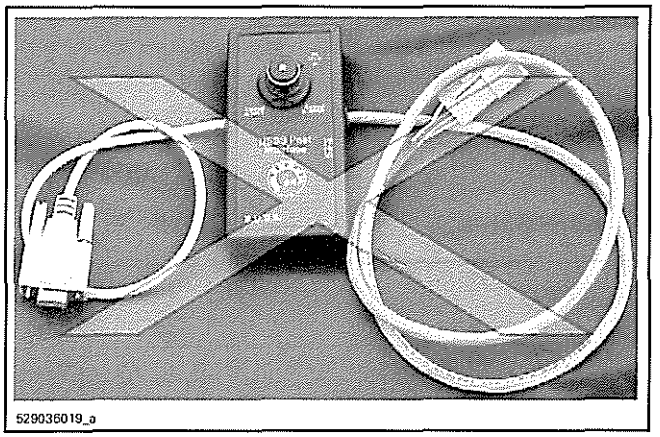
D.E.S.S. KEY (600 HO E-TEC AND 1200 4-TEC MODELS)

D.E.S.S. Key Programming

Use the proper B.U.D.S. version available from BOSSWeb.

Carry out the proper connections to use B.U.D.S. Refer to *COMMUNICATION TOOLS AND B.U.D.S.*

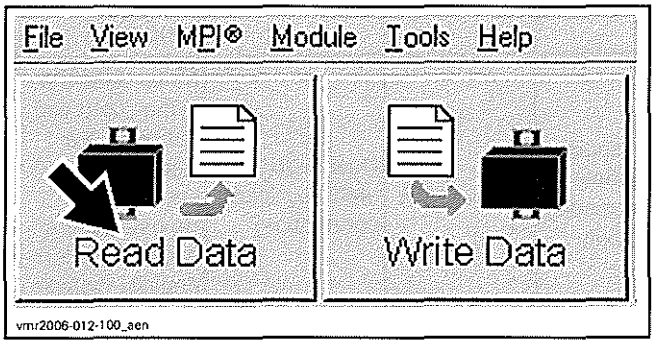
Do not use the D.E.S.S. POST INTERFACE (P/N 529 036 019).



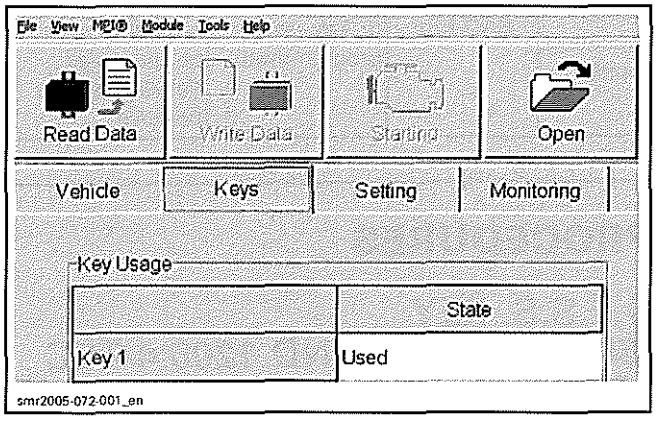
NOTE: Ensure all connections have been made **before starting B.U.D.S.** to allow proper operation.

Start B.U.D.S. and logon.

Read the ECM by clicking the **Read Data** button.

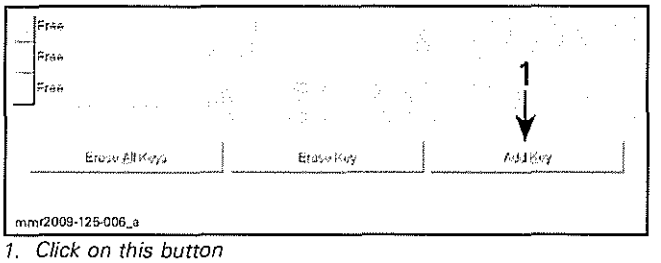


Click on **Keys** tab.



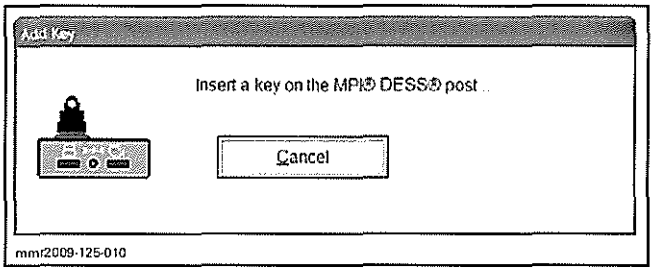
Adding a Key

1. Install the **NEW** tether cord cap (D.E.S.S. key) (**to be programmed**) on engine cut-off switch.
2. Click on **Add Key** button at bottom of screen.



1. Click on this button

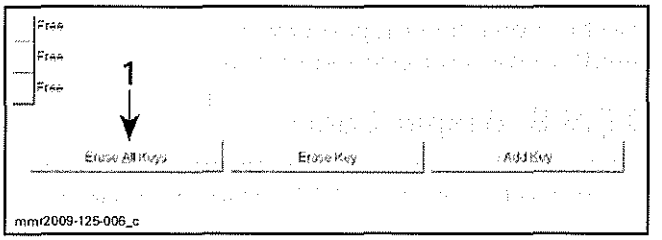
NOTE: If the following window pops up, rock the tether cord cap on the engine cut-off switch to make a good contact until window disappears.



3. A new window will confirm the new key has been saved in the PC computer.
4. To program any other key, restart the complete *ADDING A KEY* procedure from step 1.
5. When done, write the changes to the ECM. Refer to *WRITING CHANGES IN ECM* in this subsection.
6. Ensure the newly programmed key(s) work on the vehicle.

Erasing all Keys

1. Click on **Erase All Keys** button at bottom of screen.

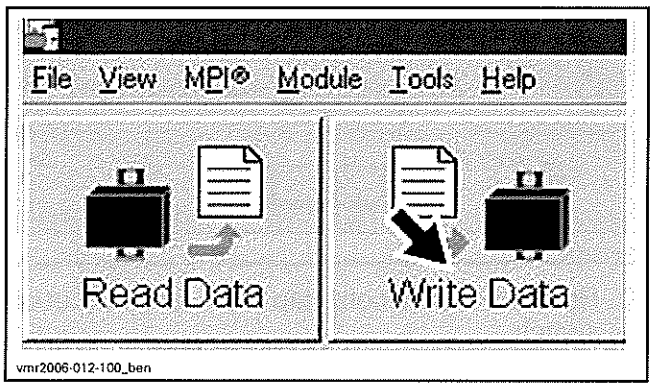


1. Click on this button

2. When done, program at least a new key in the ECM.
3. Write the changes to the ECM. Refer to *WRITING CHANGES IN ECM* in this subsection.
4. Ensure the erased keys do not work anymore on the vehicle (if possible) and ensure the newly added key(s) work.

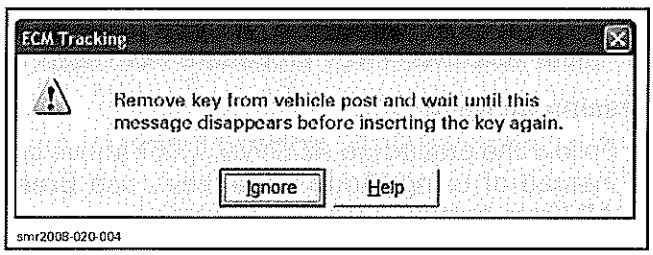
Writing Changes in ECM

Save the changes in the ECM by clicking the **Write Data** button.



1200 4-TEC Models

There will be an ECM Tracking box that will say "Remove key from the vehicle...".



When this occurs, remove tether cord cap and wait until the message disappears (it lasts approximately 20 seconds after tether cord cap removal).

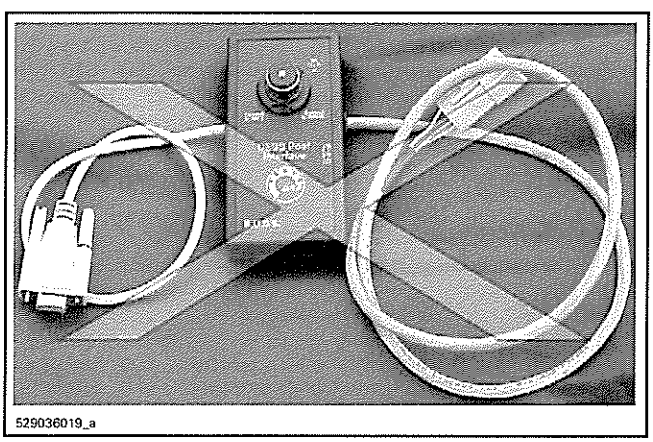
D.E.S.S. KEY (600 ACE MODELS)

D.E.S.S. Key Programming

Use the proper B.U.D.S. version available from BOSSWeb.

Carry out the proper connections to use B.U.D.S. Refer to *COMMUNICATION TOOLS AND B.U.D.S. SOFTWARE*.

Do **not** use the D.E.S.S. POST INTERFACE (P/N 529 036 019).

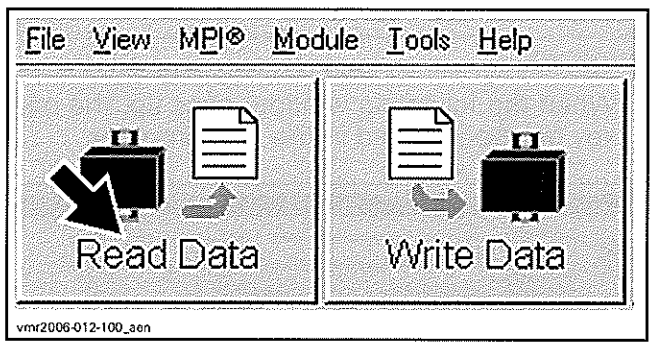


Adding a Key

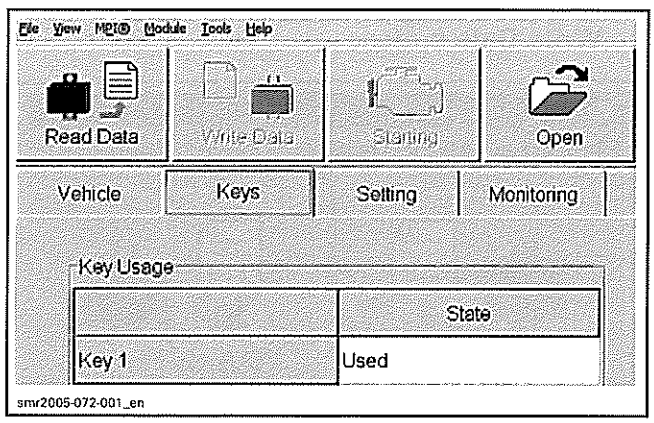
1. Unplug T-harness from the vehicle diagnostic connector.
2. Wait until the ECM shuts down (indicated by the gauge that turns off after approximately 10 seconds).
3. Install the **NEW** tether cord cap (D.E.S.S. key) **(to be programmed)** on engine cut-off switch.
4. Connect the T-harness to the vehicle diagnostic connector.

NOTE: The D.E.S.S. light will flash in the gauge and the beeper will sound until the new key is written to the ECM.

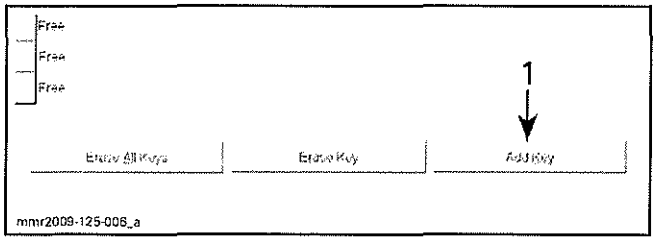
5. Start B.U.D.S. and logon.
6. Read the ECM by clicking the **Read Data** button.



7. Click on the **Keys** tab.

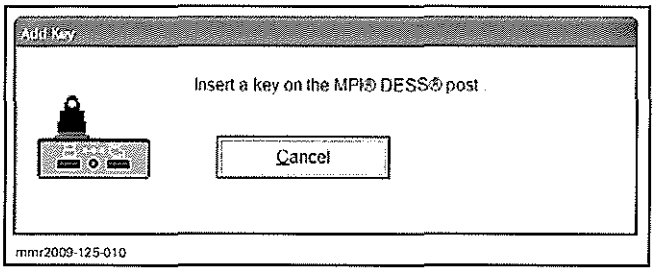


8. Click on **Add Normal Key** button at bottom of screen.

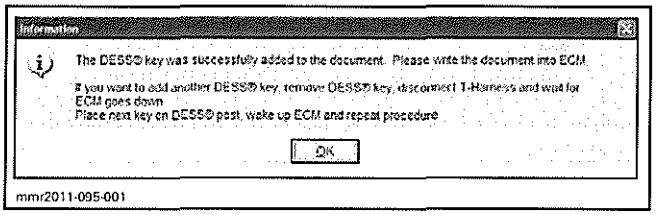


TYPICAL
1. Click on this button

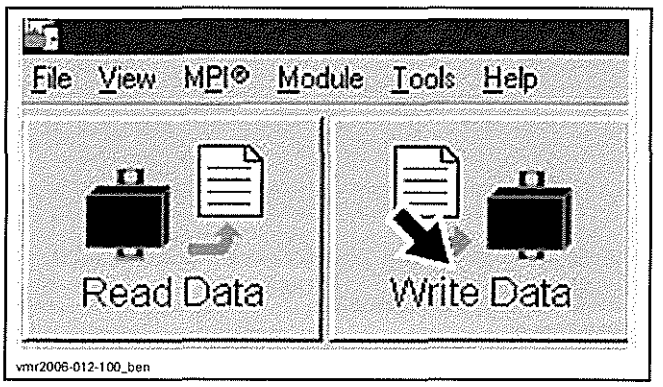
NOTE: If the following window pops up, rock the tether cord cap on the engine cut-off switch to make a good contact until window disappears.



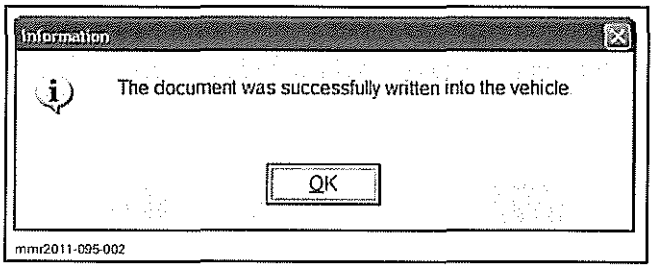
9. When the following window pops up, the new key has been saved in the PC computer.



10. Save the changes in the ECM by clicking the **Write Data** button.



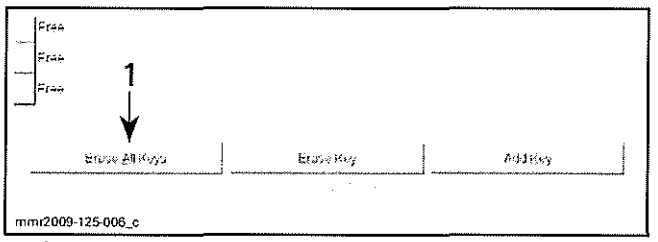
11. Wait for the following window that confirms that the ECM has been written properly.



12. Remove tether cord cap from engine cut-off switch.
13. Unplug T-harness from the vehicle diagnostic connector.
14. Wait until the ECM shuts down (indicated by the gauge that turns off after approximately 10 seconds).
15. To program any other key, restart the complete *ADDING A KEY* procedure from step 1.

Erasing all Keys

1. Follow the procedure *ADDING A KEY* above but instead of using "Add normal key", use **Erase All Keys** button at bottom of screen.



1. Click on this button

NOTE: No confirmation message will be displayed.

2. When done, program at least a new key in the ECM.

BEEPER

The beeper is integrated in the multifunction gauge and cannot be replaced alone.

If the beeper does not sound when starting engine, check the beeper operation. Refer to *LIGHTS, GAUGE AND ACCESSORIES.*

LIGHTS, GAUGE AND ACCESSORIES

SERVICE TOOLS

Description	Part Number	Page
12 V BATTERY SUPPLY CABLE	529 035 997	662
FLUKE 115 MULTIMETER	529 035 868	664–665, 667, 670–672, 679–682, 686
T-HARNESS	529 035 869	662, 670

SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
MULTILOCK - TERMINAL EXTRACTION TOOL	755430-2	683

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 5900	293 800 066	677

GENERAL

NOTE: It is a good practice to check for fault codes using B.U.D.S. software as a first troubleshooting step. Refer to *DIAGNOSTIC AND FAULT CODES* subsection.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to. Locking devices (e.g.: locking tabs, elastic stop nuts, self-locking fasteners, cotter pins, etc.) must be replaced with new ones.

600 HO E-TEC

⚠ CAUTION The battery fuse (F1) should always be removed before carrying out any maintenance on the vehicle to prevent any unexpected electrical activation. Removal of this fuse isolates the battery from the vehicle electrical system, except for the starter relay input terminal.

NOTICE The 12 Vdc primary circuit is not to be used to power accessory loads. All accessories are to be powered from the secondary 12 Vdc circuit.

TROUBLESHOOTING

Some accessories are specific to models.

DIAGNOSTIC TIPS

If more than one accessory stopped working, check applicable fuse(s). Refer to *POWER DISTRIBUTION*. Refer to *WIRING DIAGRAM* for circuit details.

LIGHTING AND ACCESSORIES SYSTEM TESTING

600 HO E-TEC

All vehicle lights are powered from the primary 12 Vdc circuit. This circuit is powered from and controlled by the ECM when the engine reaches 800 RPM.

There are no relays or fuses outside the ECM to test or replace for the lights circuits. Refer to *CHARGING SYSTEM* for more information on testing the primary 12 Vdc circuits.

If a light does not come ON, carry out the following:

- Obtain access to the bulb and make sure it is not burnt.
- Test for input voltage to the bulb.
- Test for continuity of the ground circuit.
- Test the applicable control switch (brake switch, headlight switch).

Accessory outlets are powered from the secondary 12 Vdc system.

Refer to *WIRING DIAGRAM* for light circuit details.

To provide power to specific circuits, refer to the following chart to meet the required conditions.

SYSTEM	MODEL	CONDITIONS REQUIRED
– Lights – Gauge	Standard gauge	– T-HARNESS (P/N 529 035 869) – 12 V BATTERY SUPPLY CABLE (P/N 529 035 997) (for manual start)
– Lights – Gauge – Heaters	Premium gauge	
– Heaters	Standard gauge	– Start engine and rev above 2000 RPM for at least 2 seconds OR
– Accessories (power outlet)	All	– Use B.U.D.S. and activate the Accessory Relay

To use B.U.D.S., refer to the *COMMUNICATION TOOLS AND B.U.D.S.* subsection for proper connections.

NOTE: It is not necessary to connect the MPI-2 interface unless a test calls for a connection to B.U.D.S. software, or the accessory circuit to test is powered from the secondary 12 Vdc circuit.

NOTE: The accessory relay is internal to the ECM.

600 ACE and 1200 4-TEC Models

The relays can be activated by starting engine. This way, all relays will be activated.

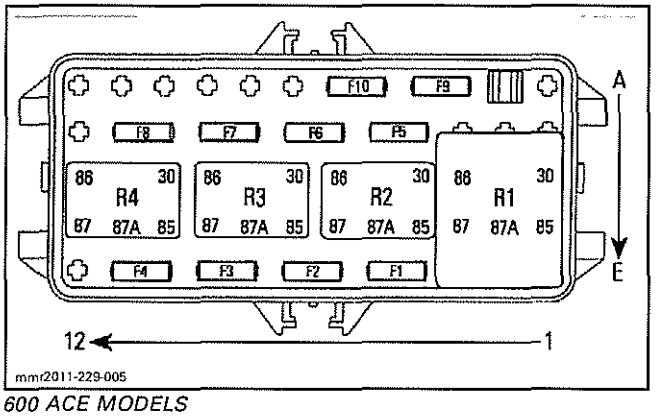
The relays can be activated without starting engine by following these procedures.

To energize relay 1 (R1) for testing, install the T-HARNESS (P/N 529 035 869) on the diagnostic connector. This will also ready the use of B.U.D.S. software when needed. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection for proper connection.

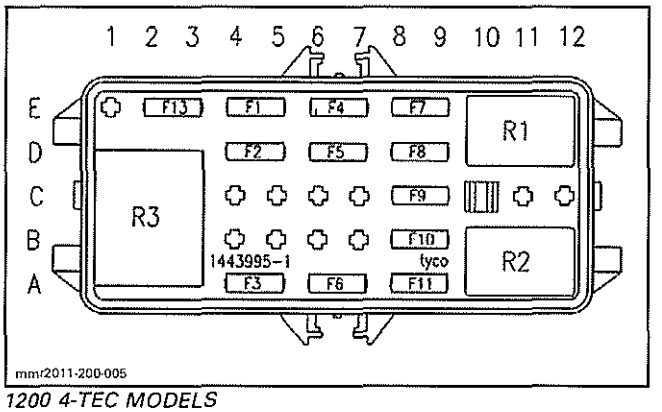
On the 600 ACE models, briefly press the Start button to wake up the ECM.

To test the components supplied by relay 2 (R2) or relay 3 (R3), replace relay by a suitable fused jumper between fuse box pins as per table.

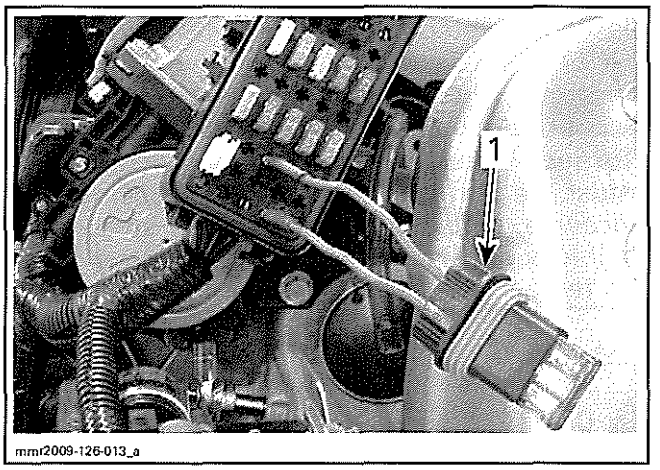
MODEL	RELAY	PIN TO JUMP
600 ACE	R2	4C and 6D
	R3	7C and 9D
1200 4-TEC	R3	1B and 3C



600 ACE MODELS



1200 4-TEC MODELS



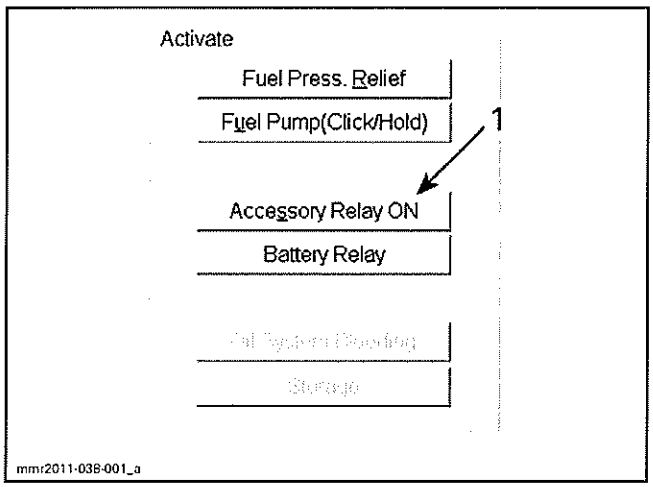
TYPICAL — 1200 4-TEC SHOWN
1. Fused jumper

ACCESSORY CIRCUIT TEST WITH B.U.D.S.

600 HO E-TEC

1. The accessory relay can be powered for testing using the B.U.D.S. software.
2. Connect to the B.U.D.S. software version applicable using the MPI-2 interface, refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
3. Select the **Activation** tab.

4. At the bottom of the page, select the ECM tab.
5. Select the Accessory Relay button.



1. Select this button

If the accessory relay does not function, try a new ECM.

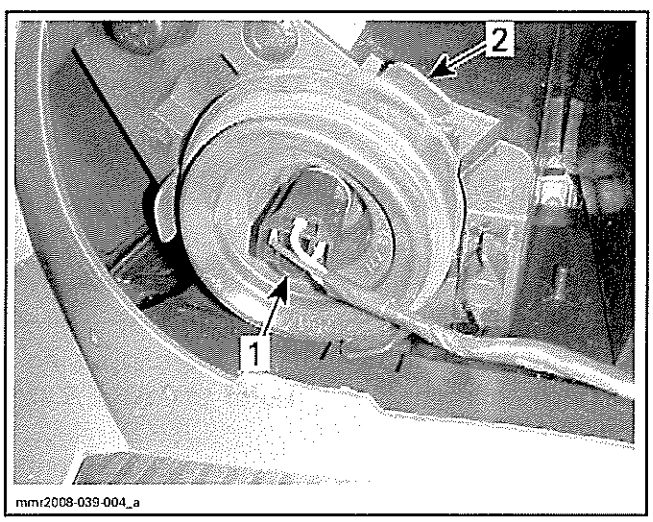
PROCEDURES

HEADLIGHTS

Headlight Bulb Removal

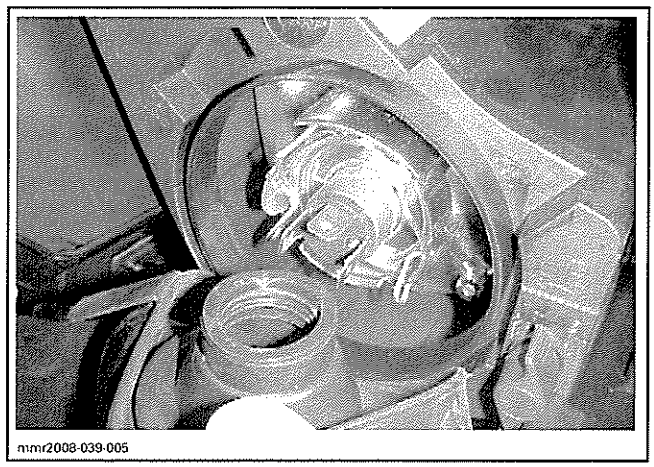
If a headlight bulb is burnt, proceed as follows.

1. Remove multifunction gauge to gain access to headlight bulbs, see procedure in this section.
2. Remove bulb connector.
3. Remove top and center portion of rubber boot from headlight.

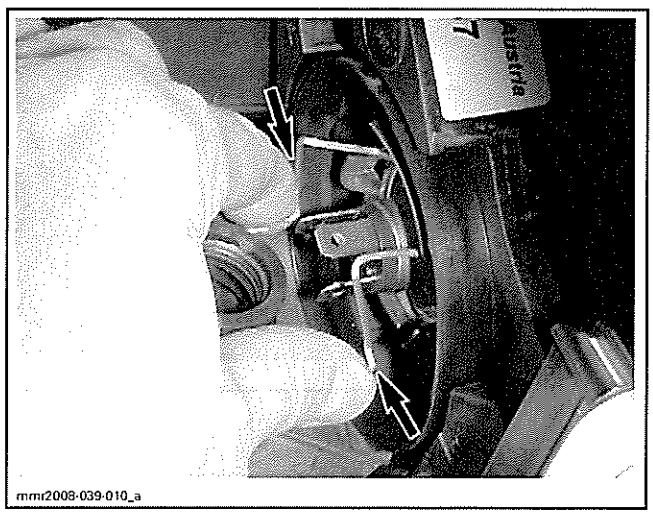


1. Remove headlight connector
2. Remove rubber boot

NOTE: It is not necessary to fully remove rubber boot.

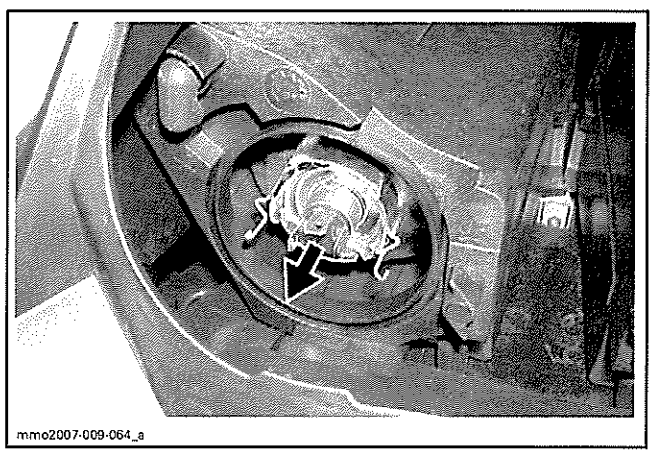


4. Press both sides of the bulb holder (spring clip) inwards at the same time, and pull it out to release it from the bulb support.



SQUEEZE INWARDS AND PULL OUT

5. Pull bulb from headlight.



PULL TO REMOVE BULB

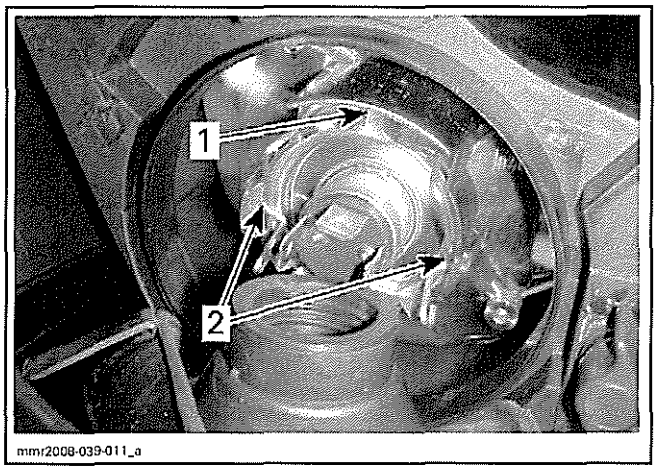
Headlight Bulb Installation

NOTICE Never touch glass portion of a halogen bulb with bare fingers, it shortens its operating life. If glass is touched, clean it with isopropyl alcohol which will not leave a film on the bulb.

1. Insert bulb in headlight.

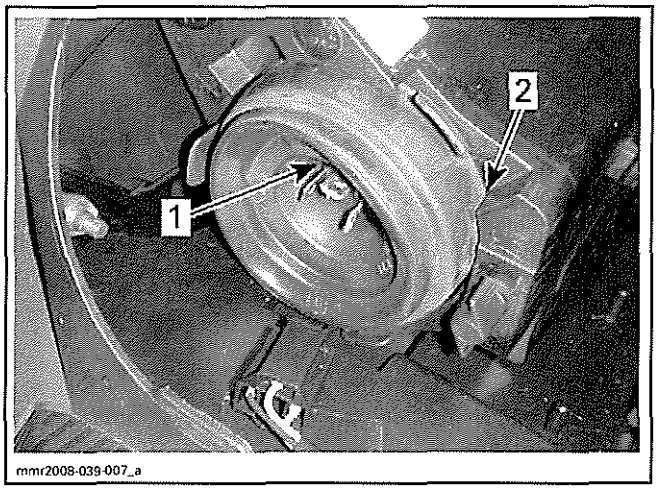
NOTE: Widest alignment tab on bulb should be at top of headlight.

2. Insert top of bulb holder (spring clip) as you squeeze the two sides inwards. Release bulb holder so that it locks in the grooves on either side of headlight.



1. *Wide bulb tab*
2. *Bulb holder locked*

3. Install rubber boot. Ensure cover is properly inserted in groove provided in the headlight, and around the base of the bulb.



1. *Insert around bulb*
2. *Insert in groove provided*

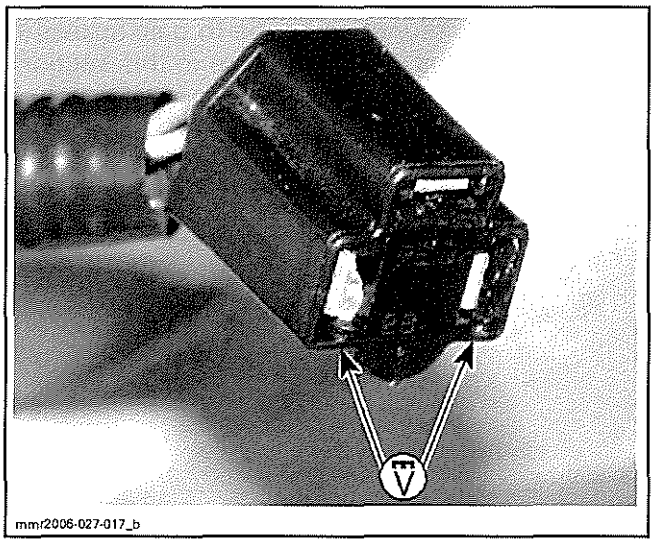
4. Install light connector.
5. Always test light operation after bulb replacement.
6. Install gauge, see procedure in this section.

Headlight Input Voltage Test

If headlight(s) does not function with a known good bulb, proceed as follows.

1. Remove multifunction gauge, see procedure in this subsection.
2. Disconnect headlight connector(s).
3. Provide power to the electrical system for testing. Refer to *LIGHTING AND ACCESSORIES SYSTEM TESTING* in the *TROUBLESHOOTING* topic at the beginning of this subsection for proper procedure.
4. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Vdc.
5. Read voltage at headlight connector as follows:

HEADLIGHT INPUT VOLTAGE TEST			
SWITCH POSITION	WIRE COLOR (HEADLIGHT CONNECTOR)		VOLTAGE
LO BEAM	GY/BK	BK	Battery voltage
HI BEAM	GY	BK	



If voltage is inadequate, carry out the following:

- Check applicable fuse. Refer to *POWER DISTRIBUTION* subsection.
- Test supply and ground circuits independently. Refer to *WIRING DIAGRAM*.
- Test headlights dimmer switch. Refer to *HEADLIGHT DIMMER SWITCH CONTINUITY TEST* in this subsection.

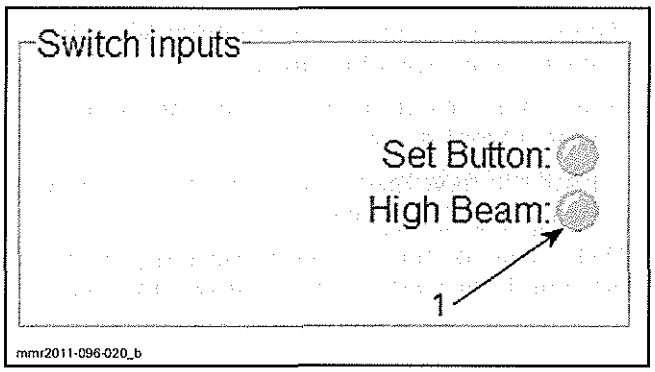
Headlight Dimmer Switch Test with B.U.D.S.

Provide power to the electrical system for testing. Refer to *LIGHTING AND ACCESSORIES SYSTEM TESTING* in the *TROUBLESHOOTING* topic at the beginning of this subsection for proper procedure.

Using the B.U.D.S. software, select the **Monitoring** tab.

On the bottom of the page, choose the **Cluster** tab.

Set vehicle dimmer switch to High Beam and look for applicable indicator light in the **Switch inputs** field to turn green.



TYPICAL
1. Indicator light

If the indicator light come ON in B.U.D.S., the dimmer switch is functioning correctly.

If the indicator light does not come ON, proceed with *HEADLIGHT DIMMER SWITCH CONTINUITY TEST.*

Headlight Dimmer Switch Continuity Test

Using the FLUKE 115 MULTIMETER (P/N 529 035 868), select the Ω position.

Test switch circuits as per table.

HEADLIGHT DIMMER SWITCH CONTINUITY TEST (MULTIFUNCTION SWITCH)			
SWITCH POSITION	WIRE		RESISTANCE
HIGH	RD/OR	GY	Close to 0 Ω
		GY/VI	Infinite (OL)
LOW	RD/OR	GY/VI	Close to 0 Ω

If tests were good, switch is functioning properly.

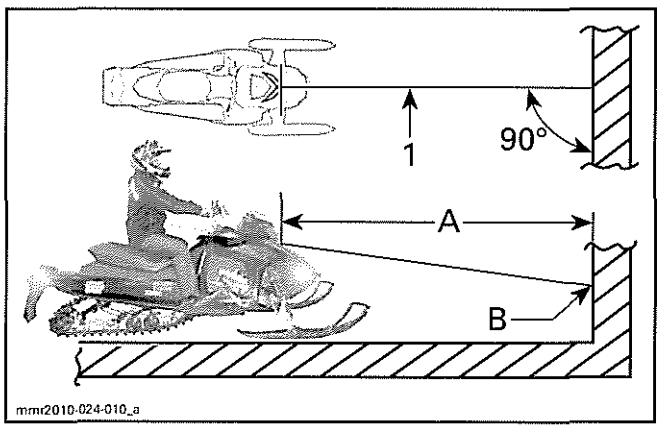
If any test failed, check wiring and connections going to switch.

– If test of wiring and connections was good, replace switch.

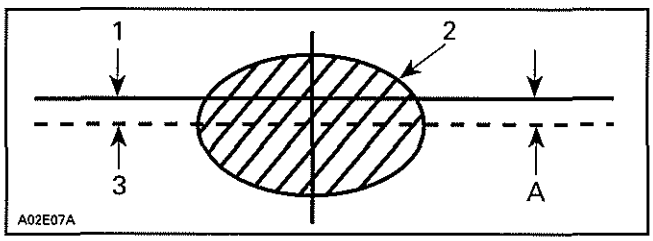
Headlight Beam Aiming

Beam aiming is correct when center of high beam is 25 mm (1 in) below the headlight horizontal center line, scribed on a test surface, 381 cm (12.5 ft) away.

1. Place the vehicle on a flat surface perpendicular to test surface (wall or screen) and 381 cm (12.5 ft) away from it.
2. Ask rider to sit rider on, or apply equivalent weight on the vehicle.
3. Select **high** beam.
4. Measure headlight center distance from ground. Scribe a line at this height on test surface (wall or screen). Light beam center should be 25 mm (1 in) below scribed line.



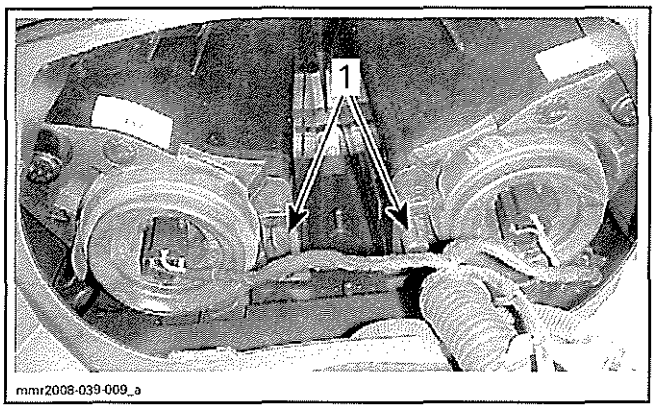
TYPICAL
1. Headlight center line
A. 381 cm (12.5 ft)
B. 25 mm (1 in) below center line



1. Headlight horizontal
2. Light beam (high beam) (projected on the wall)
3. Light beam center
A. 25 mm (1 in)

Beam Aiming Adjustment

1. Remove multifunction gauge.
2. Turn knob on headlight to adjust beam height.

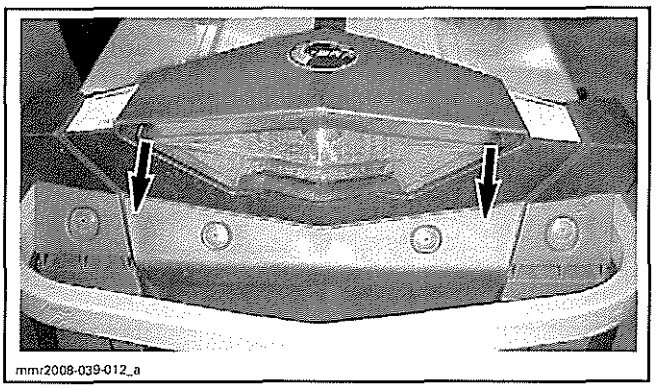


TYPICAL
1. Beam height adjustment knobs

TAILLIGHT AND BRAKE LIGHT

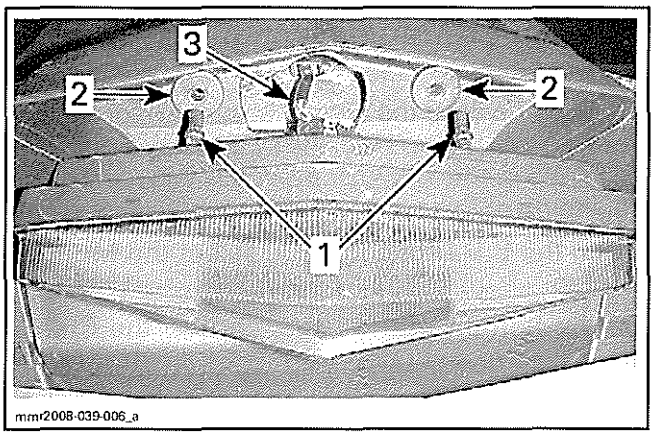
Taillight Bulb Replacement

Remove taillight housing by carefully pulling on lens at both ends.



CAREFULLY PULL OUT AT CORNERS

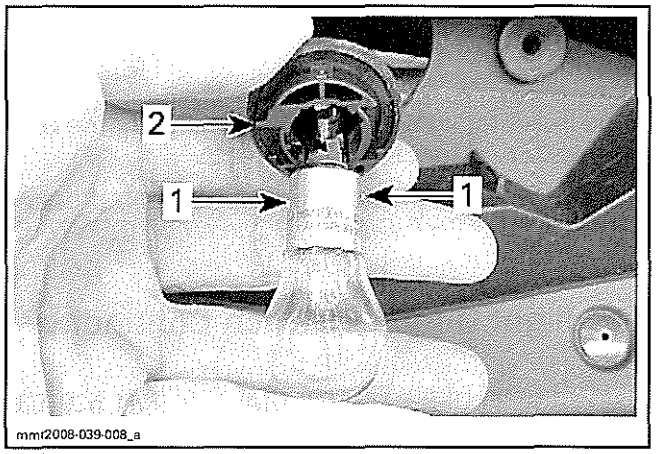
NOTICE Taillight housing is held in place by two plastic pins inserted in rubber grommets. If housing is forced too far sideways when removing, the lens mounting pins may break and housing will have to be replaced. Do not pull housing out too far to avoid damaging wiring.



1. Taillight housing retaining pins
2. Retaining grommets
3. Light wire harness

1. Rotate bulb socket counterclockwise to remove it from taillight housing.
2. Push in and rotate bulb counterclockwise to remove it from its socket.
3. Install the new bulb by pushing it in the socket and turning it clockwise.

NOTE: Note position of bulb locking pins on its base, and bulb holder alignment key to lens.



1. Bulb locking pins
2. Bulb holder alignment key

Taillight Input Voltage Test

If taillight(s) does not function with a known good bulb, proceed as follows.

1. Access taillight connector(s) as explained *TAILLIGHT BULB REPLACEMENT.*
2. Disconnect connector(s).
3. Provide power to the electrical system for testing. Refer to *LIGHTING AND ACCESSORIES SYSTEM TESTING* in the *TROUBLESHOOTING* topic at the beginning of this subsection for proper procedure.

4. Set FLUKE 115 MULTIMETER (P/N 529 035 868) to Vdc.
5. Read voltage at taillight connector(s) as follows:

TAILLIGHT INPUT VOLTAGE TEST		
PROBES		VOLTAGE
YE/RD wire	BK wire	Battery voltage

Reading should be battery voltage. If no voltage is read, refer to *WIRING DIAGRAM* and check ground and supply circuits independently. Repair open circuit as needed.

Brake Light Input Voltage Test

1. If brake light(s) does not function with a known good bulb, carry out steps 1 to 4 of *TAILLIGHT INPUT VOLTAGE TEST.*
2. Apply parking brake.
3. Read voltage at taillight connector(s) as follows:

BRAKE LIGHT INPUT VOLTAGE TEST		
PROBES		VOLTAGE
WH wire	BK wire	Battery voltage

Reading should be battery voltage. If no voltage is read, refer to *WIRING DIAGRAM* and check ground and supply circuits independently. Repair open circuit if needed. To check brake light switch, refer to *BRAKE* subsection.

Taillight Holder Replacement

If the taillight lens is broken, see the *TAILLIGHT BULB REPLACEMENT* procedure in this section.

The taillight holder is part of the snow guard. If it needs to be replaced, refer to *BODY* subsection.

If the light bulb socket or wiring need to be replaced, you will have to lift up the rear of the fuel tank to access and disconnect the harness connector, refer to *FUEL TANK AND FUEL PUMP* section.

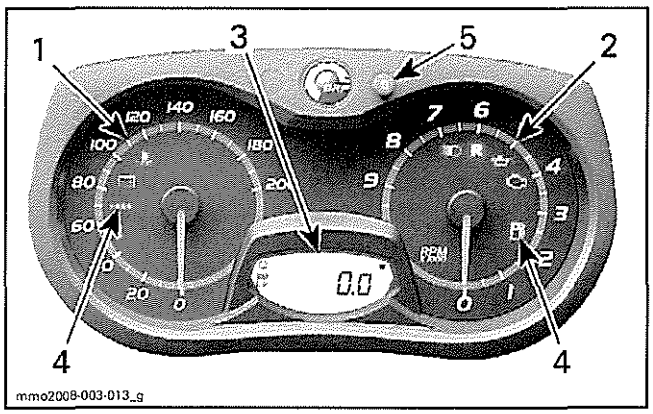
GAUGE

Gauge Description

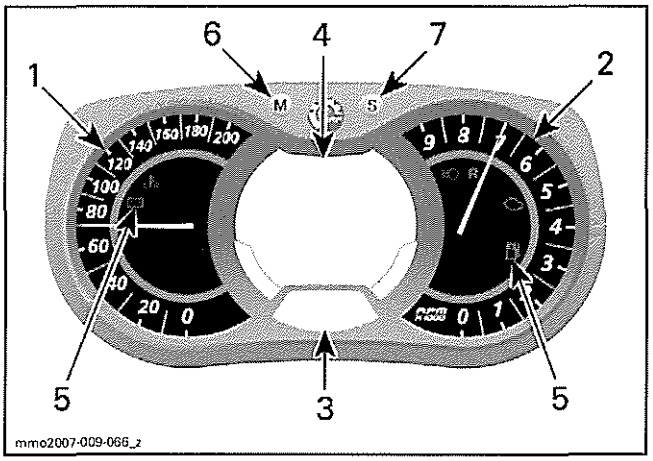
Two different type of gauges which provide all indications in a single unit are used. An **analog/digital gauge (standard gauge)** and a **multifunction analog/digital gauge (premium gauge)**.

The premium gauge provides more functions and display features.

Both units can be set to indicate in metric or imperial units.



TYPICAL — ANALOG/DIGITAL GAUGE (STANDARD)
1. *Speedometer*
2. *Tachometer (RPM)*
3. *Gauge Digital Display*
4. *Gauge Pilot Lamps*
5. *Gauge SET "S" button*



MULTIFUNCTION ANALOG/DIGITAL GAUGE (PREMIUM)
1. *Speedometer*
2. *Tachometer (RPM)*
3. *Gauge Digital Display*
4. *Gauge Multifunction Digital Display*
5. *Gauge Pilot Lamps*
6. *Gauge MODE "M" button*
7. *Gauge SET "S" button*

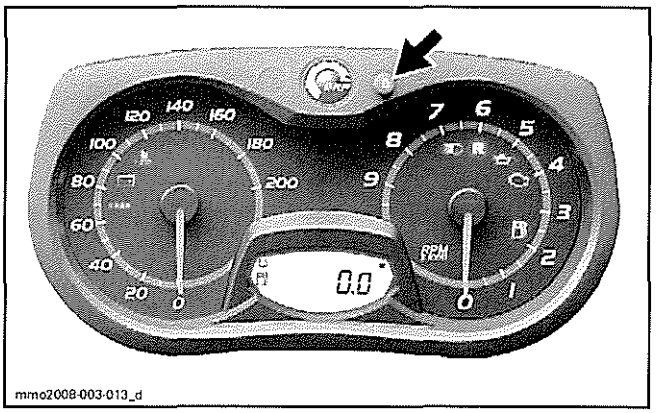
The premium gauge is also used to control 9 temperature settings for the heated hand grips and the heated throttle lever.

NOTE: On the premium gauge, the setups made on the multifunction digital display will not be stored in the memory unless they are performed with the engine running.

Mode and Set Button Functions

Analog/Digital Gauge (Standard)

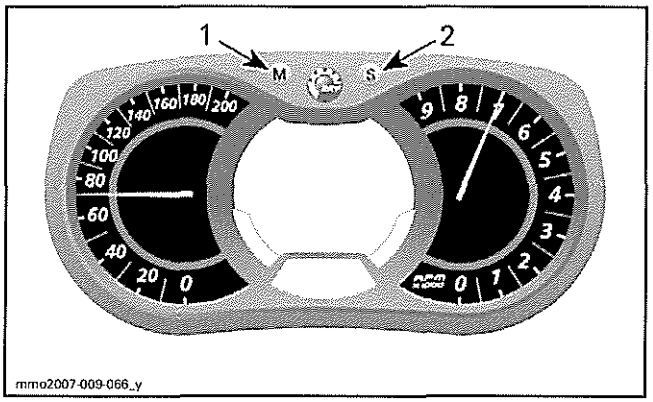
The standard gauge is equipped with a SET button only.



SET "S" BUTTON

Multifunction Analog/Digital Gauge (Premium)

Premium gauge is equipped with MODE and SET buttons at the top of the indicator.



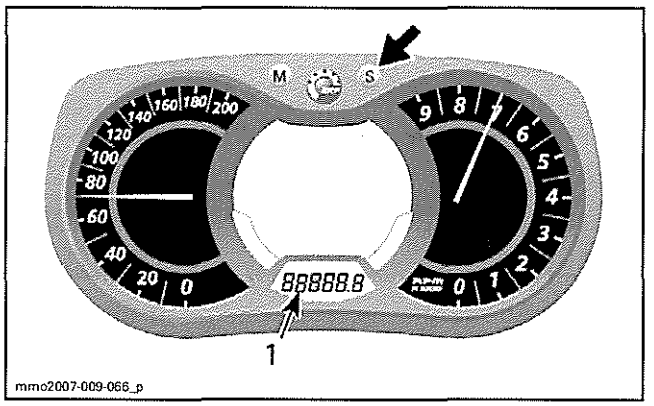
PREMIUM GAUGE
1. MODE button
2. SET button

These buttons allow you to toggle through the different functions and settings of the indicator.

The vehicles that are factory equipped with the premium gauge also come with a remote M/S button on the LH multifunction switch. It can be used instead of the buttons on the gauge simply by pressing the "M" for MODE and "S" for SET.

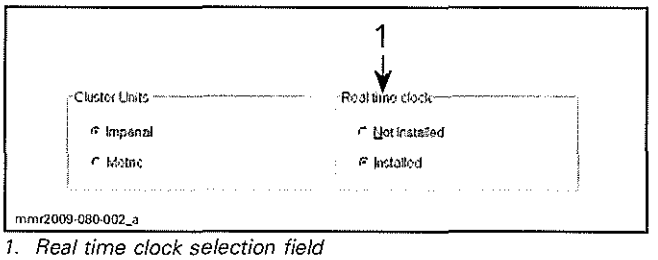
Clock Activation (Premium Gauge)

The gauge has an internal clock that can display the time of day in the lower digital display (when selected).



1. Clock displayed

1. Use B.U.D.S. and select the **Setting** tab.
2. At the bottom of the page, select the **Cluster** tab.
3. Select the **Installed** in the **Real time clock** field



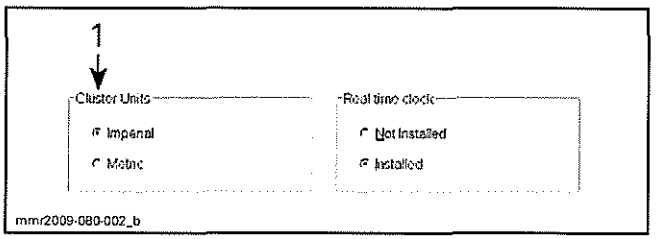
1. Real time clock selection field

Changing Gauge Units

The gauges are factory preset to indicate in imperial units and can be changed using the B.U.D.S. software.

To change the gauge units of measurement in B.U.D.S.:

1. Provide electrical power to the gauge. Refer to *LIGHTING AND ACCESSORIES SYSTEM TESTING* in the *TROUBLESHOOTING* topic at the beginning of this section for proper procedure.
2. Use B.U.D.S. and select the **Setting** tab.
3. At the bottom of the page, select the **Cluster** tab.
4. Select **Imperial** or **Metric** in the **Cluster Units** field.



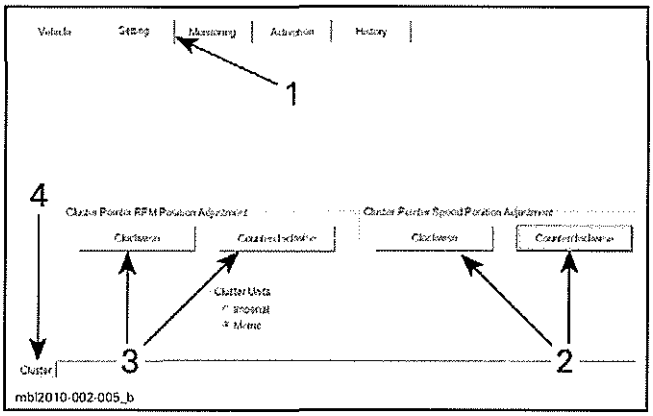
TYPICAL
1. Cluster Units field

NOTE: Speedometer, odometer and trip meter will have their units (kilometer or miles) changed all together.

Speedometer and Tachometer Pointer Adjustment

To set the pointers in B.U.D.S.

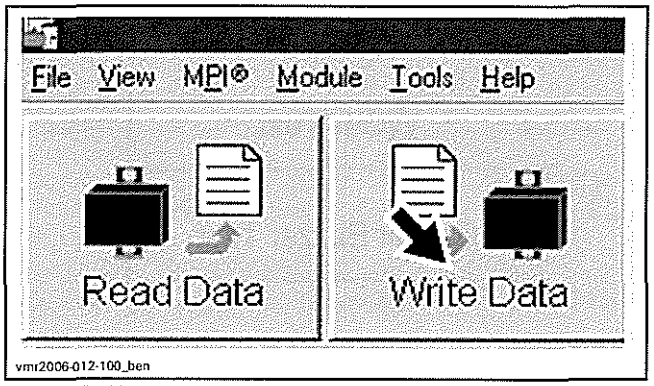
1. Provide power to the electrical system for testing. Refer to *LIGHTING AND ACCESSORIES SYSTEM TESTING* in the *TROUBLESHOOTING* topic at the beginning of this subsection for proper procedure.
2. Select the **Setting** tab.
3. At the bottom of the page, select the **Cluster** tab.
4. Ensure to be facing gauge to prevent parallax error.
5. Click on **Clockwise** or **Counterclockwise** button to align gauge pointer with the zero (0).



TYPICAL
1. *Setting tab*
2. *Speedometer pointer buttons*
3. *Tachometer pointer buttons*
4. *Cluster tab*

NOTE: Because of the fine tuning of the pointer, the button must be pressed several times before perceiving pointer movement.

6. Click on **Write Data** to save the new setting in the gauge.



WRITE DATA

Displaying "P" Codes (Premium Gauge Only)

1. To activate P CODE mode, push and hold the "M" button for 2 seconds.
2. As you hold the "M" button, quickly turn ON and OFF the high beams a few times. The gauge should enter P CODE mode.
3. While in P CODE mode, use the "M" or "S" button to scroll over available failure codes.
4. Push and hold the "M" button to exit P CODE mode.

A NO ACTIVE P CODE message is displayed if there are no P CODES in memory.

Gauge Self-Test

On **ECM wake-up**, the gauge will perform a self-test. All indications should come ON and gauge pointers will cycle once. You will have a few seconds to ensure the indications (LEDs and LCDs) are functioning correctly.

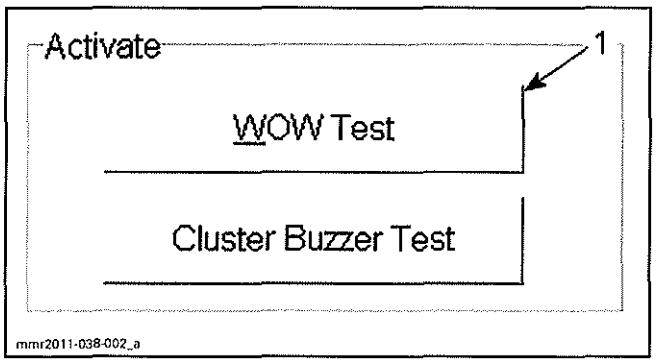
NOTE: This test only validates the gauge operation of the LEDs, LCDs in the gauge digital display and the pointers. It does not test the actual circuit functions related to each indication.

If the self test does not take place, proceed with the *GAUGE POWER INPUT TEST*.

Gauge Test With B.U.D.S.

The *GAUGE SELF TEST* can be duplicated using B.U.D.S.

1. Provide power to the electrical system for testing. Refer to *LIGHTING AND ACCESSORIES SYSTEM TESTING* in the *TROUBLESHOOTING* topic at the beginning of this subsection for proper procedure.
2. Choose the **Activation** tab.
3. At the bottom of the page, select the **Cluster** tab.
4. Select **WOW Test** in the **Activate** field.



TYPICAL
1. Select this button

Gauge Power Input Test (Main 12 Vdc)

If the gauge does not come on when the engine is started, carry out the following test.

1. Check fuse/relay as applicable. Refer to *POWER DISTRIBUTION* subsection.
2. Remove multifunction gauge.
3. Disconnect the gauge connector.
4. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Vdc.
5. Press on start button or install T-HARNESS (P/N 529 035 869) on diagnostic connector.
6. Measure voltage with the battery ground as per following table.

GAUGE POWER INPUT TEST		
PROBES		VOLTAGE
Gauge connector pin 8	Battery ground	Battery voltage

7. If gauge main power input test was as specified, carry out the gauge *GROUND CIRCUIT CONTINUITY TEST*.
8. If no voltage was read, test wiring continuity. Refer to *WIRING DIAGRAM* for details.

NOTE: On 600 HO E-TEC, the gauge receives its main power input directly from the primary 12 Vdc bus. There are no fuses or relays to test, only wiring and connectors.

Gauge Ground Circuit Continuity Test

1. Set multimeter to Ω.
2. Measure gauge ground wire for continuity as per following table.

GAUGE GROUND CIRCUIT CONTINUITY TEST		
PROBES		RESISTANCE
Gauge connector pin 11 (BK)	Battery ground	Close to 0 Ω

If ground test failed, check vehicle ground. Refer to *POWER DISTRIBUTION* subsection.

If gauge power input test and ground circuit continuity tests are good, replace gauge.

Clock 12 Vdc Input Test (Premium Gauge)

NOTE: The clock receives 12 Vdc from the battery in order to maintain correct time when the engine is not running.

If the clock resets when engine is stopped, carry out the following test.

1. Remove multifunction gauge.
2. Disconnect the gauge connector.
3. Set multimeter to Vdc.
4. Measure voltage as per following table.

CLOCK 12 VDC INPUT TEST		
PROBES		VOLTAGE
Gauge connector pin 9	Battery ground	Battery voltage

If no voltage is read, test input wire continuity. Refer to *WIRING DIAGRAM* for circuit details.

Gauge Beeper Test

600 ACE Models

NOTE: The following test assumes the reverse switch is functional.

1. Start engine.
2. Set shift lever to reverse.

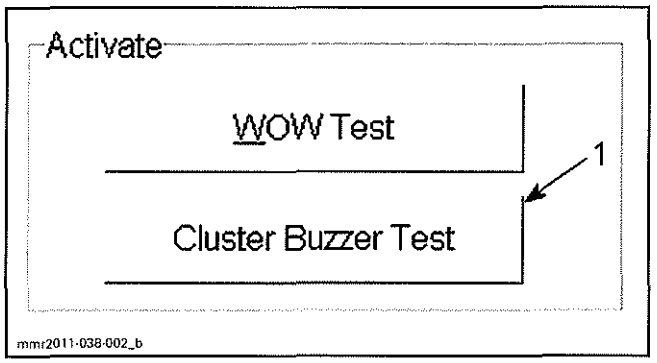
You should hear the beeper.

– If you do not hear the beeper, replace gauge.

600 HO E-TEC and 1200 4-TEC Models

To test beeper, perform the following test with B.U.D.S.

1. Provide power to the electrical system for testing. Refer to *LIGHTING AND ACCESSORIES SYSTEM TESTING* in the *TROUBLESHOOTING* topic at the beginning of this subsection for proper procedure.
2. Choose the **Activation** tab.
3. At the bottom of the page, select the **Cluster** tab.
4. Select **Cluster Buzzer Test** in the **Activate** field.



TYPICAL
1. Select this button

You should hear a few beeps.

– If you do not hear the beeper, replace gauge.

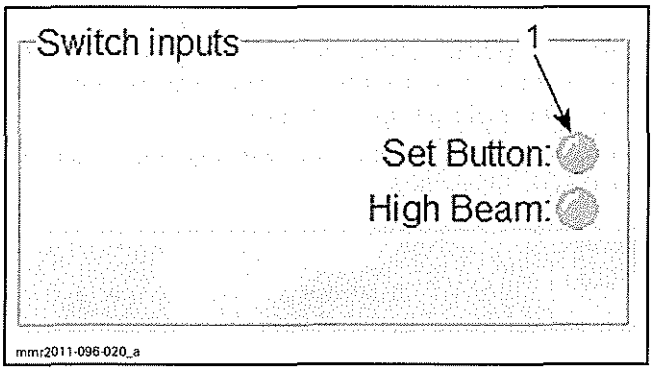
Gauge Button Test with B.U.D.S.

Using the B.U.D.S. software, select the **Monitoring** tab.

On the bottom of the page, choose the **Cluster** tab.

Standard Gauge

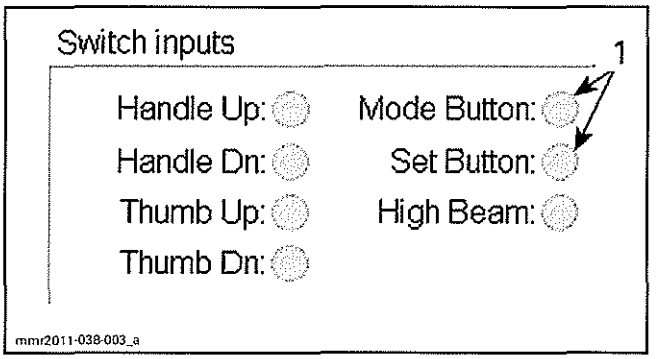
Press on the gauge "S" button and look for applicable indicator light in the **Switch inputs** field to turn green.



1. Indicator light

Premium Gauge

Alternately press on the gauge "M" and "S" buttons and look for applicable indicator light in the **Switch inputs** field to turn green.



1. Indicator lights

All Gauges

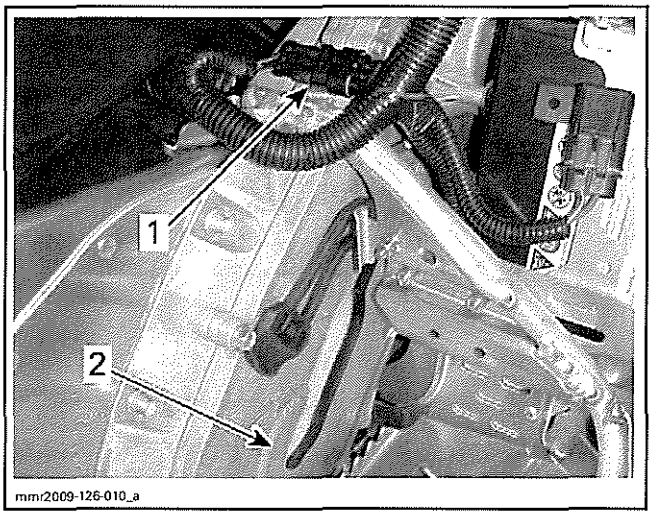
If the indicator light(s) come ON in B.U.D.S., the gauge button(s) is(are) functioning correctly.

If the indicator light(s) do not come ON, check button(s). If they are in good condition, replace gauge.

Gauge Speedometer Function Test

First ensure the gauge pointer is not stuck. Refer to *GAUGE TEST WITH B.U.D.S.* in this subsection.

1. Unplug speed sensor connector.



TYPICAL
1. Speed sensor connector
2. Speed sensor (inside cover)

2. Provide power to the electrical system for testing. Refer to *LIGHTING AND ACCESSORIES SYSTEM TESTING* in the *TROUBLESHOOTING* topic at the beginning of this subsection for proper procedure.
3. Use the FLUKE 115 MULTIMETER (P/N 529 035 868).
4. Set multimeter to Vdc.
5. Probe connector on vehicle harness side as per table.

600 E-TEC Models

GAUGE VOLTAGE TEST		
SPEED SENSOR CONNECTOR (MAIN HARNESS SIDE)		VOLTAGE
RD/BK	BK	Close to battery voltage
WH/GN	BK	Close to battery voltage

600 ACE Models

GAUGE VOLTAGE TEST		
SPEED SENSOR CONNECTOR (MAIN HARNESS SIDE)		VOLTAGE
VI/BK	RD/BK	Close to battery voltage
WH/GN	RD/BK	Close to battery voltage

1200 4-TEC Models

GAUGE VOLTAGE TEST		
SPEED SENSOR CONNECTOR (MAIN HARNESS SIDE)		VOLTAGE
GN/RD	BK	Close to battery voltage
WH/GN	BK	Close to battery voltage

If test succeeded, gauge is good, proceed with *SPEED SENSOR SIGNAL TEST*.

If test failed, check wiring harness going to gauge. If wiring harness is good, replace gauge.

Gauge Fuel Level Function Test

1. Unplug fuel level sensor connector.
2. Provide power to the electrical system for testing. Refer to *LIGHTING AND ACCESSORIES SYSTEM TESTING* in the *TROUBLESHOOTING* topic at the beginning of this subsection for proper procedure.
3. Use the FLUKE 115 MULTIMETER (P/N 529 035 868).
4. Set multimeter to Vdc.
5. Probe connector on vehicle harness side as per table.

600 E-TEC and 1200 4-TEC Models

GAUGE VOLTAGE TEST		
FUEL LEVEL SENSOR CONNECTOR (MAIN HARNESS SIDE)		VOLTAGE
BU	GN/BK	Approximately 5 V

600 ACE Models

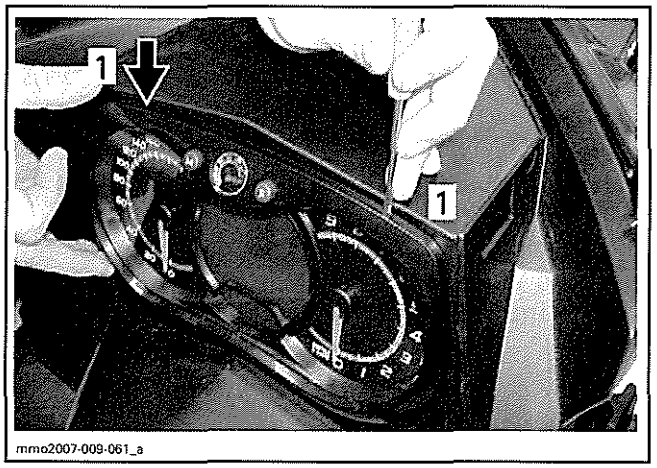
GAUGE VOLTAGE TEST		
FUEL LEVEL SENSOR CONNECTOR (MAIN HARNESS SIDE)		VOLTAGE
BU	RD/BK	Approximately 5 V

If test succeeded, gauge is good, proceed with *FUEL LEVEL SENSOR TEST* in *FUEL TANK AND FUEL PUMP* section.

If test failed, check wiring harness going to gauge. If wiring harness is good, replace gauge.

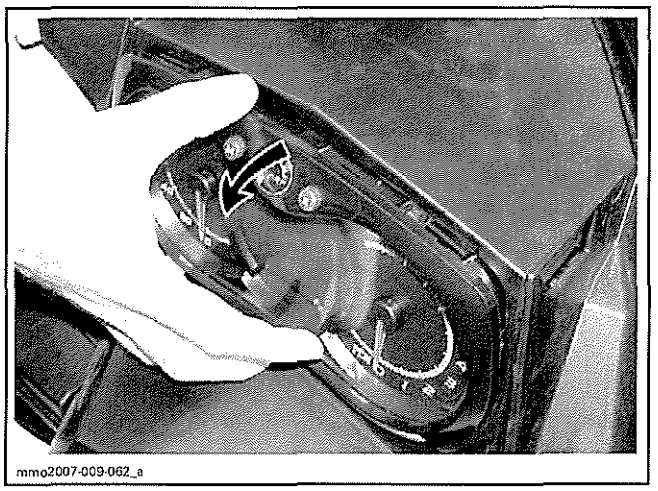
Gauge Removal

1. Insert a small screwdriver in one of the rectangular slots at top of gauge.
2. As you gently press down on the screwdriver to release multifunction gauge locking tab, pull out and hold gauge in position.
3. Insert screwdriver in second hole and press to release other tab.



TYPICAL
1. Locking tabs

4. Gently pull multifunction gauge from gauge support.



TYPICAL

5. Press on connector locking tab and pull connector off gauge.
6. Store gauge in a secure area to prevent it from being damaged.

Gauge Installation

1. Carefully align and install gauge connector, pressing it in until connector lock engages.
2. Insert bottom of gauge in gauge holder.
3. Press top of gauge in holder until you feel locking tabs engage in holder.
4. Start engine and test gauge functions.

NOTE: If a new gauge is installed, refer to *GAUGE TO ECM MATCHING*.

Gauge to ECM Matching

NOTE: If the gauge is replaced, the VIN (Vehicle Identification Number) and the vehicle model number must be entered in the gauge memory so they match those stored in the vehicle ECM.

600 E-TEC Models

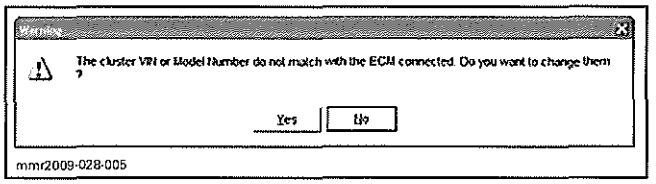
If the identification numbers stored in the gauge do not match those stored in the ECM, the new gauge will operate partially. The LCD display will remain blank and the D.E.S.S. LED will be turned ON.

600 ACE and 1200 4-TEC Models

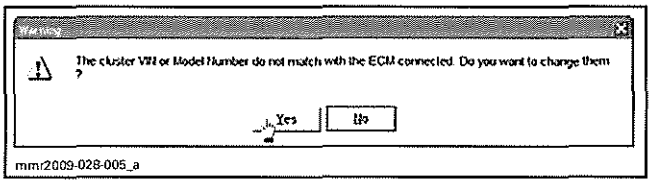
If the identification numbers stored in the gauge do not match those stored in the ECM, the gauge will operate normally however the ECM will send a message to B.U.D.S. through the diagnostic connector.

All Models

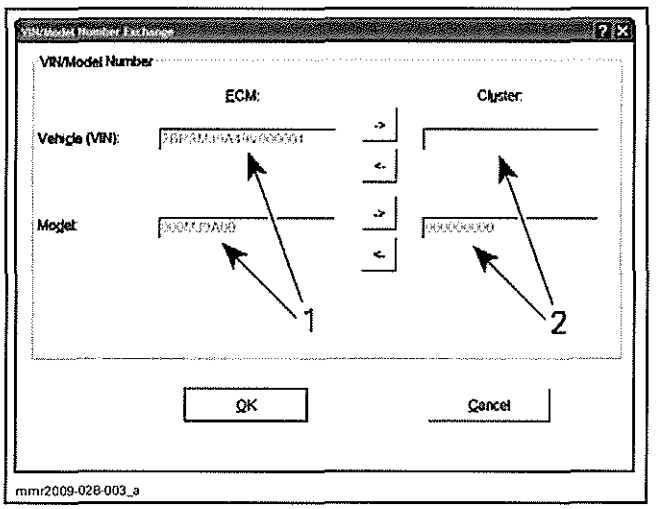
1. To write the VIN number and model number into the gauge, connect to the B.U.D.S. software version applicable to the vehicle. Refer to the *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. Follow the instructions in the referenced section and in the software.
3. Once connected and activated, select the **Read Data** button. You will see a message similar to the following illustration.



4. Select **Yes** in the displayed window.

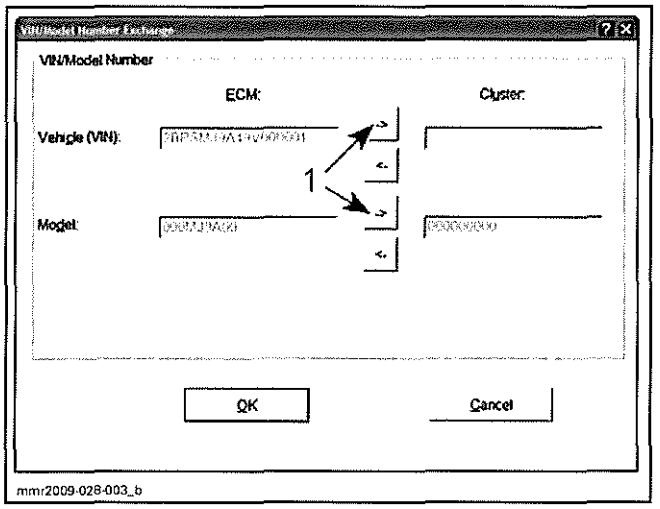


The following window illustrates that the VIN number or model number in the ECM and cluster are not the same.



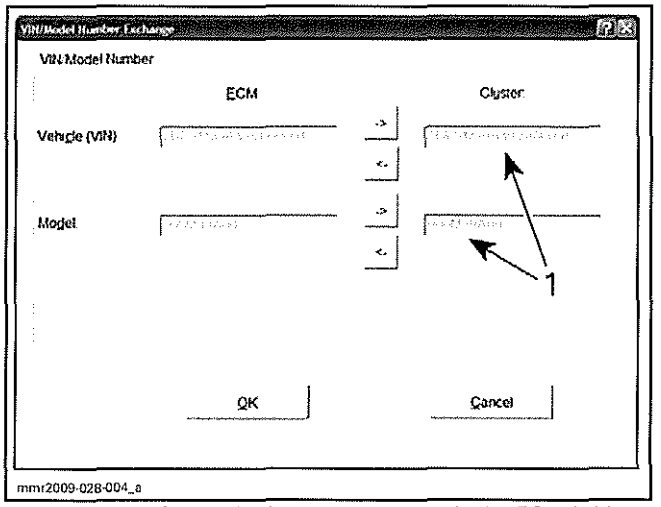
1. *Numbers stored in ECM*
2. *No numbers stored in new cluster*

5. Select each of the arrows indicated in the following illustration to copy the VIN and model numbers from the ECM to the cluster.



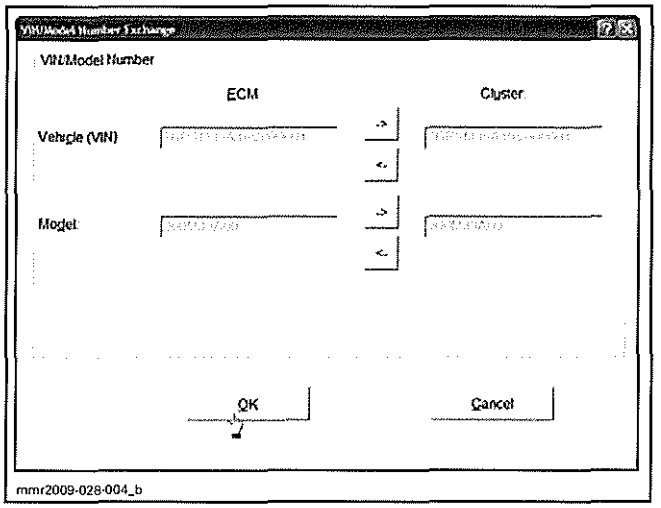
1. Select each arrow button indicated

Note how the numbers in the Cluster field now matches those in the ECM field.



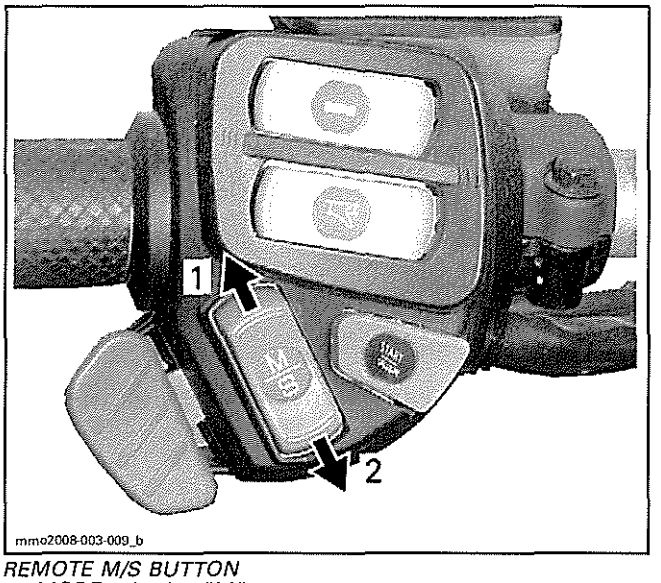
1. Numbers in Cluster field now match those in the ECM field

6. Select OK to continue.



7. Once the gauge has been matched to the ECM, you will need to set the units of measurement, imperial or metric (imperial is the default setting). See procedure in this section.
8. Ensure the gauge functions properly and that all settings and indications are within parameters.
9. Be sure to set the clock function according to gauge and vehicle type, refer to *CLOCK ACTIVATION (PREMIUM GAUGE)* in this subsection.
10. Shut down vehicle and disconnect the communication tools.

REMOTE MODE AND SET BUTTONS (PREMIUM GAUGE)



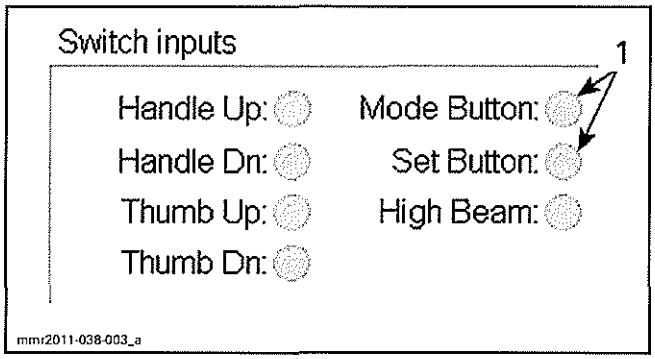
REMOTE M/S BUTTON
1. MODE selection "M"
2. SET selection "S"

Gauge Input Test with B.U.D.S.

Using the B.U.D.S. software, select the **Monitoring** tab.

On the bottom of the page, choose the **Cluster** tab.

Alternately press on the "M" and "S" and look for applicable indicator light in the **Switch inputs** field to turn green.



1. Indicator lights

If the indicator lights come ON in B.U.D.S., the remote M/S button is functioning correctly and the gauge receives the signals from the switches.

If the indicator lights do not come ON, carry out the *REMOTE M/S BUTTON CONTINUITY TEST* procedure in this section.

Remote Button Continuity Test

1. If using the M/S button does not affect the indication, try using the buttons on the gauge. If they function, the remote M/S button circuit may be open.
2. Using a multimeter set to Ω, carry out the following continuity test.

REMOTE M/S BUTTON TEST			
SWITCH SELECTION	SWITCH WIRE		RESISTANCE
Centered	YE/BN	BK	Infinite Ω
	YE/GN		
"M"	YE/BN	BK	Close to 0 Ω
"S"	YE/GN		

If you do obtain the values as specified, repair or replace switch, wiring and connections.

SPEED SENSOR

Speed Sensor Location

The speed sensor is mounted in the gearbox cover.

Speed Sensor Signal Test

First proceed with the *GAUGE SPEEDOMETER FUNCTION TEST* in this subsection.

1. Lift and support rear of vehicle.

⚠ CAUTION Use proper lifting techniques, notably using your leg force. Do not attempt to lift the vehicle if it is above your limits.

2. Ensure speed sensor connector is plugged.
3. Provide power to the electrical system for testing. Refer to *LIGHTING AND ACCESSORIES SYSTEM TESTING* in the *TROUBLESHOOTING* topic at the beginning of this subsection for proper procedure.
4. Rotate driven pulley so that tracks rotates slowly.
5. Back-probe connector with Fluke TP88 rigid back probe pins or equivalent, between wires as per table.

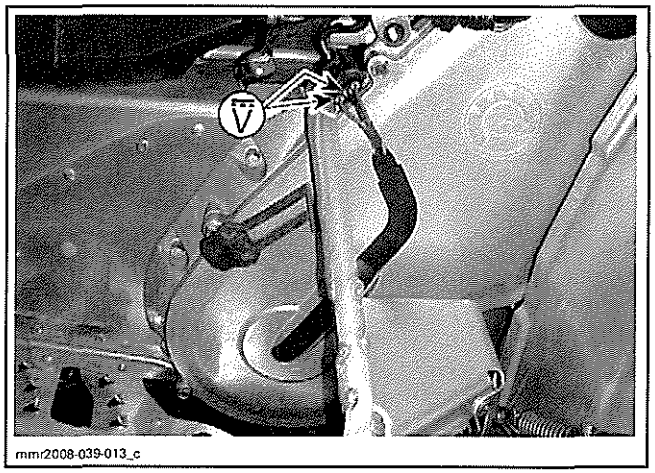
NOTICE Be careful not to damage connector seals when back probing.

600 HO E-TEC Models

SPEED SENSOR SIGNAL TEST			
ROTATE DRIVEN PULLEY	SPEED SENSOR CONNECTOR (SENSOR SIDE)		VOLTAGE
	WH/GN	RD/BK	Alternating voltage within 0 and 12 Vdc

600 ACE and 1200 4-TEC Models

SPEED SENSOR SIGNAL TEST			
ROTATE DRIVEN PULLEY	SPEED SENSOR CONNECTOR (SENSOR SIDE)		VOLTAGE
	WH/GN	BK	Alternating voltage within 0 and 12 Vdc



TYPICAL — SENSOR SIGNAL VOLTAGE TEST

The signal voltage should alternate as per specification.

If test failed, replace the speed sensor.

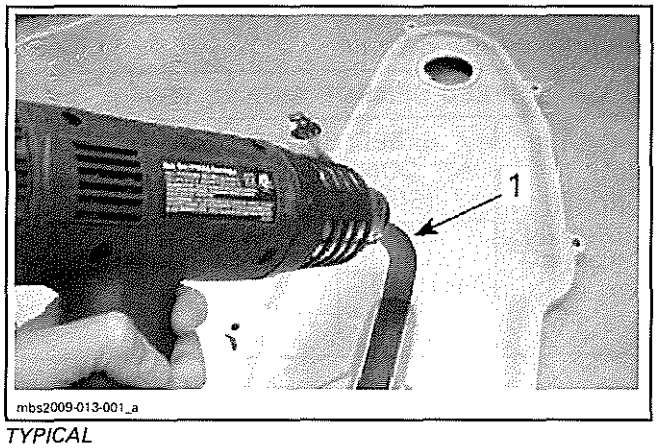
Speed Sensor Replacement

The sensor can be replaced with the gearbox cover as an assembly. In such a case, refer to *CHAINCASE* subsection.

To replace sensor only, proceed as follows.

Speed Sensor Removal

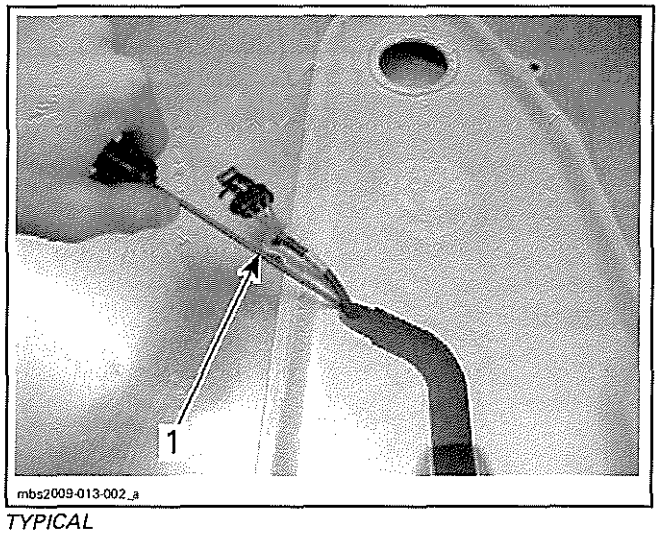
1. Remove gearbox cover, refer to *GEARBOX* subsection.
2. Using a heat gun, heat the speed sensor at plastic sheath end.



TYPICAL
1. Plastic sheath end

NOTE: Plastic sheath color will slightly change, which tells it is adequately heated.

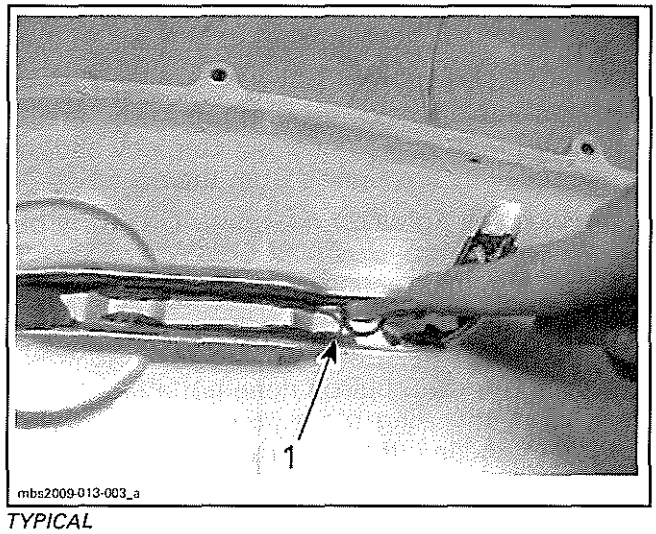
3. Use a flat screwdriver to pry out the end of the plastic sheath from gearbox cover.



TYPICAL
1. Prying out plastic sheath

NOTICE Use care when prying out the plastic sheath not to damage the gearbox cover.

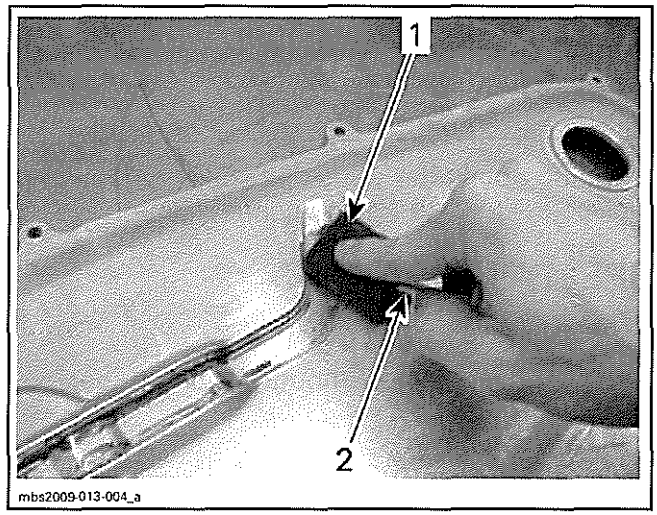
4. Heat the next section of the plastic sheath.
5. Pry out the heated section using the flat screwdriver.
6. Repeat steps 4 and 5 until the plastic sheath is completely removed.
7. Use the flat screwdriver to remove the remaining sealant from the gearbox cover.



TYPICAL
1. Remaining sealant

NOTICE Do not apply excessive pressure when removing the remaining sealant not to damage the gearbox cover.

8. Rub the sealant using a scouring pad.



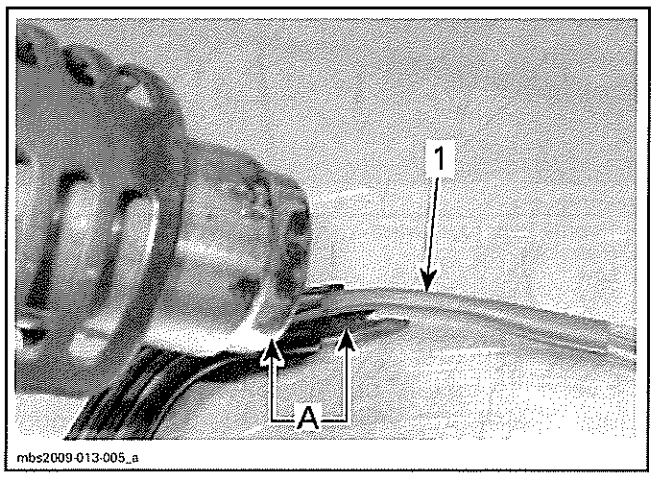
TYPICAL
1. Scouring pad
2. Flat screwdriver

Speed Sensor Installation

1. Thoroughly clean the surface where the speed sensor is to be stuck.

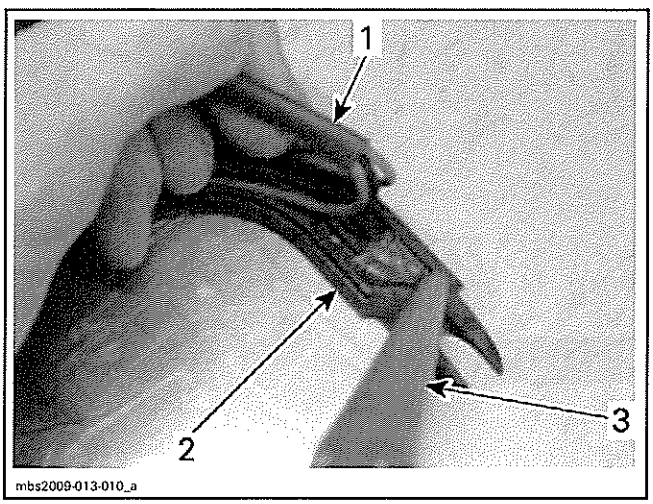
NOTE: Make sure surface is clean and free of grease.

2. Slide the shrink tubing into sensor plastic housing. The end of tubing must be inside sensor plastic housing about 15 mm (19/32 in).



TYPICAL
1. Shrink tubing
A. 15 mm (19/32 in)

3. Apply LOCTITE 5900 (P/N 293 800 066) under the sensor wires, between the end of the guide grooves and the plastic sheath extremity.

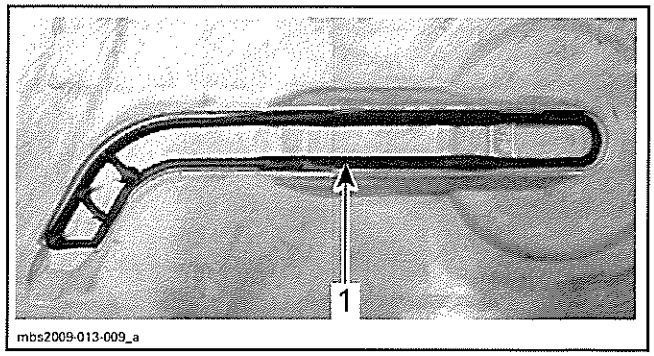


TYPICAL
1. Sensor wires
2. Plastic sheath extremity
3. Loctite 5900 (P/N 293 800 066) bottle tip

NOTE: The assembly must be watertight.

4. Apply LOCTITE 5900 (P/N 293 800 066) all around the plastic sheath location on the gearbox cover.

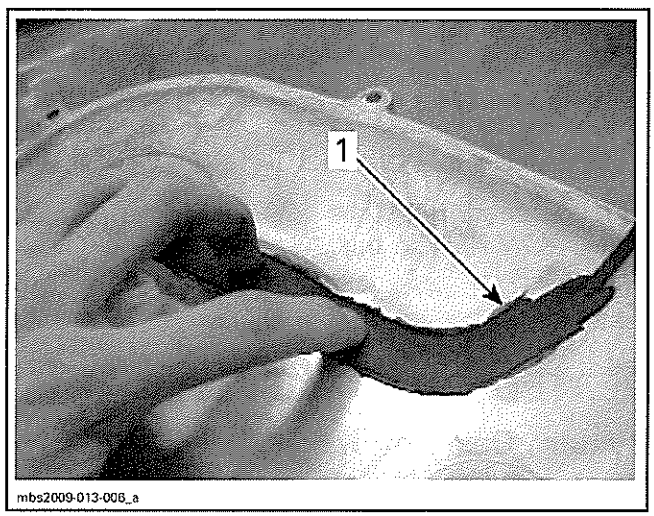
Follow the pattern shown on the next picture.



TYPICAL
1. Loctite 5900 (P/N 293 800 066)

NOTE: Make sure the plastic sheath circumference is well covered.

5. Place the plastic sheath in position and firmly push in order to evacuate all the surplus sealant. Keep pressure for at least 1 minute.

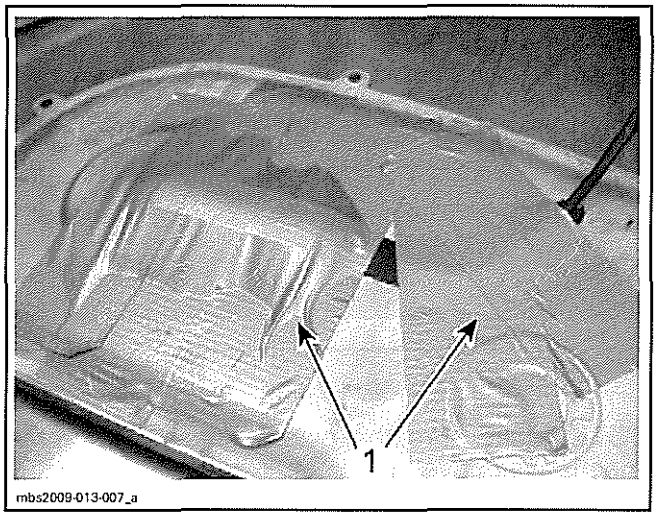


TYPICAL
1. Surplus sealant

6. Wipe off all the sealant surplus around the plastic sheath.
7. Once cleaned up, inspect all the circumference for sealant lacks.

NOTE: Sealant must be visible all around.

8. Place some adhesive tape on the sensor to maintain a pressure on the sensor for at least 24 hours.



TYPICAL
1. Adhesive tape

NOTE: Wait for at least 1 hour before exposing vehicle to cold temperature.

9. Reinstall gearbox cover, refer to *GEARBOX* subsection.

FUEL LEVEL SENSOR

First proceed with the *GAUGE FUEL LEVEL FUNCTION TEST* in this subsection.

Refer to *FUEL TANK AND FUEL PUMP* for sensor test.

HEATED THROTTLE LEVER

System Description

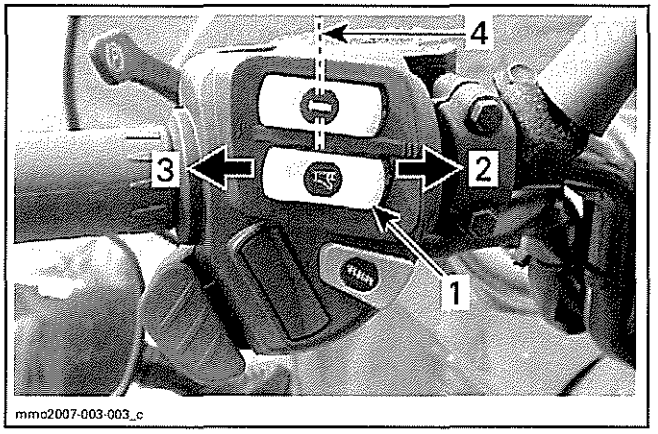
There are two types of throttle lever heating systems used.

The type of system used is determined by the gauge package installed at the factory, standard gauge or premium gauge.

Models with Standard Gauge

On vehicles equipped with a "Standard" gauge, the throttle lever heater is controlled by a toggle switch on the LH multifunction switch.

The switch allows you to select **High**, center (**Off**), and **Low** heat settings. The switch button will remain in the selected position until another selection is made.



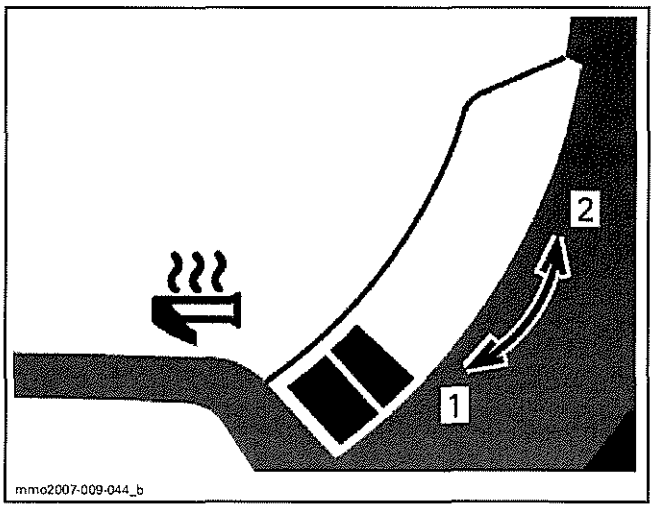
1. Throttle lever heat switch
2. High
3. Low
4. Heat OFF (center position)

Models with Premium Gauge

On vehicles factory equipped with a "Premium" gauge, the throttle lever heat is controlled through the gauge.

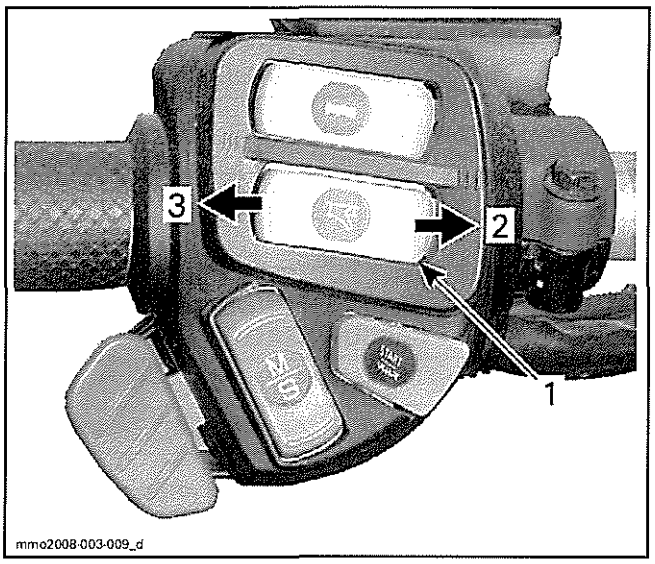
NOTE: The heated throttle lever will not be powered until the engine runs at least 2000 RPM.

A three position switch on the LH multifunction switch assembly allows selection of 9 heat levels, which are displayed in the indicator.



THROTTLE LEVER HEAT INDICATOR
1. Decrease heat
2. Increase heat

The switch selection sends a signal to the premium gauge to increase or decrease heat.



1. Throttle lever heat switch
2. Increase heat
3. Decrease heat

The gauge then applies the appropriate amount of current to the heater according to the selection.

To turn OFF the heaters, select heat down until there is no more indication on the bar graph.

When released, the switch springs back to the center neutral position.

Throttle Lever Heat Switch Test (Standard Gauge)

Using the FLUKE 115 MULTIMETER (P/N 529 035 868), select the Ω position.

Test throttle lever switch and circuits as per table.

600 HO E-TEC Models

THROTTLE LEVER SWITCH TEST STANDARD GAUGE			
INTENSITY	SWITCH WIRE		RESISTANCE
HIGH	OR/RD	OR	Close to 0 Ω
		OR/VI	Infinite (OL)
LOW	OR/RD	OR	Infinite (OL)
		OR/VI	Close to 0 Ω

600 ACE Models

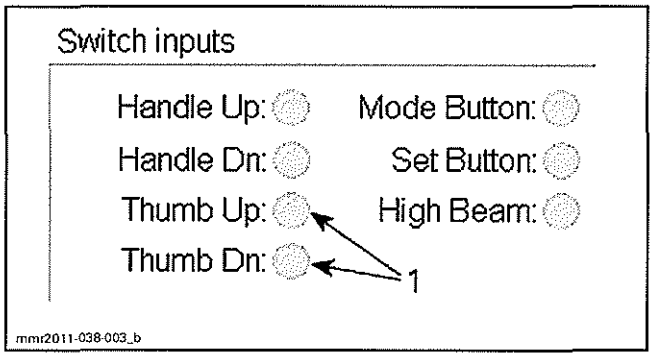
THROTTLE LEVER SWITCH TEST STANDARD GAUGE			
INTENSITY	SWITCH WIRE		RESISTANCE
HIGH	OR/RD	BN	Close to 0 Ω
		BN/VI	Infinite (OL)
LOW	OR/RD	BN	Infinite (OL)
		BN/VI	Close to 0 Ω

If continuity test is as per specification, proceed with *THROTTLE LEVER HEATING ELEMENT TEST* in this section.

If continuity test is out of specification, check switch circuit. If good, replace switch.

Gauge Input Test with B.U.D.S. (Premium Gauge)

1. Using the B.U.D.S. software, select the **Monitoring** tab.
2. On the lower LH side of the page, choose the **Cluster** tab.
3. Press on the vehicle thumb lever heat switch to alternately increase or decrease heat.
4. In B.U.D.S., look for the applicable indicator light in the **Switch inputs** field to turn GREEN (Thumb Up or Thumb Dn).



1. Throttle lever heat selection

If test is good, proceed with *GAUGE HEATER OUTPUT TEST WITH B.U.D.S. (PREMIUM GAUGE)* in this subsection.

If test failed, proceed with *THROTTLE LEVER HEAT SWITCH TEST (PREMIUM GAUGE)* in this subsection.

Throttle Lever Heat Switch Test (Premium Gauge)

Using the FLUKE 115 MULTIMETER (P/N 529 035 868), select the Ω position.

Test throttle lever switch and circuits as per table.

600 HO E-TEC Models

THROTTLE LEVER SWITCH TEST PREMIUM GAUGE			
INTENSITY	SWITCH WIRE		RESISTANCE
HIGH	BK	BR	Close to 0 Ω
		BR/YE	Infinite (OL)
LOW	BK	BR	Infinite (OL)
		BR/YE	Close to 0 Ω

1200 4-TEC Models

THROTTLE LEVER SWITCH TEST PREMIUM GAUGE			
INTENSITY	SWITCH WIRE		RESISTANCE
HIGH	BK	BN	Close to 0 Ω
		YE/BN	Infinite (OL)
LOW	BK	BN	Infinite (OL)
		YE/BN	Close to 0 Ω

If tests are good, switch is functioning properly. Check the gauge heater output. Refer to *GAUGE HEATER OUTPUT TEST WITH B.U.D.S. (PREMIUM GAUGE)* in this subsection.

If continuity test failed, check switch circuit. If good, replace switch.

Gauge Heater Output Test with B.U.D.S. (Premium Gauge)

1. Using the B.U.D.S. software, select the **Activation** tab.
2. On the lower LH side of the page, choose the **Cluster** tab.
3. In B.U.D.S., select the **ON** button next to **Thumb**
4. If test is good, the gauge output to throttle lever heater is good. Proceed with *THROTTLE LEVER HEATING ELEMENT TEST* in this subsection.
5. If the test failed, replace the gauge.

NOTE: When finished testing, ensure to select the **OFF** button next to **Thumb** in B.U.D.S.

Throttle Lever Heating Element Test

1. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Ω.
2. Carry out a resistance check of the heating elements as follows.

THROTTLE LEVER HEATER TEST STANDARD GAUGE			
INTENSITY	HEATER WIRE		RESISTANCE @ 20°C (68°F)
LOW	OR/WH	BK	5.7 to 18.5 Ω
HIGH	OR		1.7 to 4.2 Ω

THROTTLE LEVER HEATER TEST PREMIUM GAUGE		
HEATER WIRE		RESISTANCE @ 20°C (68°F)
OR/WH	BK	1.7 to 4.2 Ω

3. If readings are out of specifications, replace throttle lever.
4. If heating element readings are within specifications, check wiring and connections.
5. Reconnect connectors.

HEATED HANDLEBAR GRIPS

System Description

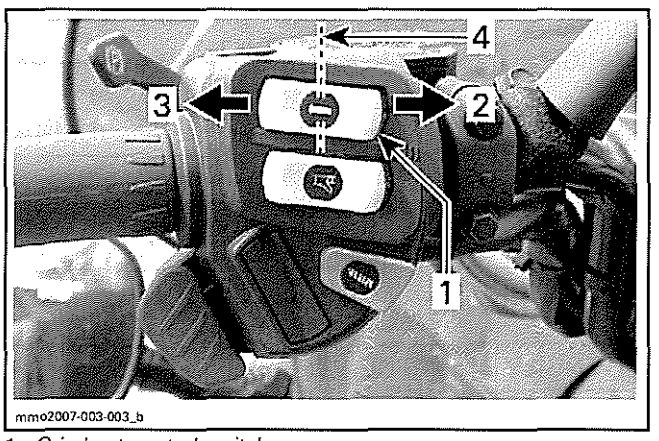
There are two types of grip heating systems.

The type of system used is determined by the gauge package installed at the factory, standard gauge or premium gauge.

Models with Standard Gauge

On vehicles equipped with a "Standard" gauge, the grip heater is controlled by a toggle switch on the LH multifunction switch.

The switch allows you to select **High**, center (**Off**), and **Low** heat settings. The switch button will remain in the selected position until another selection is made.



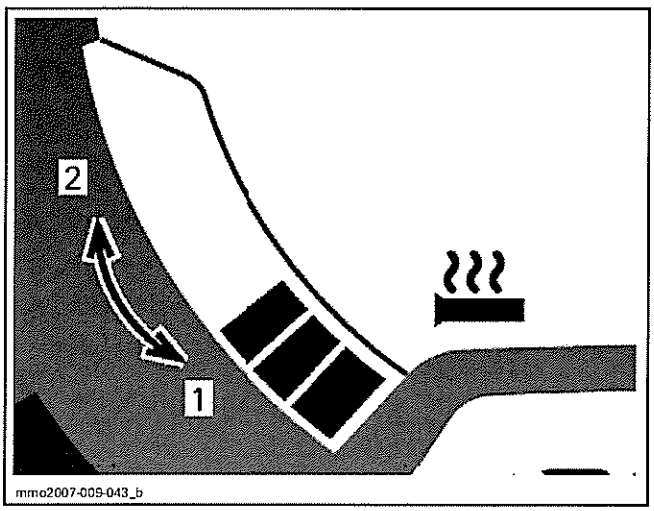
1. *Grip heat control switch*
2. *High*
3. *Low*
4. *Heat OFF (center position)*

Models with Premium Gauge

On vehicles factory equipped with a "Premium" gauge, the grip heat is controlled through the gauge.

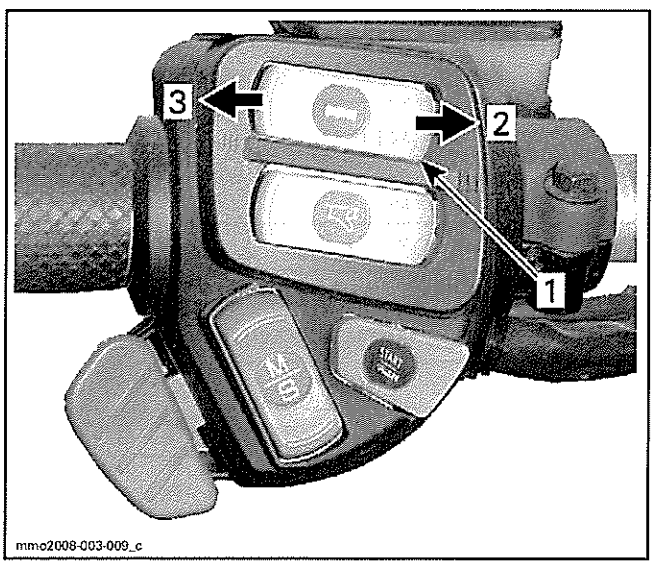
NOTE: The heated hand grips will not be powered until the engine runs at 2000 RPM or above.

A three position switch on the LH multifunction switch assembly allows selection of 9 heat levels, which are displayed in the indicator.



1. Decrease heat
2. Increase heat

The switch selection sends a signal to the premium gauge to increase or decrease heat.



1. Grip heat control switch
2. Increase heat
3. Decrease heat

The gauge then applies the appropriate amount of current to the heater according to the selection.

To turn OFF the heaters, select heat down until there is no more indication on the bar graph.

When released, the switch springs back to the center neutral position.

Handlebar Grip Heat Switch Test (Standard Gauge)

Using the FLUKE 115 MULTIMETER (P/N 529 035 868), select the Ω position.

Test handlebar grip switch and circuits as per table.

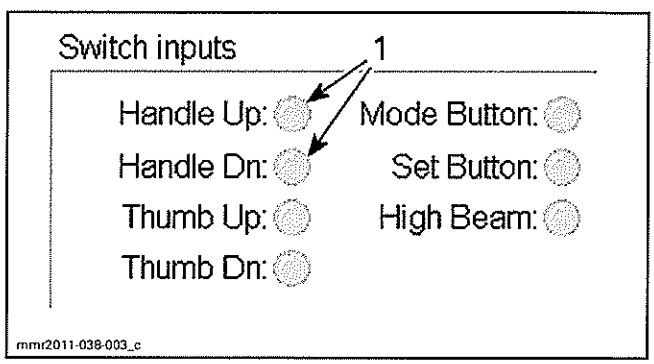
HANDLEBAR GRIP SWITCH TEST STANDARD GAUGE			
INTENSITY	SWITCH WIRE		RESISTANCE
HIGH	OR/RD	OR	Close to 0 Ω
		OR/VI	Infinite (OL)
LOW	OR/RD	OR	Infinite (OL)
		OR/VI	Close to 0 Ω

If continuity test is as per specification, proceed with *HANDLEBAR GRIP HEATING ELEMENT TEST* in this section.

If continuity test is out of specification, check switch circuit. If good, replace switch.

Gauge Input Test with B.U.D.S. (Premium Gauge)

1. Using the B.U.D.S. software, select the **Monitoring** tab.
2. On the lower LH side of the page, choose the **Cluster** tab.
3. Press on the vehicle handle grip heat switch to alternately increase or decrease heat.
4. In B.U.D.S., look for the applicable indicator light in the **Switch inputs** field to turn GREEN (Handle Up or Handle Dn).



1. Handle grip heat selection

If test is good, proceed with *GAUGE HEATER OUTPUT TEST WITH B.U.D.S. (PREMIUM GAUGE)* in this subsection.

If test failed, proceed with *HANDLEBAR GRIP HEAT SWITCH TEST (PREMIUM GAUGE)* in this subsection.

Handlebar Grip Heat Switch Test (Premium Gauge)

Using the FLUKE 115 MULTIMETER (P/N 529 035 868), select the Ω position.

Test handlebar grip switch circuits as per table.

HANDLEBAR GRIP SWITCH TEST PREMIUM GAUGE			
INTENSITY	SWITCH WIRE		RESISTANCE
HIGH	BK	OR/WH	Close to 0 Ω
		OR/VI	Infinite (OL)
LOW	BK	OR/WH	Infinite (OL)
		OR/VI	Close to 0 Ω

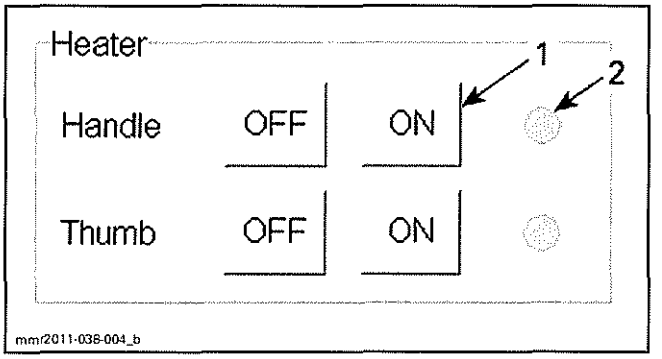
If continuity tests are as per specifications, switch is functioning properly. Check the gauge heater output. Refer to *GAUGE HEATER OUTPUT TEST WITH B.U.D.S. (PREMIUM GAUGE)* in this subsection.

If continuity test is out of specification, check switch circuit. If good, replace switch.

- If test of wiring and connections was good, replace switch.
- If test failed, repair or replace wiring or connections.

Gauge Heater Output Test with B.U.D.S. (Premium Gauge)

1. Using the B.U.D.S. software, select the Activation tab.
2. On the lower LH side of the page, choose the Cluster tab.
3. In B.U.D.S., select the ON button next to Handle
4. Look for the indicator light next to the ON button to turn GREEN.



1. *Hand grip heat selection*
2. *Indicator light should turn GREEN*

5. If test is good, the gauge heater to handlebar grip heater is good. Proceed with *HANDLEBAR GRIP HEATING ELEMENT TEST* in this subsection.
6. If the test failed, replace the gauge.

NOTE: When finished testing, ensure to select the OFF button next to Handle in B.U.D.S.

Grip Heating Element Test

If you cannot feel the temperature increase of a hand grip heating element, carry out the following.

1. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Ω.
2. Test heating elements on either side as per following specifications.

Adhesive Film Heaters on Steel Handlebar (painted)

HANDLEBAR GRIP HEATING ELEMENT TEST VEHICLES WITH STANDARD GAUGE			
INTENSITY	HEATER WIRE		RESISTANCE @ 20°C (68°F)
LOW	OR/VI	BK	17 to 21 Ω
HIGH	OR	BK	8.5 to 10.5 Ω

HANDLEBAR GRIP HEATING ELEMENT TEST VEHICLES WITH PREMIUM GAUGE		
HEATER WIRE		RESISTANCE @ 20°C (68°F)
OR/WH	BK	8.5 to 10.5 Ω

3. If readings are out of specifications, replace applicable handle grip heating element.

If heating element readings are within specifications, check wiring and connections.

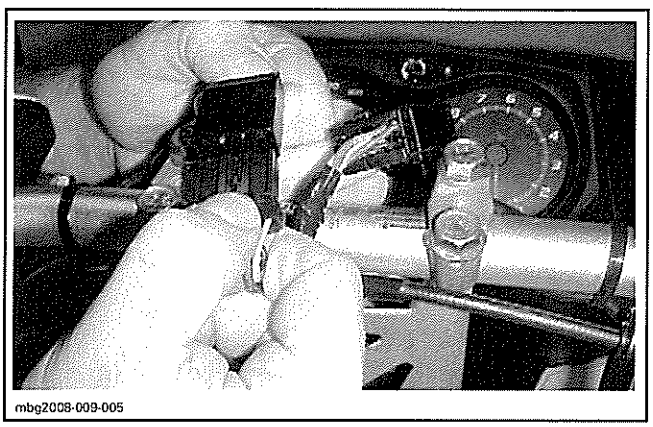
4. Reconnect connectors.

Grip Heater Element Removal

NOTICE Heater wire routing may vary significantly due to different type handlebars and vehicles. Its highly important to take note of exact positioning of grip heaters, locking ties, and wire routing before removing them from the handle bars. Failure to properly route wires may lead to equipment damage or failure.

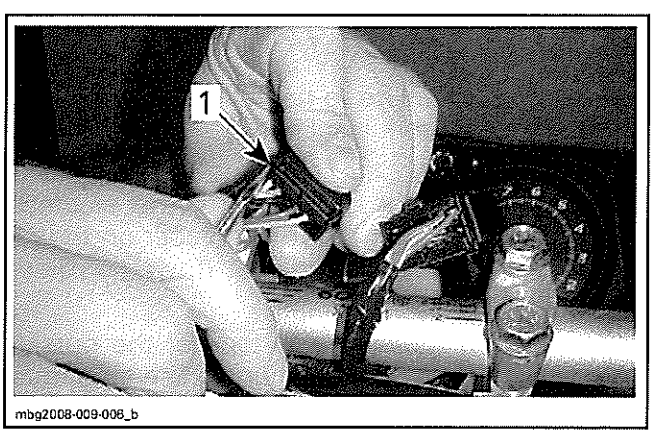
Models with Adhesive Film Heaters

1. Remove the following items as applicable, refer to *STEERING SYSTEM* section for details.
   - Steering cover
   - Rubber hand grip
   - Multifunction switch cover.
2. Disconnect the LH or RH steering connectors under the steering cover.



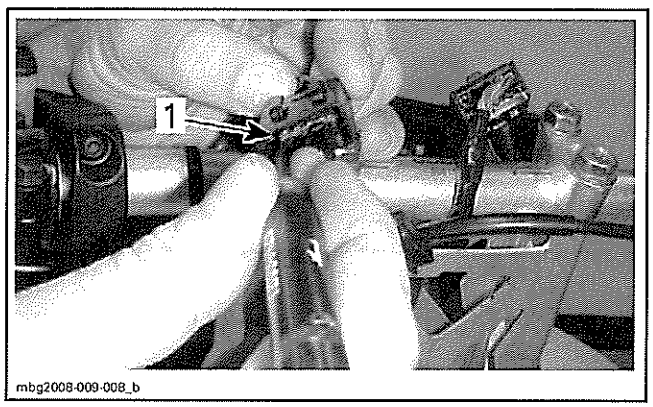
TYPICAL - STEERING CONNECTORS

3. Open the cover on the back of the connector housing using a small screwdriver or a suitable tool.



TYPICAL
1. Connector housing cover locks (one each side)

4. Using an appropriate tool such as the MULTILOCK - TERMINAL EXTRACTION TOOL (P/N 755430-2), unlock the heater wire terminals and push them out of the connector housing.



TYPICAL - UNLOCKING CONNECTOR PIN (FRONT SIDE)
1. Pin removal tool inserted above pin

NOTE: Terminals are unlocked and pushed out from the front (pin side) of the connector housing.

Standard Gauge Models

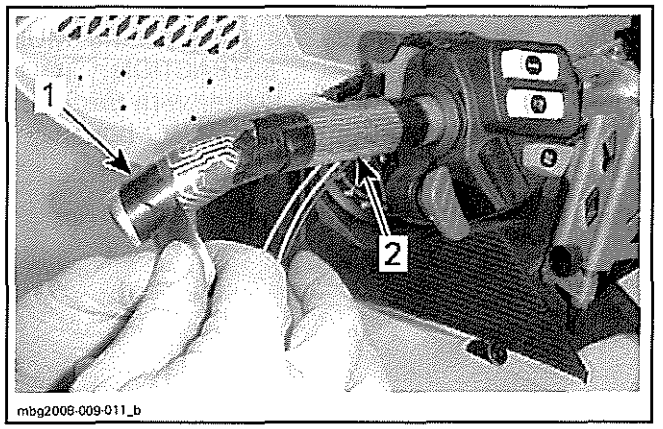
HEATER TERMINALS (HANDLEBAR CONNECTOR)	
HIGH	OR
LOW	OR/VI
GROUND	BK

Premium Gauge Models

HEATER TERMINALS (HANDLEBAR CONNECTOR)	
SUPPLY	OR/WH
GROUND	BK

NOTICE Be sure to take note of exact positioning of grip heaters, locking ties, and wire routing before removing them from the handlebar.

5. Cut locking ties securing heater wires to handlebar.
6. Pull wires from harness protective sheath, multifunction switch housing or throttle lever housing.
7. Cut and remove BLACK electrical tape from heater element and remove heater from cork insulator.



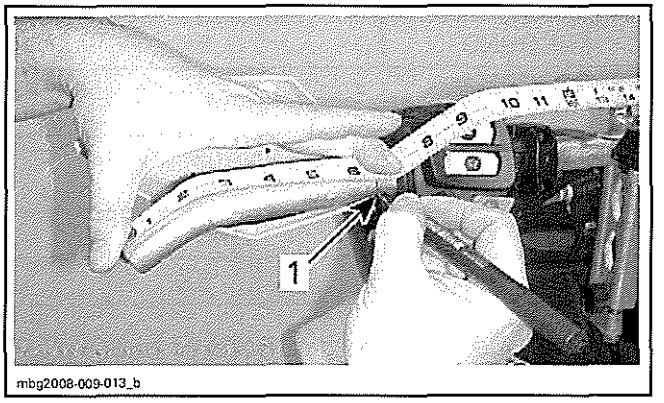
TYPICAL - LH HEATER
1. *Electrical tape*
2. *Heater element*

8. If damaged, remove cork insulator from handle bar and clean all adhesive residue from the handlebar.

Grip Heater Element Installation

Models with Adhesive Film Heaters

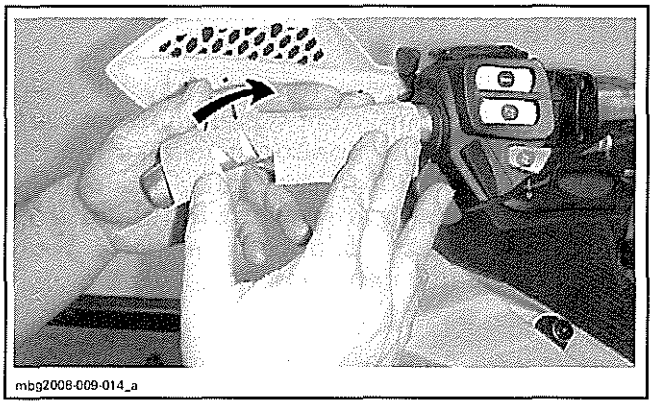
1. Measure specified distance from the end of the handlebar, and across the top of the bend in the bar (if applicable). Trace a reference line with a marker at that point on the handle bar as shown.



TYPICAL
1. *Trace reference line*

HANDLEBAR TYPE	REFERENCE LINE DISTANCE
STEEL	135 mm (5.3 in)

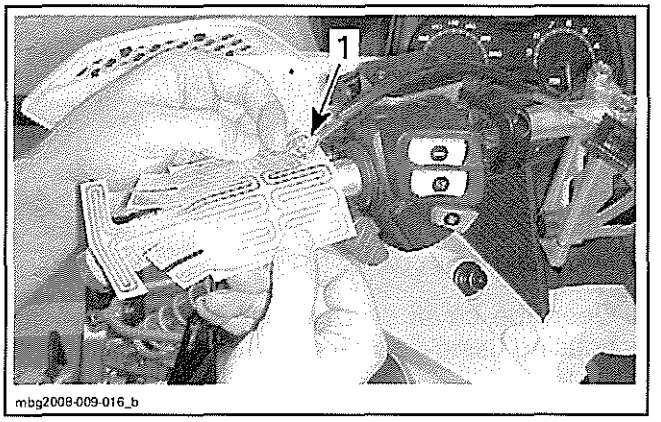
2. Align the edge of the cork insulator with the reference line centered with the handlebar folding axis as illustrated. The ends should meet to form the joint under the handlebar.



TYPICAL

3. Apply firm pressure to cork insulator to assure proper adherence to handlebar.
4. Install the film heater element on the cork insulator and center of handlebar folding axis as per following table.

HANDLEBAR TYPE	HEATER ALIGNMENT
STEEL	At 2.5 mm (3/32 in) of the inside edge of insulator

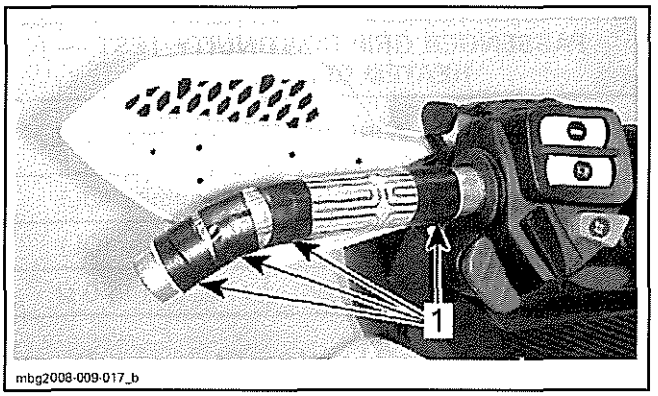


TYPICAL
1. *Heater wire position (LH front, RH rear)*

5. Apply firm pressure to heater to assure proper adherence to cork insulator.

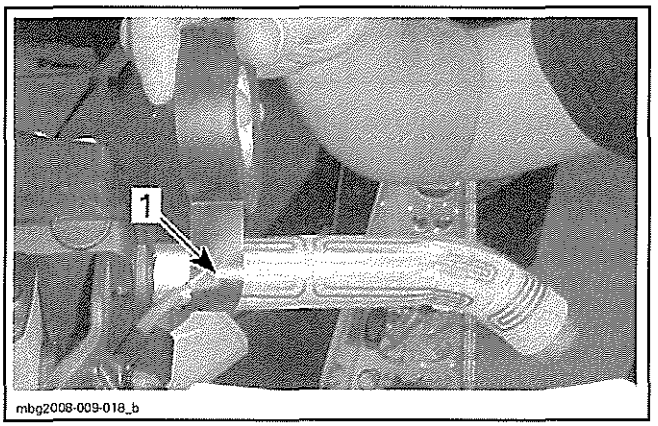
NOTE: The same heater element is used for both the LH and RH sides. Therefore, the electrical wiring will be in front of the handlebar on the LH side, and behind the handlebar (towards driver) on the RH side.

6. On steel handlebar, apply tape at the outside and inside ends (two locations). The tape must cover the edges of the heater element and welds to prevent snagging and damage to the element during rubber grip installation.



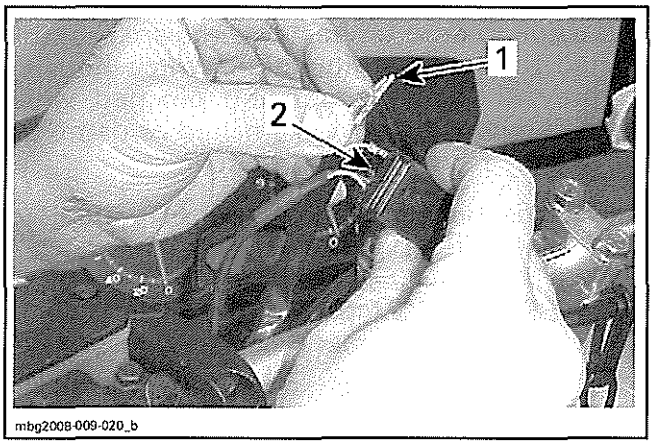
TYPICAL
1. Electrical tape application

NOTE: It is highly important to apply tape so that it fully secures the electrical wire connections and covers welds. This will ease installation of the rubber hand grip and prevent undue stress to the connections.



TYPICAL - IMPORTANT
1. Tape application over wire connections

7. Install rubber hand grip, refer to *STEERING SYSTEM* section for detail.
8. Route wiring as noted during the removal procedure.
9. Insert wire connectors in steering connector housing.



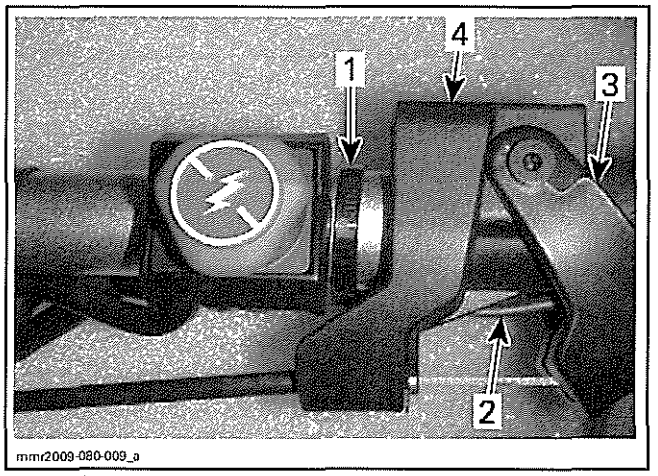
TYPICAL
1. Heater wire terminals
2. Insertion through back of connector

NOTE: On vehicles equipped with a premium gauge, only two of the heater wires are used. The ORANGE/VIOLET wire terminal will need to be cut off near the connector, insulated using heat shrink, a terminal end or electrical tape, then stored inside the wire harness protective sheath.

10. Install locking ties to secure the heater wire tightly against the handlebar.

⚠ WARNING

To ensure RH heater wires does not prevent smooth operation of throttle lever, it must be passed straight through the housing without any slack, and secured with a locking tie immediately after the lever housing.



TYPICAL
1. Locking tie
2. Heater wire straight through throttle lever housing
3. Throttle lever
4. Lever housing

NOTICE Ensure LH heater wires are properly routed through multifunction switch housing to prevent them from being pinched when installing housing cover. Pinched or damaged wires may result in a short circuit.

11. Provide power to the electrical system for testing. Refer to *LIGHTING AND ACCESSORIES SYSTEM TESTING* in the *TROUBLESHOOTING* topic at the beginning of this subsection for proper procedure.
12. Using the hand grip heat switch, turn on the hand grip heaters and ensure they are functioning correctly.

PASSENGER HEATED GRIPS

System Description

The grip heater is controlled by a toggle switch (OFF-Low-High).

Passenger Grip Voltage Input Test

1. Refer to *BODY* and remove passenger seat.
2. Locate the tail light connector.
3. Set FLUKE 115 MULTIMETER (P/N 529 035 868) to Vdc.
4. Provide power to the electrical system for testing. Refer to *LIGHTING AND ACCESSORIES SYSTEM TESTING* in the *TROUBLESHOOTING* topic at the beginning of this subsection for proper procedure.
5. Back probe connector and read voltage as follows:

PASSENGER GRIP VOLTAGE INPUT TEST			
SWITCH POSITION	PROBES		VOLTAGE
LOW	OR/VI	BK	Battery voltage
HIGH	OR		

Reading should be battery voltage. If no voltage is read, refer to *WIRING DIAGRAM* and check switch, ground and supply circuits independently. Repair open circuit or replace switch as needed.

PASSENGER GRIP CONTINUITY TEST — HEATED GRIP SWITCH			
SWITCH POSITION	WIRE		RESISTANCE
LOW	YE/RD	OR/VI	Close to 0 Ω

PASSENGER GRIP CONTINUITY TEST — HEATED GRIP SWITCH			
SWITCH POSITION	WIRE		RESISTANCE
OFF	YE/RD	OR/VI	Infinite (OL)
OFF	YE/RD	OR	Infinite (OL)
HIGH	YE/RD	OR	Close to 0 Ω

Passenger Grip Heating Element Test

1. Set multimeter to Ω.
2. Test heating element as per following specifications.

PASSENGER GRIP HEATING ELEMENT TEST			
INTENSITY	HEATER WIRE		RESISTANCE @ 20°C (68°F)
LOW	OR/VI	BK	17 to 21 Ω
HIGH	OR		8.5 to 10.5 Ω

If heating element readings are not within specifications, replace heating element.

If heating element readings are within specifications, carry out *PASSENGER GRIPS VOLTAGE INPUT TEST.*

12-VOLT POWER OUTLET

12-Volt Power Outlet Test

First try another accessory, if it does not function, test outlet as follows:

1. Disconnect both power outlet connectors.
2. Provide power to the electrical system for testing. Refer to *LIGHTING AND ACCESSORIES SYSTEM TESTING* in the *TROUBLESHOOTING* topic at the beginning of this subsection for proper procedure.
3. Set the FLUKE 115 MULTIMETER (P/N 529 035 868)
4. Measure the voltage as follows.

FRONT 12-VOLT POWER OUTLET TEST		
WIRES		VOLTAGE
YE/RD	BK	Battery voltage

Expedition SE 1200 4-TEC

REAR 12-VOLT POWER OUTLET TEST		
WIRES		VOLTAGE
RD/BK	BK	Battery voltage

If voltage reading is good, replace 12 volt power outlet.

If no voltage is read, refer to *WIRING DIAGRAM* and check ground and supply circuits independently. Repair open circuit as needed.

Expedition SE 1200 4-TEC

For the REAR 12V power outlet on this model, test first its switch according to this table.

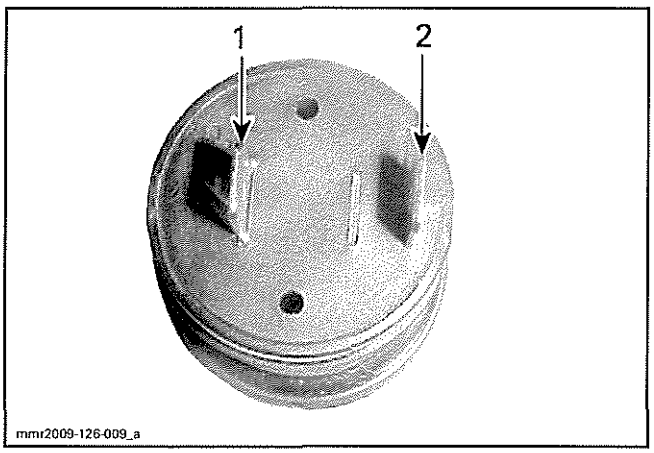
REAR 12-VOLT POWER OUTLET SWITCH TEST		
SWITCH POSITION	WIRE	RESISTANCE
OFF	RD/BK	Infinite (OL)
ON		Close to 0 Ω

If switch is good, refer to *WIRING DIAGRAM* and check ground and supply circuits independently. Repair open circuit as needed.

12-Volt Power Outlet Installation

1. Connect both connectors.

NOTE: Respect polarities. The negative terminal is located closest to the power outlet edge.



1. Positive terminal
2. Negative terminal (closer to the edge)

DRIVE BELT

SERVICE TOOLS

Description	Part Number	Page
DRIVEN PULLEY OPENING TOOL	529 017 200	690

GENERAL

APPLICATION CHART

ENGINE	DRIVE BELT
600 HO E-TEC	(P/N 417 300 383)
600 ACE	(P/N 414 860 700)
1200 4-TEC	(P/N 417 300 377)

PROCEDURES

DRIVE BELT GUARD

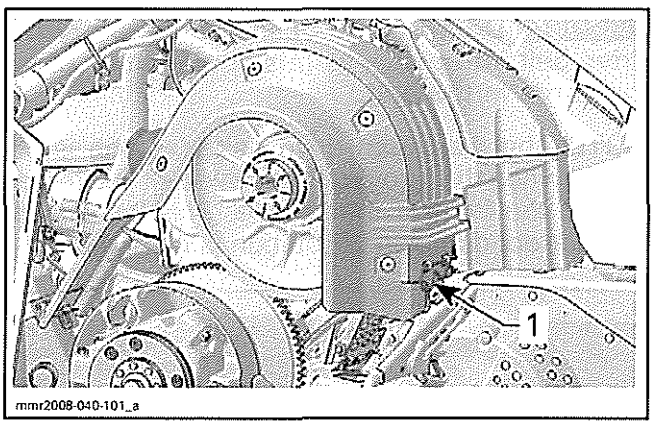
Drive Belt Guard Removal

⚠ WARNING

NEVER operate the snowmobile without the drive belt guard securely installed.

Open the LH side panel.

Remove retaining pin.



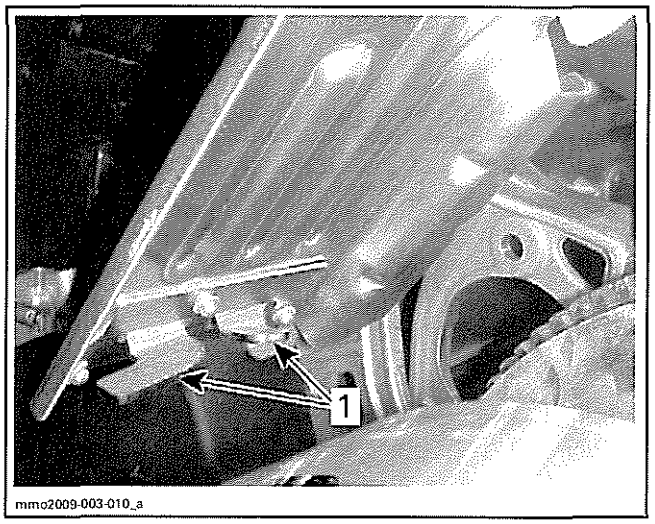
TYPICAL
1. Retaining pin

Lift rear portion of guard then release from front tabs by pivoting the guard outwards.

Drive Belt Guard Installation

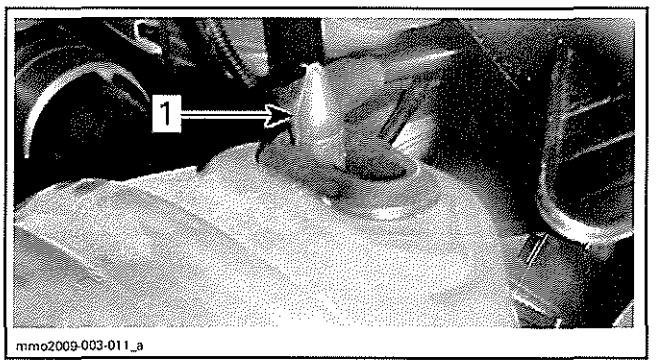
Place the front LH slot of the guard over the longest tab.

Pivot the guard inward to engage the shortest tab in the RH slot.



1. Tabs

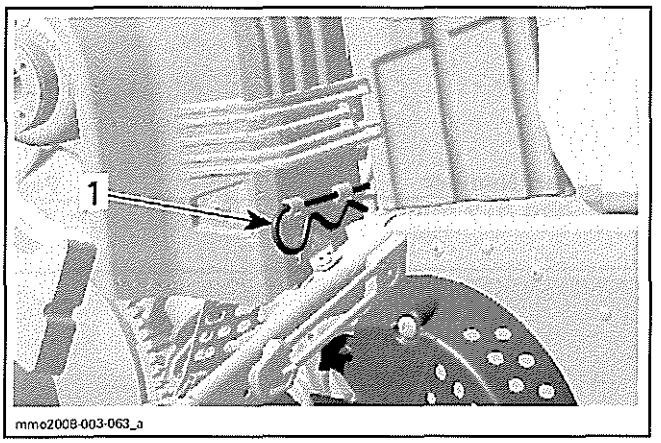
Position the grommet over the retaining rod. It may be necessary to slightly lift the console to make room.



1. Retaining rod

Position rear portion of the drive belt guard over the retainer and secure it using the retaining pin.

NOTE: The drive belt guard is purposely made slightly oversize to maintain tension on its pins and retainers preventing undue noise and vibration. It is important that this tension be maintained when reinstalling.

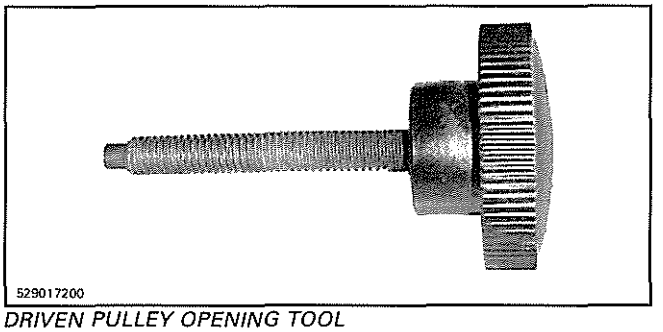


TYPICAL
1. Retaining pin

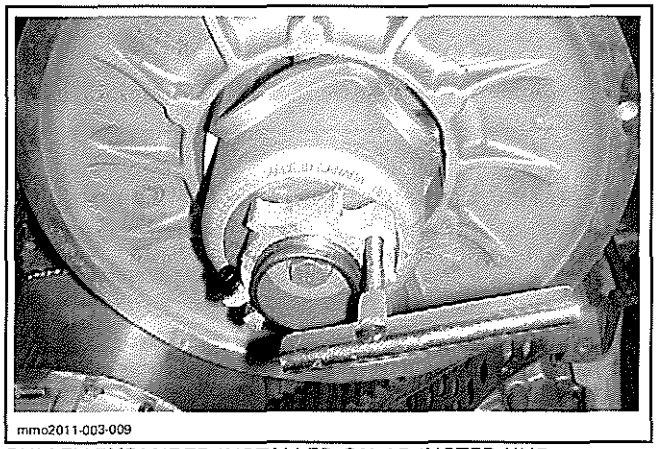
DRIVE BELT

Drive Belt Removal

1. Remove the drive belt guard.
2. Insert the DRIVEN PULLEY OPENING TOOL (P/N 529 017 200) (or the pulley expander provided in the tool box) in the threaded hole on the adjuster hub.



DRIVEN PULLEY OPENING TOOL



PULLEY EXPANDER INSTALLED ON ADJUSTER HUB

3. Open the driven pulley by screwing the tool in.
4. To remove belt, slip the belt over the top of driven pulley, then over the drive pulley.

Drive Belt Inspection

Inspect belt for:
- Cracks
- Fraying
- Abnormal wear (uneven wear, wear on one side, missing cogs, cracked fabric).

If abnormal wear is noted, probable cause could be:
- Pulley misalignment
- Excessive RPM with frozen track
- Fast starts without warm-up period
- Scratched or rusty sheave
- Oil on belt
- Distorted spare belt.

Check drive belt width. Replace the drive belt if its width is under minimum recommended specification.

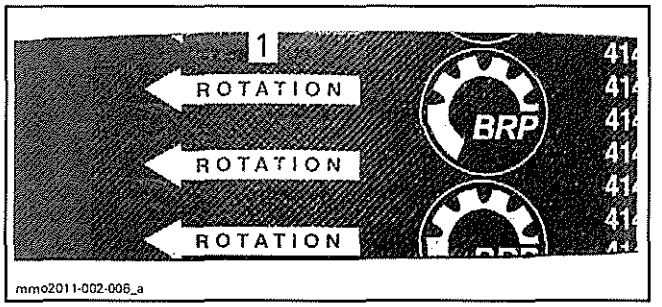
ENGINE	MINIMUM WIDTH (WEAR LIMIT)
600 HO E-TEC	36.1 mm (1.421 in)
600 ACE	32.1 mm (1.264 in)
1200 4-TEC	35.9 mm (1.413 in)

Drive Belt Installation

1. Make sure the driven pulley is opened.
2. Set the drive belt inside drive pulley, then slip the top of drive belt over the driven pulley.

NOTICE **Do not force or use tools to pry the drive belt into place, as this could cut or break the cords in the belt.**

NOTE: The maximum drive belt life span is obtained when the arrow on the drive belt is directed toward the front of the vehicle. This will ensure that correct direction of rotation is respected.



1. Arrow pointing the front of vehicle

3. Unscrew and remove the driven pulley opening tool from the pulley.

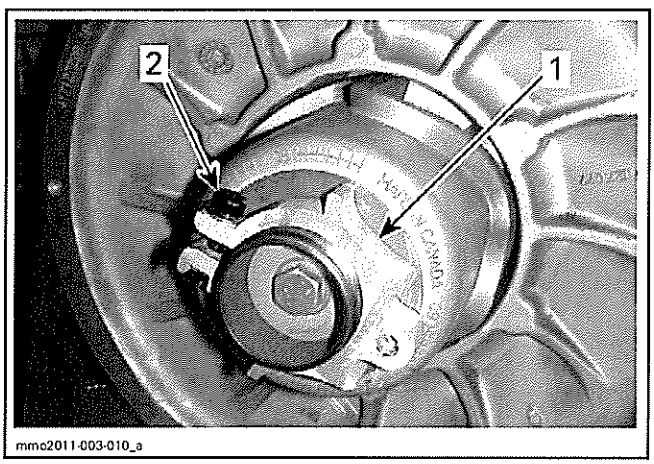
4. Rotate the driven pulley several times to properly set the drive belt between the sheaves.
5. Adjust the drive belt height. Refer to *DRIVE BELT HEIGHT ADJUSTMENT* and follow steps 3 to 5.

Drive Belt Height Adjustment

The drive belt height must be checked every time a new drive belt is installed.

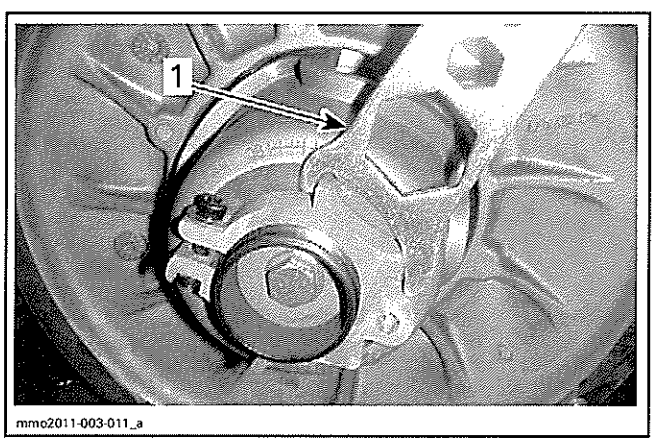
To adjust the drive belt height, proceed as follows:

1. Remove tether cord cap from engine cut-off switch.
2. Remove drive belt guard.
3. Loosen the clamping screw.



1. Adjuster hub
2. Clamping screw

4. Using the suspension adjustment tool provided in the tool kit, turn the ring 1/4 turn at a time then rotate the driven pulley to properly set the drive belt between the pulley sheaves.



1. Suspension adjustment tool

NOTE: The adjustment ring has **left hand treads.**

Repeat step 4 until the external surface of drive belt is even with the driven pulley edge.

NOTE: Turning the ring counterclockwise lowers the drive belt in the pulley. Turning the ring clockwise raises the drive belt in the pulley.

5. Firmly tighten the clamping screw. If possible, tighten to specified torque using a torque wrench.

CLAMPING SCREW TIGHTENING TORQUE
5.5 N•m ± 0.5 N•m (49 lbf•**in** ± 4 lbf•**in**)

6. Install drive belt guard.
7. Install side panel.

NOTE: This setting is correct as a preliminary adjustment for most models. In some cases, when starting the engine, the vehicle could creep, indicating that the drive belt is too tight.

If the vehicle creeps, lower the drive belt height from the preliminary setting. Repeat procedure until creeping stops.

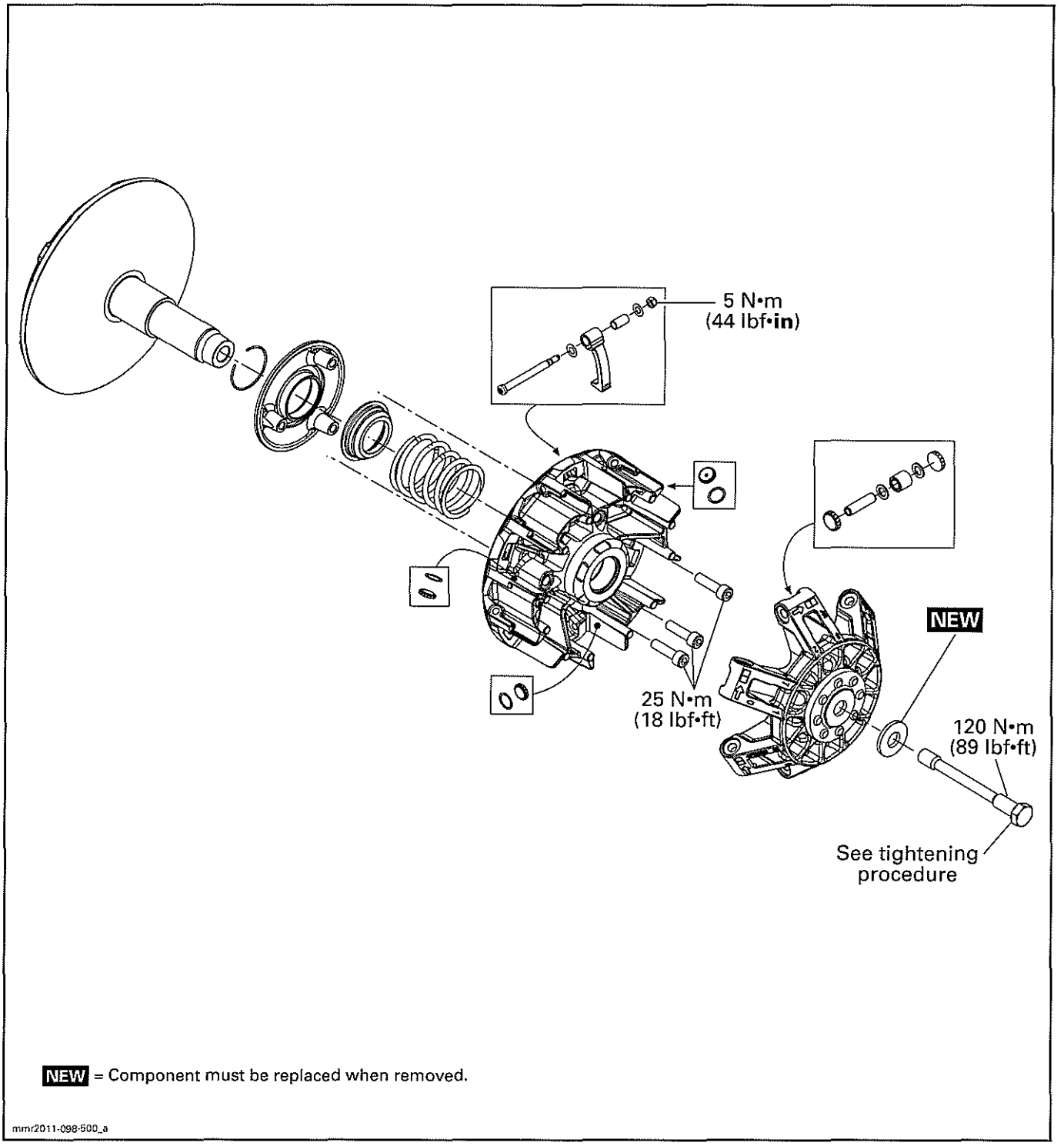
DRIVE PULLEY (eDRIVE)

SERVICE TOOLS

Description	Part Number	Page
DRIVE PULLEY HOLDER (CVT)	529 006 400	695
DRIVE PULLEY PULLER	529 000 064	696
PULLEY SPRING COMPRESSOR TOOL	529 036 012	698

SERVICE PRODUCTS

Description	Part Number	Page
PULLEY FLANGE CLEANER	413 711 809	698–699



NEW = Component must be replaced when removed.

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GENERAL

This drive pulley is lubrication free. Never lubricate any components.

Always refer to appropriate *PARTS CATALOG* for replacement part.

During assembly/installation, use the torque values and service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

Some drive pulley calibration components (spring, ramps) can be changed to adapt to different altitudes. Refer to appropriate *SERVICE BULLETIN.*

⚠ WARNING

Torque wrench tightening specifications must strictly be adhered to.
Locking devices when removed must be replaced (e.g.: locking tabs, elastic stop nuts, cotter pin, etc.).

⚠ WARNING

Any drive pulley repairs must be performed by an authorized Ski-Doo dealer. Subcomponent installation and assembly tolerances require strict adherence to procedures detailed.

⚠ WARNING

The clutch assembly is a precisely balanced unit. Never replace parts with used parts from another clutch assembly.

NOTICE This pulley has metric threads. Do not use a puller with ANS or IS type threads. Always tighten puller by hand to ensure that the drive pulley has the same type of threads (metric vs ANS or IS) prior to fully tightening.

NOTICE Never use any type of impact wrench for drive pulley removal and installation.

TROUBLESHOOTING

ERRATIC DRIVE PULLEY PERFORMANCE

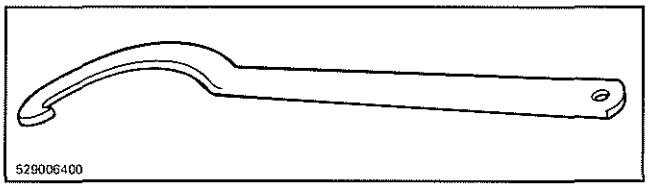
1. Damaged slider shoe O-ring.
   - *Install new O-rings, refer to DRIVE PULLEY ASSEMBLY.*
2. Missing slider shoe O-ring.
   - *Install new O-rings, refer to DRIVE PULLEY ASSEMBLY.*
3. Excessive wear on slider shoes.
   - *Inspect slider shoes, refer to DRIVE PULLEY INSPECTION.*

PROCEDURES

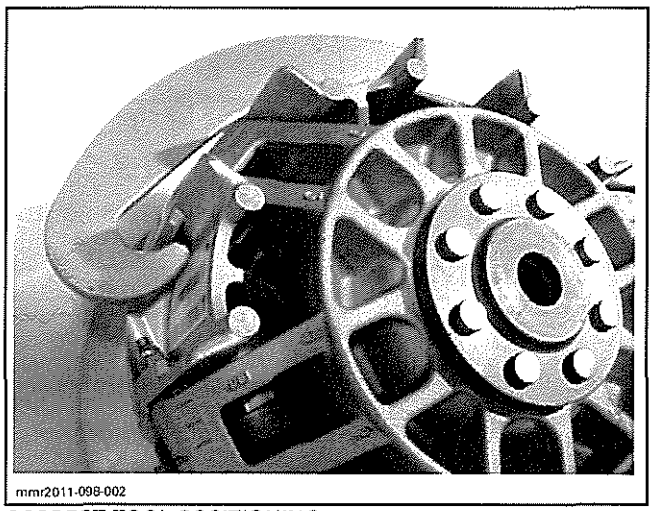
DRIVE PULLEY

Drive Pulley Removal

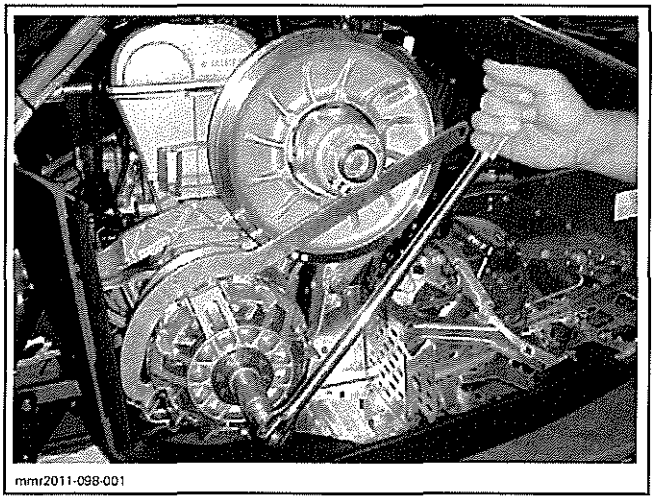
1. Remove drive belt. Refer to *DRIVE BELT* subsection.
2. Hold drive pulley using the DRIVE PULLEY HOLDER (CVT) (P/N 529 006 400).



NOTICE Do not hook the tool on a slider shoe guide.



CORRECT TOOL POSITIONING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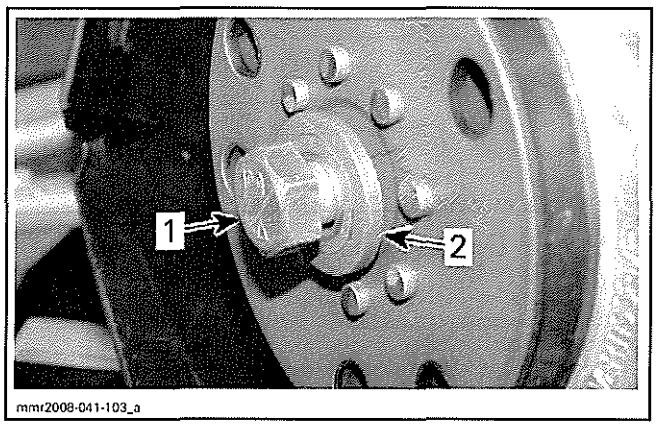
3. Remove drive pulley retaining screw.



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TYPICAL
1. *Drive pulley retaining screw*
2. *Conical spring washer*

4. Remove drive pulley from engine using the specified drive pulley puller.

DRIVE PULLEY PULLER (P/N 529 000 064)

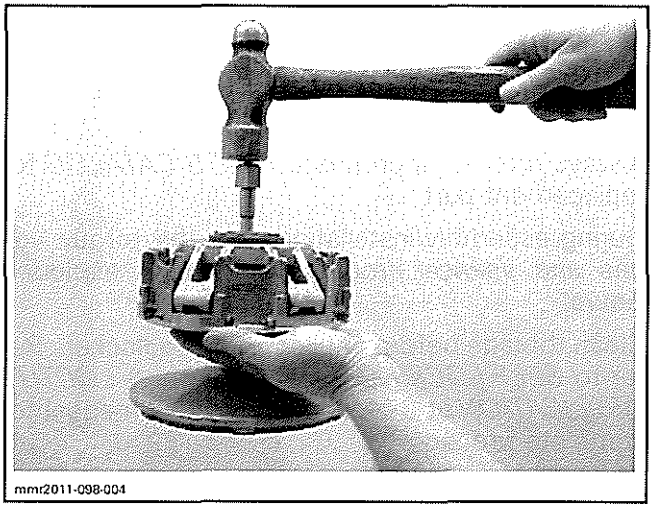
NOTICE Always use the specified tool to avoid damaging crankshaft.

Drive Pulley Disassembly

Fixed Sheave

Separate fixed sheave from sliding sheave as follows:

- Screw puller into fixed sheave shaft (about 13 mm (1/2 in).
- Hold drive pulley in your hand by the sliding sheave as illustrated.
- Tap on puller head to disengage fixed sheave.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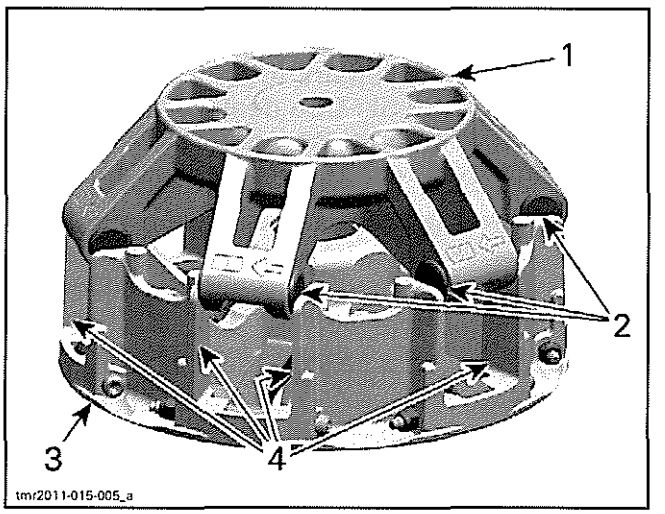
NOTE: If necessary, use a heat gun to slightly heat the governor cup to ease disassembly.

NOTICE Never use any type of torch to heat governor cup.

Governor Cup

Carefully pull up on governor cup until the slider shoes are at their highest position in the guides.



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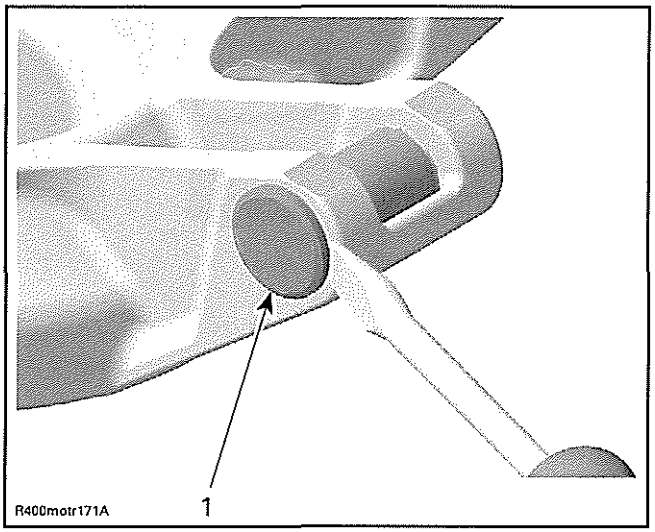
1. *Governor cup*
2. *Slider shoes*
3. *Sliding sheave*
4. *Guides*

Slider Shoes and Roller

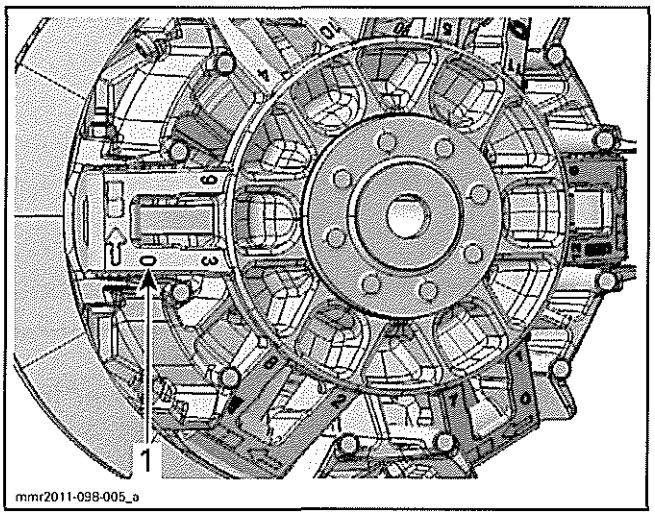
1. Remove slider shoes from governor cup using a flat screwdriver.



1. Slider shoe

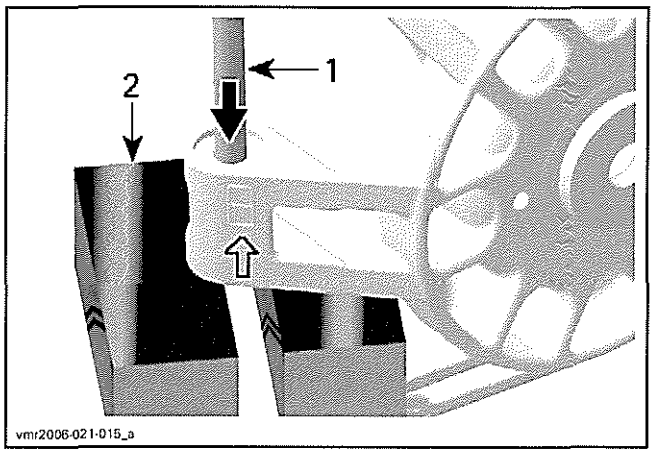
2. Remove O-ring from slider shoes.

NOTE: The O-rings are positioned on the slider shoes identified by an O on the governor cup. (total of 3 slider shoes with O-rings).

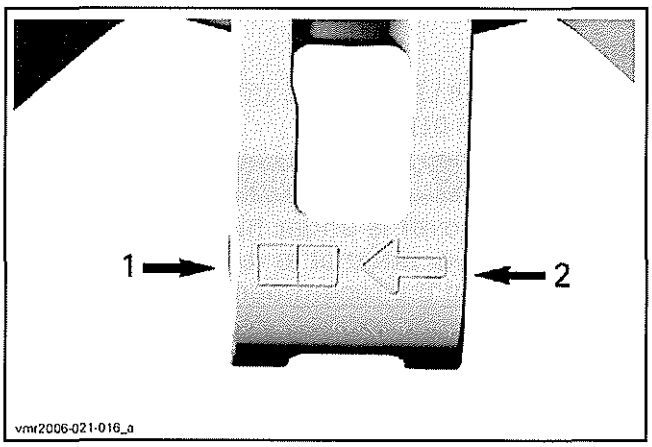


O-RING POSITION
1. O on governor cup

3. Place governor cup on a vice using protection plates.
4. Remove bearing sleeve using a punch by pushing it towards the opposite direction of the arrow.



1. Punch
2. Vice

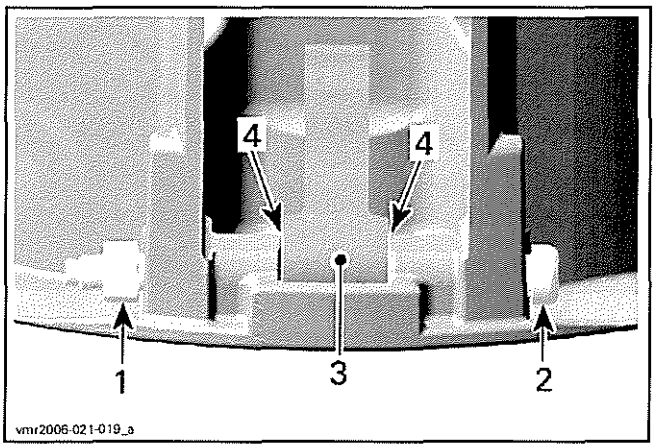


1. Removal direction
2. Assembly direction

NOTICE Do not clamp governor cup in the vice to avoid damaging it.

Centrifugal Lever

1. Unscrew lock nut and remove centrifugal lever pivot bolt.
2. Remove centrifugal lever and both thrust washers.



1. *Lock nut*
2. *Centrifugal lever pivot bolt*
3. *Centrifugal lever*
4. *Thrust washers*

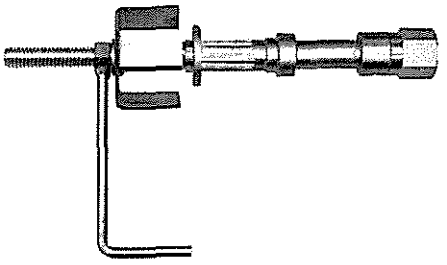
Spring Cover

1. Use the PULLEY SPRING COMPRESSOR TOOL (P/N 529 036 012).

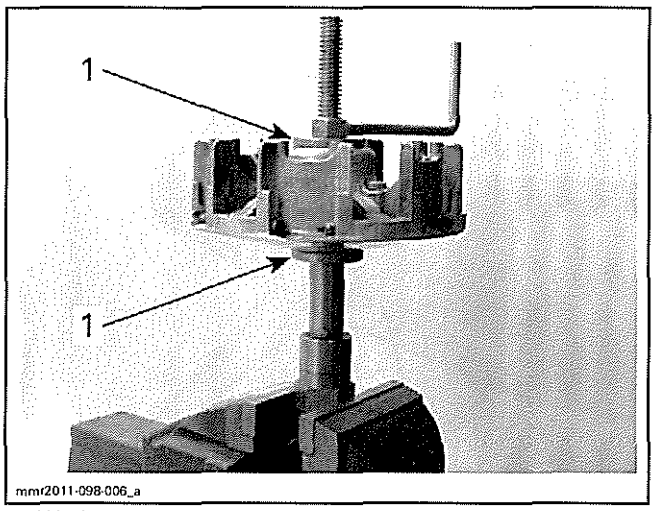
⚠ WARNING

The spring cover is under high clutch spring preload. Never attempt to remove the spring cover without the recommended tool.

PULLEY SPRING COMPRESSOR TOOL (P/N 529 036 012)

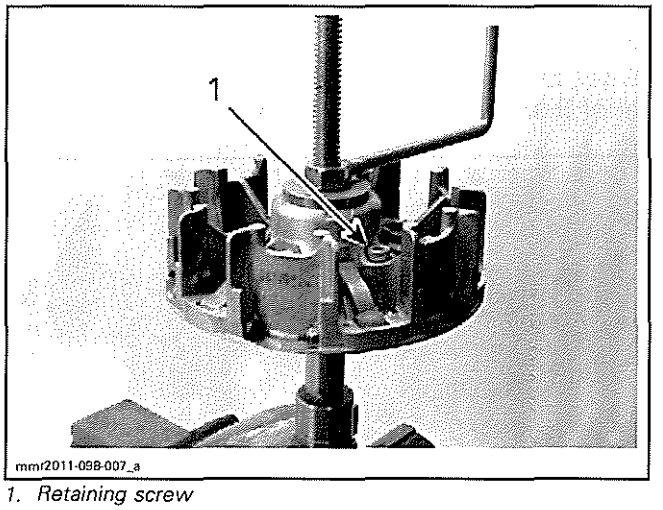


2. Install pulley spring compressor tool in a vice with the sliding sheave between the washers.



1. *Washers*

3. Remove retaining screws from spring cover.



1. *Retaining screw*

4. Unscrew tool to disengage spring cover from sliding sheave.

Drive Pulley Cleaning

NOTICE **Always use the specified cleaning solvent and abrasive type to avoid damaging components.**

Clean pulley faces and shaft using fine steel wool and dry cloth.

Clean the following components using a paper towel with PULLEY FLANGE CLEANER (P/N 413 711 809).

- Crankshaft tapered end
- Crankshaft threads
- Fixed sheave shaft
- Inside the fixed sheave taper
- Drive pulley screw threads.

NOTICE Avoid contact between cleaner and crankshaft seal.

If additional cleaning is required on tapered surfaces, use a medium or coarse steel wool or a no. 600 sand paper.

Reclean tapered surfaces with paper towel and PULLEY FLANGE CLEANER (P/N 413 711 809).

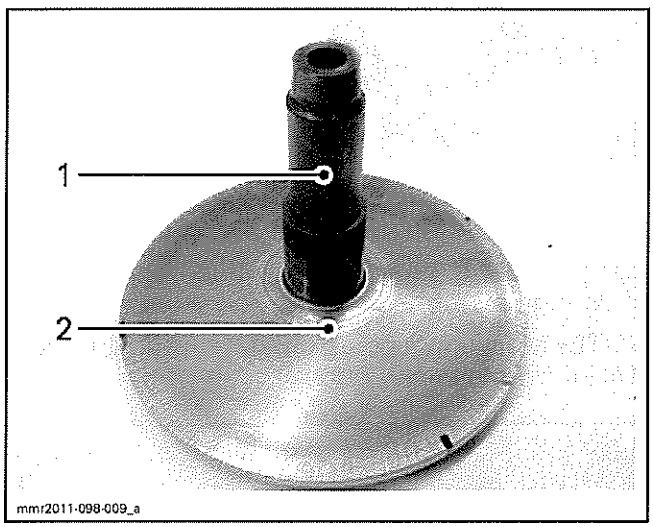
NOTICE Tapered surfaces must be free of any foreign particles.

Drive Pulley Inspection

NOTE: Unless otherwise noted, during inspection, replace any component found defective or out of specifications.

Fixed Sheave

Check fixed sheave shaft and surface for scratches or other damage.



1. Fixed sheave shaft
2. Fixed sheave surface

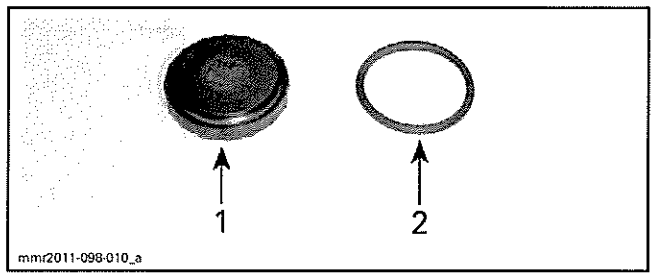
Governor Cup

Check governor cup for cracks or other visible damage.

Slider Shoes and Roller

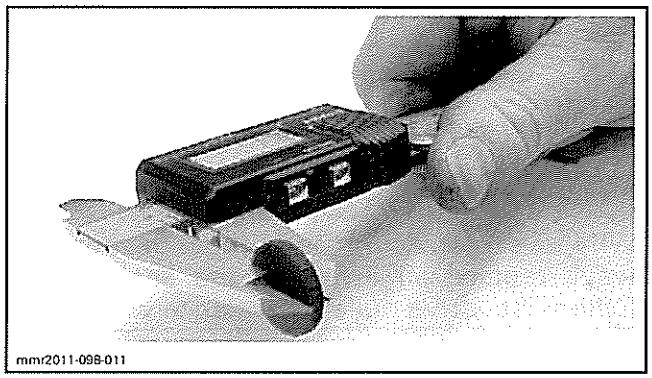
Check if O-rings of slider shoes are cracked, cut or crushed.

Check slider shoes for visible wear.



1. Slider shoe
2. O-ring

Measure the thickness of the slider shoes.



NOTE: Take measurement at the center of slider shoe.

SLIDER SHOE SERVICE LIMIT	
With O-ring	3.70 mm (.146 in)
Without O-ring	3.80 mm (.15 in)

Check each roller for roundness of external diameter.

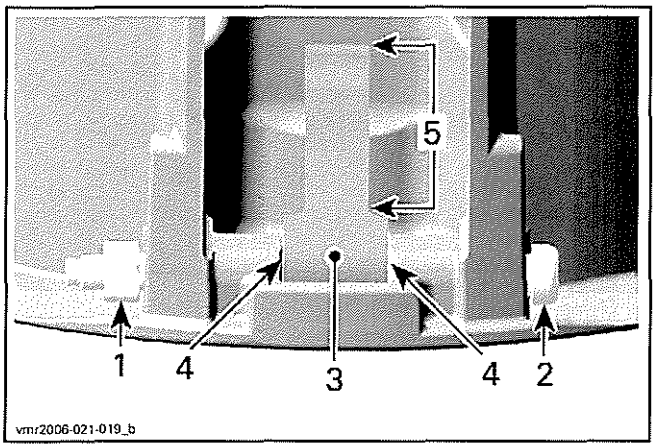
Check if rollers move freely.

NOTICE Whenever replacing rollers and slider shoes, always replace all rollers and slider shoes at the same time.

Centrifugal Lever

Check contact surfaces of centrifugal lever for visible wear.

If major wear is visible, replace the following:
- Centrifugal levers
- Thrust washers
- Centrifugal lever pivot bolts
- Centrifugal lever pivot lock nuts.

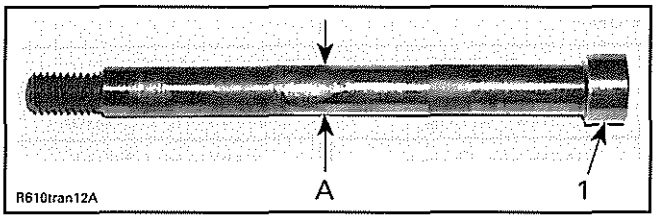


1. *Lock nut*
2. *Centrifugal lever pivot bolt*
3. *Centrifugal lever*
4. *Thrust washers*
5. *Contact surface to the roller*

⚠ WARNING

Whenever replacing centrifugal levers, always replace all levers at the same time. Otherwise, drive pulley imbalance will occur.

Measure diameter of centrifugal lever pivot bolt.

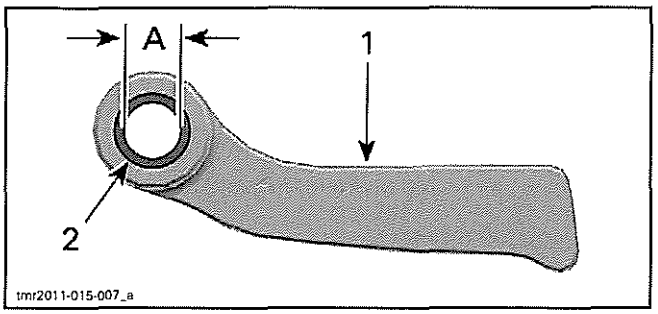


1. *Centrifugal lever pivot bolt*

A. Measure diameter here

CENTRIFUGAL LEVER PIVOT BOLT	
SPECIFICATION	**DIAMETER**
NOMINAL	6.063 mm to 6.091 mm (.239 in to .24 in)
SERVICE LIMIT	6.00 mm (.236 in)

Measure diameter of centrifugal lever bushing.



1. *Centrifugal lever*
2. *Bushing*

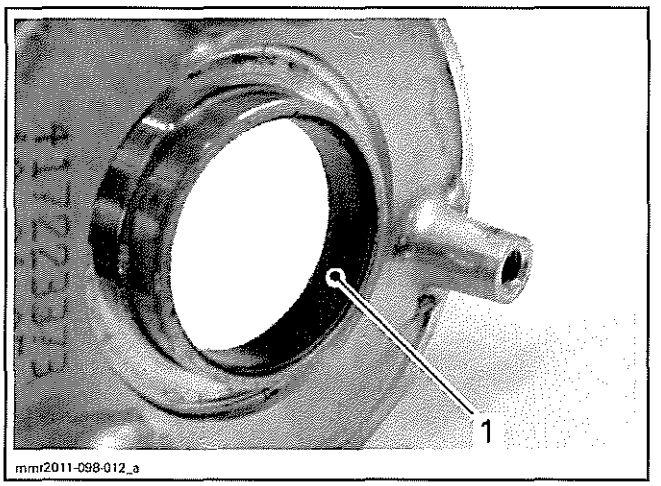
A. Bushing inner diameter

CENTRIFUGAL LEVER BUSHING	
SPECIFICATION	**INNER DIAMETER**
NOMINAL	6.00 mm to 6.12 mm (.236 in to .241 in)
SERVICE LIMIT	6.200 mm (.244 in)

Spring Cover

Check spring cover for cracks or wear.

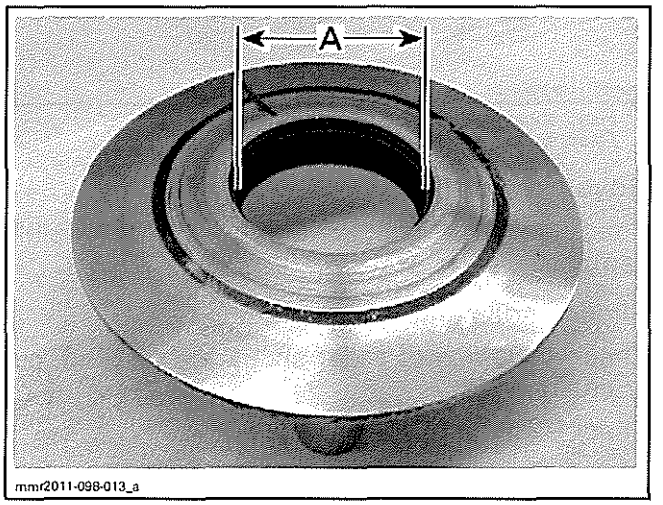
Check coating of spring cover bushing for wear.



1. *Coating of spring cover bushing*

Using a bore gauge, measure the inner diameter of spring cover bushing.

NOTE: Measuring point must be at least 5 mm (1/4 in) from bushing edge.



A. Inner diameter of spring cover bushing

SPRING COVER BUSHING	
SPECIFICATION	**INNER DIAMETER**
SERVICE LIMIT	38.37 mm (1.511 in)

If bushing is out of specification, replace spring cover.

Spring

Check spring free length.

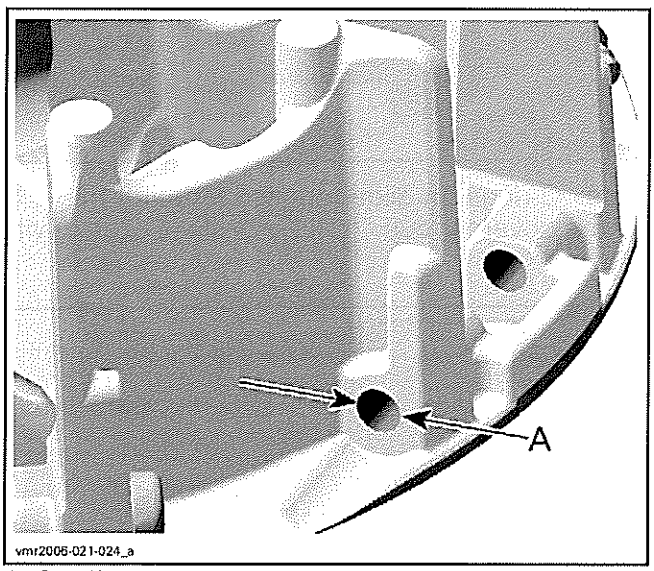
SPRING FREE LENGTH	
COLOR CODE	FREE LENGTH
RED/WHITE	115.0 mm (4.528 in)

Sliding Sheave

Check sliding sheave for cracks or other damage.

Check sliding contact surface for excessive wear.

Measure centrifugal lever pivot bolt bores.



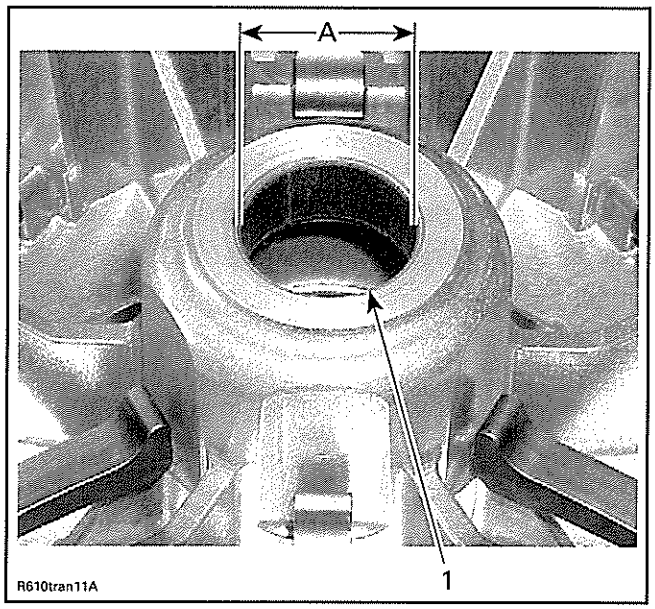
A. Centrifugal lever pivot bolt bore diameter

CENTRIFUGAL LEVER PIVOT BOLT	
SPECIFICATION	**BORE DIAMETER**
NOMINAL	6.113 mm to 6.171 mm (.241 in to .243 in)
SERVICE LIMIT	6.300 mm (.248 in)

Check coating of sliding sheave bushing for wear.

Measure bushing diameter of sliding sheave.

NOTE: Use a dial bore gauge to measure bushing diameter. Measuring point must be at least 5 mm (1/4 in) from bushing edge.



TYPICAL
1. Sliding sheave bushing
A. Inner diameter of bushing

SLIDING SHEAVE BUSHING	
SPECIFICATION	**INNER DIAMETER**
NOMINAL	32.01 mm to 32.13 mm (1.26 in to 1.265 in)
SERVICE LIMIT	33.22 mm (1.308 in)

If bushing is out of specification, replace sliding sheave.

Drive Pulley Assembly

Spring Cover

The installation is the reverse of removal procedure, however pay attention to the following.

Tighten spring cover retaining screws to specification.

SPRING COVER RETAINING SCREW TORQUE
25 N•m (18 lbf•ft)

Centrifugal Lever

The installation is the reverse of removal procedure, however pay attention to the following.

Install centrifugal levers with both thrust washers.

NOTICE **Centrifugal levers must move easily after installation.**

Tighten centrifugal lever pivot nuts to specification.

CENTRIFUGAL LEVER PIVOT NUT TORQUE
5 N•m (44 lbf•**in**)

Slider Shoes and Roller

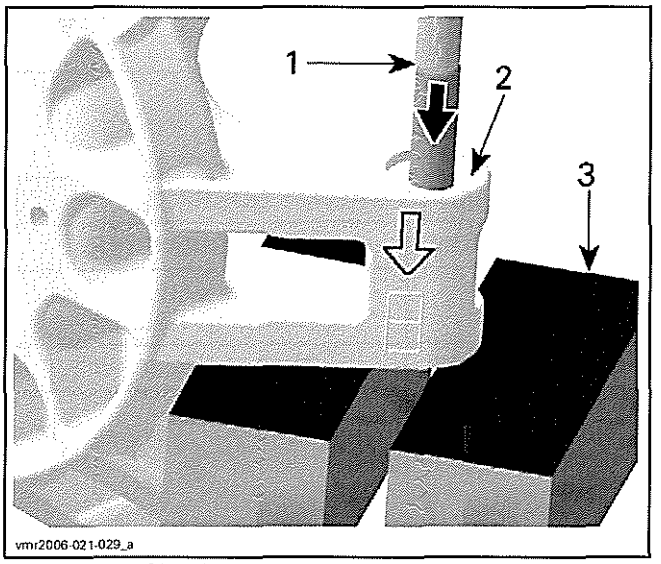
The installation is the reverse of removal procedure, however pay attention to the following.

Ensure that rollers move easily after installation.

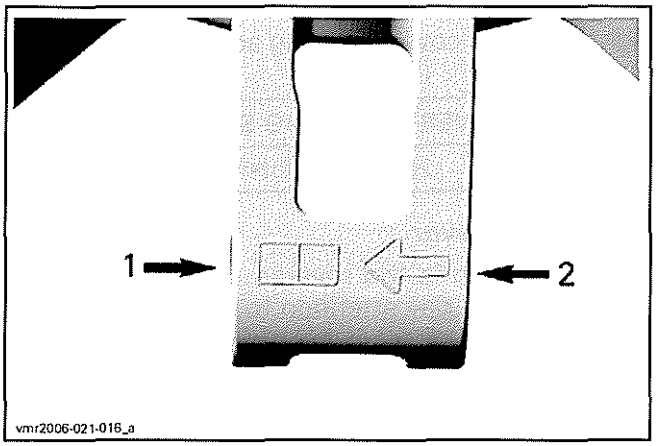
Install bearing sleeve by pushing it towards the same direction as the arrow.

Ensure the bearing sleeve is aligned with the contact surface of the slider shoes (no protrusion).

NOTICE Do not clamp governor cup **in** the vice to avoid to damaging it.

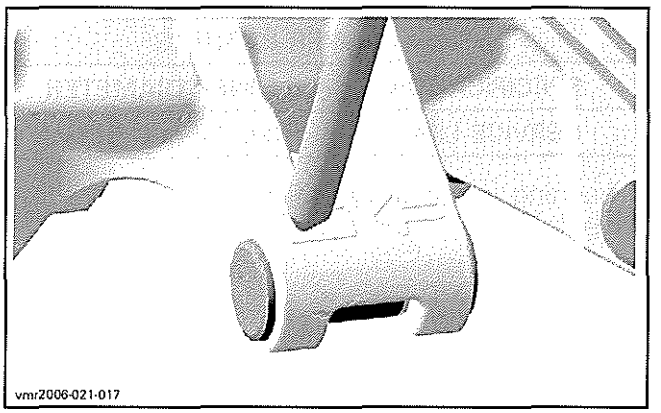


1. Top edge of bearing sleeve
2. Contact surface of slider shoes
3. Vice

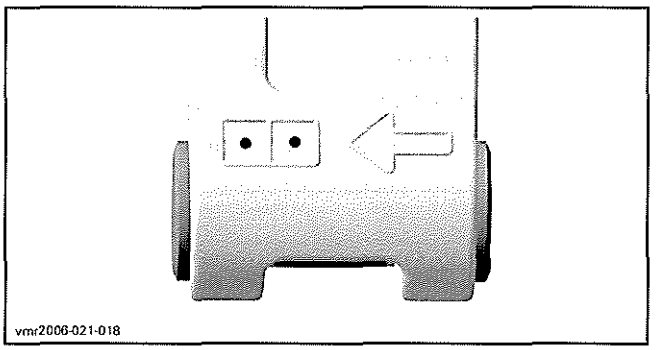


1. Removal direction
2. Assembly direction

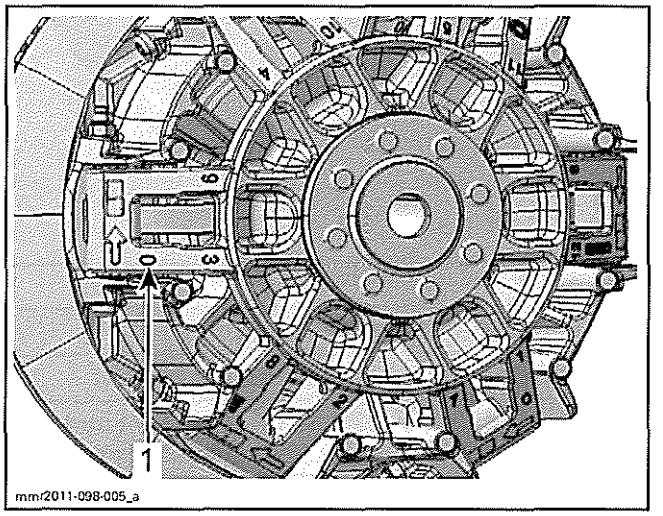
Carefully mark governor cup box using a punch.



NOTE: Never install a governor cup with two marks.



Install O-rings on slider shoes identified by an O on the governor cup. (total of 3 slider shoes with O-rings).



O-RING POSITION
1. O on governor cup

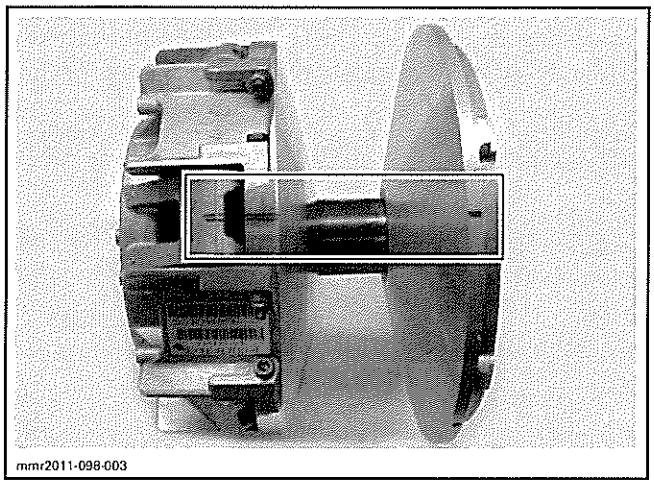
Governor Cup

The installation is the reverse of removal procedure.

Fixed Sheave

The installation is the reverse of removal procedure, however pay attention to the following.

Align fixed sheave, sliding sheave and governor cup together using the index marks (index marks have been traced at the factory).


mmr2011-098-003

Drive Pulley Installation

For installation, reverse the removal procedure. However, pay attention to the following.

NOTICE Do not apply antiseize or any lubricant on crankshaft and drive pulley tapers.

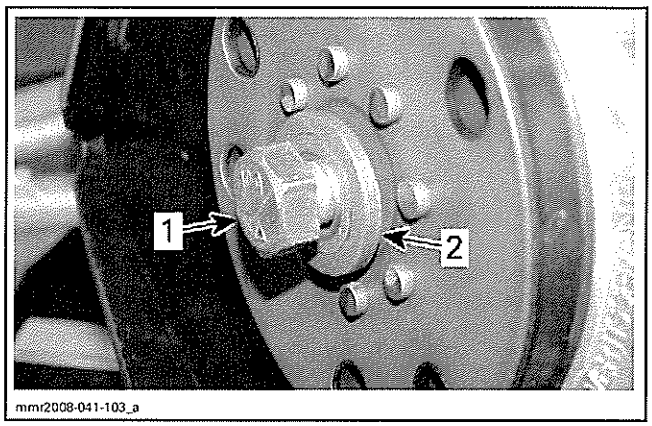
NOTICE Never use any type of impact wrench for drive pulley removal and installation.

Clean mounting surfaces as described in *DRIVE PULLEY CLEANING* above.

Install NEW conical spring washer with its concave side towards drive pulley.

Install and tighten drive pulley screw as per the following procedure.

NOTICE Always use BRP genuine parts for conical spring washer and screw.



mmr2008-041-103_a

TYPICAL
1. *Drive pulley screw*
2. *Conical spring washer*

1. Tighten drive pulley retaining screw to specification.

DRIVE PULLEY FIRST TORQUE
120 N•m (89 lbf•ft)

2. Lift rear of vehicle and support it safely.

⚠ WARNING

Ensure the track is free of particles which could be thrown out while track is rotating. Keep hands, tools, feet and clothing clear of track. Ensure nobody is standing near the vehicle.

3. Start engine.
4. Release parking brake.
5. Accelerate vehicle at low speed (maximum 32 km/h (20 MPH)).
6. Apply brake.
7. Repeat the above sequence 5 times.
8. Stop engine.
9. Lower vehicle back on ground.
10. Retighten drive pulley retaining screw to specification.

DRIVE PULLEY FINAL TORQUE
120 N•m (89 lbf•ft)

⚠ WARNING

After 10 hours of operation, the torque of the drive pulley retaining screw must be checked.

DRIVE PULLEY (TRA III)

SERVICE TOOLS

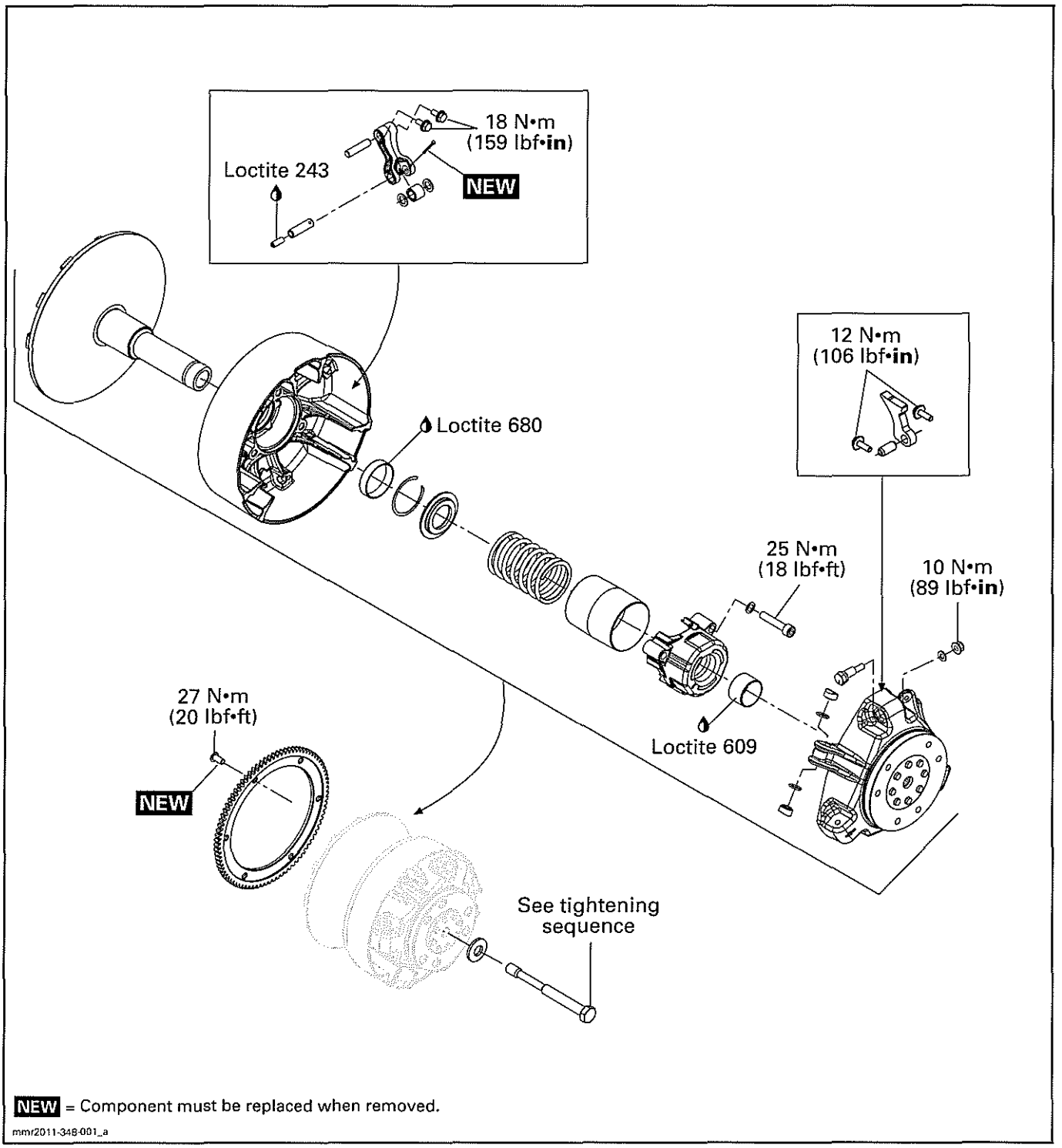
Description	Part Number	Page
BUSHING PULLER/INSTALLER	529 031 200	711
BUSHING REMOVER/INSTALLER	529 035 931	711, 713
DRIVE PULLEY HOLDER	529 035 674	707, 717
DRIVE PULLEY PULLER	529 000 064	707
PULLEY SPRING COMPRESSOR TOOL	529 036 012	709, 711, 713, 715
SLIDER SHOE FORK	529 005 500	708, 714

SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
TEMPILSTIK INDICATOR STICK	TS212F	710

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 243 (BLUE)	293 800 060	716
LOCTITE 680	293 800 118	713
PULLEY FLANGE CLEANER	413 711 809	712


18 N•m
(159 lbf•in)
Loctite 243
NEW
12 N•m
(106 lbf•in)
Loctite 680
25 N•m
(18 lbf•ft)
10 N•m
(89 lbf•in)
27 N•m
(20 lbf•ft)
NEW
Loctite 609
See tightening
sequence
NEW = Component must be replaced when removed.
mmr2011-348-001_a

GENERAL

TRA™ drive pulley stands for **T**otal **R**ange **A**djustable drive pulley.

These are lubrication free drive pulleys. Do not lubricate any component.

Always refer to appropriate *PARTS CATALOG* for replacement part.

Most parts of TRA III are not interchangeable with those of the TRA VII.

NOTICE Never use any type of impact wrench at drive pulley removal and installation. The use of impact wrench could damage the drive pulley and modify the calibration.

Some drive pulley components (return spring, ramp) can be changed to improve vehicle performance in high altitude regions. A Service Bulletin gives information about calibration according to altitude.

NOTICE Such modifications should only be performed by experienced mechanics since they can greatly affect vehicle performance. Verify spring specifications before installation. Do not only refer to the spring color code.

⚠ WARNING

Any drive pulley repairs must be performed by an authorized Ski-Doo dealer. Subcomponent installation and assembly tolerances require strict adherence to procedures detailed.

During assembly/installation, use torque values and service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, cotter pins, etc.) must be replaced.

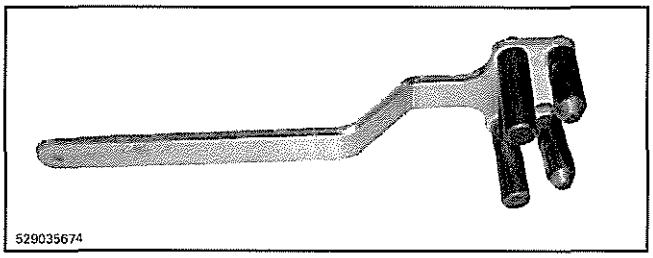
PROCEDURES

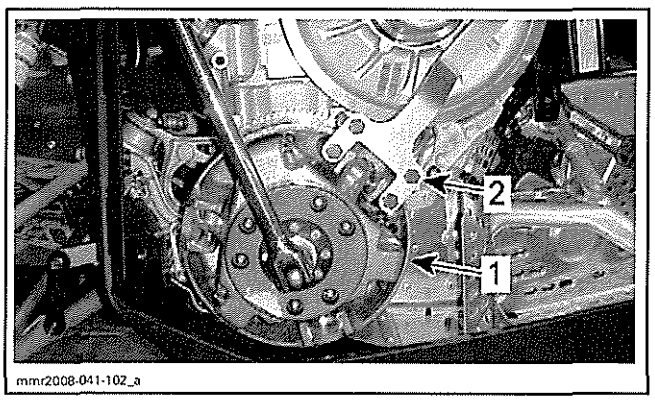
DRIVE PULLEY

Drive Pulley Removal

Remove drive belt. Refer to *DRIVE BELT* subsection.

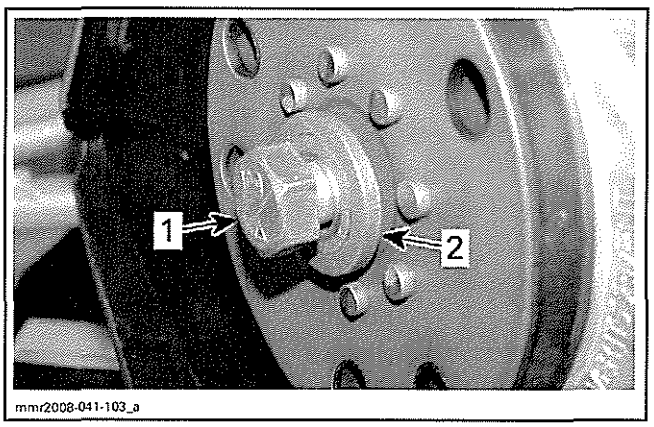
Secure drive pulley with the DRIVE PULLEY HOLDER (P/N 529 035 674). Install it over a sliding sheave tower.





TYPICAL
1. *Drive pulley*
2. *Drive pulley holder*

Remove the drive pulley bolt and its conical spring washer.

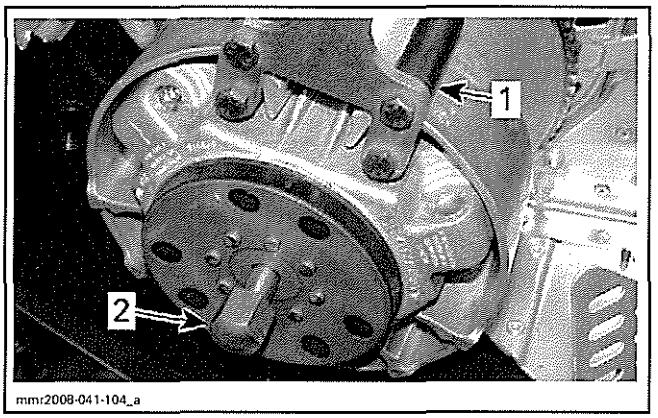


1. *Drive pulley bolt*
2. *Conical spring washer*

To remove drive pulley from engine, use the following tools:

TOOL	
DRIVE PULLEY HOLDER (P/N 529 035 674)	
DRIVE PULLEY PULLER (P/N 529 000 064)	

To remove the drive pulley, hold drive pulley and tighten the puller.



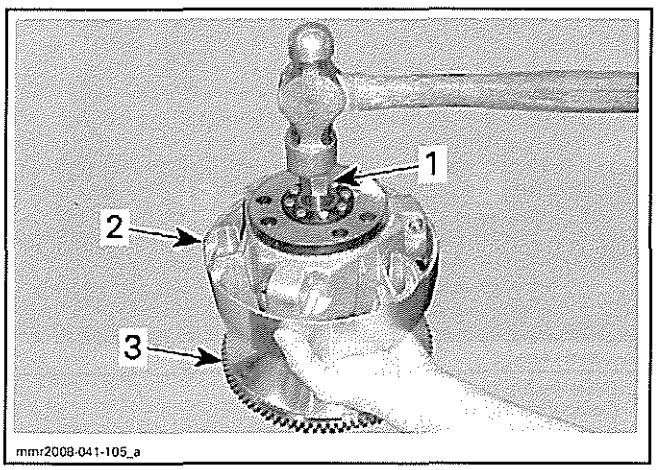
1. Drive pulley holder
2. Drive pulley puller

NOTICE These pulleys have metric threads. Do not use a puller with ANS (American National Standard) or IS (International Standard) type threads. Always tighten puller by hand to ensure that the drive pulley has the same type of threads (metric vs ANS or IS)) prior to fully tightening.

Drive Pulley Disassembly

To separate fixed sheave from sliding sheave, screw puller into fixed sheave shaft about 13 mm (1/2 in). Raise drive pulley and hold it by the sliding sheave while knocking on puller head to disengage fixed sheave.

NOTICE NEVER tap on governor cup.



TYPICAL
1. Puller screwed 13 mm (1/2 in) in fixed sheave
2. Sliding sheave
3. Fixed sheave

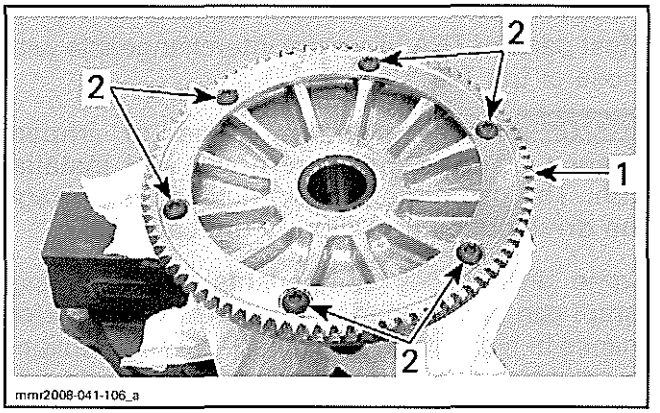
NOTE: No components marking is required before disassembling this drive pulley since it has factory mark and arrows as indexing reference.

If separation of the fixed sheave from the sliding sheave is hard, use a heat gun to slightly heat the governor cup to expand its taper.

NOTICE Never use any type of torch to heat governor cup.

Ring Gear

To remove the ring gear, use a heat gun to break the threadlocker on ring gear screws. Discard the ring gear screws.

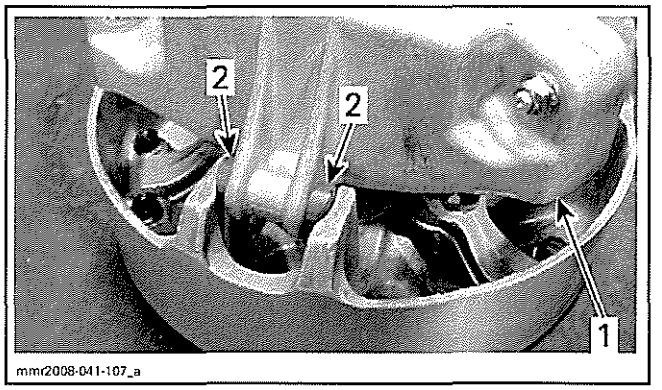


1. Ring gear
2. Ring gear screws

NOTICE If another tool than a heat gun is used, do not exceed 150°C (302°F).

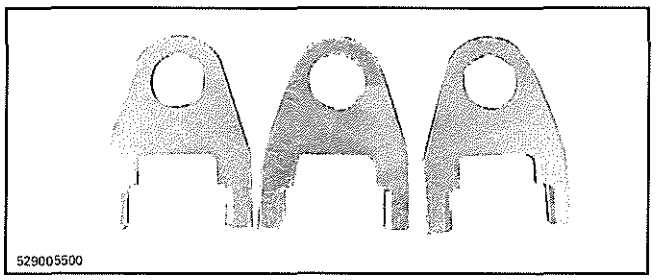
Slider Shoes and Governor Cup

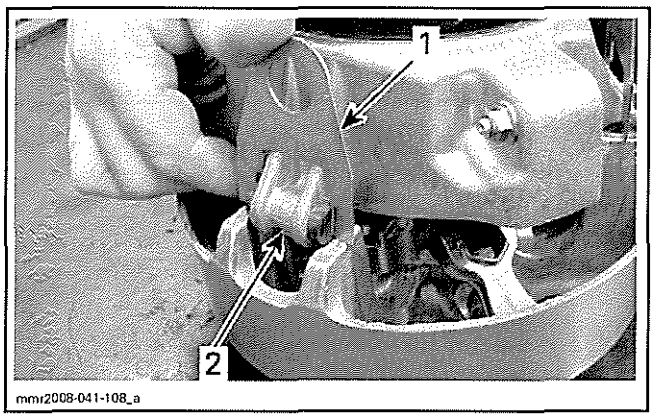
Carefully lift governor cup until slider shoes come at their highest position into guides.



1. Governor cup
2. Slider shoes

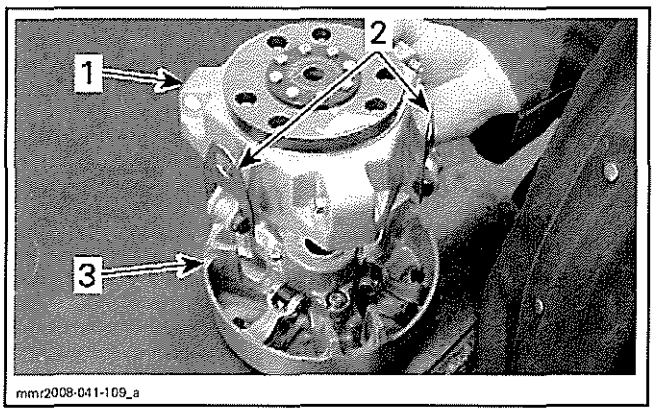
Hold a slider shoe set then carefully lift its housing and install a SLIDER SHOE FORK (P/N 529 005 500). Proceed the same way for other housings lifting one at a time.





1. Governor cup
2. Slider shoe forks

When all slider shoes are held with the forks, remove the governor cup.



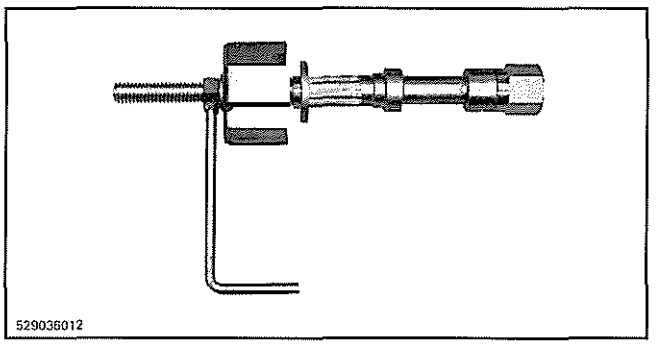
1. Governor cup
2. Slider shoe forks
3. Sliding sheave

Spring Cover

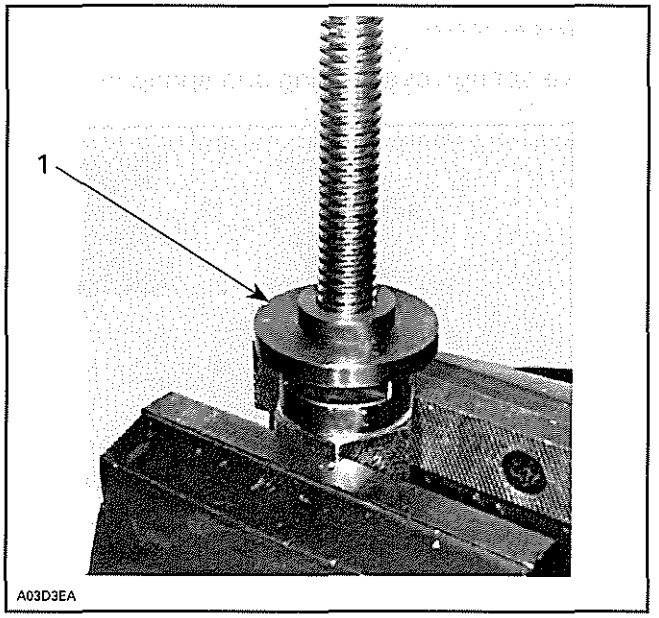
To remove the spring cover, always use the PULLEY SPRING COMPRESSOR TOOL (P/N 529 036 012). The spring cover is under high clutch spring preload.

⚠ WARNING

Clutch spring is very strong. Never attempt to remove spring cover without the recommended tools.



Install support guide of spring compressor in a vice.

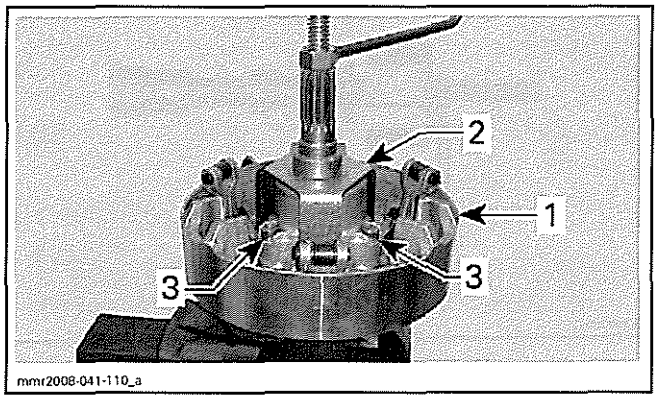


1. Support guide

NOTE: The support guide will prevent bushing damages.

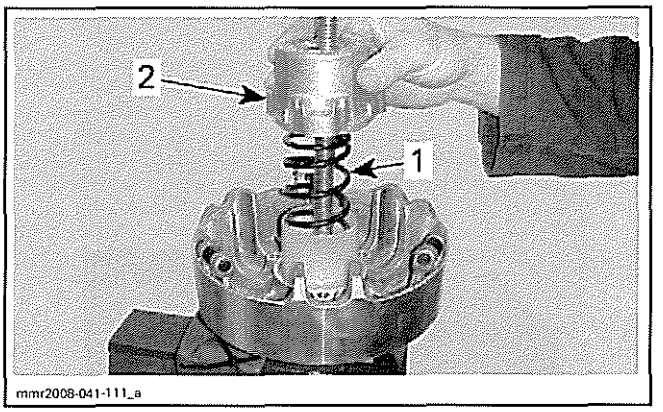
Install sliding sheave then the support cup over spring cover.

Remove 3 Allen screws retaining spring cover then unscrew compressor.



TYPICAL
1. *Sliding sheave*
2. *Support cup*
3. *Spring cover screws*

Remove spring cover, spring and spring seat.



1. *Spring*
2. *Spring cover*

Hollow Threaded Pin Set Screw

Position a propane torch at ± 25.4 mm (1 in) from the end of the pin (on the opposite side of the cotter pin).

Heat during 10 to 15 seconds or until the end of the pin reaches 100°C (212°F) and stop heating.

NOTE: Probe the end of the pin with a temperature indicator stick such as the TEMPILSTIK INDICATOR STICK (P/N TS212F), which will liquefy when pin reaches the correct temperature.

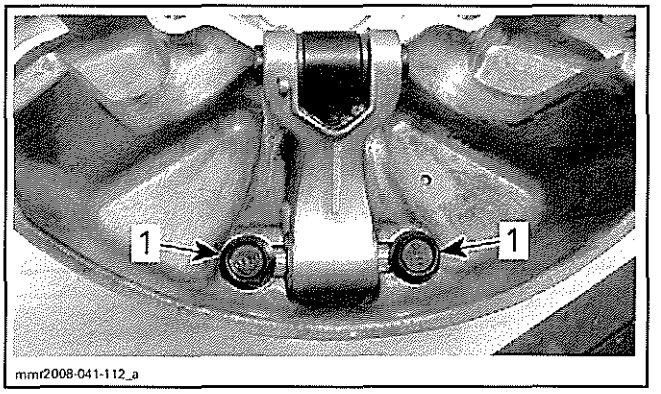
NOTICE **Make sure not to exceed 100°C (212°F). Exceeding this temperature will cause severe pulley damages.**

Wait approximately 30 seconds and remove the set screw.

NOTE: If the set screw cannot be removed, heat the pin end again during 5 seconds and try again to remove set screw. Make sure not to exceed 100°C (212°F).

Lever, Roller and Pin

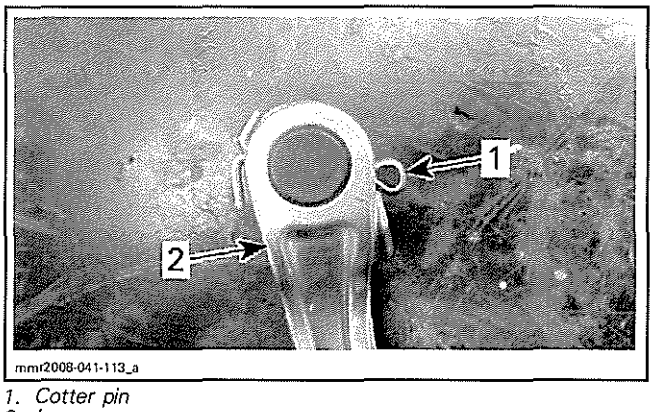
Remove lever screws.



1. *Lever screws*

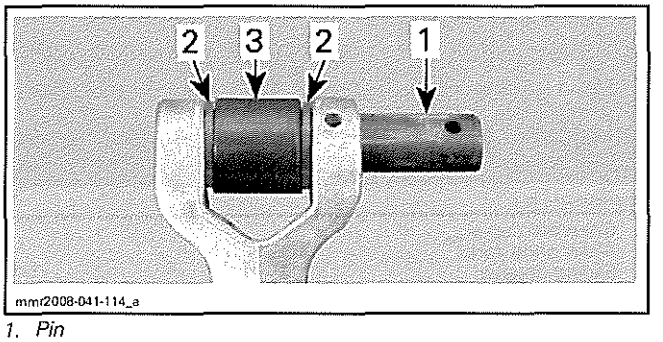
Pull lever to remove it from sliding sheave.

Remove and discard the cotter pin.



1. *Cotter pin*
2. *Lever*

Remove pin, thrust washers and roller.

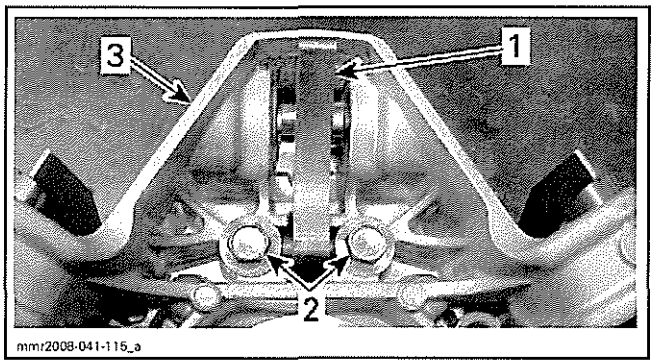


1. *Pin*
2. *Thrust washers*
3. *Roller*

Ramp

Turn the governor cup up side down.

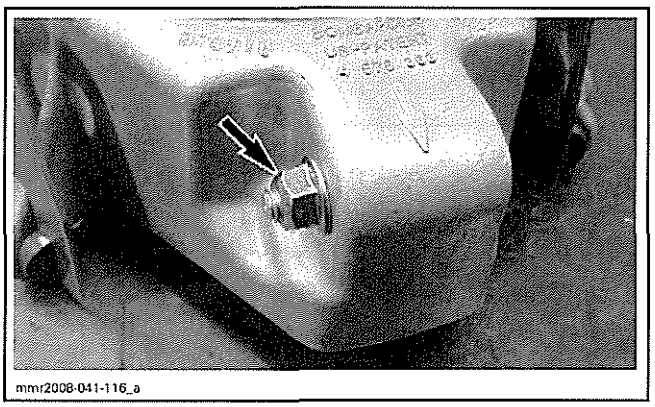
Remove screws retaining ramp to governor cup.



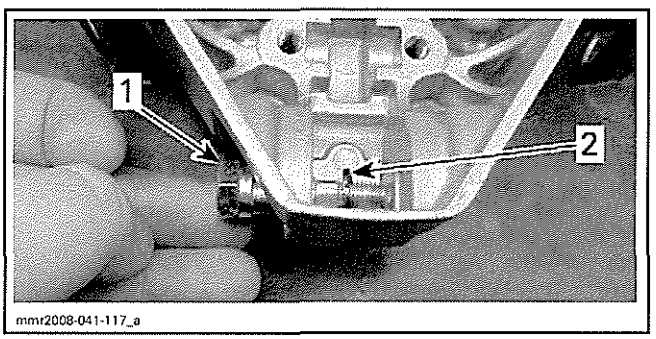
1. *Ramp*
2. *Ramp screws*
3. *Governor cup*

Calibration Screw

Unscrew the nut securing the calibration screw.



Remove calibration screw and its washer.



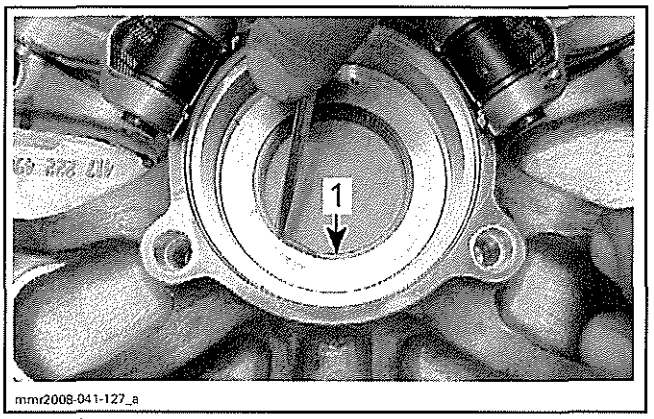
1. *Calibration screw*
2. *Washer*

Sliding Sheave Bushing Removal

NOTE: In case of worn out bushing, it is advisable to replace whole sliding sheave assembly as replacing just the bushing may reduce the drive pulley performance.

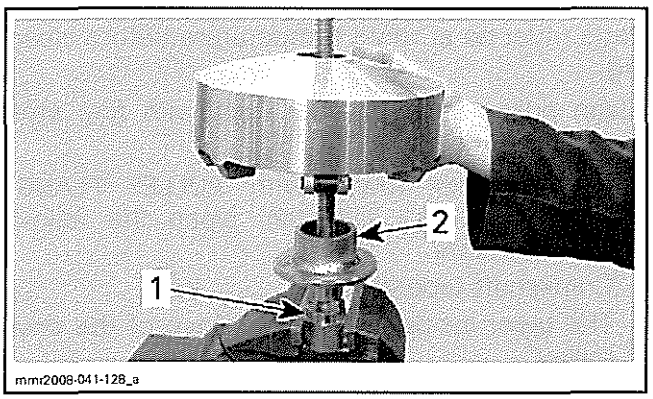
If bushing is out of specifications, remove it as follows:

1. Remove circlip from the sliding sheave.



1. *Circlip*

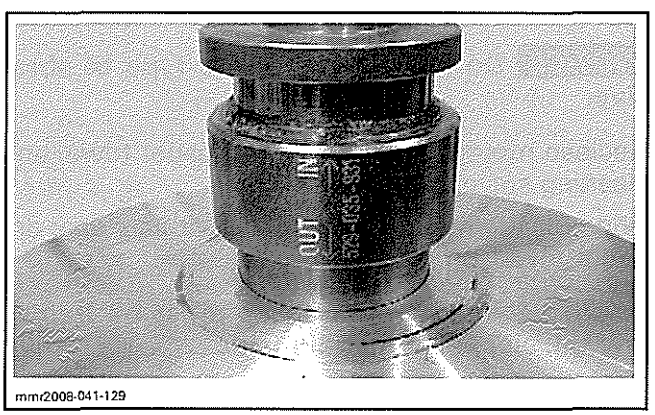
2. Secure the PULLEY SPRING COMPRESSOR TOOL (P/N 529 036 012) in a vice.
3. Mount the BUSHING PULLER/INSTALLER (P/N 529 031 200) and the sliding sheave assembly on it.



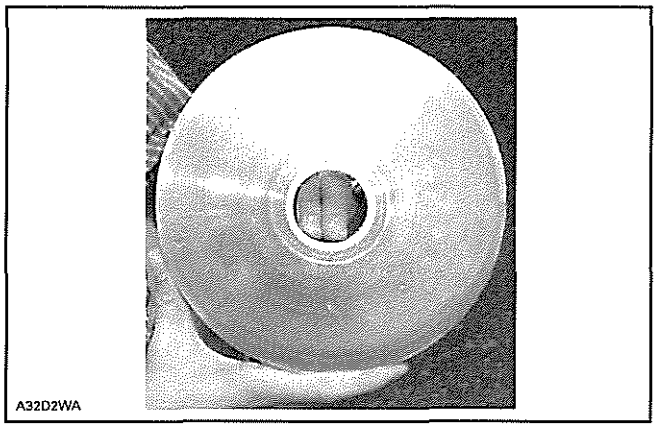
1. *Spring compressor*
2. *Bushing remover/installer*

4. Use the BUSHING REMOVER/INSTALLER (P/N 529 035 931) to press out old bushing.

NOTE: Make sure to use the tool as marked; to remove the bushing press using the side marked "OUT", as shown below in the picture.



5. Use a soft sand paper to clean sliding sheave bushing mounting surface.



6. Clean sliding sheave bushing mounting surface with PULLEY FLANGE CLEANER (P/N 413 711 809).
7. Clean the circlip groove.

Drive Pulley Cleaning

Parts must be at room temperature before cleaning.

Clean pulley sheaves and shaft with fine steel wool and dry cloth.

Using a paper towel with PULLEY FLANGE CLEANER (P/N 413 711 809), clean the following components.

- Crankshaft tapered end
- The taper inside the fixed sheave of the drive pulley
- Crankshaft threads
- Retaining screw threads.

NOTICE Avoid contact between cleaner and crankshaft seal because damage may occur.

Remove all hardened oil deposits that are baked on crankshaft and pulley tapered surfaces with coarse or medium steel wool and/or sand paper no. 600.

NOTICE Do not use any other type of abrasive.

Reclean mounting surfaces with paper towel and cleaning solvent.

Wipe off the mounting surfaces with a clean, dry paper towel.

NOTICE Mounting surfaces must be free of any oil, cleaner or towel residue.

Drive Pulley Inspection

NOTE: During inspection, replace any component if found defective or out of specifications.

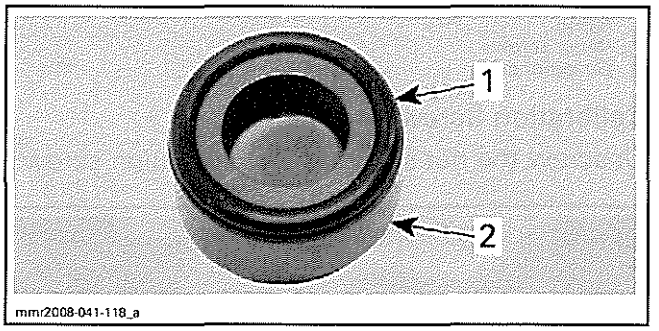
Fixed Sheave and Governor Cup

Inspect fixed sheave for marks or scratches.

Inspect splines and free play between both parts. Maximum free play is 0.5 mm (.02 in) measured at calibration screw radius.

Slider Shoes

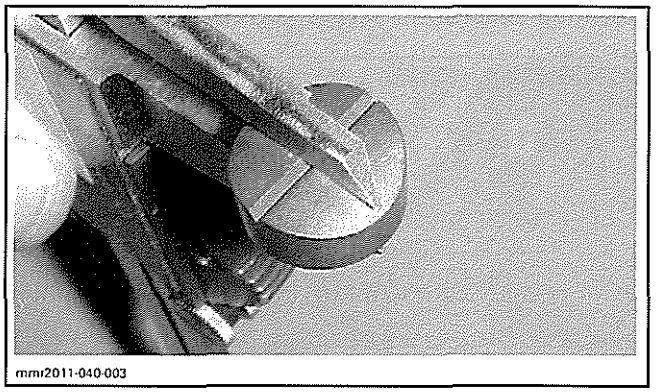
Check if slider shoe O-rings are cracked, cut or crushed.



1. O-ring
2. Slider shoe

Measure the thickness of slider shoes. Take measurement at the center of slider shoe, perpendicularly with the groove.

MODELS	SERVICE LIMIT
600 HO E-TEC	7.45 mm (19/64 in)

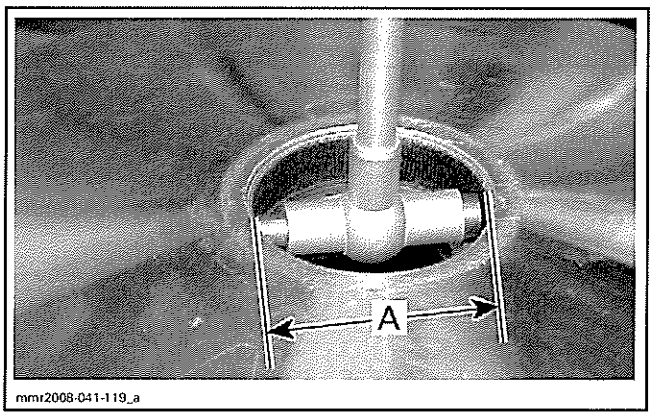


Sliding Sheave

Inspect pulley sheave for marks or scratches.

Visually inspect coating of bushings.

Using a bore gauge, measure the inner diameter of sliding sheave bushing. Measuring point must be at least 5 mm (1/4 in) from bushing edge.



A. Inner diameter of sliding sheave bushing

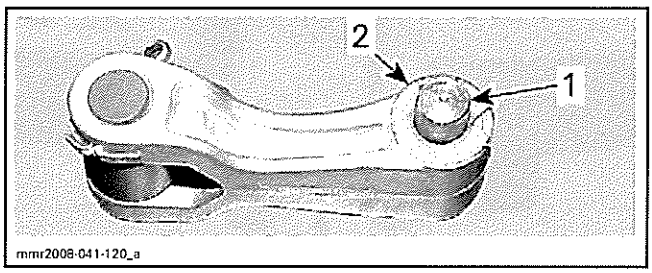
BUSHING	SERVICE LIMIT
Sliding sheave bushing	40.3 mm (1.587 in)

Lever, Roller and Pin

Check levers for cracks, distortion or other damages.

Check lever pivot for wear.

Check lever flanged bushing for wear.



1. Lever pivot
2. Lever flanged bushing

Check rollers for roundness of external diameter.

Check thrust washers for thickness wear.

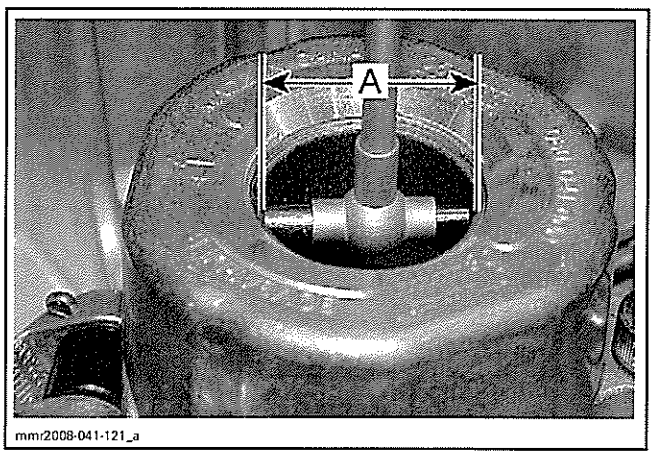
Check roller pins for wear.

Spring Cover

Check spring cover for cracks or wear.

Visually inspect the coating of spring cover bushing for wear.

Using a bore gauge, measure the inner diameter of spring cover bushing. Measuring point must be at least 5 mm (1/4 in) from bushing edge.



A. Inner diameter of spring cover bushing

BUSHING	SERVICE LIMIT
Spring cover bushing	30.4 mm (1.197 in)

Replace the spring cover if the inner diameter of bushing is out of specification.

Spring

Check spring color code and free length. Replace if necessary.

DRIVE PULLEY SPRING	
COLOR CODE	FREE LENGTH
YELLOW/RED	121.1 mm (4.768 in)

Drive Pulley Assembly

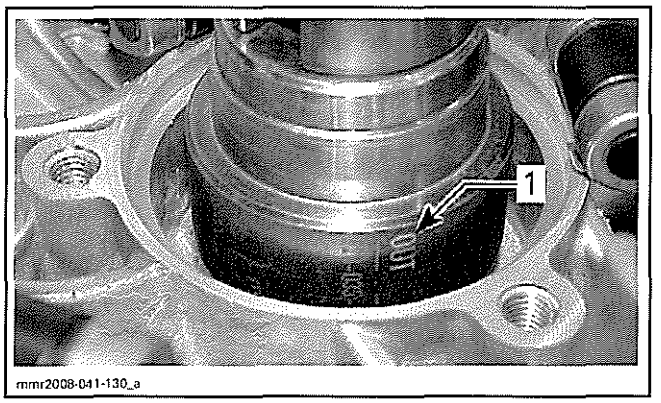
Sliding Sheave Bushing Installation

To install a **NEW** bushing, secure the PULLEY SPRING COMPRESSOR TOOL (P/N 529 036 012) in a vice and mount the sliding sheave.

Apply LOCTITE 680 (P/N 293 800 118) on the outside of bushing face.

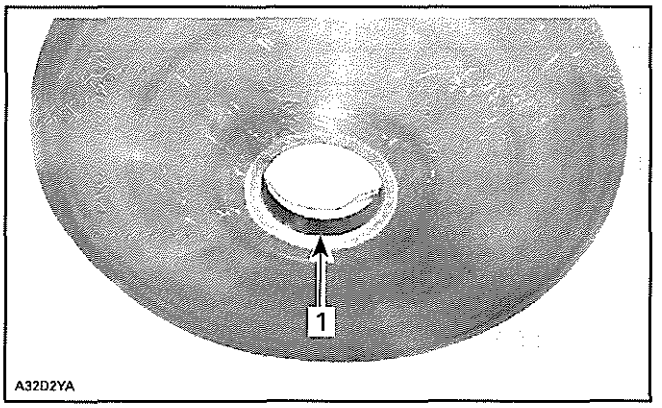
Insert the bushing from inner side of sliding sheave.

Mount the BUSHING REMOVER/INSTALLER (P/N 529 035 931) with side marked "IN" to press in a new bushing.



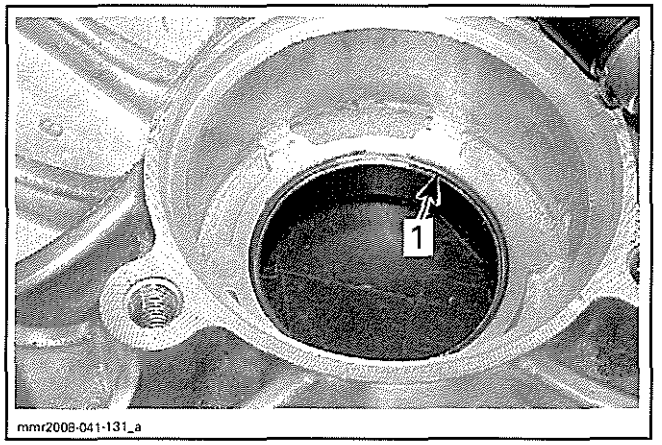
1. Mark "OUT" toward outside

NOTE: Make sure that the bushing is well seated on the sliding sheave.



1. Bushing

Install the circlip.



1. Circlip

NOTICE Make sure that the circlip is properly position in its groove.

Ring Gear

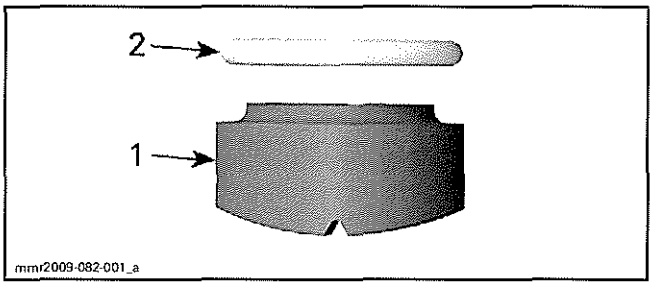
Clean ring gear and the inner threads of fixed sheave.

Install NEW ring gear screws and torque them in accordance with the following chart.

RING GEAR SCREW TORQUE
27 N•m (20 lbf•ft)

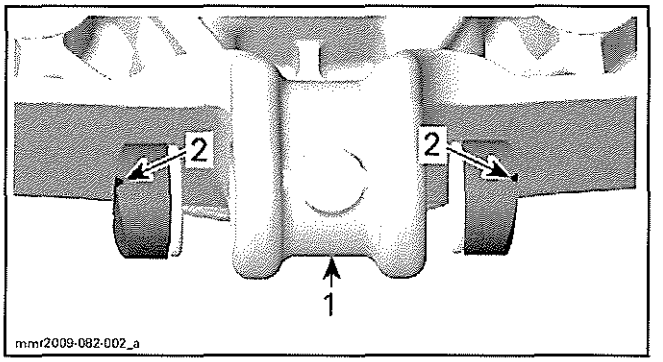
Sliding Sheave, Slider Shoes and Governor Cup

Install an O-ring on each slider shoes.



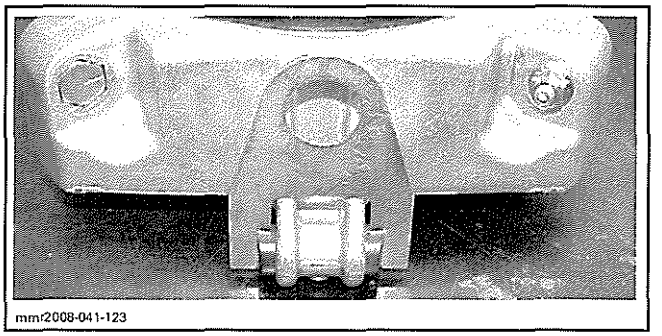
1. Slider shoe
2. O-ring

Insert slider shoes into governor cup so that groove in each slider shoe is vertical to properly slide in guides.

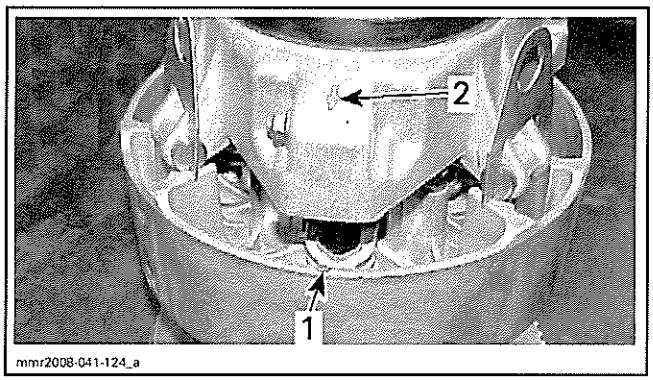


1. Governor cup
2. Slider shoe grooves

Install a SLIDER SHOE FORK (P/N 529 005 500) into slider shoe grooves to maintain them for governor cup installation. Proceed on 3 set of slider shoes.



Make sure to align governor cup arrow with sliding sheave mark.



1. *Sliding sheave mark*
2. *Governor cup arrow*

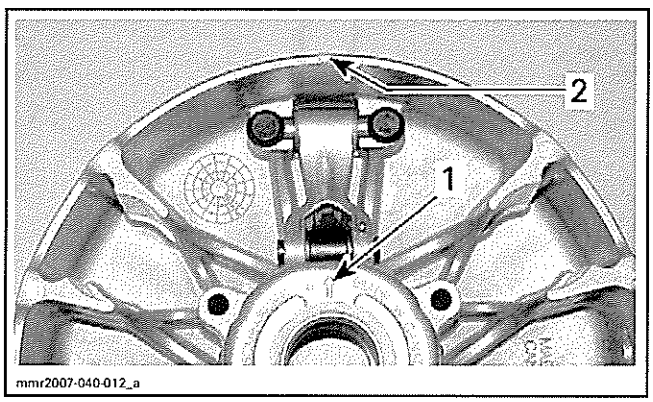
Carefully slide governor cup into sliding sheave.

Remove forks and push governor cup.

Spring Cover

To install spring cover, use PULLEY SPRING COMPRESSOR TOOL (P/N 529 036 012).

Align spring cover arrow with sliding sheave mark.

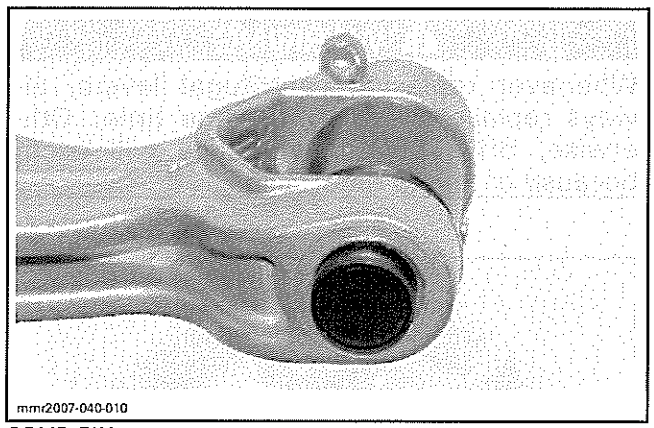


TYPICAL
1. *Spring cover arrow*
2. *Sliding sheave mark*

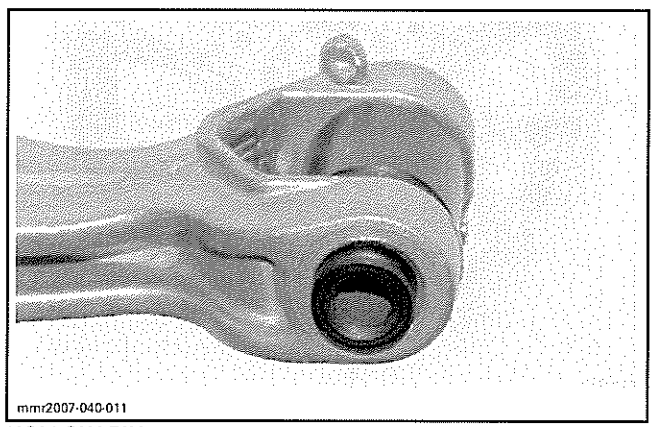
Tighten spring cover screws to 25 N•m (18 lbf•ft).

Lever, Roller and Pin

Always use the same type of pin as originally installed when servicing. Refer to *TECHNICAL SPECIFICATIONS*.



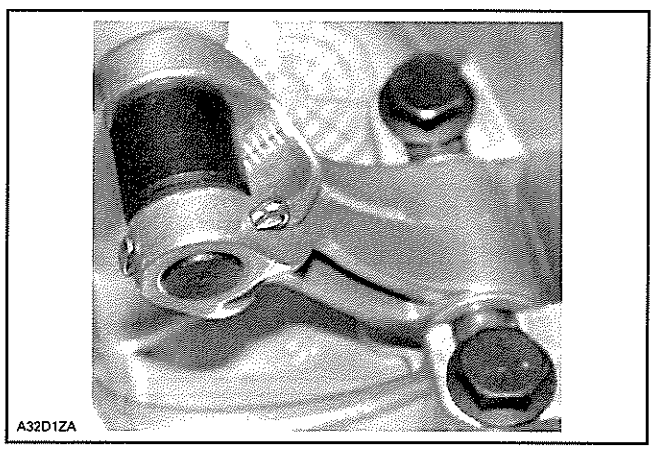
SOLID PIN



HOLLOW PIN

NOTE: Different types have different weights for calibration purpose. Refer to *HIGH ALTITUDE BULLETIN*.

While installing lever make sure that the curved sides of the levers are outwards as shown.

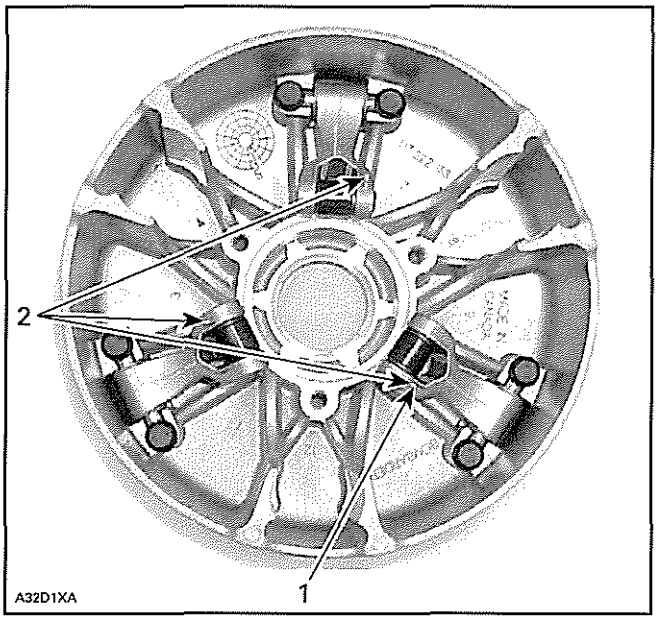


Always install lever assemblies so cotter pin heads are oriented on top when lever is set at the bottom of sliding sheave.

Bend cotter pin ends to sit perfectly against lever.

⚠ WARNING

Whenever replacing centrifugal levers, always replace all 3 at the same time. Otherwise, drive pulley unbalance will occur because of levers difference.



1. Cotter pin head on top
2. All on the same side

Torque lever screws to 18 N•m (159 lbf•**in**).

NOTICE Levers and rollers must move easily after installation.

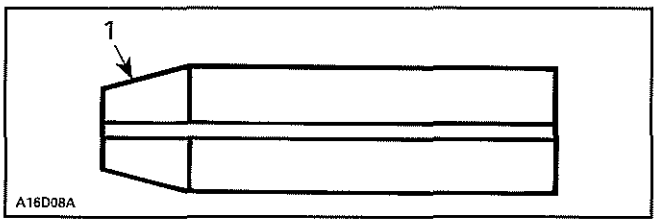
Hollow Threaded Pin Set Screw

Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on set screw.

Tighten the set screw completely inside the hollow threaded pin.

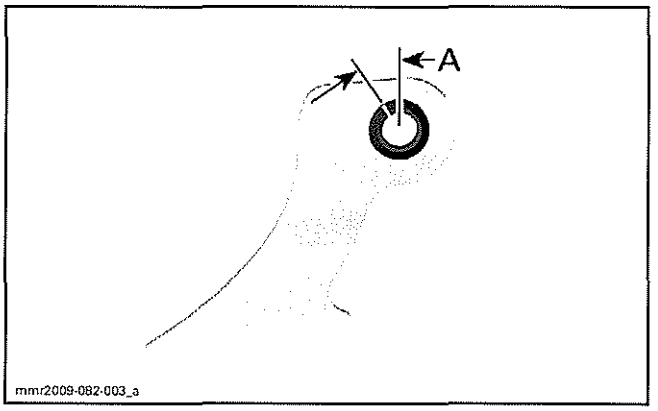
Ramp

Insert dowel tube from chamfered side.



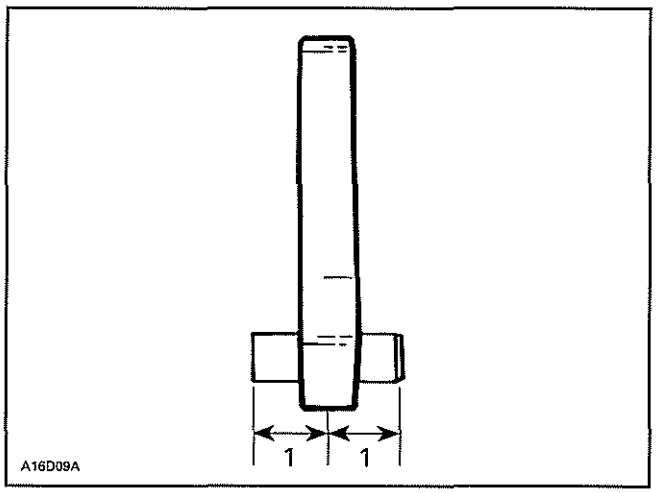
1. Chamfered side

Position dowel tube split at the angle "A".



MODEL	ANGLE "A"
All	45 ± 3°

Make sure ramp is centered on dowel tube.

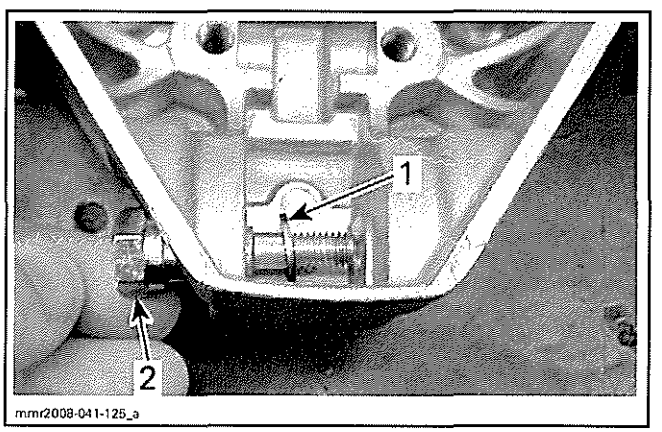


1. Equal distance

Torque ramp screws to 12 N•m (106 lbf•**in**).

Calibration Screw

When installing calibration screw, make sure to install washer as shown.



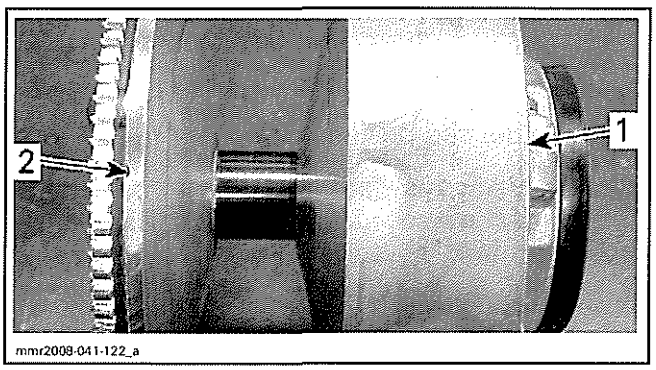
1. Washer
2. Calibration screw

NOTE: Refer to *DRIVE PULLEY ADJUSTMENT*, further in this section, to install the calibration screws in original setting.

Torque locking nut to 10 N•m (89 lbf•**in**).

Sliding Sheave and Fixed Sheave

To assemble the sliding sheave on the fixed sheave, align sliding sheave mark with the dot at the back of fixed sheave.



1. Sliding sheave mark
2. Fixed sheave dot

NOTE: Push sliding sheave until governor cup splines are engaged on fixed sheave splines.

Drive Pulley Installation

Clean mounting surfaces as described in *DRIVE PULLEY CLEANING* above.

NOTICE **Do not apply antiseize or any lubricant on crankshaft and drive pulley tapers.**

Install drive pulley on crankshaft extension.

Install a NEW conical spring washer with its concave side towards drive pulley then install drive pulley bolt.

NOTICE **Always use BRP genuine parts for conical spring washer and bolt.**

Install the drive pulley bolt.

NOTICE **Make sure to use the proper bolt length to avoid damaging the crankshaft.**

DRIVE PULLEY BOLT LENGTH
152.5 mm (6.004 in)

Use the DRIVE PULLEY HOLDER (P/N 529 035 674) to retain drive pulley. See removal procedure.

Torque drive pulley bolt.

DRIVE PULLEY FIRST TORQUE	
All engines	120 N•m (89 lbf•ft)

Before starting engine, perform drive pulley adjustment, see further in this section.

Install drive belt and guard.

Raise the rear of the vehicle and support it with a mechanical stand.

⚠ WARNING

Ensure that the track is free of particles which could be thrown out while track is rotating. Keep hands, tools, feet and clothing clear of track. Ensure nobody is standing near the vehicle.

Accelerate the vehicle at low speed (maximum 32 km/h (20 MPH) and apply the brake, repeat 5 times.

Re-torque drive pulley bolt.

DRIVE PULLEY FINAL TORQUE	
All engines	120 N•m (89 lbf•ft)

⚠ WARNING

After 10 hours of operation the transmission system of the vehicle must be inspected to ensure drive pulley bolt is properly torqued.

Drive Pulley Adjustment

The drive pulley is factory calibrated to transmit maximum engine power at a predefined RPM. Factors such as ambient temperature, altitude or surface condition may vary this critical engine RPM thus affecting snowmobile efficiency.

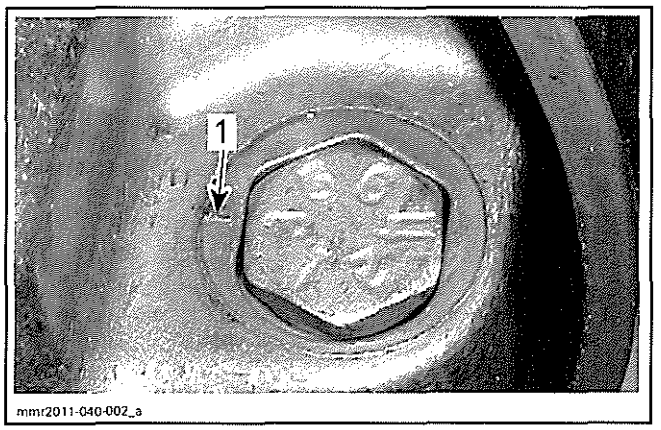
This adjustable drive pulley allows setting maximum engine RPM in the vehicle to maintain maximum power. Refer to *ENGINE MANAGEMENT SYSTEM* for engine RPM adjustment.

Calibration screws should be adjusted so that actual maximum engine RPM in vehicle matches the maximum horsepower RPM given in *TECHNICAL SPECIFICATIONS*.

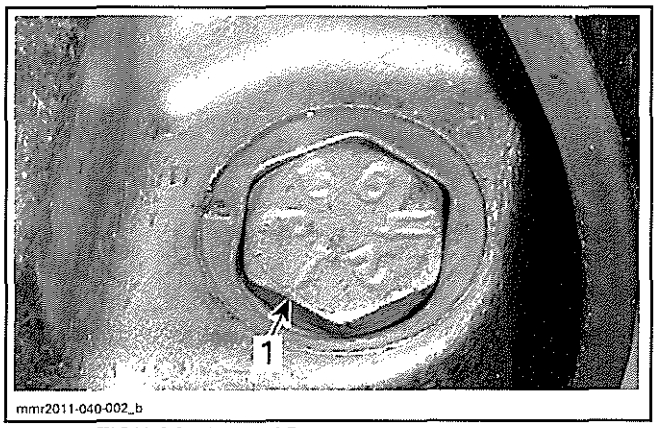
NOTE: The adjustment has an effect on high RPM only.

To adjust, modify ramp end position by turning calibration screws.

Governor cup has a notch while calibration screw head has 6 positions numbered 1 to 6.



GOVERNOR CUP
1. Notch



CALIBRATION SCREW HEAD
1. Position 1

See the following table for original setting.

CALIBRATION SCREW FACTORY SETTING
2

Each number modifies maximum engine RPM by about 200 RPM.

Lower numbers decrease engine RPM in steps of 200 RPM and higher numbers increase it in steps of 200 RPM.

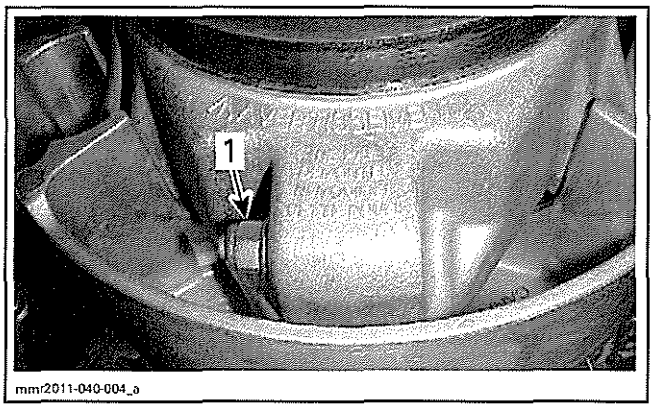
Example:

Calibration screw is set at position 3 and is changed to position 5. So maximum engine RPM is increased by about 400 RPM.

To Adjust:

Just loosen locking nut enough to pull calibration screw **partially** out. Do not completely remove the locking nut.

NOTICE Do not completely remove calibration screw otherwise its inside washer will fall off.



1. Loosen just enough to permit rotating of calibration screw

Adjust to desired position.

NOTICE Always adjust all 3 calibration screws and make sure they are all set at the same number.

Torque locking nuts to 10 N•m (89 lbf•**in**).

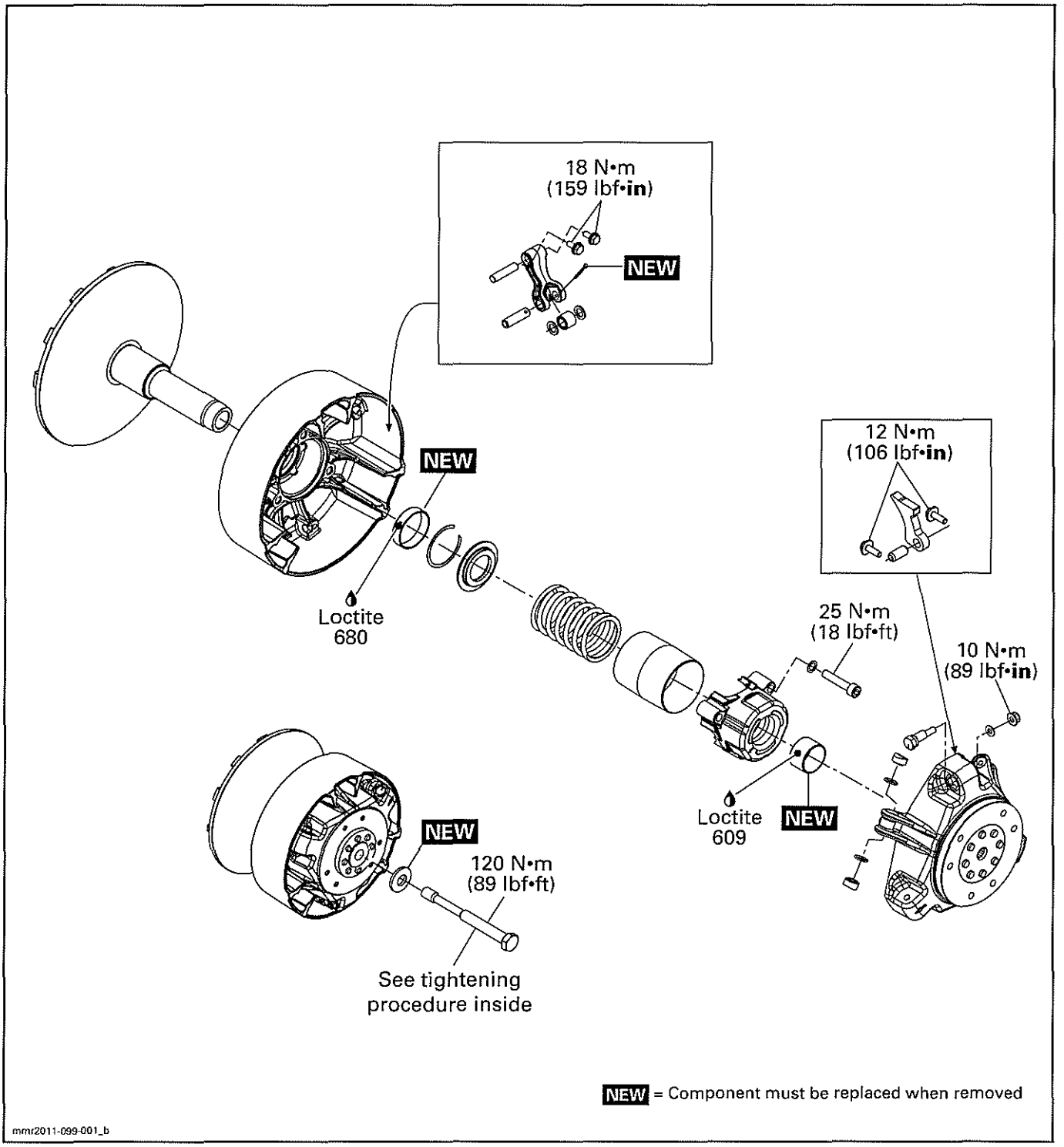
DRIVE PULLEY (TRA IV)

SERVICE TOOLS

Description	Part Number	Page
BUSHING PULLER/INSTALLER	529 031 200	725
BUSHING REMOVER/INSTALLER	529 035 931	726, 728
DRIVE PULLEY HOLDER	529 035 674	721, 732
DRIVE PULLEY PULLER	529 000 064	721
PULLEY SPRING COMPRESSOR TOOL	529 036 012	723, 725, 728–729
SLIDER SHOE FORK	529 005 500	722, 729

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 680	293 800 118	728
PULLEY FLANGE CLEANER	413 711 809	726


18 N•m
(159 lbf•in)
NEW
NEW
Loctite
680
12 N•m
(106 lbf•in)
25 N•m
(18 lbf•ft)
10 N•m
(89 lbf•in)
Loctite
609
NEW
NEW
120 N•m
(89 lbf•ft)
See tightening
procedure inside
NEW = Component must be replaced when removed
mmr2011-099-001_b

GENERAL

TRA drive pulley stands for **Total Range Adjustable** drive pulley.

These are lubrication free drive pulleys. Do not lubricate any component.

Always refer to appropriate *PARTS CATALOG* for replacement part.

Most parts of TRA IV are not interchangeable with those of the other TRA pulley type.

NOTICE Never use any type of impact wrench for drive pulley removal and installation. The use of an impact wrench could damage the drive pulley and modify the calibration.

Some drive pulley components (return spring, ramp) can be changed to improve vehicle performance in high altitude regions. A *SERVICE BULLETIN* provides information about pulley calibration according to altitude.

NOTICE Such modifications should only be performed by experienced mechanics since they can greatly affect vehicle performance. Verify spring specifications before installation. Do not only refer to the spring color code.

⚠ WARNING

Any drive pulley repairs must be performed by an authorized Ski-Doo dealer. Subcomponent installation and assembly tolerances require strict adherence to procedures detailed.

During assembly/installation, use torque values and service products as in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

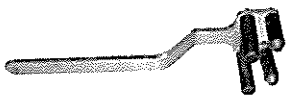
Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, cotter pins, etc.) must be replaced.

PROCEDURES

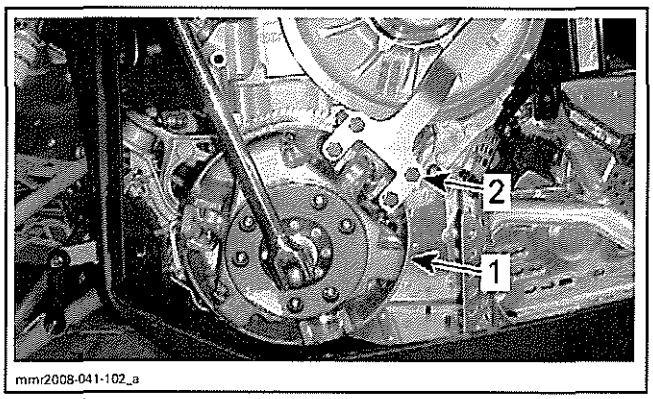
DRIVE PULLEY

Drive Pulley Removal

1. Remove drive belt. Refer to *DRIVE BELT* subsection.

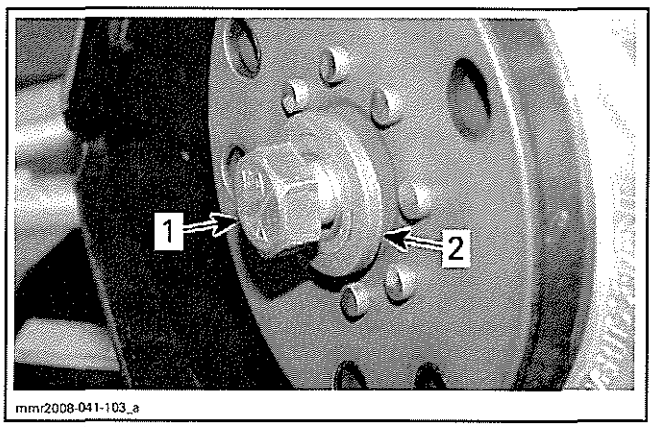
DRIVE PULLEY REMOVAL TOOLS	
DRIVE PULLEY PULLER (P/N 529 000 064)	DRIVE PULLEY HOLDER (P/N 529 035 674)
	

2. Secure drive pulley using the drive pulley holder. Install it over a sliding sheave tower as per following illustration.



TYPICAL
1. *Drive pulley*
2. *Drive pulley holder*

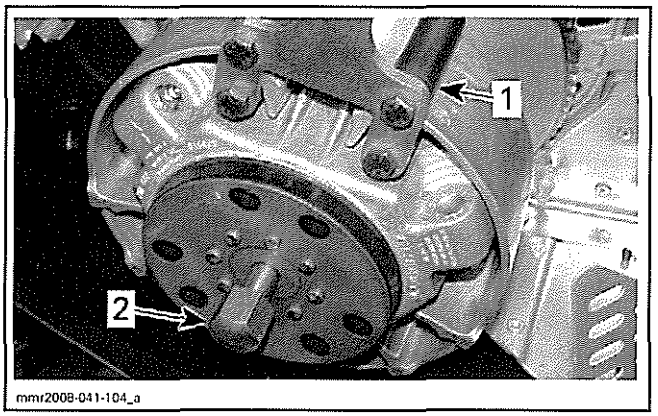
3. Remove the drive pulley retaining bolt and discard its conical spring washer.



TYPICAL
1. *Drive pulley retaining bolt*
2. *Conical spring washer*

NOTICE These pulleys have metric threads. Do not use a puller with ANS (American National Standard) or IS (International Standard) type threads. Always tighten puller by hand to ensure that the drive pulley has the same type of threads (metric vs ANS or IS) prior to fully tightening.

4. Install the drive pulley puller in the pulley shaft.
5. As you retain the drive pulley using the drive pulley holder, tighten the drive pulley puller until the pulley comes off the drive shaft.



TYPICAL
1. Drive pulley holder
2. Drive pulley puller

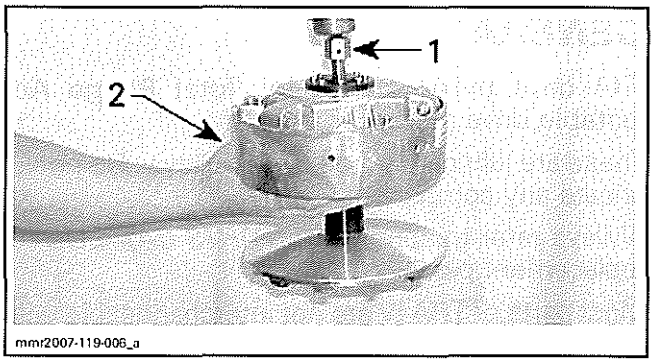
Drive Pulley Disassembly

Fixed Sheave

NOTICE NEVER tap on governor cup.

To separate fixed sheave from sliding sheave:
- Screw puller into fixed sheave shaft about 13 mm (1/2 in).
- Hold drive pulley in your hand by the sliding sheave as illustrated.
- Tap on puller head to disengage fixed sheave.

NOTE: No component marking is required before disassembly since this drive pulley has factory index marks references.



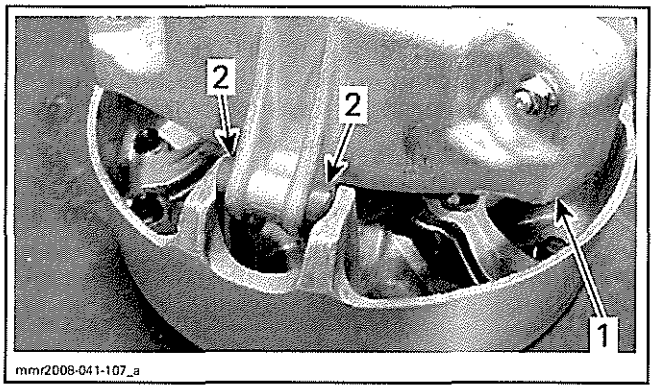
TYPICAL
1. Puller
2. Holding sliding sheave

If separation of the fixed sheave from the sliding sheave is hard, use a heat gun to slightly heat the governor cup to expand its taper.

NOTICE Never use any type of torch to heat governor cup.

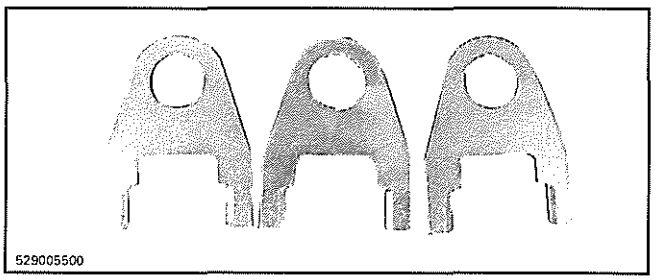
Slider Shoes and Governor Cup

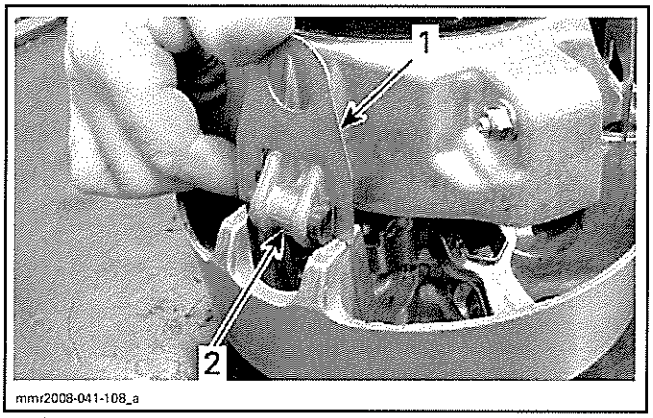
1. Carefully pull up on governor cup until the slider shoes are at their highest position in the guides.



1. Governor cup
2. Slider shoes

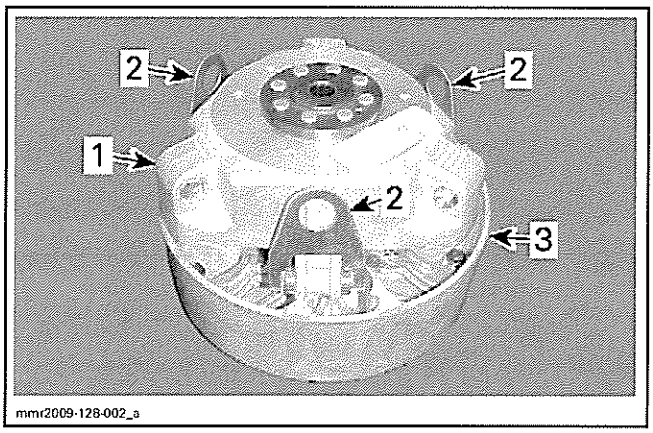
2. Hold a slider shoe set, then carefully lift its housing and install a SLIDER SHOE FORK (P/N 529 005 500) as illustrated.
3. Proceed the same way for other housings lifting one at a time.





1. Governor cup
2. Slider shoe forks

4. When all slider shoes are held with the forks, remove the governor cup.



1. Governor cup
2. Slider shoe forks
3. Sliding sheave

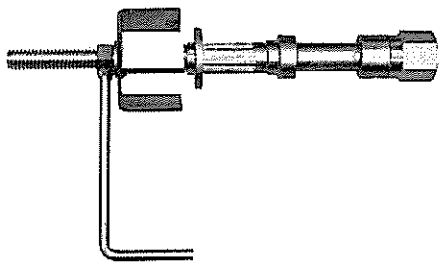
Spring Cover

To remove the spring cover, always use the PULLEY SPRING COMPRESSOR TOOL (P/N 529 036 012).

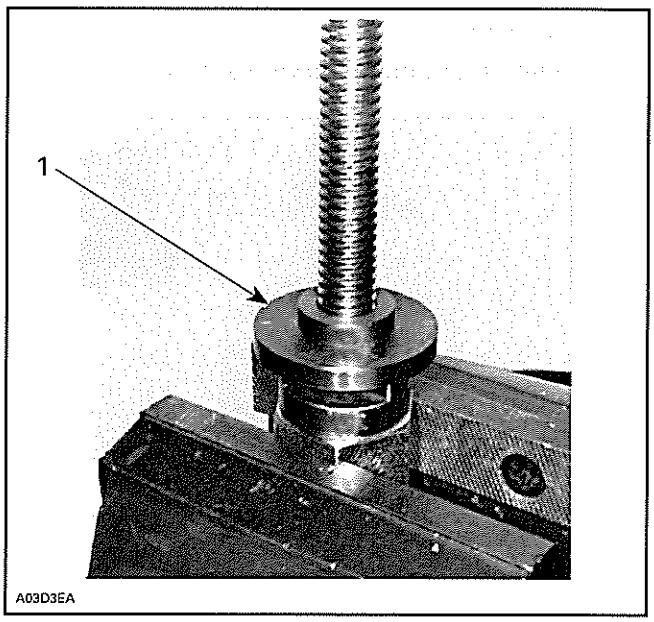
⚠ WARNING

Clutch spring cover is under high clutch spring preload. Never attempt to remove the spring cover without the recommended tool.

PULLEY SPRING COMPRESSOR TOOL
(P/N 529 036 012)



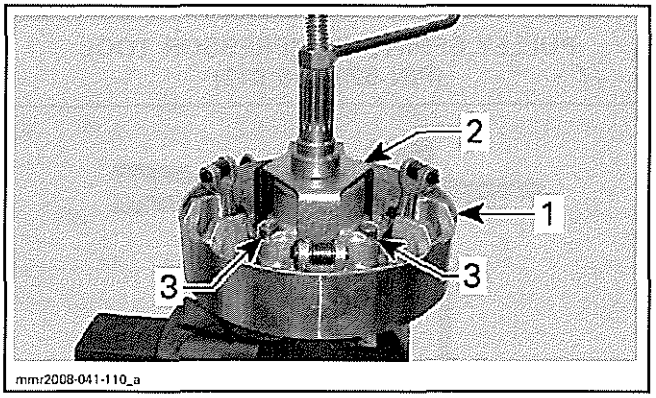
1. Install support guide of spring compressor in a vice.



1. Support guide

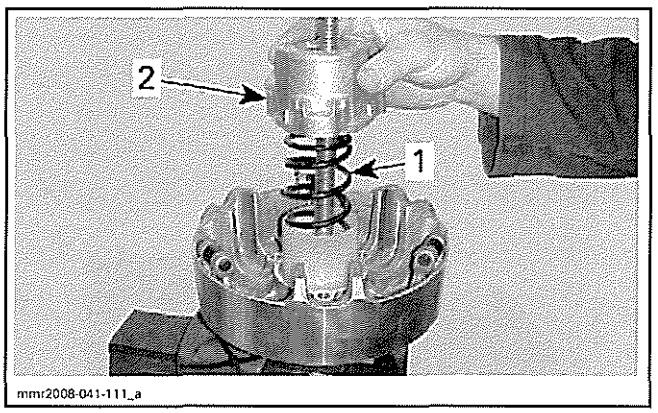
NOTE: The support guide will prevent bushing damages.

2. Install sliding sheave then the support cup over spring cover.
3. Remove 3 Allen screws retaining spring cover.



TYPICAL
1. *Sliding sheave*
2. *Support cup*
3. *Spring cover screws*

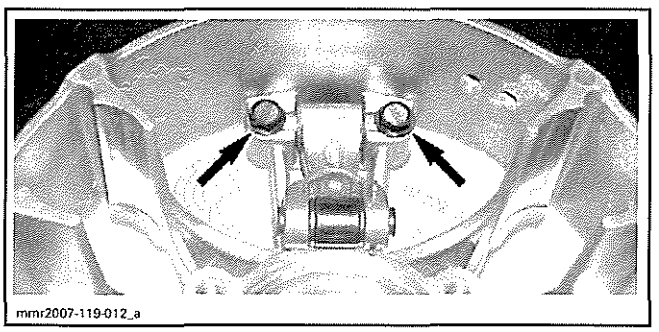
4. Unscrew tool to disengage spring cover from sliding sheave.
5. Remove spring cover, spring and spring seat.



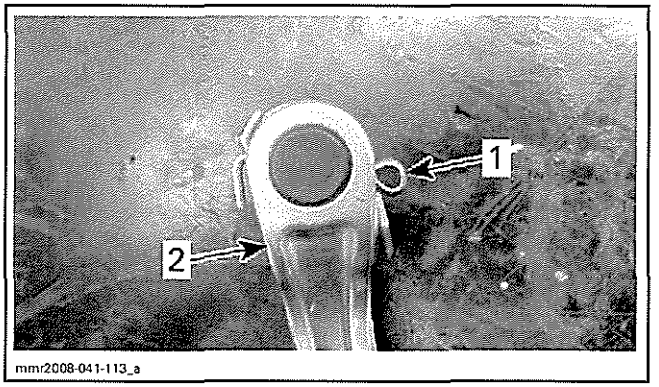
1. *Spring*
2. *Spring cover*

Lever, Roller and Pin

1. Remove lever retaining screws.

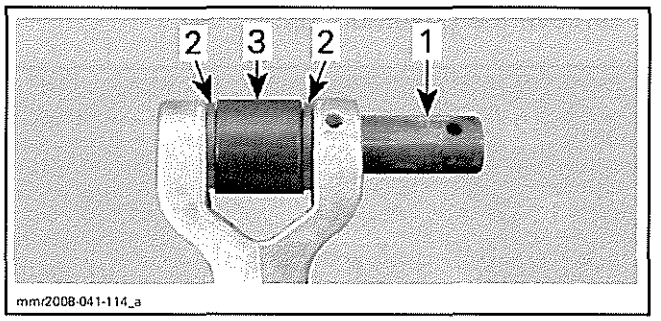


2. Pull lever to remove it from sliding sheave.
3. Remove and discard the cotter pin that retains the roller pin.



1. *Cotter pin*
2. *Lever*

4. Remove roller pin, thrust washers and roller.

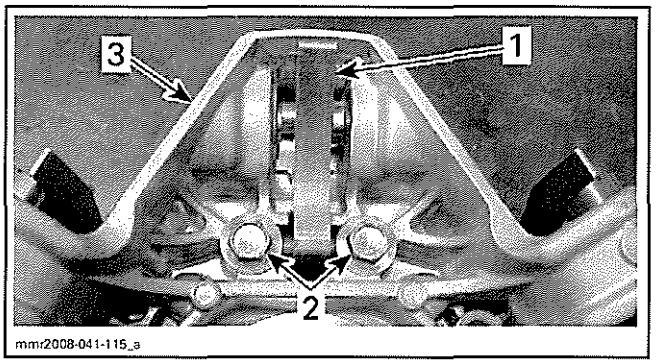


1. *Pin*
2. *Thrust washers*
3. *Roller*

Ramp

Turn the governor cup up side down.

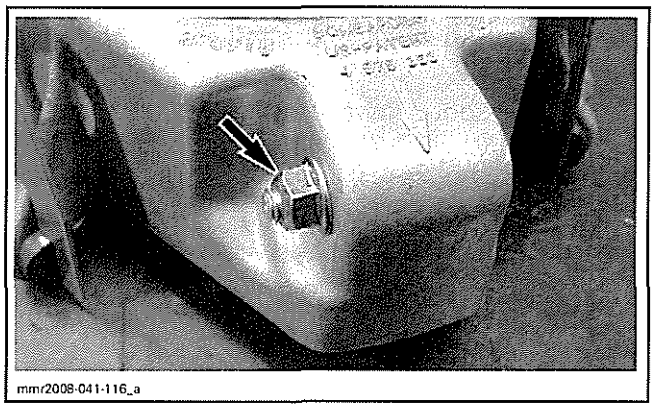
Remove screws retaining ramp to governor cup.



1. *Ramp*
2. *Ramp screws*
3. *Governor cup*

Calibration Screw

Unscrew the nut securing the calibration screw.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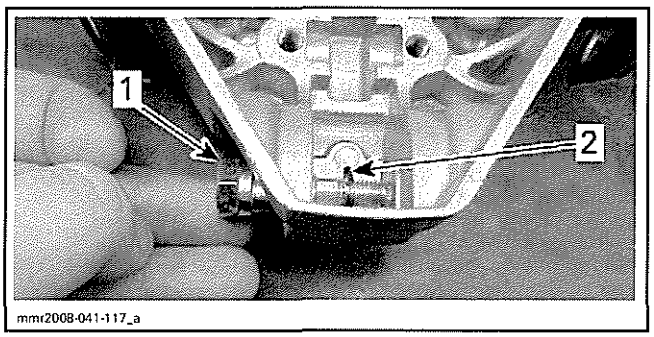
Remove calibration screw and its washer.



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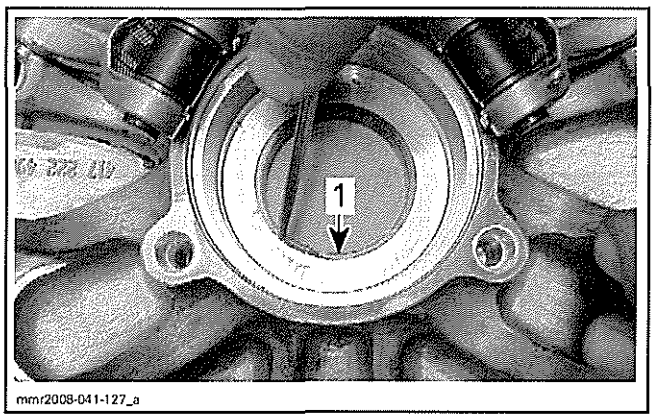
1. *Calibration screw*
2. *Washer*

Sliding Sheave Bushing Removal

NOTE: In case of worn out bushing, it is advisable to replace the whole sliding sheave assembly as replacing just the bushing may reduce the drive pulley performance.

If bushing is out of specifications, remove it as follows:

1. Remove circlip from the sliding sheave.



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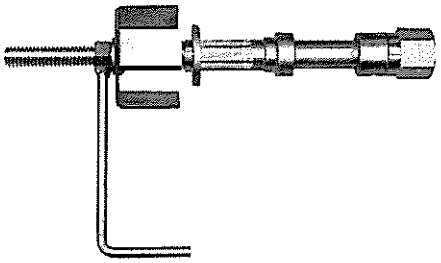
1. *Circlip*

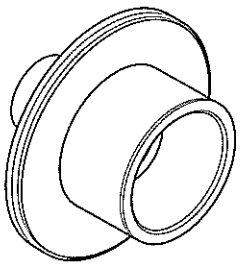
2. Secure the pulley spring compressor tool in a vice.

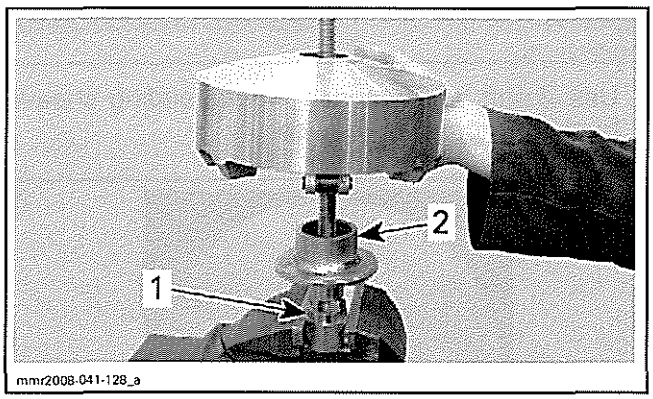
PULLEY SPRING COMPRESSOR TOOL (P/N 529 036 012)



3. Mount the bushing puller/installer and the sliding sheave assembly on the spring compressor tool as per following illustration.

BUSHING PULLER/INSTALLER (P/N 529 031 200)





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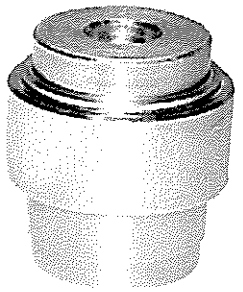
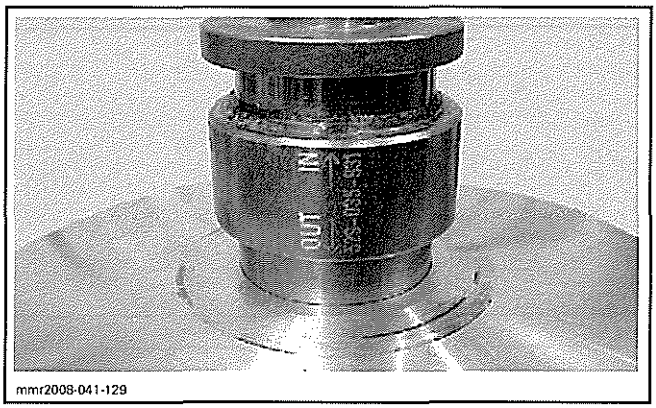
1. *Spring compressor*
2. *Bushing remover/installer*

4. Use the bushing remover/installer to press out old bushing.

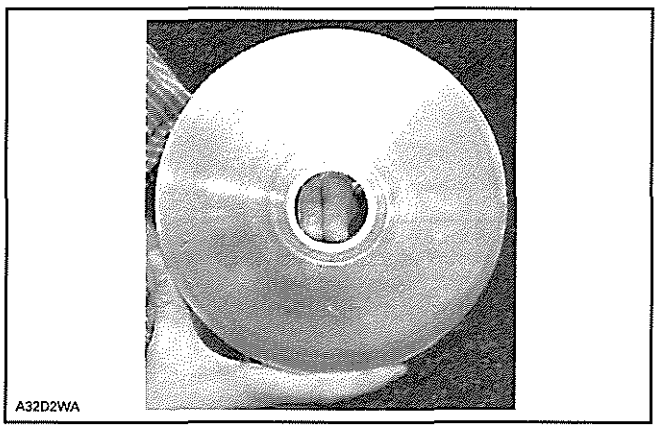
BUSHING REMOVER/INSTALLER (P/N 529 035 931)



NOTE: Make sure to use the tool as marked; to remove the bushing press using the side marked "OUT", as illustrated in the following picture.



5. Use a soft sand paper to clean sliding sheave bushing mounting surface.



6. Clean sliding sheave bushing mounting surface with PULLEY FLANGE CLEANER (P/N 413 711 809).
7. Clean the circlip groove.

Drive Pulley Cleaning

Parts must be at room temperature before cleaning.

Clean pulley sheaves and shaft using fine steel wool and a dry cloth.

Using a paper towel and PULLEY FLANGE CLEANER (P/N 413 711 809), clean the following components:

- Crankshaft tapered end
- The taper inside the fixed sheave of the drive pulley
- Crankshaft threads
- Retaining screw threads.

NOTICE **Avoid contact between cleaner and crankshaft seal as damage may occur.**

Remove all hardened oil deposits that are baked on crankshaft and pulley tapered surfaces using coarse or medium steel wool and/or sand paper no. 600.

NOTICE **Do not use any other type of abrasive.**

Reclean mounting surfaces using a paper towel and cleaning solvent.

Wipe off the mounting surfaces using a clean, dry paper towel.

NOTICE **Mounting surfaces must be free of any oil, cleaner or towel residue.**

Drive Pulley Inspection

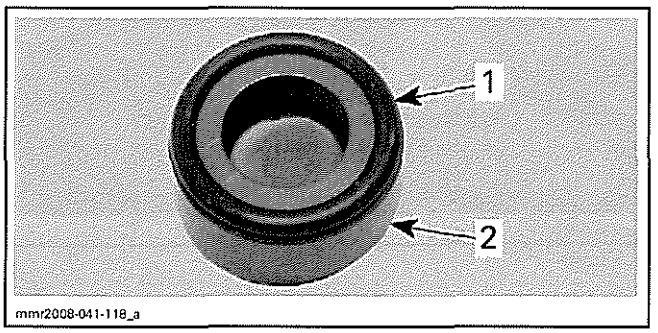
NOTE: During inspection, replace any component found defective or out of specifications.

Fixed Sheave and Governor Cup

Inspect fixed sheave for scratches or other damage.

Slider Shoes

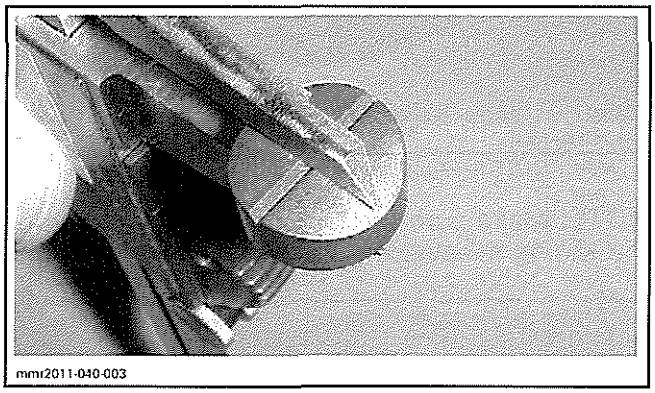
Check if slider shoe O-rings are cracked, cut or crushed. Replace as required.



1. O-ring
2. Slider shoe

Measure the thickness of slider shoes at the center of the slider shoe, perpendicular with the groove. See following illustration.

MODEL	SERVICE LIMIT
1200 4-TEC	7.95 mm (5/16 in)

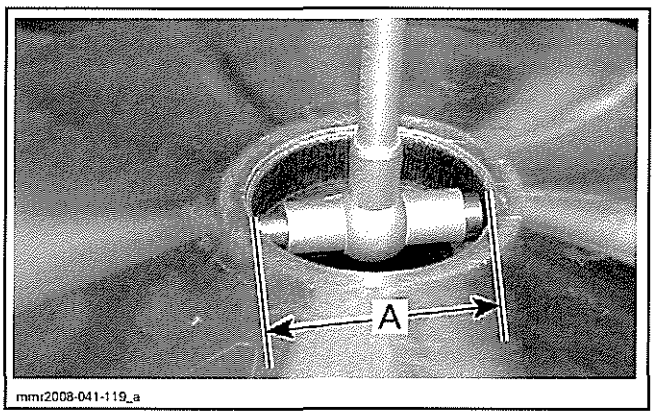


Sliding Sheave

Inspect pulley sheave for scratches or other damages.

Visually inspect coating of bushings.

Using a bore gauge, measure the inner diameter of the sliding sheave bushing.



A. Inner diameter of sliding sheave bushing

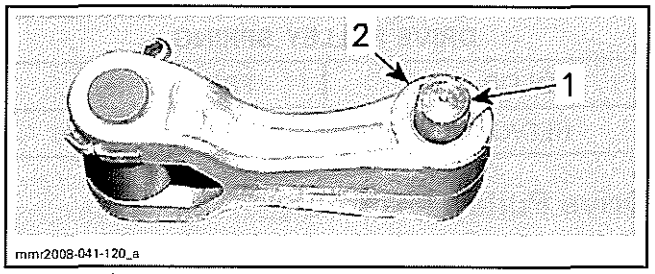
SLIDING SHEAVE BUSHING	
MEASURING POINT	At least 5 mm (1/4 in) from bushing edge
SERVICE LIMIT	40.3 mm (1.587 in)

Lever, Roller and Pin

Check levers for cracks, distortion or other damages.

Check lever pivot for wear.

Check lever flanged bushing for wear.



1. Lever pivot
2. Lever flanged bushing

Check rollers for roundness of external diameter.

Check thrust washers for thickness wear.

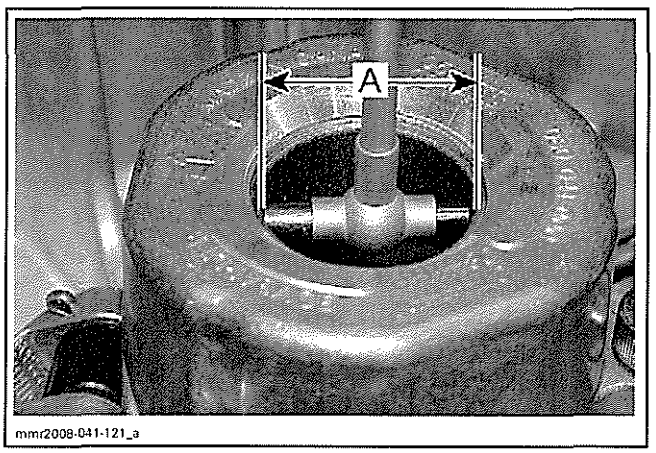
Check roller pins for wear.

Spring Cover

Check spring cover for cracks or wear.

Visually inspect the coating of spring cover bushing for wear.

Using a bore gauge, measure the inner diameter of the spring cover bushing.



A. Inner diameter of spring cover bushing

SPRING COVER BUSHING	
MEASURING POINT	At least 5 mm (1/4 in) from bushing edge
SERVICE LIMIT	30.4 mm (1.197 in)

Replace the spring cover if the inner diameter of the bushing is out of specification.

Spring Inspection

Check spring color code and free length. Replace if necessary.

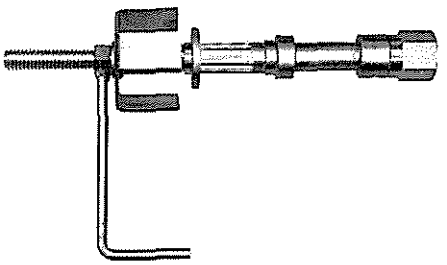
DRIVE PULLEY SPRING	
COLOR CODE	FREE LENGTH
RED/ORANGE	91.2 mm (3.591 in)

Drive Pulley Assembly

Sliding Sheave Bushing Installation

To install a NEW bushing, secure the pulley spring compressor tool in a vice and mount the sliding sheave.

PULLEY SPRING COMPRESSOR TOOL
(P/N 529 036 012)

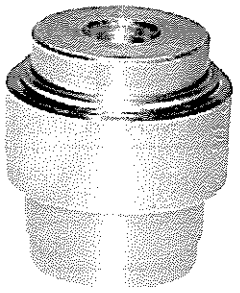


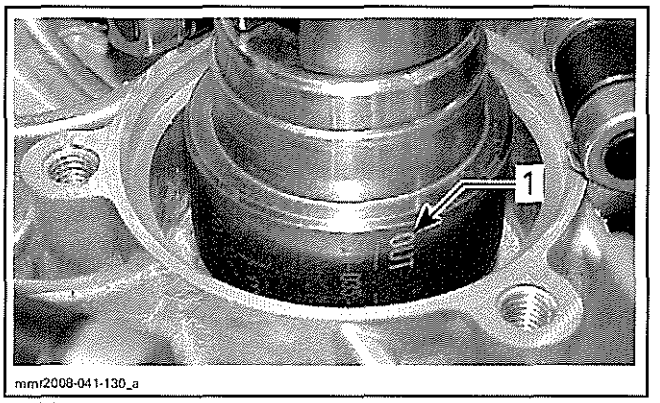
Apply LOCTITE 680 (P/N 293 800 118) on the outside of bushing face.

Insert the bushing from inner side of sliding sheave.

Mount the bushing remover/installer with side marked "IN" to press in a new bushing.

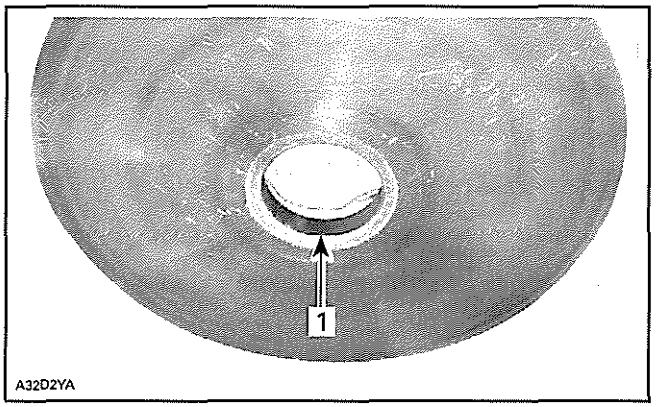
BUSHING REMOVER/INSTALLER
(P/N 529 035 931)





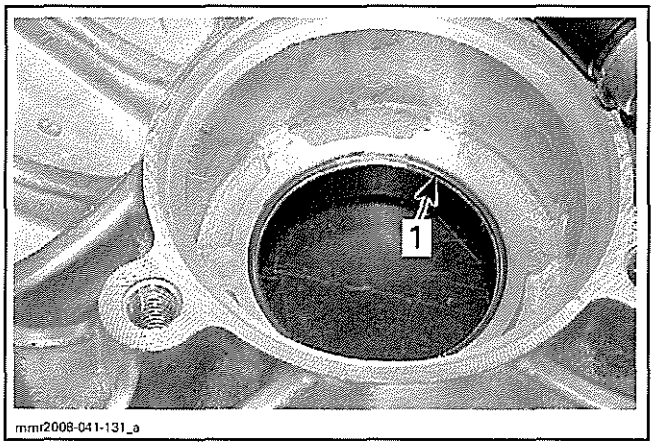
1. Mark "OUT" toward outside

NOTE: Make sure the bushing is well seated on the sliding sheave.



1. Bushing

Install the circlip.

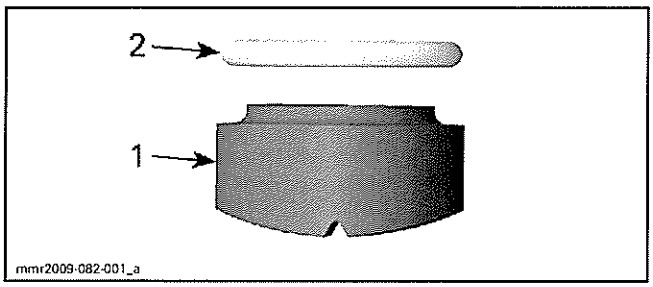


1. Circlip

NOTICE Make sure that the circlip is properly positioned in its groove.

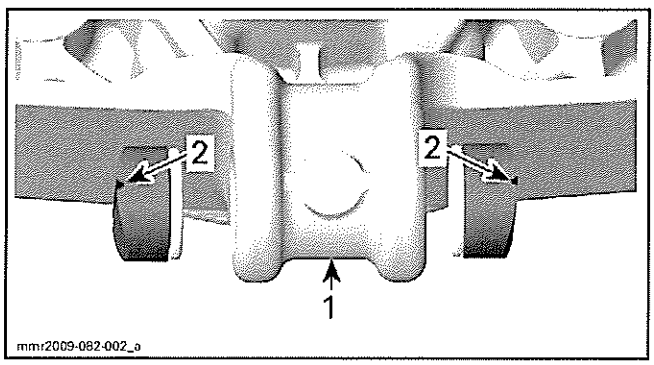
Sliding Sheave, Slider Shoes and Governor Cup

Install an O-ring on each slider shoe.



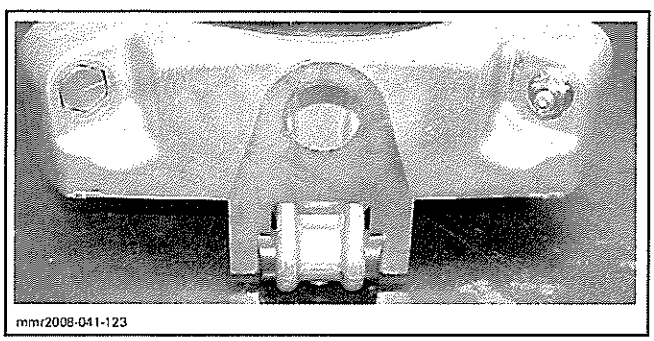
1. Slider shoe
2. O-ring

Insert slider shoes in the governor cup so the groove in each slider shoe is vertical to ensure they slide properly in the guides.

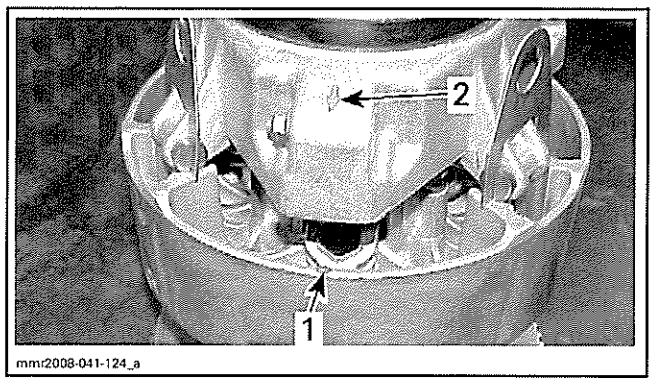


1. Governor cup
2. Slider shoe grooves vertical

Install a SLIDER SHOE FORK (P/N 529 005 500) in the slider shoe grooves to maintain them fast for governor cup installation. Repeat for 3 sets of slider shoes.



Align governor cup arrow with sliding sheave index mark.



1. Sliding sheave index mark
2. Governor cup arrow

Carefully insert the governor cup in the sliding sheave.

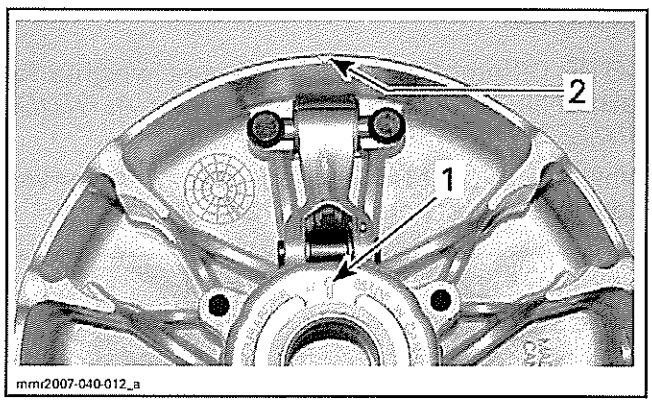
Remove forks and push governor cup all the way in the sliding sheave.

Spring Cover

To install spring cover, use PULLEY SPRING COMPRESSOR TOOL (P/N 529 036 012).

Reverse the removal procedure however, pay attention to the following.

Align spring cover arrow with sliding sheave index mark.



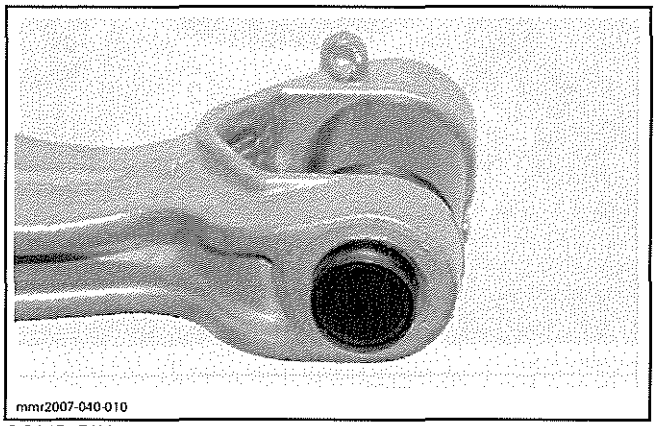
TYPICAL
1. Spring cover arrow
2. Sliding sheave mark

Install all retaining screws finger tight, then tighten as specified.

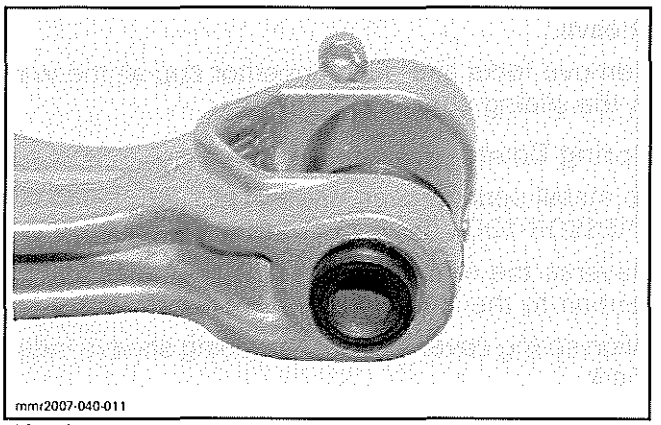
SPRING COVER RETAINING SCREW TORQUE
25 N•m (18 lbf•ft)

Lever, Roller and Pin

Always use the same type of pin as originally installed when servicing. Refer to *TECHNICAL SPECIFICATIONS* subsection.



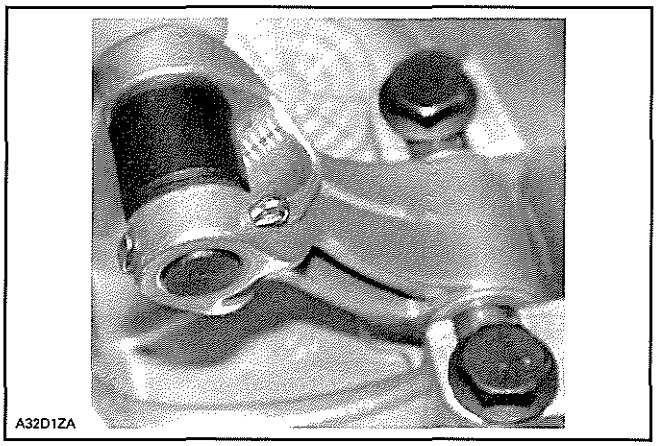
SOLID PIN



HOLLOW PIN

NOTE: Different types use different weights for calibration purposes. Refer to *HIGH ALTITUDE BULLETIN*.

While installing lever, make sure that the curved side of the levers are outwards as illustrated.

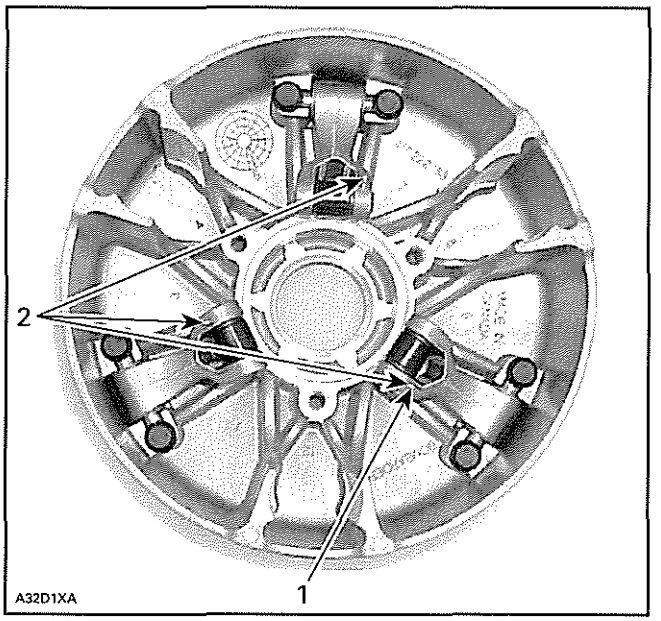


Always install lever assemblies so cotter pin heads are oriented on top when lever is set at the bottom of the sliding sheave.

Bend cotter pin ends to sit perfectly against lever.

⚠ WARNING

Whenever replacing centrifugal levers, always replace all 3 at the same time. Otherwise, drive pulley unbalance will occur because of levers difference.



1. Cotter pin head on top
2. All on the same side

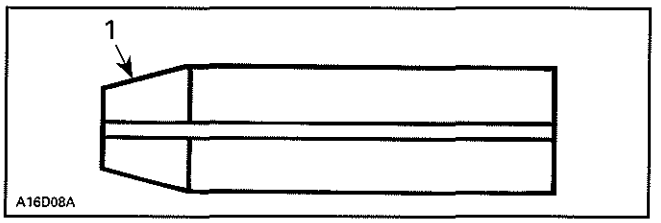
Torque lever retaining screws as specified.

LEVER RETAINING SCREW TORQUE
18 N•m (159 lbf•**in**)

NOTICE Levers and rollers must move easily after installation.

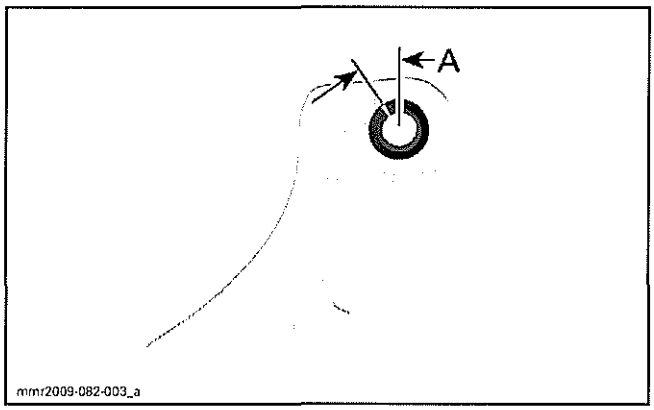
Ramp

Insert dowel tube from chamfered side.



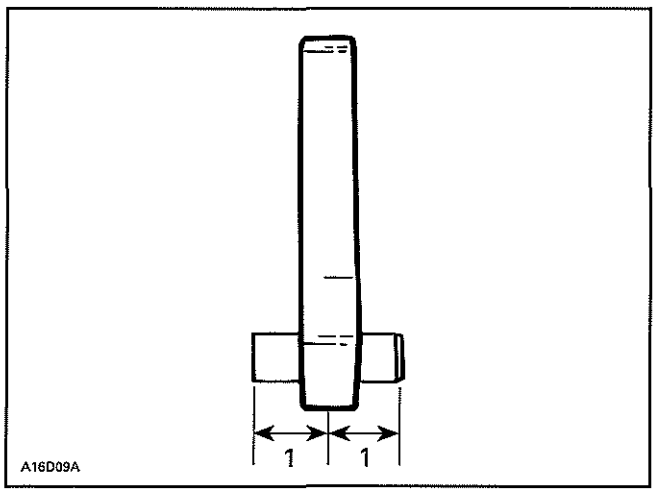
1. Chamfered side

Position dowel tube split at the angle "A".



MODEL	ANGLE "A"
TRA IV	45 ± 3°

Make sure ramp is centered on dowel tube.



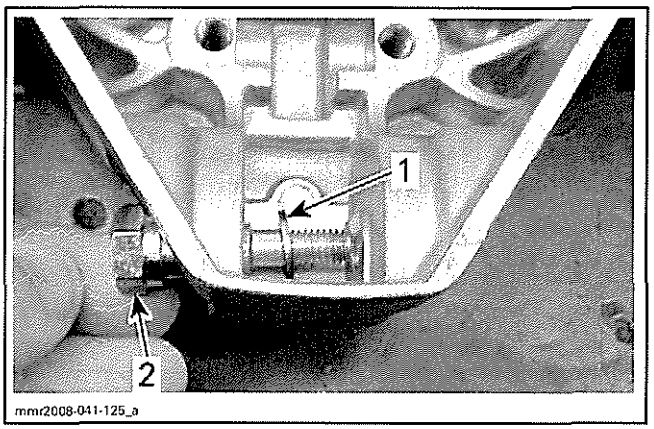
1. Equal distance

Torque ramp screws as specified.

RAMP SCREW TORQUE
12 N•m (106 lbf•**in**)

Calibration Screw

When installing the calibration screws, make sure to install their washer as illustrated.



1. Washer
2. Calibration screw

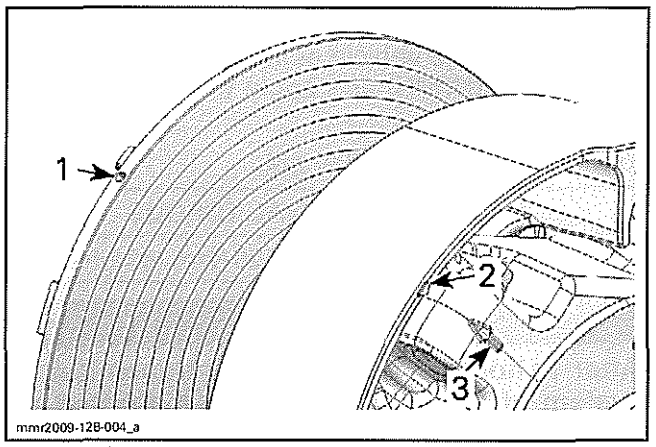
NOTE: Refer to *DRIVE PULLEY ADJUSTMENT* further in this subsection to install the calibration screws to their original setting.

Torque calibration screw lock nuts as specified.

CALIBRATION SCREW LOCK NUT TORQUE
10 N•m (89 lbf•**in**)

Sliding Sheave and Fixed Sheave

To assemble the sliding sheave on the fixed sheave, align the sliding sheave index mark with the dot at the back of the fixed sheave.



1. Fixed sheave index mark (dot)
2. Sliding sheave index mark
3. Governor cup index mark

Drive Pulley Installation

1. Clean mounting surfaces as described in *DRIVE PULLEY CLEANING* in this subsection.

NOTICE Do not apply antiseize or any lubricant on crankshaft and drive pulley tapers. Mounting surfaces must be free of any oil, cleaner or towel residue.

2. Install drive pulley on crankshaft extension.

3. Install a NEW conical spring washer with its concave side towards drive pulley then install drive pulley bolt.

NOTICE Always use BRP genuine parts for conical spring washer and bolt.

4. Use the DRIVE PULLEY HOLDER (P/N 529 035 674) to retain drive pulley. See removal procedure.
5. Torque drive pulley bolt.

DRIVE PULLEY FIRST TORQUE	
TRA IV	120 N•m (89 lbf•ft)

6. Before starting engine, perform the *DRIVE PULLEY ADJUSTMENT*. See further in this subsection.
7. Install drive belt and guard.
8. Raise the rear of the vehicle and support it with a mechanical stand.

⚠ WARNING

Ensure the track is free of particles which could be thrown out while track is rotating. Keep hands, tools, feet and clothing clear of track. Ensure nobody is standing near the vehicle.

9. Accelerate the vehicle at low speed (maximum 32 km/h (20 MPH) and apply the brake, repeat 5 times.
10. Re-torque drive pulley bolt.

DRIVE PULLEY FINAL TORQUE	
TRA IV	120 N•m (89 lbf•ft)

⚠ WARNING

After 10 hours of operation, the transmission system of the vehicle must be inspected to ensure drive pulley bolt is properly torqued.

Drive Pulley Adjustment

The drive pulley is factory calibrated to transmit maximum engine power at a predefined RPM. Factors such as ambient temperature, altitude or surface condition may vary this critical engine RPM thus affecting snowmobile efficiency.

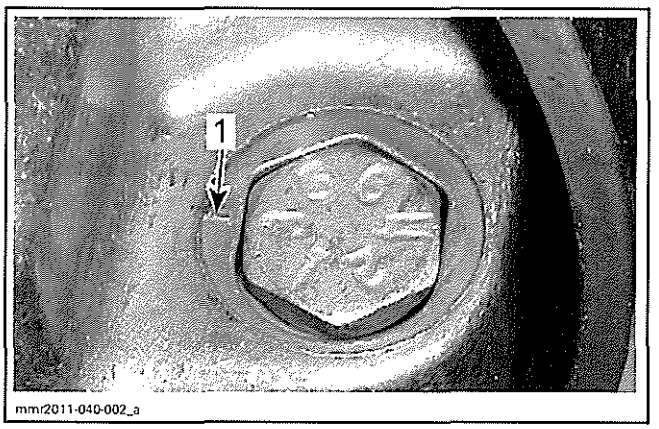
This adjustable drive pulley allows setting maximum engine RPM in the vehicle to maintain maximum power. Refer to *ENGINE MANAGEMENT SYSTEM* for engine RPM adjustment.

Calibration screws should be adjusted so that the actual maximum engine RPM of the vehicle matches the maximum horsepower RPM given in the *TECHNICAL SPECIFICATIONS* subsection.

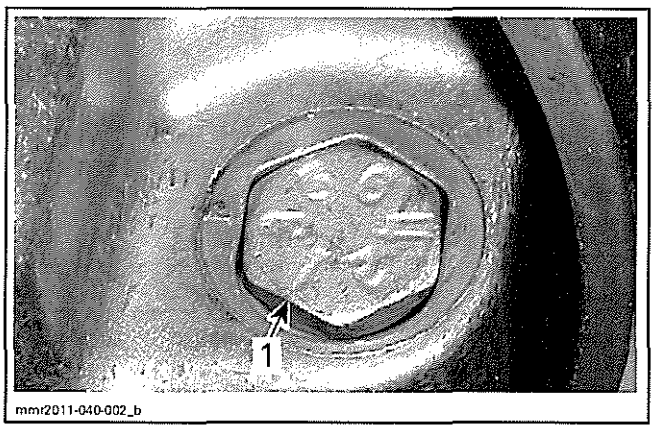
NOTE: The adjustment has an effect on high RPM only.

To adjust the drive pulley, modify ramp end position by turning the calibration screws.

The governor cup has an index mark, while the calibration screw head positions are numbered 1 to 6.



GOVERNOR CUP
1. Notch



CALIBRATION SCREW HEAD
1. Position 1

See the following table for original setting.

CALIBRATION SCREW	
MODEL	POSITION
Expedition SE/LE 1200 4-TEC	2

Each number modifies maximum engine RPM by about 200 RPM.

Lower numbers decrease engine RPM in steps of 200 RPM and higher numbers increase it in steps of 200 RPM.

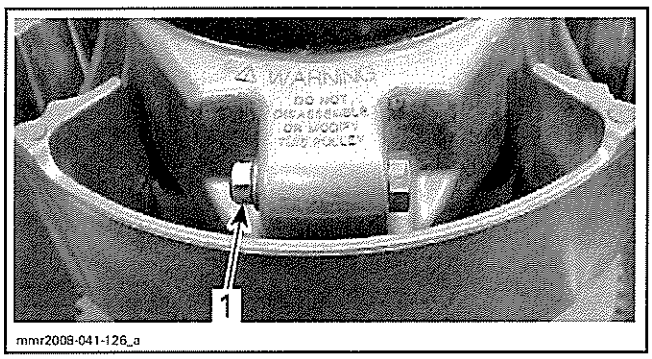
Example:

Calibration screw is set at position 3 and is changed to position 5. So maximum engine RPM is increased by about 400 RPM.

To Adjust:

Loosen lock nut sufficiently to pull calibration screw **partially** out. Do not completely remove the lock nut.

NOTICE Do not completely remove calibration screw otherwise its inner washer will fall off.



1. Loosen just enough to permit rotating of calibration screw

Adjust to desired position.

NOTICE Always adjust all 3 calibration screws and make sure they are all set to the same setting number.

Torque calibration screw lock nuts as specified.

CALIBRATION SCREW LOCK NUT TORQUE
10 N•m (89 lbf•**in**)

DRIVEN PULLEY AND COUNTERSHAFT (600 ACE)

SERVICE TOOLS

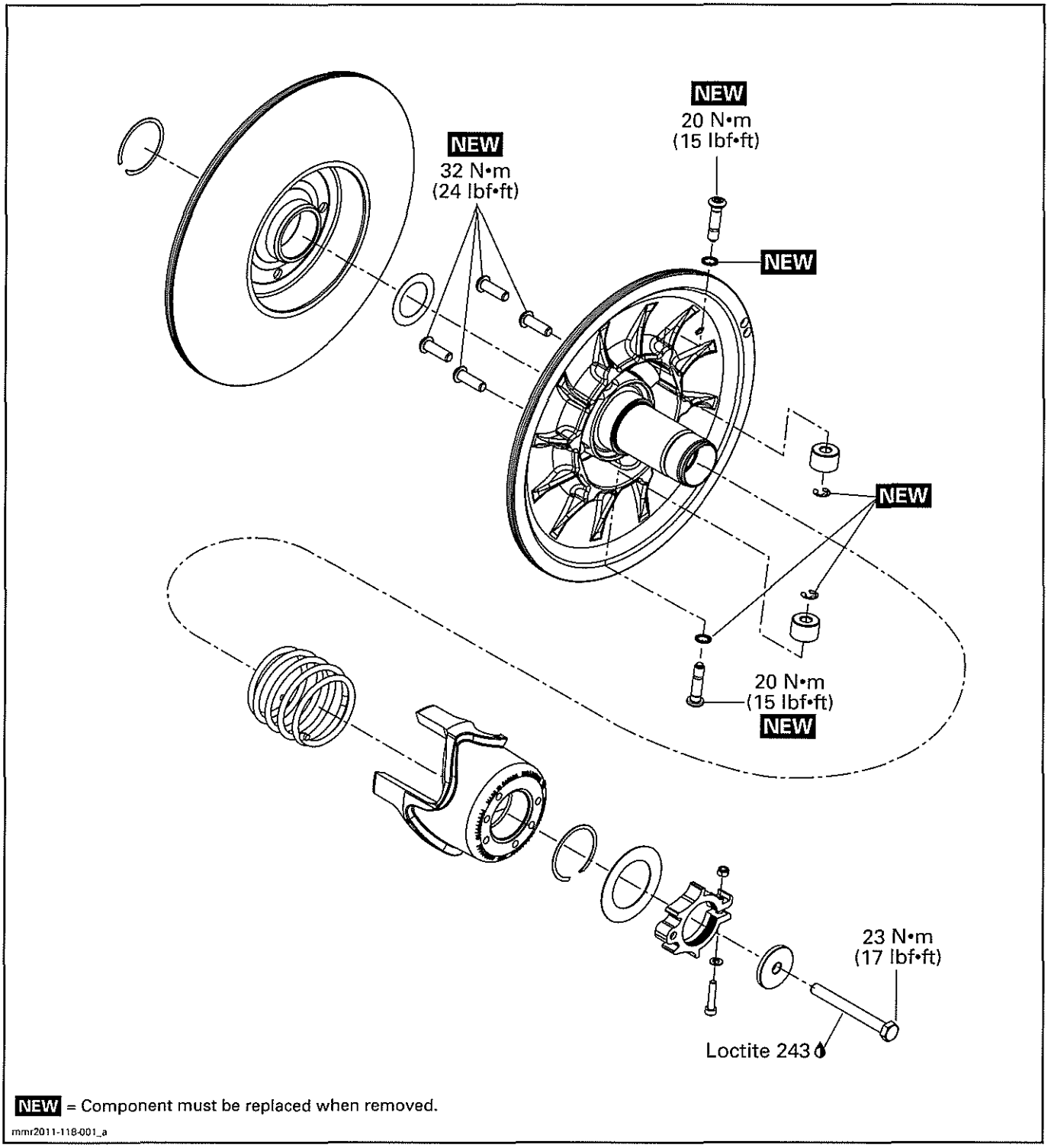
Description	Part Number	Page
ALIGNMENT BAR	529 036 157	738
DRIVEN PULLEY SPRING COMPRESSOR	529 036 182	741
ENGINE LIFTING TOOL	529 036 217	747
PRELOAD TESTER	529 036 164	739

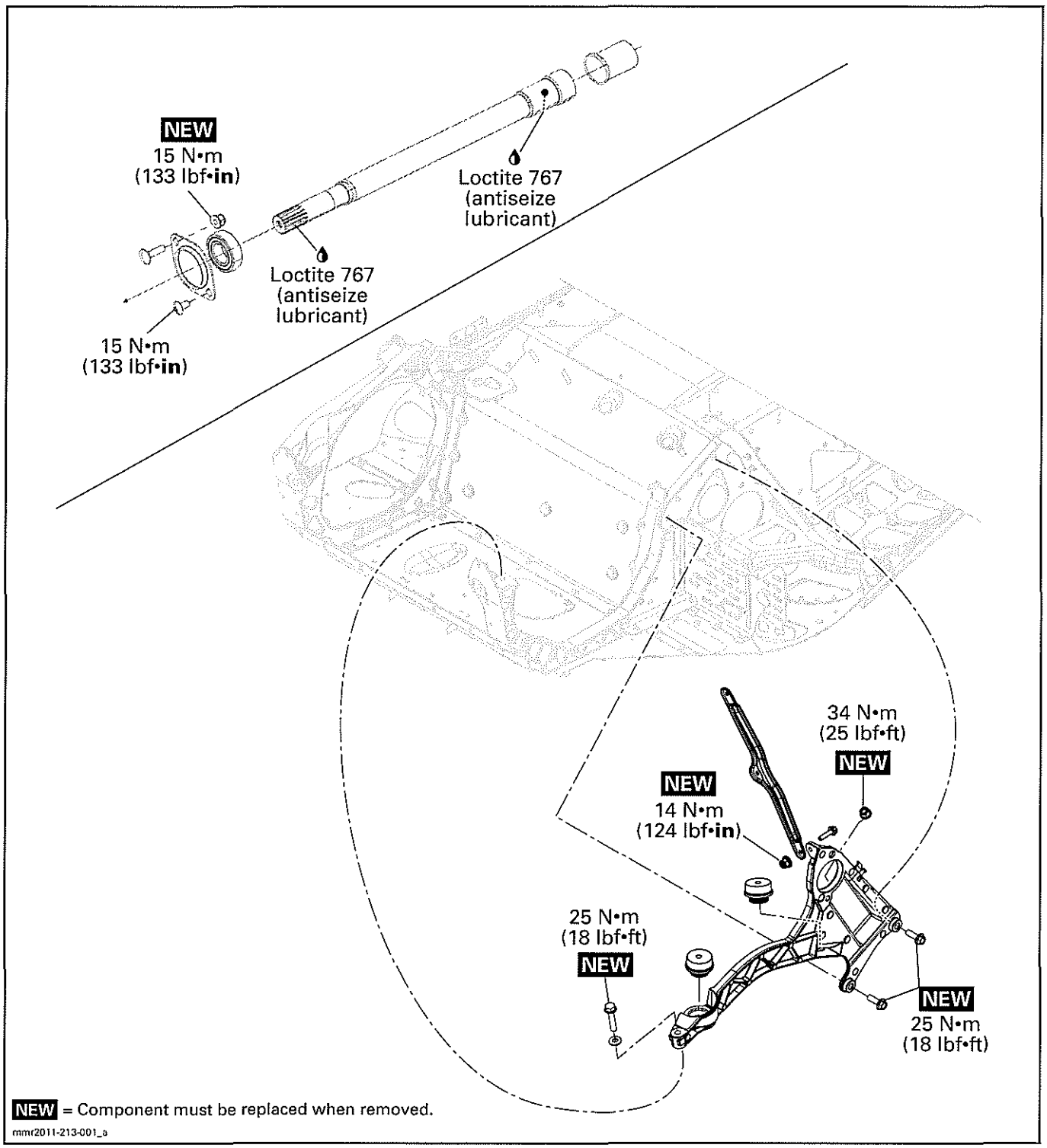
SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
ROTOR CLIP® APPLICATOR	A-150	744

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 243 (BLUE)	293 800 060	745
LOCTITE 609	413 703 100	746
LOCTITE 767 (ANTISEIZE LUBRICANT)	293 800 070	744, 746
PULLEY FLANGE CLEANER	413 711 809	746


NEW
20 N•m
(15 lbf•ft)
NEW
32 N•m
(24 lbf•ft)
NEW
NEW
20 N•m
(15 lbf•ft)
NEW
23 N•m
(17 lbf•ft)
Loctite 243
NEW = Component must be replaced when removed.
mmr2011-118-001_a


NEW
15 N•m
(133 lbf•in)
Loctite 767
(antiseize
lubricant)
Loctite 767
(antiseize
lubricant)
15 N•m
(133 lbf•in)
34 N•m
(25 lbf•ft)
NEW
NEW
14 N•m
(124 lbf•in)
25 N•m
(18 lbf•ft)
NEW
NEW
25 N•m
(18 lbf•ft)
NEW = Component must be replaced when removed.
mmr2011-213-001_a

GENERAL

During assembly/installation, use the torque values and the service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, cotter pins, etc.) must be replaced.

⚠ WARNING

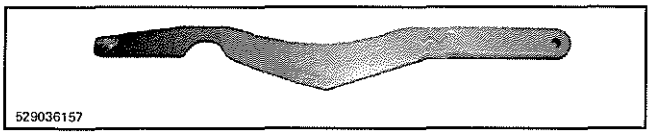
Never start engine when the pulley guard is removed.

NOTICE Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.

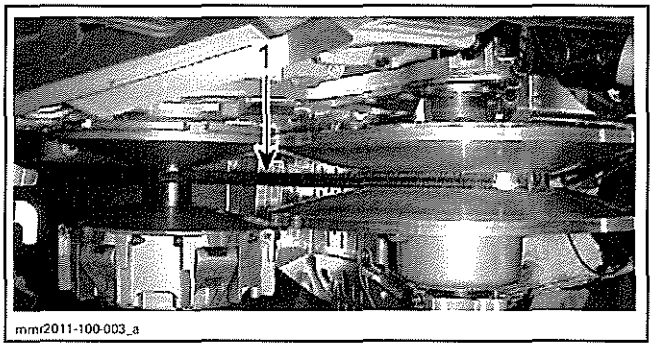
ADJUSTMENT

DRIVEN PULLEY ALIGNMENT

1. Remove drive belt, refer to *DRIVE BELT* subsection.
2. Completely open driven pulley.
3. Insert ALIGNMENT BAR (P/N 529 036 157) between the pulley sheaves. The half moon recess must match the drive pulley fixed sheave shaft.

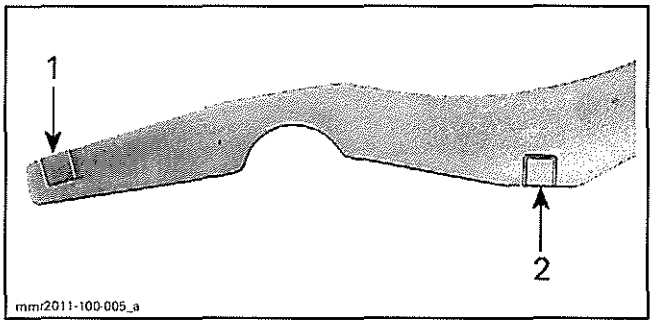


4. Close the driven pulley on the alignment bar. Make sure it stays against the pulley bottom.



1. Alignment bar

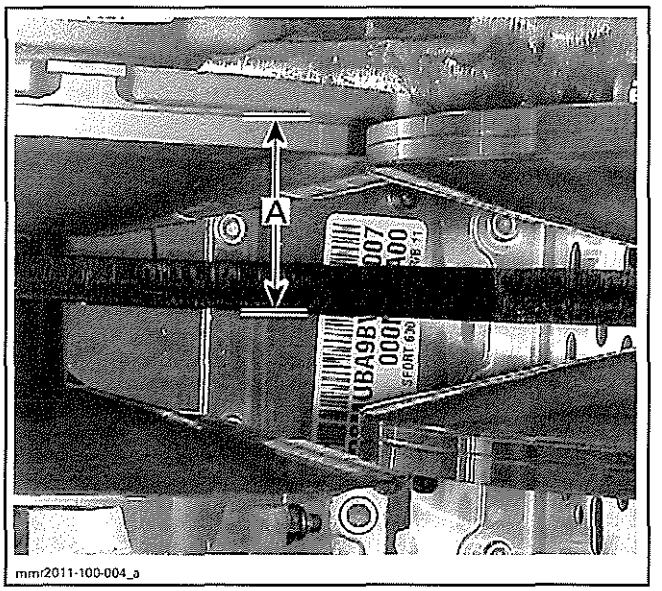
5. Locate the measurement points on the alignment bar.



1. Front measurement point
2. Aft measurement point

6. Measure "X" distance as per the following illustration.

NOTE: Always measure "X" distance from the farther alignment bar side to the fixed sheave inner edge (including alignment bar thickness).

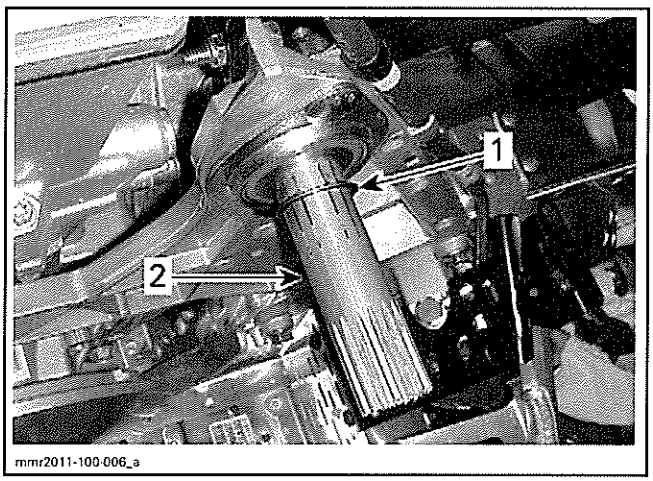


A. "X" distance

7. Compare the result to the specification.

"X" DISTANCE SPECIFICATION	
Minimum	36.7 mm (1.445 in)
Maximum	37.7 mm (1.484 in)

8. If an alignment is necessary:
   8.1 Remove driven pulley, see *DRIVEN PULLEY REMOVAL* in this subsection.
   8.2 Add or remove shim(s) to obtain the specified alignment.



1. Shim
2. Countershaft

   8.3 Refer to the following table to use the proper shim thickness.

SHIM THICKNESS P/N	
504 112 000	0.42 mm ± 0.05 mm (.017 in ± .002 in)

NOTICE Total shim thickness must not exceed 3 mm (.118 in).

9. Install drive belt, refer to *DRIVE BELT INSTALLATION* in *DRIVE BELT* subsection.

PROCEDURES

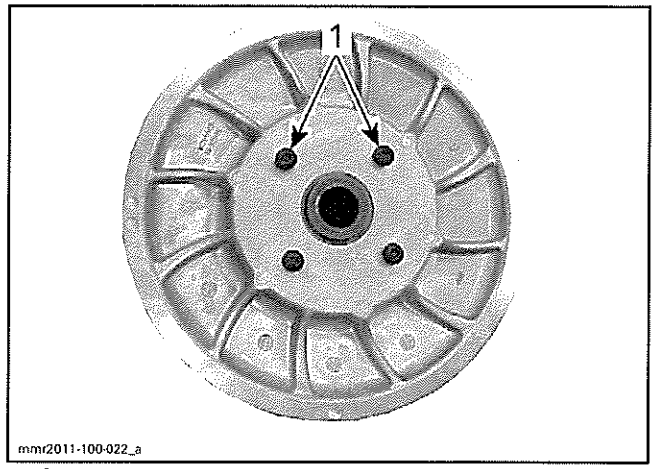
DRIVEN PULLEY

Driven Pulley Spring Preload Verification

1. Remove driven pulley, see procedure in this subsection.
2. Loosen 2 cam screws without removing them.

NOTE: Heat the cam screws to ease loosening.

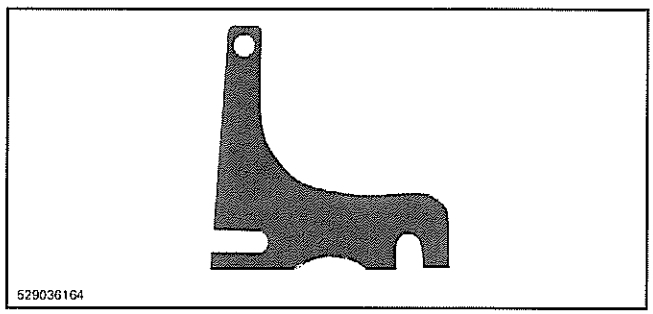
NOTICE If screws are completely removed, they must be replaced.

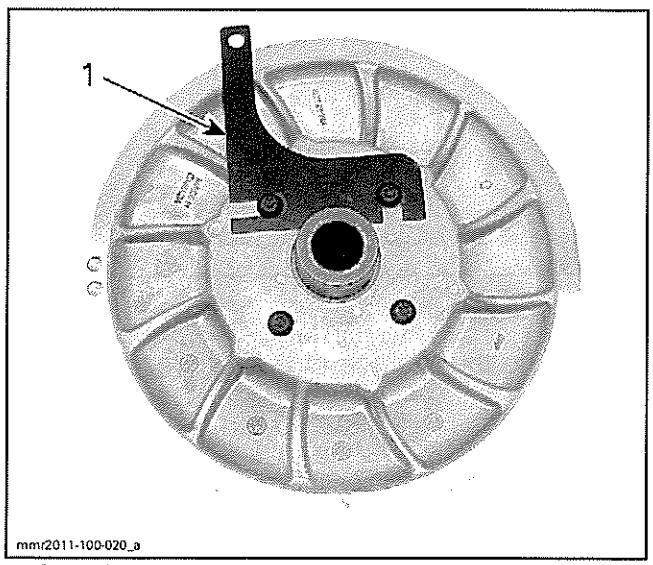


1. Screws to be loosened

3. Install the specified service tool.

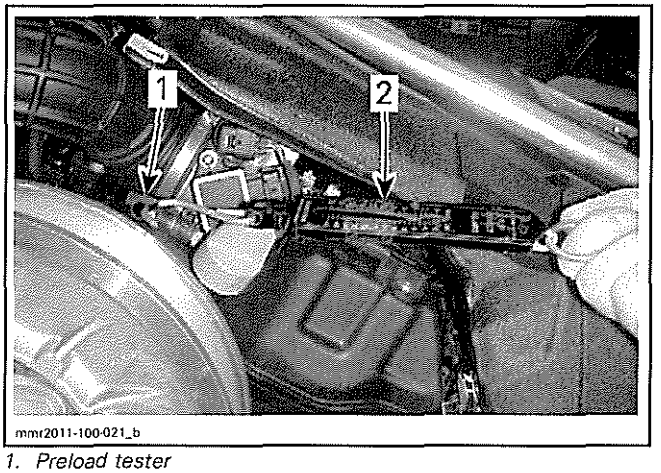
SERVICE TOOL
PRELOAD TESTER (P/N 529 036 164)





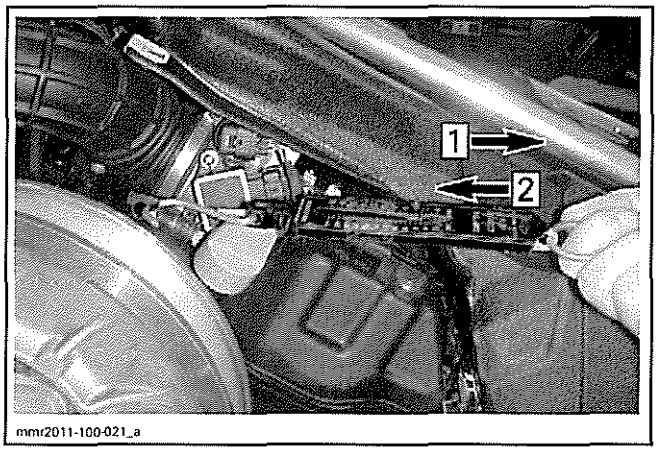
1. Preload tester

4. Install driven pulley.
5. Hook a fish scale to the preload tester.



1. Preload tester
2. Fish scale

6. Pull the preload tester using the fish scale, then read the torsion force as follows:
   6.1 Take a 1st measurement when sliding sheave begins to turn.
   6.2 Hold fish scale in this position.
   6.3 Slowly release tension and take a 2nd measurement when sliding sheave begins to return.



Step 1: 1st measurement
Step 2: 2nd measurement

7. Calculate the average of the two readings.

$$\frac{\text{1ST MEASUREMENT (WHEN OPENING)} + \text{2ND MEASUREMENT (WHEN CLOSING)}}{2} = \text{SPRING PRELOAD}$$

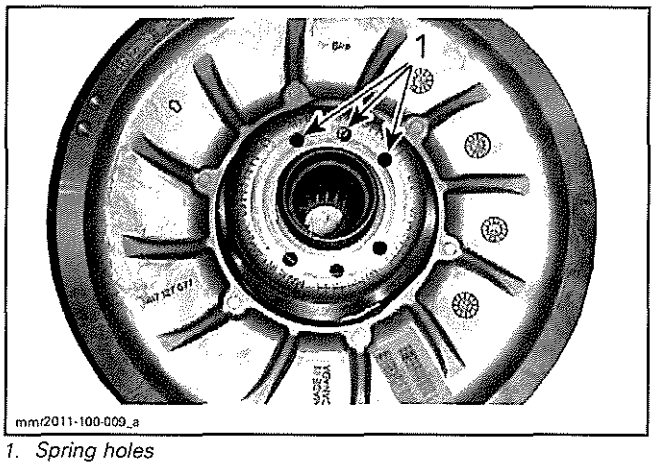
Example:

$$\frac{\text{6.8 KG (15 LB) (WHEN OPENING)} + \text{6.4 KG (14 LB) (WHEN CLOSING)}}{2} = \text{6.6 KG (15 LB) ACTUAL SPRING PRELOAD}$$

8. Compare the result to the specifications.

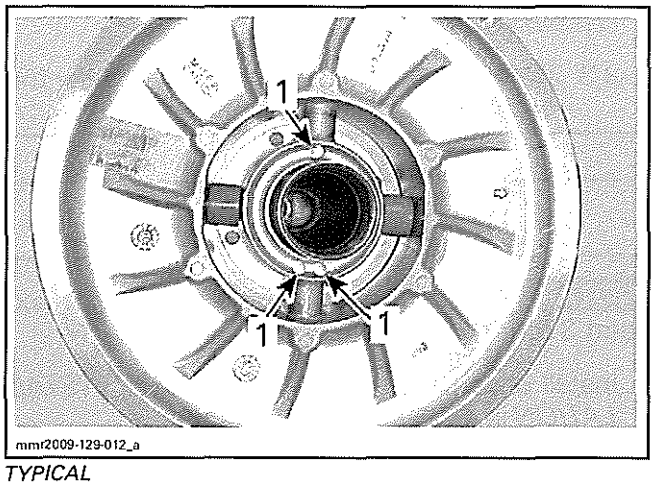
SPRING PRELOAD SPECIFICATION	
Minimum	6.4 kg (14 lb)
Maximum	7.0 kg (15 lb)

If spring preload is out of specification, move the spring hook in another cam hole to increase or decrease preload.



1. Spring holes

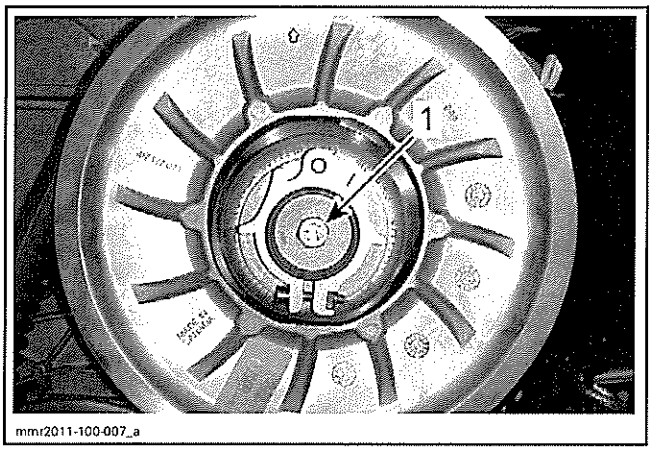
If correct spring preload is unattainable, use the fixed sheave holes.



TYPICAL
1. Fixed sheave holes

Driven Pulley Removal

1. Apply parking brake.
2. Remove drive belt, refer to *DRIVE BELT* subsection.
3. Remove driven pulley retaining screw and shouldered washer.



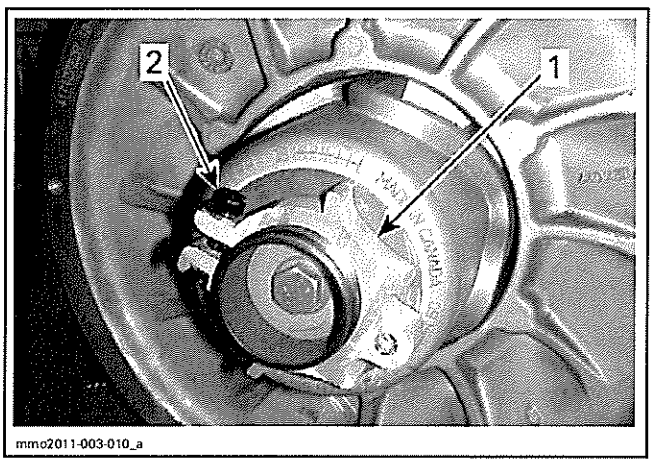
1. Driven pulley retaining screw

4. Remove driven pulley from countershaft.

Driven Pulley Disassembly

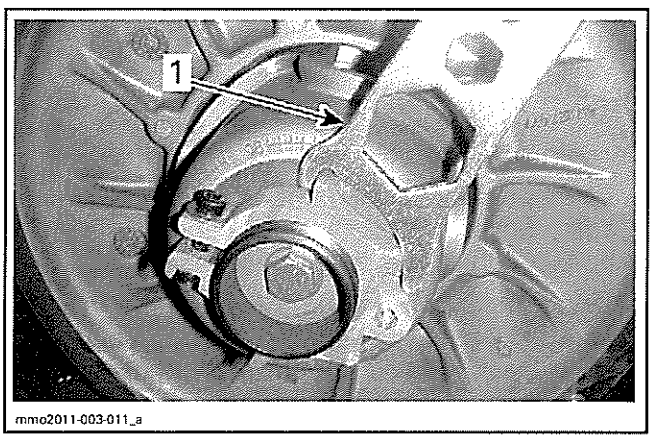
Cam and Spring

1. Loosen the adjuster ring clamping screw.



1. Adjuster hub
2. Clamping screw

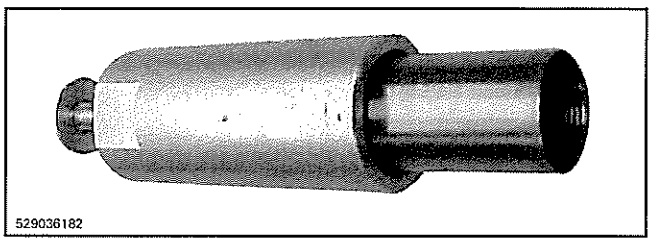
2. Unscrew the adjuster hub **clockwise**, using the suspension adjustment tool.



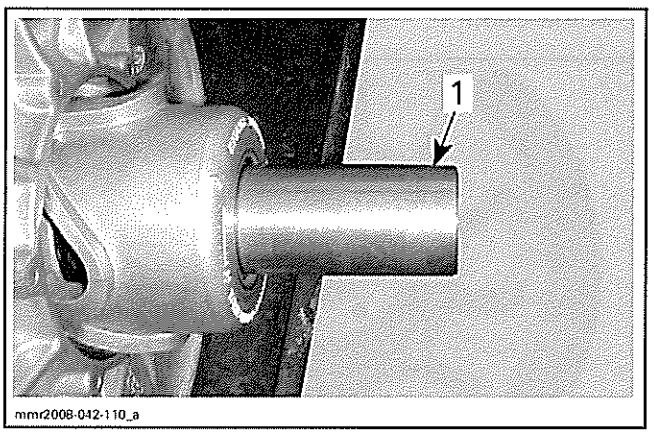
1. Suspension adjustment tool

NOTE: When reaching the end of the threads, slightly spread the adjuster ring to remove it from the pulley.

3. Install the threaded adapter of the DRIVEN PULLEY SPRING COMPRESSOR (P/N 529 036 182) on the driven pulley.

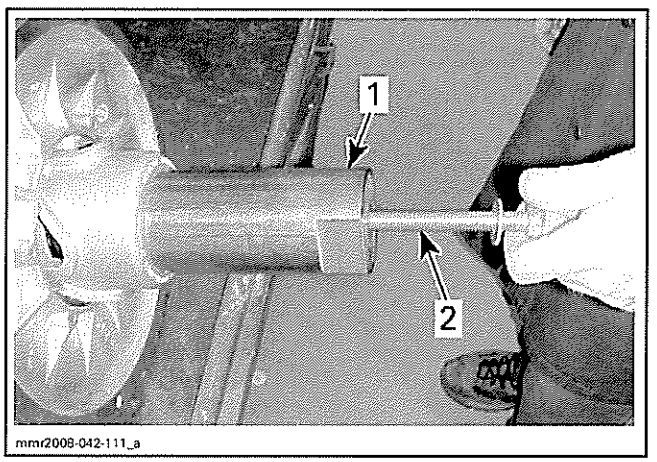


THREADED ADAPTER



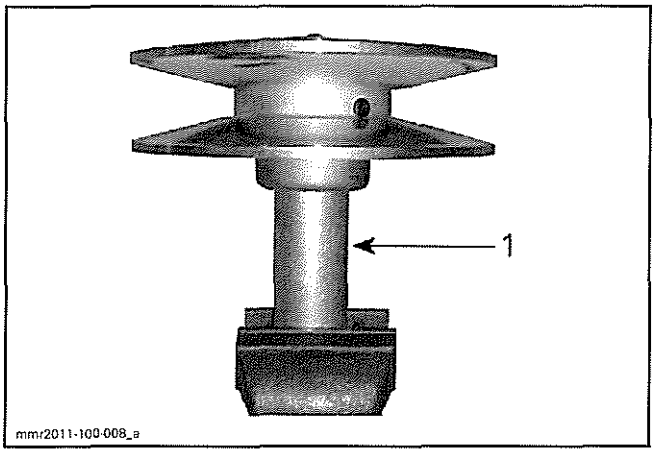
1. Threaded adapter

4. Install the external sleeve over the threaded adapter and secure sleeve with the tool screw.



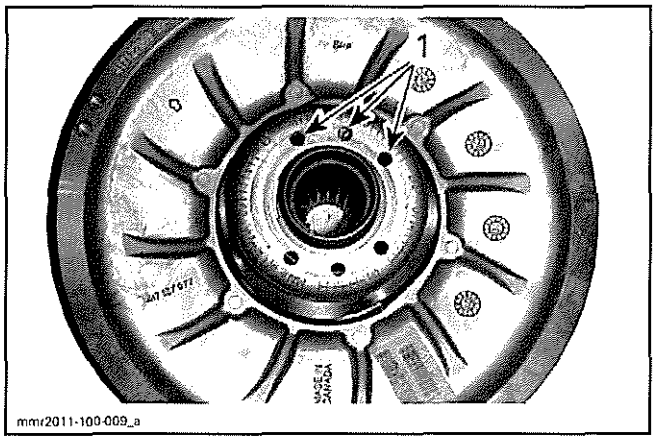
1. External sleeve
2. Driven pulley spring compressor screw

5. Tighten the tool screw to compress the cam.
6. Install the tool in a vice.



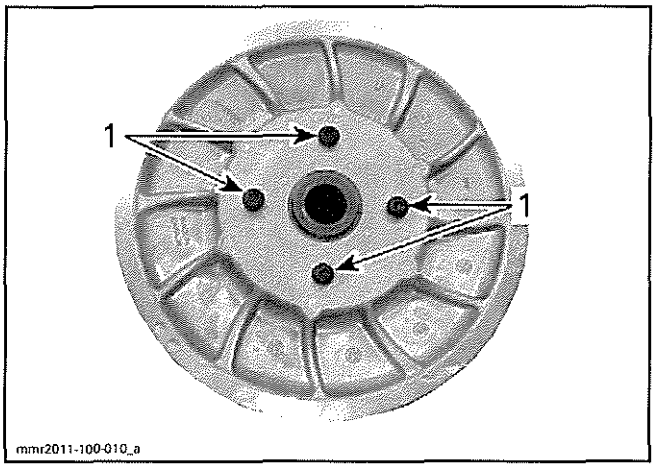
1. Driven pulley spring compressor

7. Note in which hole the spring hook is inserted in the cam.



1. Spring holes

8. Using a heat gun, heat cam screws to break the thread locker.

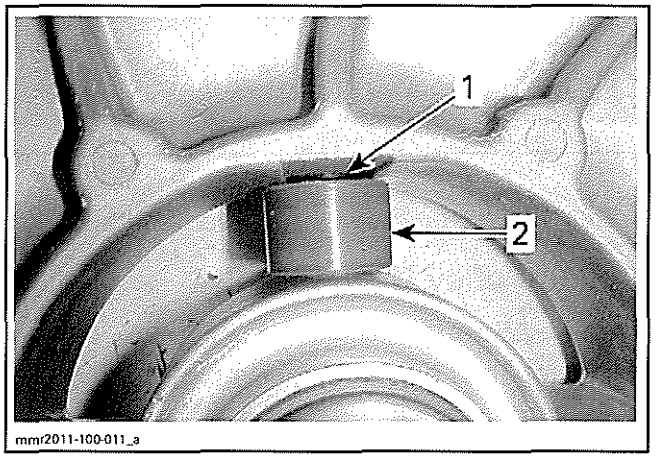


1. Heat cam screws

9. Remove and discard cam screws.
10. Remove the sliding sheave.
11. Unscrew the tool screw completely.
12. Note in which hole the spring hook is inserted to the fixed sheave.
13. Remove cam and spring.
14. Remove the tool threaded adapter.

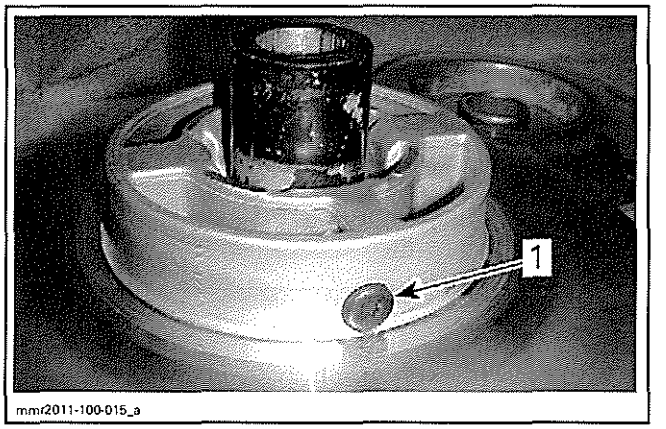
Driven Pulley Rollers

1. Remove and discard the E-clips.



1. E-clip
2. Roller

2. Remove and **discard** pivot screws.



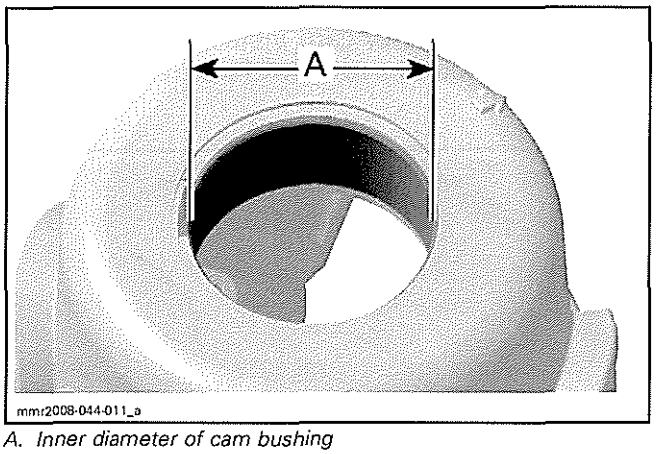
1. Pivot screw

3. Remove rollers.

Driven Pulley Inspection

Cam and Spring

1. Verify contact surfaces of cam for visible damage. Ensure circlip properly locks the inner bushing. Replace part if necessary.
2. Using a dial bore gauge, measure the inner diameter of cam bushing. Measuring point must be at least 5 mm (1/4 in) from bushing edge.



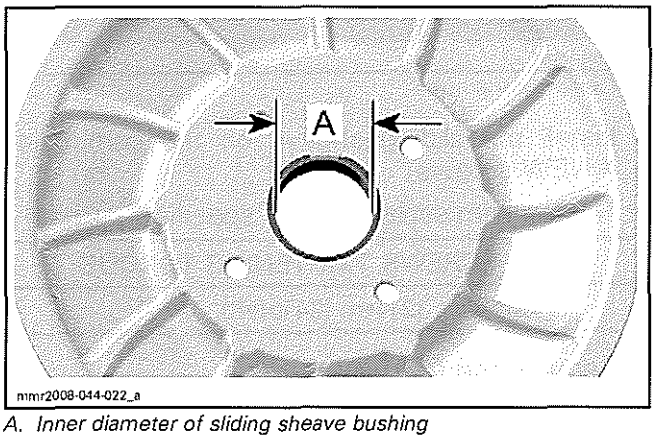
A. Inner diameter of cam bushing

BUSHING	SERVICE LIMIT
Cam bushing	41.5 mm (1.634 in)

3. Replace the cam if the inner diameter of bushing is out of specification.

Sliding Sheave

1. Inspect pulley sheave for marks or scratches.
2. Ensure circlip properly locks the inner bushing. Replace part if necessary.
3. Using a dial bore gauge, measure the inner diameter of sliding sheave bushing. Measuring point must be at least 5 mm (1/4 in) from bushing edge.



A. Inner diameter of sliding sheave bushing

BUSHING	SERVICE LIMIT
Sliding sheave bushing	41.5 mm (1.634 in)

4. Replace the sliding sheave if the inner diameter of bushing is out of specification.

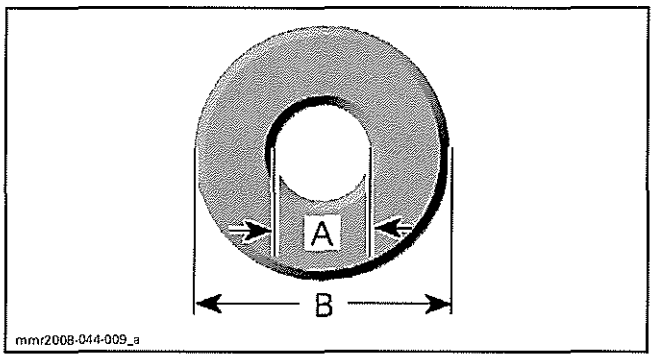
Fixed Sheave

Replace fixed sheave and countershaft if one of the following problem is detected:

- Marks or scratches on pulley sheave
- Bent, twisted or otherwise damaged countershaft
- Defective splines and threads at the end of countershaft.

Driven Pulley Rollers

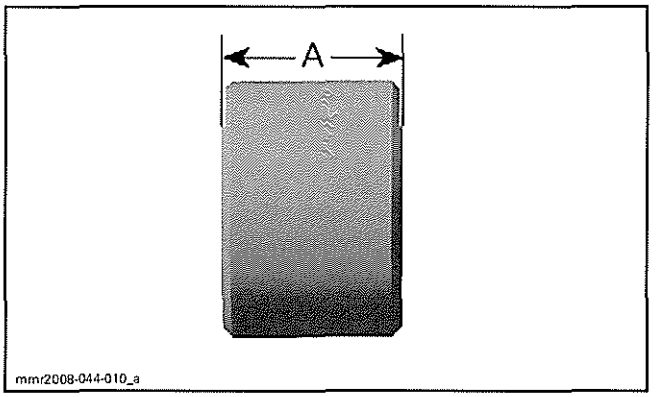
1. Check the rollers for flat spots, cracks or other visible damage. Replace if necessary (as a set).
2. Measure inner and outer diameter of rollers.



A. Inner diameter
B. Outer diameter

ROLLER DIAMETER	SERVICE LIMIT
Inner diameter	8.5 mm (.335 in)
Outer diameter	21.5 mm (.846 in)

3. Measure the roller thickness.



A. Thickness of roller

ROLLER THICKNESS	
SERVICE LIMIT	14.75 mm (.581 in)

4. If a roller is out of specifications, replace both rollers at the same time.

Driven Pulley Assembly

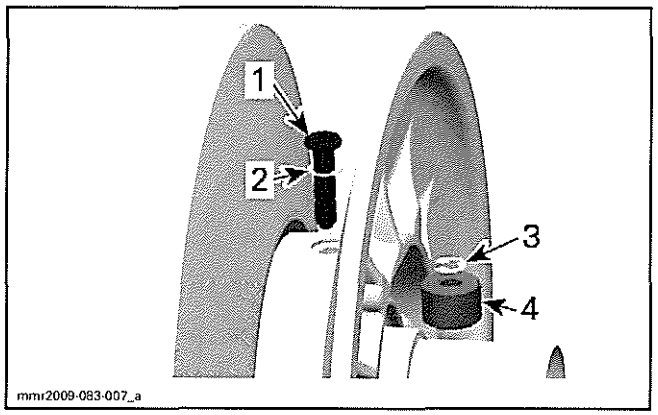
Driven Pulley Rollers

1. Using a screw tap, clean pivot screw threaded holes into fixed sheave.

2. Install rollers into fixed sheave using NEW pivot screws with ribbed lock washers.

NOTICE Always use new pivot screws with pre-applied threadlocker.

3. Tighten pivot screws to the specified torque.

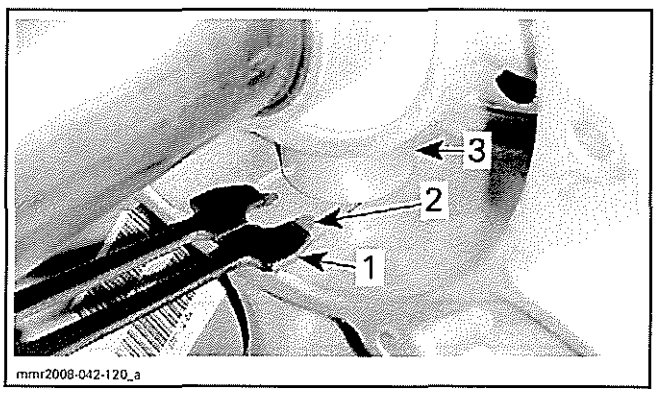


TYPICAL
1. *Pivot screw*
2. *Ribbed lock washer*
3. *E-clip*
4. *Roller*

PIVOT SCREWS TIGHTENING TORQUE
20 N•m (15 lbf•ft)

4. Using a ROTOR CLIP® APPLICATOR (P/N A-150), install NEW E-clips to lock pivot screws.

NOTE: To purchase an applicator, contact Rotor Clip Company at www.rotorclip.com.

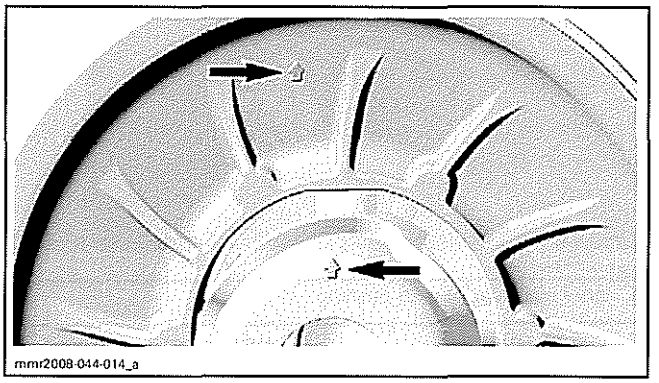


1. *E-clip applicator*
2. *E-clip*
3. *Roller*

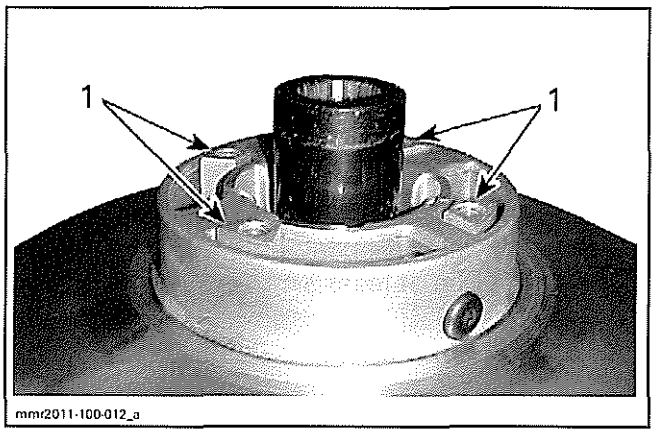
Cam and Spring

1. Install the spring compressor threaded adapter on the fixed sheave.
2. Slide the cam over the tool threaded adapter.
3. Turn cam against the spring and align its arrow with the arrow on the fixed sheave.

NOTE: At the end of cam installation, the arrow on the cam should have moved clockwise (approximately 30°).



4. Compress spring until cam mounting holes exceed the fixed sheave.



1. *Cam mounting holes*

5. Install the sliding sheave on the cam using 4 NEW screws.
6. Tighten cam screws to the specified torque.

CAM SCREWS TIGHTENING TORQUE
32 N•m (24 lbf•ft)

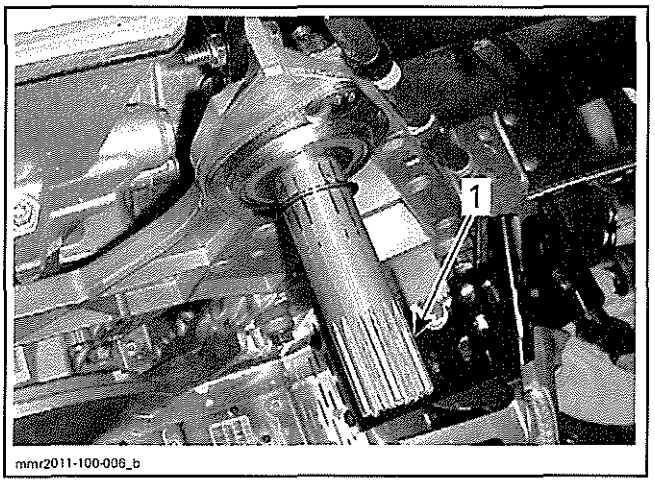
7. Remove the tool.

Driven Pulley Installation

The installation is the reverse of removal procedure, however pay attention to the following.

Apply LOCTITE 767 (ANTISEIZE LUBRICANT) (P/N 293 800 070) on countershaft splines.

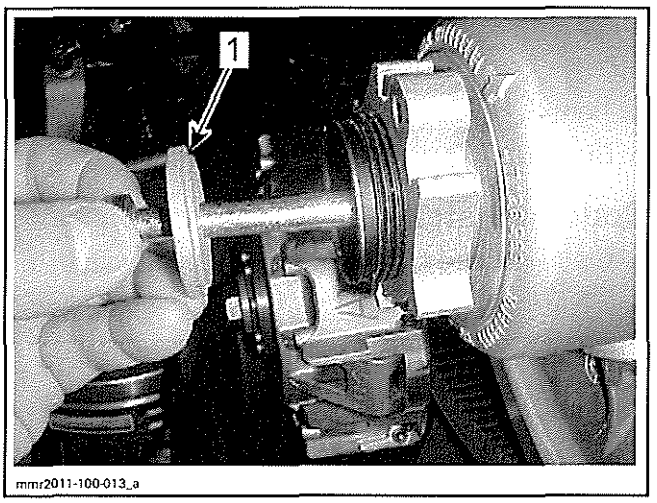
Rotor Clip® is a trademark of Rotor Clip Company, Inc.



1. Apply antiseize lubricant here

Check pulley alignment, refer to *DRIVEN PULLEY ALIGNMENT* in this subsection.

Install driven pulley shouldered washer as per illustration.



Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on driven pulley retaining screw threads.

Tighten driven pulley retaining screw to the specified torque.

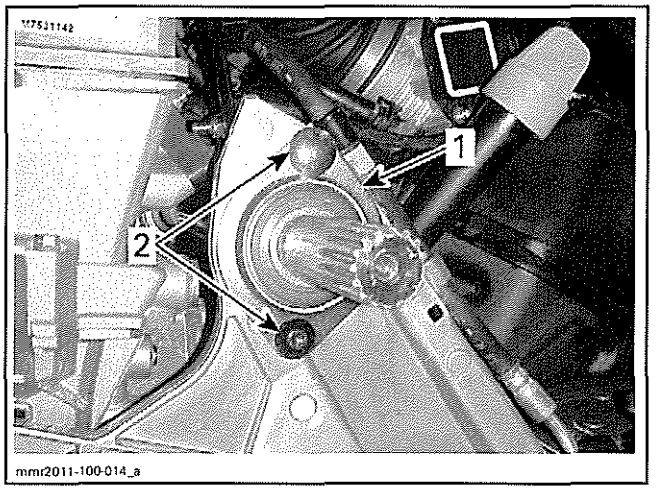
DRIVEN PULLEY RETAINING SCREW TIGHTENING TORQUE
23 N•m (17 lbf•ft)

NOTICE Driven pulley alignment must always be checked whenever pulleys have been removed, disassembled or replaced.

COUNTERSHAFT

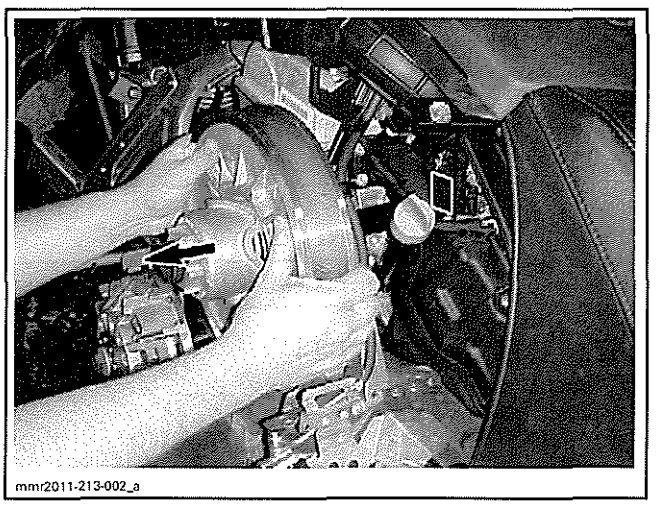
Countershaft Removal

1. Remove side panels, refer to *BODY* subsection.
2. Remove driven pulley, see *DRIVEN PULLEY REMOVAL* in this subsection.
3. Remove countershaft bearing flange as follows:
   3.1 Remove retaining fasteners.



1. Countershaft bearing flange
2. Retaining fasteners

   3.2 Be careful not to loose the brake hose retainer.
   3.3 Remove countershaft bearing flange from support.
4. Install drive pulley.
5. Firmly grab the drive pulley and pull the assembly out.



REMOVE PULLEY AND COUNTERSHAFT AS AN ASSEMBLY

6. Remove pulley from countershaft.

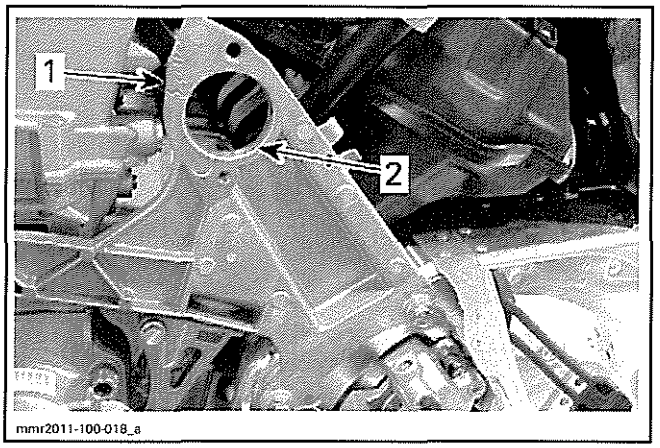
Countershaft Inspection

Replace countershaft if one of the following problem is detected:
- Bent, twisted or otherwise damaged countershaft.
- Defective splines and threads at the end of countershaft.

Countershaft Installation

The installation is the reverse of removal procedure, however pay attention to the following.

Remove any rust on bearing shoulder of countershaft bearing support using sand paper (600-grit or 1000-grit) or steel wool.



1. Bearing shoulder
2. Countershaft bearing support

Apply LOCTITE 767 (ANTISEIZE LUBRICANT) (P/N 293 800 070):
- Bearing shoulder
- Countershaft internal splines (gearbox end).

Ensure countershaft bearing is installed properly into the countershaft bearing support.

Secure the brake hose using the upper flange retaining bolt.

Tighten countershaft bearing flange bolts to the specified torque.

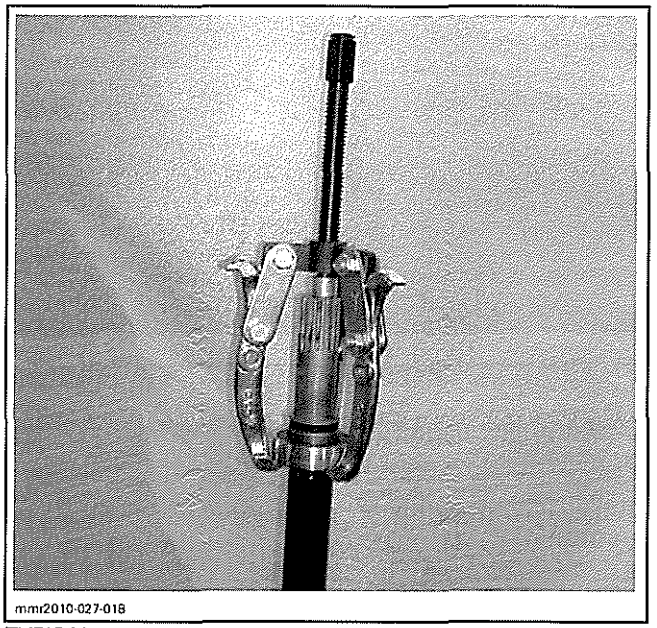
COUNTERSHAFT BEARING FASTENERS TIGHTENING TORQUE
25 N•m (18 lbf•ft)

Install driven pulley. Refer to *DRIVEN PULLEY INSTALLATION* in this subsection.

COUNTERSHAFT BEARING

Countershaft Bearing Removal

1. Proceed with *COUNTERSHAFT REMOVAL*, see procedure in this subsection.
2. Install an appropriate puller on the countershaft bearing.

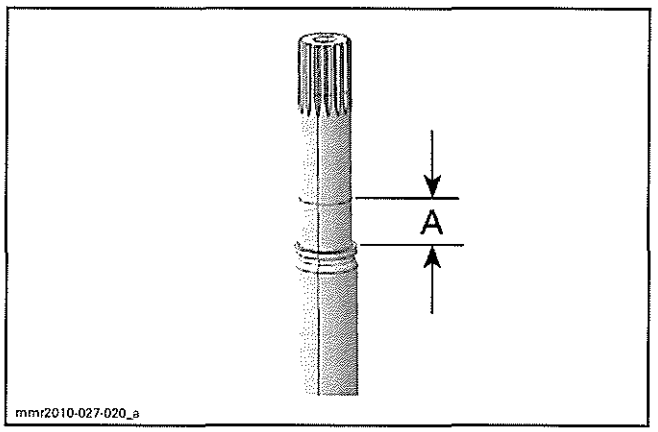


TYPICAL

3. Tighten puller to extract the bearing.
4. Discard the bearing.

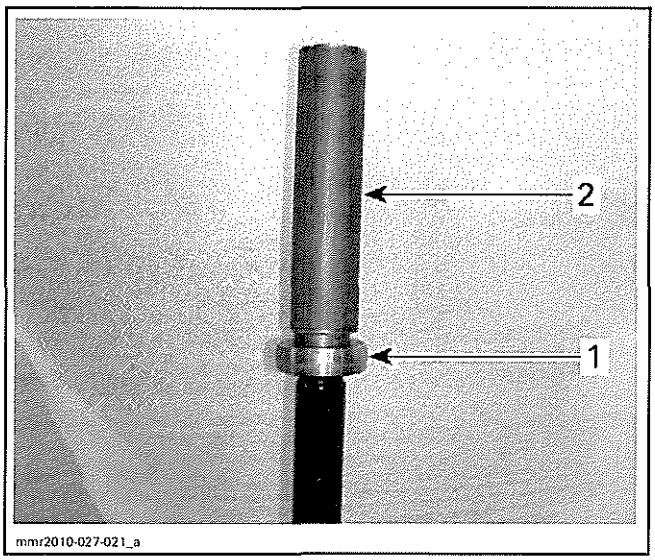
Countershaft Bearing Installation

1. Clean residues on countershaft bearing area using PULLEY FLANGE CLEANER (P/N 413 711 809).



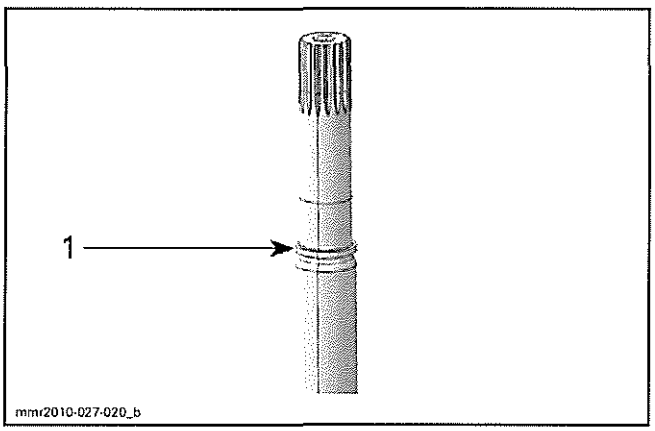
A. Countershaft bearing area

2. Apply LOCTITE 609 (P/N 413 703 100) on countershaft bearing area.
3. Install a NEW bearing on countershaft using a press and a pipe with the proper diameter.



1. New bearing
2. Pipe with the proper diameter

4. Press bearing until it is properly seated on countershaft flange.



1. Countershaft flange

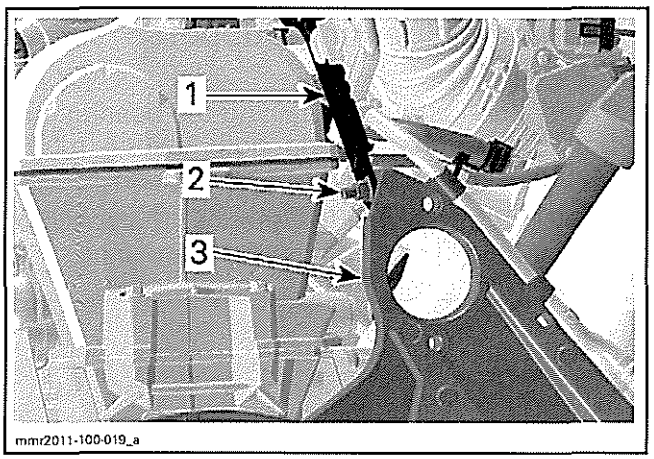
5. Clean the surplus of Loctite with a rag to avoid having Loctite on sliding sheave bushing.

NOTICE Always use a press, never tap on countershaft bearing installer with an hammer to avoid damaging bearing and countershaft. Always apply force on the inner race of the bearing.

COUNTERSHAFT BEARING SUPPORT

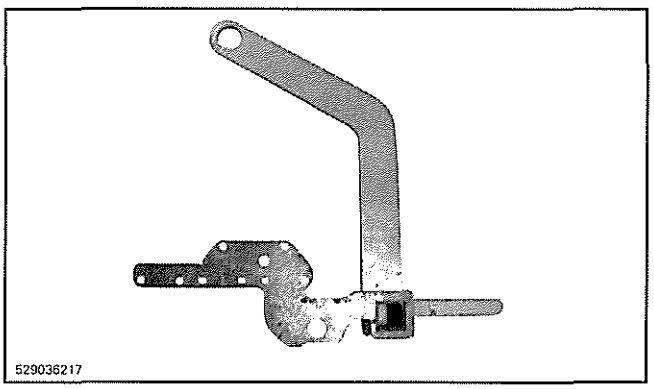
Countershaft Bearing Support Removal

1. Remove countershaft, see *COUNTERSHAFT REMOVAL* in this subsection.
2. Remove the bolt attaching the upper frame member to the countershaft bearing support.

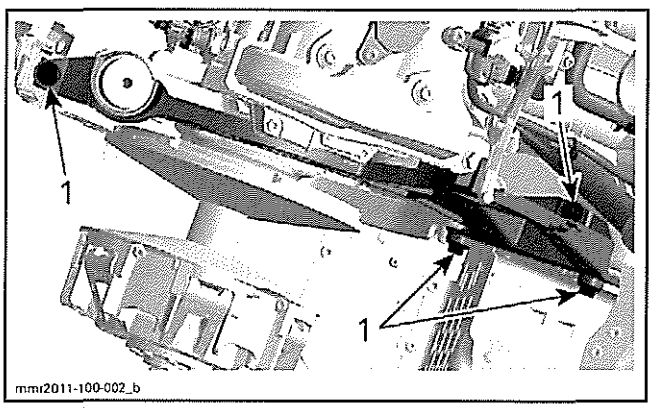


TYPICAL
1. Upper frame member
2. Bolt
3. Countershaft bearing support

3. Install the ENGINE LIFTING TOOL (P/N 529 036 217) in order to support the LH side of the engine. Refer to *ENGINE REMOVAL AND INSTALLATION*.



4. Remove the bolts securing the engine to the LH rubber mounts.
5. Remove the countershaft bearing support retaining fasteners.

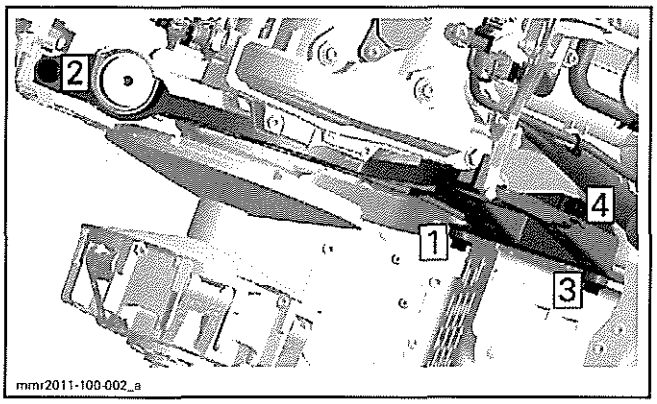


TYPICAL
1. Countershaft bearing support retaining fasteners

6. Remove the countershaft bearing support.

Countershaft Bearing Support Installation

1. Thread the fasteners retaining the bearing support to the chassis and both engine rubber mounts screws without tightening yet.
2. Tighten the retaining fasteners to the specified torque following the illustrated sequence.



BEARING SUPPORT TIGHTENING SEQUENCE

COUNTERSHAFT BEARING SUPPORT FASTENERS TIGHTENING TORQUE	
Bearing support to side of tunnel screws	25 N•m (18 lbf•ft)
Front of bearing support retaining screw	25 N•m (18 lbf•ft)
Bearing support to top of tunnel nut	34 N•m (25 lbf•ft)

3. Tighten the rear engine rubber mount screw to the specified torque.

REAR RUBBER MOUNT SCREW TIGHTENING TORQUE
25 N•m (18 lbf•ft)

4. Tighten the front engine rubber mount screw to the specified torque.

FRONT RUBBER MOUNT BOLT TIGHTENING TORQUE
25 N•m (18 lbf•ft)

5. Install the upper frame member to the bearing support and tighten bolt to the specified torque.

BEARING SUPPORT TO UPPER FRAME MEMBER BOLT TIGHTENING TORQUE
14 N•m (124 lbf•**in**)

6. Install all other removed parts.

DRIVEN PULLEY AND COUNTERSHAFT (600 HO E-TEC AND 1200 4-TEC)

SERVICE TOOLS

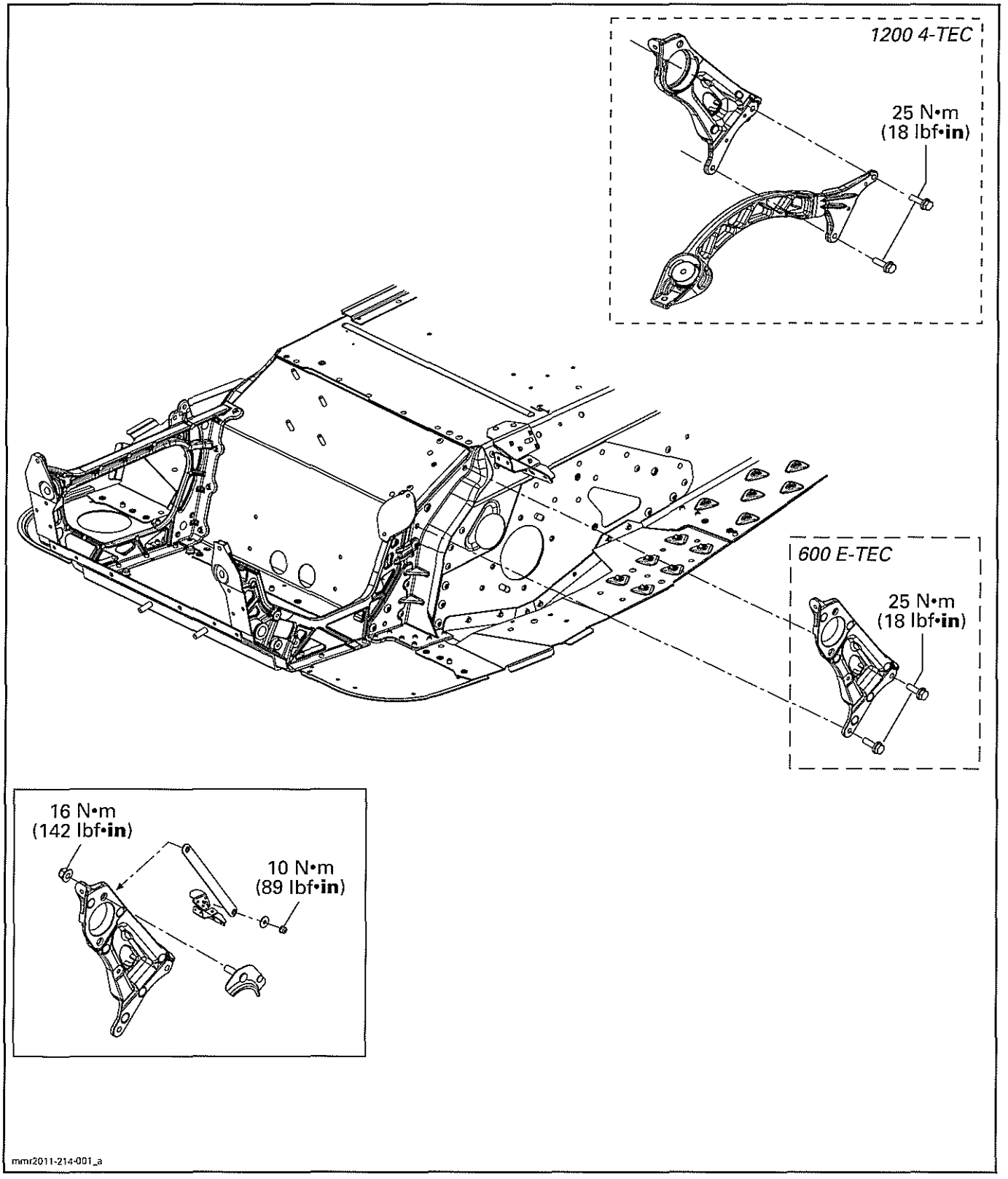
Description	Part Number	Page
COUNTERSHAFT BEARING INSTALLER	529 036 066	760
COUNTERSHAFT BEARING REMOVER	529 036 065	759
COUNTERSHAFT RETAINING TOOL	529 036 165	757
COUNTERSHAFT SUPPORT	529 036 067	760
DRIVEN PULLEY SPRING COMPRESSOR	529 036 064	759
DRIVEN PULLEY SPRING COMPRESSOR	529 036 182	753
ENGINE LIFTING TOOL	529 036 151	762
PRELOAD TESTER	529 036 164	757

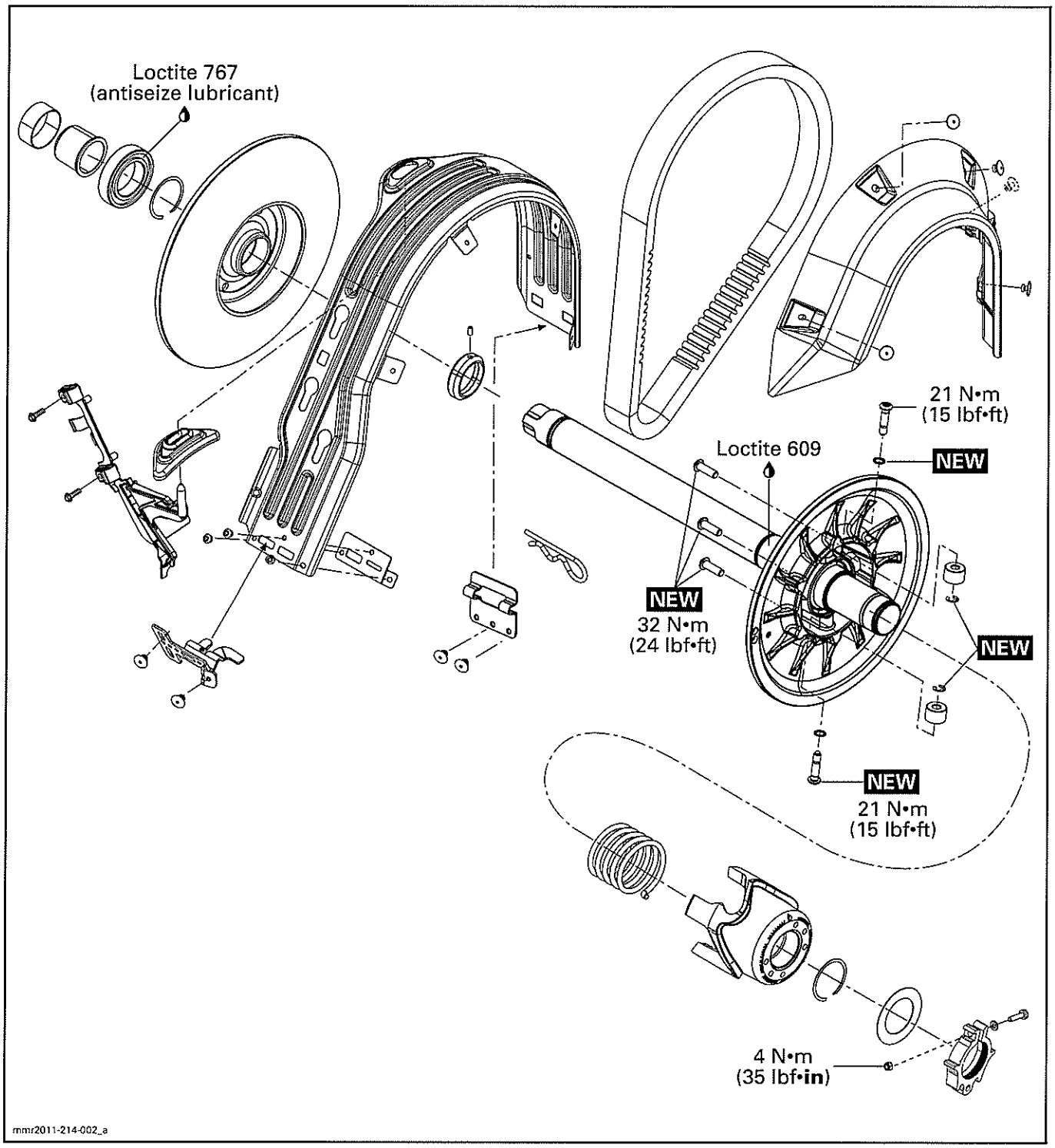
SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
ROTOR CLIP® APPLICATOR	A-150	756

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 609	413 703 100	760
LOCTITE 767 (ANTISEIZE LUBRICANT)	293 800 070	759
PULLEY FLANGE CLEANER	413 711 809	756, 760


1200 4-TEC
25 N•m
(18 lbf•in)
600 E-TEC
25 N•m
(18 lbf•in)
16 N•m
(142 lbf•in)
10 N•m
(89 lbf•in)
mmr2011-214-001_a


Loctite 767
(antiseize lubricant)
21 N•m
(15 lbf•ft)
NEW
Loctite 609
NEW
32 N•m
(24 lbf•ft)
NEW
NEW
21 N•m
(15 lbf•ft)
4 N•m
(35 lbf•in)
mmr2011-214-002_a

GENERAL

During assembly/installation, use the torque values and the service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, cotter pins, etc.) must be replaced.

⚠ WARNING

Never start engine when the pulley guard is removed.

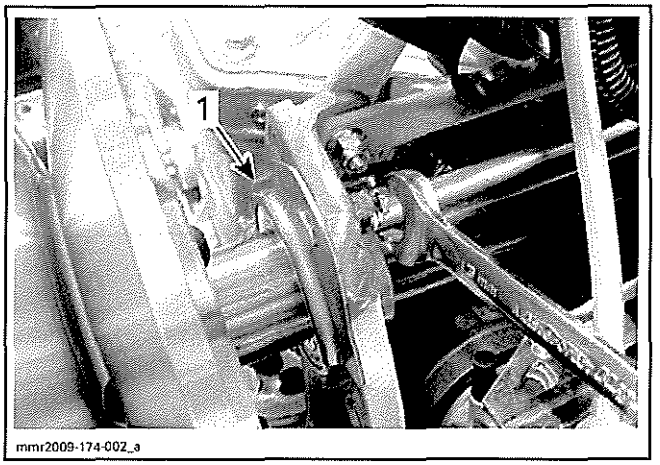
NOTICE Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.

PROCEDURES

DRIVEN PULLEY

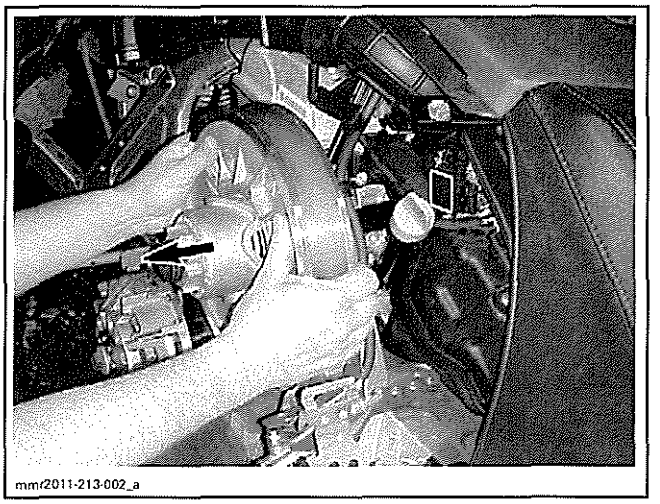
Driven Pulley Removal

1. Remove drive belt. Refer to *DRIVE BELT* subsection.
2. Set gearbox to *NEUTRAL*.
3. Remove bearing flange from countershaft bearing support.



1. Bearing flange

4. Firmly grab the drive pulley and pull the assembly out.

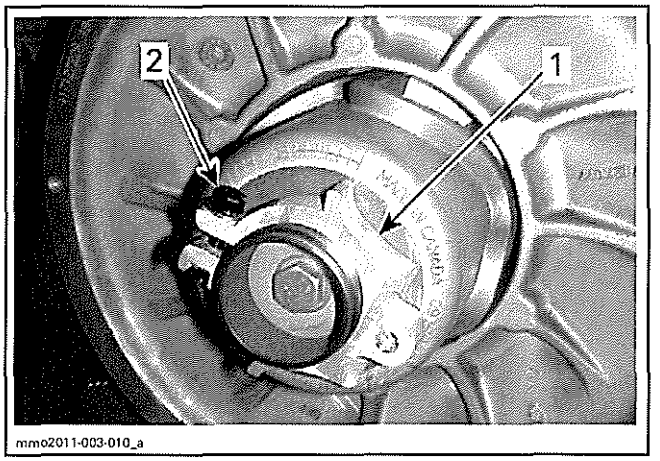


TYPICAL - REMOVE PULLEY AND COUNTERSHAFT AS AN ASSEMBLY

Driven Pulley Disassembly

Cam and Spring

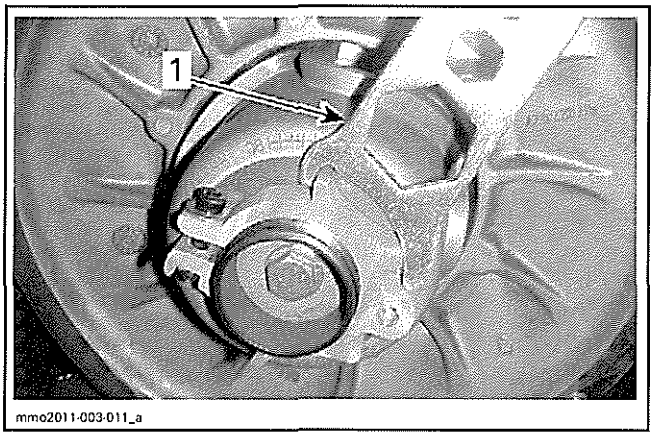
1. Loosen the adjuster ring clamping screw.



TYPICAL
1. Adjuster hub
2. Clamping screw

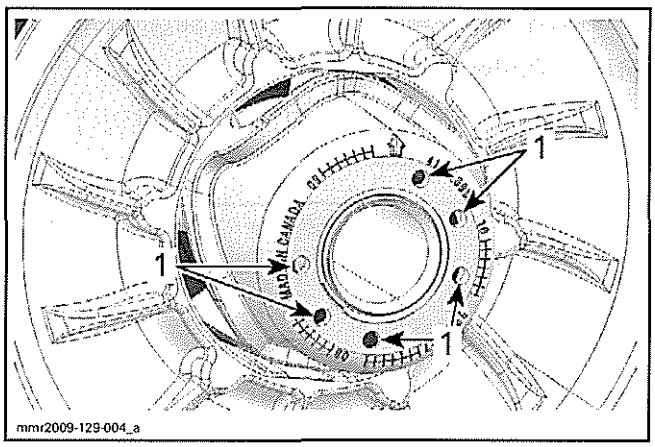
2. Unscrew the adjuster hub **clockwise**, using the suspension adjustment tool.

NOTE: When reaching the end of the threads, slightly spread the adjuster ring to remove it from the pulley.



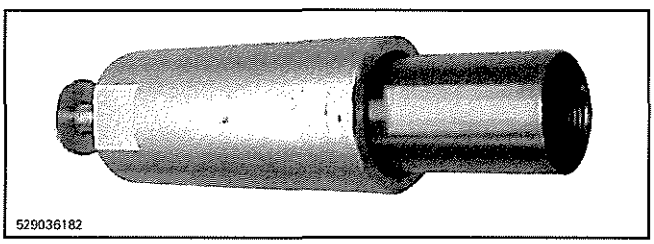
TYPICAL
1. Suspension adjustment tool

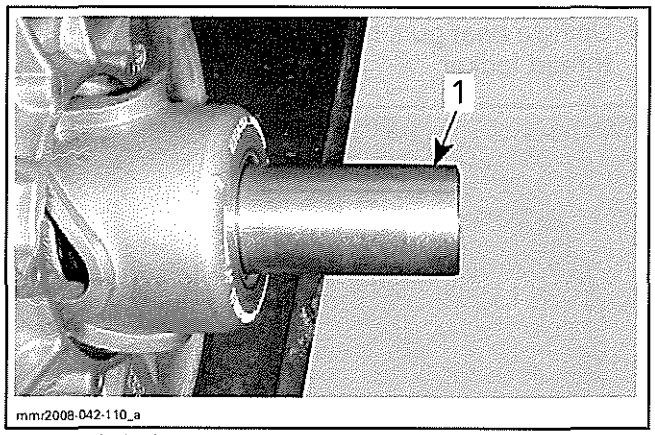
3. Remember spring position for reinstallation.



1. Available spring positions

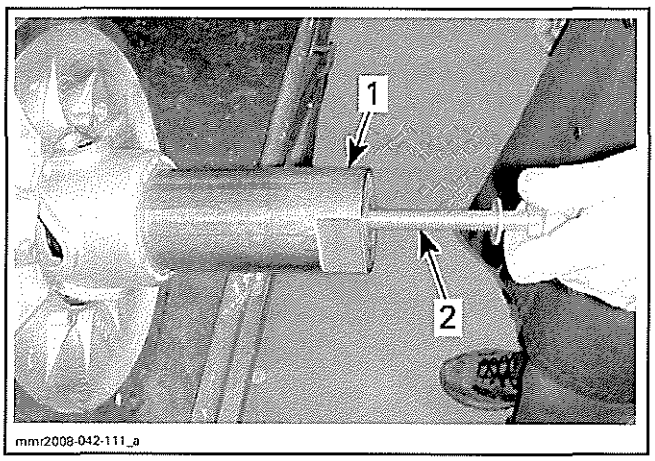
4. Install the threaded adapter of the DRIVEN PULLEY SPRING COMPRESSOR (P/N 529 036 182) on the driven pulley.





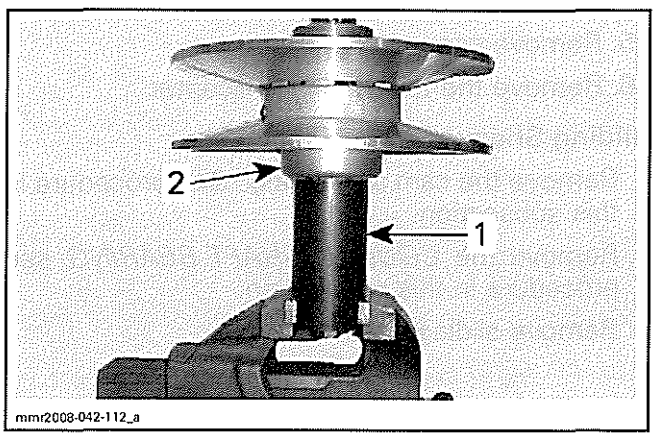
1. Threaded adapter

5. Install the external sleeve over the threaded adapter.
6. Thread spring compressor screw in the threaded adapter.



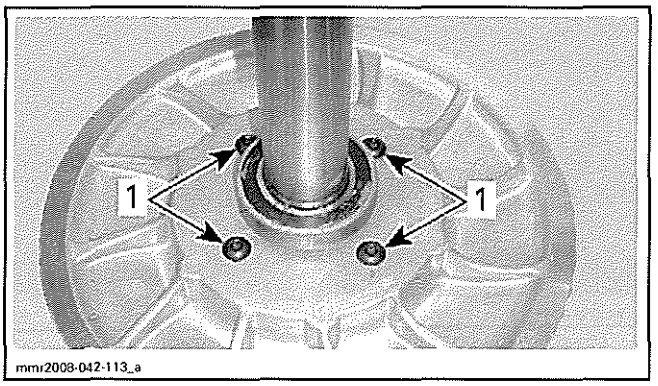
1. External sleeve
2. Driven spring compressor screw

7. Tighten the driven spring compressor screw to compress the cam.
8. Install the driven pulley spring compressor in a vice.



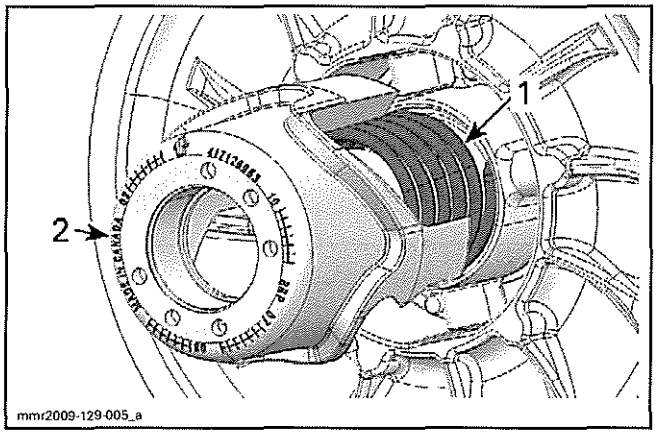
1. Driven pulley spring compressor
2. Driven pulley

9. Using a heat gun, heat cam screws to break the thread locker.



1. Heat cam screws

10. Remove and discard the cam screws.
11. Unscrew the spring compressor screw completely.
12. Retain cam and spring in position.
13. Hold spring against the fixed sheave and remove cam.
14. Note in which hole the spring hook is inserted to the fixed sheave.

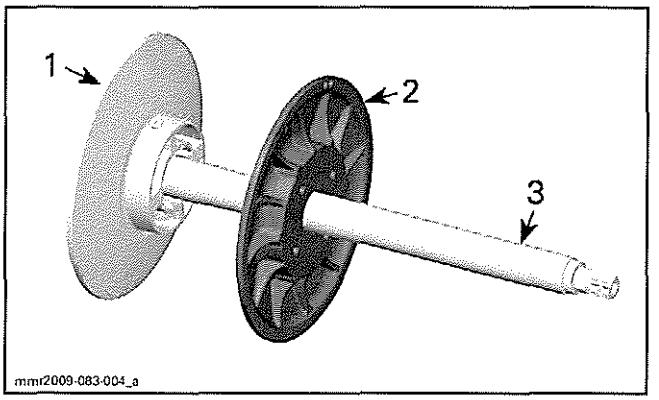


1. Spring
2. Cam

15. Remove cam and spring.
16. Remove the tool threaded adapter.

Sliding Sheave

1. Remove the cam and spring. See procedure in this subsection.
2. Remove the *COUNTERSHAFT BEARING*, see procedure in this subsection.
3. Remove sliding sheave.



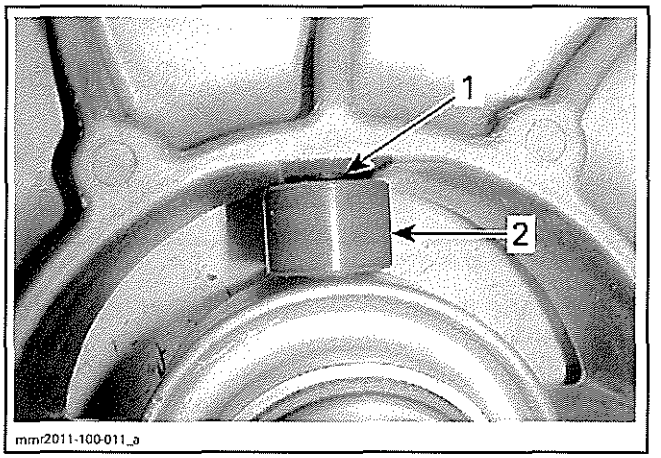
1. Fixed sheave
2. Sliding sheave
3. Countershaft

Fixed Sheave

The fixed sheave and countershaft are sold as an assembly. They are not available separately.

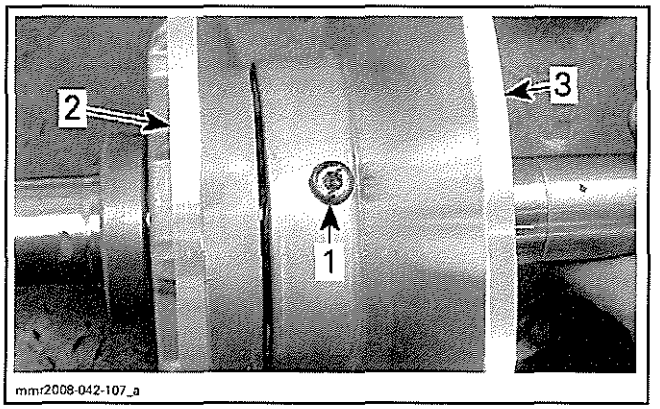
Driven Pulley Rollers

1. Move sliding and fixed sheaves apart.
2. Remove and discard the E-clips.



1. E-clip
2. Roller

3. Remove and **discard** pivot screws.



1. Pivot screw
2. Sliding sheave
3. Fixed sheave

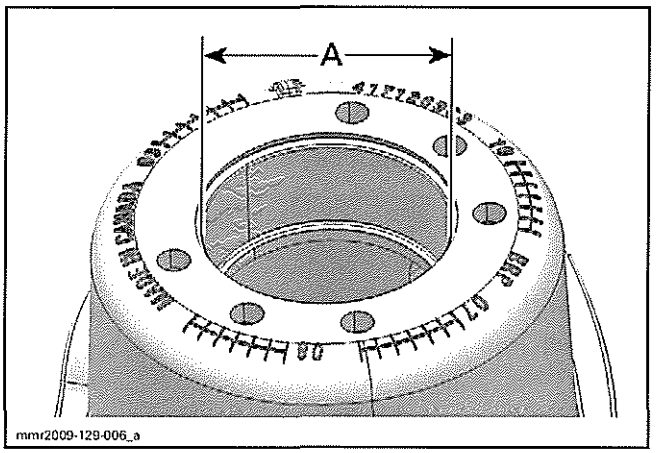
4. Remove rollers.

Driven Pulley Inspection

Cam and Spring

Verify contact surfaces of cam for visible damage. Replace cam if necessary.

Using a dial bore gauge, measure the inner diameter of cam bushing. Measuring point must be at least 5 mm (1/4 in) from bushing edge.



A. Inner diameter of cam bushing

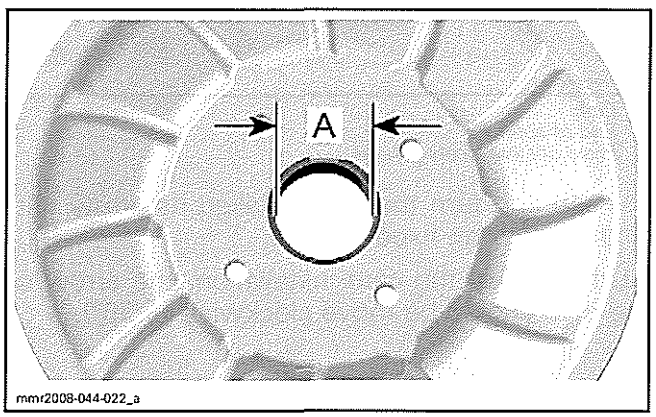
BUSHING	SERVICE LIMIT
Cam bushing	41.5 mm (1.634 in)

Replace the cam if the inner diameter of bushing is out of specification.

Sliding Sheave

Inspect pulley sheave for marks or scratches.

Using a dial bore gauge, measure the inner diameter of sliding sheave bushing. Measuring point must be at least 5 mm (1/4 in) from bushing edge.



A. Inner diameter of sliding sheave bushing

BUSHING	SERVICE LIMIT
Sliding sheave bushing	41.5 mm (1.634 in)

Replace sliding sheave if the inner diameter of bushing is out of specification.

Fixed Sheave

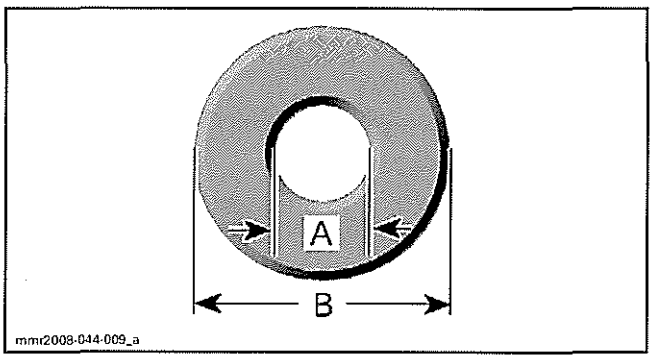
Replace fixed sheave and countershaft if one of the following problem is detected:

- Marks or scratches on pulley sheave
- Bent, twisted or otherwise damaged countershaft
- Defective splines and threads at the end of countershaft.

Driven Pulley Rollers

Check the rollers for flat spots, cracks or other visible damages. Replace if necessary.

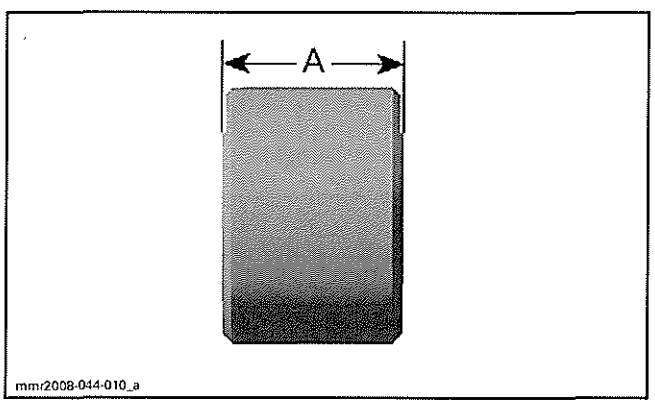
Measure inner and outer diameter of rollers.



A. Inner diameter
B. Outer diameter

ROLLER DIAMETER	SERVICE LIMIT
Inner diameter	8.5 mm (.335 in)
Outer diameter	21.5 mm (.846 in)

Measure the roller thickness.



A. Thickness of roller

ROLLER THICKNESS	
SERVICE LIMIT	14.75 mm (.581 in)

If a roller is out of specifications, replace both rollers at the same time.

Driven Pulley Cleaning

Use the PULLEY FLANGE CLEANER (P/N 413 711 809) and a clean rag to clean pulley sheaves.

Clean residues of adhesive product on sliding sheave bushing area.

Cam and Spring

When a dust deposit has to be removed from the cam or the countershaft, use dry cloth to avoid removing transferred teflon.

NOTE: During break-in period, teflon from bushing moves to cam or countershaft surface. A teflon over teflon running condition occurs, leading to low friction. Do not remove this deposit.

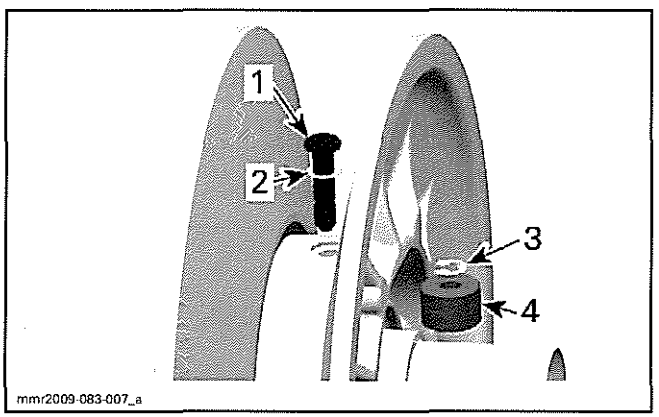
Driven Pulley Assembly

Driven Pulley Rollers

1. Using a screw tap, clean pivot screw threaded holes into fixed sheave.
2. Install rollers into fixed sheave using NEW pivot screws with ribbed lock washers.

NOTICE Always use new pivot screws with pre-applied threadlocker.

3. Tighten pivot screws to the specified torque.

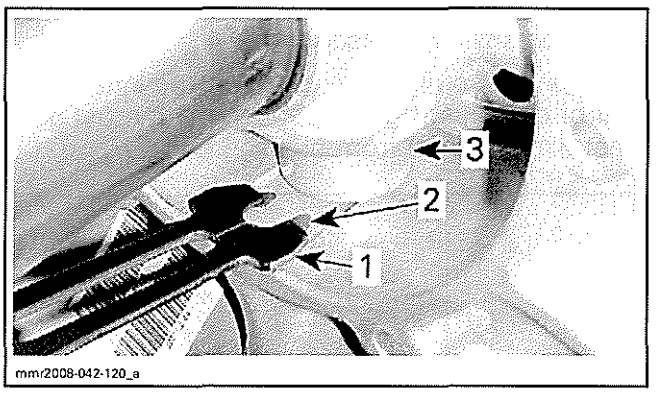


1. *Pivot screw*
2. *Ribbed lock washer*
3. *E-clip*
4. *Roller*

PIVOT SCREWS TIGHTENING TORQUE
20 N•m (15 lbf•ft)

4. Using a ROTOR CLIP® APPLICATOR (P/N A-150), install NEW E-clips to lock pivot screws.

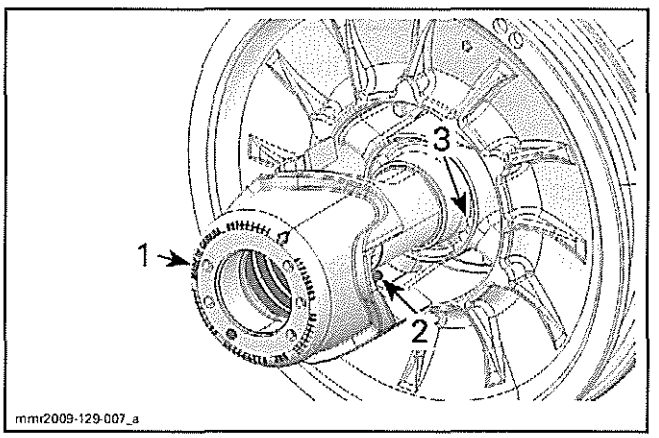
NOTE: To purchase an applicator, contact Rotor Clip Company at www.rotorclip.com.



1. *E-clip applicator*
2. *E-clip*
3. *Roller*

Cam and Spring

1. Insert one end of the spring into the appropriate cam locating hole (previously noted during removal).
2. Install cam and spring. Enter the other end of the spring in the fixed sheave locating hole previously noted during removal.

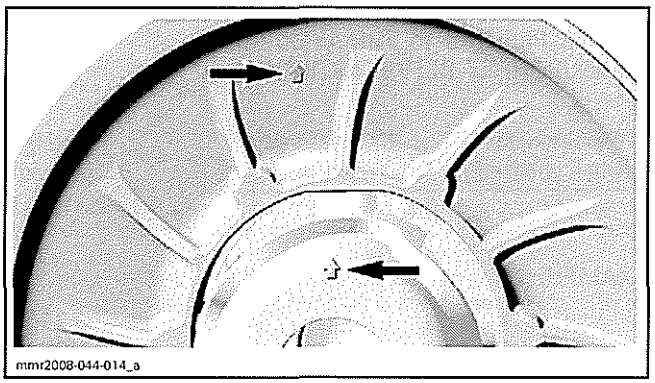


1. *Cam*
2. *End of spring*
3. *Fixed sheave locating holes*

3. Push and turn the cam to align its arrow with the arrow on fixed sheave.

At the end of the cam installation, the arrow on the cam should be move clockwise (± 30°).

Rotor Clip® is a trademark of Rotor Clip Company, Inc.



4. Install the driven spring compressor sleeve and tighten the driven spring compressor screw until cam is completely pressed against sliding sheave.
5. Check the *SPRING TORSIONAL PRELOAD*, see procedure in this subsection.
6. When preload is within specification, install 4 NEW cam screws.
7. Tighten cam screws to the specified torque.

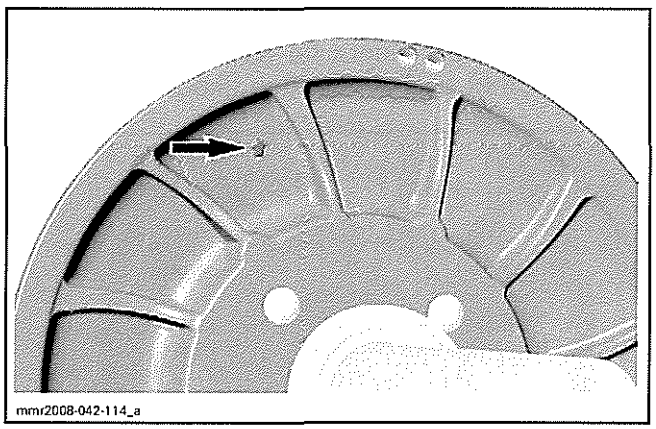
CAM SCREWS TIGHTENING TORQUE
32 N•m (24 lbf•ft)

8. Remove the driven spring compressor.

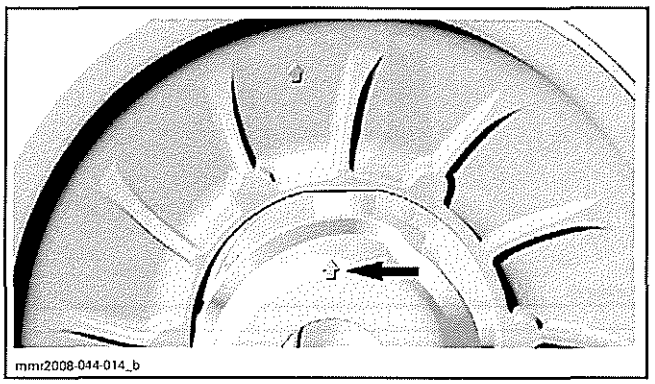
Sliding Sheave

The assembly of sliding sheave is the reverse of the disassembly. However, pay attention to the following.

When installing sliding sheave, make sure to align its arrow with the arrow on cam.



SLIDING SHEAVE ARROW

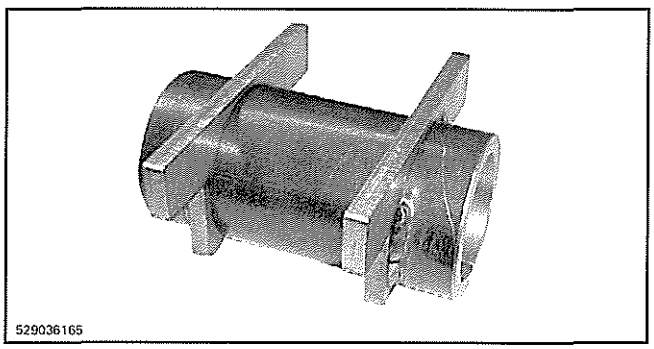


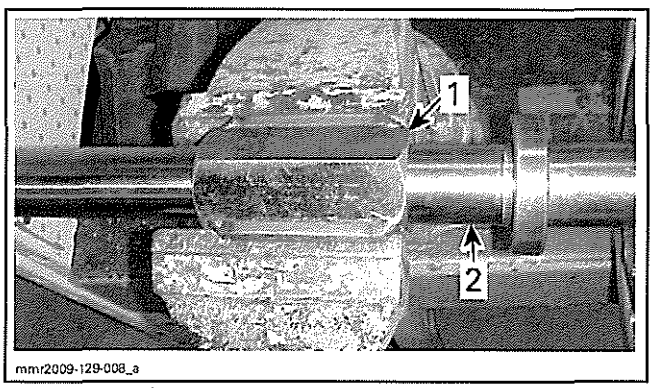
CAM ARROW

Spring Torsional Preload

NOTE: It is usual to experience spring setting during break-in period of a new spring. The factory spring preload is slightly higher (about 1 kg (2 lb)) to compensate for spring setting. Specifications in *TECHNICAL SPECIFICATIONS* are applicable after break-in period (about 10 hours of use).

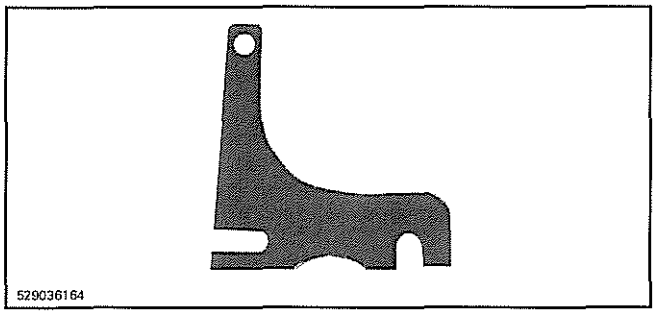
1. Secure the countershaft in a vise using the COUNTERSHAFT RETAINING TOOL (P/N 529 036 165).

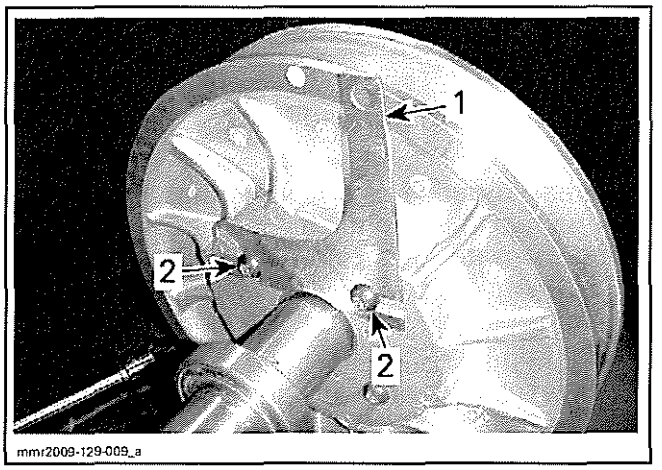




1. *Countershaft retaining tool*
2. *Countershaft*

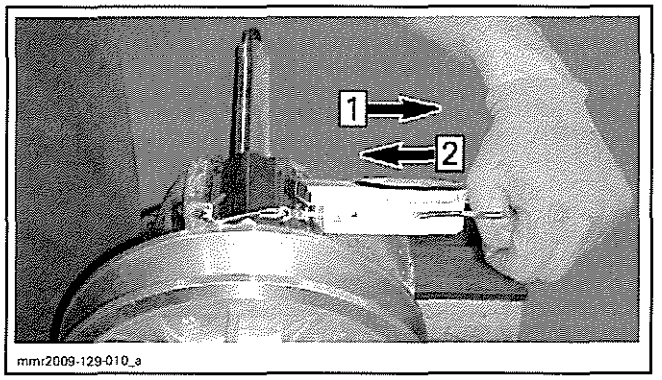
2. Install the PRELOAD TESTER (P/N 529 036 164) using old cam screws.





1. Preload tester
2. Cam screws

3. Hook a fish scale to the preload tester.
4. Pull the preload tester using the fish scale perpendicularly with pulley axle.
   - 4.1 Take a 1st measurement when sliding sheave begins to turn.
   - 4.2 Hold fish scale in this position.
   - 4.3 Slowly release tension and take a 2nd measurement when sliding sheave begins to return.



Step 1: 1st measurement
Step 2: 2nd measurement

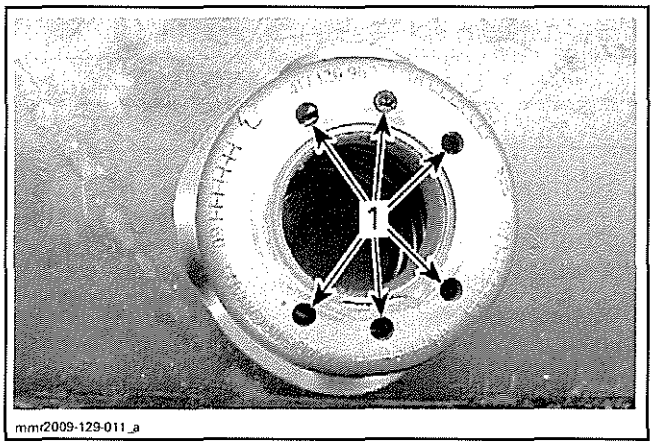
SPRING PRELOAD IS THE AVERAGE MEASUREMENT BETWEEN THESE 2:

$$\frac{\text{1st measurement (when opening)} + \text{2nd measurement (when closing)}}{2} = \text{Spring preload}$$

EXAMPLE:

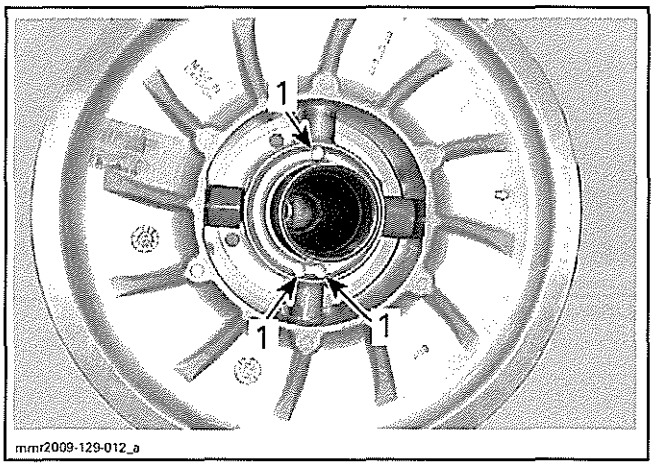
$$\frac{\text{8.2 kg (18 lb) (when opening)} + \text{6.5 kg (14 lb) (when closing)}}{2} = \text{7.3 kg (16 lb) Actual spring preload}$$

To adjust spring preload, relocate spring end in the cam, moving it clockwise to increase the preload and counterclockwise to decrease it. Always recheck torsional preload after an adjustment.



1. Cam locating holes

If spring preload cannot be adjusted, try to relocate the other end of spring in fixed sheave.

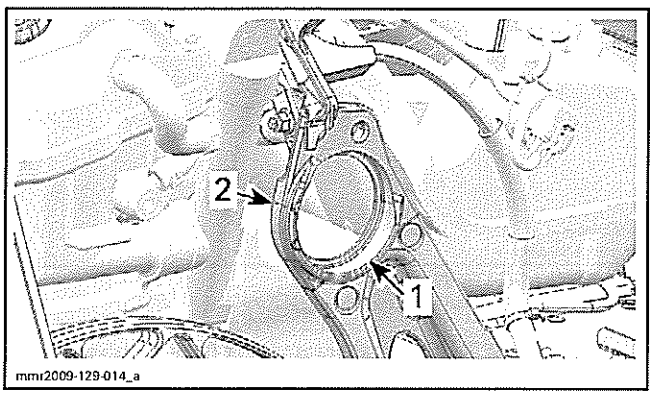


1. Fixed sheave locating holes

5. Finalize driven pulley assembly.

Driven Pulley Installation

1. Using sand paper (600-grit or 1000-grit) or steel wool, remove any rust on bearing shoulder of countershaft bearing support.

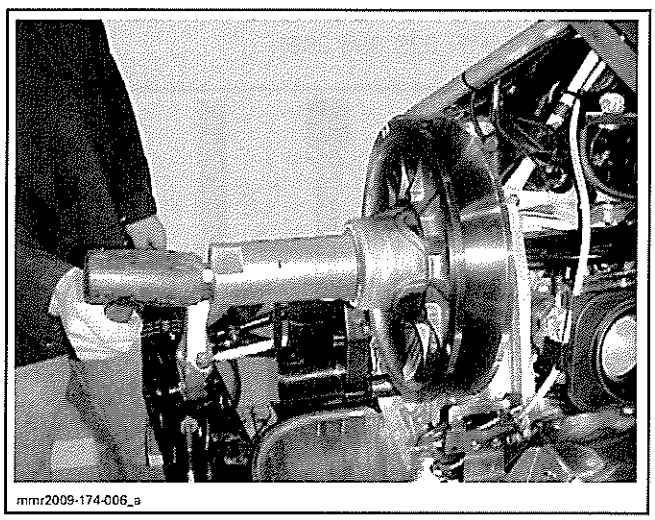


1. Bearing shoulder
2. Countershaft bearing support

2. Apply a thin layer of LOCTITE 767 (ANTISEIZE LUBRICANT) (P/N 293 800 070) on bearing shoulder.

Apply LOCTITE 767 (ANTISEIZE LUBRICANT) (P/N 293 800 070):
- Bearing shoulder
- Countershaft internal splines (gearbox end).

3. Install DRIVEN PULLEY SPRING COMPRESSOR (P/N 529 036 064) on the driven pulley.
4. Position countershaft on gearbox input shaft.
5. Properly insert countershaft through countershaft bearing support using a plastic hammer.



6. On LH side, install the bearing flange on countershaft bearing support.
7. Tighten nut bearing flange to the specified torque.

BEARING FLANGE NUT TIGHTENING TORQUE
16 N•m (142 lbf•**in**)

8. Remove driven pulley spring compressor.
9. Install the adjuster ring on the countershaft end and adjust drive belt. Refer to *DRIVE BELT* subsection.
10. Install all other removed parts.

COUNTERSHAFT

The countershaft and the fixed sheave are sold as an assembly. They are not available separately.

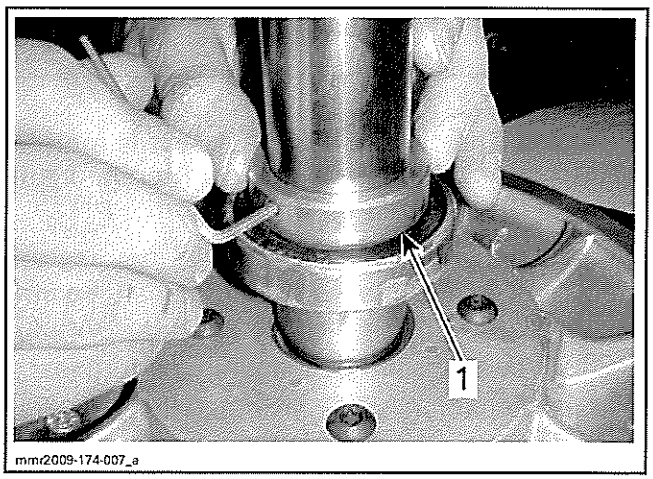
Countershaft Removal and Installation

Refer to *DRIVEN PULLEY* in this subsection.

COUNTERSHAFT BEARING

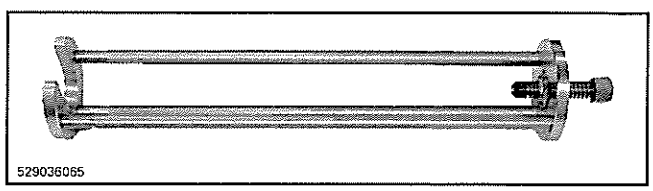
Countershaft Bearing Removal

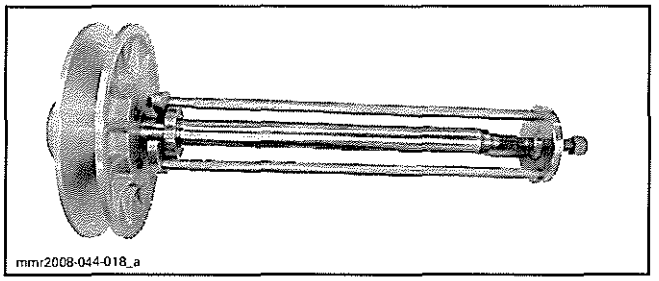
1. Remove *DRIVEN PULLEY*, see procedure in this subsection.
2. Remove bearing retaining collar from countershaft.



1. Retaining collar

3. Install the COUNTERSHAFT BEARING REMOVER (P/N 529 036 065) on countershaft.

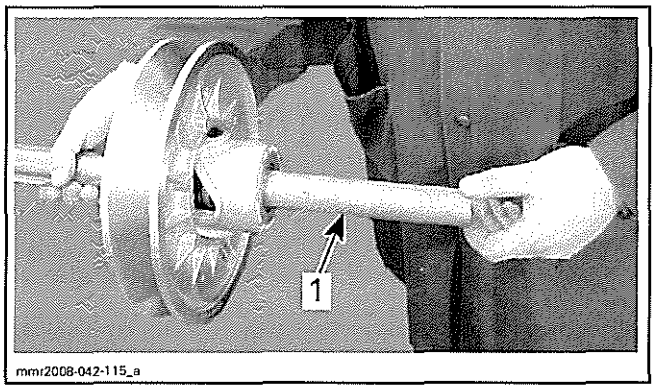




4. Tighten the screw at the end of tool to extract the bearing. Discard the bearing.

Countershaft Bearing Installation

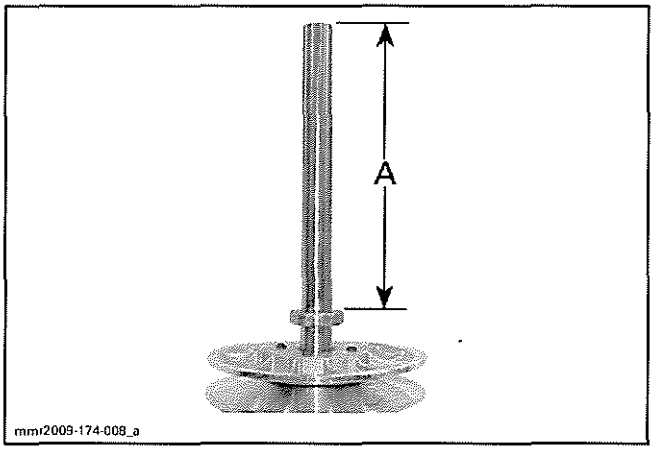
1. Remove the adjustment ring on the cam.
2. Insert the COUNTERSHAFT SUPPORT (P/N 529 036 067) into the countershaft.



1. Countershaft support

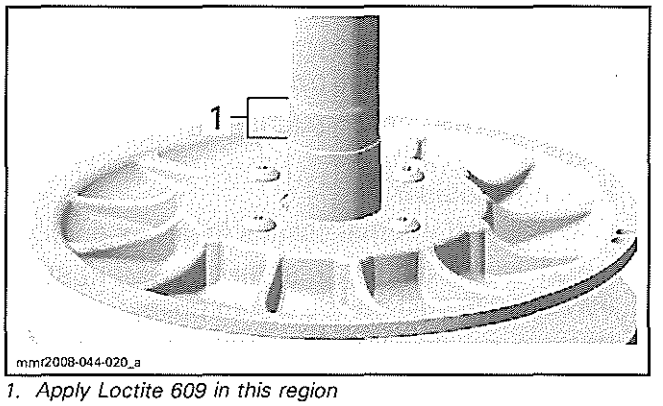
NOTICE The countershaft support is mandatory to avoid damaging the countershaft and the cam during bearing installation.

3. Using PULLEY FLANGE CLEANER (P/N 413 711 809), clean residues on countershaft bearing surface.
4. Check countershaft bearing surface for wear.
5. Mark countershaft at 362 mm ± 0.3 mm (14.252 in ± .012 in) from the gearbox end.



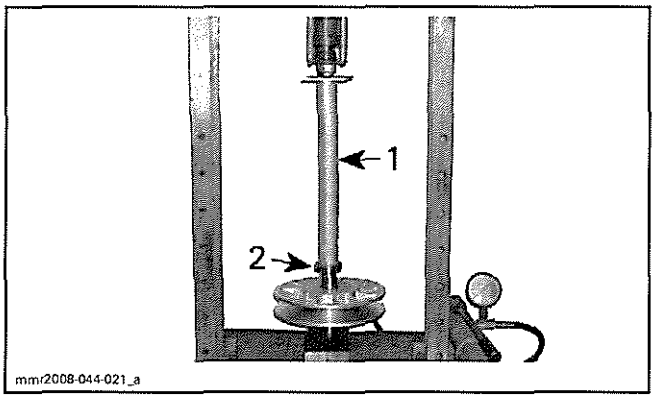
BEARING LOCATION MARK
A. 362 mm ± 0.3 mm (14.252 in ± .012 in)

6. Apply LOCTITE 609 (P/N 413 703 100) on countershaft bearing surface.



1. Apply Loctite 609 in this region

7. Install a NEW bearing on countershaft using a press and the COUNTERSHAFT BEARING INSTALLER (P/N 529 036 066).



1. Countershaft bearing installer
2. NEW bearing

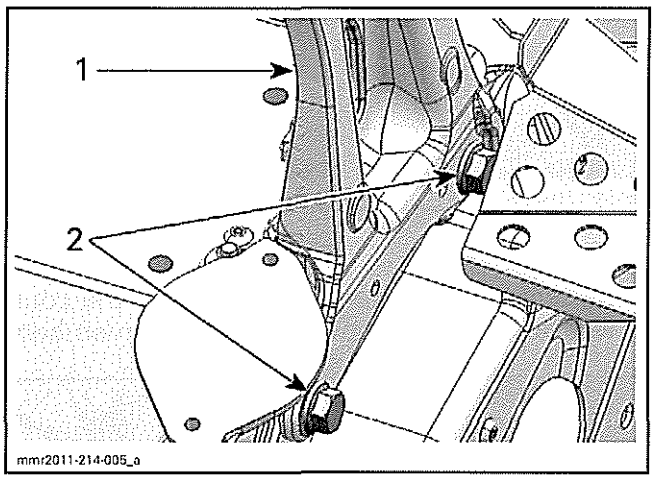
NOTICE Always use a press, never tap on countershaft bearing installer with an hammer to avoid damaging bearing and countershaft.

8. Clean the surplus of Loctite with a rag to avoid having Loctite on sliding sheave bushing.

COUNTERSHAFT BEARING SUPPORT (600 HO E-TEC)

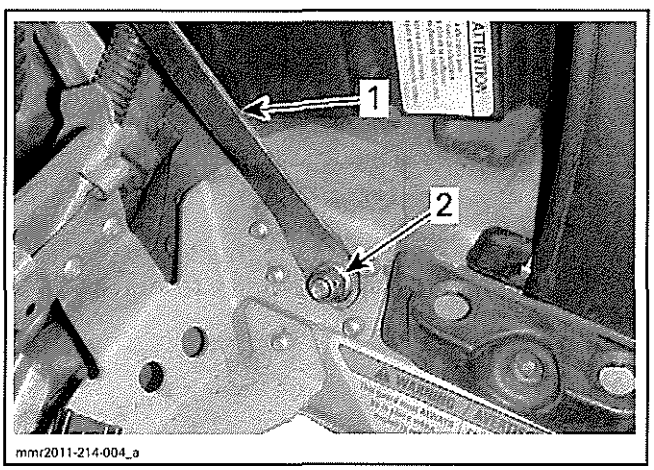
Countershaft Bearing Support Removal

1. Remove *DRIVEN PULLEY*, see procedure in this subsection.
2. Remove screws securing the bottom of countershaft bearing support to the frame.



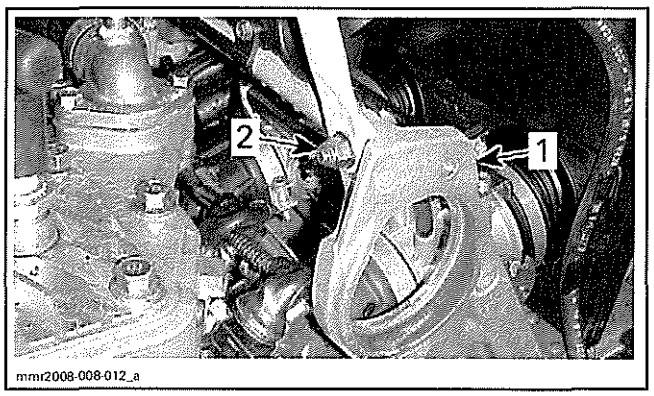
1. Countershaft bearing support
2. Screws

3. Loosen the rear bracket lower retaining nut, then move bracket aside.



1. Rear bracket
2. Lower retaining nut

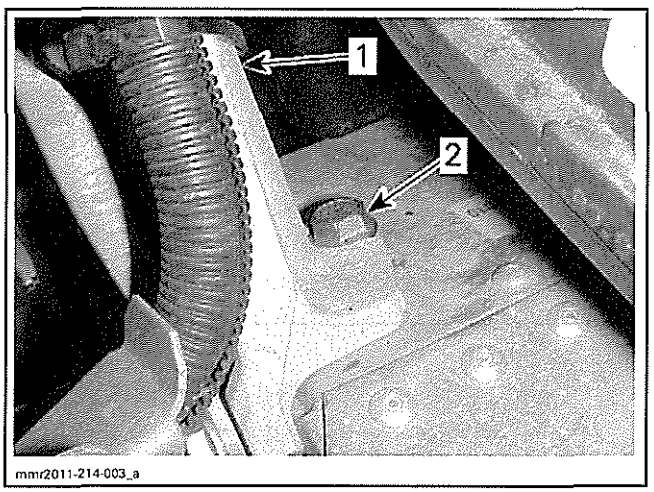
4. Remove the bolt retaining the top of countershaft bearing support to the frame members.



1. Countershaft bearing support
2. Bolt

5. Remove the primary air intake silencer.
6. Loosen the lower screw located behind the countershaft bearing support.

NOTE: For an easier access to the bolt, slightly move throttle body upwards.



1. Countershaft bearing support
2. Lower screw

7. Remove the countershaft bearing support.

Countershaft Bearing Support Installation

The installation is the reverse of removal procedure, however pay attention to the following.

Tighten the bolt securing the top of bearing support to the frame members loosely last.

Tighten fasteners to the specified torque.

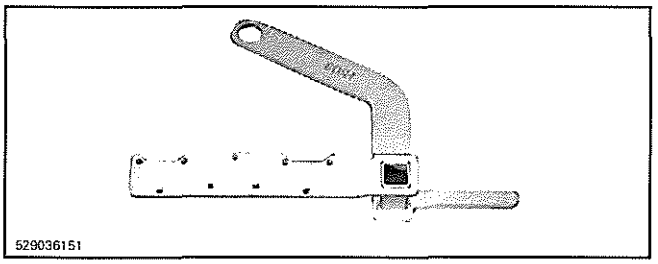
COUNTERSHAFT BEARING SUPPORT FASTENERS TIGHTENING TORQUE	
Top of bearing support to frame members	14 N•m (124 lbf•**in**)
Bearing support to frame screws	34 N•m (25 lbf•ft)
Bearing flange nut	16 N•m (142 lbf•**in**)
Bottom of rear bracket nut	10 N•m (89 lbf•**in**)

1. Install all other removed parts.

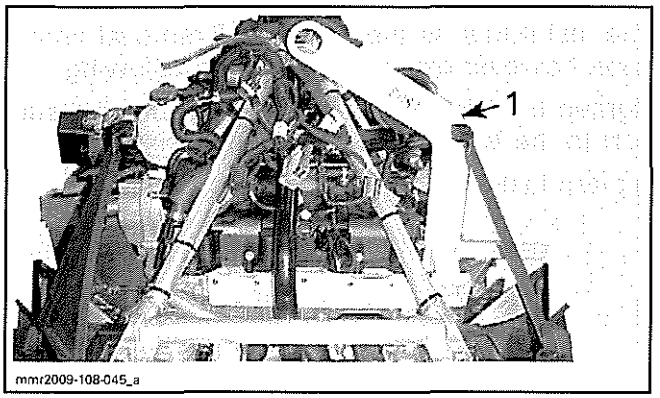
COUNTERSHAFT BEARING SUPPORT (1200 4-TEC)

Countershaft Bearing Support Removal

1. Remove the exhaust manifold. Refer to *EXHAUST SYSTEM* subsection.
2. Remove the drive pulley. Refer to *DRIVE PULLEY* subsection.
3. Remove the driven pulley, see procedure in this subsection.
4. Install the ENGINE LIFTING TOOL (P/N 529 036 151) in order to support the PTO side of engine.
   4.1 Install the tool instead of exhaust manifold.



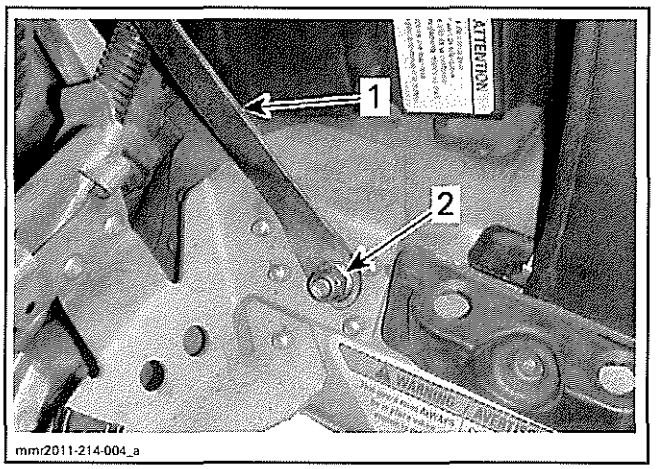
   4.2 Using exhaust manifold nuts, secure the tool.



1. Engine lifting tool

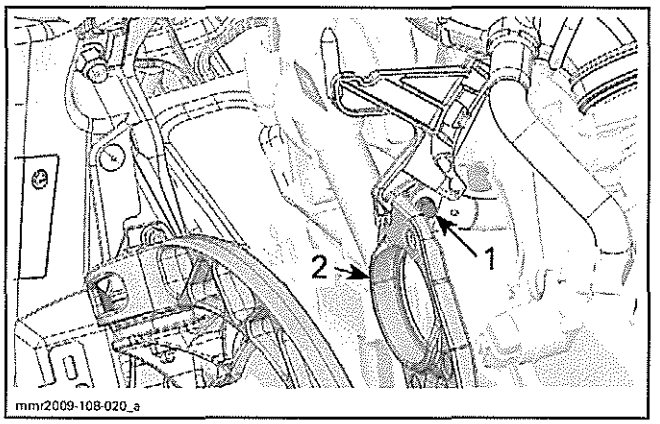
   4.3 Support the engine using a hoist.

5. Loosen the rear bracket lower retaining nut, then move bracket aside.



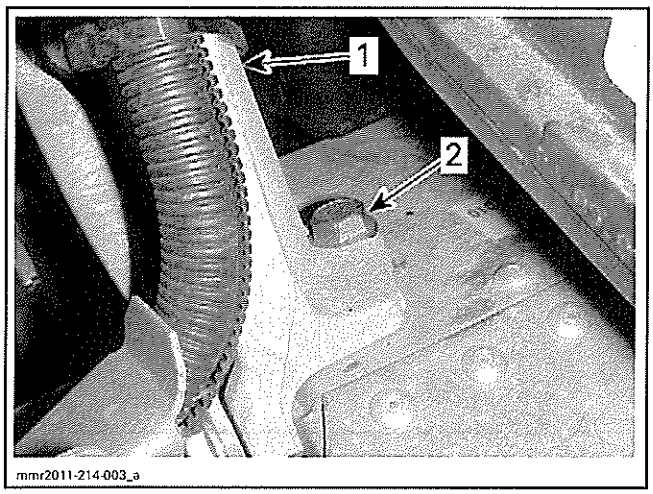
1. Rear bracket
2. Lower retaining nut

6. Remove the bolt securing the top of the countershaft bearing support to the frame members.



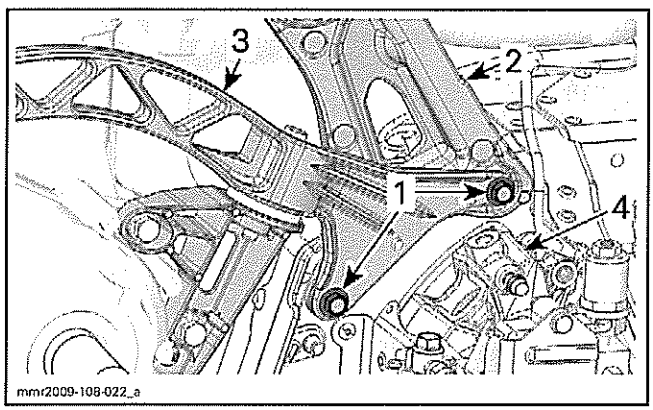
1. bolt
2. Countershaft bearing support

7. Loosen the screw retaining the bottom of countershaft bearing support to the frame.



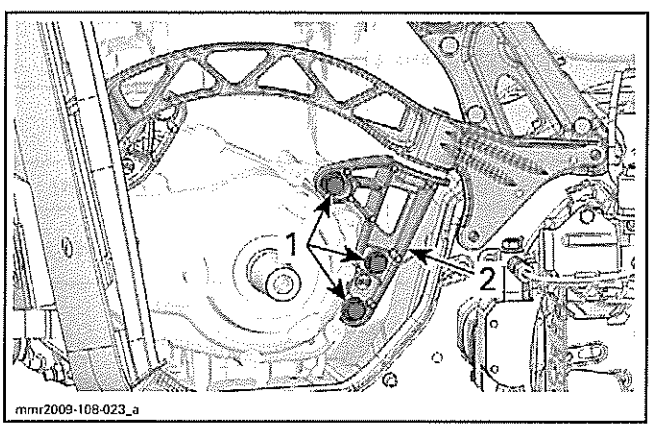
1. *Countershaft bearing support*
2. *Lower screw*

8. Remove both screws retaining the brace and the countershaft bearing support to the frame.



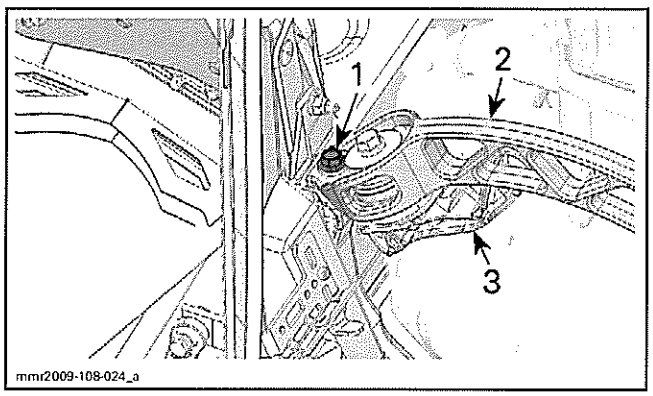
1. *Remove these screws*
2. *Countershaft bearing support*
3. *Brace*
4. *Caliper*

9. Remove screws and washers securing the rear engine support to the engine.



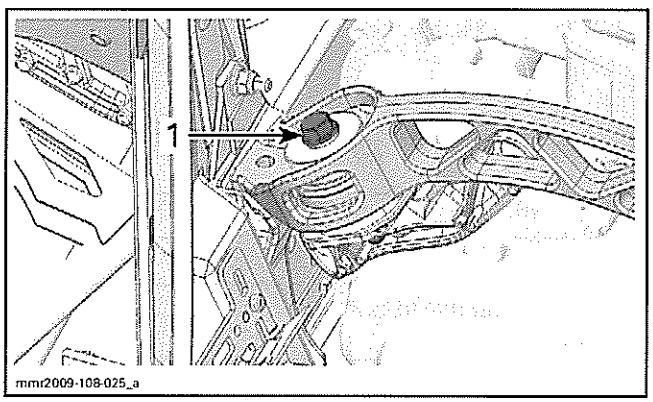
1. *Rear engine support screws*
2. *Rear engine support*

10. Remove the screw and washer retaining the brace to the frame (front of engine).



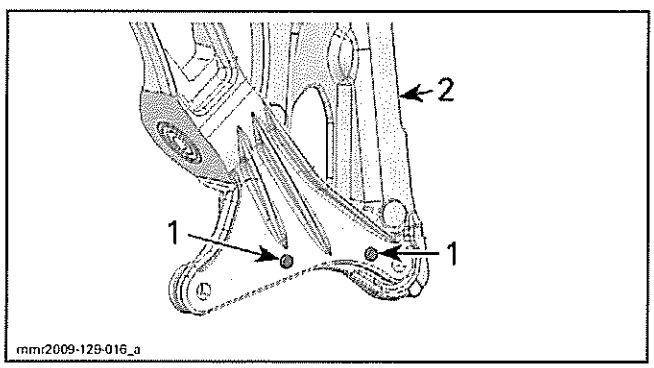
1. *Brace screw*
2. *Brace*
3. *Front engine support*

11. Remove the front engine mount bolt.



1. *Front engine mount bolt*

12. Remove the brace with countershaft bearing support and rear engine support.
13. Drill rivets securing the countershaft bearing support to the brace.



1. *Rivets*
2. *Countershaft bearing support*

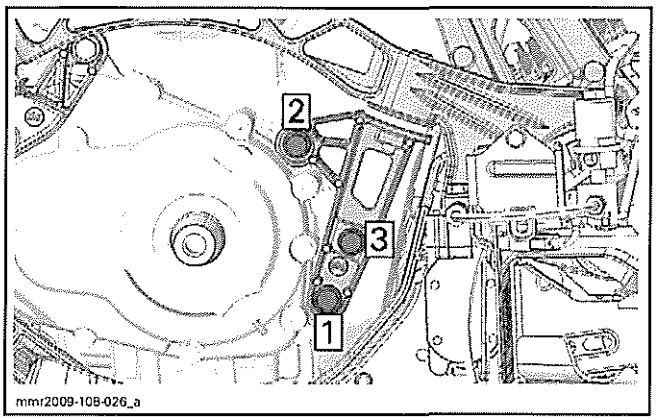
14. Remove the bearing support.

Countershaft Bearing Support Installation

1. Install the countershaft bearing support on the brace using two rivets.

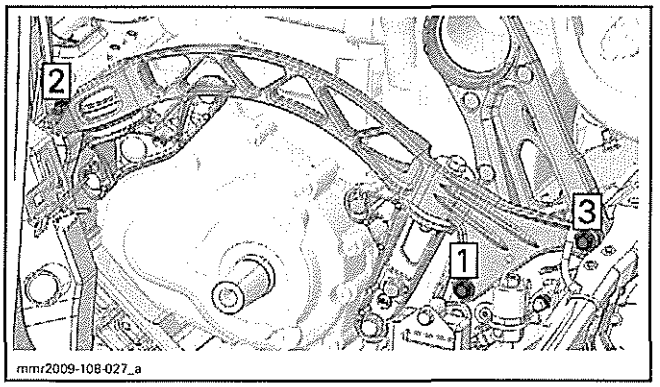
2. Thread all retaining fasteners but do not tighten yet.
3. Tighten rear engine support fasteners in the following order.

REAR ENGINE SUPPORT	
Screw tightening torque (follow sequence)	42 N•m (31 lbf•ft)



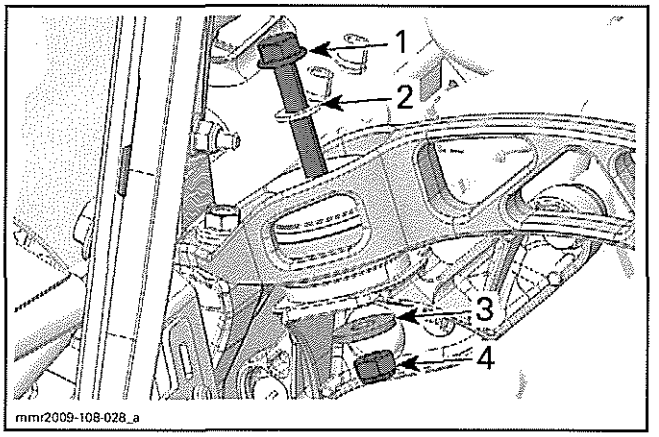
TIGHTENING SEQUENCE - REAR ENGINE SUPPORT

BRACE TO FRAME	
Screw tightening torque (follow sequence)	25 N•m (18 lbf•ft)



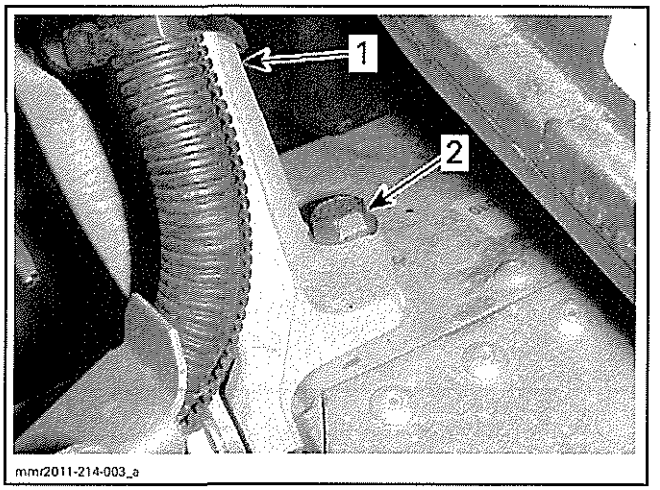
TIGHTENING SEQUENCE - BRACE TO FRAME

FRONT RUBBER MOUNT	
Bolt tightening torque	25 N•m (18 lbf•ft)



1. *Bolt*
2. *Small flat washer*
3. *Large flat washer with Teflon*
4. *Nut*

REAR OF COUNTERSHAFT BEARING SUPPORT	
Screw tightening torque	34 N•m (25 lbf•ft)



1. *Countershaft bearing support*
2. *Lower screw*

Tighten other fasteners to the specified torque.

COUNTERSHAFT BEARING SUPPORT FASTENERS TIGHTENING TORQUE	
Top of bearing support to frame members	14 N•m (124 lbf•**in**)
Bearing flange nut	16 N•m (142 lbf•**in**)
Bottom of rear bracket nut	10 N•m (89 lbf•**in**)

4. Install all other removed parts.

BRAKE

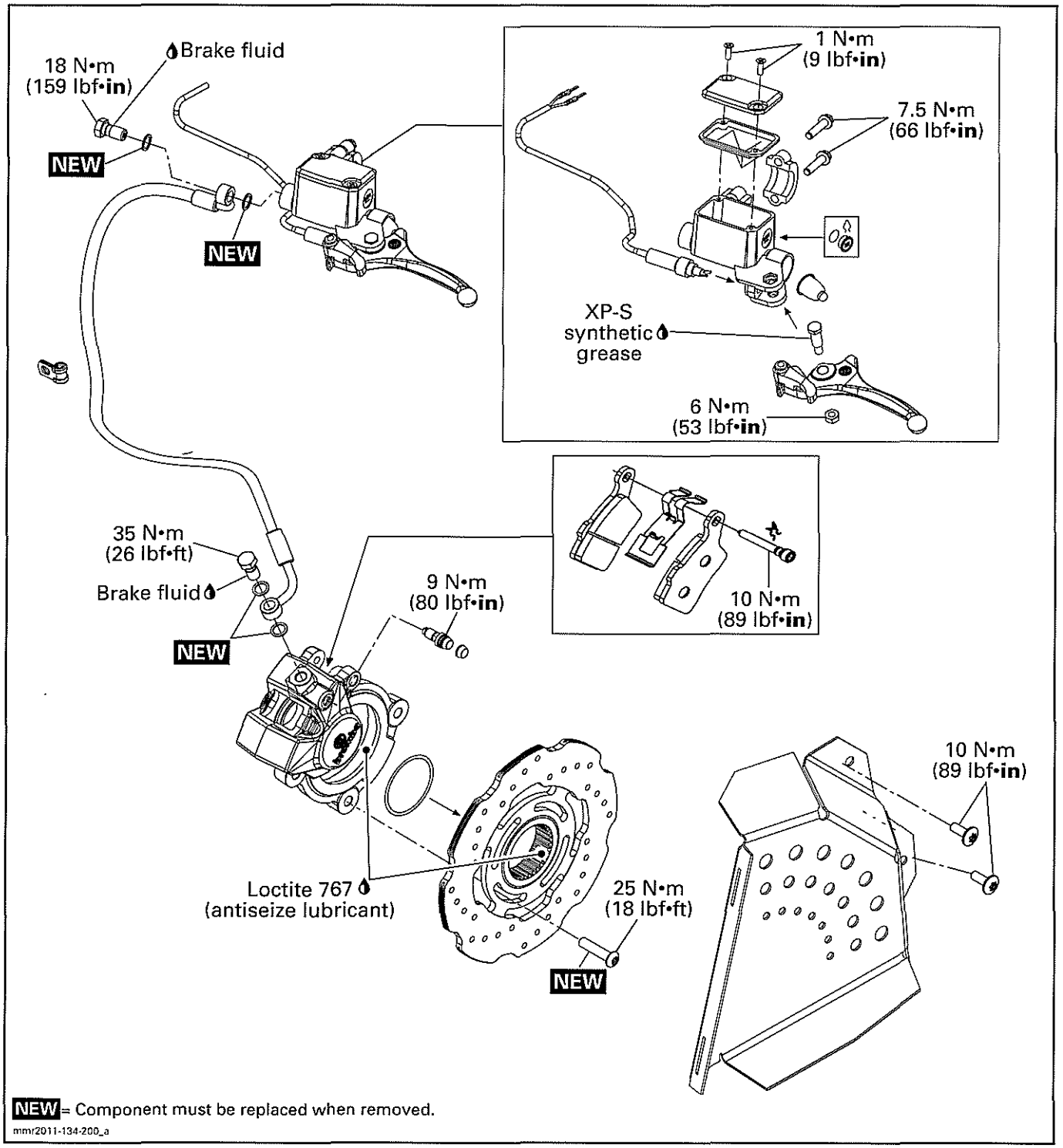
SERVICE TOOLS

Description	Part Number	Page
CALIPER PULLER	529 036 145	770
FLUKE 115 MULTIMETER	529 035 868	774
PROTECTIVE CAP	529 036 150	770

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 767 (ANTISEIZE LUBRICANT)	293 800 070	771
XPS SYNTHETIC GREASE	293 550 010	774

REV-XU


18 N•m
(159 lbf•in)
Brake fluid
NEW
NEW
1 N•m
(9 lbf•in)
7.5 N•m
(66 lbf•in)
XP-S
synthetic
grease
6 N•m
(53 lbf•in)
35 N•m
(26 lbf•ft)
Brake fluid
NEW
9 N•m
(80 lbf•in)
10 N•m
(89 lbf•in)
Loctite 767
(antiseize lubricant)
25 N•m
(18 lbf•ft)
NEW
10 N•m
(89 lbf•in)
NEW = Component must be replaced when removed.
mmr2011-134-200_a

GENERAL

During assembly/installation, use torque values and service products as in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, cotter pins, etc.) must be replaced.

NOTICE Hoses, cables, locking ties removed during a procedure must be reinstall as per factory standards.

⚠ WARNING

Never apply anything to brake fittings. The use of thread sealant or Teflon tape could cause brake system failure. Severe injury or death can occur.

⚠ WARNING

A contaminated brake disc or pad reduces braking efficiency. Discard contaminated pads and clean contaminated disc with a high quality brake degreasing agent.

NOTICE Avoid spilling brake fluid on plastic, rubber or painted parts. Protect these parts with a rag when servicing brake system.

NOTICE Wipe up any brake fluid spillage.

NOTICE To avoid serious damage to the brake system, use only DOT 4 brake fluid from a sealed container. Do not use brake fluid taken from old or already opened containers, nor mix different fluids for topping off.

NOTICE Sealing washers must be discarded and replaced with NEW ones every time a Banjo fitting is unscrewed.

Dispose brake fluid as per your local environmental regulation.

PROCEDURES

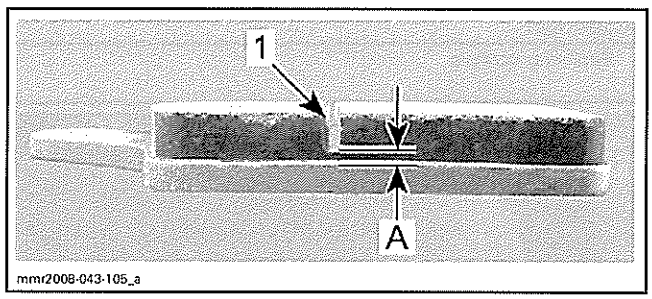
BRAKE PADS

Brake Pad Inspection

1. Measure brake pad lining thickness.

SERVICE LIMIT	
Brake pad thickness	1 mm (1/32 in)

NOTICE Brake pads must always be replaced in pairs.

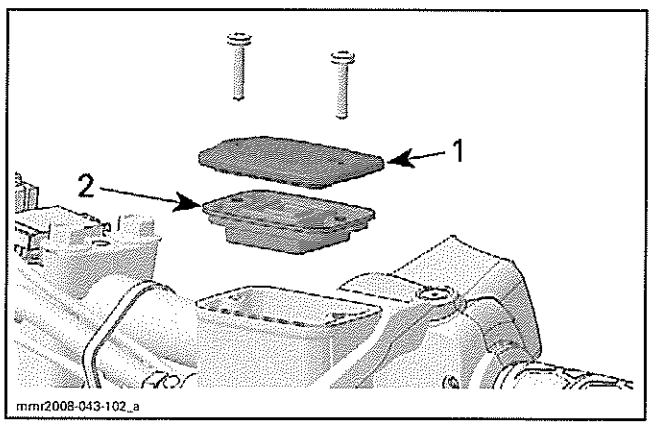


1. Groove on pad lining
A. Brake pad minimum thickness 1 mm (1/32 in)

2. Inspect brake disc at the same time.

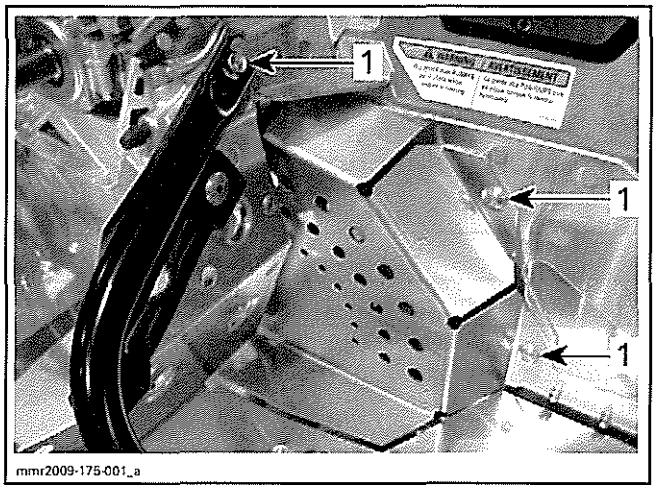
Brake Pad Replacement

1. Place the vehicle on a level surface.
2. Cover the plastic parts under and near master cylinder in the event that brake fluid would be spilled.
3. Remove reservoir cover with its diaphragm.

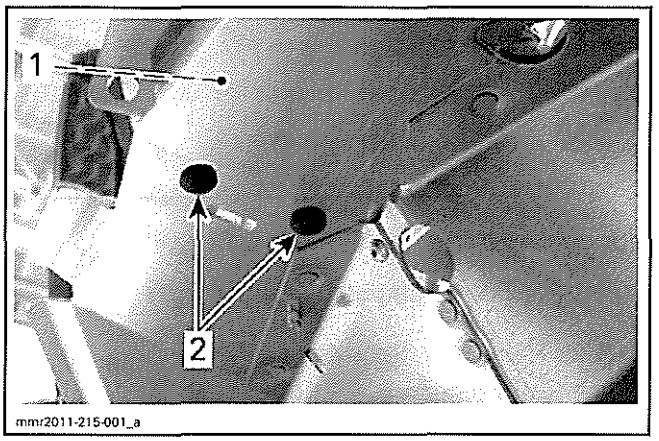


1. Reservoir cover
2. Diaphragm

4. Remove the brake disc protective cover by unscrewing the retaining screws.

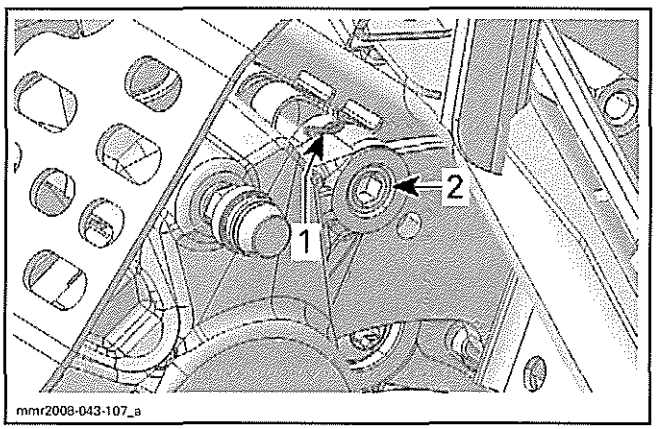


1. Retaining screws



1. Underside of foot board
2. Retaining screw

5. Remove the clip securing pad pin.
6. Unscrew and remove the pad pin.

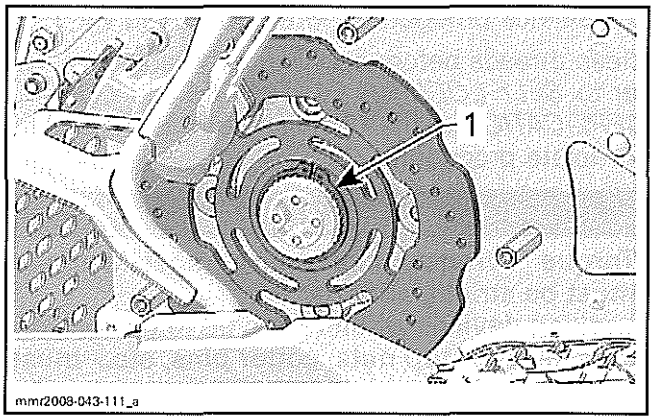


TYPICAL
1. Clip
2. Brake pad pin

7. Using a flat screwdriver, retract pistons into their bores.

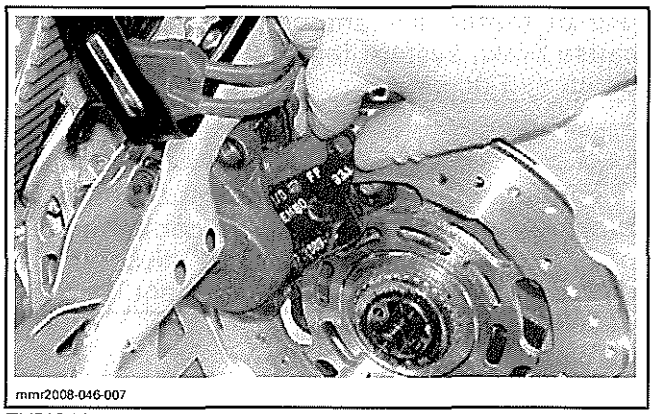
NOTICE Pay attention to avoid scratching brake disc.

8. Remove the circlip securing brake disc to drive shaft.



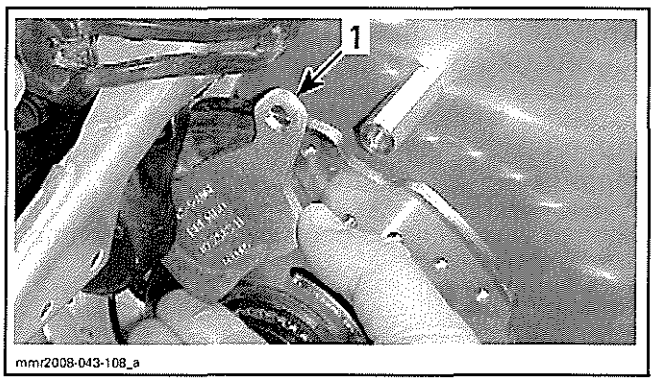
TYPICAL
1. Brake disc circlip

9. Remove brake pads.
   9.1 Remove the external pad first.
   9.2 Pull the brake disc and remove the internal pad.



TYPICAL

10. At this time, check brake disc condition. Refer to *BRAKE DISC INSPECTION* further in this subsection.
11. Install NEW brake pads with tabs upward.

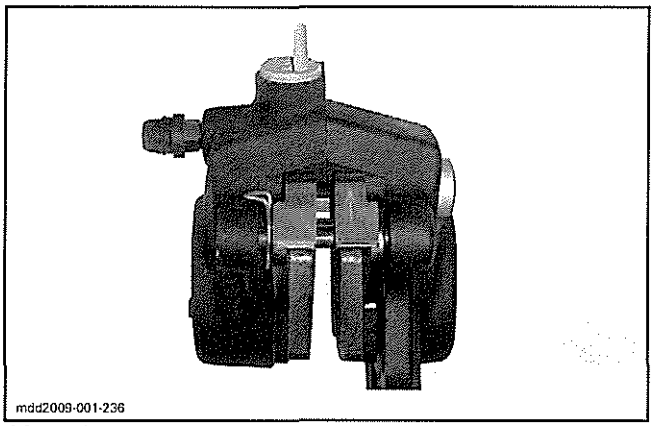


TYPICAL
1. Brake pad tab

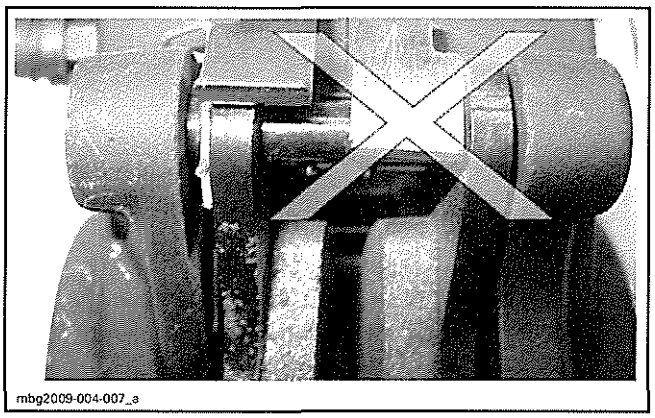
12. Install brake pad pin.
13. Tighten pin to specified torque.

BRAKE PAD PIN TORQUE
10 N•m (89 lbf•**in**)

14. Install clip on brake pad pin. If the clip seems loose, replace it with a new one.
15. Make sure spring ends on brake pads pins are correctly installed as per the following pictures.



CORRECT



INCORRECT (ON RIGHT SIDE)

16. Operate the brake lever several times to bring the brake pads into contact with the brake disc.
17. Check brake fluid level in master cylinder and refill if necessary.
18. Install the diaphragm and the reservoir cover.
19. Install the protective cover of the brake disc.
20. Ride the vehicle a few minutes to make sure the repair is successful.

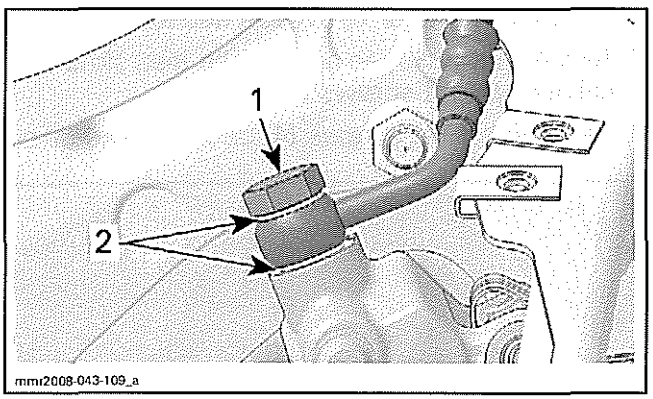
CALIPER

Caliper Removal

1. Open LH side panels.
2. Remove drive belt guard support. Refer to *DRIVE BELT* subsection.

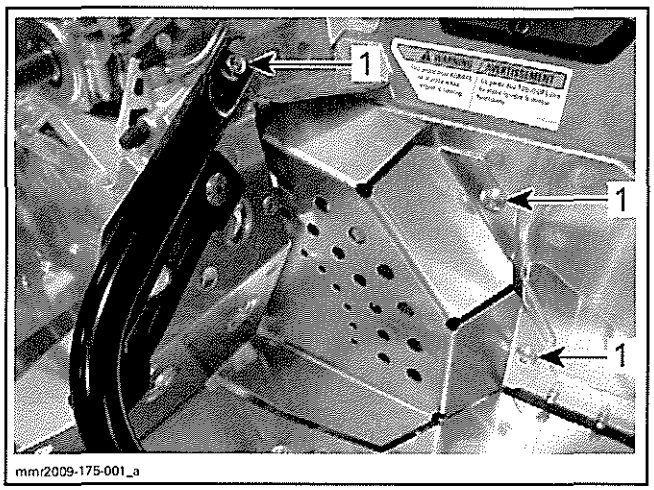
NOTE: If the caliper is not replaced, omit steps 3 and 4 concerning the brake system draining and brake hose removal.

3. Drain the brake system, refer to *BRAKE FLUID REPLACEMENT* in *PERIODIC MAINTENANCE PROCEDURES* subsection.
4. Remove the Banjo fitting and discard the sealing washers.

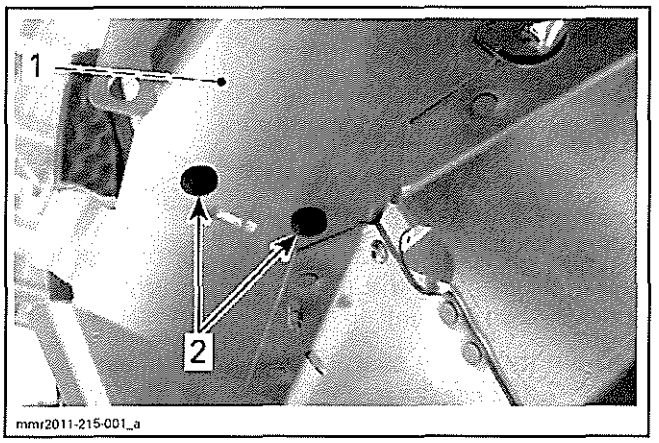


1. Banjo fitting
2. Sealing washers

5. Remove the protective cover from over the brake disc.

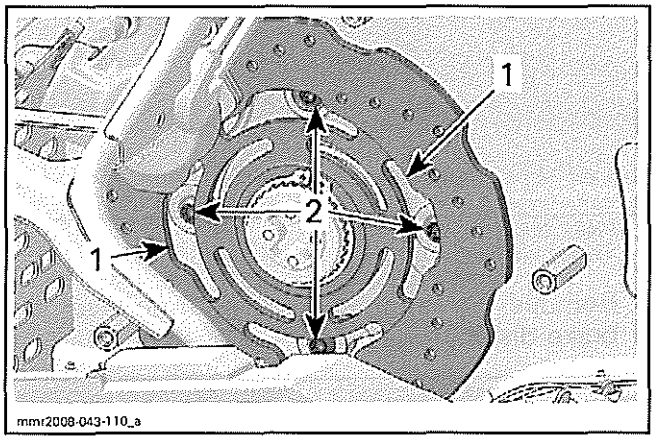


TYPICAL
1. Screws



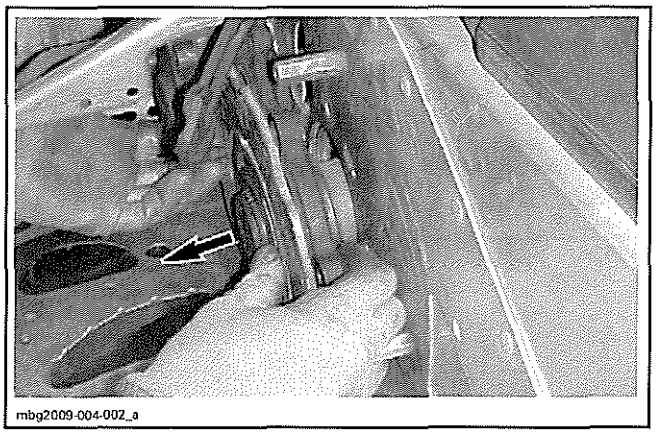
1. *Underside of foot board*
2. *Retaining screws*

6. Lift rear of vehicle and release track tension completely. Refer to *TRACK* subsection.
7. Turn driven pulley to align brake disc slots with caliper bracket screws.
8. Remove caliper screws (4) behind brake disc.



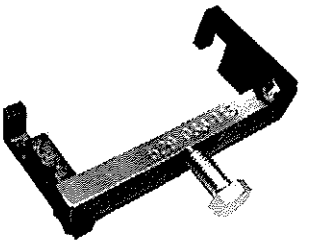
TYPICAL
1. *Brake disc slots*
2. *Caliper screws behind brake disc*

9. Pull the drive axle assembly (brake disc, caliper and bearing) from LH side.



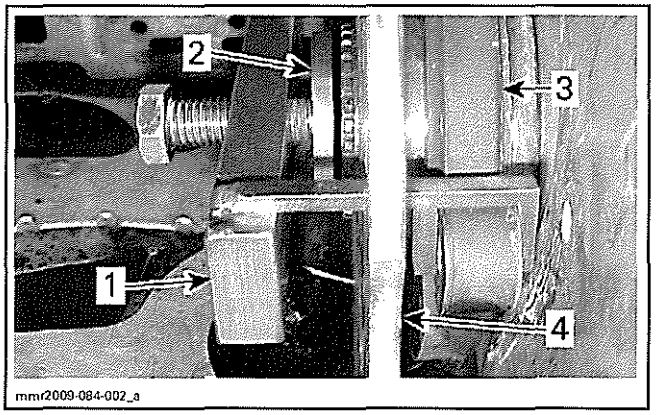
PULL

10. Remove *BRAKE PADS*, see procedure in this subsection.
11. Install the caliper puller on the brake caliper through the brake disc slots.

CALIPER PULLER (P/N 529 036 145)


NOTE: Make sure puller tabs are correctly engaged on caliper.

12. Install the PROTECTIVE CAP (P/N 529 036 150) between caliper puller bolt and plastic cap.



1. *Caliper puller*
2. *Protective cap*
3. *Caliper bracket*
4. *Brake disc*

13. Tighten caliper puller bolt to separate caliper from drive axle bearing.

NOTICE Never use an impact tool to operate caliper puller. The caliper or the puller could break.

14. When the brake disc is disengaged from the drive shaft splines, remove it.
15. Remove caliper.

NOTICE Do not let caliper hang by the hose and do not stretch or twist the hose.

Caliper Inspection

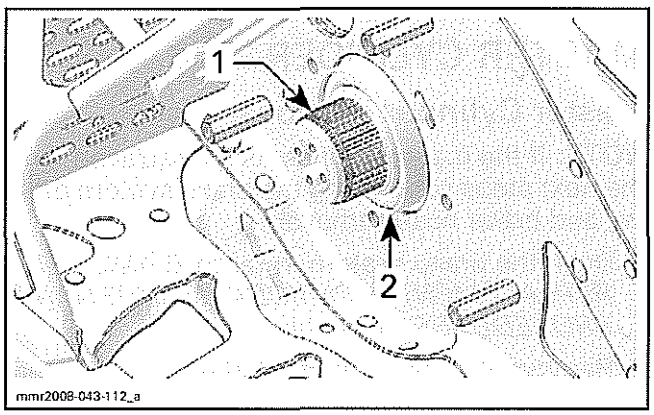
Check pistons for:
- Rust
- Scratches
- Leaks.

Check caliper bracket for:
- Cracks
- Rust on bearing shoulder (clean with a steel wood).

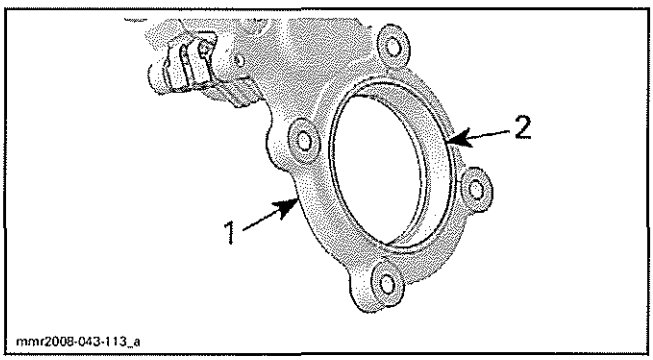
Replace caliper if required.

Caliper Installation

1. Using your fingers or a small piece of wood, push both pistons into their bores.
2. Clean brake caliper bearing shoulder with fine steel wool.
3. Apply LOCTITE 767 (ANTISEIZE LUBRICANT) (P/N 293 800 070) on drive shaft splines and on caliper bracket bearing shoulder.

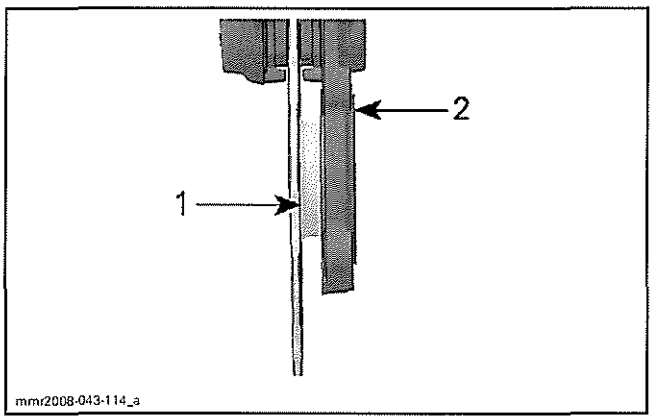


TYPICAL
1. *Drive shaft splines*
2. *Drive shaft bearing*



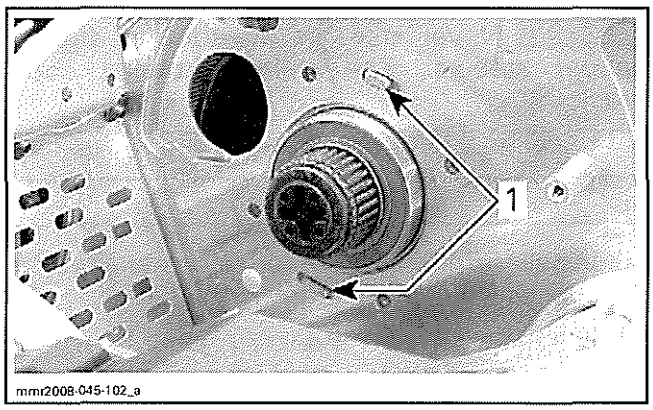
1. *Caliper bracket*
2. *Bearing shoulder*

4. Insert brake disc in the caliper. The brake disc collar must be inserted in the caliper bracket.



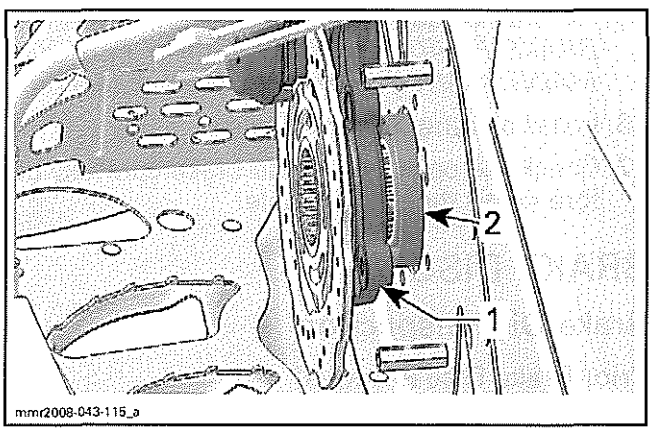
1. *Brake disc collar*
2. *Caliper bracket*

5. Ensure drive shaft bearing flange is properly locked in the frame. Tabs must be properly inserted in frame slots.



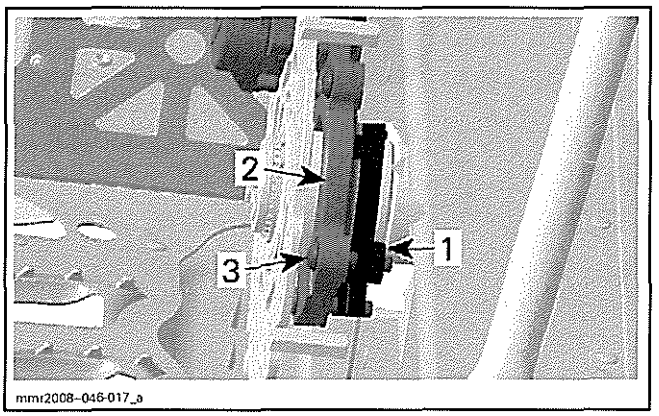
VIEW FROM OUTSIDE FRAME
1. *Bearing flange locking tabs*

6. Align brake disc splines with drive shaft splines and push the disc onto the shaft.
7. Push the caliper bracket over the drive shaft bearing.



1. *Caliper bracket*
2. *Drive shaft bearing*

8. Align caliper bracket holes with bearing flange holes and install caliper retaining screws.



1. Bearing flange (inside frame)
2. Caliper bracket
3. Caliper screws

9. HAND TORQUE each caliper bracket screw evenly in a criss-cross pattern until bracket is correctly positioned against frame.

NOTICE Never use an air tool to tighten caliper screws. The caliper bracket could crack.

CALIPER RETAINING SCREW TORQUE
25 N•m (18 lbf•ft)

10. Install *BRAKE PADS*, see procedure in this subsection.
11. Install the brake disc circlip.
12. Apply brake fluid on Banjo fitting threads.
13. Install the Banjo fitting with two NEW sealing washers.
14. Torque Banjo fitting as specified.

BANJO FITTING TORQUE
35 N•m (26 lbf•ft)

15. Fill and bleed the brake system. Refer to *BRAKE FLUID REPLACEMENT* in *PERIODIC MAINTENANCE PROCEDURES* subsection.
16. Install all other removed parts.
17. Check the operation of the brake carefully before riding the snowmobile.

BRAKE DISC

Brake Disc Inspection

Prior Brake Disc Removal

1. Remove the protective cover from over the brake disc.
2. Check for scoring, cracking or bending, replace as required.
3. Measure brake disc thickness. If the brake disc is out of specification, replace it with a new one.

NOTICE Brake disc should never be machined.

BRAKE DISC THICKNESS	
Minimum thickness	5.5 mm (.217 in)

After Brake Disc Removal

1. Check brake disc splines and drive shaft splines for wear or other damages. Replace defective parts.

Brake Disc Removal and Installation

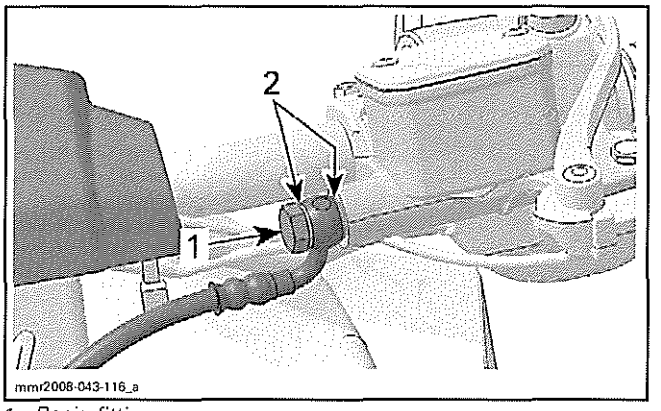
Use the same procedure as for the caliper.

MASTER CYLINDER

Master Cylinder Removal

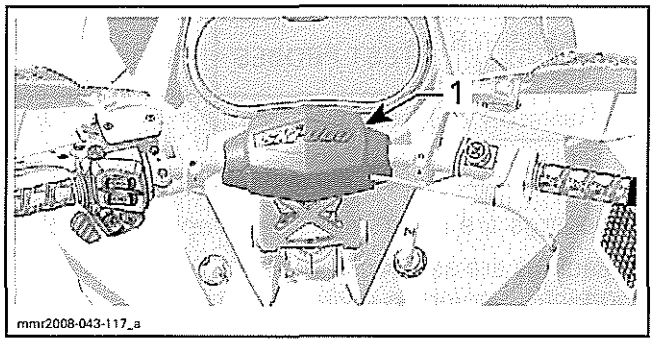
NOTE: If the master cylinder is not replaced, omit the next steps concerning the brake system draining and brake hose removal.

1. Drain the brake system, refer to *BRAKE FLUID REPLACEMENT* in *PERIODIC MAINTENANCE PROCEDURES* subsection.
2. Remove the Banjo fitting and discard the sealing washers.



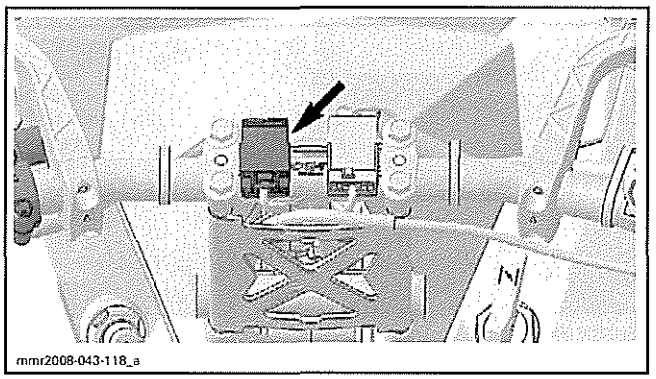
1. Banjo fitting
2. Sealing washers

3. Remove steering pad.



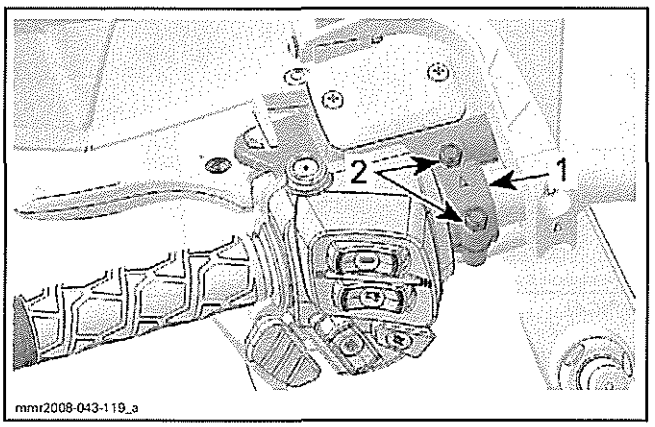
TYPICAL
1. Steering pad

4. Disconnect the LH steering connector atop the handlebar and remove the two brake light switch wires from the connector.



TYPICAL

5. Cut locking tie securing brake light switch wiring to handlebar.
6. Remove screws and clamp securing master cylinder to handlebar.



1. Master cylinder clamp
2. Master cylinder clamp screws

7. Remove master cylinder.

NOTICE Do not let master cylinder hang by the hose and do not stretch or twist the hose.

Master Cylinder Inspection

Discard all remaining fluid inside master cylinder reservoir.

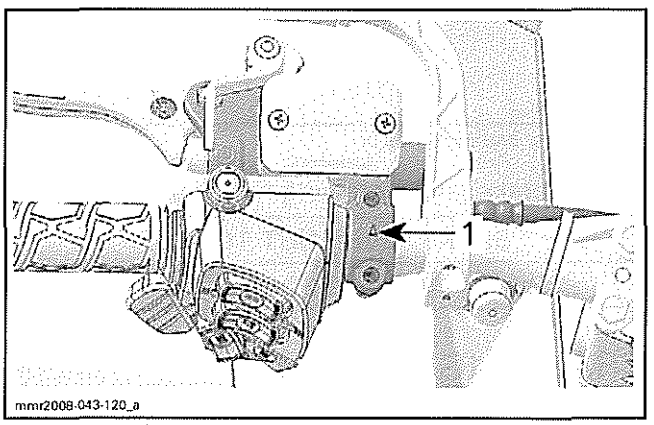
Check the seal of the reservoir cap. If brittle, hard or damaged, replace it.

If the reservoir is damaged or leaking, replace master cylinder.

Check the brake lever. If bent, cracked or otherwise damaged, replace it as required.

Master Cylinder Installation

1. Place the master cylinder on the handlebar.
2. Install master cylinder clamp with its arrow pointing toward the front of vehicle.



1. Arrow on clamp

3. Install master cylinder clamp screws finger tight.
4. With the handlebar in a straight ahead position, position the reservoir parallel to the ground.
5. Tighten brake lever clamp screws as specified.

SCREW TORQUE, BRAKE LEVER SCREWS
10 N•m (89 lbf•**in**)

6. Install the Banjo fitting with two NEW sealing washers.
7. Torque Banjo fitting as specified.

BANJO FITTING TORQUE
18 N•m (159 lbf•**in**)

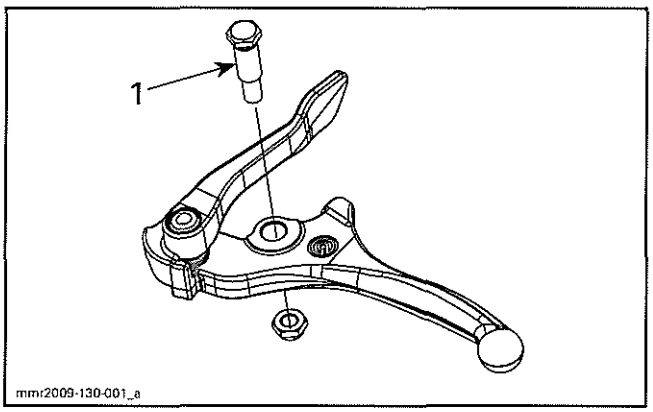
8. Fill and bleed the brake system. Refer to *BRAKE FLUID REPLACEMENT* in the *PERIODIC MAINTENANCE PROCEDURES* subsection.
9. Insert the brake light switch wires in the LH steering connector and reconnect the steering connector.

10. Install steering cover.

BRAKE LEVER

Brake Lever Replacement

Lubricate brake lever pivot screw using XPS SYNTHETIC GREASE (P/N 293 550 010).



1. Lubricate brake lever pivot

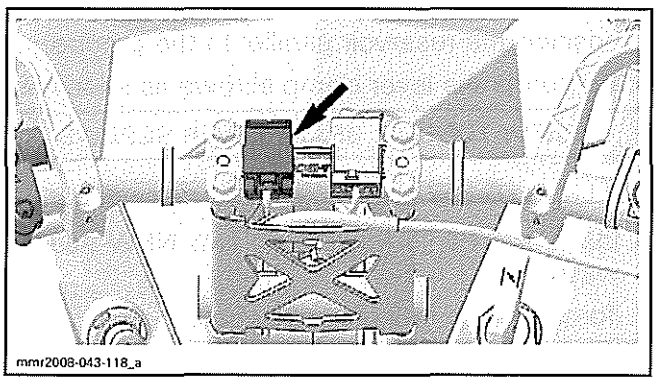
Torque brake lever retaining nut as specified.

BRAKE LEVER NUT TORQUE
6 N•m (53 lbf•**in**)

BRAKE LIGHT SWITCH

Brake Light Switch Continuity Test

1. Remove steering cover.
2. Disconnect LH steering connector.



TYPICAL

3. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Ω.
4. Test for continuity through brake switch as per the following table.

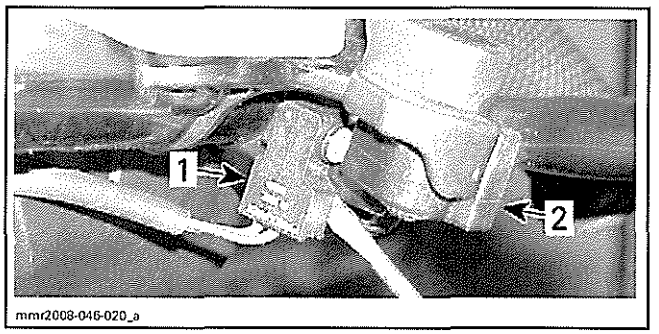
BRAKE LEVER POSITION	TEST PROBES	RESISTANCE
Released	GY and WH wires	Open (OL)
Pull in		

If readings are not as specified, replace switch.

If readings are as specified, check fuse, wiring and connectors going to switch. Repair or replace defective part(s). Refer to *LIGHTS, GAUGE AND ACCESSORIES* subsection.

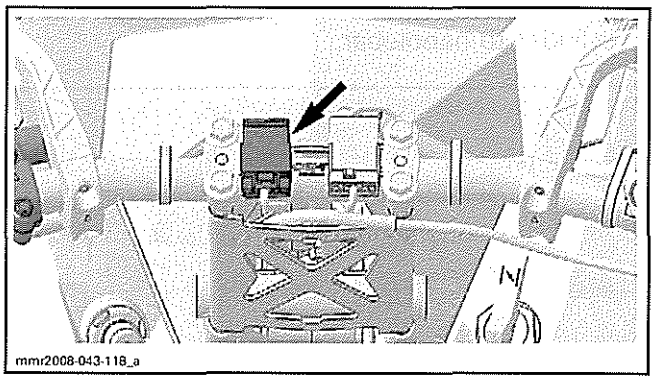
Brake Light Switch Removal

1. Slip a small screwdriver between brake light switch and brake lever and separate them.



1. Brake light switch
2. Brake lever

2. Remove the steering cover and disconnect the LH steering connector.



TYPICAL

3. Cut all locking ties securing switch wires.
4. Remove switch wires from connector.

NOTE: Observe and note wire location for reinstallation.

Brake Light Switch Installation

1. Squeeze brake lever.
2. Insert both tabs on switch in the brake lever body.

3. Insert switch wires in the steering connector as noted prior to removal.
4. Connect the steering connector.
5. Check for proper switch operation.
6. Install new locking ties and the steering cover.

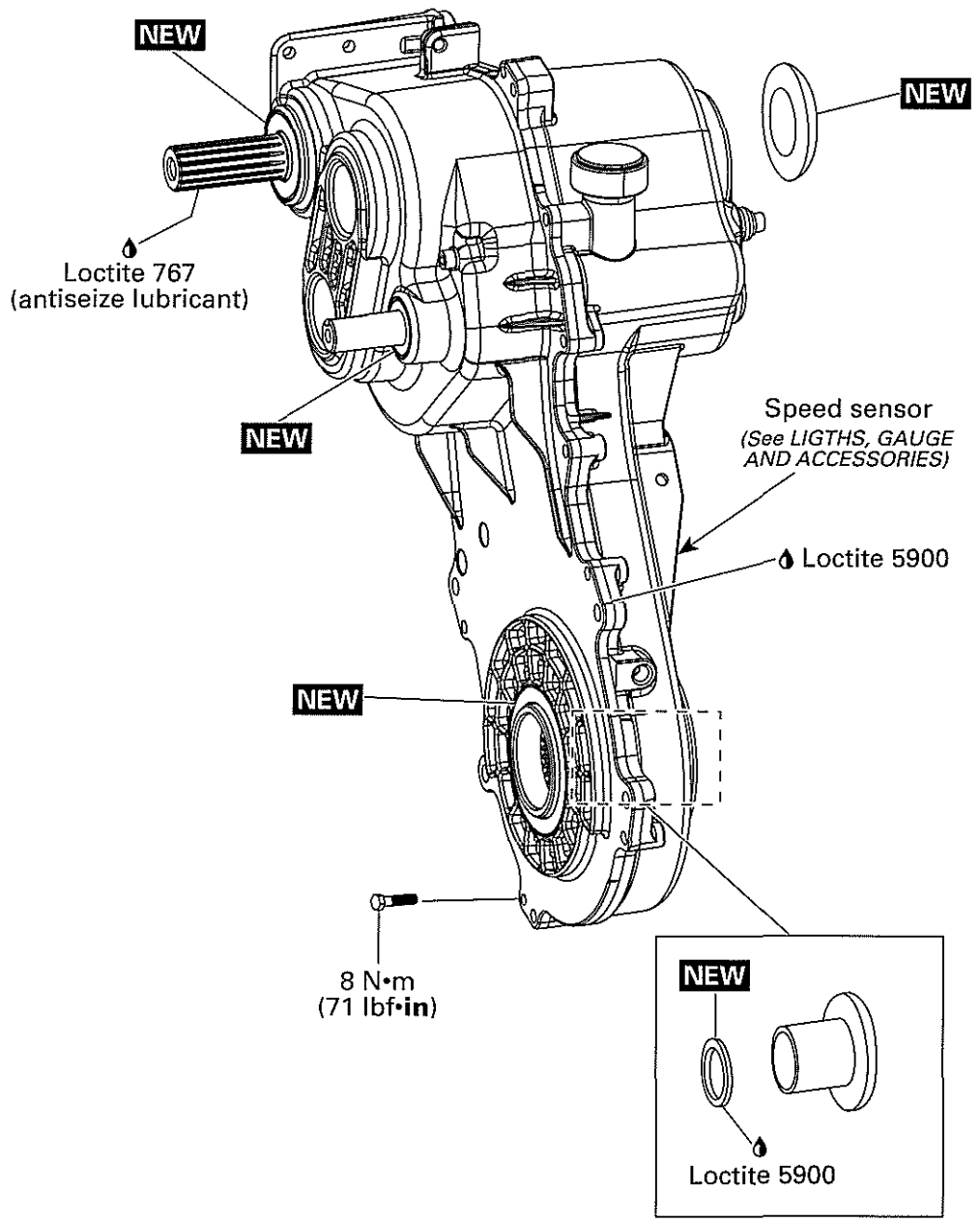
GEARBOX

SERVICE TOOLS

Description	Part Number	Page
FLUKE 115 MULTIMETER	529 035 868	781

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 5900	293 800 066	786
LOCTITE 767 (ANTISEIZE LUBRICANT)	293 800 070	786–787
LOCTITE CHISEL (GASKET REMOVER)	413 708 500	785
PULLEY FLANGE CLEANER	413 711 809	786



NEW = Component must be replaced when removed.

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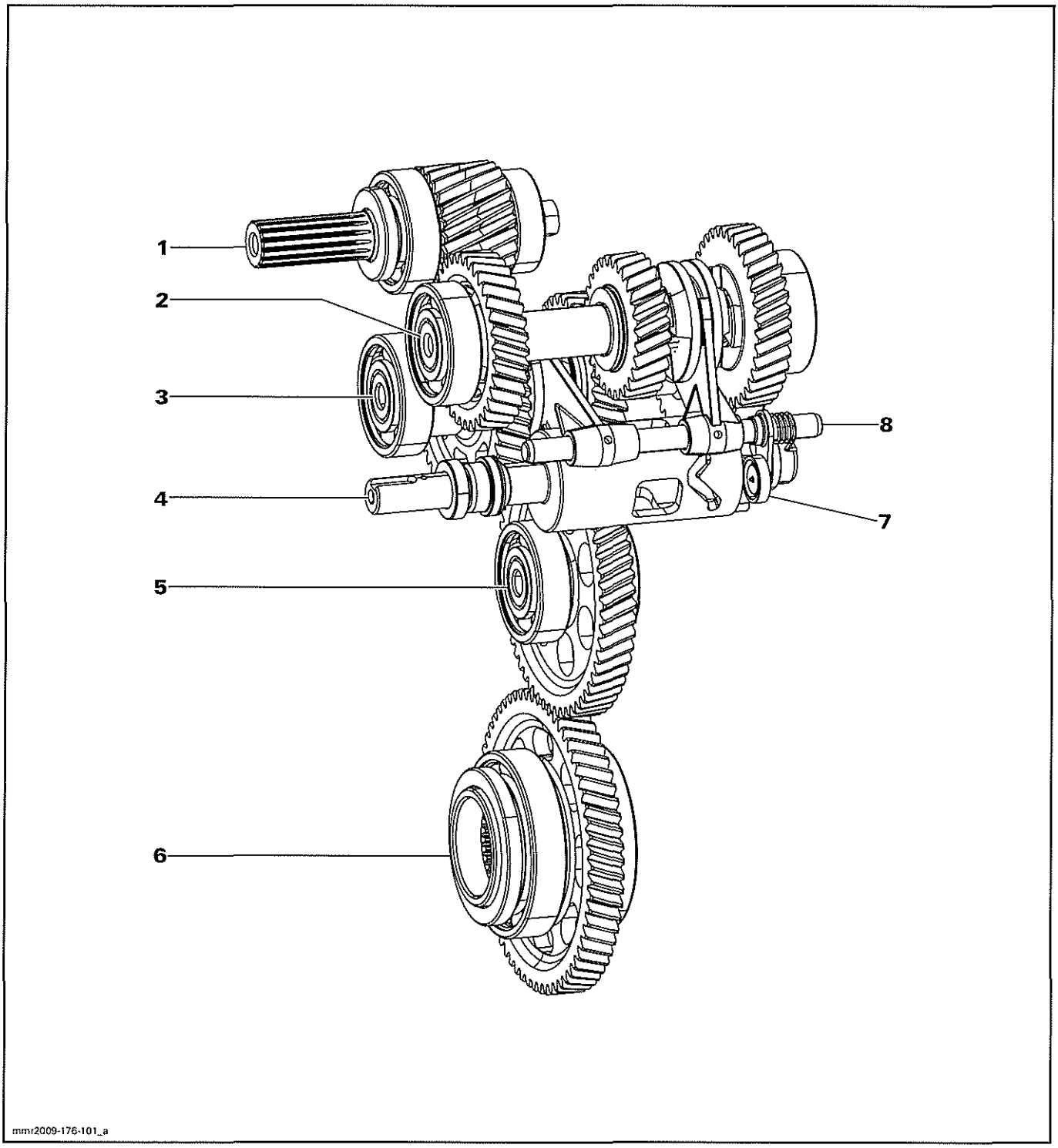


1. *Input shaft*
2. *Main shaft*
3. *Reverse shaft*
4. *Shift drum*
5. *Middle gear*
6. *Lower gear*
7. *Index lever*
8. *Shift fork shaft*

GENERAL

During assembly/installation, use the torque values and service products as in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* subsections for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must strictly be adhered to.
Locking devices when removed (e.g.: locking tabs, cotter pin, etc.) must be replaced.

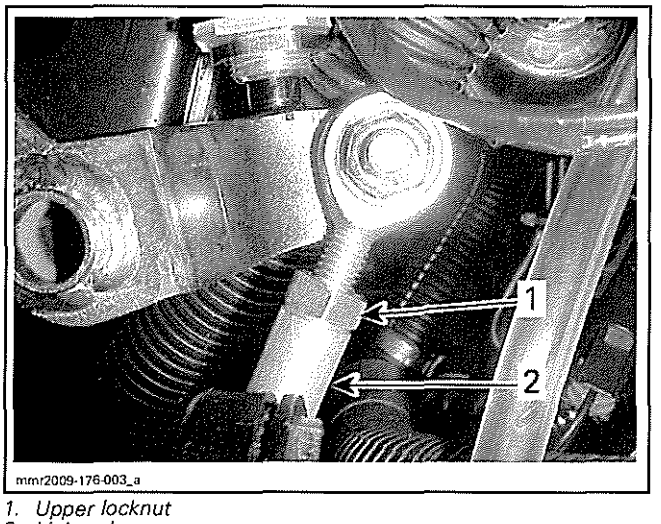
ADJUSTMENT

GEARSHIFT LEVER

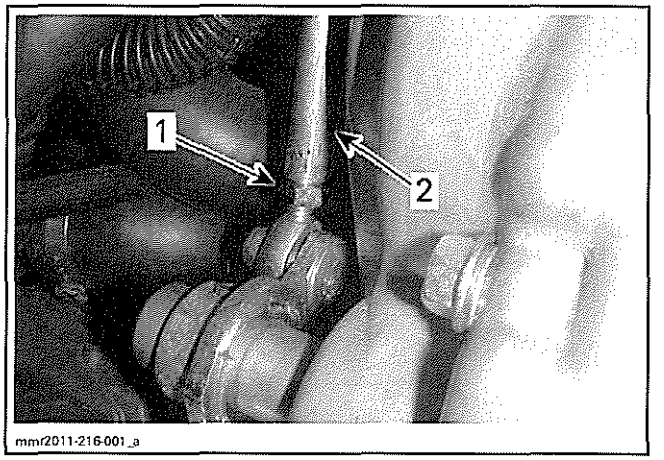
Gearshift lever adjustment

1. Refer to *BODY* and remove RH side panels.
2. Loosen both gearshift link rod locknuts and unscrew a few turns.

NOTE: The upper locknut has LH threads.

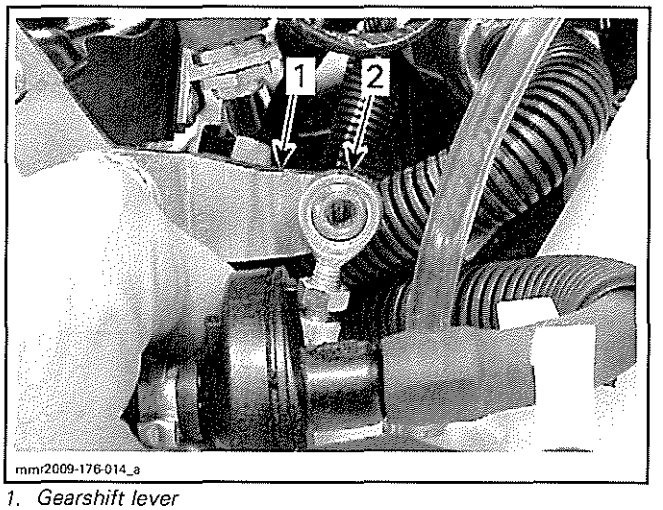


1. Upper locknut
2. Link rod



1. Lower locknut
2. Link rod

3. Detach gearshift linkage from gearshift lever.
4. Place gearshift lever to neutral.
5. Shift gearbox to neutral by moving shift drum lever.
6. Turn gearshift link rod in order to align the link rod bolt hole with the gearshift lever hole.



1. Gearshift lever
2. Link rod

7. Reinstall link rod to gearshift lever.
8. Tighten the link rod locknuts without turning the link rod.

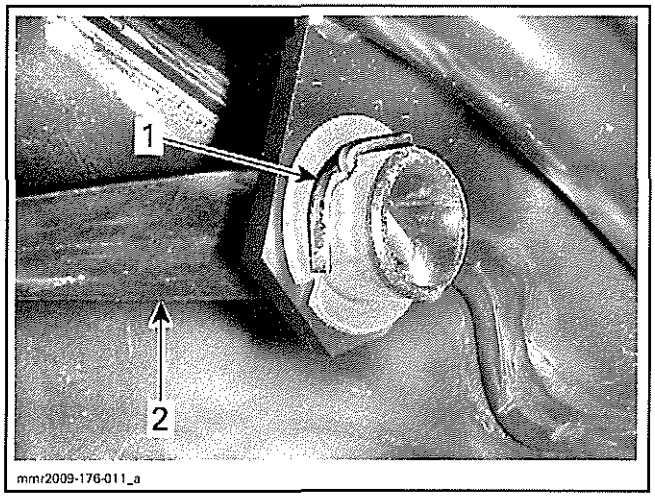
PROCEDURES

GEARSHIFT LEVER

Gearshift Lever Removal

1. Remove gearshift lever knob screw, then remove knob. Be prepared to catch the spring as the knob comes off the lever.
2. Refer to *BODY* and remove console.

3. Remove and discard cotter pin on the LH side of gearshift lever shaft.



1. Cotter pin
2. Gearshift lever shaft

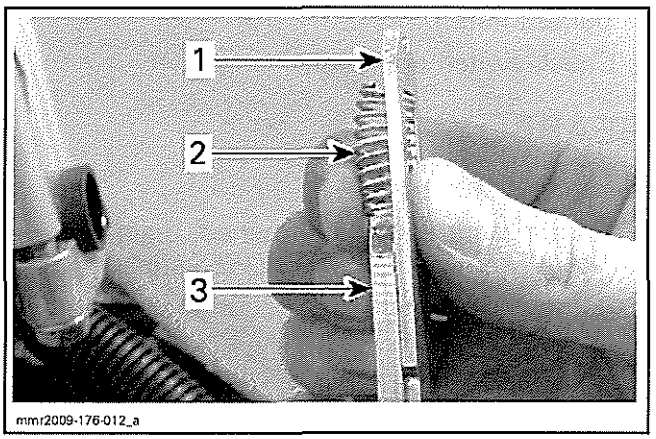
4. Pull gearshift lever assembly out.

Gearshift Lever Installation

Installation of the lever is the reverse of removal.

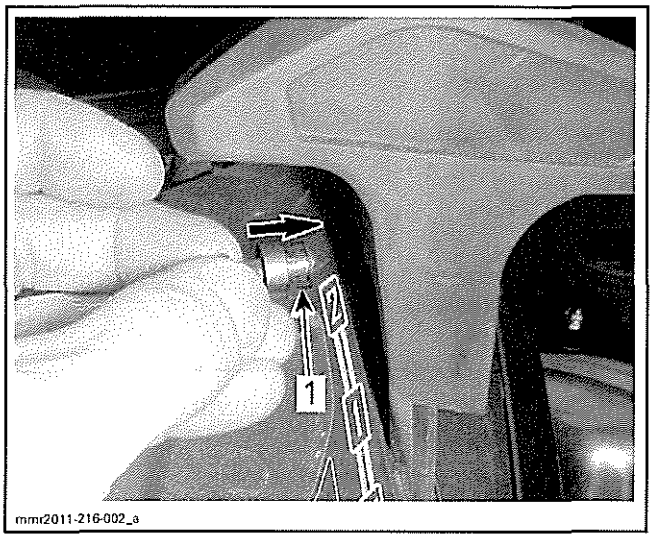
To instal knob, proceed as follows:

1. Shift gearbox to a forward gear.
2. Install spring in the slot between the lock lever and the shift lever, then hold it in position.



1. Lock lever
2. Spring
3. Shift lever

3. Slide knob over the levers.
4. Install spacer with the smallest diameter towards the knob.



1. Spacer smallest diameter

5. Secure knob with the screw.

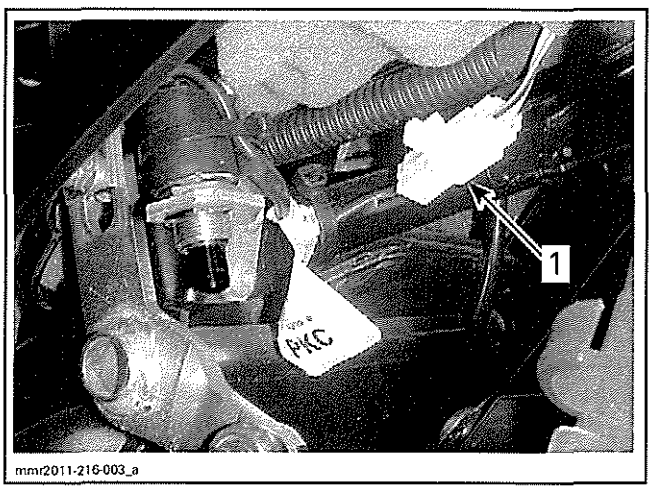
NOTE: Make sure the spacer engages in the shift lever slot and that the knob moves freely downwards.

REVERSE BEEPER SWITCH

The reverse switch activates the beeper (integrated in gauge) for reverse operation by switching the ECM beeper circuit to ground.

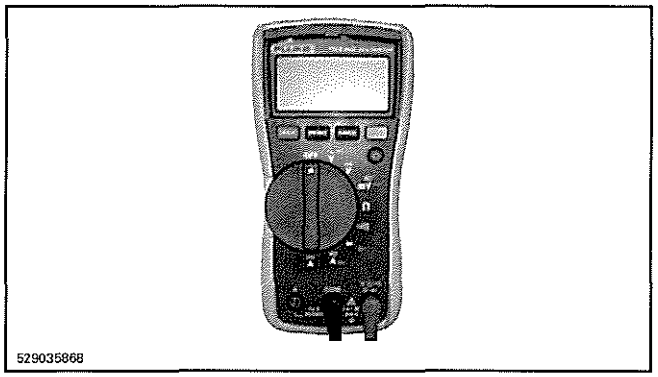
Reverse Beeper Switch Testing

1. Remove RH upper side panel.
2. Disconnect reverse beeper switch connector.



1. Reverse beeper switch connector

3. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Ω.



4. Probe the terminals on the switch harness and measure resistance as follows:

TEST PROBES	SWITCH POSITION	RESISTANCE
Switch terminals	Button in	Close to 0 Ω
	Button out	Infinite (open)

If resistance is as specified, check switch adjustment.

If resistance is not as specified, replace switch.

Reverse Beeper Switch Circuit Testing

1. Check the continuity between reverse beeper switch and ground. See *WIRING DIAGRAM* for wire color.
2. Check the continuity between reverse beeper switch and ECM. Use the following table to identify ECM pin. See *WIRING DIAGRAM* for wire color.

REVERSE BEEPER ECM PIN IDENTIFICATION	
ENGINE	ECM PIN
600 ACE	B connector Pin 3H
600 HO E-TEC	J1A connector Pin 31
1200 4-TEC	B connector Pin 7

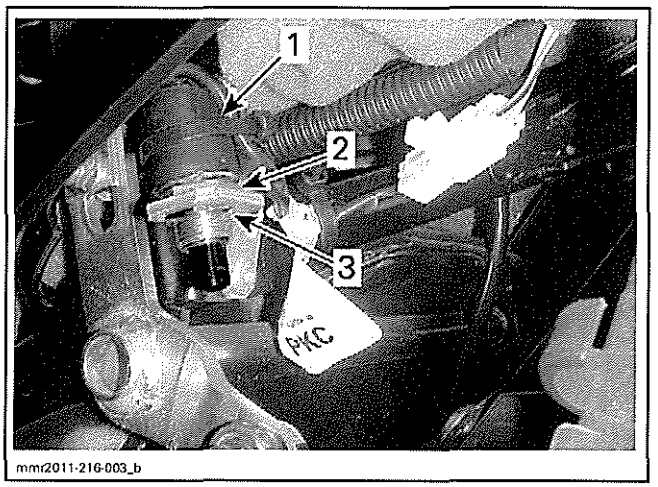
Repair wiring or connectors if necessary.

Reverse Beeper Switch Replacement

1. Refer to *BODY* and remove RH upper side panel.
2. Disconnect reverse beeper switch connector.
3. Remove the lower reverse beeper switch nut.
4. Remove reverse beeper switch.
5. Pass the NEW switch through holder with the upper nut installed.
6. Loosely install the other nut and adjust reverse beeper switch. Refer to *REVERSE BEEPER SWITCH ADJUSTMENT.*

Reverse Beeper Switch Adjustment

1. Refer to *BODY* and remove RH upper side panel.
2. Loosen both switch nuts.



1. Reverse beeper switch
2. Upper nut
3. Lower nut

3. Adjust switch height so that switch button goes in when gearbox is shifted in reverse without being forced into it.
4. Tighten nuts.
5. Check switch operation.

GEARBOX

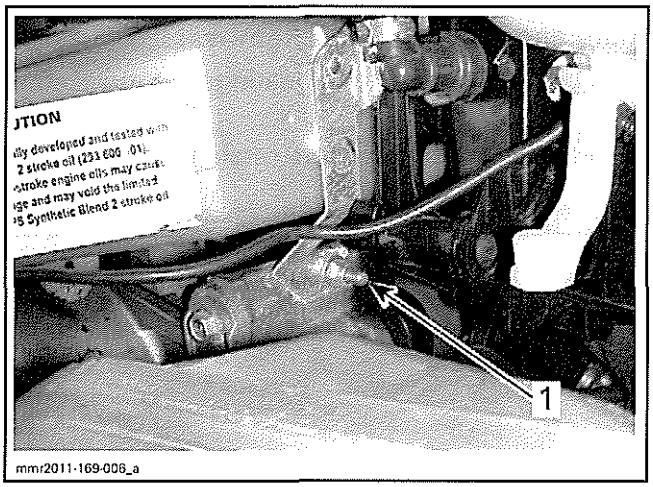
Gearbox Removal

NOTE: If gearbox is to be opened, drain oil, refer to *MAINTENANCE PROCEDURES* subsection.

1. Remove driven pulley and countershaft, refer to *DRIVE SYSTEM AND BRAKE* section.
2. Remove muffler, refer to *EXHAUST SYSTEM* subsection.
3. Completely release track tension.

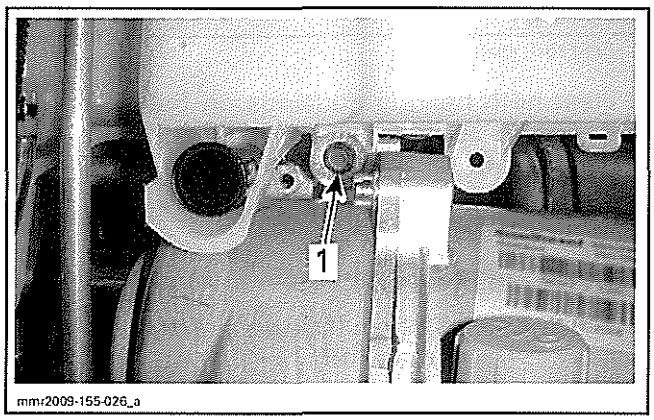
600 HO E-TEC Models

4. Remove bolt securing coolant tank support to gearbox.



FRONT OF GEARBOX
1. Coolant tank support bolt

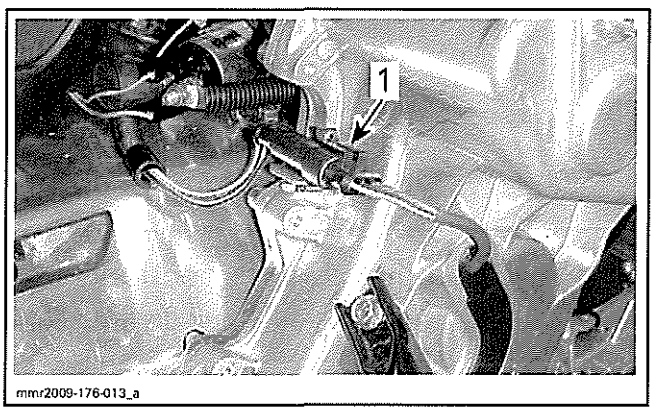
5. Remove screw securing oil tank to gearbox.



REAR OF GEARBOX
1. Oil tank retaining screw

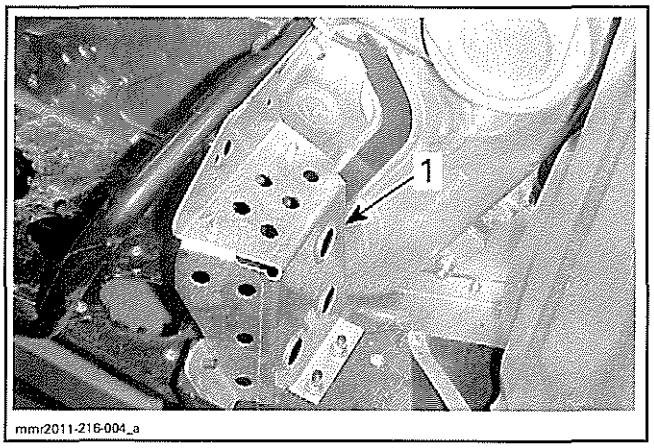
All Models

6. Remove gearshift link rod.
7. Remove the bolt retaining the frame member to the top of gearbox.
8. Disconnect the speed sensor connector and detach from gearbox casing.



1. Speed sensor connector

9. Remove the RH footrest.



1. RH footrest

10. Remove all four nuts retaining gearbox to the chassis.
11. Carefully pull gearbox outwards to free it from the chassis, then from the drive axle splines.

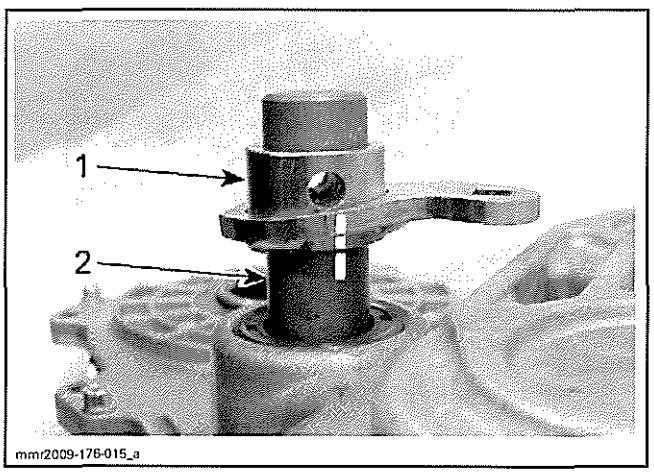
Gearbox Disassembly

Casing Separation

1. Remove all 10 screws securing the gearbox casing halves together.

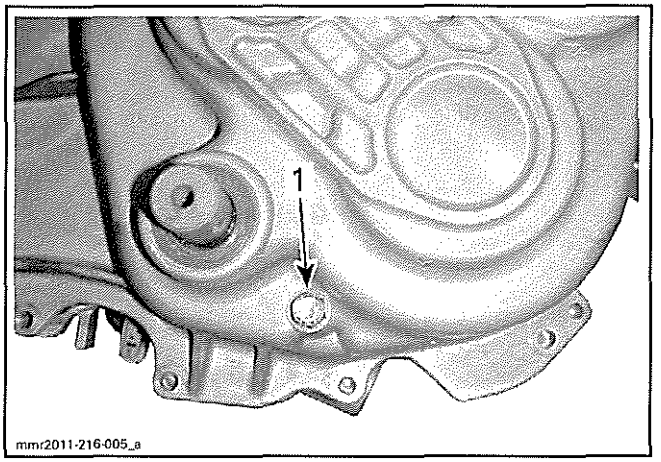
NOTE: There is one screw installed on the outer (RH) side casing half.

2. Mark shift drum lever position on shift drum shaft.



1. Shift drum lever
2. Shift drum shaft

3. Remove shift drum lever spring pin, then shift drum lever using a suitable puller.
4. Remove the shift fork shaft retaining screw from the inner (LH) casing half.

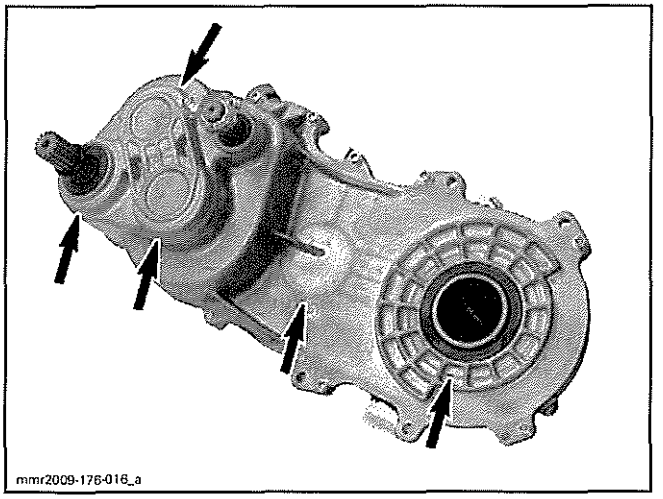


1. Shift fork shaft screw

5. Heat every bearing housing of the inner (LH) casing half and the dowel pins area equally to approximately 150°C (302°F).

NOTE: While heating, apply an upwards motion from time to time.

NOTICE Never pry between the mating surfaces or force casing. Be very careful when splitting casing to avoid breakage or warpage.



BEARING HOUSINGS TO BE HEATED

6. Separate casing.

NOTE: If there is a shim on the reverse shaft bearing, keep it for reassembly.

Input Shaft, Middle and Lower Gear Removal

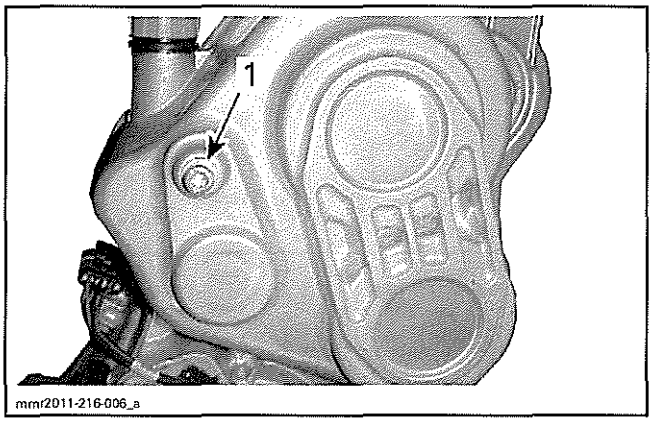
Heat the applicable bearing housing on the outer (RH) casing half to approximately 150°C (302°F).

While heating, pull on shaft or gear from time to time until shaft or gear comes out.

Main and Reverse Shaft Removal

NOTE: Gears, shafts and bearings are replaced as an assembly.

1. Remove shift fork shaft retaining screw from the exterior of casing.



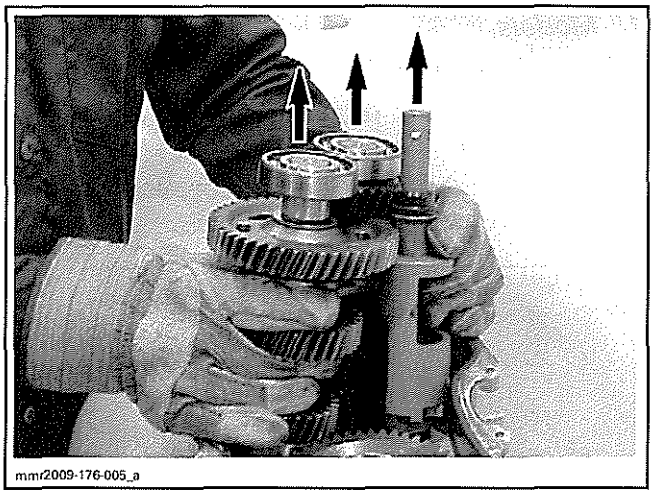
1. Shift fork shaft screw

2. Heat both bearing housings on the outer (RH) casing to approximately 150°C (302°F) to free bearings from the casing.

NOTE: While heating, pull on shafts from time to time.

3. Free both bearings.
4. Grab both shafts, shift drum and shift forks and extract as an assembly.

NOTE: Pull on shift fork shaft from time to time during this procedure to ease parts removal.



Gearbox Cleaning and Inspection

1. Clean parts in clean solvent, then dry with compressed air.
2. Check bearings and gear teeth condition for wear, signs of overheating or other damage.

3. Remove all sealant residue from casing mating surfaces using LOCTITE CHISEL (GASKET REMOVER) (P/N 413 708 500) and a brass brush. Wipe with a clean hand towel.
4. Remove and discard oil seals and rubber plug.
5. Clean casing in clean solvent, then dry with compressed air.

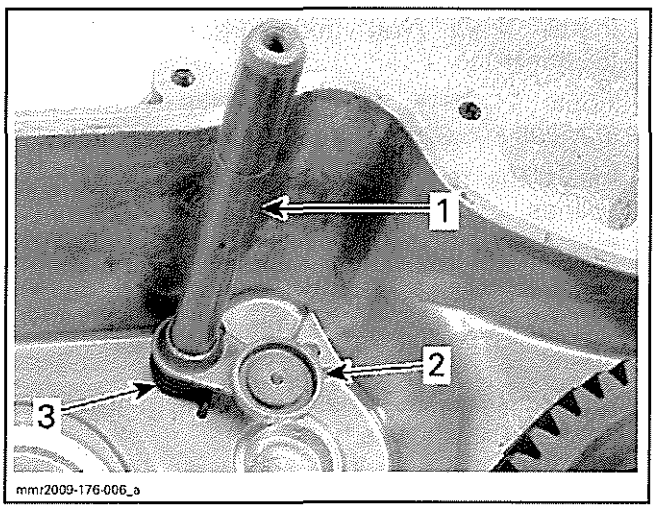
NOTICE To avoid damage to casing mating surfaces, do not use a steel brush or scraper.

6. Check casing for cracks, scored mating surfaces or other damage.

Gearbox Assembly

Gearing and Shift Mechanism Installation

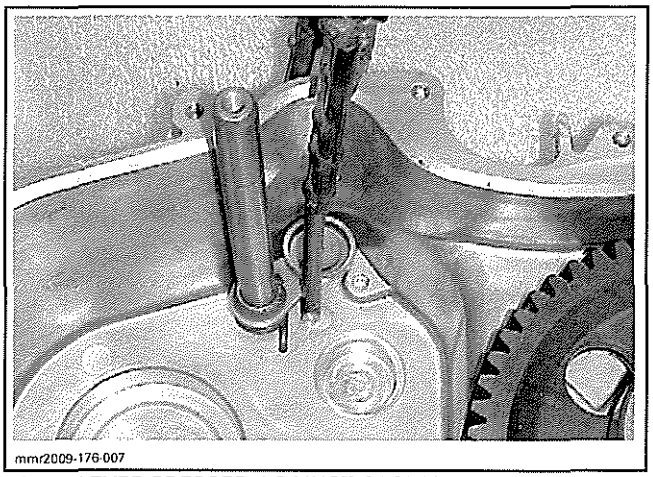
1. Install index lever spring, index lever and shift fork shaft in the outer (RH) casing half.



1. Shift fork shaft
2. Index lever
3. Index lever spring

2. Press index lever against the casing.

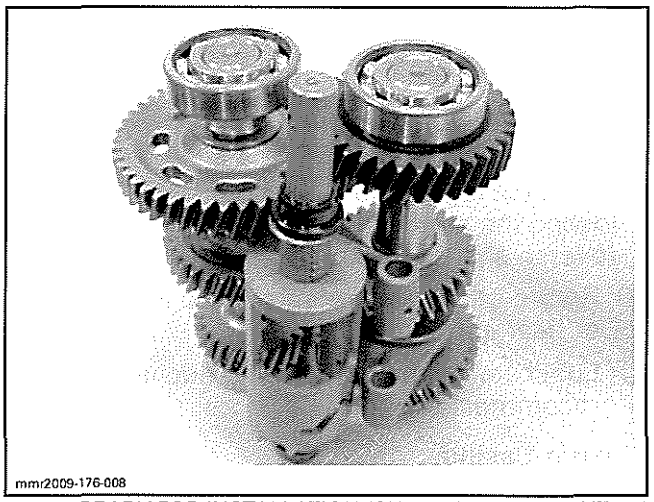
NOTE: For this purpose, use a pair of locking pliers with jaws of at least 10 cm (4 in).



INDEX LEVER PRESSED AGAINST CASING

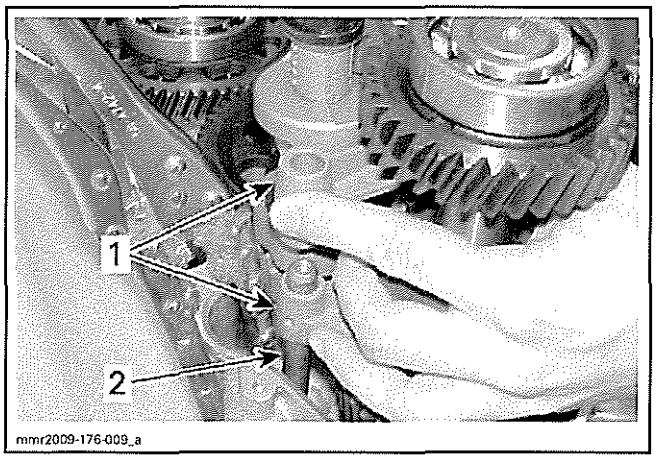
3. Assemble the following parts on a workbench as shown.
   - Main shaft
   - Reverse shaft
   - Shift drum
   - Shift forks.

NOTE: Set the shift forks to neutral (fork pins inserted in straight grooves of the shift drum).



PARTS READY FOR INSTALLATION (SHIFT FORKS TO NEUTRAL POSITION)

4. Heat the bearing housings equally from the exterior of the casing to approximately 150°C (302°F).
5. Carefully put the assembled parts in the casing.
   5.1 Pass the shift forks bores over the shift fork shaft.
   5.2 Align both bearings and shift drum in their bores.



1. Shift forks
2. Shift fork shaft

6. Align the input shaft bearing in its bore.
7. Completely insert all bearings in their bores.

NOTE: If necessary, continue heating until complete insertion.

During this procedure, make sure that:
- Shift drum bushing remains aligned with the casing bore.
- Shift fork pins are properly inserted into the shift drum grooves.
- Shift forks are properly inserted into the sliding sleeve grooves.

8. Once bearings and shift drum are bottomed in their casing bores, remove the pliers.
9. Install the input, middle gear and lower gear following the method used to install the main and reverse shafts (steps 4 and 6).
10. Rotate gearing to be sure there is no binding or gear interference.
11. Lubricate gearing and shift mechanism with recommended oil.

Closing Casing

1. Clean the casing mating surfaces with PULLEY FLANGE CLEANER (P/N 413 711 809) or equivalent.
2. If applicable, put the shim on the reverse shaft bearing.
3. Put a thin regular bead of LOCTITE 5900 (P/N 293 800 066) on the outer (RH) casing half.
4. Heat all five bearing housings of the inner (LH) casing half equally to approximately 150°C (302°F).
5. Carefully lower the inner casing half until it contacts the other half. Heat more if necessary.

NOTE: It may be necessary to gently strike the dowel pins area with a soft faced hammer.

6. Install and hand tighten the casing screws.

NOTICE Never tighten screws if there is a gap between casing halves. Make sure mating surfaces are brought into contact before tightening screws.

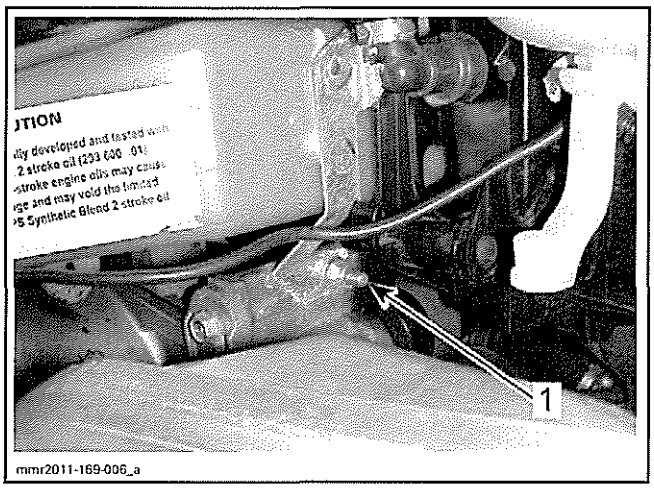
7. Tighten screws to 8 N•m (71 lbf•**in**) in a crossed pattern starting from the middle of the casing.
8. Install both shift fork shaft retaining screws with their washers and tighten to 8 N•m (71 lbf•**in**).
9. Install shift drum lever.
10. Confirm gearbox operation by rotating the input shaft in all gear ranges.
11. Install NEW seals.

Gearbox Installation

1. Install drain plug and torque to 10 N•m (89 lbf•**in**).
2. Apply LOCTITE 767 (ANTISEIZE LUBRICANT) (P/N 293 800 070) to the drive axle splines.
3. Insert the drive axle splines into lower gear splines.
4. Protect the gearbox area on chassis to prevent scratches.
5. Pry gearbox upwards and tilt to reach the proper angle.
6. Insert the round shaped part of the gearbox casing into the chassis bore.
7. Align the gearbox casing mounting holes with the studs on the chassis.
8. Hand tighten NEW retaining nuts.
9. Tighten nuts to 27 N•m (20 lbf•ft) in a crossed pattern.

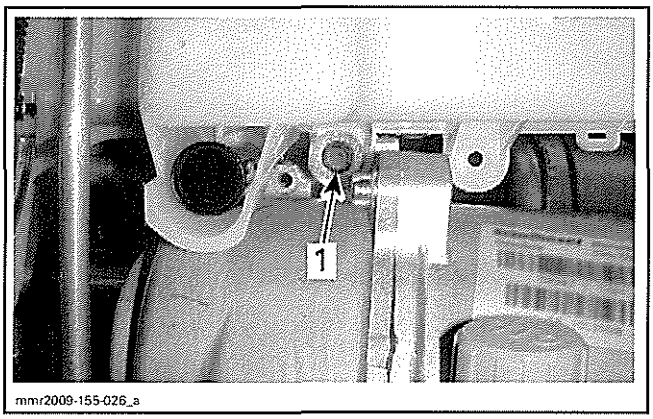
600 HO E-TEC Models

10. Install the coolant tank support retaining bolt.



FRONT OF GEARBOX
1. Coolant tank support bolt

11. Install the oil tank retaining screw.



REAR OF GEARBOX
1. Oil tank retaining screw

All Models

12. Install the bolt retaining the frame member to the top of gearbox.
13. Install and adjust gearshift link rod. Refer to *GEARSHIFT LEVER ADJUSTMENT* in this subsection.
14. Connect speed sensor and attach connector to gearbox.
15. Install driven pulley and countershaft, refer to *DRIVE SYSTEM AND BRAKE* section.
16. Apply LOCTITE 767 (ANTISEIZE LUBRICANT) (P/N 293 800 070) to the input shaft splines.
17. Install muffler, refer to *EXHAUST SYSTEM* subsection.
18. Install RH footrest.
19. Fill gearbox with recommended oil, refer to *MAINTENANCE PROCEDURES* subsection.
20. Adjust track tension, refer to *PERIODIC MAINTENANCE PROCEDURES*.

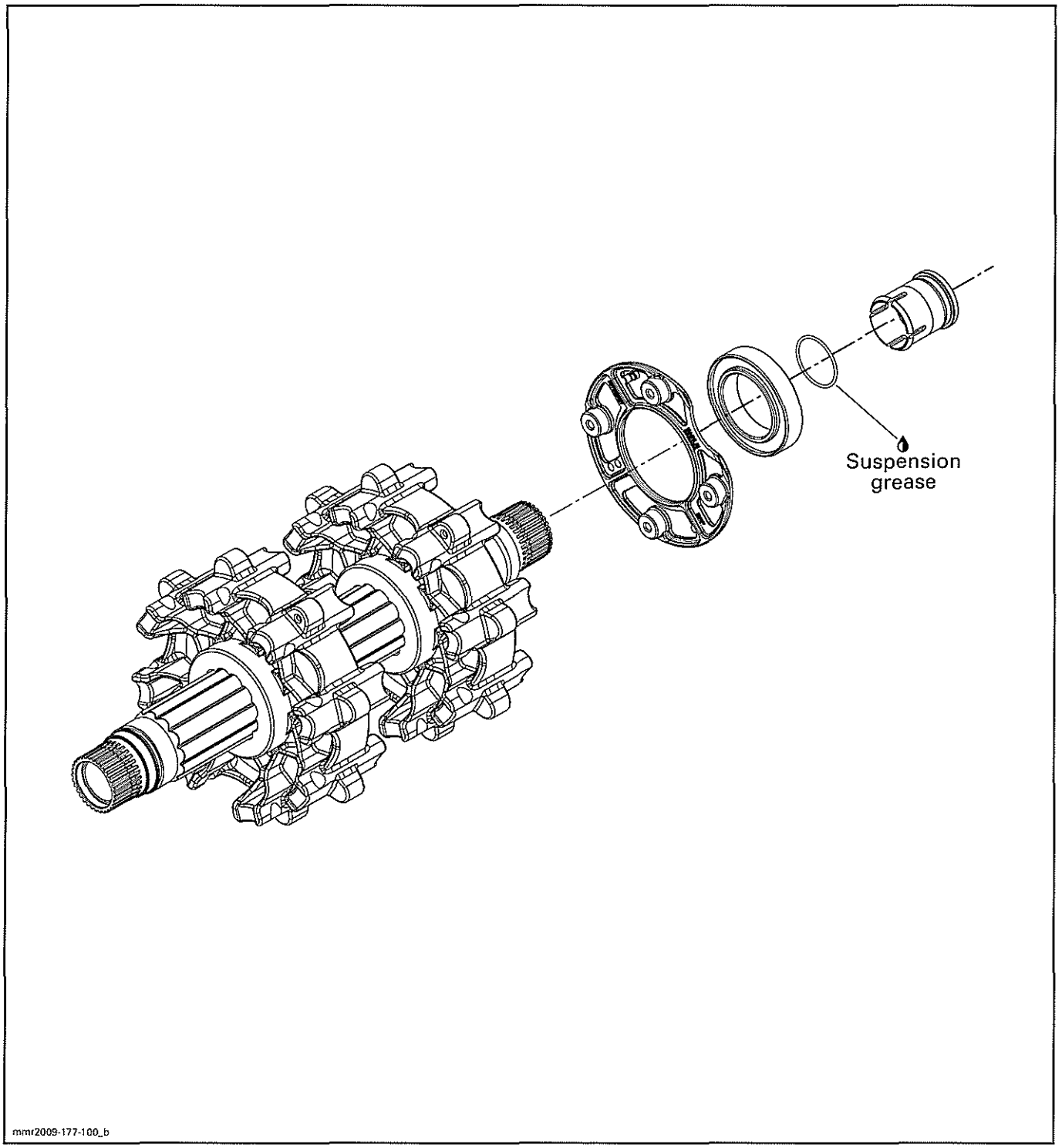
DRIVE AXLE

SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
SNAP-ON 3-JAW PULLER	CG273	791

SERVICE PRODUCTS

Description	Part Number	Page
SUSPENSION GREASE	293 550 033	792


Suspension grease
mmr2009-177-100_b

GENERAL

During assembly/installation, use torque values and service products as in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

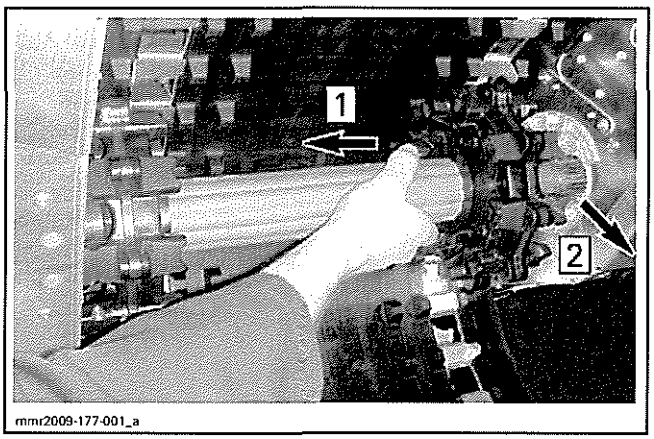
Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, cotter pins, etc.) must be replaced.

PROCEDURES

DRIVE AXLE

Drive Axle Removal

1. Remove the rear suspension. Refer to *REAR SUSPENSION* subsection.
2. Remove the brake caliper. Refer to *BRAKE* subsection.
3. From underneath of vehicle, turn the LH bearing flange counterclockwise to unlock it from frame.
4. Release drive axle sprockets from track.
5. Move drive axle toward the LH side to release it from gearbox.
6. Move drive axle downwards to remove its RH side out of frame.



Step 1: Move toward the LH side (opposite to gearbox)
Step 2: Move downwards

NOTE: The drive axle may be very tight between tunnel sides. Ensure to completely move axle toward the LH side (opposite to gearbox) to provide enough clearance to release it from the frame.

Drive Axle Inspection

Check if bearing turns smoothly and freely. Replace if necessary.

Check if bearing seals are not damaged. Replace if necessary.

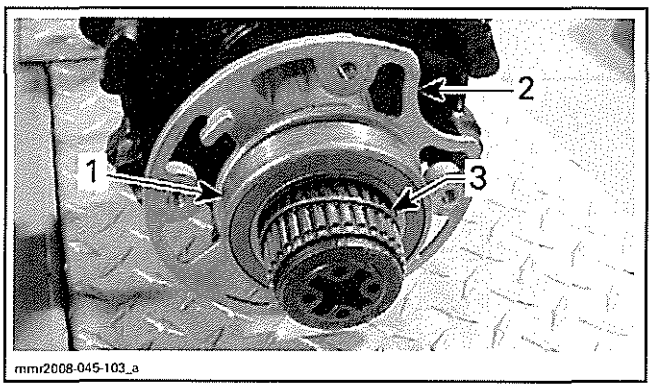
Check if the bearing flange is cracked, bent or otherwise damaged. Replace if necessary.

Replace drive axle if one of the following situations is detected:

- Cracked, worn or damaged drive axle
- Worn or damaged drive axle splines
- Worn or damaged sprockets
- Worn bearing journal.

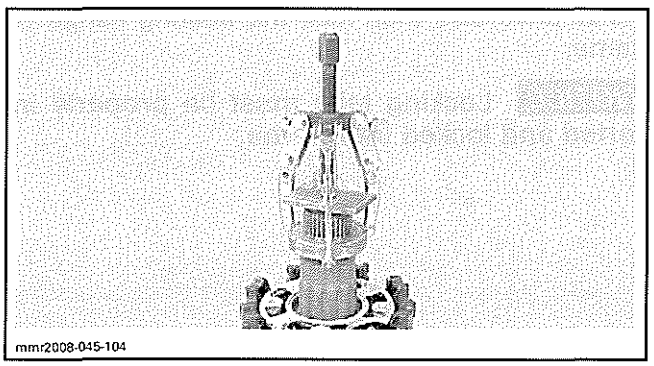
Drive Axle Bearing Removal

1. Remove drive axle from vehicle. Refer to *DRIVE AXLE REMOVAL* in this subsection.
2. Remove the O-ring.



1. Drive axle bearing
2. Bearing flange
3. O-ring

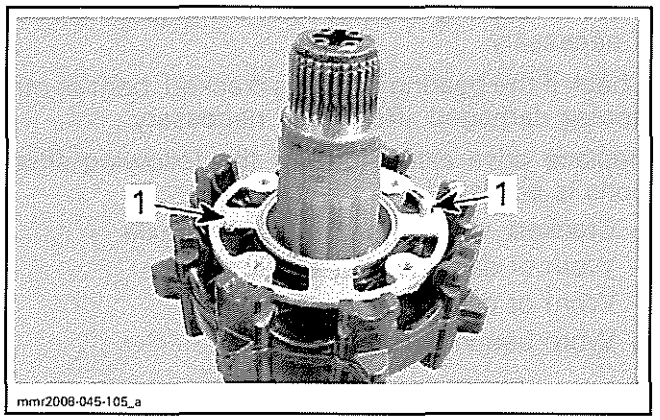
3. Using a 3 legs jaw puller such as the SNAP-ON 3-JAW PULLER (P/N CG273), remove the drive axle bearing.



4. Remove the bearing flange.

Drive Axle Bearing Installation

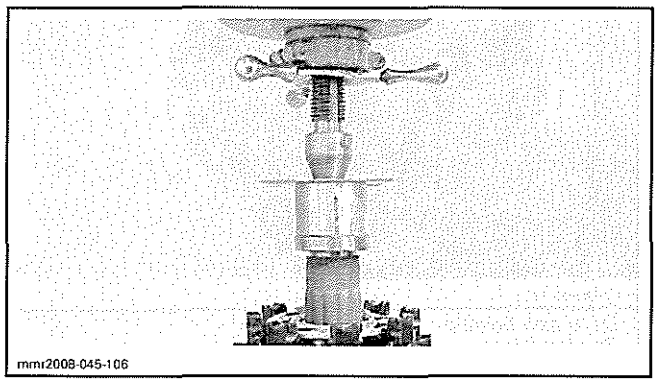
1. Install bearing flange on drive axle with locking tabs outwards.



1. Locking tabs outwards

2. Using a press and a suitable pipe, push the bearing.

NOTICE Always push the bearing by inner race.

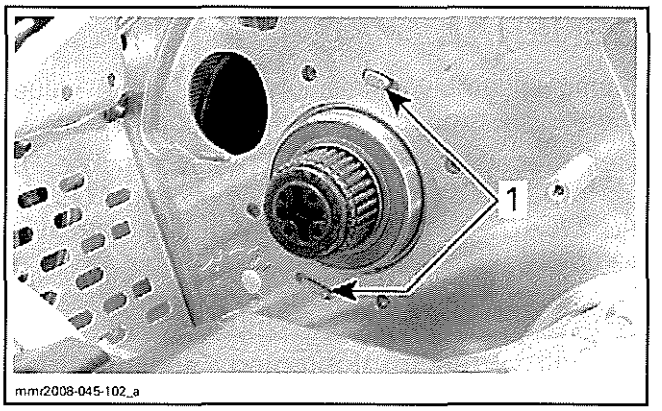


Drive Axle Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

Install drive axle then lock the bearing flange on frame.

NOTICE Locking tabs must be properly inserted and locked into frame.



VIEW FROM OUTSIDE FRAME
1. Bearing flange locking tabs

MAGNETIC CAP

Magnetic Cap Removal

For the LH side cap, remove the protective cover of the brake disc. Refer to *BRAKE* subsection.

1. Using 2 screwdrivers or pliers, pry or pull the magnetic cap out of drive axle end.
2. Discard the magnetic cap.

Magnetic Cap Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

Apply SUSPENSION GREASE (P/N 293 550 033) on O-ring.

TRACK

SERVICE TOOLS

Description	Part Number	Page
TRACK CLEAT INSTALLER	529 036 044	793

PROCEDURES

TRACK

Track Inspection

1. Visually inspect track for:
   - Cuts and abnormal wear
   - Broken rods
   - Broken or missing track cleats
   - Perforations in the track
   - Tears in the track (particularly around traction product holes)
   - Lugs that are broken or torn off, exposing portion of rods
   - Delamination of the rubber
   - Missing track guide(s).

If track is damaged or rods are broken, replace track.

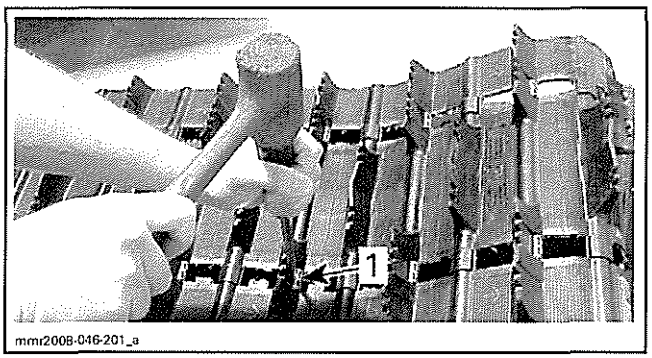
For damaged or missing cleats, replace by NEW ones.

⚠ WARNING

Do not operate a snowmobile with a cut, torn or damaged track.

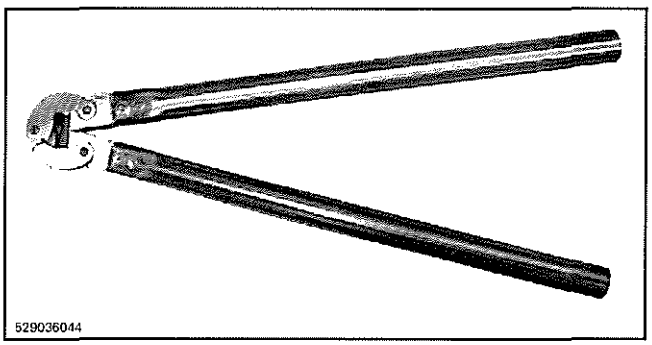
Track Cleat Replacement

1. Raise rear of vehicle off the ground.
2. Lift snow guard.
3. Rotate track to expose a cleat to be replaced.
4. Remove cleat from track using plastic hammer and a big screwdriver.

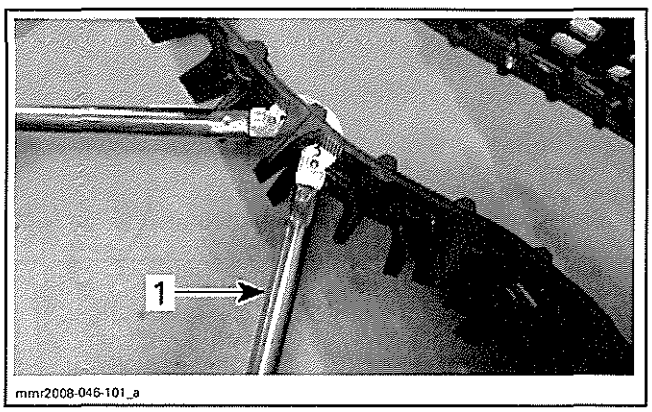


TYPICAL
1. Cleat

5. Place NEW cleat in position on the track.
6. Secure cleat using the TRACK CLEAT INSTALLER (P/N 529 036 044).



7. Bend cleat and push tabs into rubber.

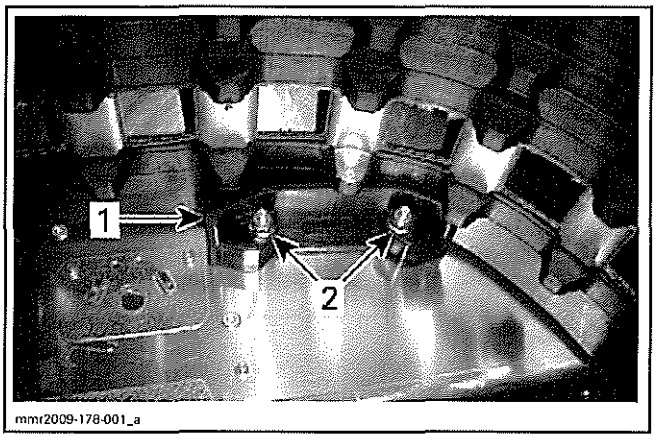


TYPICAL
1. Narrow-cleat installer

8. Reopen narrow-cleat installer.
9. Position cleat tabs on open end of tool.
10. Squeeze tabs until they are indented in rubber.

Track Removal

1. Remove rear suspension from vehicle. Refer to *REAR SUSPENSION* subsection.
2. Remove drive axle from vehicle. Refer to *DRIVE AXLE* subsection.
3. Remove track guides from inside frame tunnel (Expedition model only).



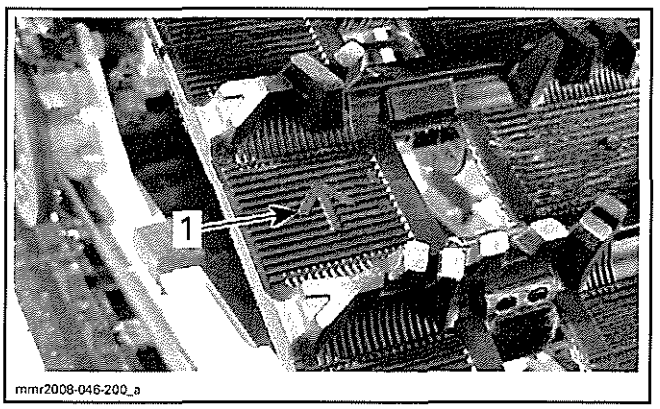
EXPEDITION MODEL
1. Track guide
2. Retaining nuts

4. Remove track from vehicle.

Track Installation

The installation is the reverse of removal procedure, however pay attention to the following.

Respect rotation direction indicated by an arrow on track thread.



1. Arrow pointing forwards

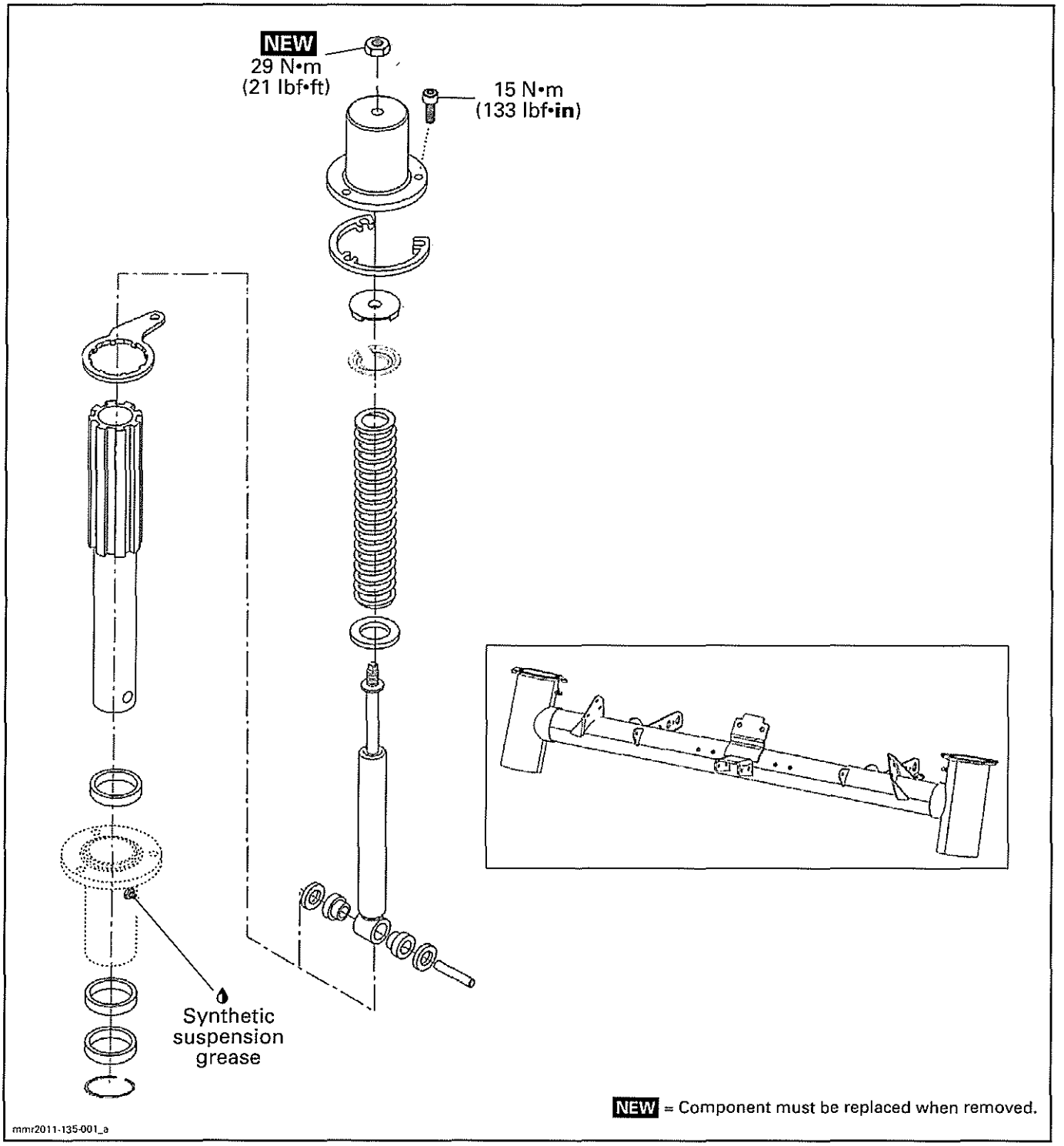
FRONT SUSPENSION (LTS)

SERVICE TOOLS

Description	Part Number	Page
SPRING COMPRESSOR	529 036 184	799

SERVICE PRODUCTS

Description	Part Number	Page
SUSPENSION GREASE	293 550 033	800


NEW
29 N•m
(21 lbf•ft)
15 N•m
(133 lbf•in)
Synthetic
suspension
grease
NEW = Component must be replaced when removed.
mmr2011-135-001_a

GENERAL

The procedure explained below is the same for the RH and LH sides unless otherwise noted.

During assembly/installation, use torque values and service products as in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ CAUTION To avoid potential burns, never touch exhaust system components immediately after the engine has been running because these components are very hot. Let engine and exhaust system cool down before performing any servicing.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, cotter pins, etc.) must be replaced.

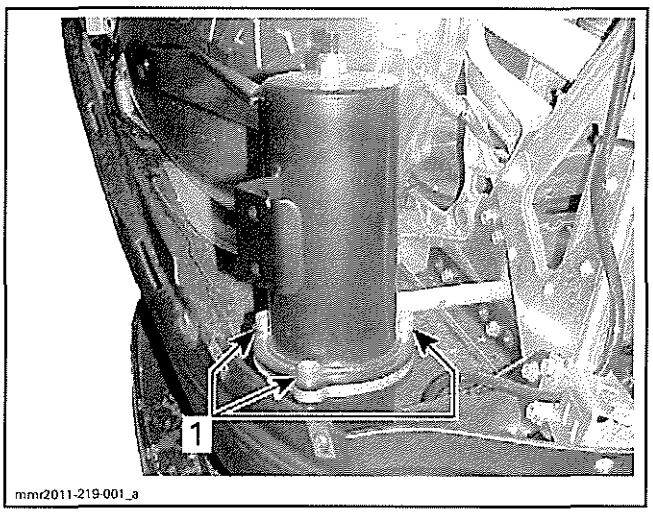
Check for loose, bent, worn out, rusted or otherwise damaged components. Replace the faulty components.

PROCEDURES

SHOCK ABSORBER COVERS

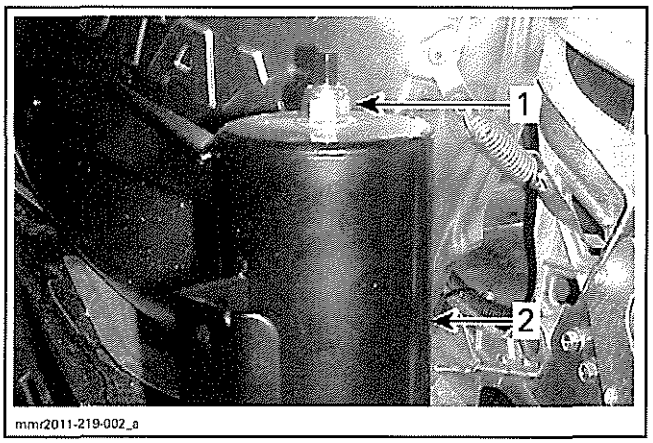
Shock Absorber Cover Removal

1. Refer to *BODY* subsection and remove the following parts:
   - Hood
   - Upper and lower side panels
   - Upper bottom pan.
2. Lift the front of vehicle until skis are off the ground.
3. Place the front portion of frame on a wooden box to support it securely.
4. Remove the three Allen socket screws retaining the shock absorber cover.



1. Allen socket screws

5. Remove the shock absorber rod nut on the top of the cover.

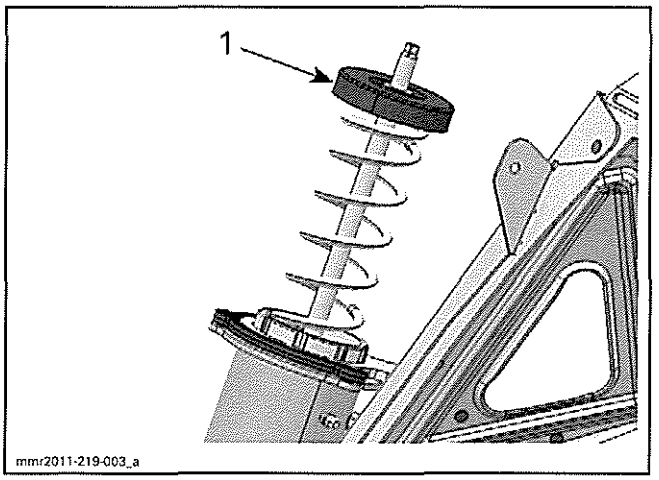


1. Shock absorber rod nut
2. Shock absorber cover

6. Remove shock absorber cover from vehicle.

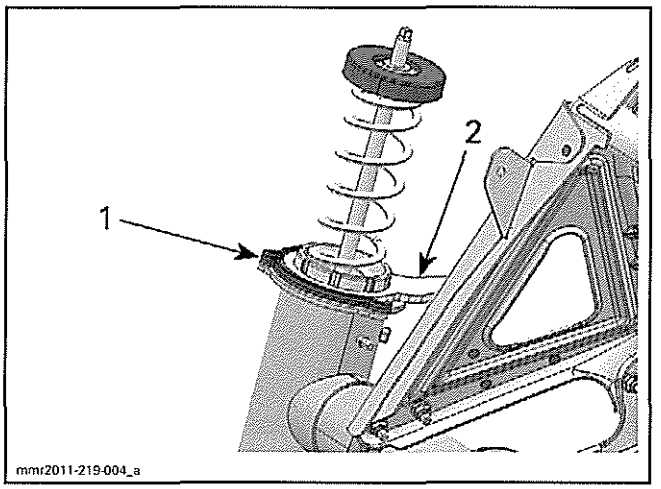
Shock Absorber Cover Installation

1. Make sure the rubber stopper on the top of the shock absorber is in place.



1. Rubber stopper

2. Check that half spacer and steering arm are properly installed on the LTS module post.



1. Half spacer
2. RH steering arm

3. Install all screws loosely, then tighten as specified.

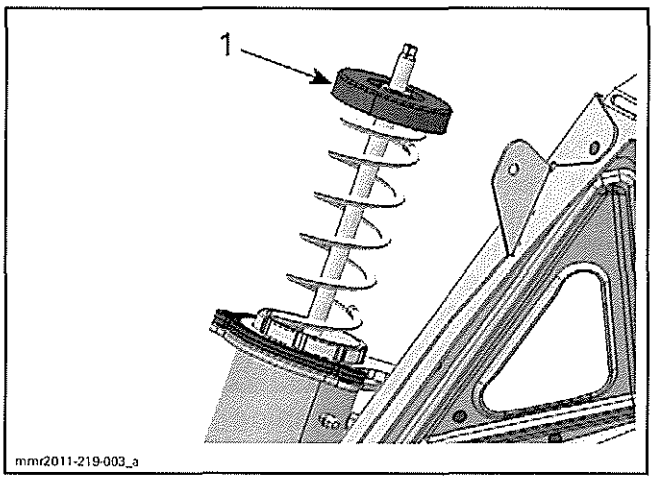
ASSEMBLY TORQUES, SHOCK ABSORBER COVER	
COVER RETAINING SCREWS	ROD NUT
24.5 N•m (18 lbf•ft)	29 N•m (21 lbf•ft)

4. Install rear bottom pan screws finger tight.
5. Install all other removed parts.

SHOCK ABSORBERS

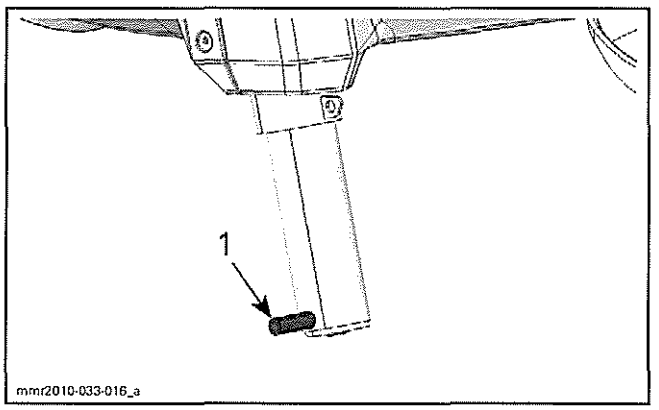
Shock Absorber Removal

1. Lift the front of vehicle until skis are off the ground.
2. Place the front portion of frame on a wooden box to support it securely.
3. Remove the ski. Refer to *STEERING SYSTEM* subsection.
4. Remove the *SHOCK ABSORBER COVER*. See procedure in this subsection.
5. Remove the rubber stopper on the top of shock absorber.



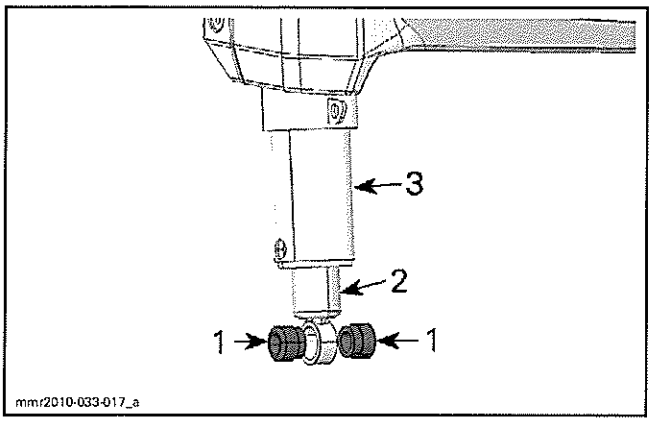
1. Rubber stopper

6. At the bottom of the ski leg, remove the steel bushing retaining the bottom of the shock absorber.



TYPICAL
1. Steel bushing

7. Lift up ski leg and remove both lower bushing from the shock absorber.



TYPICAL
1. *Shock absorber lower bushings*
2. *Shock absorber*
3. *Ski leg*

8. Pull shock absorber out through top of ski leg to remove it.

Shock Absorber Inspection

Remove spring from shock absorber.

Inspect shock as per following:

1. Extend and compress the piston at least 5 complete strokes with its rod upward and examine shock for leaks.
2. Ensure shock moves smoothly and with uniform resistance over its entire stroke.

NOTE: For the first 5 complete strokes, it could be normal to note uneven resistance.

3. Check the following conditions that will denote a defective shock:
   - A skip or a hang back when reversing stroke at mid travel.
   - Seizing or binding condition except at extreme end of either stroke.
   - Oil leakage.
   - A gurgling noise, after completing one full compression and extension strokes.
4. If suspecting a shock is freezing, place it in a freezer (temperature below 0°C (32°F)) for 4 hours.
5. Push down on rod and note its resistance. If shock is frozen it will be much more difficult to compress than one in normal condition.
6. Replace if any faults are present.

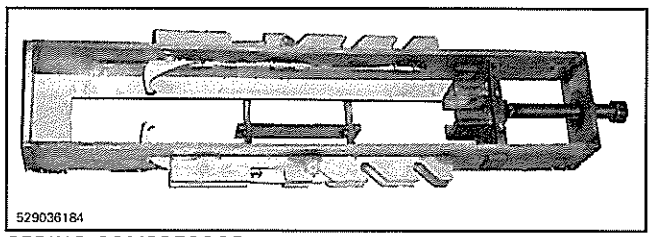
Shock Absorber Installation

For installation, reverse the removal procedure.

SPRINGS

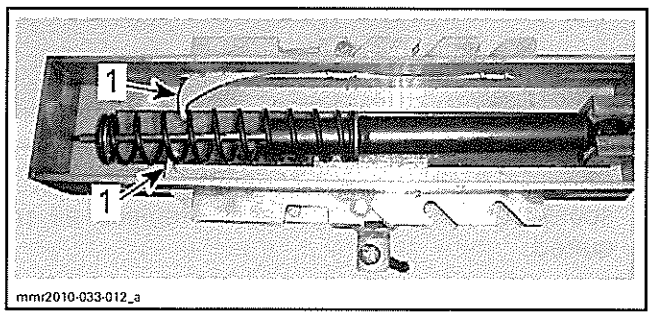
Spring Removal

1. Secure the SPRING COMPRESSOR (P/N 529 036 184) in a vise.



SPRING COMPRESSOR

2. Position the shock absorber in the tool and install the spring compressor hooks.

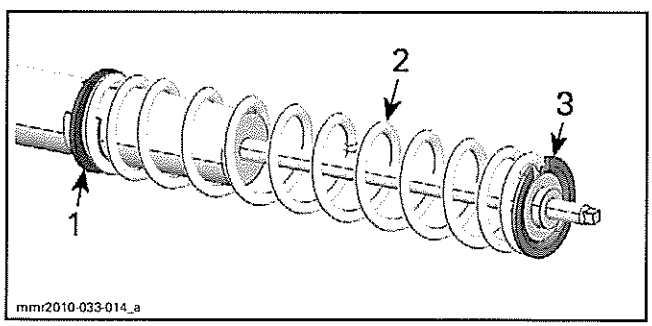


1. *Spring compressor hooks*

3. Tighten the spring compressor tool screw until the spring is sufficiently compressed to remove spring stopper.
4. Release the spring compressor tool screw.
5. Remove spring from shock absorber.

Spring Installation

Position the large washer and the spring on the shock, and secure them with the spring stopper.

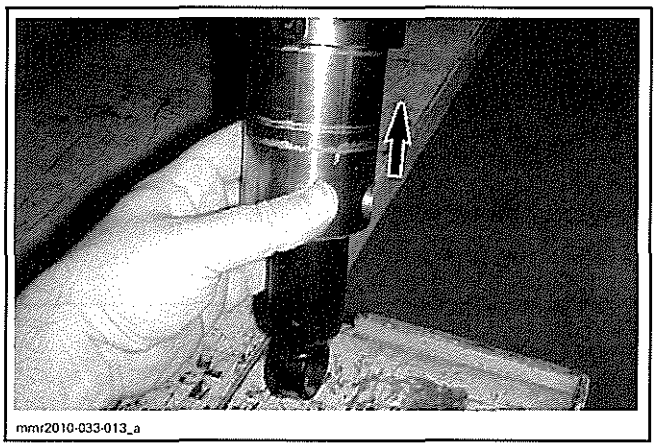


1. *Large washer*
2. *Spring*
3. *Spring stopper*

SKI LEGS

Ski Leg Inspection

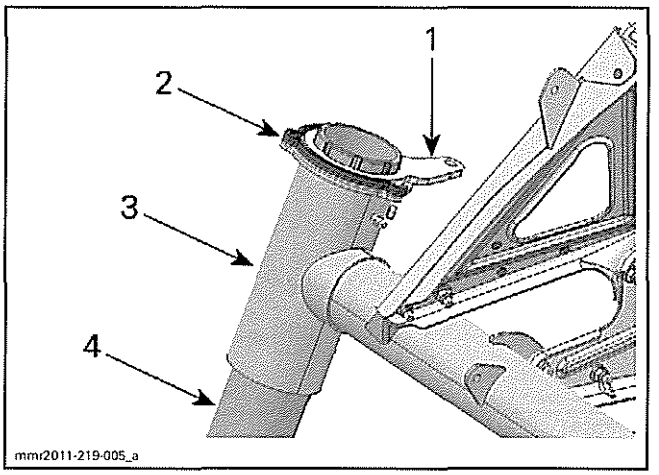
1. Remove the ski and the steel bushing that secures the shock to the bottom of the ski leg.
2. Lift the ski leg to check its freedom of movement.



3. Check the ski leg for straightness and for a scored or scratched surface. Replace as required.
4. When the shock absorber cover is removed, check the splines on ski leg and steering arm interlock for abnormal free play. Replace as necessary.

Ski Leg Removal

1. Remove the *SHOCK ABSORBER*, see procedure in this subsection.
2. Disconnect the tie-rod end from the steering arm, refer to *STEERING SYSTEM* subsection.
3. Remove the half spacer and the steering arm from the ski leg.

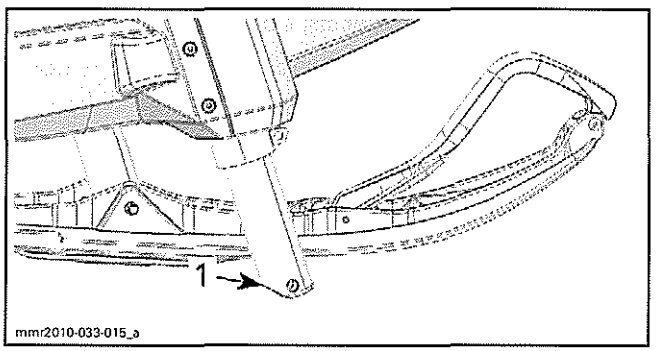


1. *Steering arm*
2. *Half spacer*
3. *LTS*
4. *Ski leg*

4. Pull the ski leg out through the top of the LTS.

Ski Leg Installation

1. Apply a thin layer of SUSPENSION GREASE (P/N 293 550 033) on ski leg splines.
2. Insert the ski leg into the LTS module tube. Make sure to place the angular end of the ski leg rearward.



TYPICAL
1. *Angular end of ski leg*

3. Reinstall all removed parts.
4. Lubricate the suspension. Refer to *PERIODIC MAINTENANCE PROCEDURE* subsection.

NOTE: When a ski leg is changed, perform a steering alignment. Refer to *STEERING SYSTEM* subsection.

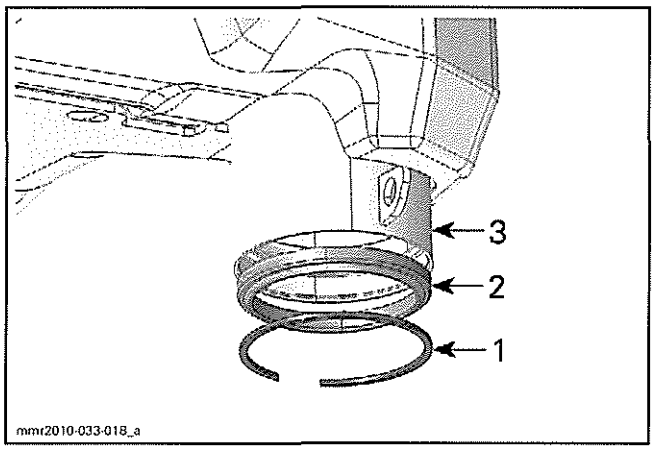
SEALS

Seal Replacement

The seals are located at the bottom ends of each LTS module tube.

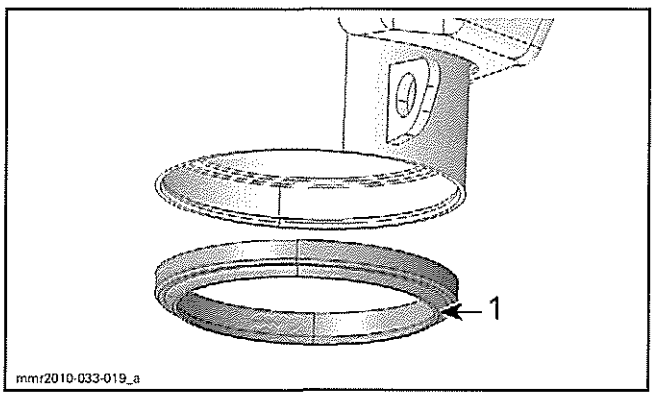
1. Remove *SKI LEG*, see procedure in this subsection.

2. Remove the circlip at the bottom of the LTS module tube.
3. Remove and discard the seal.



TYPICAL
1. Circlip
2. Seal
3. LTS module tube

4. Clean seal location inside LTS module tube. Make sure all grease is removed before inserting the new seal.
5. Install the new seal with the lips outward.



TYPICAL
1. Seal

6. Reinstall the circlip.

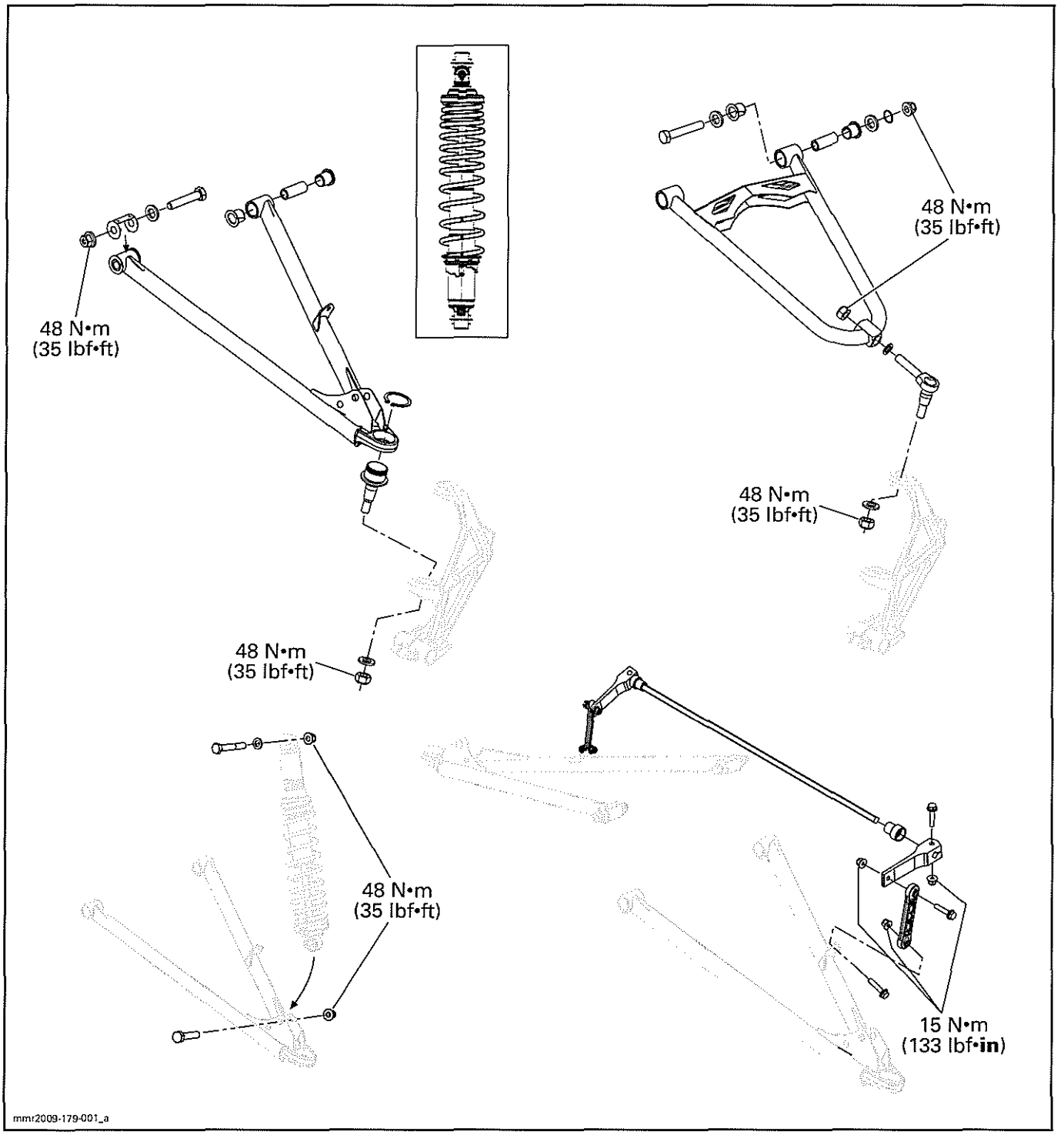
NOTE: Replace the circlip with a new one if loose.

7. Reinstall all removed parts.
8. Lubricate the suspension. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

FRONT SUSPENSION (REV-XP)

SERVICE TOOLS

Description	Part Number	Page
BALL JOINT EXTRACTOR	529 035 827	808
BALL JOINT INSTALLER	529 035 975	811
BALL JOINT REMOVER SUPPORT	529 036 121	810–811
SPRING COMPRESSOR	529 036 184	806


48 N•m
(35 lbf•ft)
48 N•m
(35 lbf•ft)
48 N•m
(35 lbf•ft)
48 N•m
(35 lbf•ft)
48 N•m
(35 lbf•ft)
15 N•m
(133 lbf•in)
mmr2009-179-001_a

GENERAL

The procedure explained below is the same for the RH and LH sides unless otherwise noted.

During assembly/installation, use torque values and service products as in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

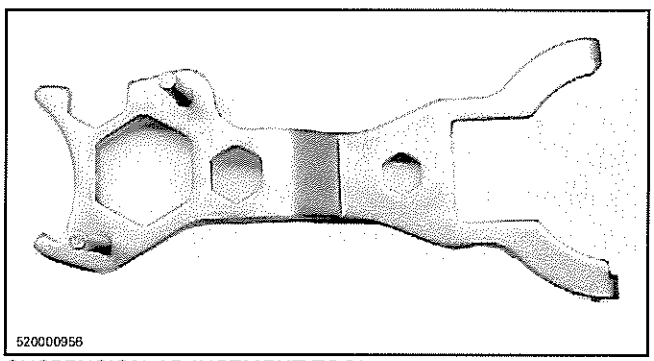
Torque wrench tightening specifications must be strictly adhered to.
Locking devices (e.g.: locking tabs, elastic stop nuts, cotter pins, etc.) must be replaced with new ones.

Check for loose, bent, worn out, rusted or otherwise damaged components. Replace the faulty components.

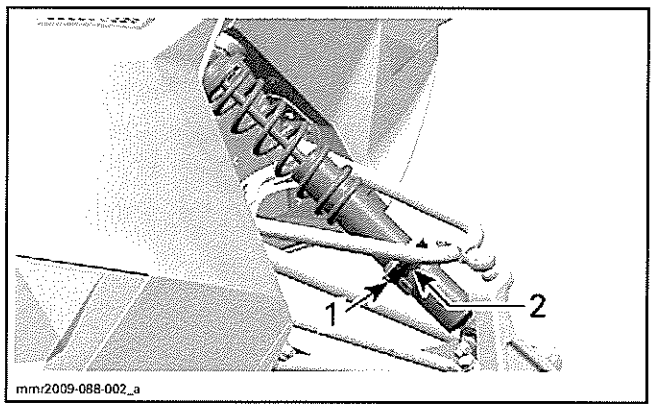
ADJUSTMENT

SPRING PRELOAD

Using the suspension adjustment tool (included in the tool kit), turn the cam to increase or decrease spring preload.



SUSPENSION ADJUSTMENT TOOL



1. *Adjustment cam*
2. *Cam positions*

⚠ WARNING

Adjust both springs to the same preload. Uneven adjustment can cause poor handling and loss of stability, and/or control, and increase the risk of an accident.

Front spring preload has an effect on front suspension firmness.

Front spring preload also has an effect on the steering behavior.

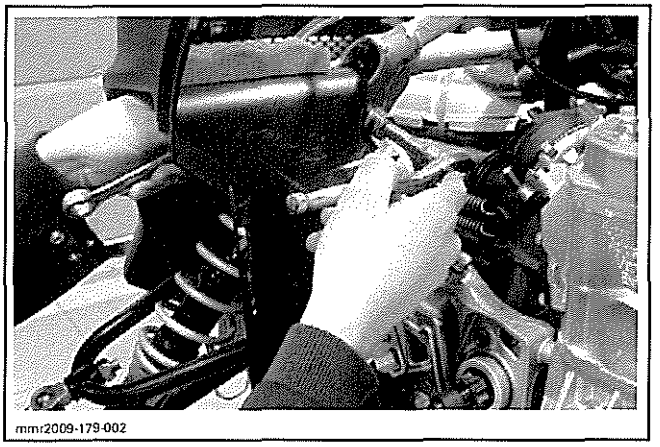
ACTION	RESULT
Increasing preload	Firmer front suspension
	Higher front end
	More precise steering
	More bump absorption capability
Decreasing preload	Softer front suspension
	Lower front end
	Lighter steering
	Less bump absorption capability

PROCEDURES

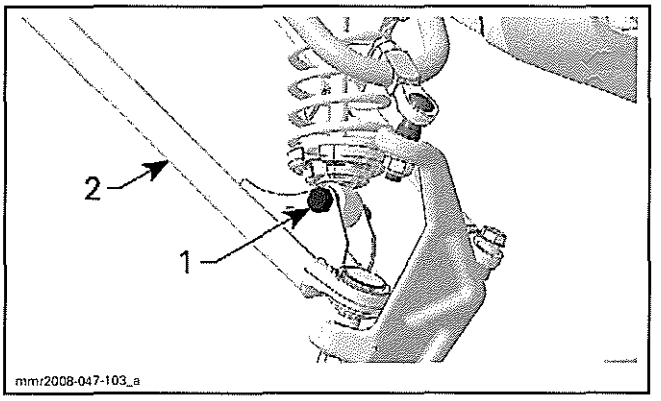
SHOCK ABSORBERS

Shock Absorber Removal

1. Remove side panels, refer to *BODY* subsection.
2. To remove the RH shock absorber, remove the muffler. Refer to *EXHAUST SYSTEM* subsection.
3. To remove the LH shock absorber, remove the pulley guard.
4. Lift the front of vehicle until skis are off the ground.
5. Remove the shock absorber upper bolt.


mmr2009-179-002

6. Remove the shock absorber lower bolt.



mmr2008-047-103_a

1. Lower bolt
2. Lower suspension arm

7. Remove the shock absorber.

Shock Absorber Inspection

1. Extend and compress the piston at least 5 complete strokes with its rod upward and examine shock for leaks.
2. Ensure shock moves smoothly and with uniform resistance over its entire stroke.

NOTE: For the first 5 complete strokes, it could be normal to note uneven resistance.

3. Check the following conditions that will denote a defective shock:
   - A skip or a hang back when reversing stroke at mid travel.
   - Seizing or binding condition except at extreme end of either stroke.
   - Oil leakage.
   - A gurgling noise after completing one full compression and extension stroke.
4. If suspecting a shock is freezing, place it in a freezer (temperature below 0°C (32°F)) for 4 hours.
5. Push down on rod and note its resistance. If shock is frozen it will be much more difficult to compress than one in normal condition.
6. Replace if any faults are present.

Shock Absorber Installation

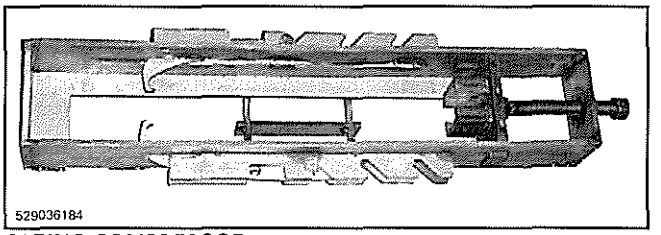
For installation, reverse the removal procedures.

NOTE: Always install shock valve outwards when applicable.

COIL SPRINGS

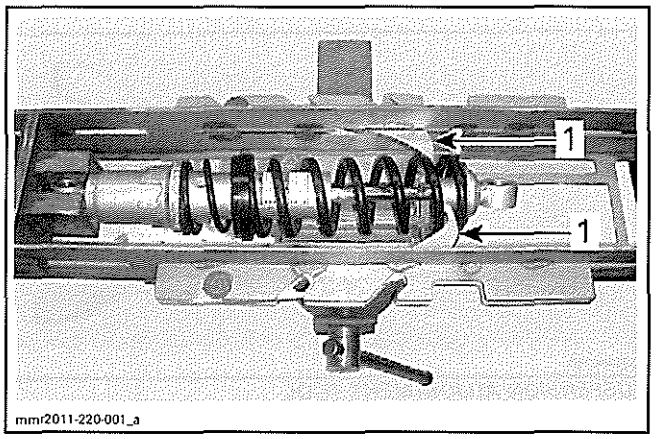
COIL Spring Removal

1. To remove spring from the shock absorber, use the SPRING COMPRESSOR (P/N 529 036 184).


529036184

SPRING COMPRESSOR

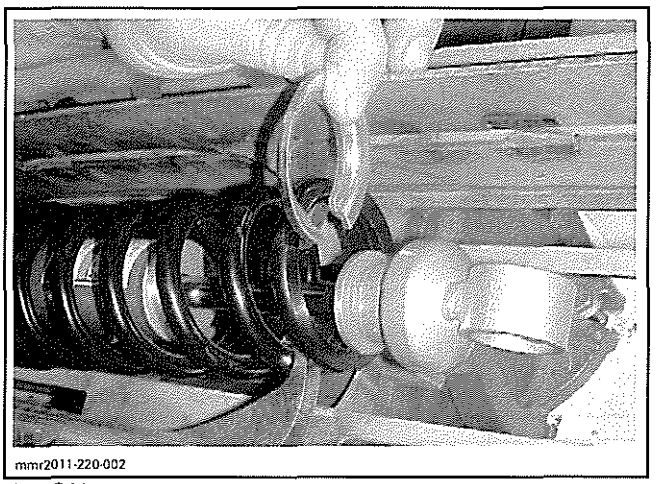
2. Place the tool in a vise.
3. Position the shock absorber in the tool and install the spring compressor hooks.



mmr2011-220-001_a

TYPICAL
1. Spring compressor hooks

4. Tighten the spring compressor tool screw until the spring is sufficiently compressed to remove spring stopper.
5. Remove spring stopper then release the spring compressor tool screw.



TYPICAL

6. Remove spring from shock absorber.

COIL Spring Inspection

Inspect spring for apparent damage.

COIL Spring Installation

For installation, reverse the removal procedure.

UPPER SUSPENSION ARMS

Upper Suspension Arm Inspection

1. Check suspension arm for distortion or damage. Replace if necessary.
2. Move suspension arm side to side, then up and down. There should be no noticeable looseness. Replace bushings and/or sleeves if necessary.

NOTE: A play of 2 mm (.079 in) is acceptable when the suspension arm is moved forward and backward.

3. Check sleeves inside suspension arm attachments for wear or damage. Replace if necessary

Upper Suspension Arm Removal

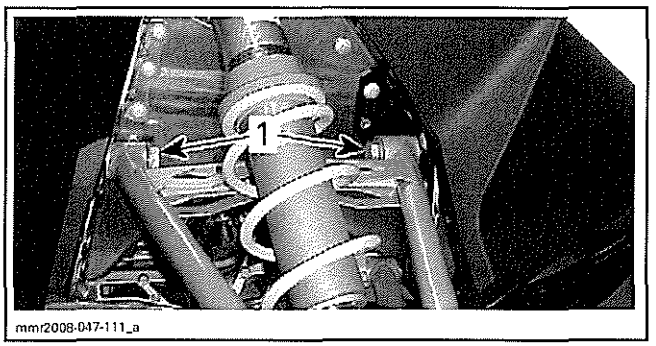
1. Lift the front of vehicle until skis are off the ground.
2. Remove muffler. Refer to applicable *EXHAUST SYSTEM* subsection.

600 HO E-TEC Model

3. Remove tuned pipe.

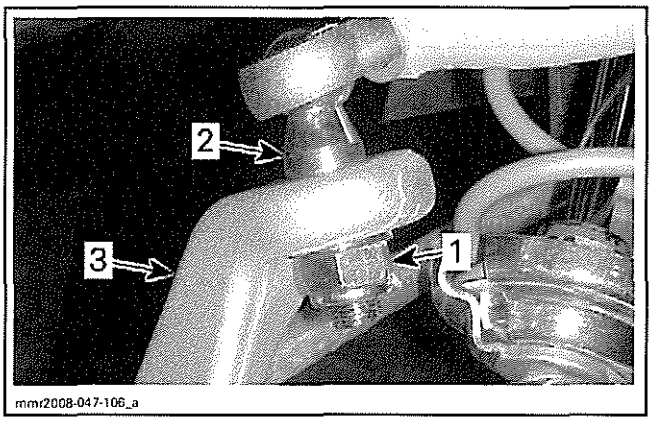
All Models

4. Remove upper shock absorber bolt. See *SHOCK ABSORBER REMOVAL* in this subsection.
5. Remove the upper suspension arm bolts.



TYPICAL
1. Upper suspension arm bolts

6. Remove ball joint from ski leg. See *UPPER BALL JOINT REMOVAL* in this subsection.



1. Ball joint nut
2. Ball joint
3. Ski leg

7. Remove upper suspension arm.

Upper Suspension Arm Installation

The installation is the reverse of the removal procedure.

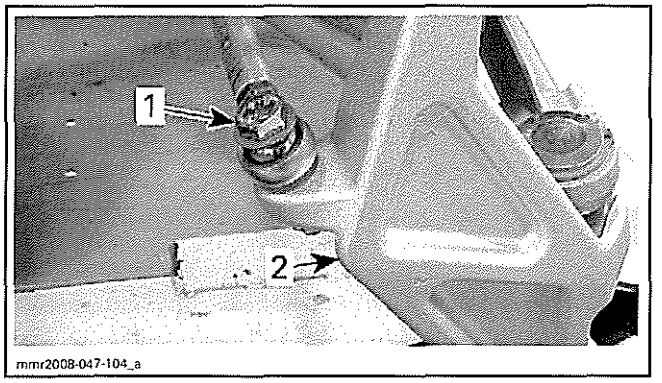
UPPER BALL JOINTS

Upper Ball Joint Inspection

Check both upper ball joints for damage, pitting, looseness and roughness. If so, replace with a new one.

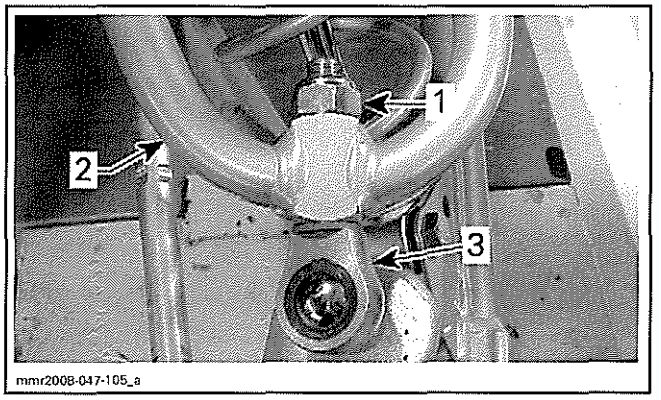
Upper Ball Joint Removal

1. Position upper suspension arm so that ball joint becomes parallel with ski leg.
2. Detach tie-rod end from ski leg.



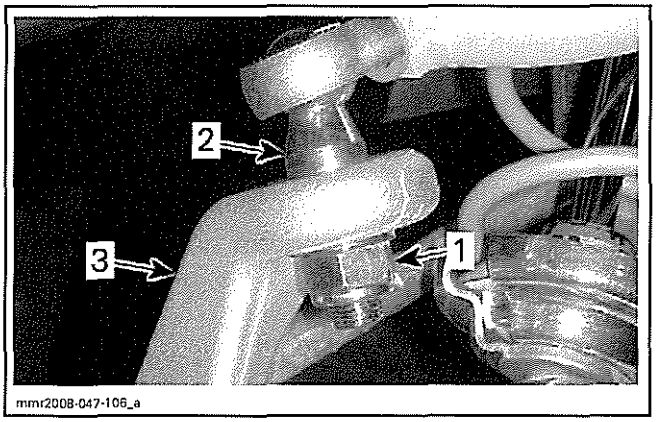
1. *Tie-rod end bolt*
2. *Ski leg*

3. Unscrew nut retaining ball joint housing to upper suspension arm.



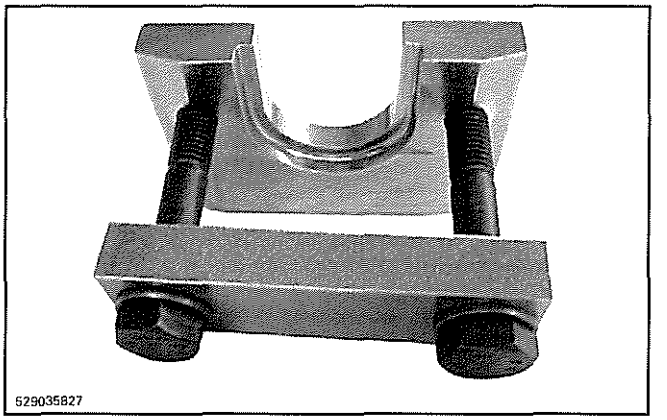
1. *Ball joint housing nut*
2. *Upper suspension arm*
3. *Ball joint housing*

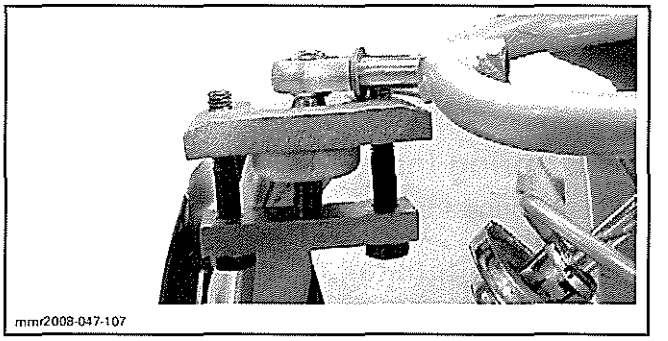
4. Remove nut securing ball joint to ski leg.



1. *Ball joint nut*
2. *Ball joint*
3. *Ski leg*

5. Install the BALL JOINT EXTRACTOR (P/N 529 035 827) and detach ball joint from ski leg.

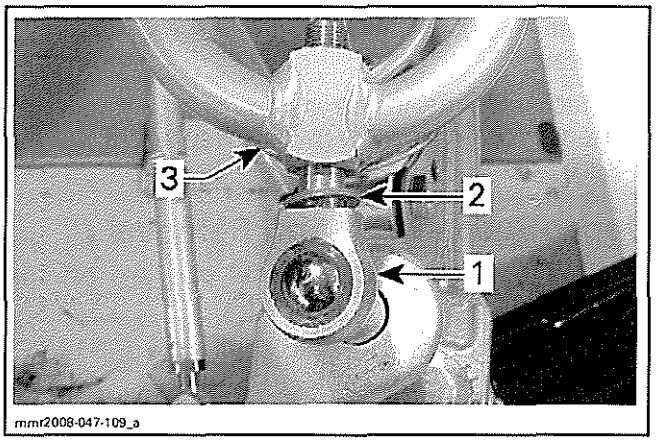




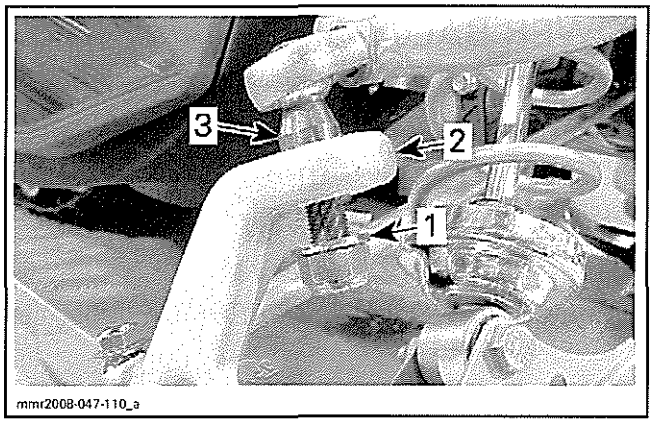
6. Alternately tighten screws on tool to remove ball joint from ski leg.
7. Remove ball joint from suspension arm.

Upper Ball Joint Installation

1. The installation is the reverse of the removal procedure. However, pay attention to the following.
2. Install ball joint washers as illustrated.



1. *Ball joint housing*
2. *Washer*
3. *Upper suspension arm*



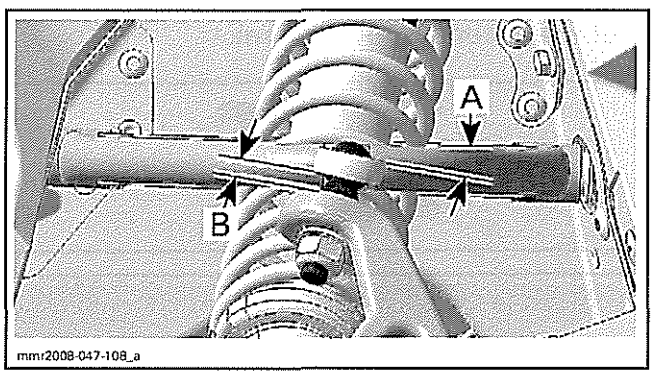
1. *Washer*
2. *Ski leg*
3. *Ball joint*

3. Tighten ball joint retaining nuts.

BALL JOINT TORQUES	
Ball joint to suspension arm	48 N•m (35 lbf•ft)
Ball joint to ski leg	

4. Ensure ball joint has the proper angle as illustrated.

NOTE: The ball joint must be parallel to its mounting surface on the ski leg. This mounting position corresponds to 10° ± 3° angle from upper arm.



A. 10° ± 3°
B. Parallel

LOWER SUSPENSION ARMS

Lower Suspension Arm Inspection

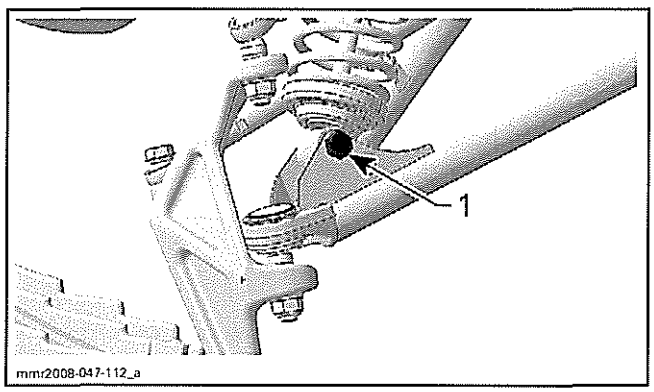
1. Check suspension arm for distortion or damage. Replace if necessary.
2. Detach shock absorber and stabilizer bar from lower suspension arm.
3. Move suspension arm side to side, then up and down. There should be no noticeable looseness. Replace bushings and/or sleeves if necessary.

NOTE: A play of 2 mm (.079 in) is acceptable when the suspension arm is moved forward and backward.

4. Check sleeves inside suspension arm attachments for wear or damage.

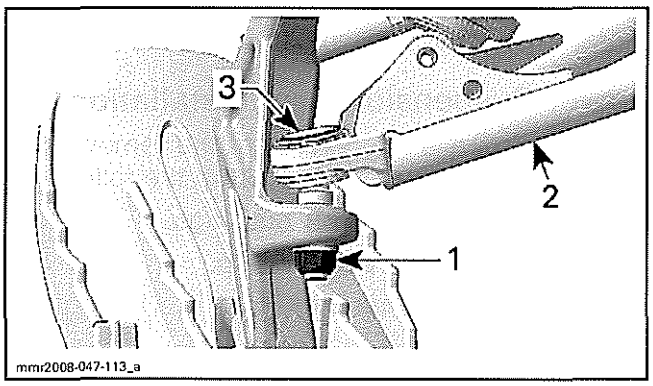
Lower Suspension Arm Removal

1. Lift the front of vehicle until skis are off the ground.
2. Remove lower shock absorber bolt.



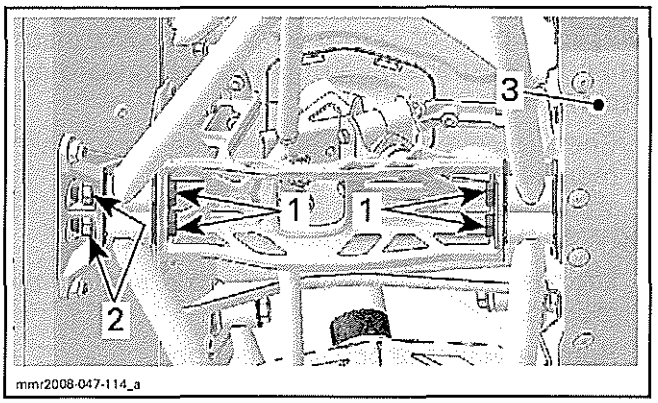
1. Shock absorber lower bolt

3. Detach stabilizer link from lower suspension arm. See *STABILIZER BAR* in this subsection.
4. Remove lower ball joint nuts.



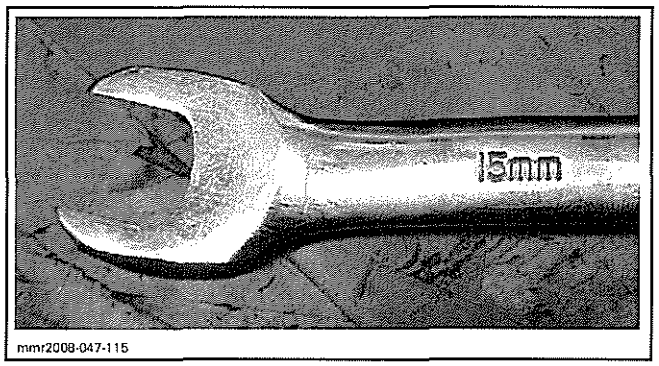
1. Ball joint nut
2. Lower suspension arm
3. Lower ball joint

5. Using a suitable ball joint remover, detach lower ball joint from ski leg.
6. Remove suspension arm retaining bolts.



UNDERNEATH FRONT OF VEHICLE
1. *Suspension arm bolts*
2. *Rear nuts*
3. *Bottom pan*

NOTE: To hold rear retaining nuts, modify a 15 mm open end wrench as illustrated.

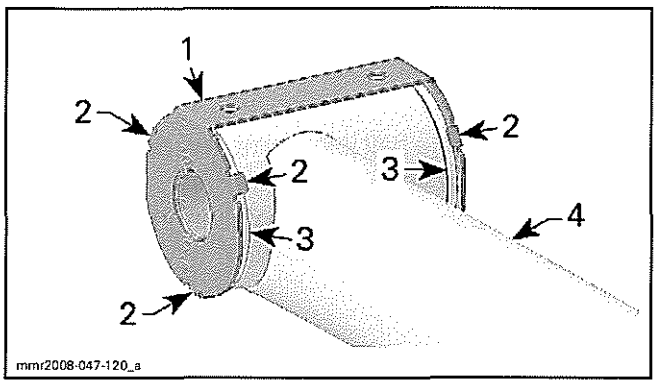


7. Remove lower suspension arm from vehicle.

Lower Suspension Arm Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

1. Install a wear plate over bushings.
2. Position the wear plate on top.
3. Fold all tabs against bushings.



1. *Wear plate*
2. *Wear plate tabs*
3. *Bushings*
4. *Lower suspension arm*

LOWER BALL JOINTS

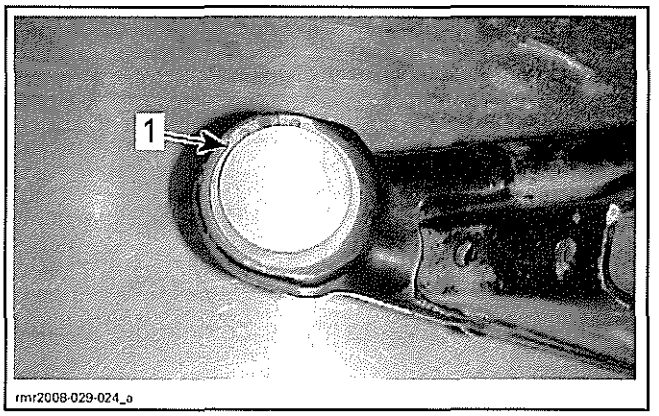
Lower Ball Joint Inspection

Inspect ball joint end for damage. Ensure freedom of movent without play.

Replace ball joints as required.

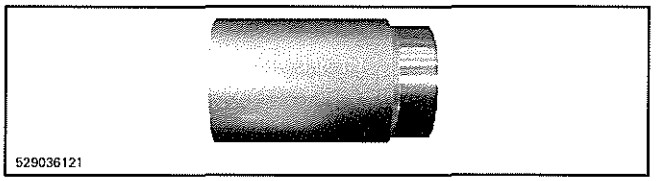
Lower Ball Joint Removal

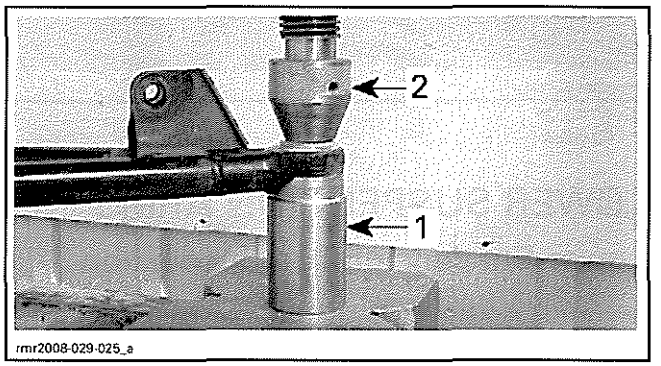
1. Remove the *LOWER SUSPENSION ARM*, see procedure in this subsection.
2. Remove circlip securing ball joint to suspension arm.



1. *Circlip*

3. Using a press and the BALL JOINT REMOVER SUPPORT (P/N 529 036 121), press ball joint out of the lower suspension arm.

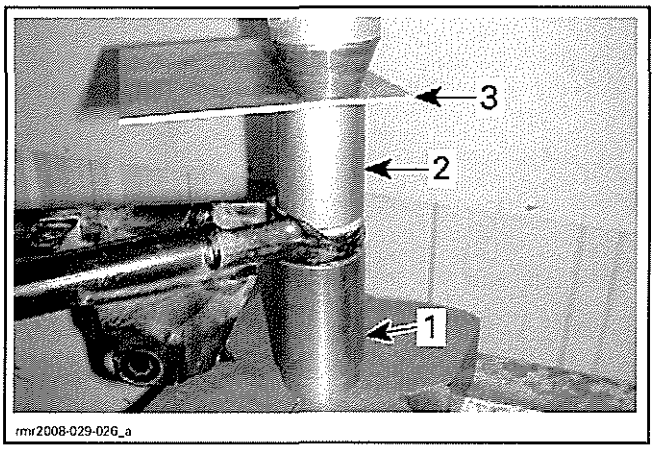




1. *Ball joint remover*
2. *Press*

Lower Ball Joint Installation

1. Using a press, the BALL JOINT REMOVER SUPPORT (P/N 529 036 121) and the BALL JOINT INSTALLER (P/N 529 035 975), press ball joint into the suspension arm end.



1. Ball joint remover support
2. Ball joint installer
3. Steel plate

2. Install the circlip.

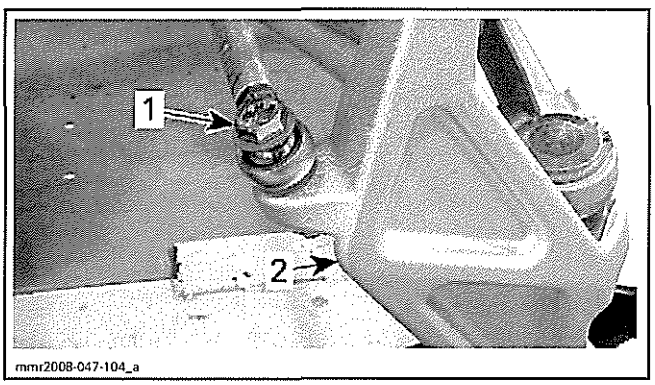
NOTE: If the circlip seems loose, replace it with a new one.

3. Install the *LOWER SUSPENSION ARM* on vehicle, see procedure in this subsection.

SKI LEGS

Ski Leg Removal

1. Remove ski from ski leg.
2. Detach tie-rod end from ski leg.



1. Tie-rod end bolt
2. Ski leg

3. Remove upper and lower ball joints from ski leg. See *UPPER BALL JOINT* and *LOWER BALL JOINT* in this subsection.

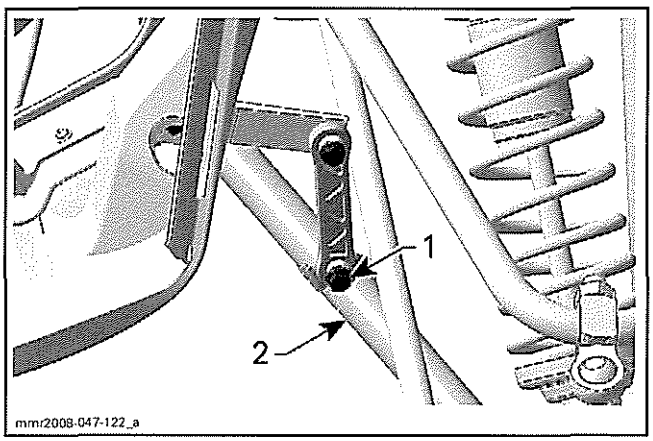
Ski Leg Installation

The installation is the reverse of the removal procedure.

STABILIZER BAR

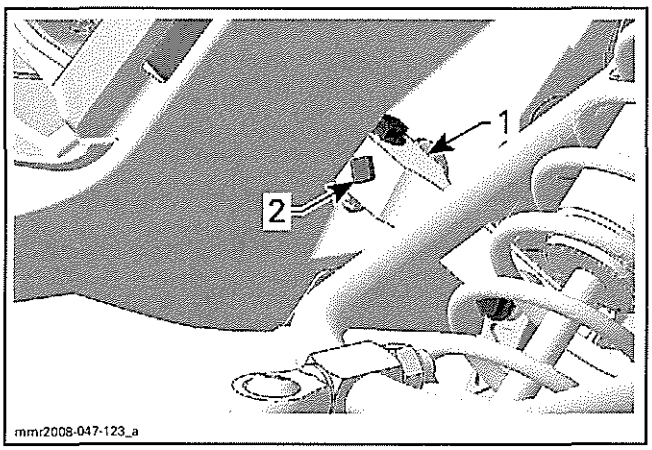
Stabilizer Bar Removal

1. Remove the RH side panels. Refer to *BODY* subsection.
2. Remove the muffler. Refer to *EXHAUST SYSTEM* subsection.
3. Remove bolts securing stabilizer links to lower suspension arms.



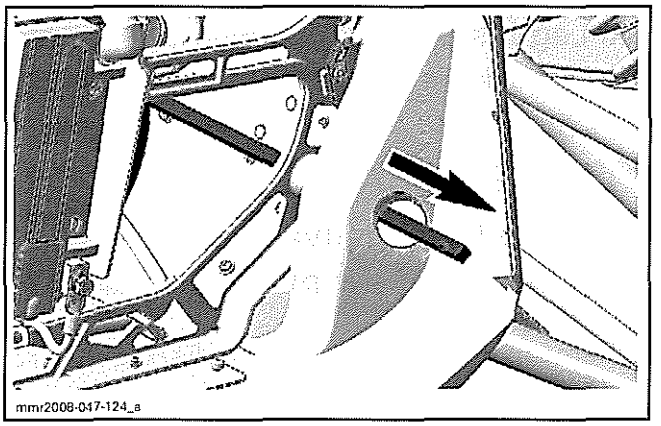
TYPICAL - RH SIDE SHOWN
1. Stabilizer link bolt
2. Lower suspension arm

4. Unscrew stabilizer lever bolts.
5. Remove stabilizer levers from stabilizer bar.



TYPICAL - RH SIDE SHOWN
1. Stabilizer lever
2. Stabilizer bar

6. Slide stabilizer bar out of vehicle.



TYPICAL - RH SIDE SHOWN

Stabilizer Bar Installation

The installation is the reverse of the removal procedure.

REAR SUSPENSION (SC-5U)

SERVICE TOOLS

Description	Part Number	Page
SHOCK ABSORBER SUPPORTS	529 036 186	821

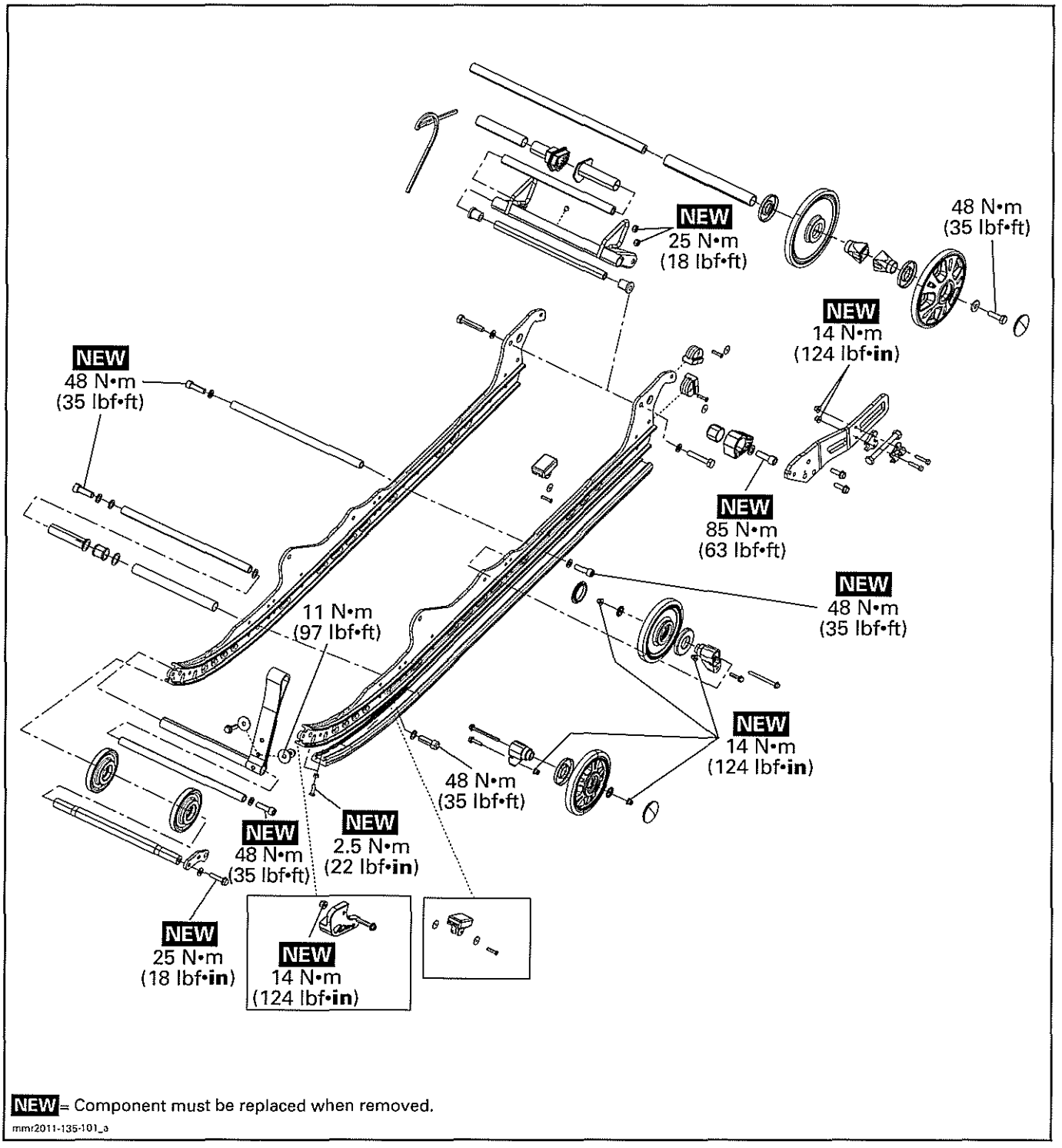
SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
BENCH SCALE SUCH AS SALTER BRECKNELL	PS 400	821

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 243 (BLUE)	293 800 060	824
SUSPENSION GREASE	293 550 033	826–827

RAILS AND IDLERS WHEELS



NEW = Component must be replaced when removed.

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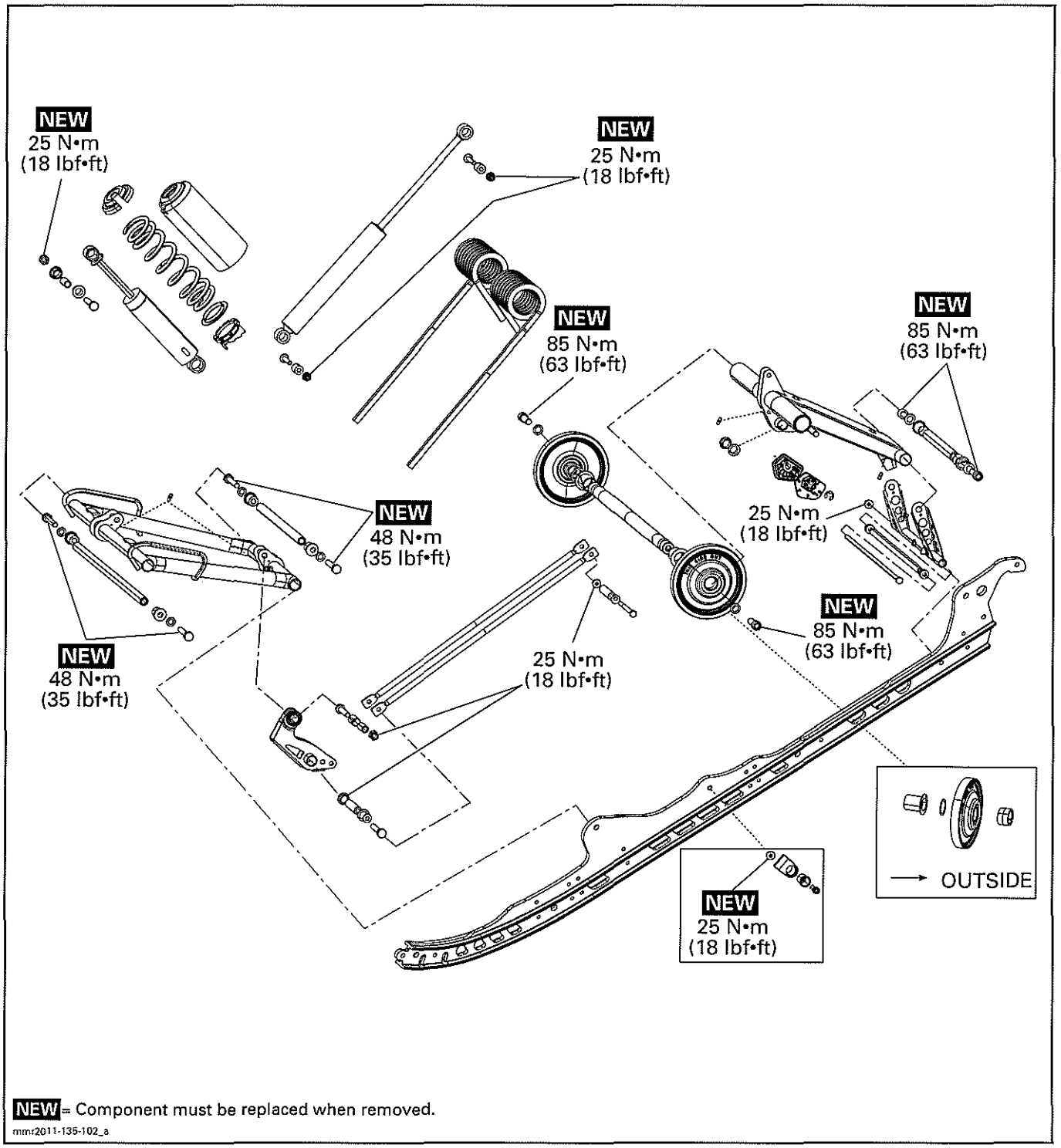
ARMS AND SHOCK ABSORBERS



NEW = Component must be replaced when removed.

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GENERAL

During assembly/installation, use torque values and service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, cotter pins, etc.) must replaced.

NOTICE **Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.**

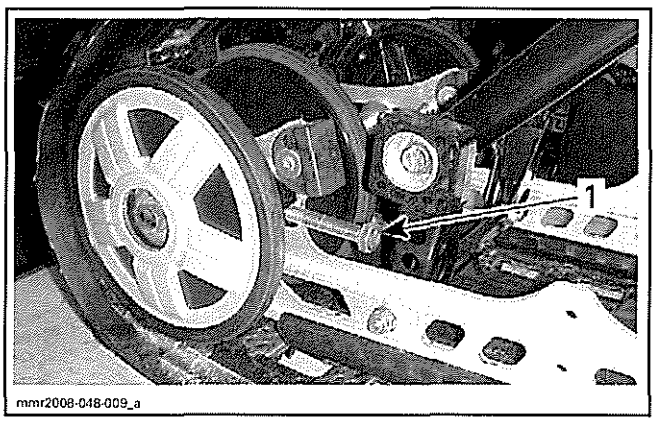
PROCEDURES

NOTE: Many parts can be changed with rear suspension in place. When specified, refer to *SUSPENSION ASSEMBLY* to remove rear suspension from the vehicle.

SUSPENSION ASSEMBLY

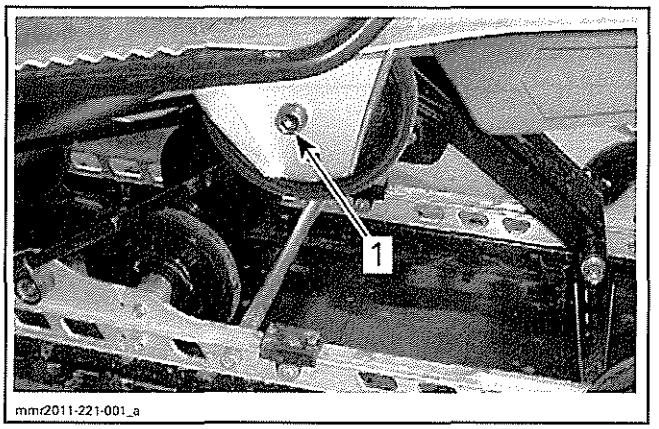
Suspension Assembly Removal

1. Lift rear of vehicle and support it off the ground.
2. Completely loosen track tension by unscrewing both adjustment screws.



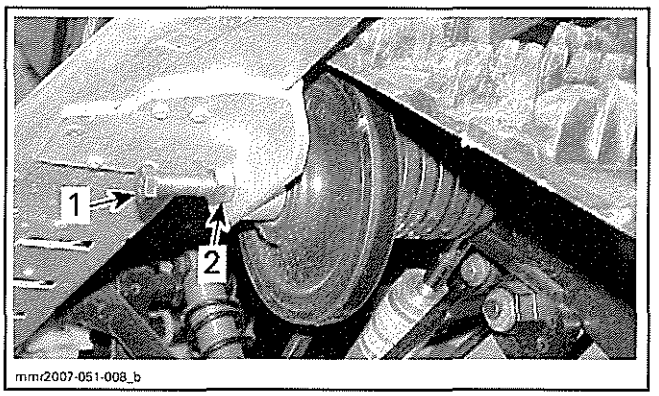
TYPICAL
1. RH adjustment screw

3. Remove and discard upper rear arm upper screws. Use the following procedure to remove screws easily.
   3.1 Unscrew one screw securing the rear arm to frame.



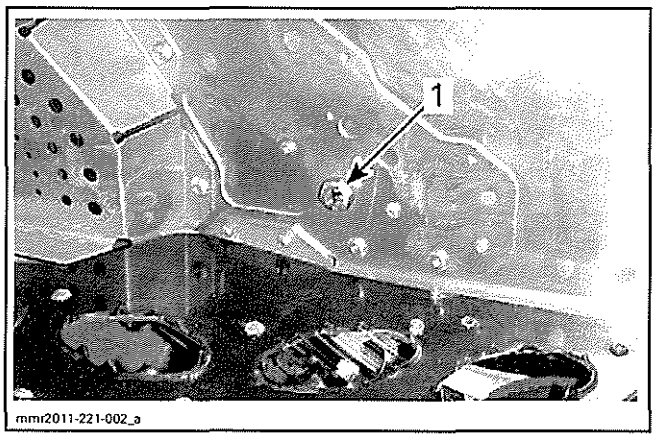
1. Rear arm retaining screw

   3.2 Replace the screw with a longer one and a nut.
   3.3 Screw in the longer screw by approximately 7 turns.
   3.4 Hold the longer screw and tighten locking nut.



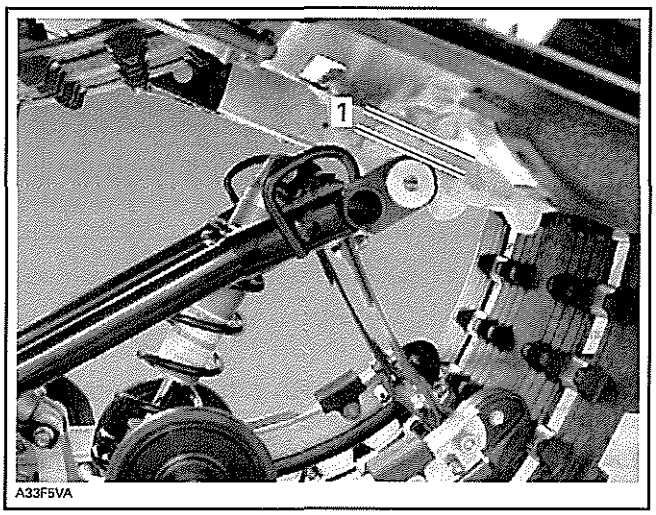
TYPICAL
1. Longer screw
2. Locking nut

   3.5 Unscrew the screw on the other side then unlock nut and remove the longer screw.
4. Remove and discard both screws retaining front arm to the tunnel.



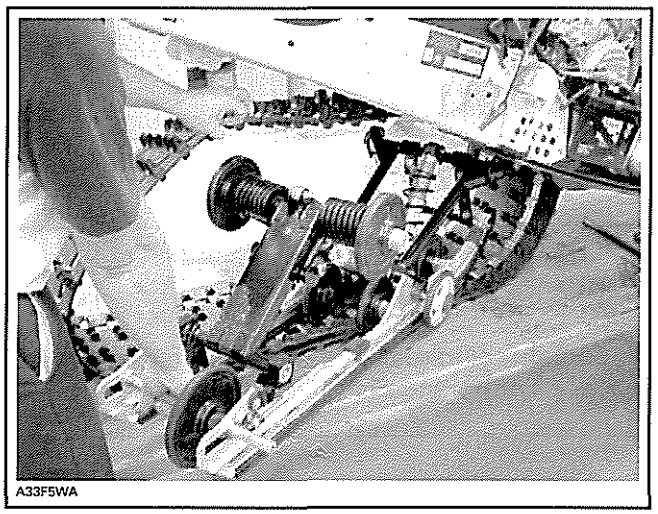
LH SIDE SHOWN
1. Front arm retaining screw

5. Lift rear of vehicle until the front arm clears the tunnel.



TYPICAL
1. Enough clearance

6. Remove suspension assembly from the vehicle.



TYPICAL — REMOVE SUSPENSION

Suspension Assembly Installation

Installation is the reverse of removal procedure. However, pay attention to the following.

Inspect track thoroughly before reinstalling suspension. Refer to *TRACK* subsection.

Install suspension into track with front portion first.

Install NEW front arm screws.

Install NEW rear arm screws.

Tighten screws to specified torque.

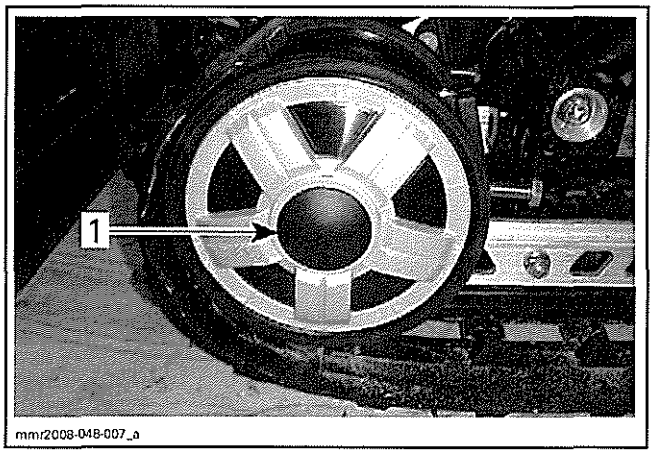
UPPER SUSPENSION ARM FASTENERS TIGHTENING TORQUE	
Front arm screws	48 N•m (35 lbf•ft)
Rear arm screws	85 N•m (63 lbf•ft)

Adjust track tension, refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

REAR AXLE

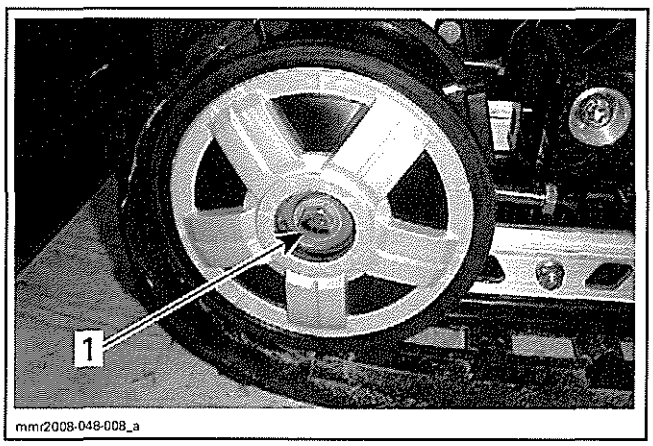
Rear Axle Removal

1. Lift rear of vehicle and support it off the ground.
2. Remove rear idler wheel caps.



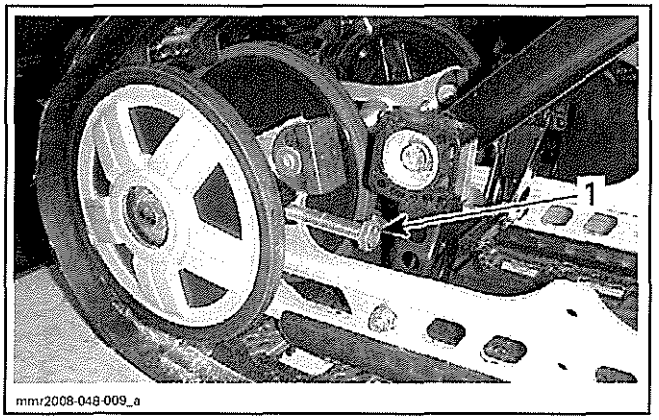
TYPICAL
1. RH rear idler wheel cap

3. Loosen rear axle screws (one each side).



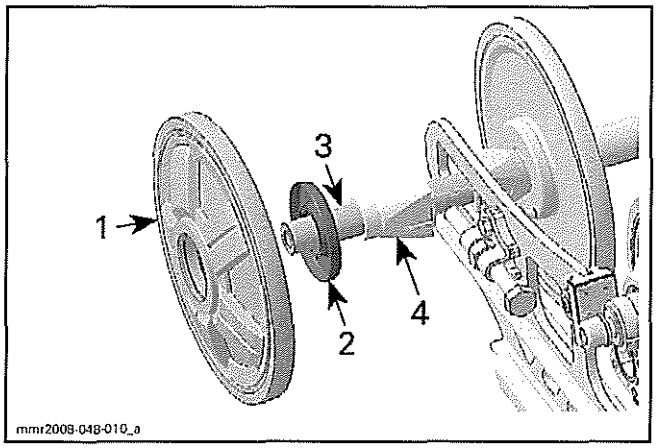
TYPICAL
1. RH rear axle screw

4. Completely loosen track tension by unscrewing both adjustment screws.



TYPICAL
1. RH adjustment screw

5. Remove both rear axle screws.
6. Remove rear idler wheels, seals and wheel spacers.



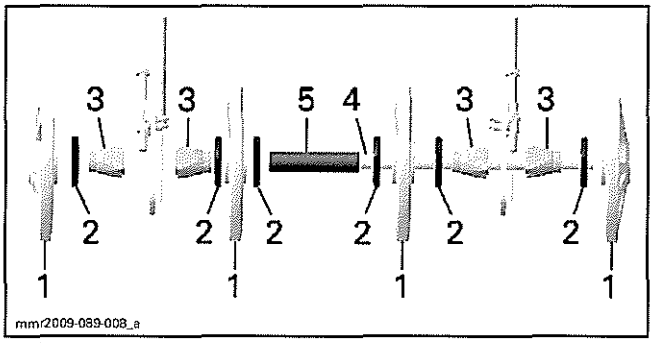
TYPICAL - RH SIDE
1. Rear idler wheel
2. Seal
3. Rear axle
4. Wheel spacer

7. Pull out the rear axle.

Rear Axle Installation

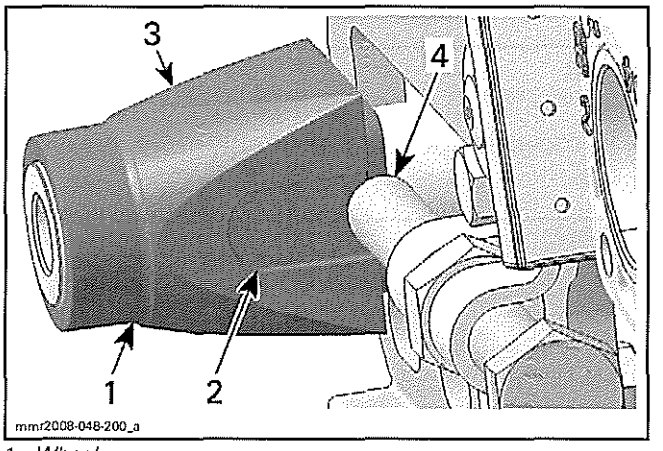
Installation is the reverse of removal procedure. However, pay attention to the following.

Make sure to position all parts correctly.



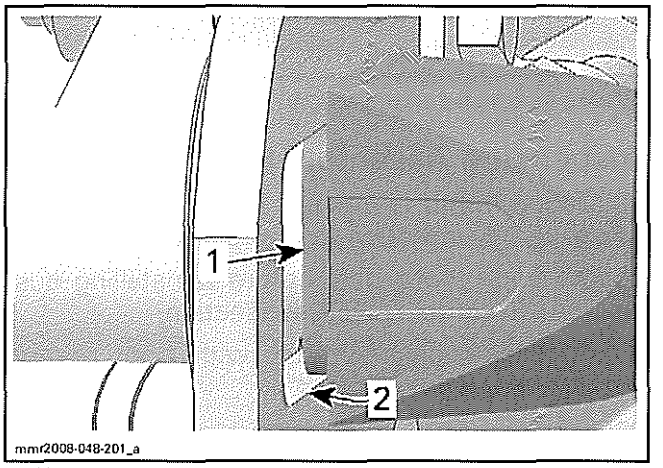
1. Idler wheels
2. Seals
3. Wheel spacers
4. Rear axle
5. Rear axle spacer

Position wheel spacers with a flat side up and a groove in front of tensioner screw.



1. Wheel spacer
2. Groove
3. Flat side
4. Tensioner screw

When tightening rear axle, make sure each wheel spacer protuberance is engaged into rail slot.



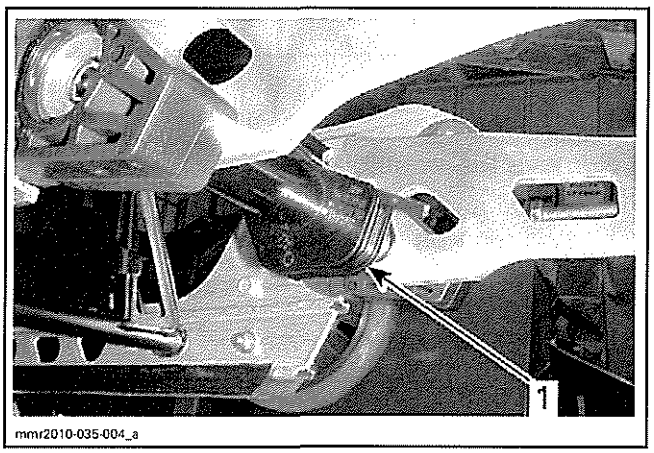
1. Wheel spacer protuberance
2. Rail slot

Adjust track tension. Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

REAR EXTENSION

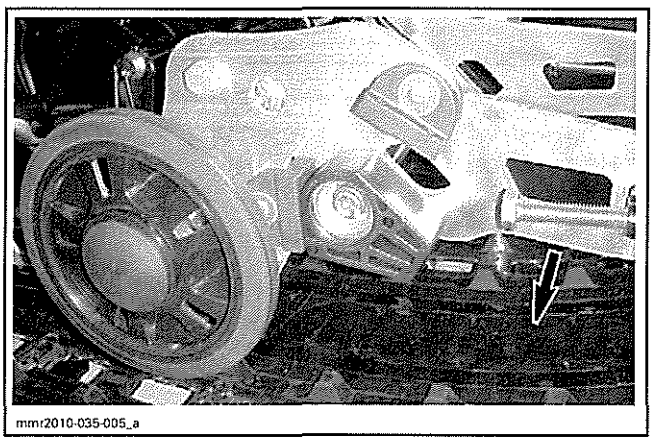
Rear Extension Removal

1. Proceed with *REAR AXLE REMOVAL*. See procedure in this subsection.
2. Unload the spring cam of rear extension by placing it to position 1.

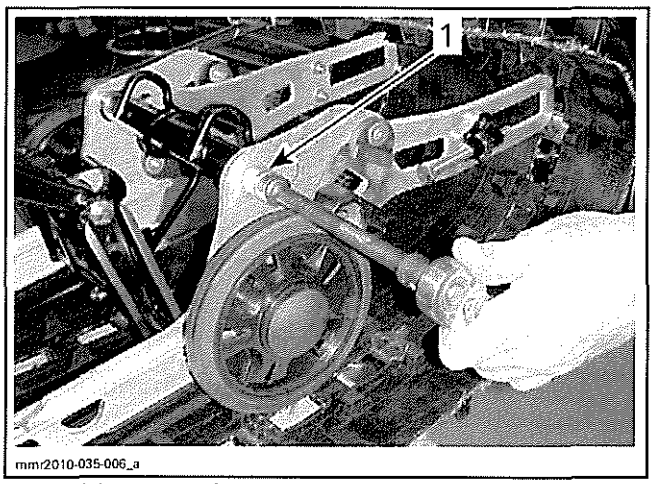


1. Spring cam set to position 1

3. Ensure that rear extension is positioned fully downwards (against lower stopper).

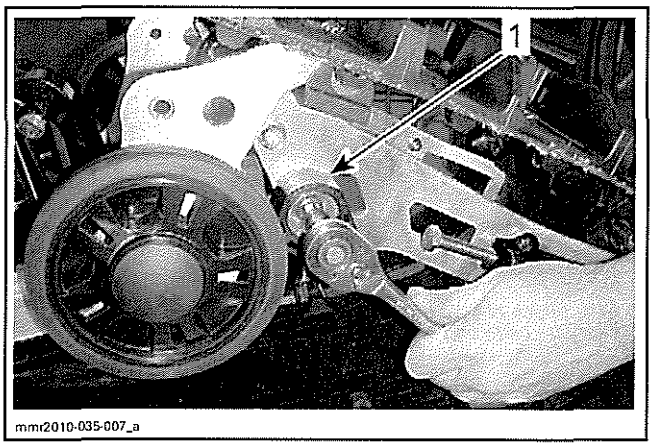


4. Remove retaining screws and washers from rear extension pivot.



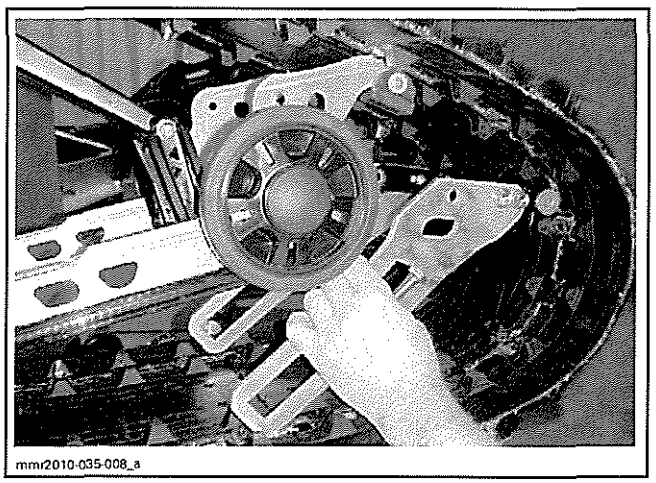
1. Retaining screw of rear extension pivot

5. Remove retaining screws and washers from rear extension block.
6. Remove rear extension blocks and spacer.



1. Rear extension block

7. Rotate rear extension downwards then remove it from rear suspension.



Rear Extension Installation

The installation is the reverse of removal procedure. However, pay attention to the following.

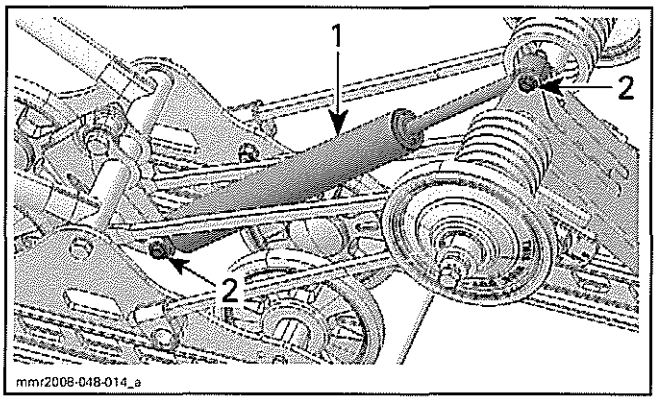
Lubricate rear extension pivot. Refer to *PERIODIC MAINTENANCE PROCEDURES* in this subsection.

SHOCK ABSORBERS

Rear Shock Absorber Removal

NOTE: If necessary, to ease shock removal, unfasten stopper straps to release shock pressure.

1. Lift rear of vehicle and support it off the ground.
2. Remove bolts and nuts from shock.

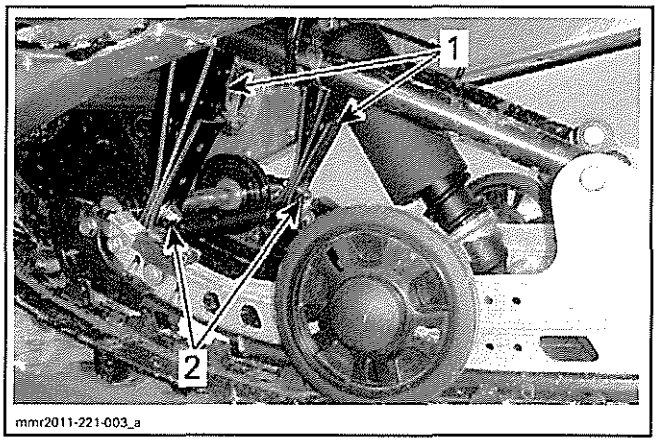


TYPICAL
1. Rear shock absorber
2. Remove bolts and washers

3. Remove rear shock absorber from the vehicle.

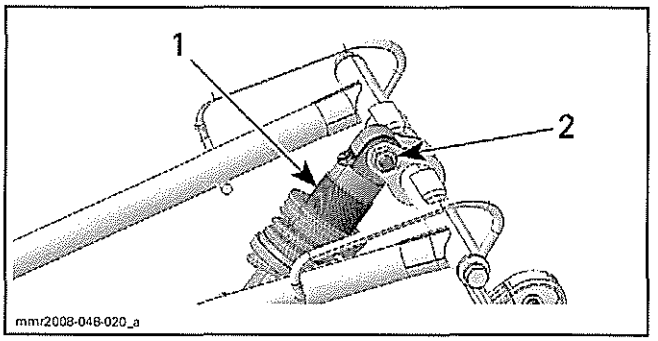
Center Shock Absorber Removal

1. Lift the rear of vehicle and support it off the ground.
2. Unfasten stopper straps.



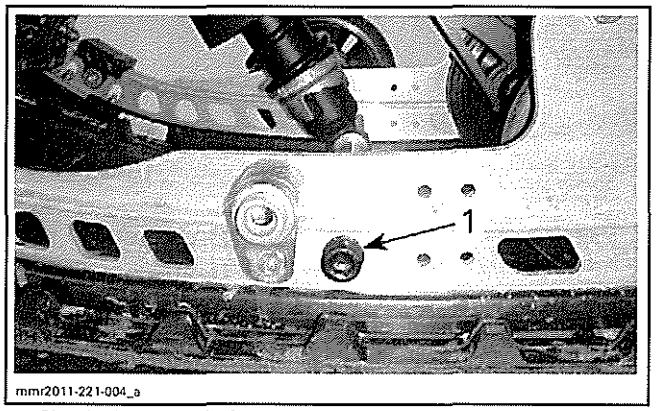
1. Stopper straps
2. Stopper strap bolts

3. Remove upper shock absorber bolt.



TYPICAL
1. Front shock absorber
2. Remove bolt

4. Remove the front idler wheels.
5. Remove and discard shock absorber shaft screws (one on each side).



1. Shock absorber shaft screw

6. Remove center shock absorber from the vehicle.
7. Remove bushings and shock shaft from shock absorber.

Shock Absorber Inspection

NOTE: Refer to *TECHNICAL SPECIFICATIONS* to identify the shock absorber relating to the vehicle model.

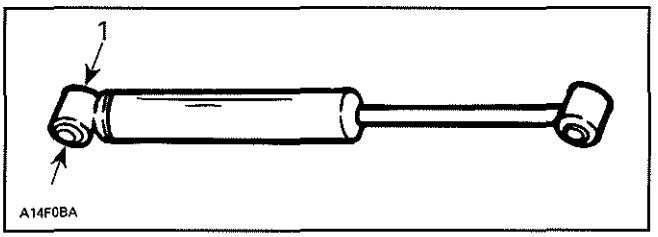
NOTE: Unless otherwise noted, shock absorber must be at normal room temperature (21°C ± 2°C (70°F ± 36°F)) during inspection.

MC Hydraulic Shock

1. Perform a visual inspection of the shock:
   - The shock must be exempt of any dent or scratch, especially on the rod.
   - Small dent on the shock body may not affect any performance or reliability of this shock.
   - Any defect on the rod, as small as it is, can lead to seal failure and oil leak.
   - If such defect (on rod) is detected, the shock must be replaced, and this will not be cover under warranty.

2. Secure the shock body end in a vise, clamping on eyelet, with its rod upward.

NOTICE Do not clamp directly on shock body.



1. Shock body eyelet

3. Examine shock for leaks. Extend and compress the piston at least 5 complete strokes with its rod upward.
4. Check that shock moves smoothly and with uniform resistance over its entire stroke.

NOTE: For the first 5 complete strokes, it could be normal to note uneven resistance.

5. Check the following conditions that will denote a defective shock:
   - A skip or a hang back when reversing stroke at mid travel.
   - Seizing or binding condition except at extreme end of either stroke.
   - Oil leakage.
   - A gurgling noise, after completing one full compression and extension strokes.
6. If suspecting a shock is freezing, place shock in a freezer (temperature below 0°C (32°F)) for 4 hours.
7. Push down on rod and note its resistance. If shock is frozen it will be much more difficult to compress than one in normal condition.
8. If any faults are present, replace shock.

All HPG™ Shock (Including KYB PRO Series)

1. Perform a visual inspection of the shock:
   - The shock must be exempt of any dent or scratch, especially on the rod.
   - Any defect on the rod, as small as it is, can lead to seal failure and oil leak.
   - If such defect is detected, the shock must be replaced and this will not be covered under warranty.
2. Completely push down shock rod into the body and check result as per table.

HPG SHOCK	RESULT
All except 551 mm (21-11/16 in) rear shock	The rod should completely get in the shock body
551 mm (21-11/16 in) rear shock	The stroke must be at least 138 mm (5-7/16 in)

NOTE: For the HPG Variable Rate Shock, it should be stiff for approximately the first 25 mm (1 in), then softer for about 50 mm (2 in), and stiffer again. This stiff/soft/stiff phenomenon shows the normal operation of VR shock.

3. Release shock from completely collapsed position and check result as per table.

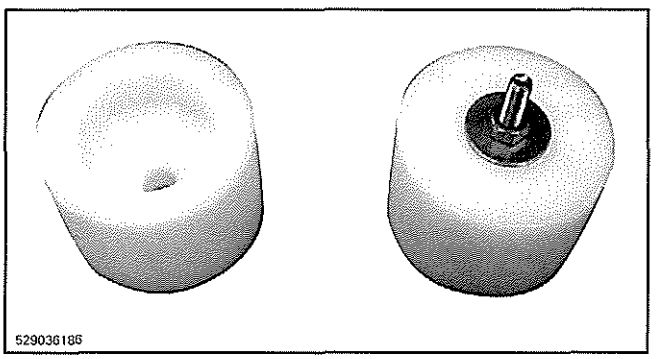
HPG SHOCK EXCEPT VARIABLE RATE
– The shock should extend unassisted. – The rod must come out at a steady speed.

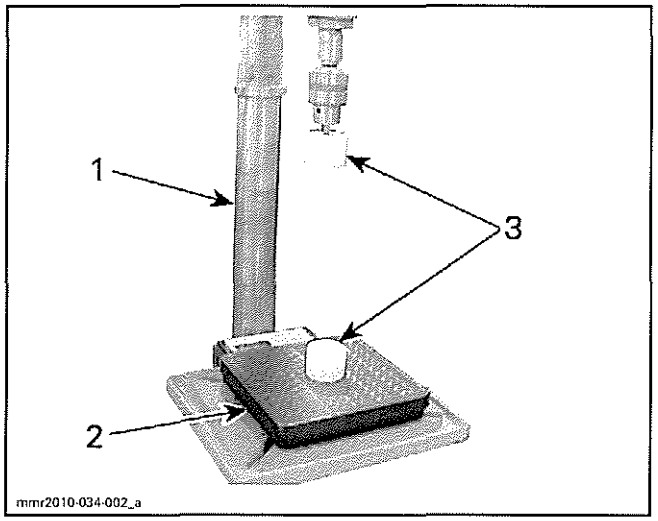
HPG VARIABLE RATE SHOCK
– The shock should extend unassisted. – Rod must come out slowly first, than faster and finally slow again for the last 25 mm (1 in).

4. Proceed with *SHOCK ABSORBER COMPRESSION TEST*. See procedure in this subsection.
5. If any faults are present, replace shock.

Shock Absorber Compression Test

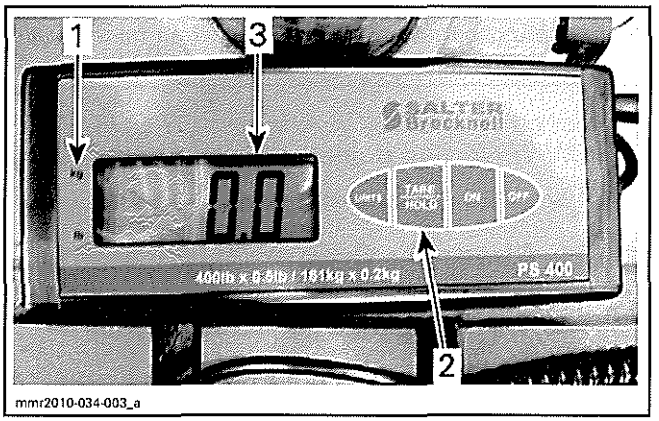
1. Ensure shock absorber is at normal room temperature (21°C ± 2°C (70°F ± 36°F)).
2. Remove spring from shock absorber (if applicable).
3. Place a BENCH SCALE SUCH AS SALTER BRECKNELL (P/N PS 400) (or an equivalent) on a suitable drill press.
4. Install SHOCK ABSORBER SUPPORTS (P/N 529 036 186) onto drill press.





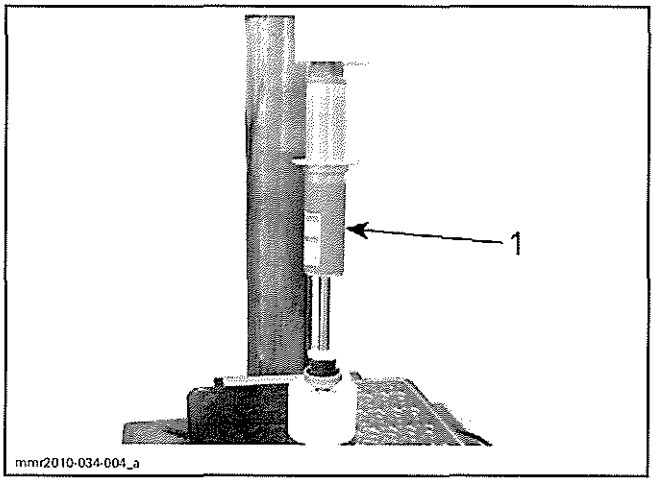
1. Drill press
2. Bench scale
3. Shock absorber supports

5. Set bench scale units to kg (or lb).
6. Press TARE to reset digits (must indicate (0) zero).



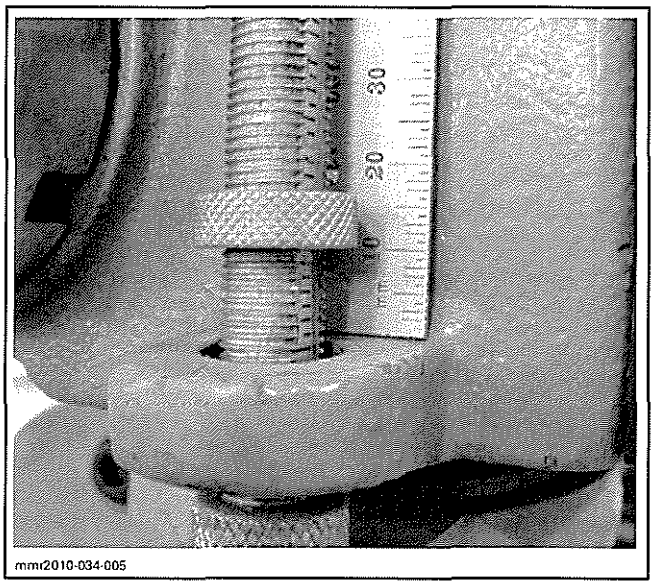
1. Units indicator lamp
2. TARE button
3. Digits

7. Install shock absorber into support with shock body upwards.
8. Adjust drill press table height in order to set the upper shock support flush with the shock body end.
9. Ensure shock absorber is aligned with drill press axis.

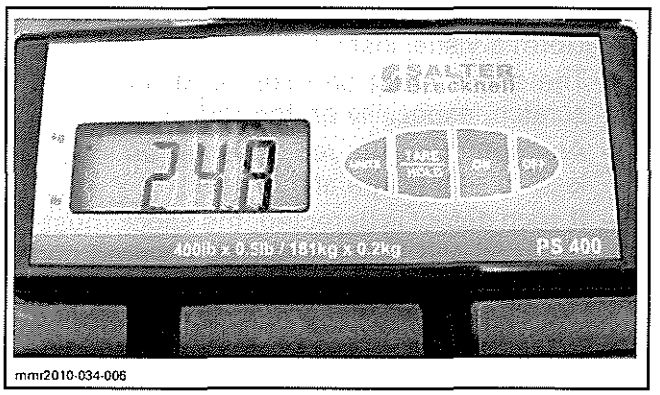


1. Shock body upwards

10. Set the drill press displacement to 10 mm (.394 in) using locking nut.



11. Compress shock absorber by 10 mm (.394 in) and hold it in position.
12. Read load recorded on the bench scale.



13. Load reading must be as per the following table.

MODEL	ROD DIAMETER	SERVICE RANGE
All HPG VR/Plus/Plus R	12.5 mm (1/2 in)	24 kgf ± 4 kgf (53 lbf ± 9 lbf)
All HPG KYB PRO	16 mm (5/8 in)	39 kgf ± 5 kgf (86 lbf ± 11 lbf)

Rear Shock Absorber Installation

Installation is reverse of removal procedure. However, pay attention to the following.

Make sure upper and lower shock absorber bushings are properly installed.

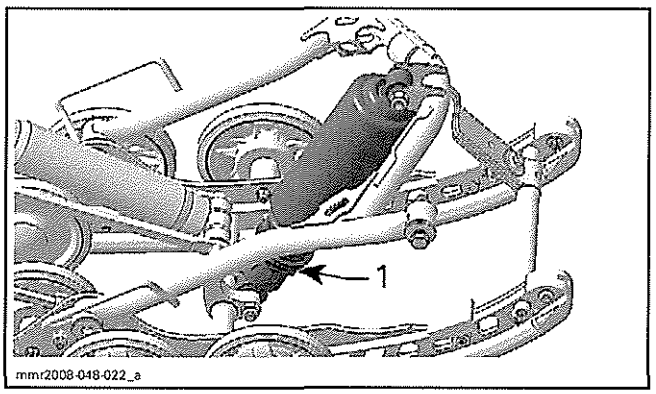
Install NEW shock absorber retaining nuts and tighten to specified torque.

REAR SHOCK ABSORBER FASTENERS TIGHTENING TORQUE
25 N•m (18 lbf•ft)

Center Shock Absorber Installation

Installation is reverse of removal procedure. However, pay attention to the following.

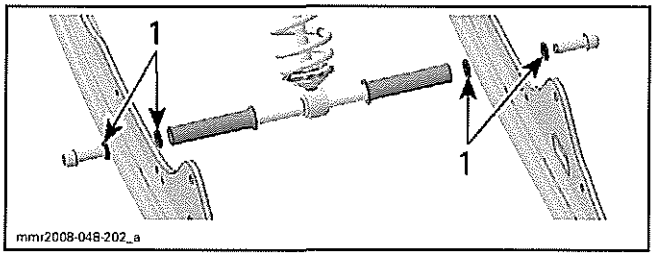
Position the adjustment cam downwards.



1. Adjustment cam

Torque shock absorber upper nut to 25 N•m (18 lbf•ft).

Position washers as shown.



TYPICAL - SHOCK ABSORBER SHAFT
1. Washers location

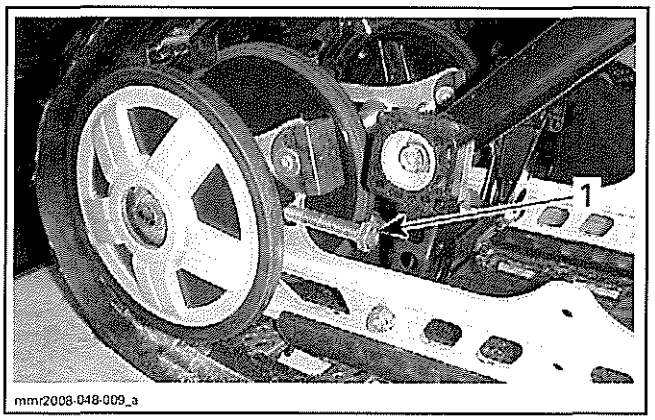
Install NEW socket screws.

Torque socket screws to 48 N•m (35 lbf•ft).

REAR SPRINGS

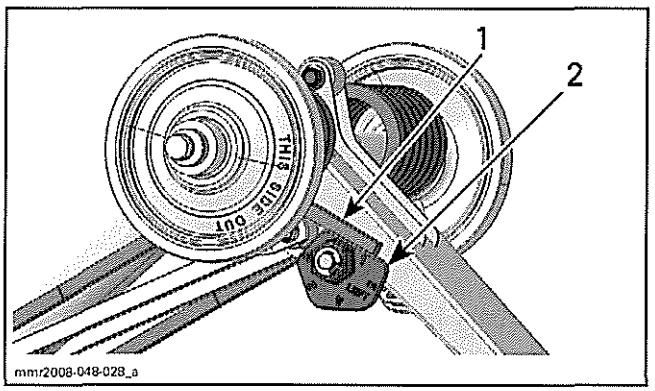
Rear Spring Removal

1. Lift rear of vehicle and support it off the ground.
2. Completely loosen track tension by unscrewing both adjustment screws.



TYPICAL
1. RH adjustment screw

3. Decrease springs preload by turning cams accordingly.

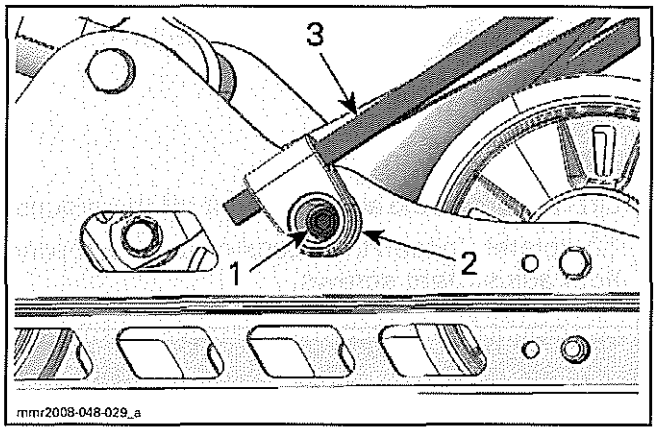


LH SIDE SHOWN
1. Rear spring
2. Cam

4. Firmly hold the spring support and unscrew its retaining bolt (one on each side).

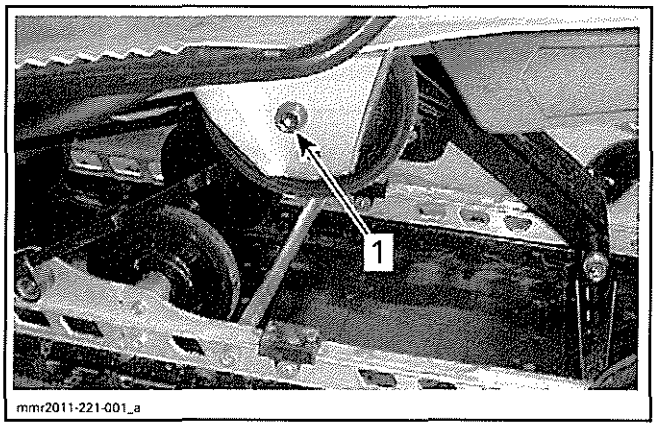
⚠ WARNING

Firmly hold the spring support, they are spring loaded.



TYPICAL
1. *Spring support bolt*
2. *Spring support*
3. *Spring*

5. Remove screws and washers from rear arm top axle.



1. *Rear arm retaining screw*

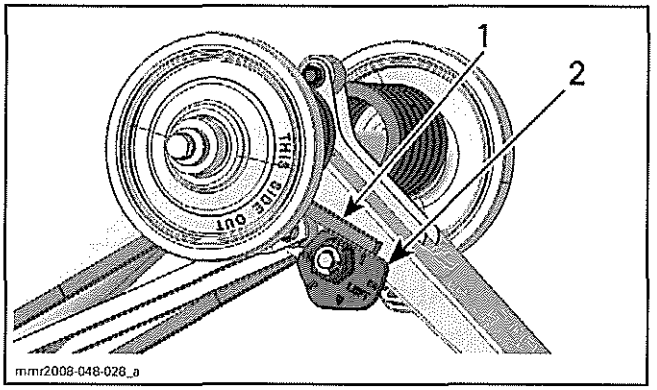
6. Remove upper idler wheels.
7. Remove springs.

Rear Spring Installation

Installation is the reverse of removal procedure. However, pay attention to the following.

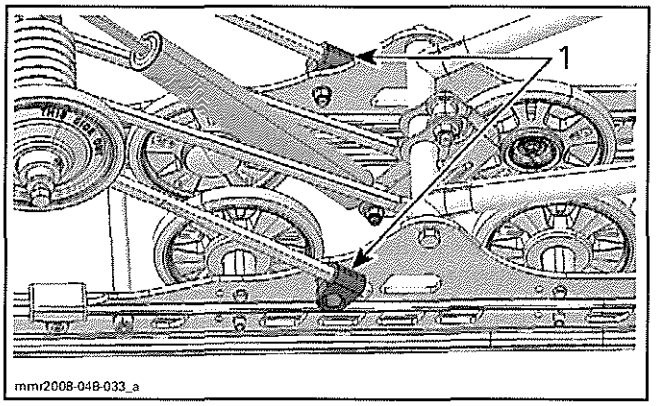
Respect THIS SIDE OUT inscription on top idler wheels.

Make sure that spring end is in cam adjuster.



TYPICAL - LH SIDE SHOWN
1. *Spring end*
2. *Cam*

Install spring supports upwards.



TYPICAL - RH SIDE SHOWN
1. *Spring supports upwards*

Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on set screw of the locking rings.

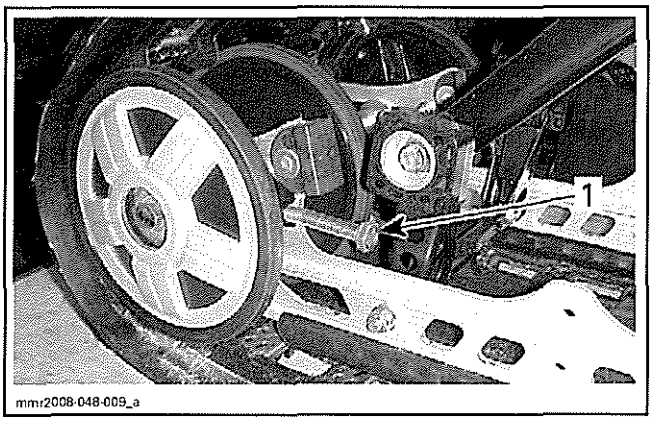
Torque screws on rear arm top axle as per the following table.

TOP AXLE SCREWS TIGHTENING TORQUE
48 N•m (35 lbf•ft)

SLIDER SHOES

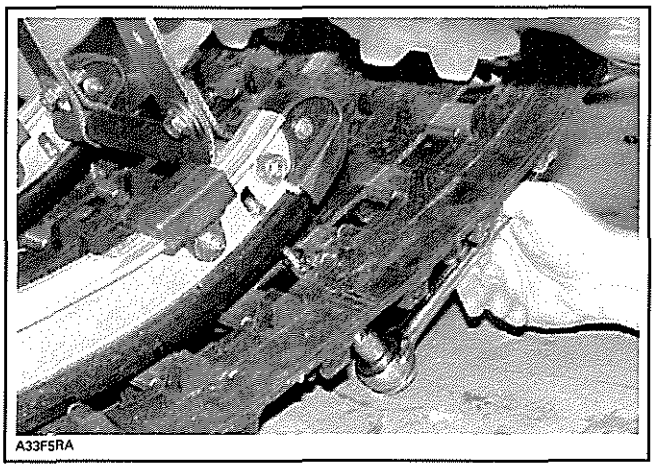
Slider Shoe Removal

1. Lift rear of vehicle and support it off the ground.
2. Completely loosen track tension by unscrewing both adjustment screws.



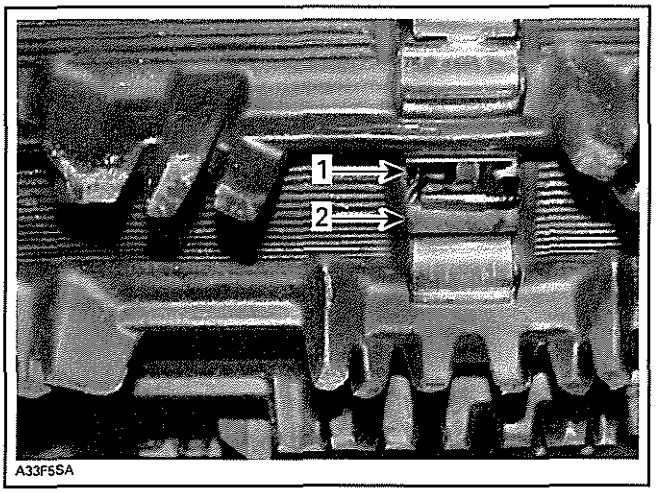
TYPICAL
1. RH adjustment screw

3. Remove nut and screw on each rail.



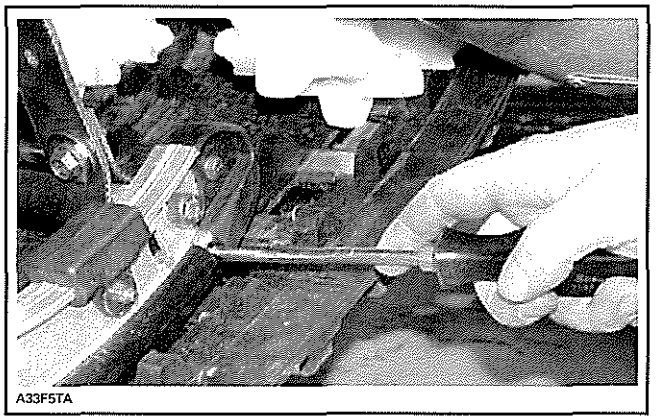
REMOVE NUT AND SCREW ON EACH RAIL

4. At the rear of vehicle, align a track window with slider shoe.



TYPICAL
1. Track window
2. Slider shoe

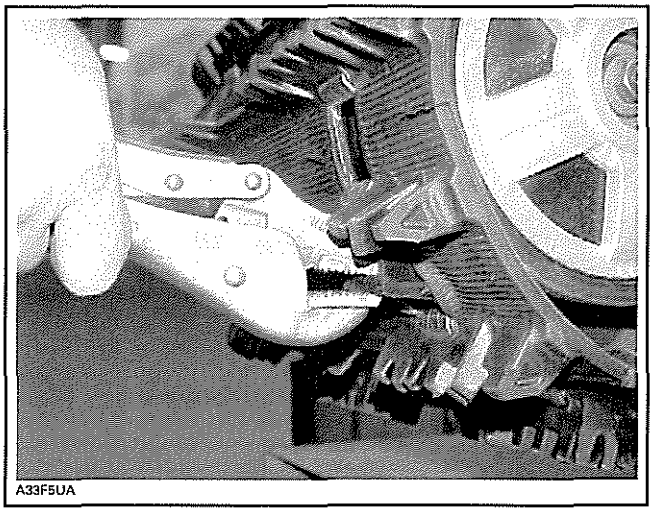
5. Using a pry bar or a screwdriver, push slider shoe rearward until it comes in contact with track.



PUSH ON SLIDER SHOE

6. Using locking pliers, pull slider shoe through track window to remove.

NOTE: If necessary, lubricate track window to facilitate slider shoe removal.



PULL ON SLIDER SHOE TO REMOVE

Slider Shoe Installation

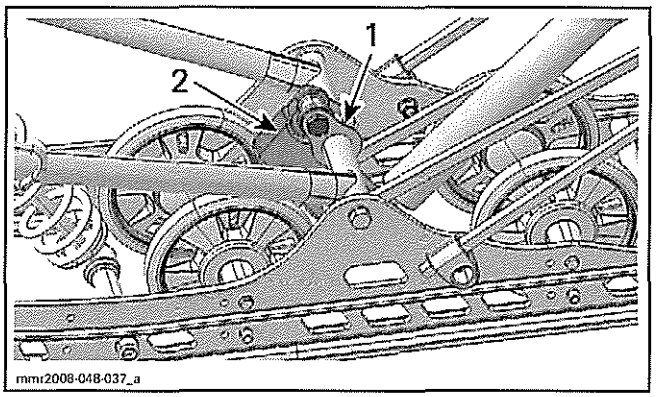
Installation is reverse of removal procedure. However, pay attention to the following.

Make sure to insert slider shoe end with hole first.

FRONT ARM

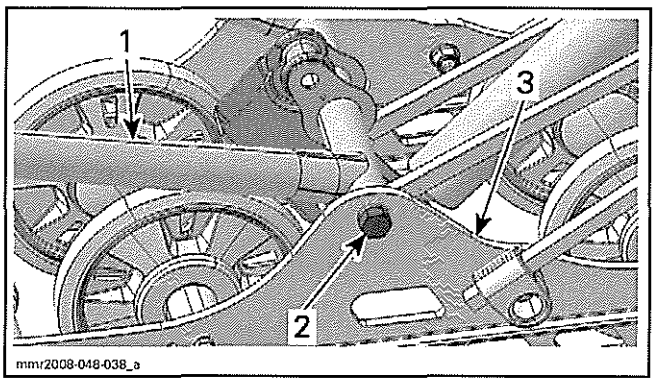
Front Arm Removal

1. Proceed with *SUSPENSION ASSEMBLY REMOVAL*. See procedure in this subsection.
2. Remove rocker to front arm bolt.



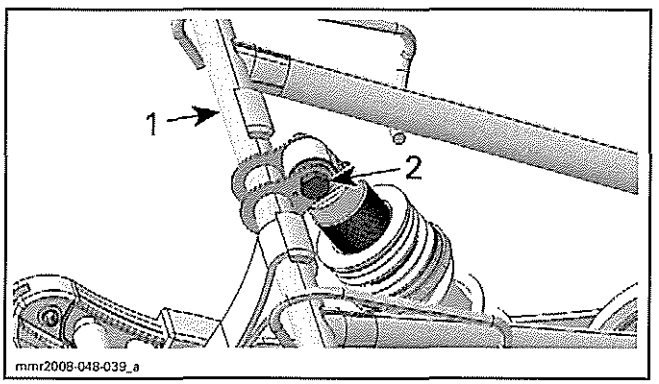
TYPICAL
1. *Front arm*
2. *Rocker*

3. Unscrew and remove the front arm lower screws and washers.



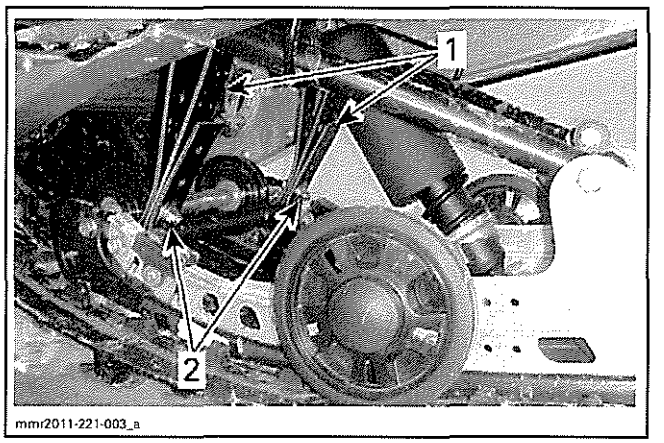
TYPICAL
1. *Front arm*
2. *Lower screw*
3. *LH rail*

4. Remove the shock absorber upper bolt.



TYPICAL
1. *Front arm*
2. *Shock absorber upper bolt*

5. Unfasten stopper straps.



1. *Stopper straps*
2. *Stopper strap bolts*

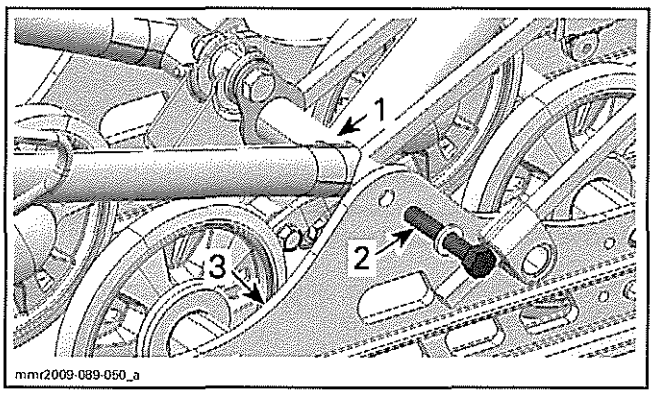
6. Remove front arm from suspension assembly.

Front Arm Installation

Installation is the reverse of removal procedure. However, pay attention to the following.

Install **NEW** front arm lower bolts.

Torque front arm lower bolts to 48 N•m (35 lbf•ft).



1. *Front arm*
2. *Front arm lower bolt (LH side)*
3. *Rail*

Torque nut securing rocker on front arm to 25 N•m (18 lbf•ft).

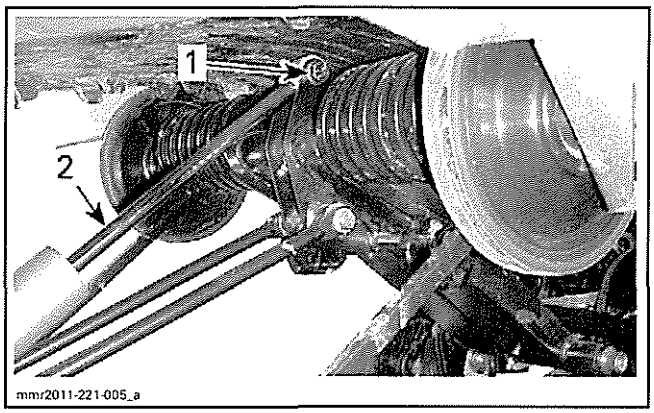
Lubricate front arm pivot at grease fitting using SUSPENSION GREASE (P/N 293 550 033). Refer to *MAINTENANCE*.

REAR ARM

Rear Arm Removal

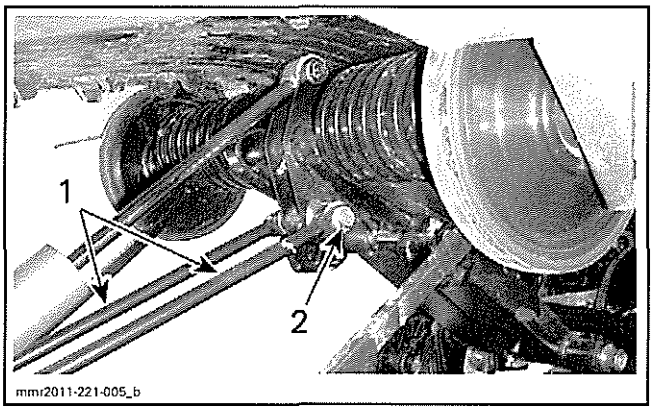
1. Proceed with *REAR SPRING REMOVAL*. See procedure in this subsection.
2. Remove the rear shock absorber upper bolt and nut.

NOTE: To ease some parts removal, lower the vehicle just enough to apply a slight load on the rear suspension.



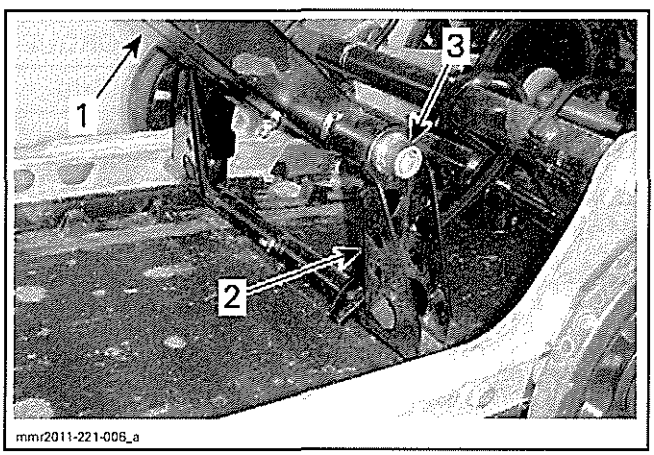
1. Rear shock absorber upper bolt
2. Rear shock absorber

3. Remove throttle rods from the rear arm.



1. Throttle rods
2. Throttle rods upper bolt

4. Remove screws and washers holding rear arm to pivot arm.



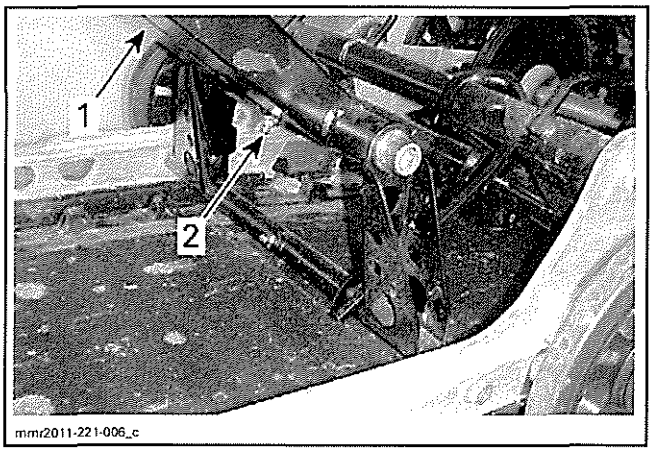
1. Rear arm
2. Pivot arm
3. Rear arm to pivot arm screws

5. Remove rear arm from vehicle.
6. Remove adjustment cams from the rear arm.

Rear Arm Installation

Installation is the reverse of removal procedure. However, pay attention to the following.

Place rear arm with grease fitting towards front.



1. Rear arm
2. Rear arm grease fitting

Install NEW rear arm screws, throttle rod and shock absorber nuts.

Torque rear arm nuts and screws as per the following table.

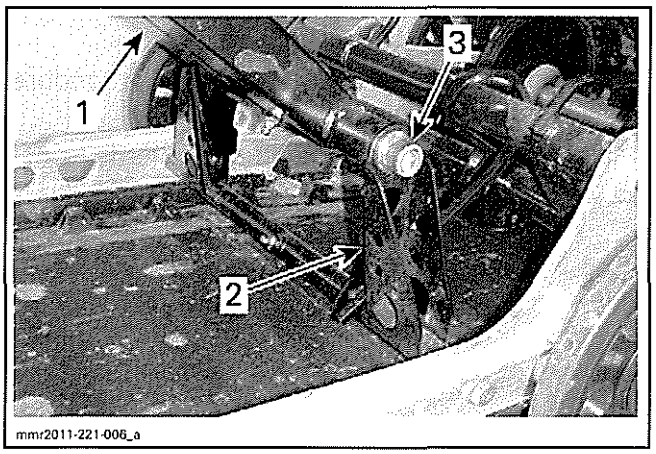
REAR ARM FASTENERS TIGHTENING TORQUE	
Rear shock absorber upper nut	25 N•m (18 lbf•ft)
Throttle rods upper nut	25 N•m (18 lbf•ft)
Rear arm upper screws	48 N•m (35 lbf•ft)
Rear arm to pivot arm screws	85 N•m (63 lbf•ft)

Lubricate rear arm at grease fittings using SUSPENSION GREASE (P/N 293 550 033). Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

PIVOT ARM

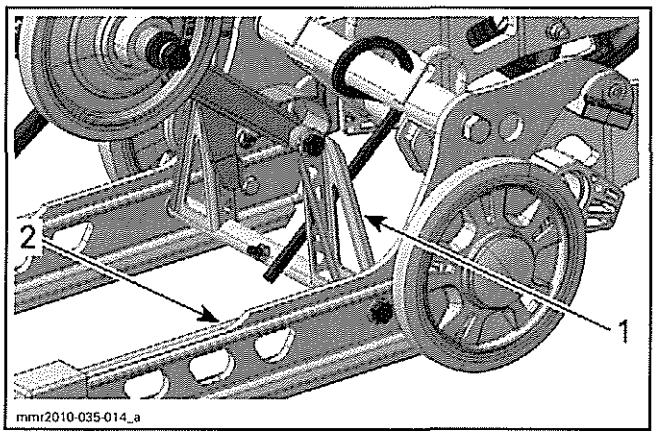
Pivot Arm Removal

1. Lift rear of vehicle and support it off the ground.
2. Completely loosen track tension by unscrewing both adjustment screws.
3. Remove rear arm to pivot arm screws.



1. Rear arm
2. Pivot arm
3. Rear arm to pivot arm screw

4. Remove bolt and washers holding pivot arm to rails.



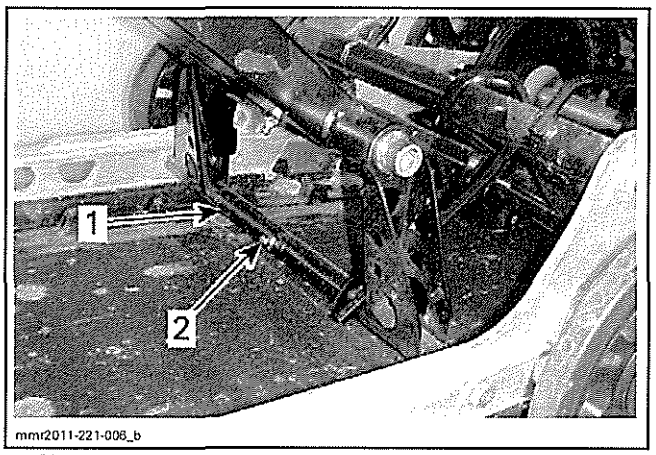
TYPICAL
1. Pivot arm
2. Rail

5. Carefully remove pivot arm from rear arm.

Pivot Arm Installation

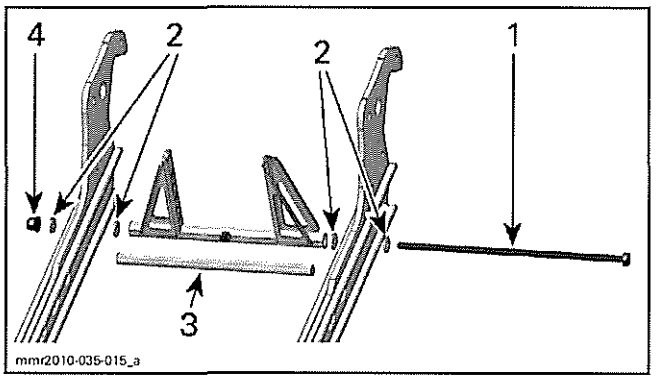
The installation is the reverse of the removal procedure. However, pay attention to the following.

Place pivot arm with grease fitting towards front.



1. Pivot arm
2. Pivot arm grease fitting

Assemble pivot arm lower fasteners as per following illustrations.



SOME PARTS REMOVED FOR CLARITY PURPOSE
1. Pivot arm lower bolt
2. Washers
3. Axle
4. Pivot arm lower nut

REAR ARM FASTENERS TIGHTENING TORQUE	
Pivot arm lower nut	25 N•m (18 lbf•ft)
Pivot arm upper screws	85 N•m (63 lbf•ft)

Lubricate pivot arm. Refer to *PERIODIC MAINTENANCE PROCEDURE* subsection.

IDLER WHEELS AND SUPPORTS

Idler Wheels Removal and Installation

Refer to the exploded views at the beginning of this subsection for parts layout and fasteners tightening torque.

STOPPER STRAPS

Stopper Strap Removal and Installation

Refer to the exploded view for stopper straps configuration and tightening torque.

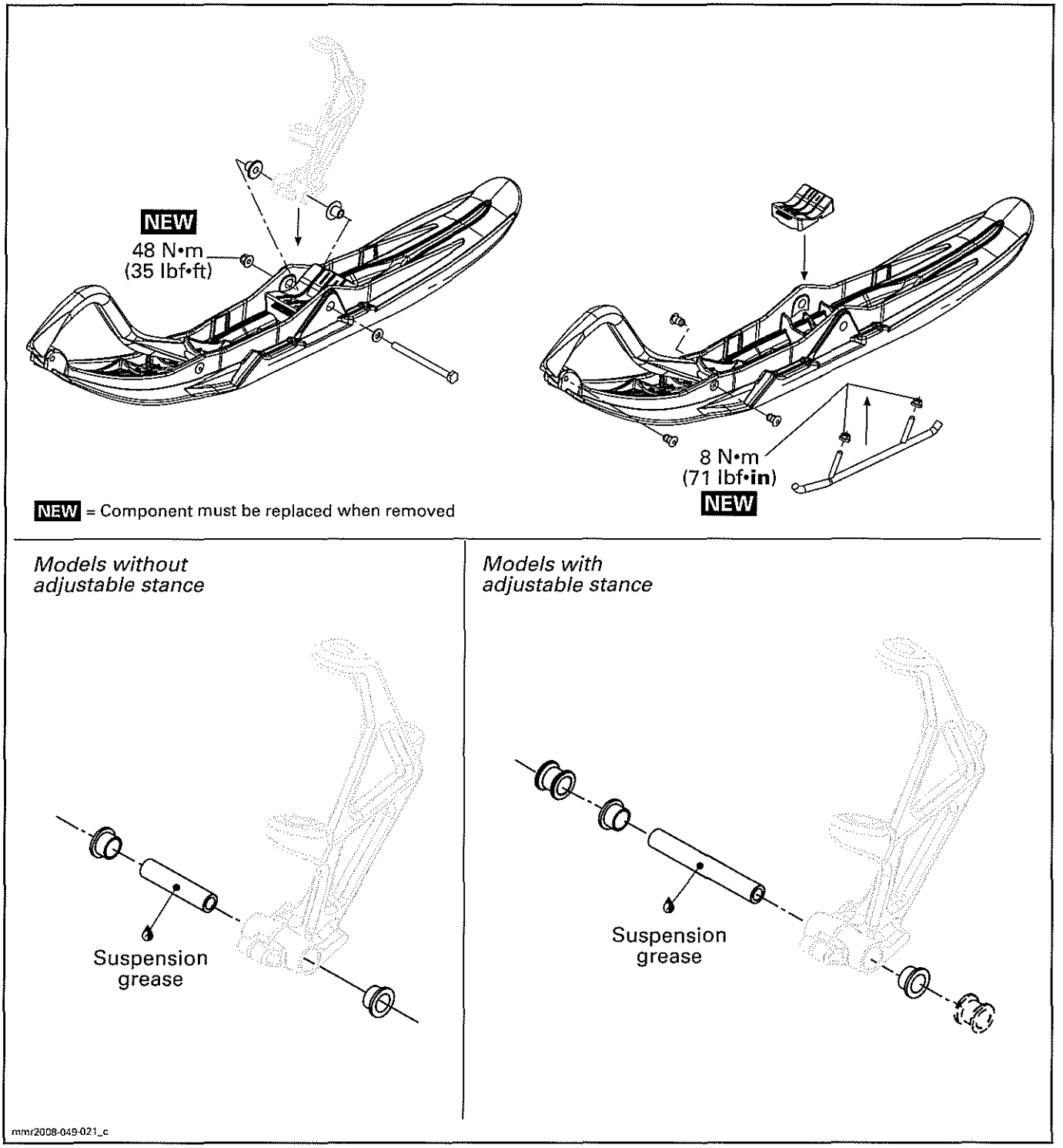
STEERING SYSTEM

SERVICE PRODUCTS

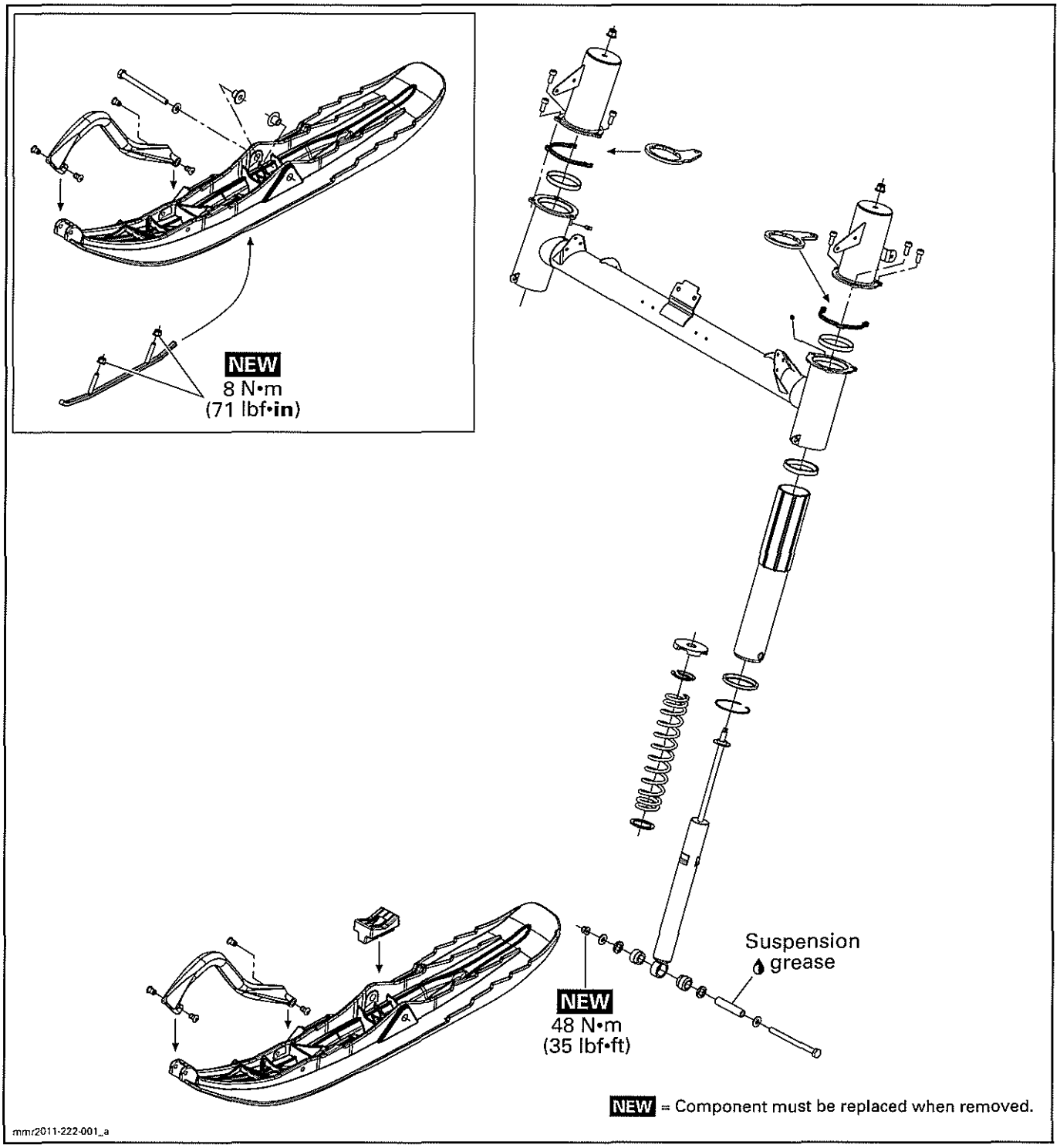
Description	Part Number	Page
SUSPENSION GREASE	293 550 033	844

SKIS

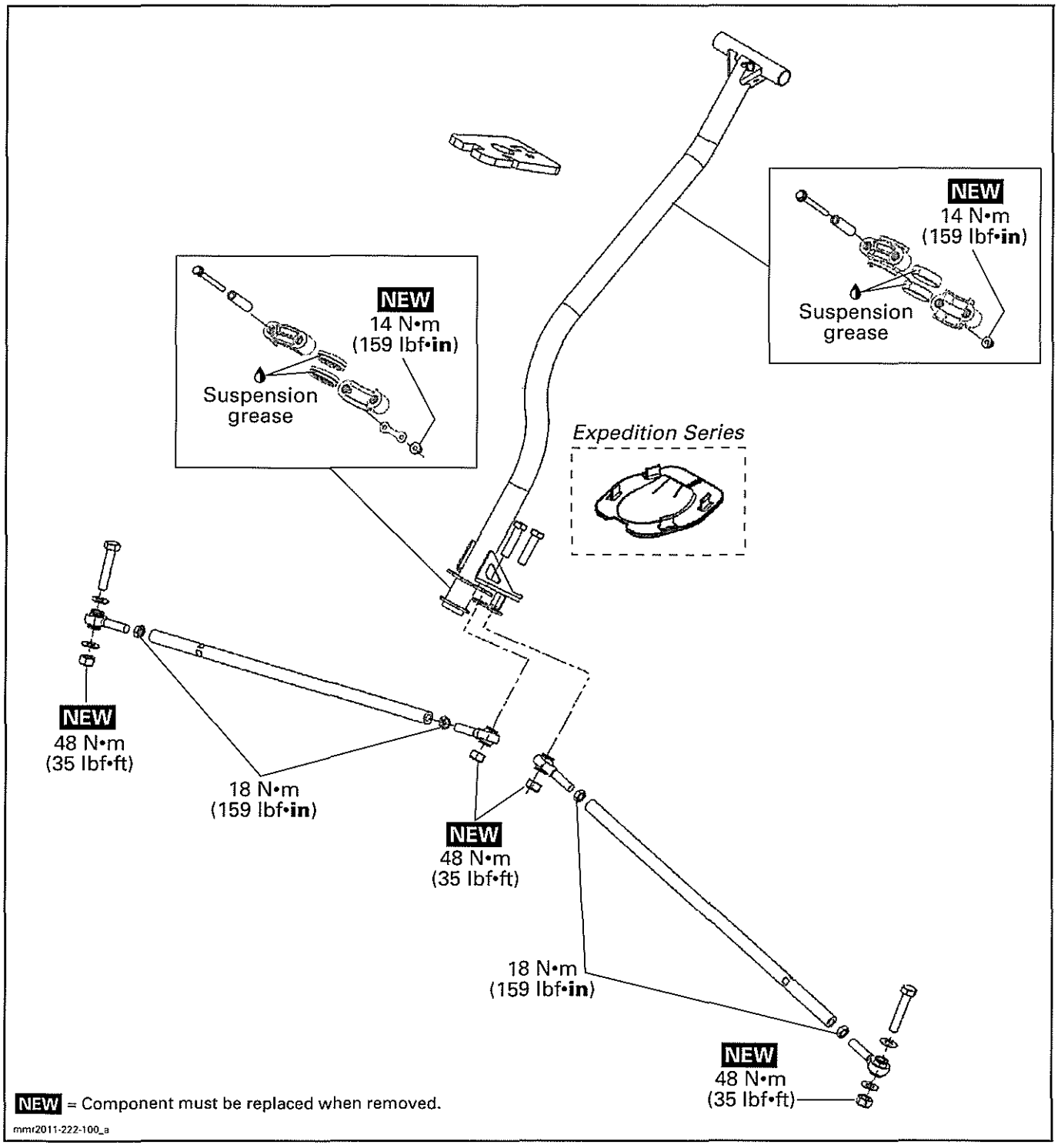
Expedition Models



Skandic WT

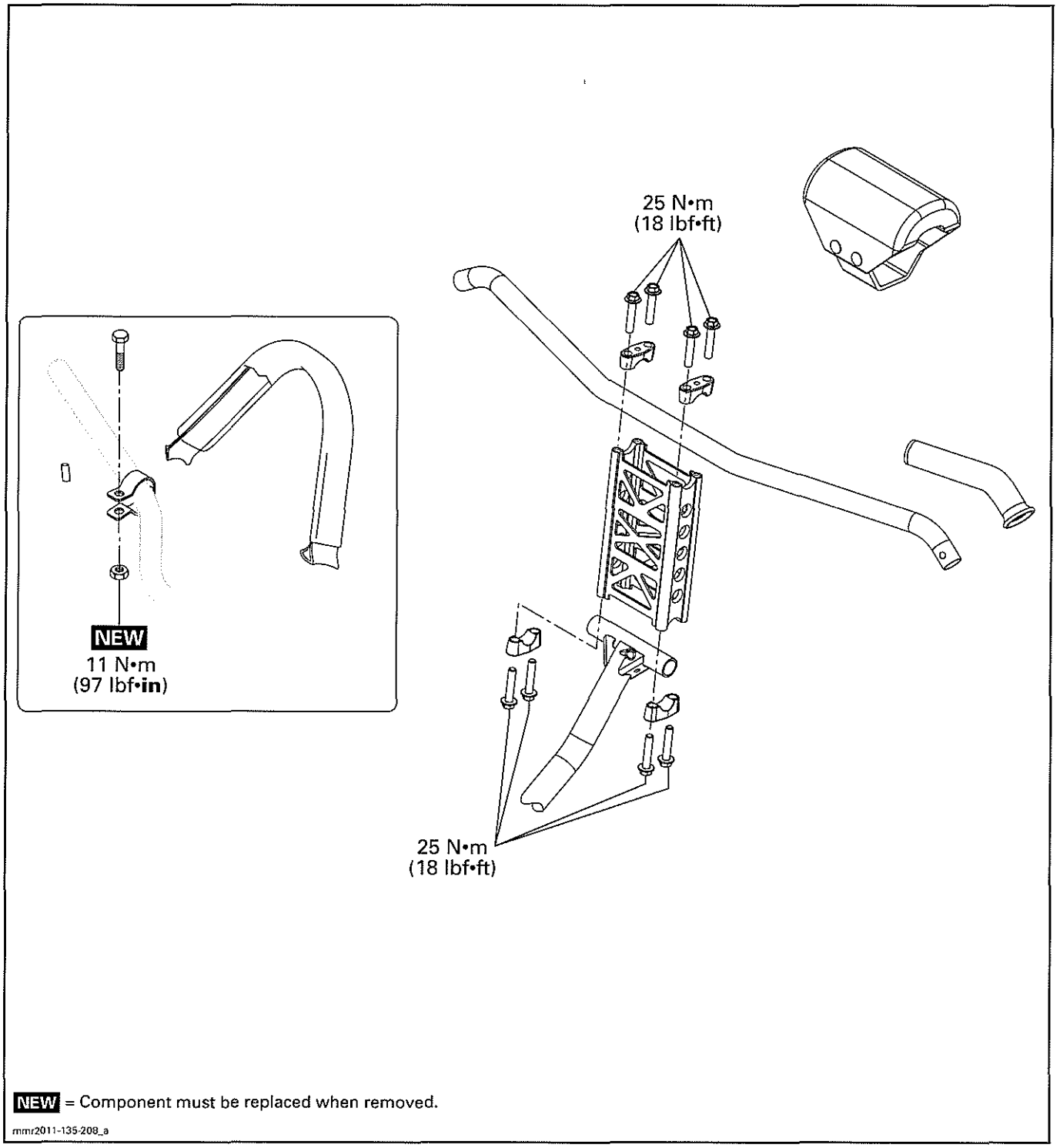

NEW
8 N•m
(71 lbf•in)
NEW
48 N•m
(35 lbf•ft)
Suspension
grease
NEW = Component must be replaced when removed.
mmr2011-222-001_a

STEERING COLUMN AND TIE-RODS



HANDLEBAR

Models without Adjustable Steering



NEW = Component must be replaced when removed.

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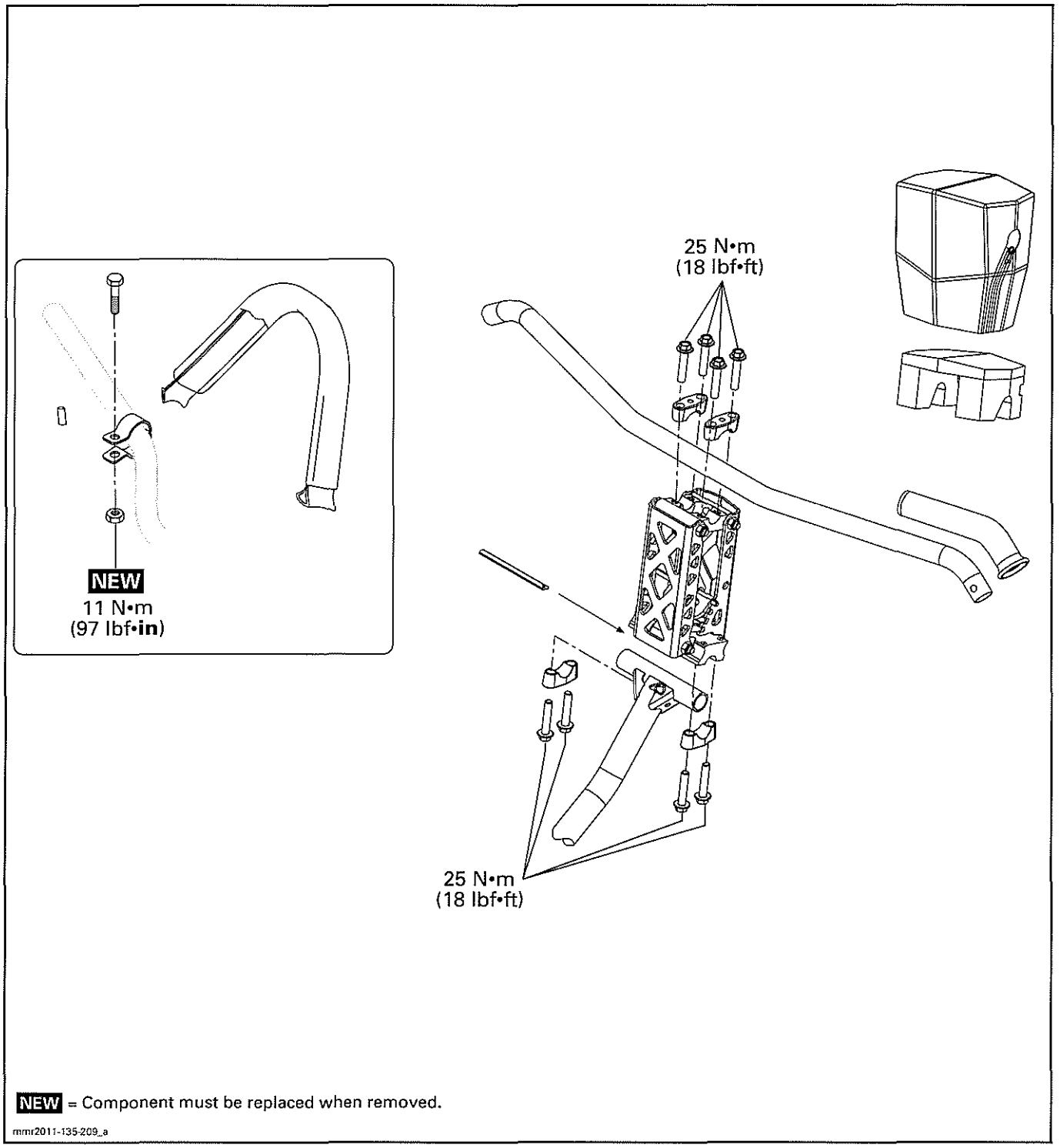
HANDLEBAR

Models with Adjustable Steering



NEW = Component must be replaced when removed.

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GENERAL

When removing or replacing a part of the steering mechanism, perform the steering alignment, refer to *STEERING ALIGNMENT* in this subsection.

During assembly/installation, use the torque values and service products as in the exploded views.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, cotter pins, etc.) must be replaced.

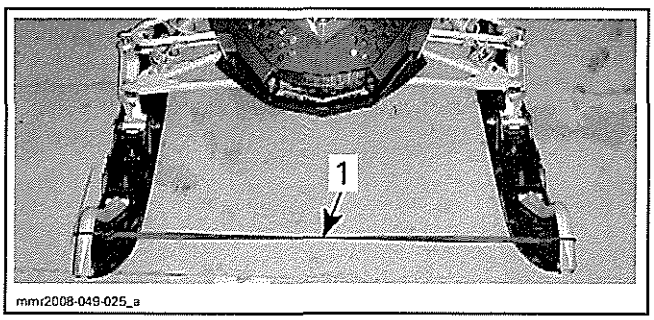
NOTICE **Hoses, cables and locking ties removed during a procedure must be reinstalled as per factory standards.**

ADJUSTMENT

STEERING ALIGNMENT

Ski alignment is performed by adjusting the length of left and right tie-rods.

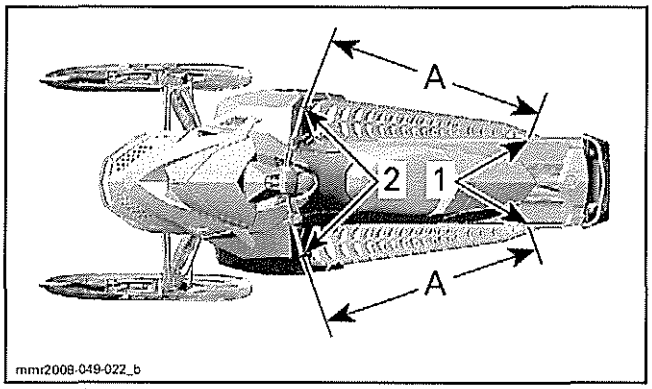
1. Leave the vehicle on the ground on its own weight.
2. Attach ski handles together with a bungee cord.



1. Bungee cord

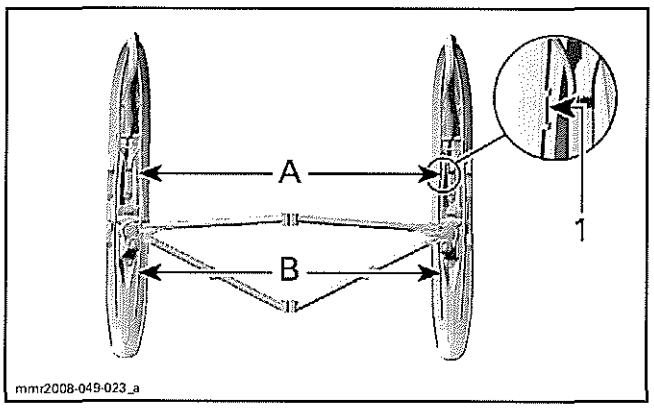
3. Position handlebar so that it is straight ahead position by measuring from the extremities of the grips to the rear most edge of the tunnel, as shown.

NOTE: The reference point must be the same to each side.



TYPICAL
1. Same fixed reference point
2. Handlebar end
A. Equal distance on each side

4. Verify if skis are in straight-ahead position by placing a straight edge against adjusted track and measuring distance between front and rear ski recesses and straight edge.
5. When skis are in straight ahead position, adjust the toe-out.
6. Measure the distance between front and rear ski recesses.
7. Use the following illustration and this equation to determine the perfect steering adjustment.

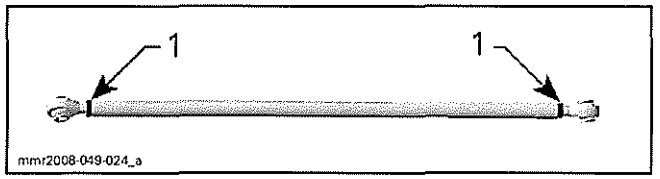


1. Recesses
A – B = 5 mm (.197 in)

STEERING ALIGNMENT	
Toe-out	5 mm (.197 in)

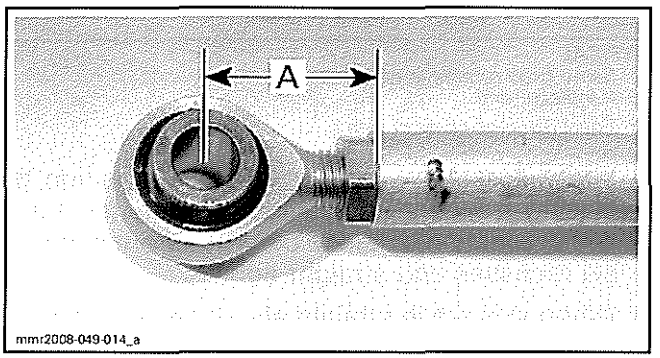
8. If adjustment is needed, loosen tie-rod jam nuts then turn tie-rods to change their length.
9. Tighten jam nuts as specified.

JAM NUT TORQUE, TIE-ROD END
18 N•m (159 lbf•**in**)



1. Jam nut

NOTE: The maximum tie-rod end length not engaged in the tie rod must not exceed 34 mm (1.339 in) to ensure proper thread engagement.



A. 34 mm (1.339 in) **maximum**

PROCEDURES

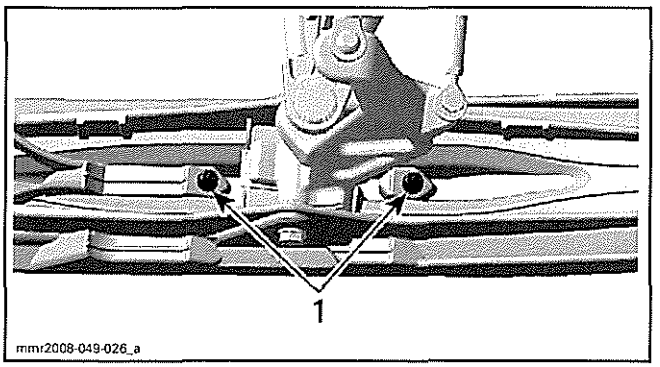
SKI RUNNERS

Ski Runner Inspection

Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

Ski Runner Removal

1. Lift the front of vehicle and support it off ground.
2. Unscrew the ski runner nuts then remove ski runners.



1. Ski runner nuts

Ski Runner Installation

The installation is the reverse of the removal procedure. Pay attention to the following.

Torque ski runner nuts to 8 N•m (71 lbf•**in**).

SKIS

Ski Inspection

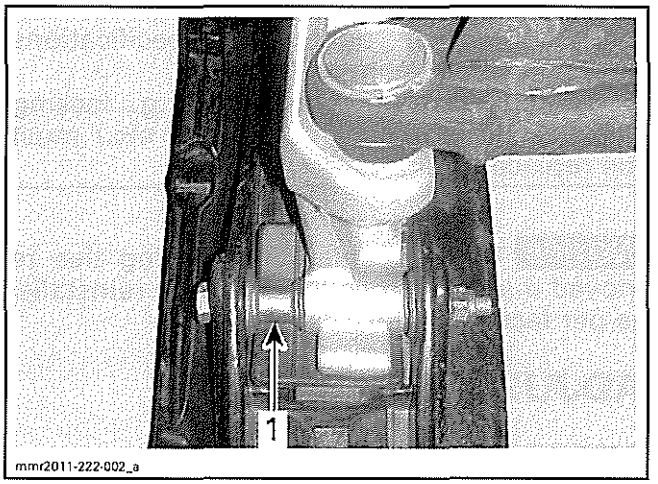
Refer to *PERIODIC MAINTENANCE PROCEDURES* subsection.

Ski Removal

1. Lift front of vehicle and support it off the ground.

Expedition SE Model

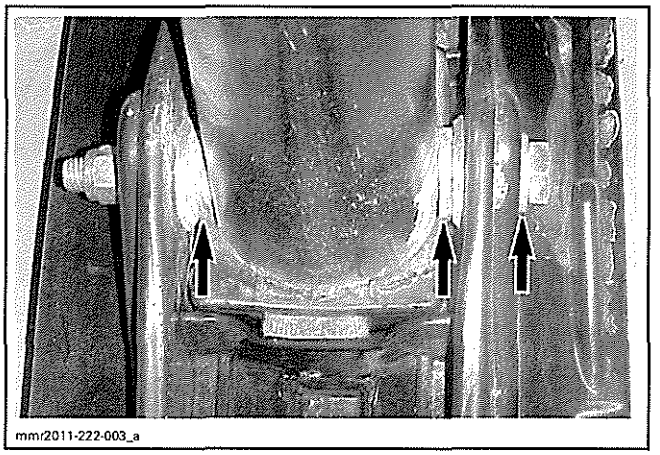
Observe and note position of ski bushing for ski stance.



ADJUSTABLE SKI STANCE - WIDE OPEN POSITION ILLUSTRATED
1. Ski bushing

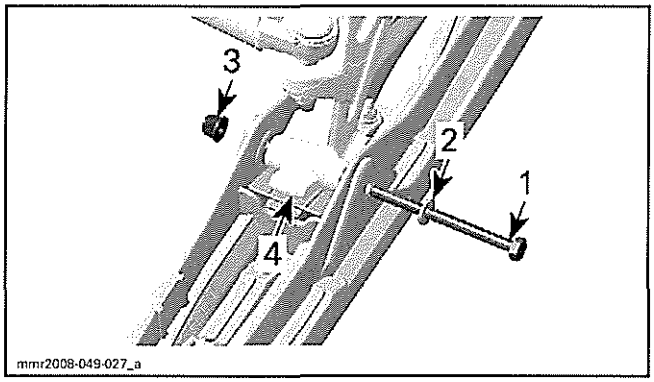
Skandic WT Models

Observe and note position and size of washer and spacers for reinstallation.



All Models

2. Unscrew nut then pull ski bolt out.

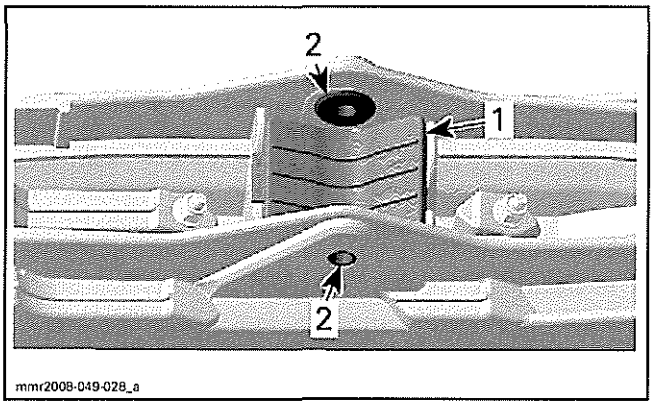


1. Ski bolt
2. Washer
3. Nut
4. Ski leg

3. Remove ski from vehicle.

Ski Installation

1. Make sure bushings are installed in ski holes.
2. Install the ski stopper. Position indicator towards the front and make sure the bump in the ski is in the groove of the ski stopper.



TYPICAL
1. Ski stopper
2. Bushings

3. Install ski bolt and tighten as specified.

SKI BOLT TORQUE
48 N•m (35 lbf•ft)

Expedition SE Model

NOTE: Be sure to install ski bushing on both skis as noted prior to removal.

Skandic WT Models

NOTE: Be sure to install washer and spacers as noted prior to removal.

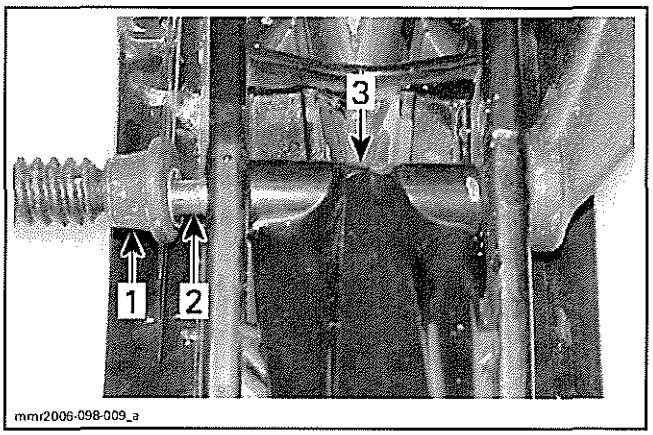
SKI HANDLES

Ski Handle Removal

1. Remove ski from vehicle.
2. Using a 9 mm (3/8 in) drill bit, remove ski handle rivets. Drill only the rivet head. Do not try to drill all the way through the rivet. Angle the drill bit to reduce the chance of spinning the rivet in the ski.
3. Remove handle from ski.
4. Place handle in hot water for 10 minutes then using a punch, drive the rivet shank out of the handle.

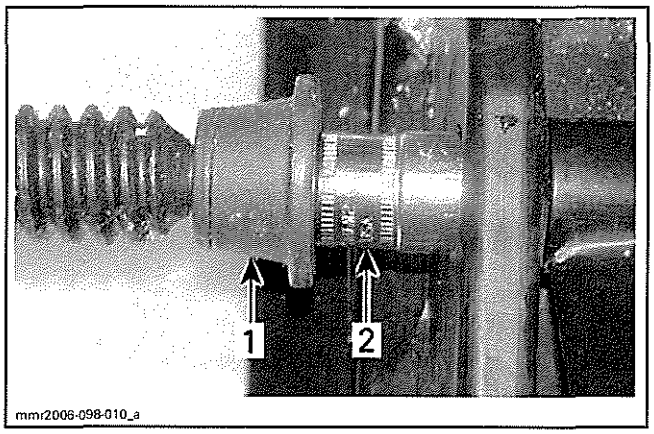
Ski Handle Installation

1. To install rivets, use a C-clamp and a short 10 mm socket.
2. Place a rivet in position and insert it into the ski and ski handle. Repeat the procedure for the other side.



1. C-clamp
2. Rivet
3. Handle

3. When both rivets are installed, use the short 10 mm socket to push rivet heads against the ski.



1. C-clamp
2. 10 mm socket

SKI LEGS

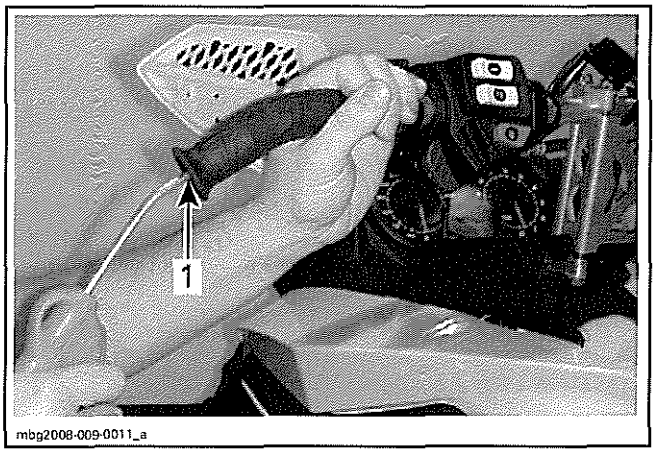
To replace a ski leg, refer to *FRONT SUSPENSION* subsection.

HANDLEBAR GRIPS

NOTE: To verify or replace heating elements, refer to *LIGHTS, GAUGE AND ACCESSORIES* subsection.

Handlebar Grip Removal

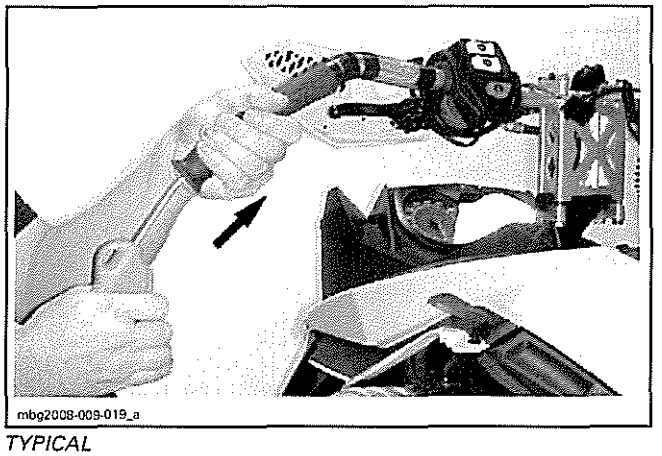
Remove grips by pulling while using compressed air to inflate or loosen the fit between the grip and handlebar as illustrated.



TYPICAL
1. Blow air in the grip hole

Handlebar Grip Installation

Insert the handlebar grip on handlebar while blowing compressed air to inflate or loosen the fit between grip and handlebar.



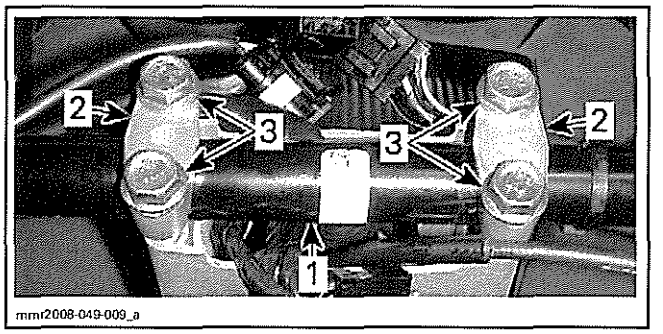
TYPICAL

HANDLEBAR

Handlebar Removal

NOTE: If the handlebar must be changed, remove all components (handle grip, throttle lever housing, etc.) before removing it from vehicle.

1. Remove steering cover.
2. Disconnect all electrical connectors.
3. Remove handlebar retaining clamp screws.



TYPICAL
1. Handlebar
2. Retaining clamps
3. Screws

4. Remove handlebar from handlebar extension.

Handlebar Inspection

1. Inspect the handlebar for:
   - Damages
   - Cracks
   - Bending.
2. Replace if any of these problems is detected.

⚠ WARNING

Do not try to repair a defective handlebar.

3. Check handlebar clamps for cracks or distortion, replace if necessary.

Handlebar Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

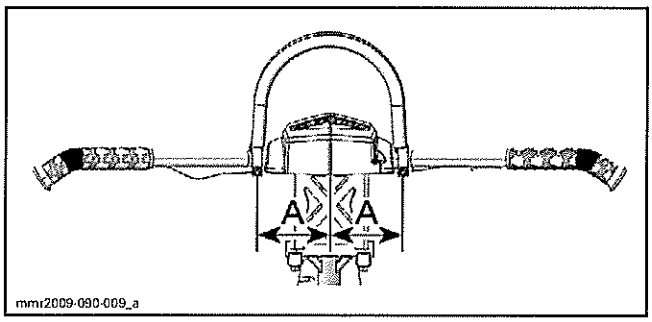
HANDLEBAR CLAMP SCREW TORQUE
25 N•m (18 lbf•ft)

Turn handlebar completely from side to side making sure it does not exert unwanted tension on handlebar wires.

Handlebar Strap

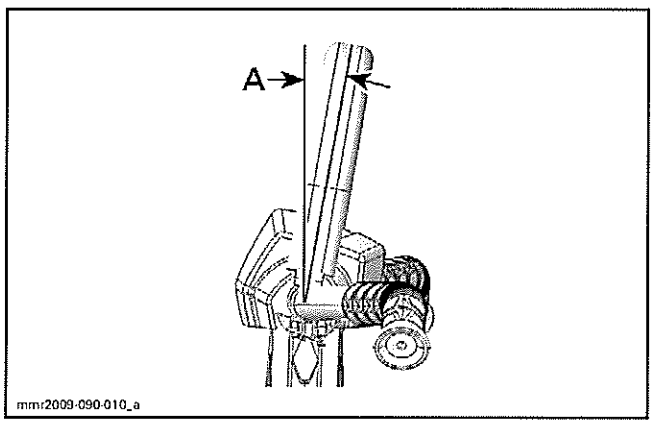
Models Equipped with a Handlebar Strap

1. Ensure to position strap symmetrically each side of handlebar retaining clamps.



A. Equal distance

2. Tilt strap 5° to 10° towards driver relative to handlebar extension.



A. 5° to 10°

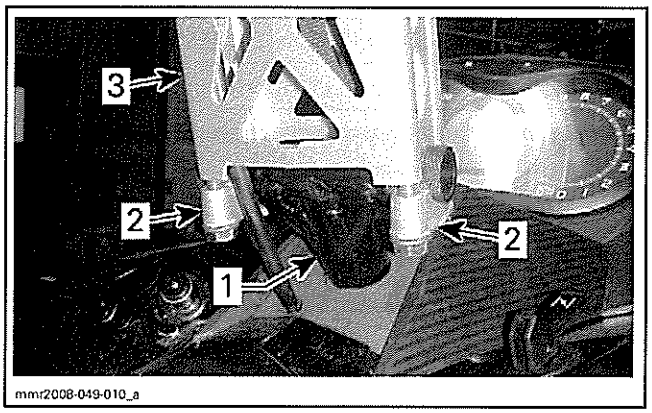
Make sure the strap clamps and bolts do not interfere with cables or wires.

STRAP RETAINING SCREW TORQUE
11 N•m (97 lbf•**in**)

HANDLEBAR EXTENSION (FIXED)

Handlebar Extension Removal

1. Proceed with *HANDLEBAR REMOVAL*, see procedure in this subsection.
2. Remove air intake silencer and gauge support as a unit, refer to *AIR INTAKE SYSTEM* subsection.
3. Disconnect the multifunction switch harness connectors.
4. Remove screws retaining the extension to steering column.



TYPICAL
1. Steering column
2. Handlebar extension clamps
3. Handlebar extension

5. Remove handlebar extension from vehicle.

Handlebar Extension Inspection

Check handlebar extension for:
- Cracks
- Deformation
- Other damages.

Replace if any of these problems is detected.

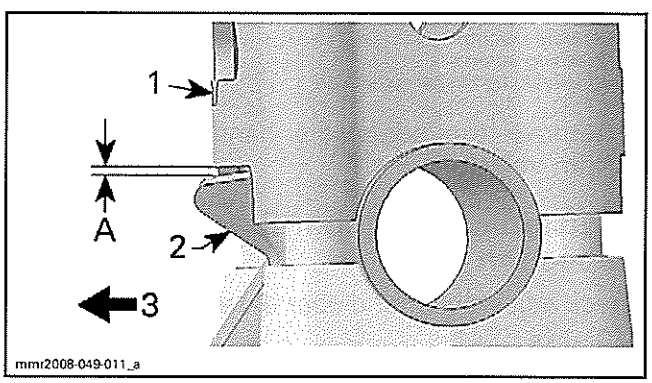
⚠ WARNING

Do not try to repair a defective handlebar extension.

Handlebar Extension Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

When installing handlebar extension, ensure to leave a gap between handlebar extension and stop block on steering column.



1. Bottom of handlebar extension
2. Steering column stop block
3. Front of vehicle

A. 1 mm (.039 in) minimum

Torque handlebar extension retaining screws.

HANDLEBAR EXTENSION SCREW TORQUE
25 N•m (18 lbf•ft)

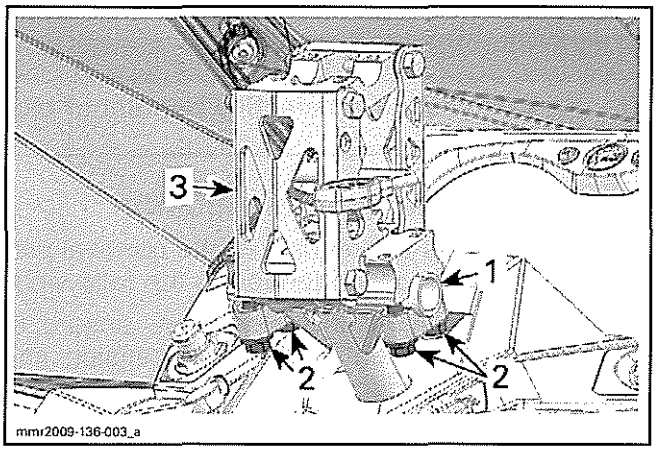
⚠ WARNING

The handlebar and it's components must not make contact with any other parts (windshield, fuel tank cap, etc.) when steering is turned.

HANDLEBAR EXTENSION (ADJUSTABLE)

Adjustable Handlebar Extension Removal

1. Proceed with *HANDLEBAR REMOVAL*, see procedure in this subsection.
2. Disconnect the multifunction switch harness connectors and cut the locking tie on the handlebar riser.
3. Remove screws retaining the adjustable extension to steering column.



1. Steering column
2. Retaining screws
3. Adjustable handlebar extension

4. Remove the adjustable handlebar extension from vehicle.

Adjustable Handlebar Extension Inspection

Check adjustable handlebar extension for:
- Cracks
- Deformation
- Other damages.

Check the proper operation of the locking mechanism.

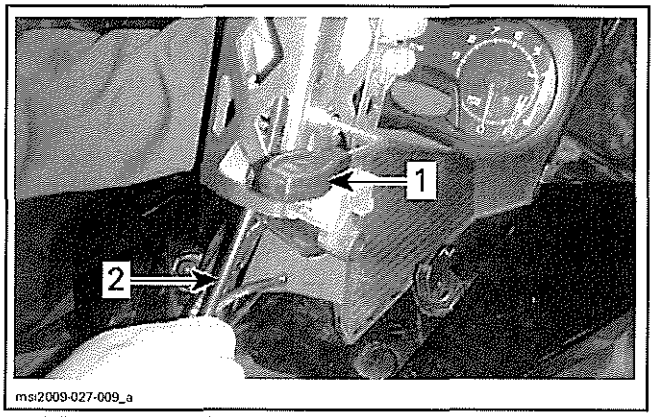
Replace if any of these problems is detected.

⚠ WARNING

Do not try to repair a defective adjustable handlebar extension.

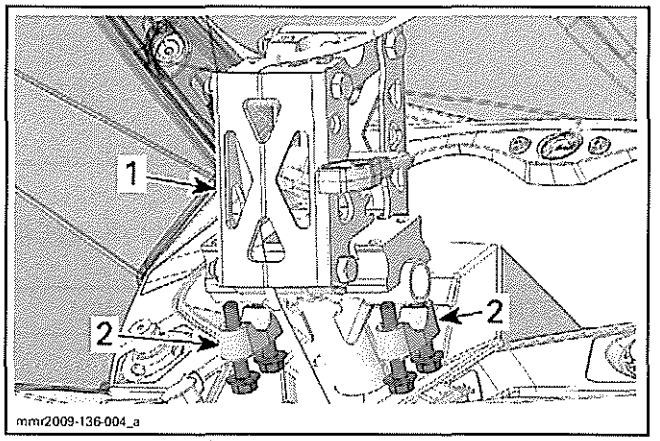
Adjustable Handlebar Extension Installation

1. Insert throttle cable in the adjustable handlebar extension.



1. Adjustable handlebar extension
2. Throttle cable

2. Secure adjustable handlebar extension to steering column.

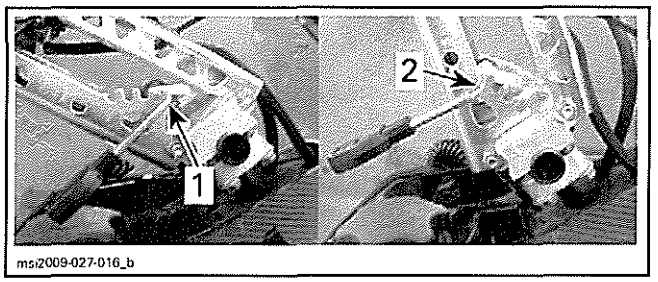


1. Adjustable handlebar extension
2. Retaining clamps

NOTE: Make sure adjustable extension is well centered on steering column.

⚠ WARNING

Handlebar and it's components, settled in any position, must not make contact with any other parts (windshield, fuel tank cap, etc.) when steering is turned.



1. *Lower position*
2. *Higher position*

3. Torque handlebar extension screws as specified.

HANDLEBAR EXTENSION SCREW TORQUE
25 N•m (18 lbf•ft)

4. Reconnect multifunction switch harness connectors and secure with a locking tie to the riser as prior to removal.
5. Reinstall all other removed parts. Refer to appropriate subsection for details.

TIE-RODS

NOTE: The same procedure is applied on RH and LH side.

Tie-Rod Inspection

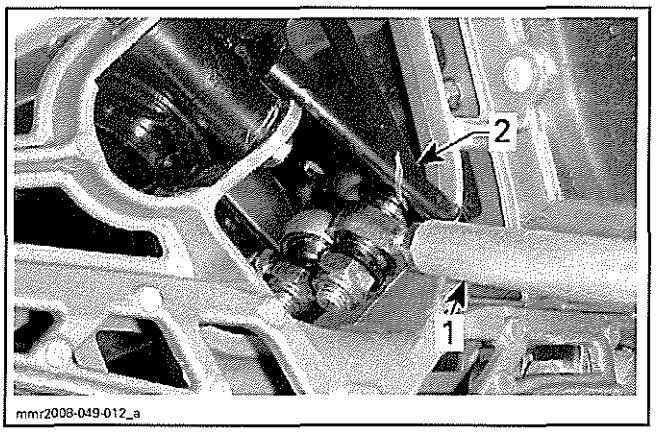
Check tie-rod ends for looseness. If play is excessive, replace tie-rod.

Check if the tie-rod is bent, cracked or otherwise damaged. Replace if necessary.

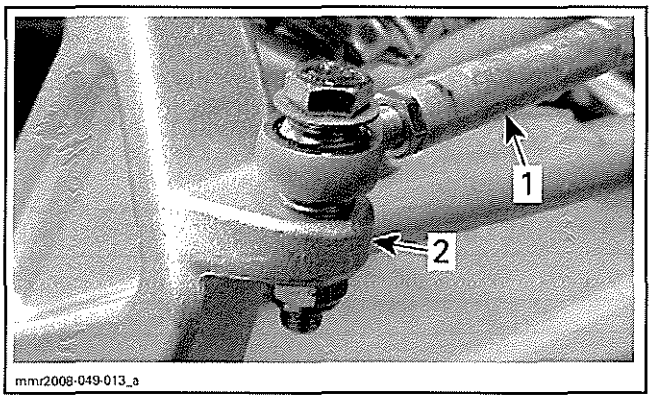
Tie-Rod Removal

1. Remove the tie-rod ends from the steering column and ski leg.

Expedition Models

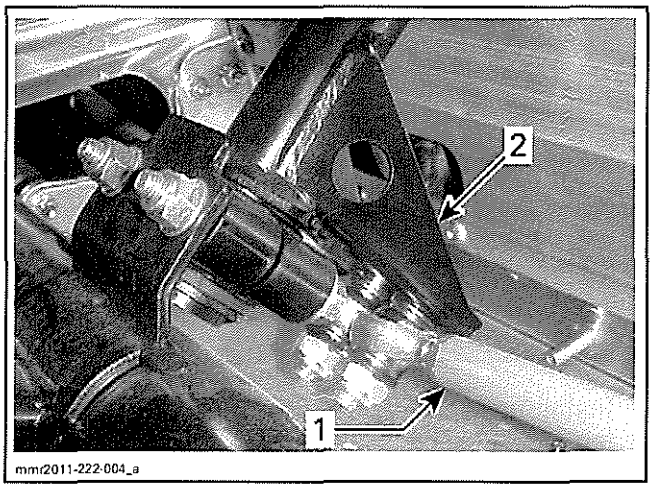


1. *Tie-rod*
2. *Steering column*

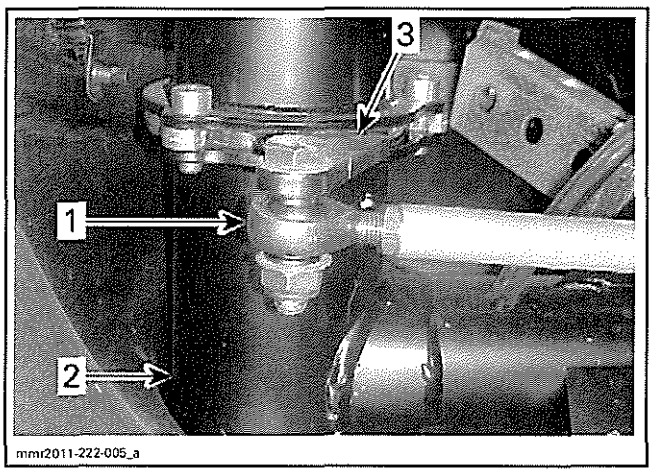


1. *Tie-rod*
2. *Ski leg*

Skandic WT Models



1. *Tie-rod*
2. *Steering column*



1. *Tie-rod end*
2. *LTS*
3. *Steering arm*

All Models

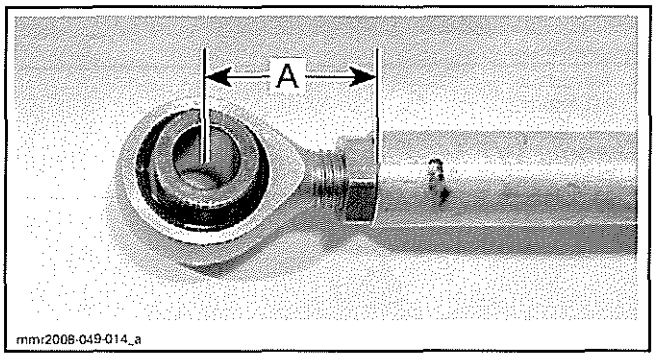
2. Remove tie-rod from vehicle.

Tie-Rod Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

1. Adjust the tie-rod ends to their nominal length without tightening the jam nuts.

NOMINAL LENGTH ADJUSTMENT, TIE-ROD END
30 mm (1.181 in)

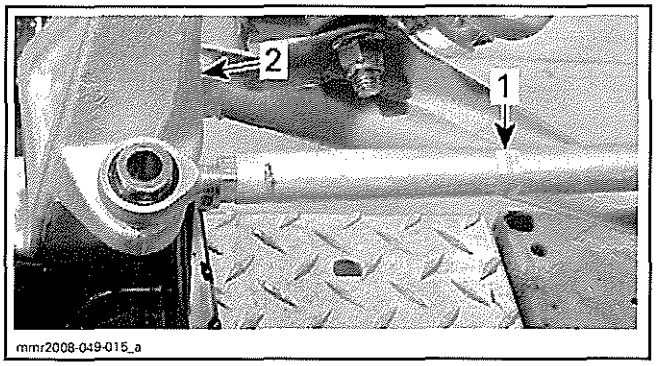


A. 30 mm (1.181 in)

⚠ WARNING

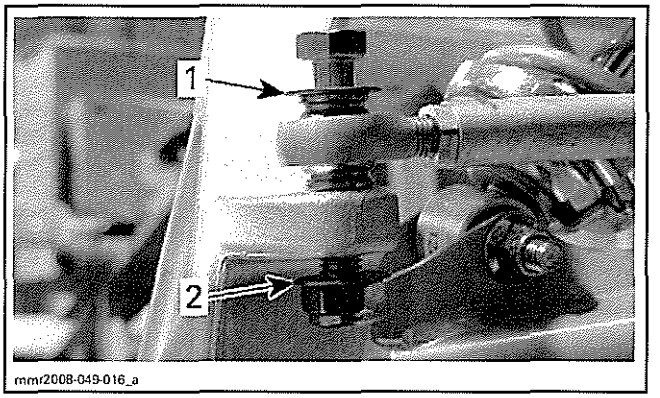
The maximum tie-rod end length must not exceed 34 mm (1.339 in) to ensure sufficient thread engagement in tie-rod.

2. Install tie-rod with the grooved end on the ski leg side.

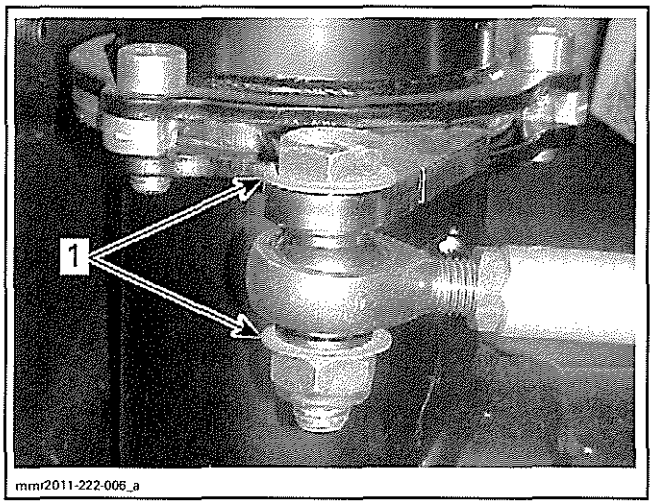


TYPICAL
1. Tie-rod groove
2. Ski leg

3. On ski leg side, install hardened washers as illustrated.



TYPICAL - EXPEDITION MODEL
1. Large hardened washer
2. Small hardened washer



TYPICAL - SKANDIC WT MODEL
1. Hardened washers

4. Install nuts retaining tie-rod ends and tighten them as specified.

RETAINING NUT TORQUE, TIE-ROD END
48 N•m (35 lbf•ft)

5. Perform a *STEERING ALIGNMENT*, see procedure in this subsection.

STEERING COLUMN

Steering Column Removal

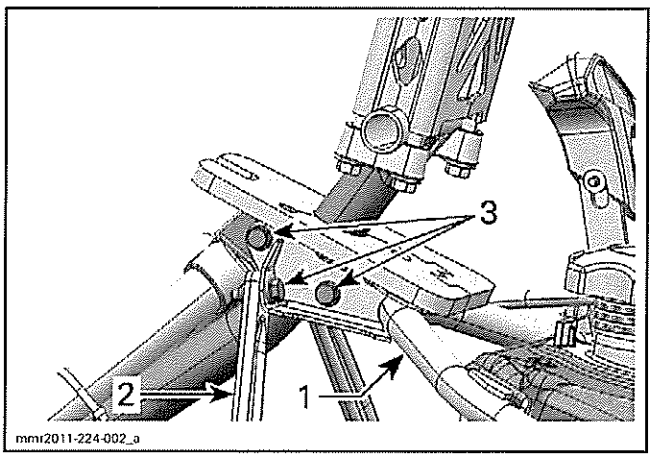
1. Refer to *BODY* subsection to remove the following parts:
   - Side panels
   - Hood
   - Console.
2. Remove air intake silencer and gauge support as a unit, refer to *AIR INTAKE SYSTEM* subsection.

600 HO E-TEC Models

3. Remove tuned pipe. Refer to *EXHAUST SYSTEM* subsection.

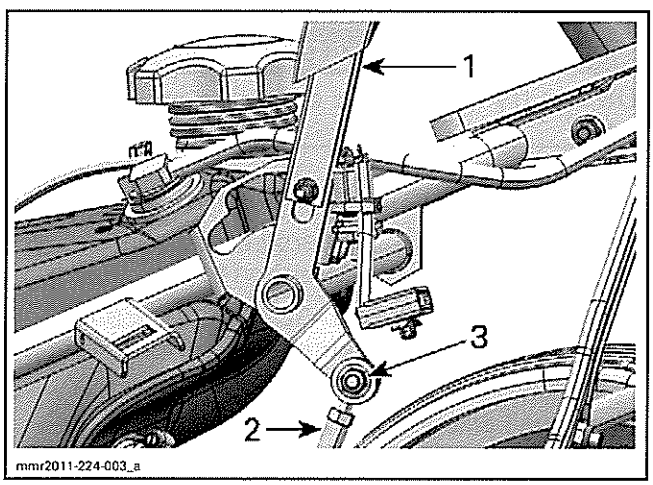
All Models

4. Remove *HANDLEBAR EXTENSION* from steering column, see procedure in this subsection.
5. Remove bolts and nuts securing upper steering column support.
6. Remove bolts and nuts securing side frame members to rear frame member at upper steering column support.



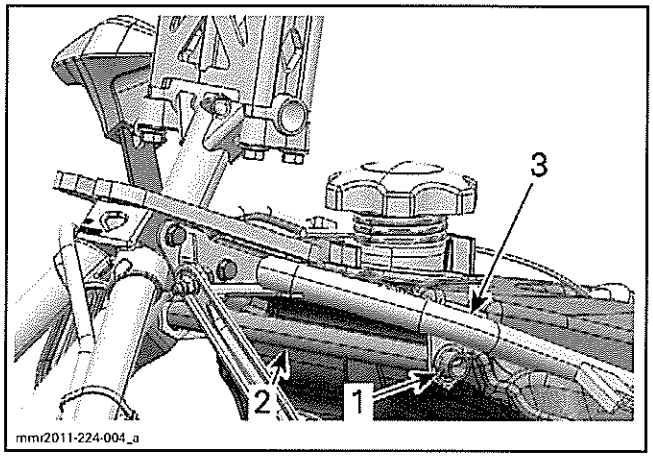
LH SIDE ILLUSTRATED
1. *Rear frame member*
2. *Side frame member*
3. *Bolts to remove*

7. Disconnect the shift rod from the shift lever.



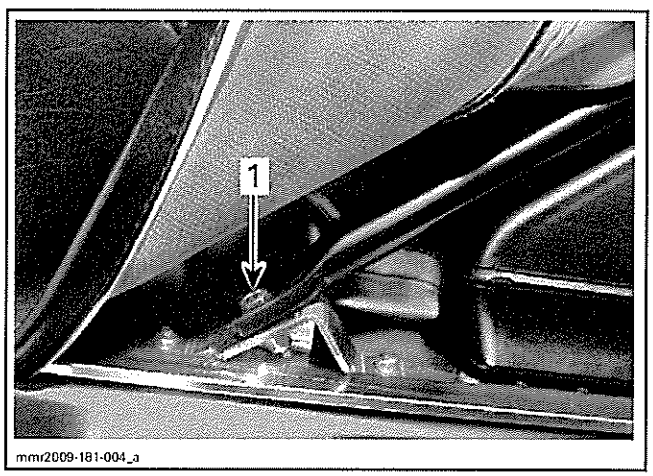
TYPICAL
1. *Shift lever*
2. *Shift rod*
3. *Remove this bolt and nut*

8. Remove the cotter pin that retains the shift lever shaft to the rear frame member and remove the shift lever.



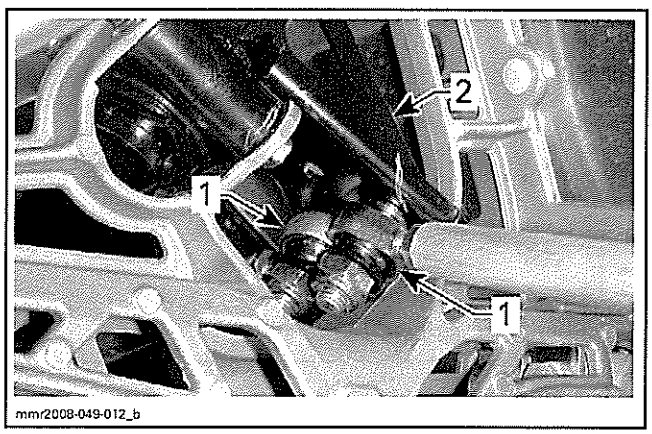
TYPICAL
1. *Cotter pin to remove*
2. *Shift lever shaft*
3. *Rear frame member*

9. Remove steering pad covering upper steering support halves.
10. Remove screw retaining the rear frame members (one each side) to the tunnel.

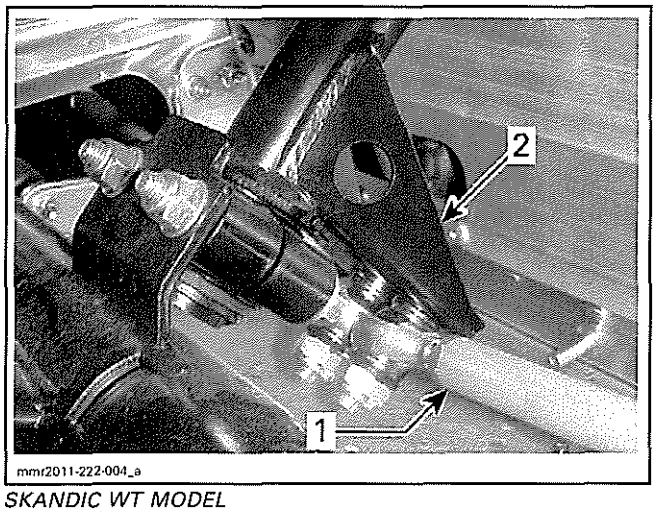


1. *Rear frame member retaining screw*

11. Remove tie-rod ends from steering column.

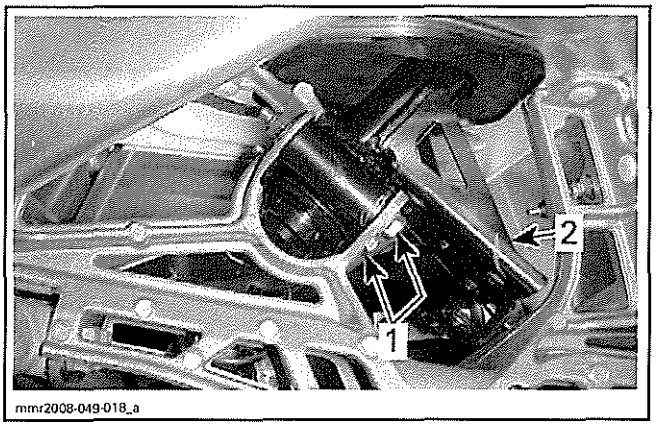


EXPEDITION MODEL
1. *Tie-rod ends*
2. *Steering column*

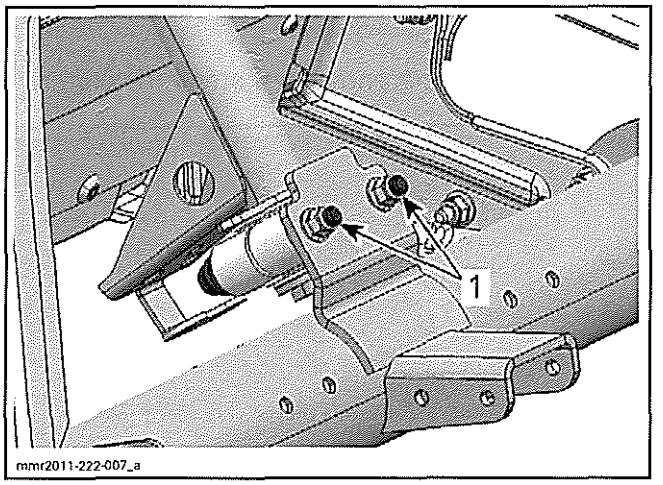


SKANDIC WT MODEL
1. *Tie-rod*
2. *Steering column*

12. Remove screws securing the steering column lower support.



EXPEDITION MODEL
1. *Steering column support screws*
2. *Steering column*

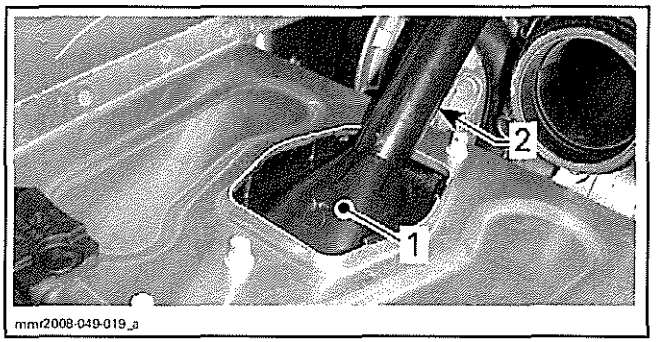


EXPEDITION MODEL
1. *Steering column support screws*

13. Remove lower steering support halves.

Expedition Models

14. Remove the steering column plate.



1. *Steering column plate*
2. *Steering column*

All Models

15. Pull steering column from top.
16. Remove the upper steering column support halves as you pull up on the steering column.

NOTE: Move the rear frame member aside as you remove the steering column. Be wary of upper and lower steering dampers.

Steering Column Inspection

Check if steering column is:
- Cracked
- Bent
- Twisted
- Otherwise damaged.

Replace steering column if necessary.

⚠ WARNING

Do not try to repair a defective steering column.

Steering Column Installation

The installation is the reverse of the removal procedure. However, pay attention to the followings.

Apply SUSPENSION GREASE (P/N 293 550 033) on vibration dampers in steering column supports before installing upper and lower supports.

Replace all elastic nuts with NEW ones.

Ensure proper operation of steering and shift lever.

MOUNTING BOLT TORQUE		
UPPER STEERING COLUMN SUPPORT	All models	14 N•m (124 lbf•**in**)
SIDE FRAME MEMBER	All models except 600 ACE	14 N•m (124 lbf•**in**)
	600 ACE models	10 N•m (89 lbf•**in**)
AFT REAR FRAME MEMBER	All models	23 N•m (17 lbf•ft)
LOWER STEERING COLUMN SUPPORT	All models	14 N•m (124 lbf•**in**)
TIE-ROD END TO STEERING	All models	48 N•m (35 lbf•ft)

BODY

SERVICE TOOLS

Description	Part Number	Page
SUPERTANIUM DRILL BIT 3/16"	529 031 800	855

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 243 (BLUE)	293 800 060	859

GENERAL

VEHICLE CLEANING

Seat Cleaning

It is recommended to clean the seat with a solution of warm soapy water, using a soft clean cloth.

NOTICE Avoid use of harsh detergents such as strong soaps, de-greasing solvents, abrasive cleaners, paint thinners, etc. that may cause damage to the seat cover.

Plastic Cleaning

Clean the vehicle thoroughly, removing all dirt and grease accumulation.

Use a soft clean cloth and either soapy water or isopropyl alcohol to clean the vehicle.

To remove grease, oil or glue use isopropyl alcohol.

NOTICE Do not apply isopropyl alcohol or acetone directly on decals.

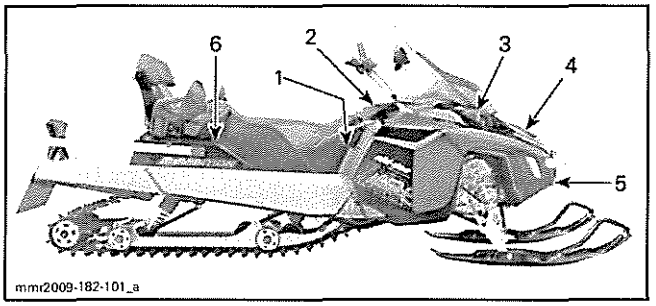
NOTICE The following products must not be applied on the plastic components used on the vehicles:

- Gasoline
- Brake fluid
- Kerosene
- Diesel fuel
- Lighter fluid
- Varsol
- Naphtha
- Acetone
- Strong detergents
- Abrasive cleaners
- Waxes containing an abrasive or a cleaning agent in their formula.

Apply only non abrasive wax on the glossy finish.

BODY PARTS REPAIR

The very first step before repairing plastic materials is to find out exactly which type of material is involved.



TYPICAL

PLASTIC PARTS		
PARTS		MATERIAL
1	Side panels	Polypropylene (PP)
2	Console	Polypropylene (PP)
3	Gauge support	Polypropylene (PP)
4	Hood	Surlyn
5	Front bottom pan	Polypropylene (PP)
6	Storage compartment	Polyethylene (PE)

NOTICE Some repair products are not compatible with certain plastics.

⚠ WARNING

Polycarbonate windshields must never be repaired by welding or otherwise.

The following company provides a complete line of products to repair plastic materials:

CREST INDUSTRIES, INC.
Trenton, MI 48183
Phone: 734 479-4141
Toll Free: 1 800 822-4100
Fax: 734 479-4040
E-Mail: info@crestauto.com
Web Site: www.crestauto.com

PROCEDURES

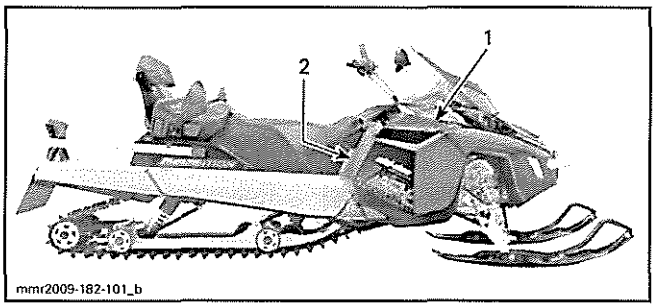
DECALS

Decal Replacement

1. To remove a decal; heat old decal with a heat gun and peel off slowly.
2. Using isopropyl alcohol, clean the surface and dry thoroughly.
3. Apply liquid soap to new decal and carefully position the decal. Using a sponge or a squeegee, remove the air bubbles and surplus water working from the center toward the edges. Allow to air dry.

NOTICE Do not apply isopropyl alcohol or solvent directly on decals. Use only in a well ventilated area.

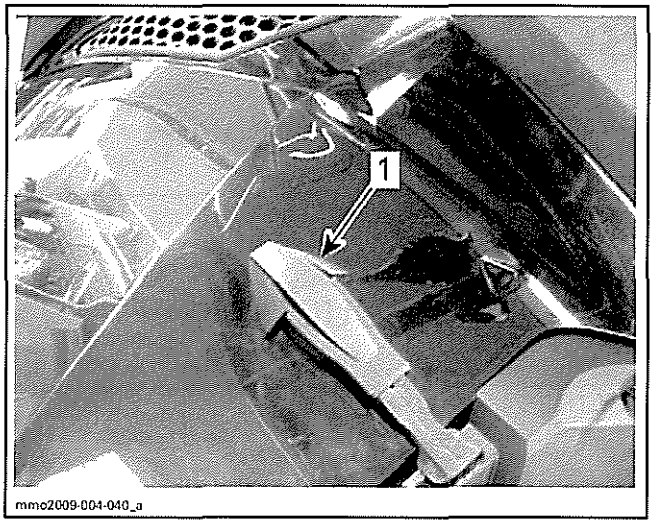
SIDE PANELS



TYPICAL
1. Upper side panel
2. Lower side panel

Upper Side Panel Removal

1. Unhook the rubber tie.



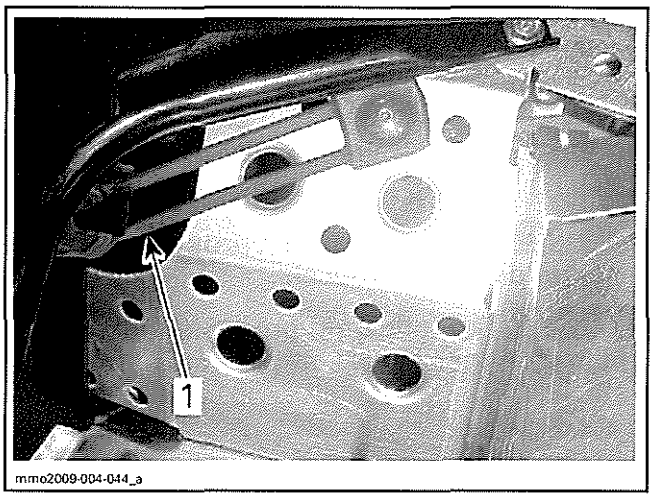
TYPICAL
1. Rubber tie

2. Lift the rear portion of panel to free the plastic tab from the console.
3. Slide panel back.

Lower Side Panel Removal

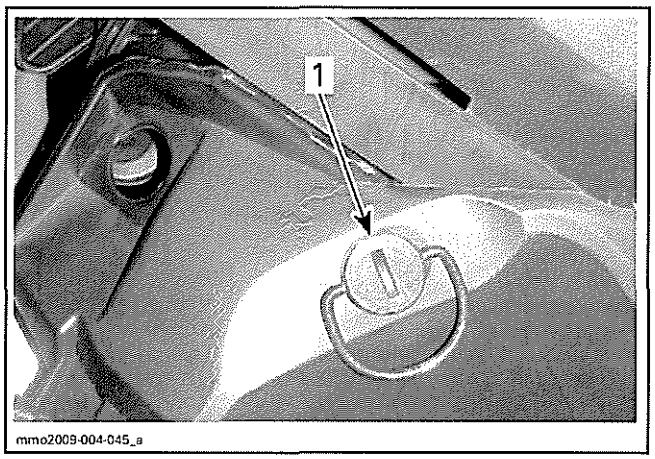
Expedition Models

1. Remove *UPPER SIDE PANEL* as explained in previous procedure.
2. Unhook the rubber tie.



1. Rubber tie

3. At the aft top corner of the panel, turn the camlock fastener 1/4 turn counterclockwise to unlock.

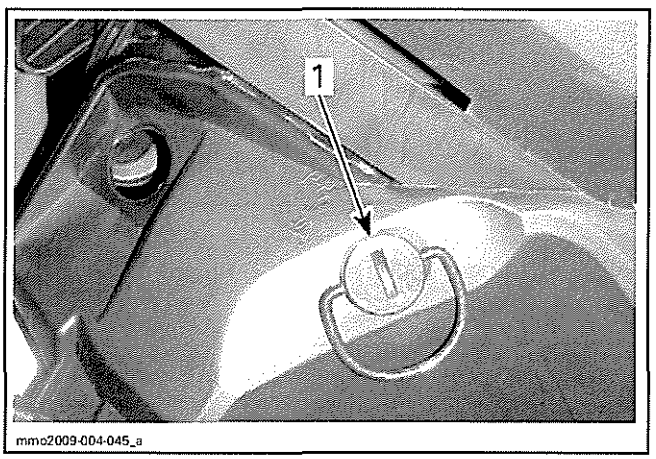


1. Cam-lock fastener

4. Slightly lift the rear of side panel, then open sideways.
5. Lift the front of side panel and free the lower hinge from its slot.
6. Free the upper hinge by lowering the panel.

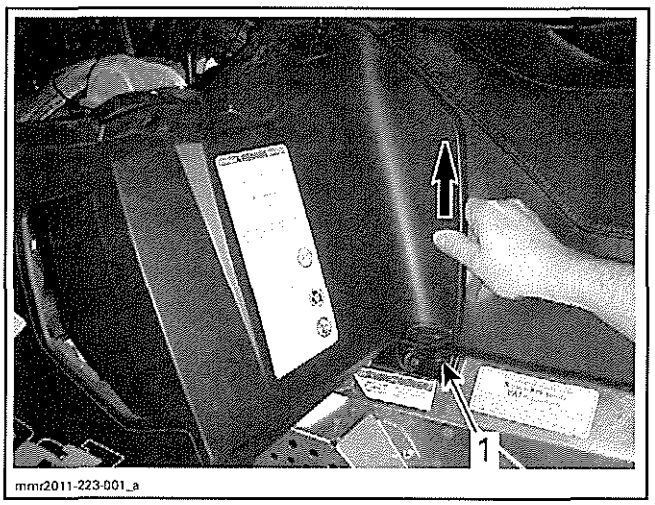
Skandic WT Models

1. Remove *UPPER SIDE PANEL*.
2. At the aft top corner of the panel, turn the cam-lock fastener 1/4 turn counterclockwise to unlock.



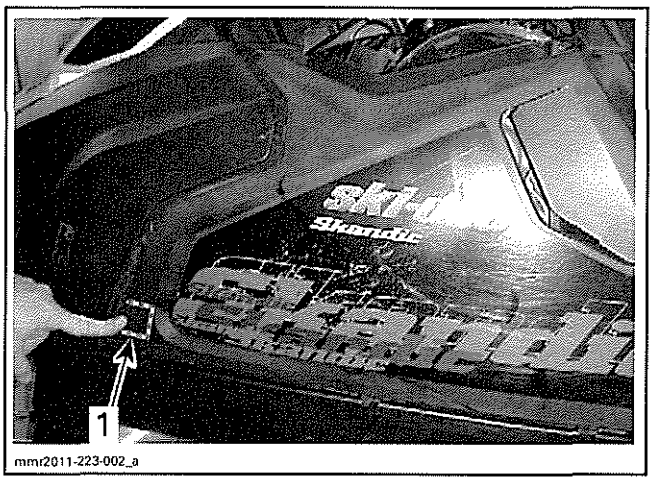
1. Cam-lock fastener

3. Slightly lift the lower aft corner of the panel to free the retaining pin from its retainer.

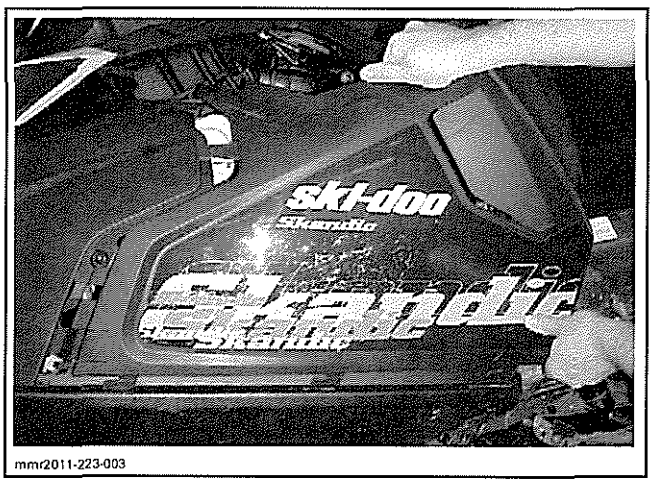


1. Pin and retainer

4. Press on the tab in the lower front corner of the panel to release it, then pull the panel back and upwards slightly to remove it.



1. Tab

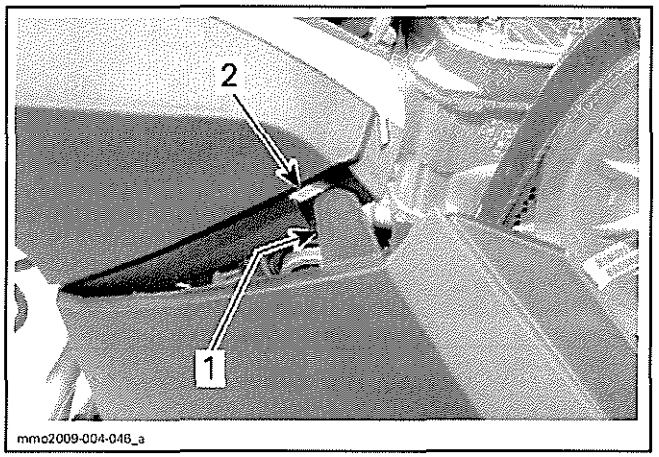


Lower Side Panel Installation

Expedition Models

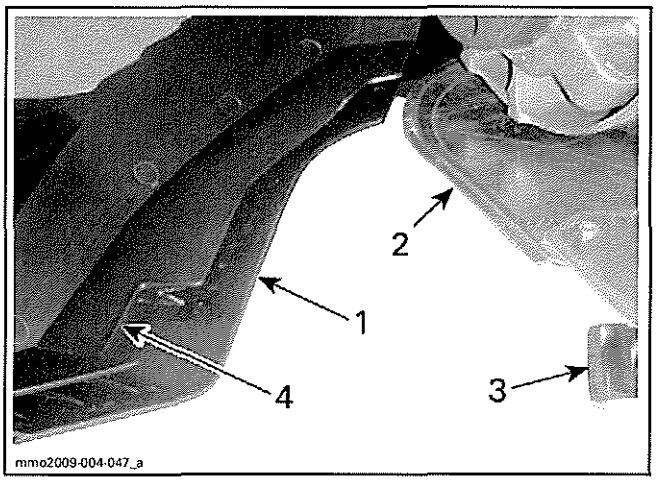
1. Insert upper hinge then lift panel upwards.

2. Insert lower hinge then push panel downwards.
3. Insert the front upper tab into the upper bottom pan slot.



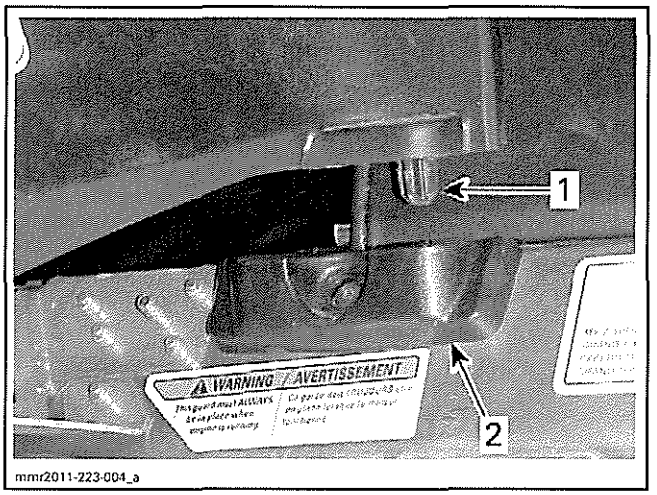
1. Tab
2. Slot

4. Insert the lower section of side panel over the aluminum chassis and the aluminum tab into the panel slot.



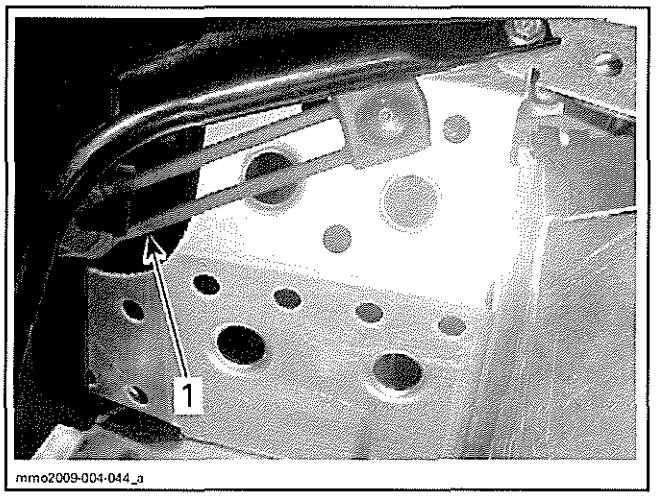
1. Lower section
2. Aluminum chassis
3. Aluminum tab
4. Panel slot

5. Insert the lower rear pin into its retainer.



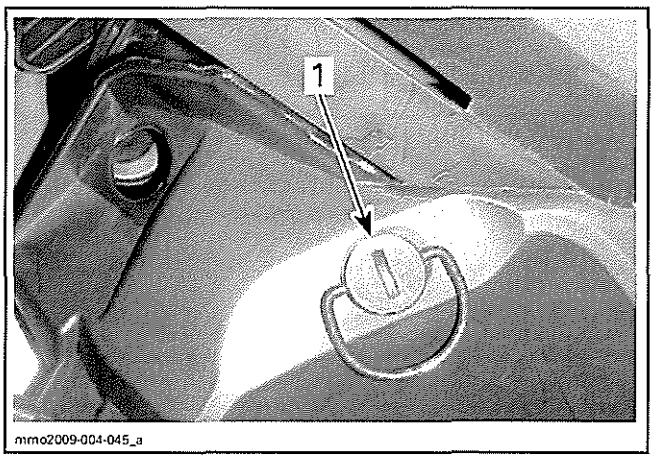
1. Pin
2. Retainer

6. Hook the rubber tie.



1. Rubber tie

7. Lock the cam-lock fastener by turning it 1/4 turn clockwise.

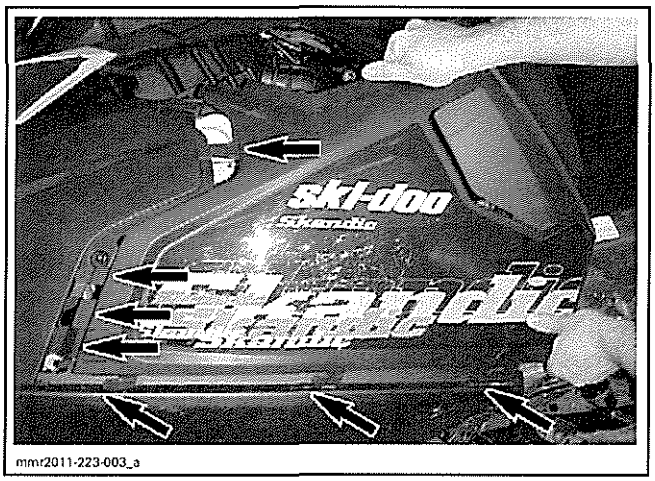


1. Cam-lock fastener

Skandic WT Models

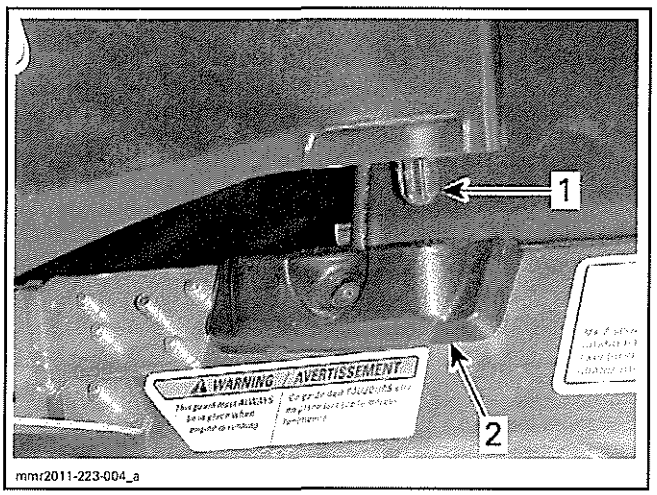
Reverse the removal procedure however, pay attention to the following.

1. As you install the panel on the bottom pan, ensure all the retaining tabs are properly engaged.



mmr2011-223-003_a

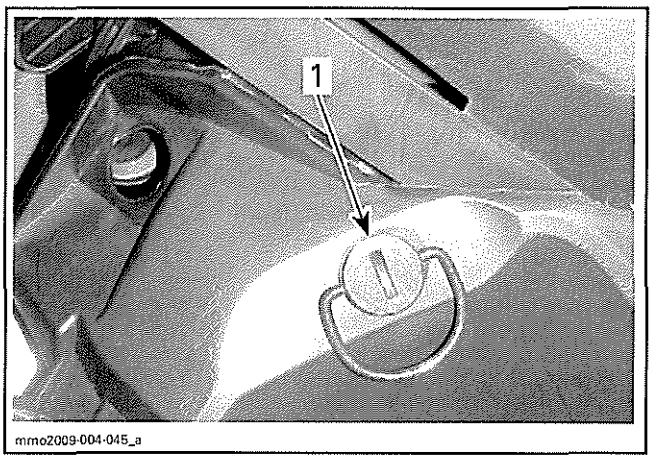
2. Insert the lower rear pin into its retainer.



mmr2011-223-004_a

1. *Pin*
2. *Retainer*

3. Lock the cam-lock fastener by turning it 1/4 turn clockwise.

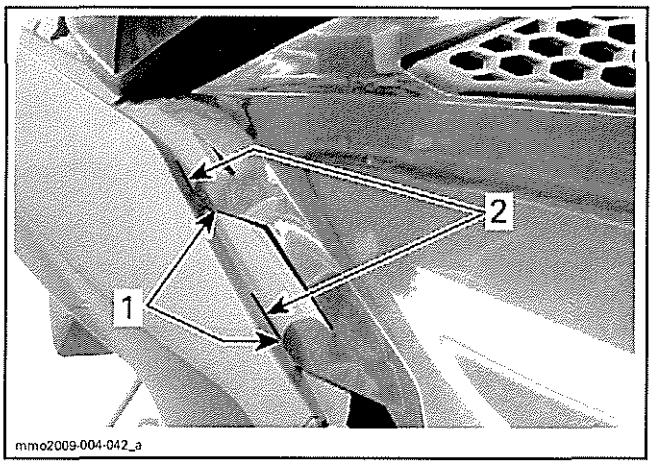


mmo2009-004-045_a

1. *Cam-lock fastener*

Upper Side Panel Installation

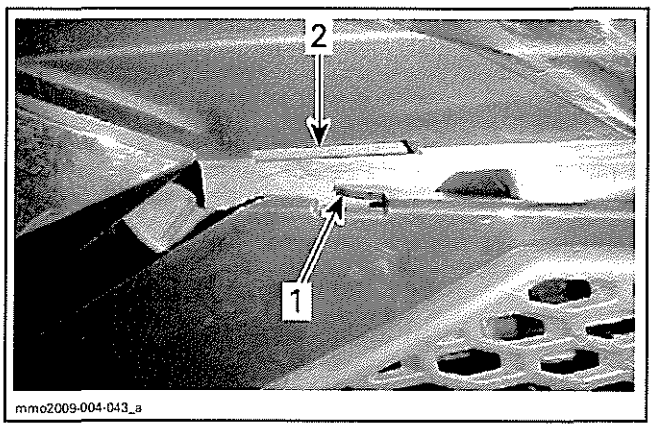
1. Install *LOWER SIDE PANEL* as explained above.
2. Insert front lower tabs into the upper bottom pan slots.



mmo2009-004-042_a

1. *Tabs*
2. *Slots*

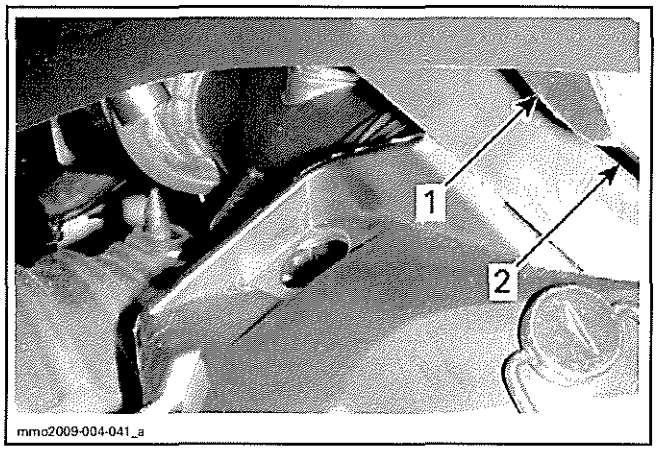
3. Insert the top center tabs into the console.



mmo2009-004-043_a

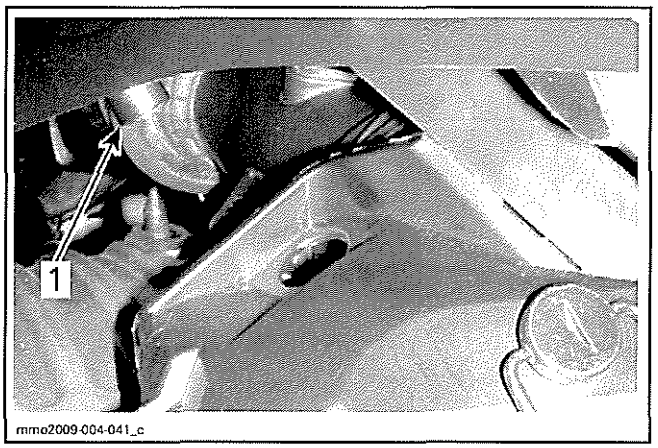
1. *Tab*
2. *Slot*

4. Insert the rear tab into the console.



1. Tab
2. Slot

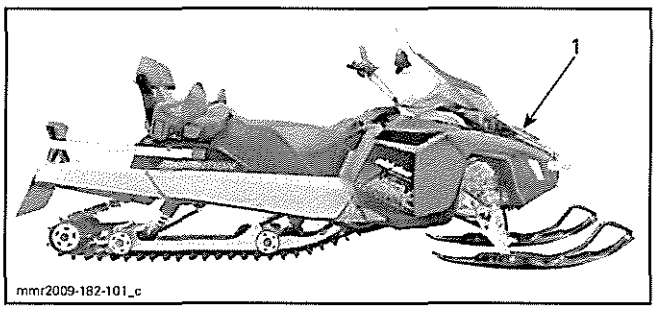
5. Align and insert both cylindrical guides into the round holes on the lower side panel.



1. Cylindrical guide

6. Hook rubber tie.

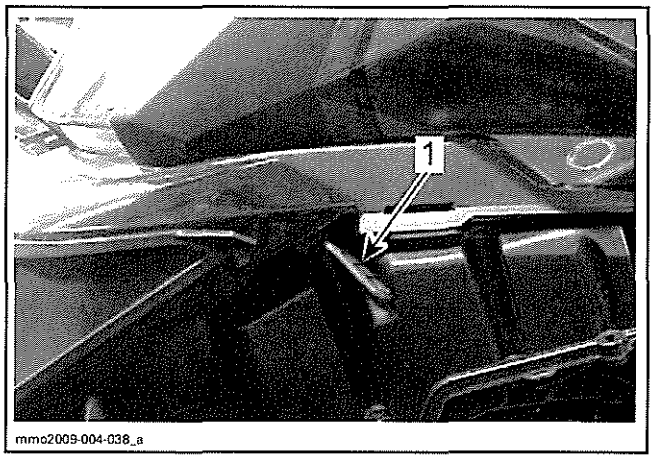
HOOD



TYPICAL
1. Hood

Hood Removal

1. Remove *UPPER SIDE PANELS*, see procedure in this subsection.
2. Unhook the rubber ties on both sides.

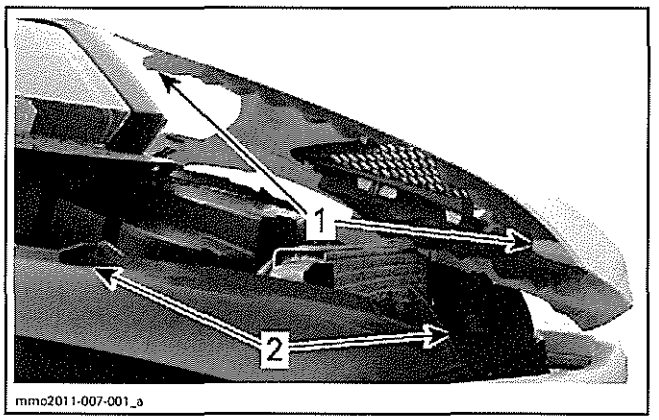


1. Rubber tie

3. Slide hood towards front to free the tabs from their slots.

Hood Installation

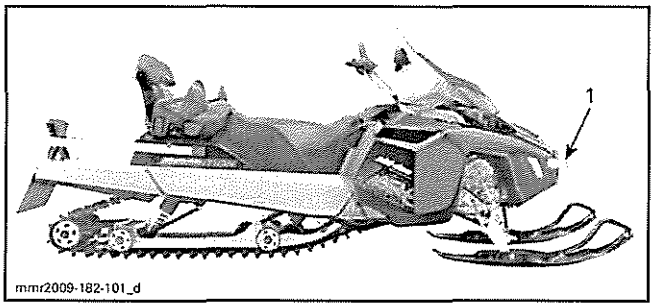
1. Engage the tabs located at front and center of the hood into the bottom pan slots.



TYPICAL
1. Hood tabs
2. Bottom pan slots

2. Slide hood towards headlights until it stops.
3. Hook the rubber ties.

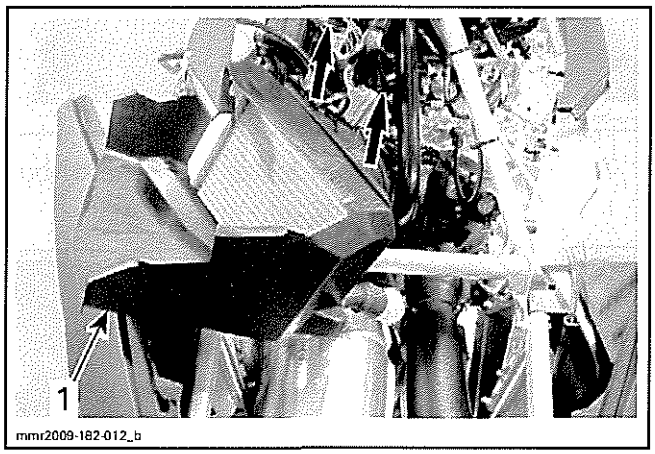
FRONT BUMPER



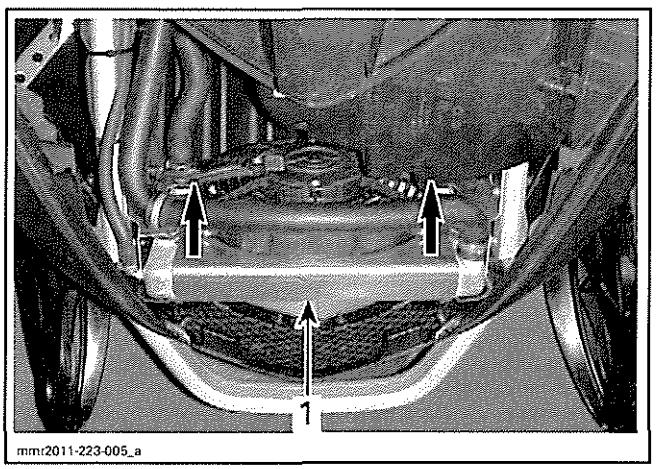
TYPICAL
1. Front bumper

Front Bumper Removal

1. Remove *HOOD*, see procedure in this subsection.
2. Remove *GAUGE SUPPORT*, see procedure in this subsection.
3. Detach front radiator from frame and move it rearward. Refer to *COOLING SYSTEM* subsection.

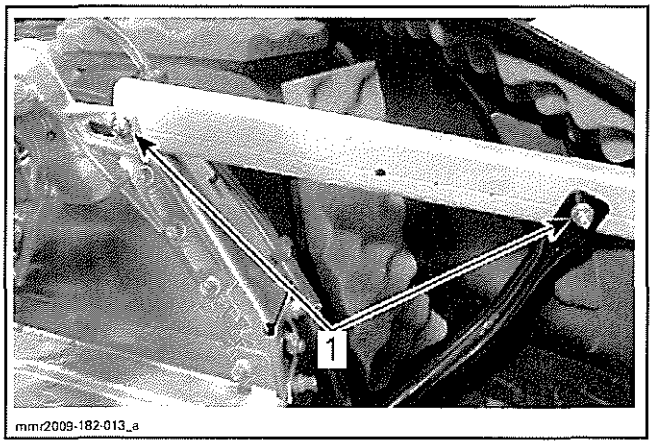


600 HO E-TEC MODELS
1. Radiator



600 ACE AND 1200 4-TEC MODELS
1. Radiator

4. Remove front bumper retaining bolts and nuts.



TYPICAL
1. Retaining nuts

5. Remove front bumper from vehicle by moving it forward.

Front Bumper Installation

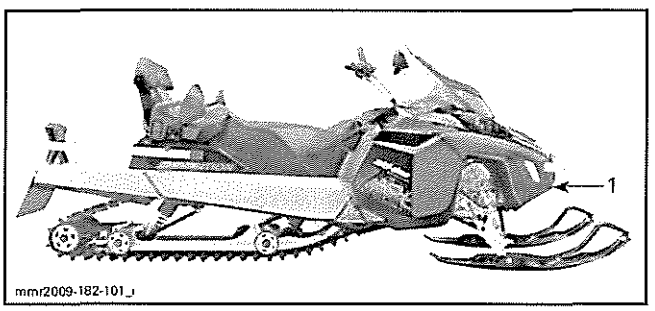
The installation is the reverse of removal procedure, however pay attention to the following.

Torque front bumper nuts to 10 N•m (89 lbf•**in**).

FRONT BOTTOM PAN

Expedition Models

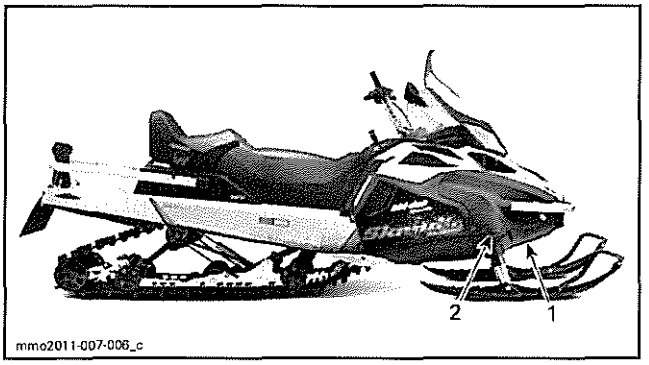
The front bottom pan is a single piece design that is riveted to the chassis.



EXPEDITION MODELS
1. Front bottom pan

Skandic WT Models

The front bottom pan is a four piece design. The two piece upper bottom pan is fastened using Torx screws, the two piece lower bottom pan is riveted to the chassis.



SKANDIC MODEL
1. *Lower front bottom pan*
2. *Upper front bottom pan*

Front Bottom Pan Removal

1. Remove *SIDE PANELS*, see procedure in this subsection.
2. Remove *HOOD*, see procedure in this subsection.
3. Remove *GAUGE SUPPORT*, see procedure in this subsection.
4. Detach front radiator from frame and move it rearward. Refer to *COOLING SYSTEM* subsection.

600 HO E-TEC Models

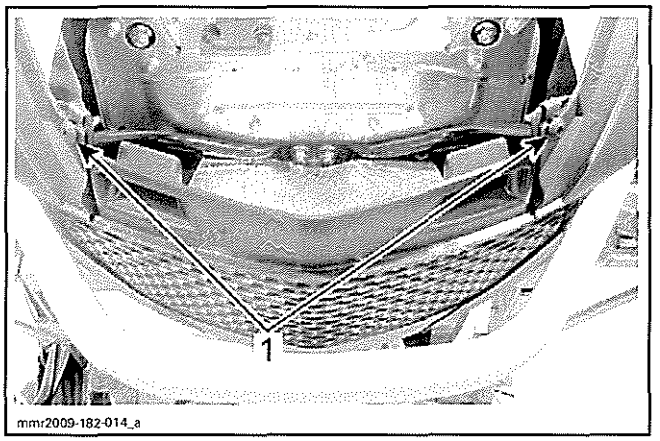
5. Remove tuned pipe. Refer to *EXHAUST SYSTEM* subsection.

600 ACE and 1200 4-TEC Models

6. Remove exhaust pipe.

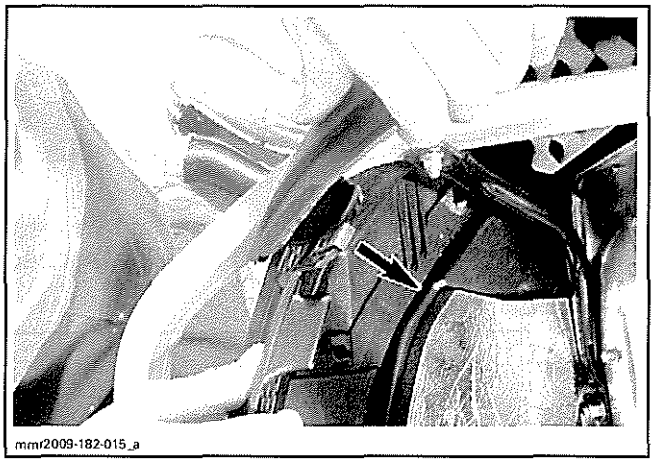
All Models

7. Remove bottom pan grille as follows:
   7.1 Remove upper screws.

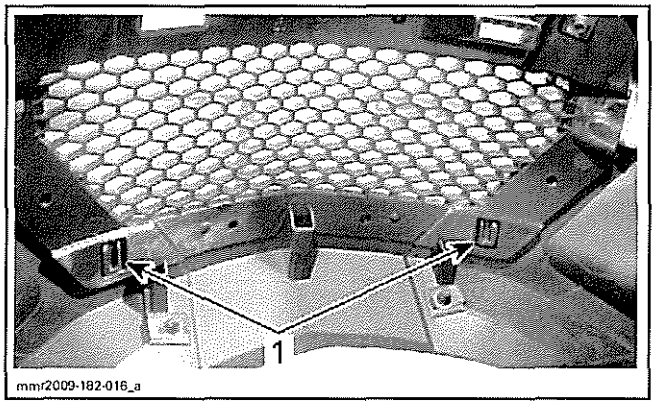


1. *Upper screws*

   7.2 Detach grille from side fixations of bottom pan.



   7.3 Detach grille from lower fixations of bottom pan.



1. *Lower fixations*

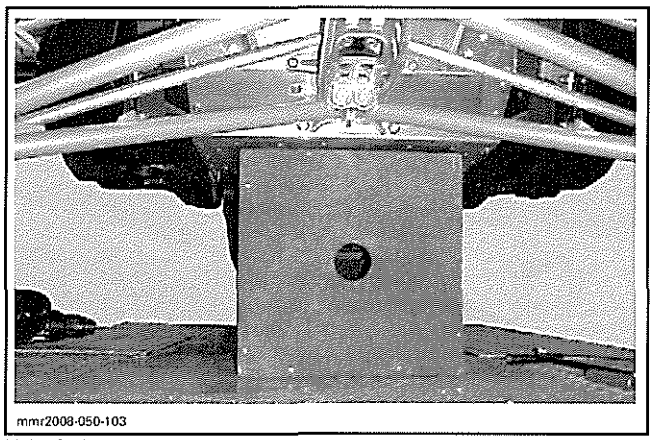
   7.4 Remove grille from vehicle.

Expedition SE Model

8. Remove skid plate.
9. Remove heavy duty bumper.

Expedition Models

10. Lift front of vehicle until skis are off the ground.
11. Place the front portion of frame on a wooden box to support it securely.


mmr2008-050-103

TYPICAL

12. Remove front shock absorbers. Refer to *FRONT SUSPENSION* subsection.
13. Using an angle drill and a SUPERTANIUM DRILL BIT 3/16" (P/N 529 031 800), remove all rivets retaining bottom pan.

NOTE: Refer to *FRAME* for proper procedure when drilling rivets retaining plastic.

14. Remove bottom pan.

Skandic WT Models

15. Remove Torx screws securing upper front bottom pan, then remove the upper front bottom pan from the vehicle.
16. Hoist front of vehicle.
17. Remove both skis.
18. Using an angle drill and a SUPERTANIUM DRILL BIT 3/16" (P/N 529 031 800), remove all rivets retaining bottom pan.

NOTE: Refer to *FRAME* for proper procedure when drilling rivets retaining plastic.

19. Remove bottom pan.

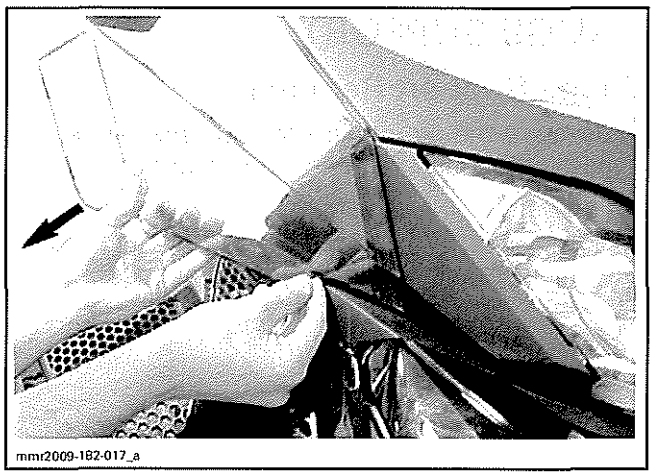
Front Bottom Pan Installation

The installation is the reverse of removal procedure.

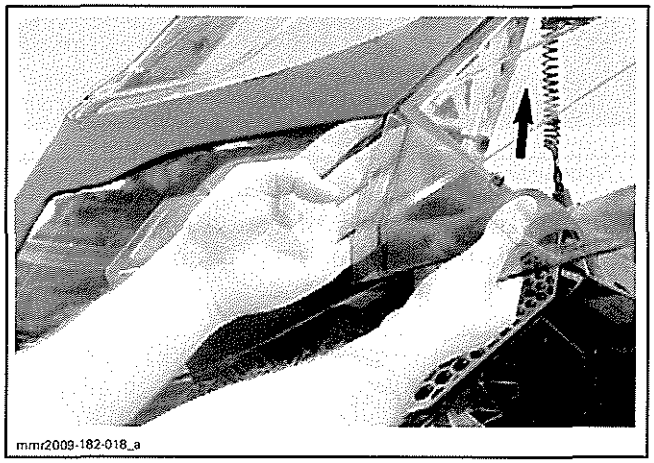
WINDSHIELD

Windshield Removal

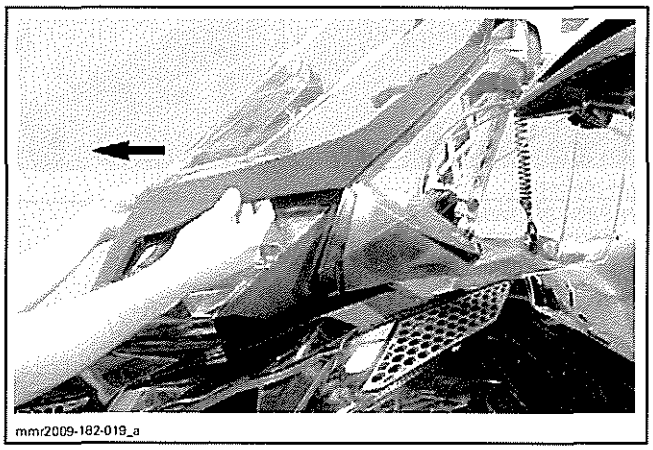
1. Detach windshield sides by pulling them toward the outside.


mmr2009-182-017_a

2. Push windshield upwards.


mmr2009-182-018_a

3. Remove windshield from vehicle by pulling it toward the front.


mmr2009-182-019_a

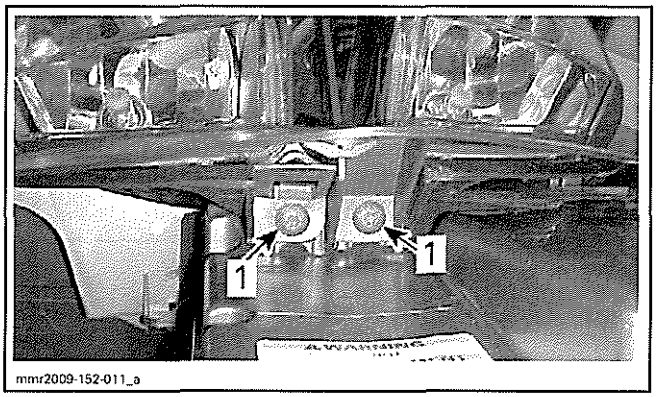
Windshield Installation

The installation is the reverse of removal procedure.

GAUGE SUPPORT

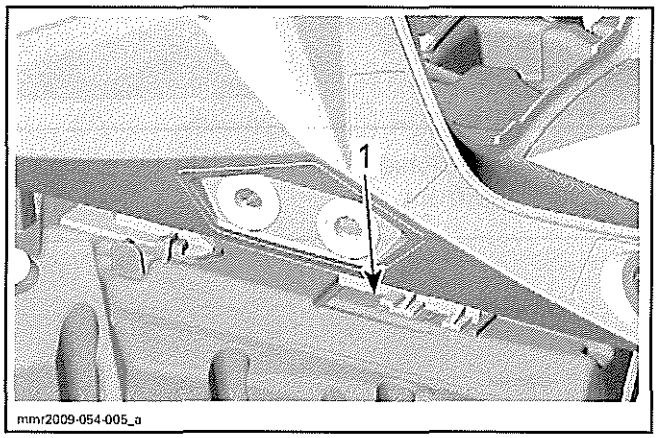
Gauge Support Removal

1. Remove the air intake silencer and gauge support as a unit, refer to *AIR INTAKE SYSTEM* subsection.
2. Remove both screws securing front of gauge support to secondary air intake silencer.

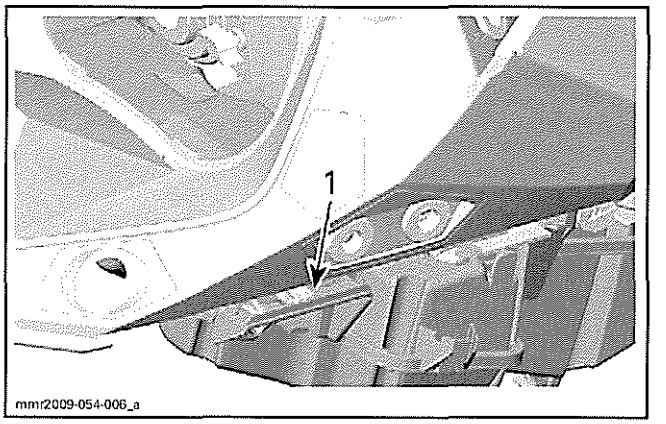


1. Front retaining screws

3. On LH and RH sides of gauge support, press and hold the tabs securing gauge support to secondary air intake silencer.



LH SIDE SHOWN
1. Press this tab



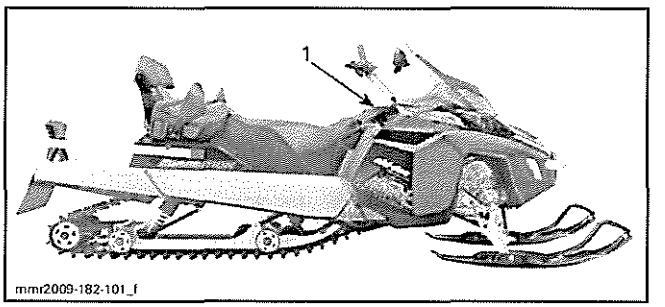
RH SIDE SHOWN
1. Press this tab

4. Slide the gauge support then lift its rear portion to separate the gauge support and the secondary air intake silencer.

Gauge Support Installation

The installation is the reverse of the removal procedure.

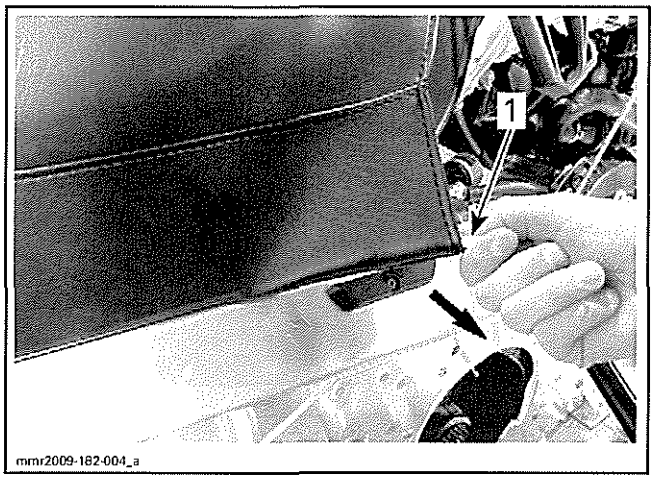
CONSOLE



1. Console

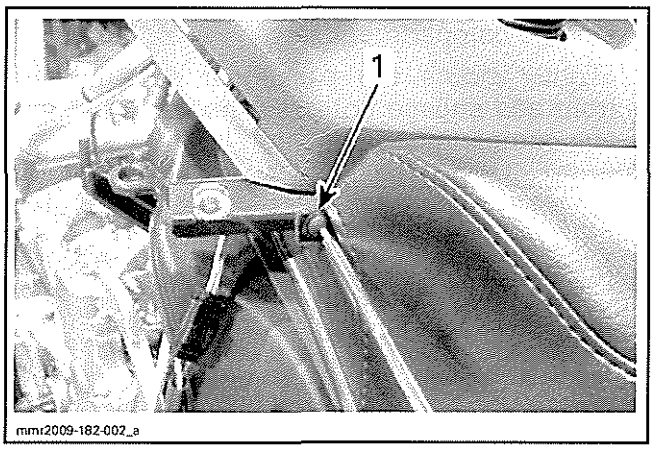
Console Removal

1. Detach the front part of seat cover from tunnel as follows:
   1.1 Pull lower side strip downward.
   1.2 Pull lower side strip toward the outside.



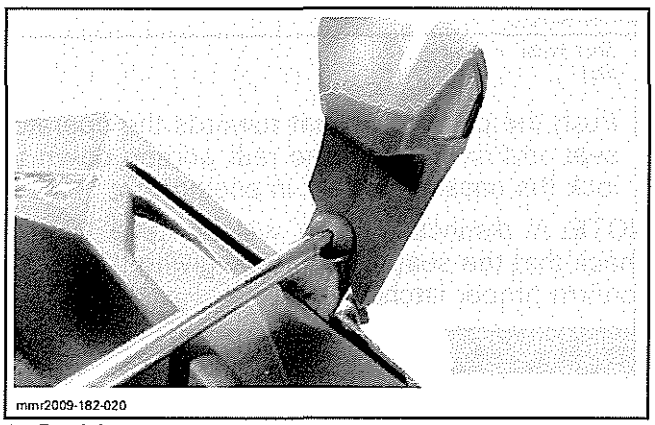
1. Lower side strip

2. Remove upper retaining screws from operator seat.



1. Upper retaining screw

3. Remove shift lever knob by unscrewing retaining screw.



1. Retaining screw

4. Remove fuel tank cap.
5. Remove console from vehicle.
6. Install fuel tank cap.

Console Installation

The installation is the reverse of removal procedure, however pay attention to the following.

Torque shift lever knob screw to 4 N•m (35 lbf•**in**).

OPERATOR SEAT

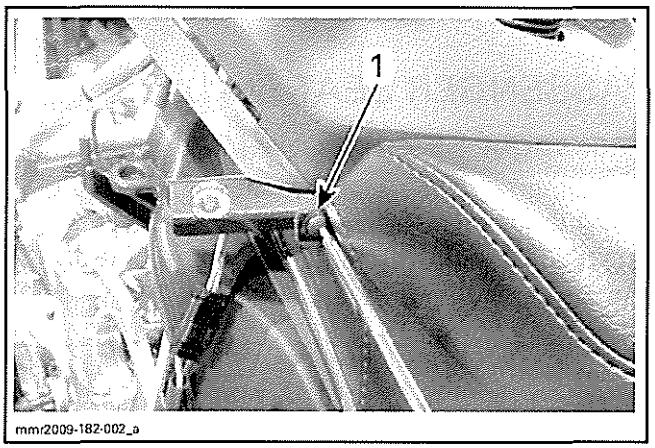
Operator Seat Removal

Expedition SE Models

1. Remove cargo box behind passenger seat.

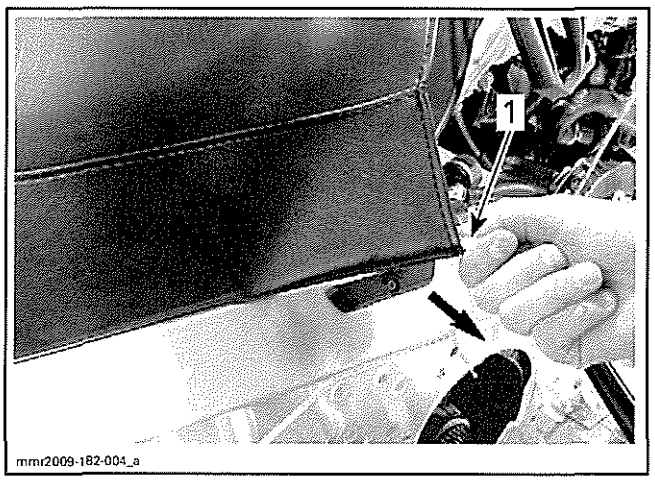
All Models

2. Remove *PASSENGER SEAT*, see procedure in this subsection.
3. Remove *STORAGE COMPARTMENT*, see procedure in this subsection.
4. Remove upper retaining screws.



1. Upper retaining screw

5. Detach seat cover from tunnel as follows:
   5.1 Pull lower side strip downward.
   5.2 Pull lower side strip toward the outside.



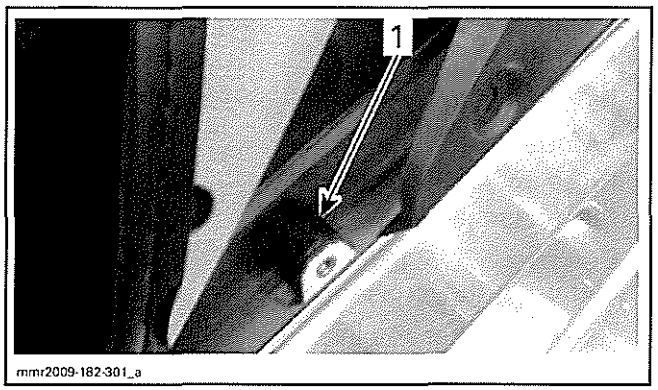
1. Lower side strip

6. Remove seat and foam from vehicle.

Operator Seat Installation

The installation is the reverse of removal procedure, however pay attention to the following.

Properly install rubber spacers before tightening the side retaining screws for the storage compartment.



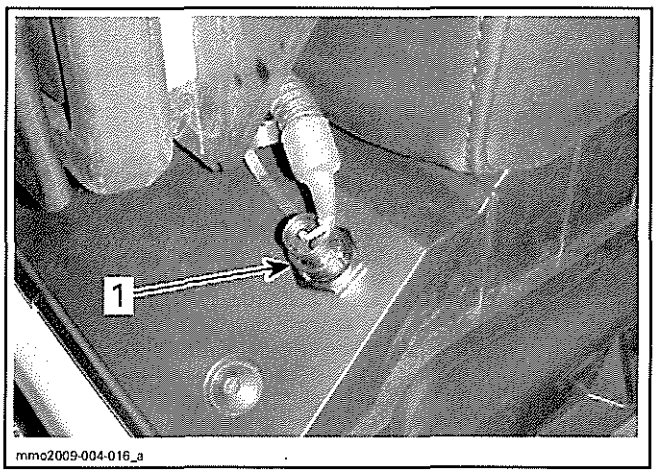
1. Rubber spacer

PASSENGER SEAT (1+1)

Passenger Seat Removal

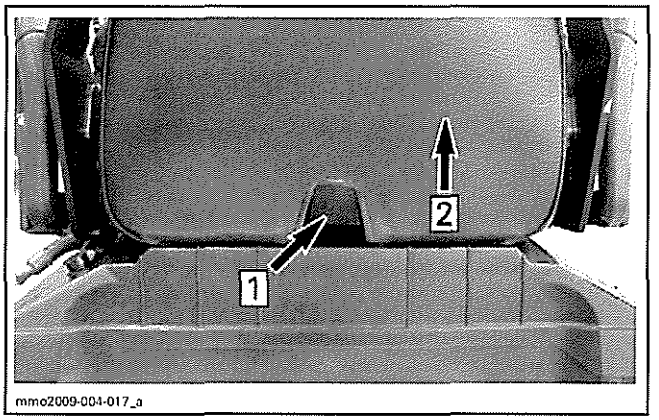
1. Disconnect the accessories connector by turning the plastic housing counterclockwise.

NOTE: The connector is located on the LH side of the storage compartment.



1. Accessories connector

2. Install the rubber plug on the connector.
3. Push the latch tab in and lift-up the rear of seat.

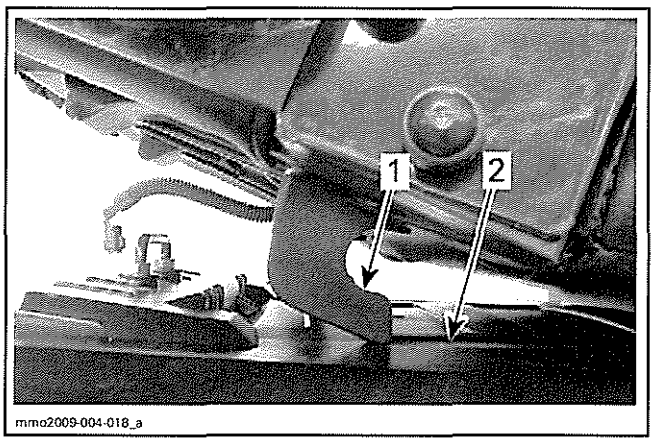


Step 1: Push tab
Step 2: Lift rear of seat

4. Slide seat rearward and set aside.

Passenger Seat Installation

1. Place the passenger seat facing forward on the storage compartment lid.
2. Slightly incline the passenger seat towards front and engage both seat hooks in the storage compartment lid slots.



1. Seat hook
2. Slot

3. Push the passenger seat towards the operator seat and firmly push the rear portion down to lock the passenger seat in position.

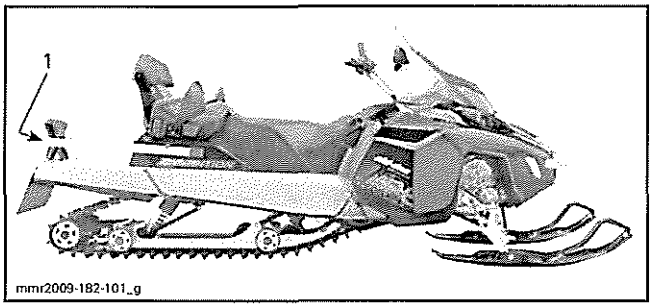
NOTE: A distinctive snap will be felt. Double check that the seat is secure by giving it a tug to confirm proper latching.

⚠ WARNING

Make sure seat is securely latched before riding.

4. Connect the accessories connector.

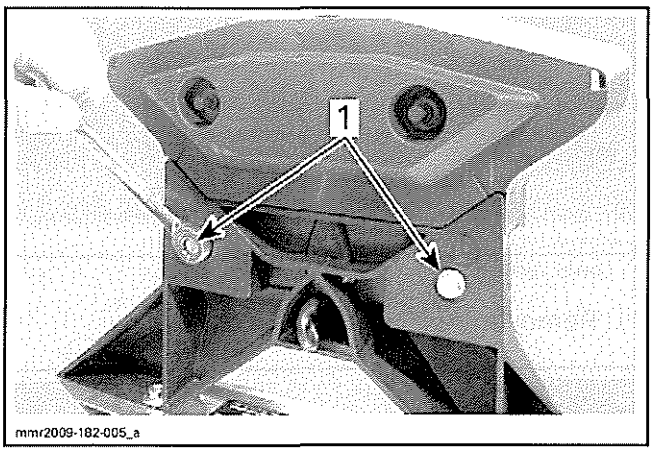
REAR BUMPER



TYPICAL
1. Rear bumper

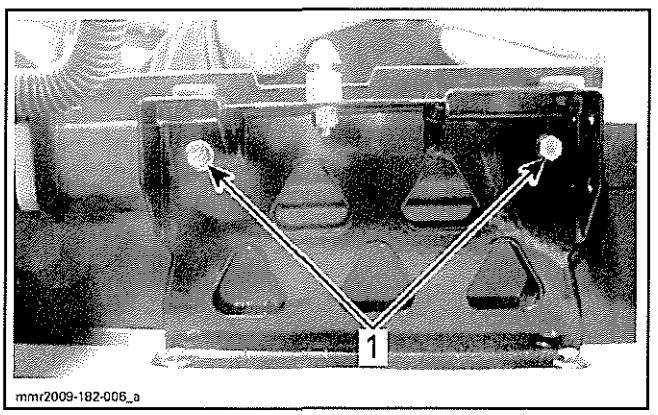
Rear Bumper Removal

1. Remove *PASSENGER SEAT*, see procedure in this subsection.
2. Remove rear retaining screws from taillight support.



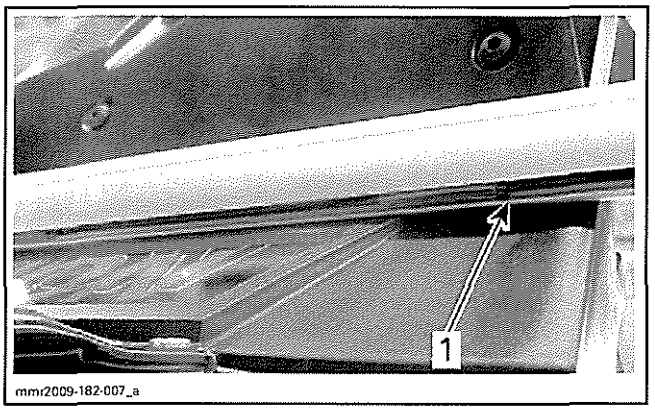
1. Rear retaining screws

3. Open storage compartment.
4. Remove side retaining screws from storage compartment support.



1. Side retaining screws

5. From underneath bumper, remove taillight harness from bumper slot.



1. Bumper slot

6. Remove rear bumper from vehicle.

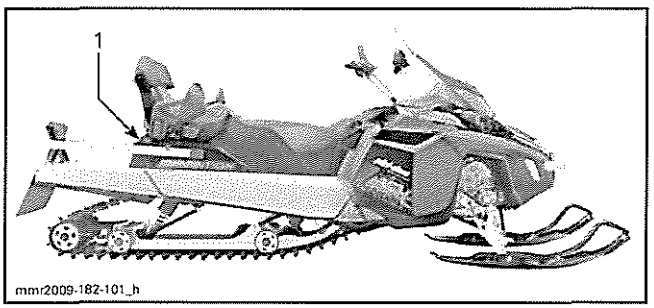
Rear Bumper Installation

The installation is the reverse of removal procedure, however pay attention to the following.

Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on bumper screws threads before reinstallation.

Torque bumper screws to 10 N•m (89 lbf•**in**).

STORAGE COMPARTMENT



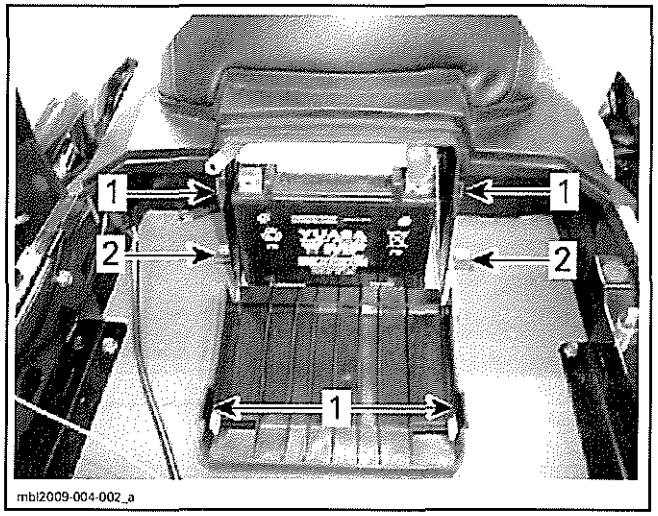
1. Storage compartment

Storage Compartment Removal

⚠ WARNING

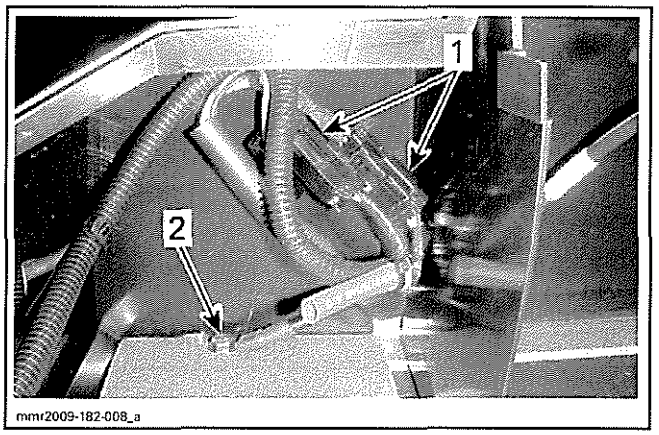
Battery BLACK negative (-) cable must always be disconnected first and connected last.

1. Remove *REAR BUMPER*, see procedure in this subsection.
2. Open battery cover.
3. Disconnect BLACK negative (-) cable from battery.
4. Disconnect RED positive (+) cable from battery.
5. Remove screws securing metal support.



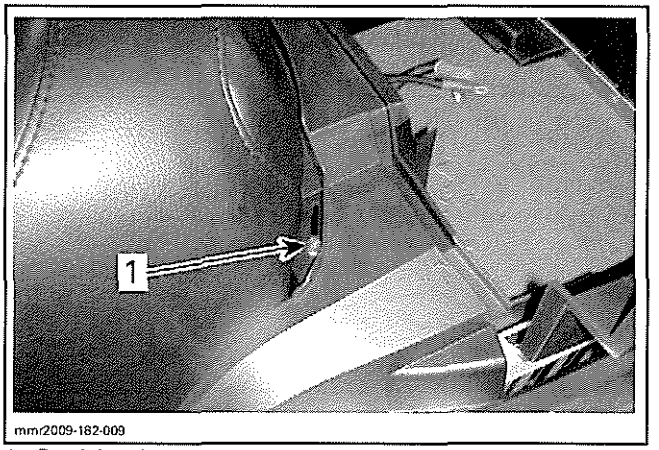
1. Battery cover latches
2. Screws from metal support

6. Remove metal support and battery from vehicle.
7. Disconnect taillight harness connectors.
8. Remove screw securing BLACK negative (-) cable on frame.



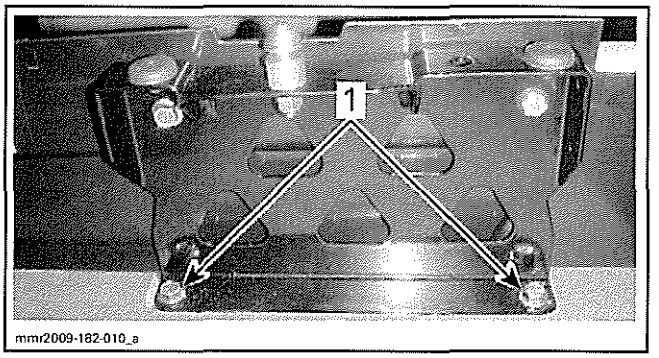
1. Taillight harness connectors
2. cable screw

9. Remove retaining tie that holds taillight harness.



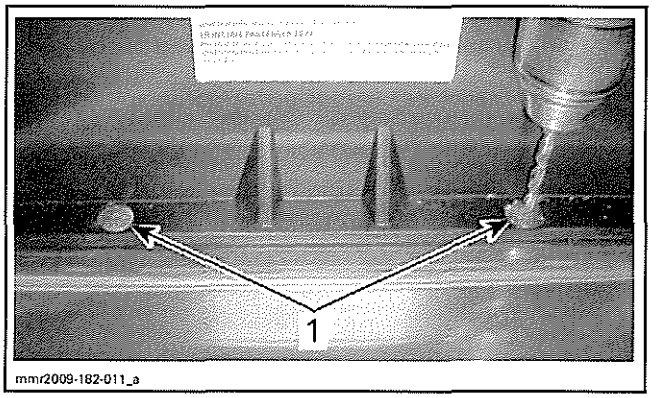
1. Retaining tie

10. Remove lower retaining screws from storage compartment support.



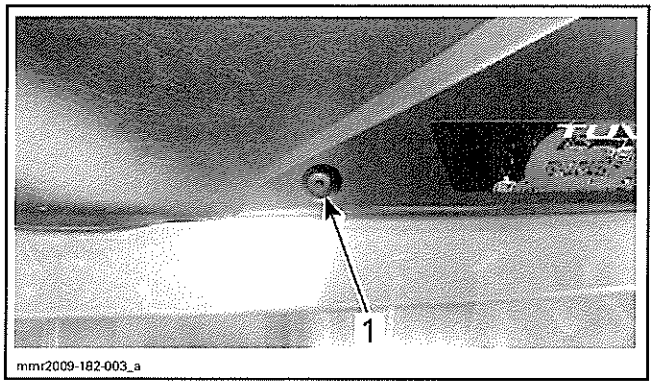
1. Lower retaining screws

11. Remove rear rivets by drilling them.



1. Rear rivets

12. Remove side retaining screws.



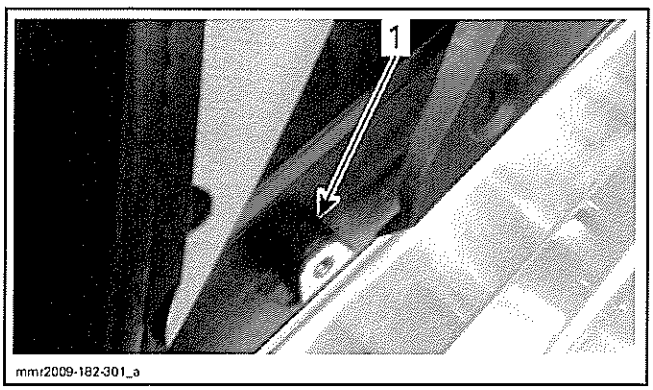
1. Side retaining screw

13. Remove storage compartment from vehicle.

Storage Compartment Installation

The installation is the reverse of removal procedure, however pay attention to the following.

Properly install rubber spacers before tightening side retaining screws.



1. Rubber spacer

Torque side retaining screws to 3 N•m (27 lbf•**in**).

FRAME

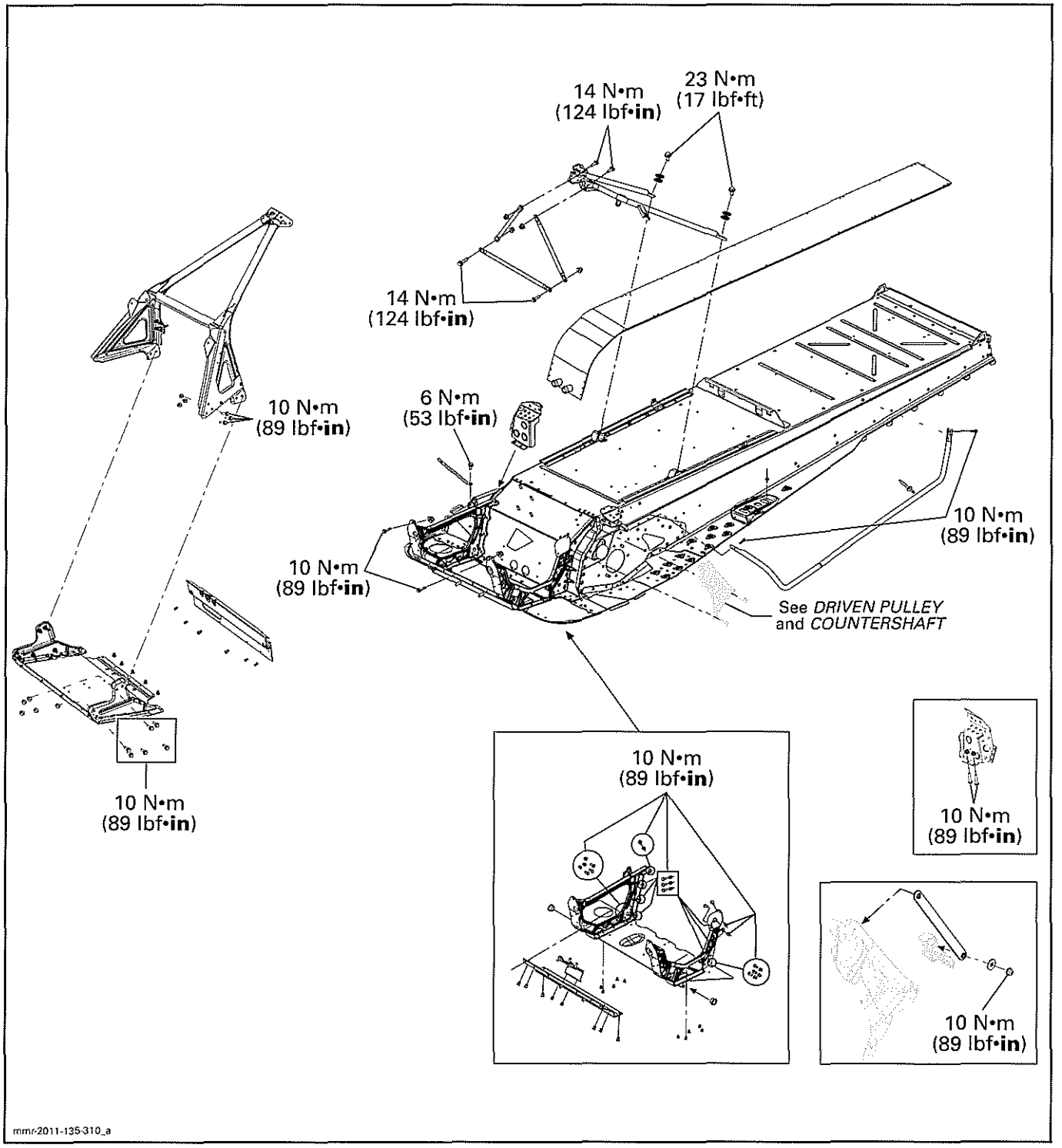
SERVICE TOOLS

Description	Part Number	Page
SUPERTANIUM DRILL BIT 3/16"	529 031 800	868

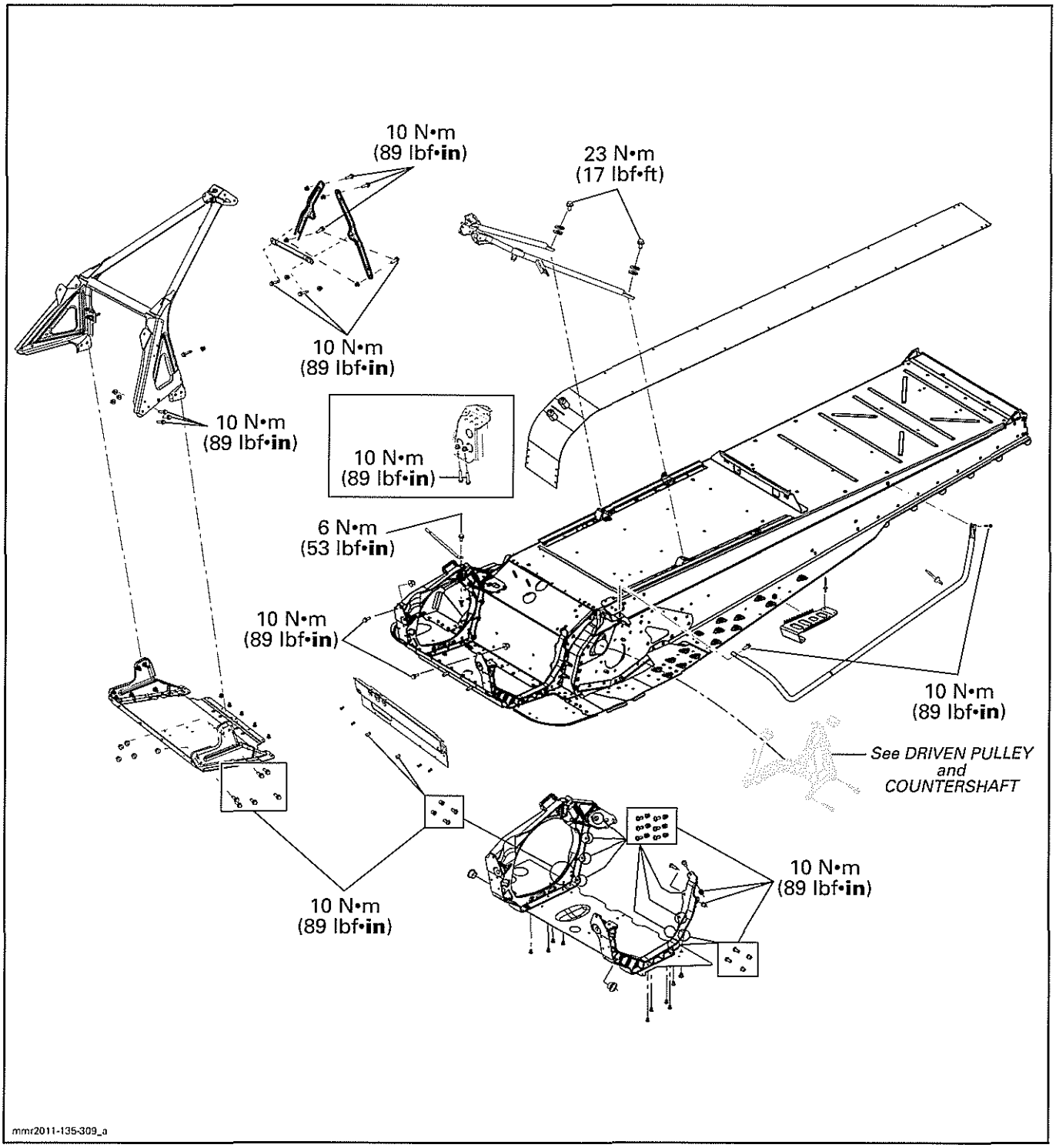
SERVICE PRODUCTS

Description	Part Number	Page
XPS SYNTHETIC CHAINCASE OIL	413 803 300	868

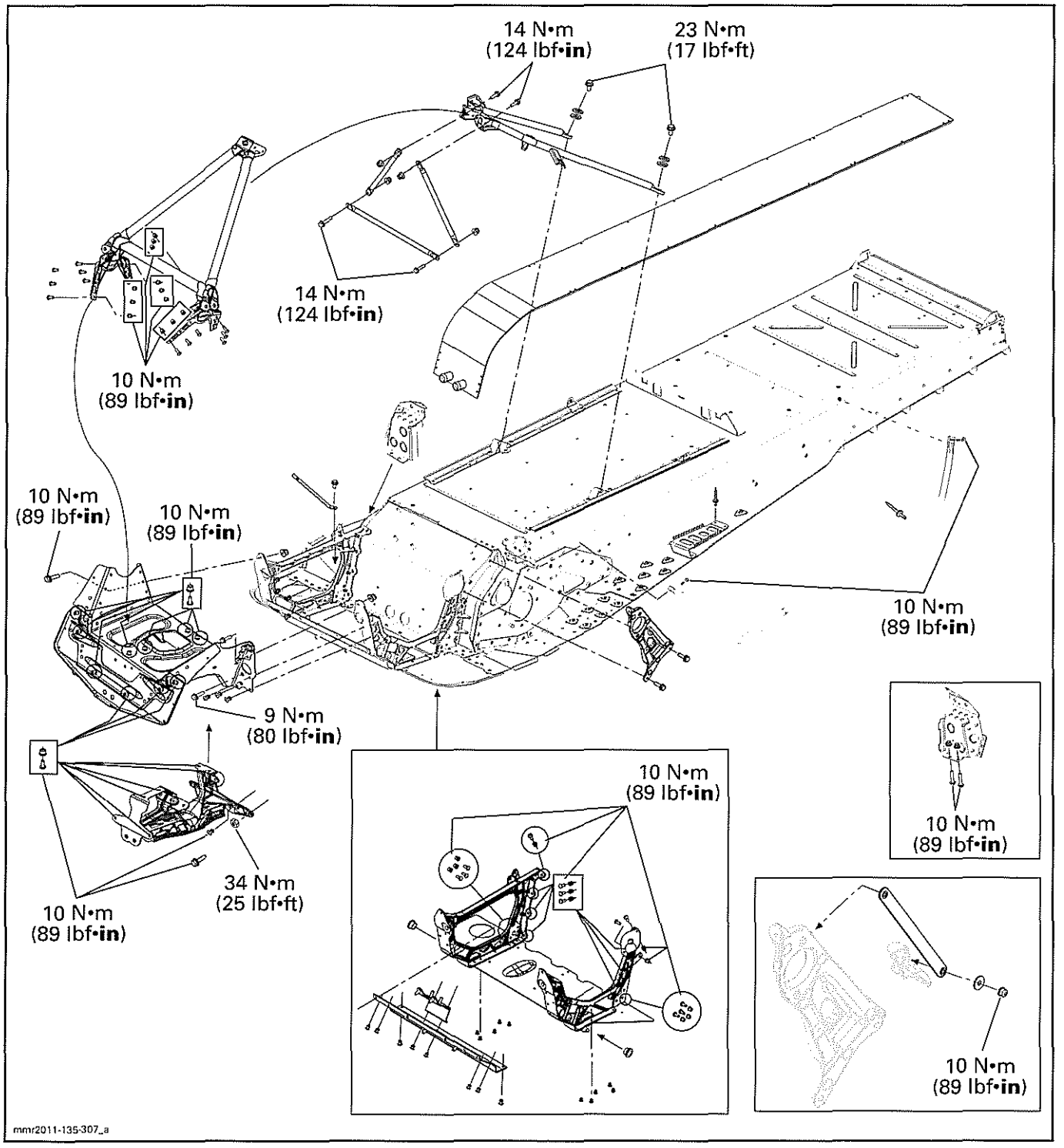
Skandic WT 600 HO E-TEC



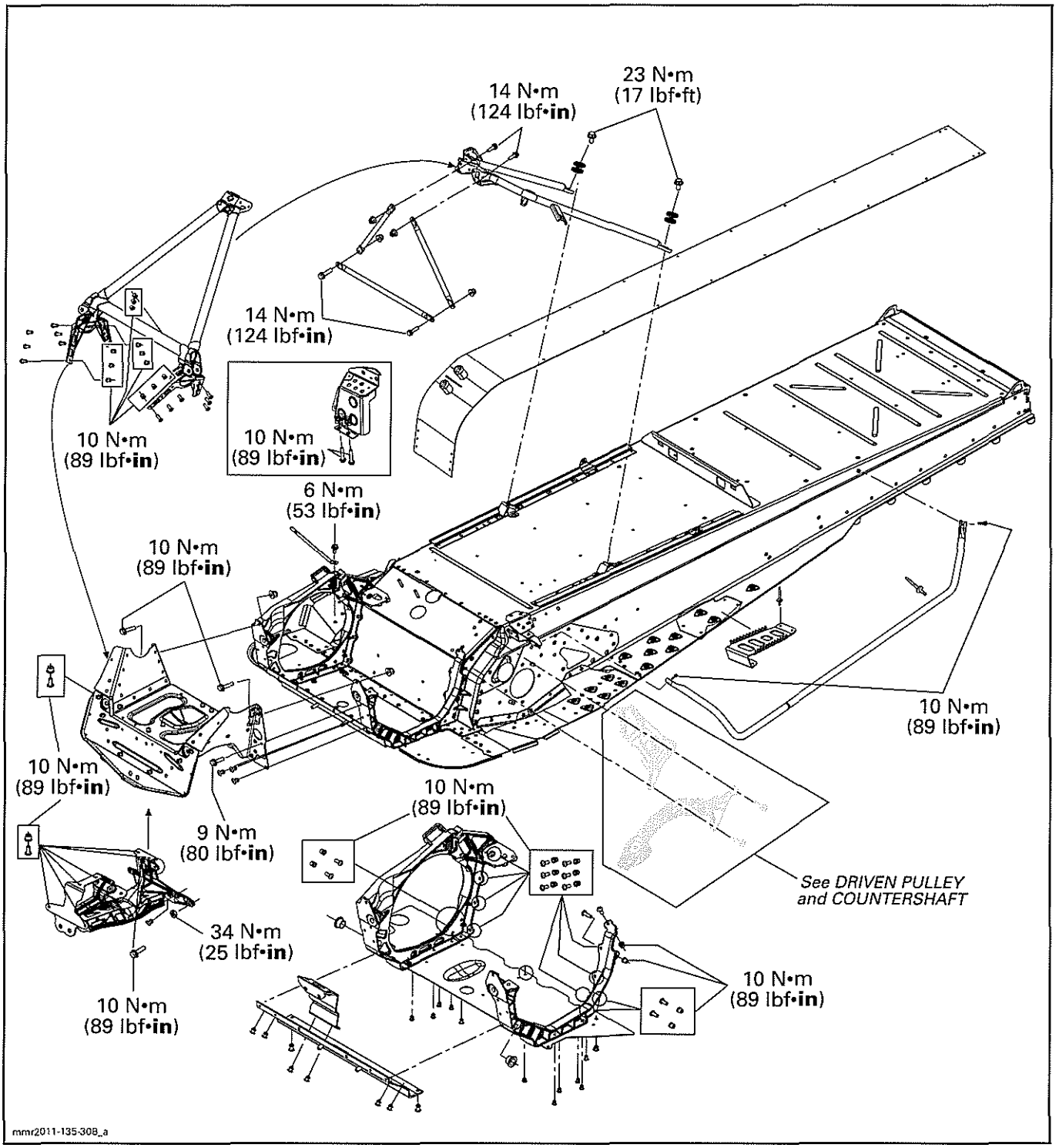
Skandic WT 600 ACE



Expedition LE/SE 600 HO E-TEC



Expedition LE/SE 1200 4-TEC



GENERAL

During assembly/installation, use the torque values and the service products as in the exploded view.

Clean threads before applying a threadlocker. Refer to *SELF-LOCKING FASTENERS* and *LOCTITE APPLICATION* at the beginning of this manual for complete procedure.

⚠ WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices (e.g.: locking tabs, elastic stop nuts, cotter pins, etc.) must be replaced with new ones.

Hoses, cables or locking ties removed during a procedure must be reinstalled as per factory standards.

PROCEDURES

RIVETS

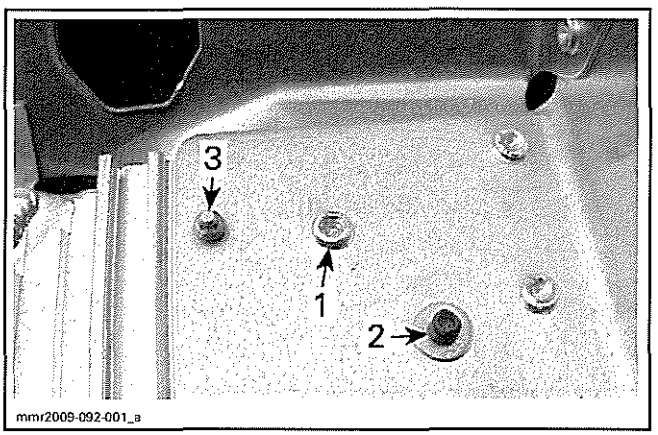
For proper drilling instructions and to prevent premature wear, follow the procedures as detailed.

NOTICE **When removing rivets, do not enlarge or deform the rivet holes in the frame.**

Self-Percing Rivet Removal

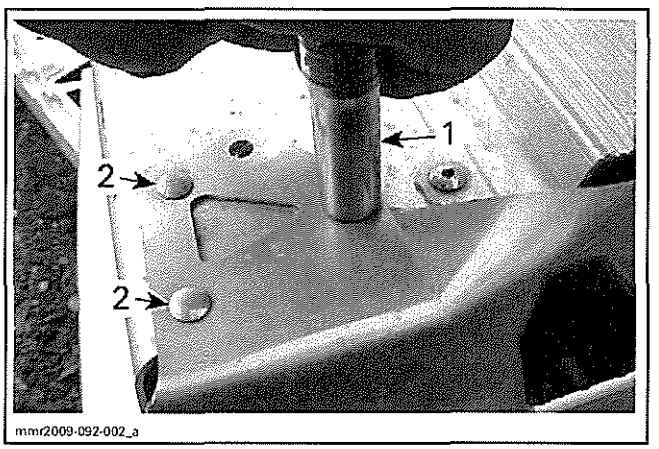
Recommended Method

1. Using a grinding disk, grind the rivet end.



1. *Grind this side of self-drilling rivet*
2. *Pop rivet*
3. *STAVEX rivet*

2. Support the frame around the rivet head with a socket on the opposite side to avoid warpage.



1. *11 mm socket over a rivet head*
2. *Rivet heads*

3. Drive out remaining rivet using a punch.

Alternative Method

1. Use a SUPERTANIUM DRILL BIT 3/16" (P/N 529 031 800) and a variable speed drill.
2. Partially drill **rivet end — not the rivet head.**

NOTICE **High speed drilling will cause excessive heat which may destroy the cutting edge of the bit; therefore, avoid using pneumatic drills.**

NOTE: To increase bit life, use XPS SYNTHETIC CHAINCASE OIL (P/N 413 803 300) as a cutting oil.

3. Cut rivet using a chisel.
4. Remove riveted part.
5. Drive out remaining rivet head using a punch.

Pop Rivet Removal

1. Use a SUPERTANIUM DRILL BIT 3/16" (P/N 529 031 800), and a variable speed drill.
2. Drill **rivet head** sufficiently to cut through rivet head.

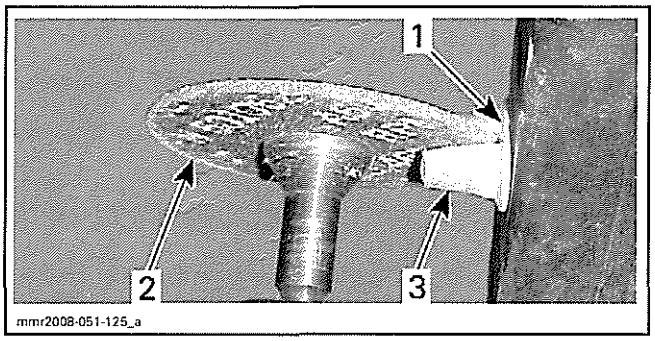
NOTICE **Drill only sufficiently to cut rivet head. Do not drill into frame material, or part secured using the rivet. When rivet is used to secure a plastic part, use pliers to avoid rotation of rivet with drill bit and heating or melting of the plastic part.**

3. Using a small punch, drive out the remaining rivet end.

HUCK Rivet Removal

Recommended Method

1. Using a cut-off tool, cut the rivet retainer without touching the retainer's shoulder.



1. Rivet retainer's shoulder
2. Cutter wheel
3. Rivet retainer

NOTE: Apply a thin layer of grease on cutter wheel to increase its durability.

2. Break the rivet retainer's shoulder using a chisel.
3. Use a small punch to drive out the rivet stem.

Alternative Method

1. Measure outside diameter of rivet stem and select appropriate drill bit.
2. Drill the **rivet stem — not the rivet head** using a variable speed drill until rivet retainer is freed.

NOTE: When possible, use an angle grinder to grind rivet head or use an air hammer to cut the rivet retainer.

FRAME

Frame Cleaning

Clean frame and tunnel with appropriate cleaners and rinse with high pressure hose.

NOTE: For bare aluminum frames use only aluminum cleaner and follow instructions on container.

NOTICE **Never direct high-pressure water jet towards decals. They will peel off.**

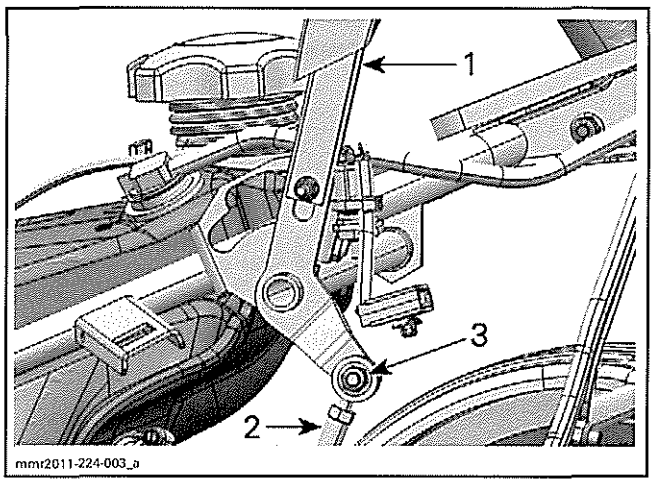
Frame Welding

Repairs using a welding technique should not be carried out on an aluminum frame unless it is specified on a BRP Bulletin.

REAR FRAME MEMBER

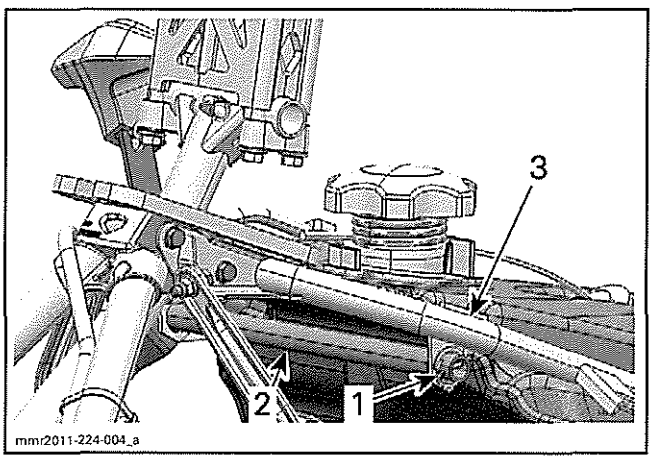
Rear Frame Member Removal

1. Refer to *BODY* subsection and remove the following:
   - Seat(s)
   - LH and RH side panels
   - Hood.
2. Refer to *AIR INTAKE SYSTEM* subsection and remove the gauge support and air intake silencer as a unit.
3. Remove console panel, refer to *BODY* subsection.
4. Disconnect the shift rod from the shift lever.



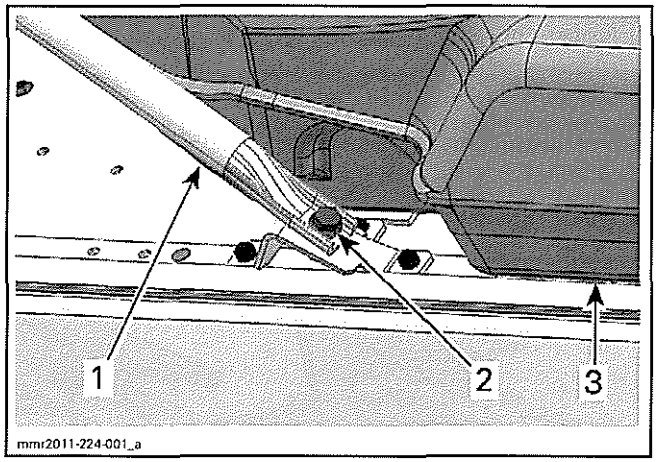
TYPICAL
1. Shift lever
2. Shift rod
3. Remove this bolt and nut

5. Remove the cotter pin that retains the shift lever shaft to the rear frame member and remove the shift lever.



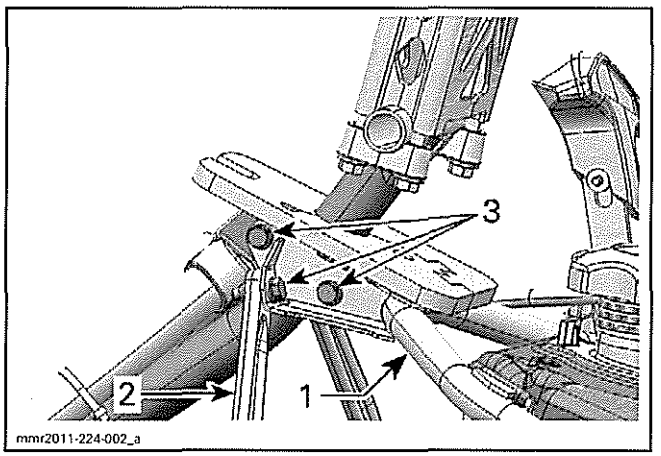
TYPICAL
1. Cotter pin to remove
2. Shift lever shaft
3. Rear frame member

6. Remove bolt and washer securing rear frame member (one each side).



TYPICAL
1. *Rear frame member*
2. *Bolt and washer to remove (each side)*
3. *Fuel tank*

7. Remove bolts securing:
   - Front and rear frame members to the upper steering column support
   - Side frame members to rear frame member.



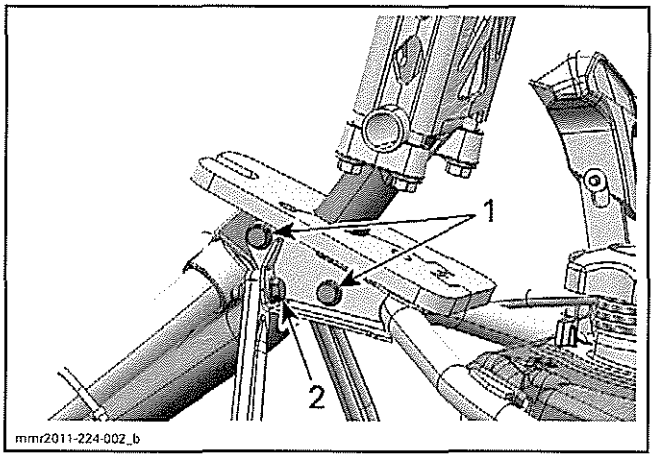
TYPICAL
1. *Rear frame member*
2. *LH side frame member*
3. *Bolts to remove*

8. Remove rear frame member.

Rear Frame Member Installation

Installation is the reverse of the removal procedure.

NOTE: Install all bolts and nuts before tightening them.



TYPICAL
1. *Mounting bolts, upper steering column support (2)*
2. *Side frame member mounting bolt (1 each side)*

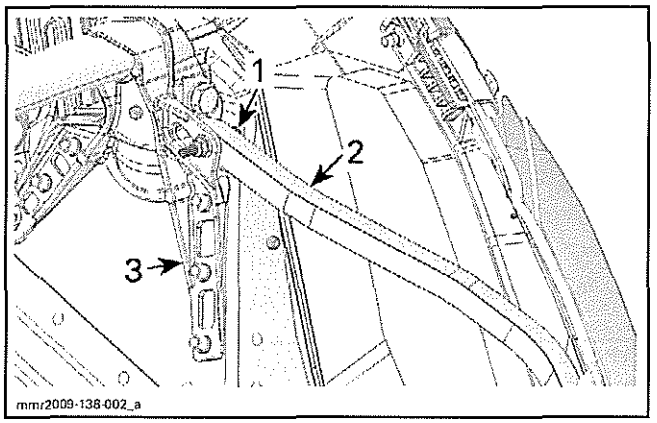
MOUNTING BOLT TORQUE		
UPPER STEERING COLUMN SUPPORT	All models	14 N•m (124 lbf•**in**)
SIDE FRAME MEMBER	All models except 600 ACE	14 N•m (124 lbf•**in**)
	600 ACE models	10 N•m (89 lbf•**in**)
AFT REAR FRAME MEMBER	All models	23 N•m (17 lbf•ft)

FRONT FRAME MEMBER

Front Frame Member Removal

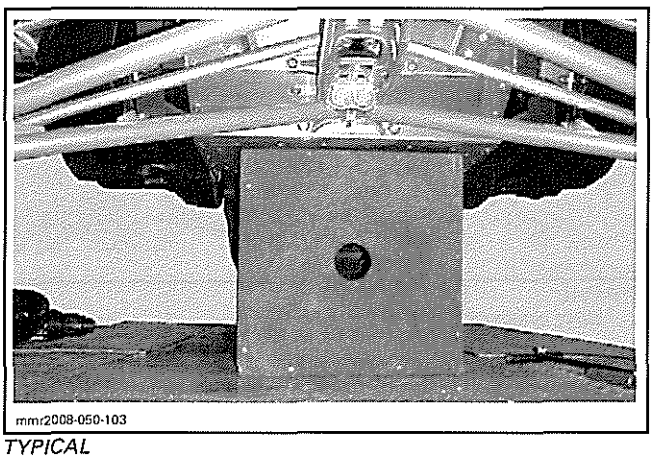
Expedition Series

1. Refer to *BODY* subsection to remove the following:
   - Seat(s)
   - LH and RH side panels
   - Hood
   - Console.
2. Refer to *AIR INTAKE SYSTEM* subsection and remove the gauge support and air intake silencer as a unit.
3. Remove the exhaust pipe. Refer to *EXHAUST SYSTEM* subsection.
4. Remove bolts securing bumper supports to front frame member (one each side).



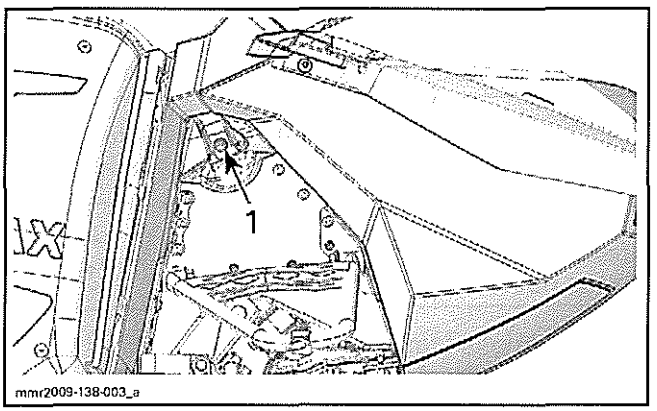
TYPICAL - LH BUMPER SUPPORT ILLUSTRATED
1. *Retaining bolt*
2. *LH bumper support*
3. *Front frame member*

5. Lift front of vehicle until skis are off the ground.
6. Place the front portion of frame on a wooden box to support it securely.



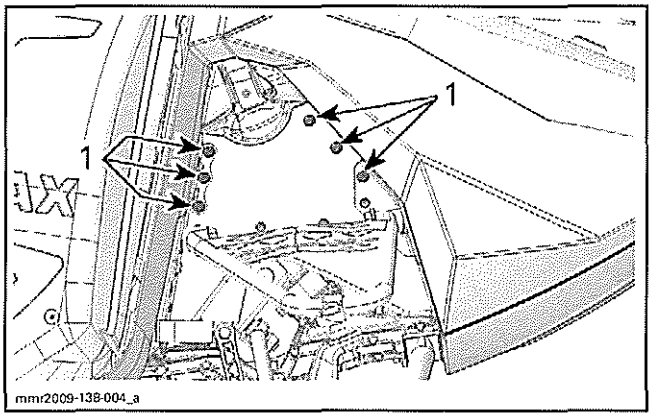
TYPICAL

7. Remove front shock absorbers.
8. Drill and remove the rivet retaining the front bottom pan to front frame member (one each side). Refer to *POP RIVET REMOVAL* at the beginning of this section.



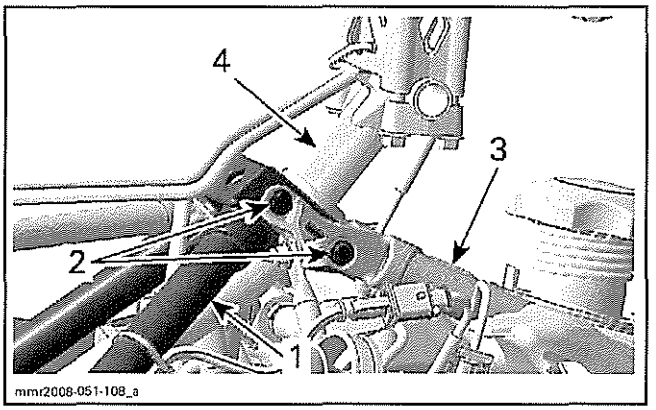
TYPICAL
1. *Remove this rivet*

9. Remove HUCK rivets (six each side), refer to *HUCK RIVET REMOVAL* procedure at the beginning of this section.



TYPICAL
1. *HUCK rivets*

10. Remove bolts securing front frame member to rear frame member and steering column support.



TYPICAL
1. *Front frame member*
2. *Bolts to remove*
3. *Rear frame member*
4. *Steering column*

11. Remove the front frame member.

Skandic WT Series

1. Refer to *BODY* subsection and remove the following parts.
   - Hood
   - Upper side panels (both sides)
   - Console.
2. Refer to *AIR INTAKE SYSTEM* subsection and remove the secondary air intake silencer and gauge support as a unit.

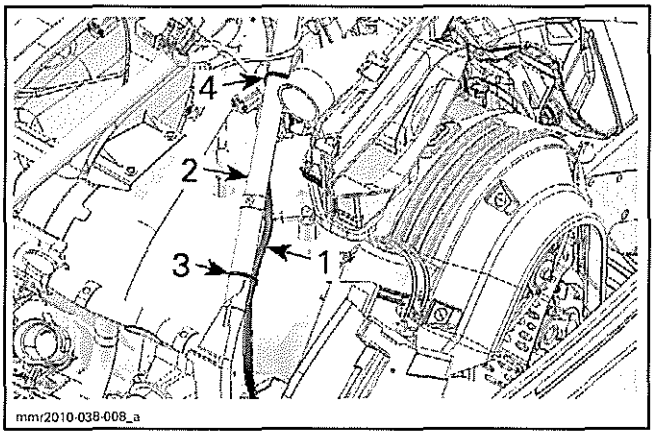
600 HO E-TEC Models

3. Refer to *EXHAUST SYSTEM* subsection and remove the tuned pipe.

4. Refer to *COOLING SYSTEM* subsection and remove the air cooled radiator.

All Models

5. Cut locking ties securing the fuel tank vent hose to the front frame member.

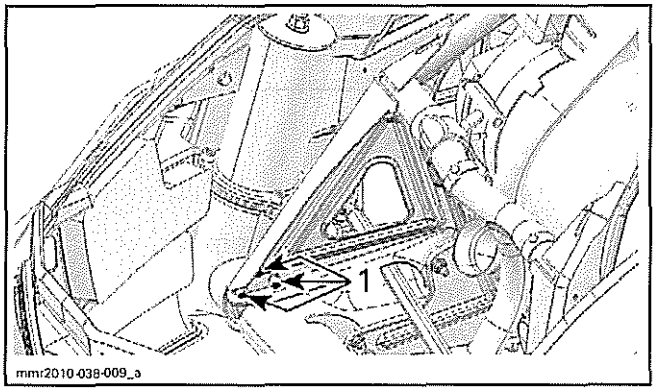


TYPICAL
1. *Fuel tank vent hose*
2. *Front frame member*
3. *Locking tie*
4. *Locking tie*

6. Place a wooden block of sufficient height under the engine module to support the weight of the engine and front suspension module.

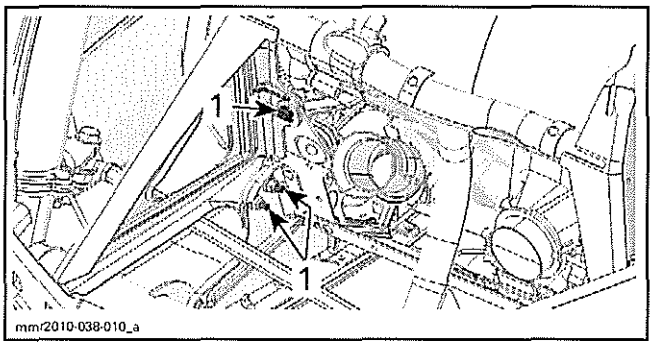
NOTE: The skis should not be lifted off the ground.

7. Remove bolts (3 on each side) securing the front frame member to the LTS module.



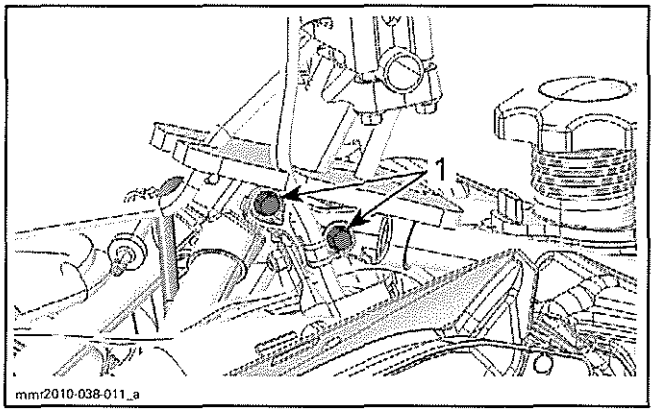
TYPICAL
1. *Huck rivets*

8. Remove bolts (3 on each side) retaining the front frame member to the front cross member and engine member.



TYPICAL
1. *Retaining bolts to remove*

9. Remove bolts securing front frame member and rear frame member at the steering column support.



TYPICAL
1. *Upper retaining bolts to remove*

10. Remove the front frame member from vehicle.

Front Frame Member Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

Expedition Series

1. Replace the HUCK rivets that secured the lower end of the front frame members with the following parts.

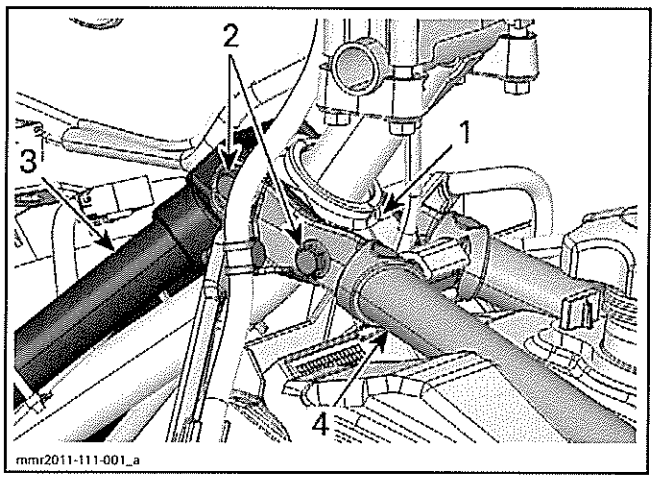
NEW FASTENERS		TORQUE
Hexagonal flanged bolt M6 x 20	(P/N 207 662 044)	Apply torque to elastic nut
Hexagonal flanged elastic stop nut M6	(P/N 233 261 414)	10 N•m (89 lbf•**in**)

NOTE: Unless stated otherwise, install bolt heads toward outside of the vehicle.

All Models

2. Ensure the steering support housing (2 halves) are properly positioned in the front member upper steering support. Refer to *STEERING SYSTEM* subsection.
3. Install bolts in upper steering column support using NEW elastic nuts and torque as per following table.

NOTE: Install all front frame member bolts loosely before any torque is applied.



TYPICAL
1. *Steering support housings (2 halves)*
2. *Mounting bolts, upper steering column support (2)*
3. *Front frame member*
4. *Rear frame member*

TORQUE FOR BOLTS IN UPPER STEERING COLUMN SUPPORT
14 N•m (124 lbf•**in**)

4. Install all bolts on the lower front portion of the front frame members using NEW elastic nuts and torque as per following table.

TORQUE FOR BOLTS IN FRONT FRAME MEMBER
10 N•m (89 lbf•**in**)

600 HO E-TEC Models

5. Refer to *COOLING SYSTEM* subsection and install the air cooled radiator as specified.

All Models

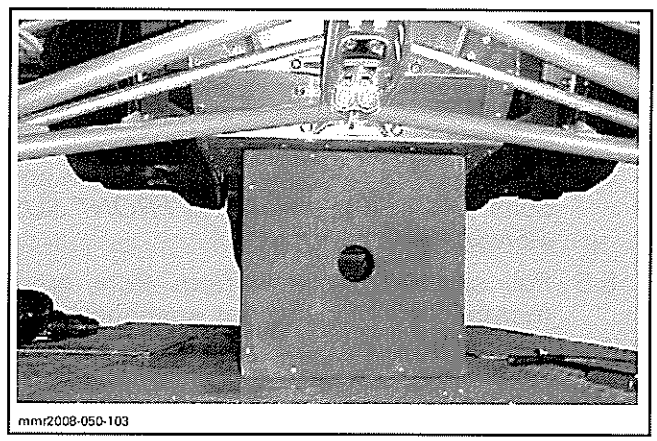
6. Secure the fuel tank vent hose to the front frame member using new locking ties.
7. Install all body parts as specified in the *BODY* subsection.

FRONT SUSPENSION MODULE

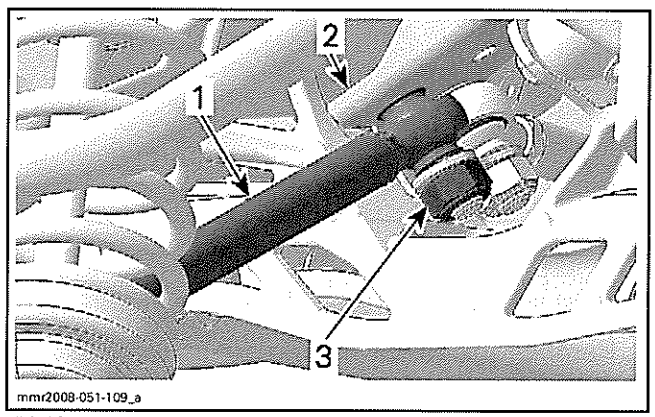
Front Suspension Module Removal

Expedition Series

1. Remove skid plate (as applicable).
2. Lift front of vehicle until skis are off the ground.
3. Place the front portion of frame on a wooden box to support it securely.

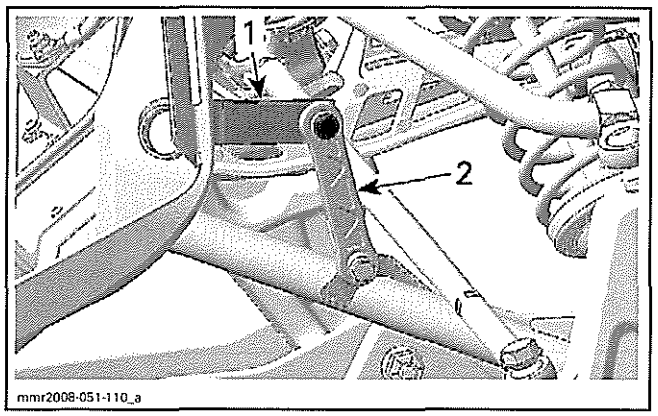


4. Remove the muffler and exhaust pipe(s), or tuned pipe as applicable. Refer to *EXHAUST SYSTEM* subsection.
5. Remove the front suspension assembly from the vehicle in the following manner:
   5.1 Disconnect both tie-rod ends from steering column.



TYPICAL
1. *Tie-rod*
2. *Steering column*
3. *Tie-rod end nut*

   5.2 Remove upper mounting bolt from both front shock absorbers.
   5.3 Remove bolt that secures stabilizer link to stabilizer lever (1 each side).



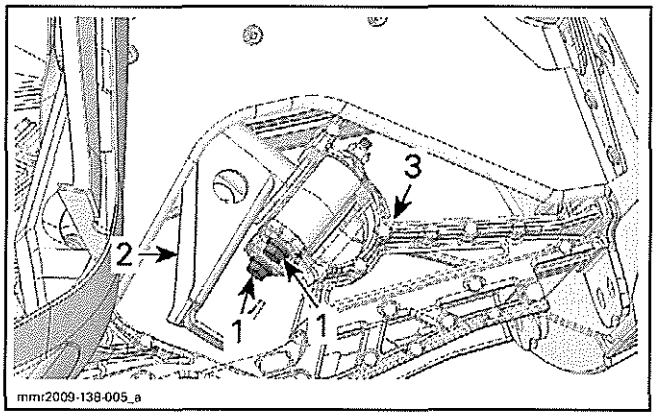
TYPICAL
1. *Stabilizer lever*
2. *Stabilizer link*

5.4 Remove upper and lower suspension arm bolts (both sides). Refer to *FRONT SUSPENSION* subsection.

5.5 Pull suspension arms from front cross member to remove front suspension assembly from vehicle.

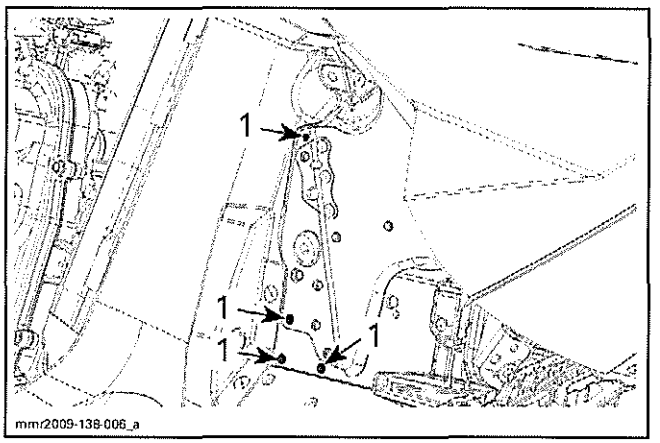
6. Remove the stabilizer bar, refer to *FRONT SUSPENSION* subsection.

7. Remove bolts securing the bottom of steering column.

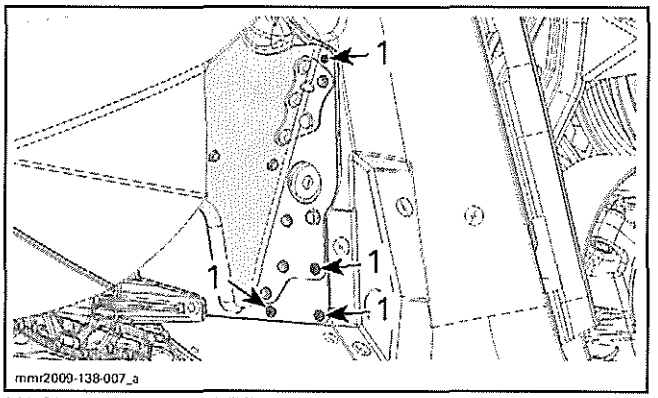


TYPICAL
1. *Steering column bolts*
2. *Steering column*
3. *Lower suspension arm support*

8. Remove the following pop rivets, refer to *POP RIVET REMOVAL* at the beginning of this subsection.

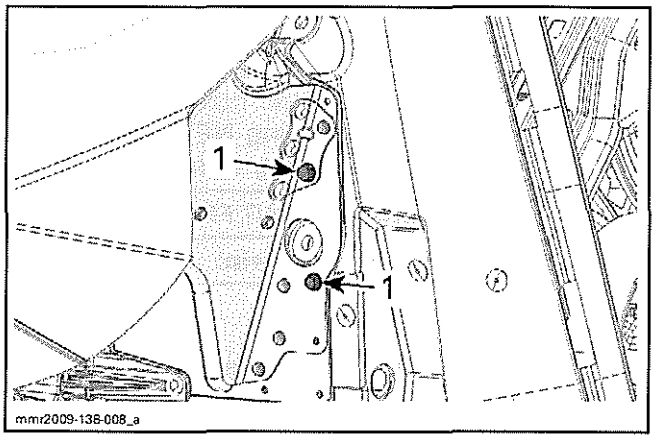


TYPICAL - RH SIDE (LOOKING AFT)
1. *Remove these rivets*



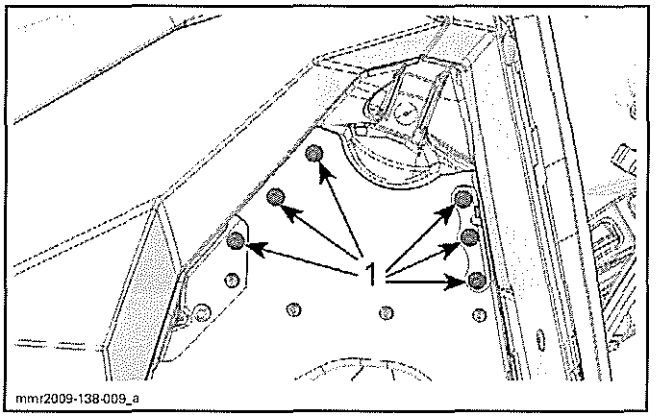
LH SIDE (LOOKING AFT)
1. *Remove these rivets*

9. Remove screws securing front cross member to frame (2 each side).



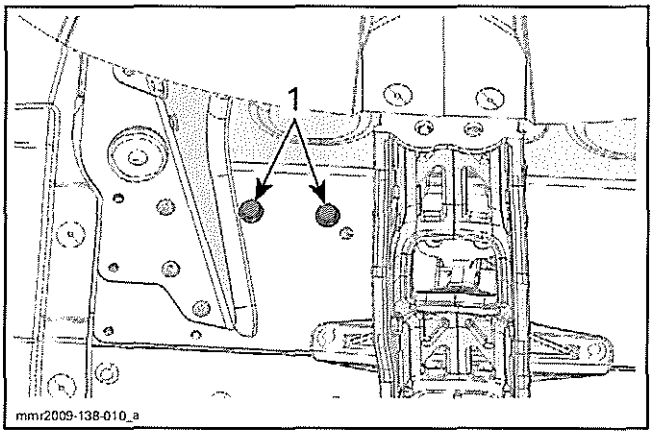
TYPICAL - LH SIDE SHOWN
1. *Hexagonal flanged bolt*

10. Remove HUCK rivets (six each side) that secure cross member to lower part of front frame member. Refer to *HUCK RIVET REMOVAL* procedure at the beginning of this subsection.



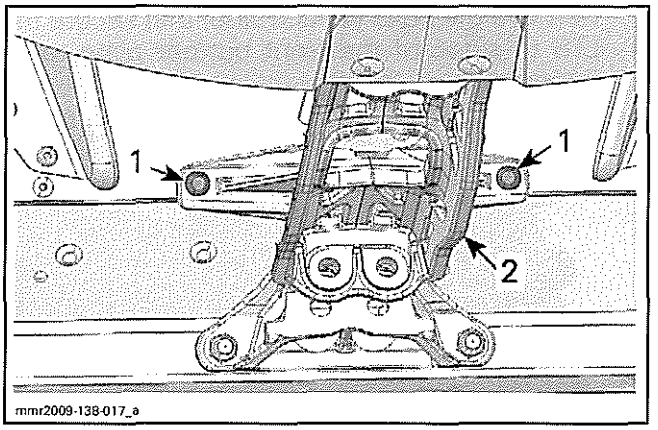
TYPICAL - LH SIDE ILLUSTRATED
1. HUCK rivets

11. Remove engine support bracket mounting screws.



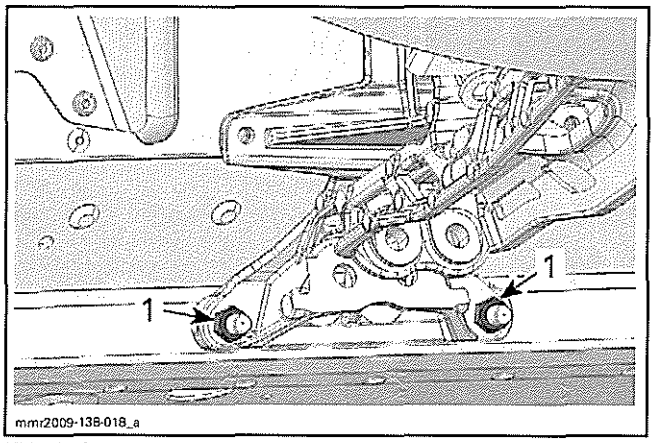
1. Engine support screws

12. Grind rivets securing the lower suspension support to engine module.



TYPICAL
1. Rivets
2. Lower suspension arm support

13. Remove the following nuts from the lower suspension support.

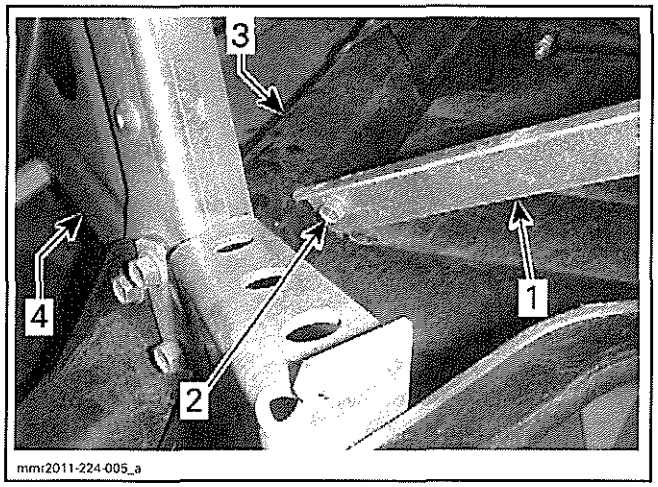


TYPICAL
1. Retaining nuts

14. Remove the front suspension module.
15. Remove front bottom pan from the front suspension module.

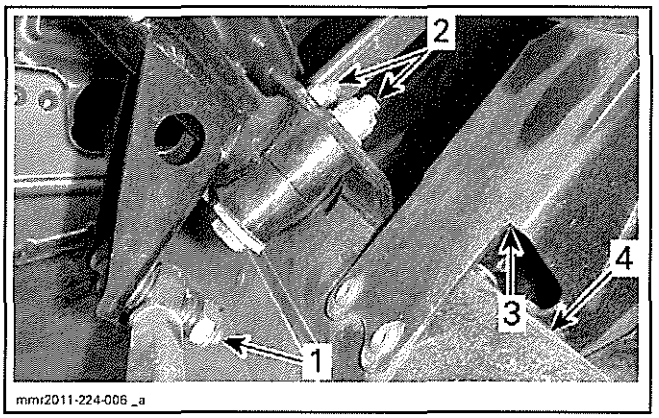
Skandic WT Series

1. Refer to *BODY* subsection and remove the following:
   - Hood
   - Upper and lower side panels.
2. Refer to *INTAKE SYSTEM* subsection and remove the secondary air intake silencer and gauge support as a unit.
3. Remove the muffler and exhaust pipe(s), or tuned pipe as applicable. Refer to *EXHAUST SYSTEM* subsection.
4. Refer to *BODY* subsection and remove the upper and lower front bottom pans.
5. With the skis hoisted off the ground, place a wooden box under the engine module to support it securely and disconnect the hoist.
6. Disconnect the lower front bumper braces from the LTS.



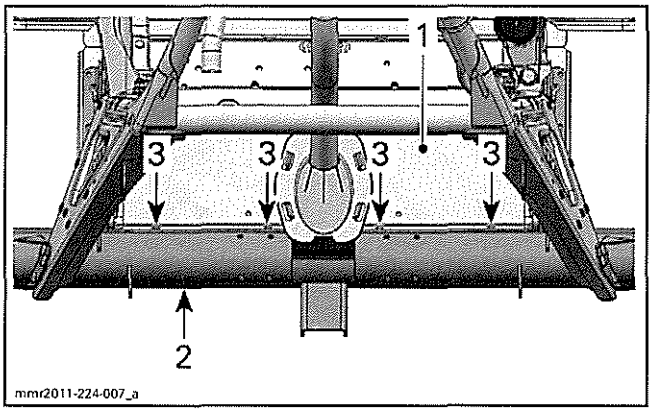
TYPICAL - RH SIDE ILLUSTRATED
1. *Lower front bumper brace*
2. *Bolt to remove*
3. *LTS center tube*
4. *RH front frame member*

7. Completely remove both tie rods.
8. Remove lower steering mounting bolts.



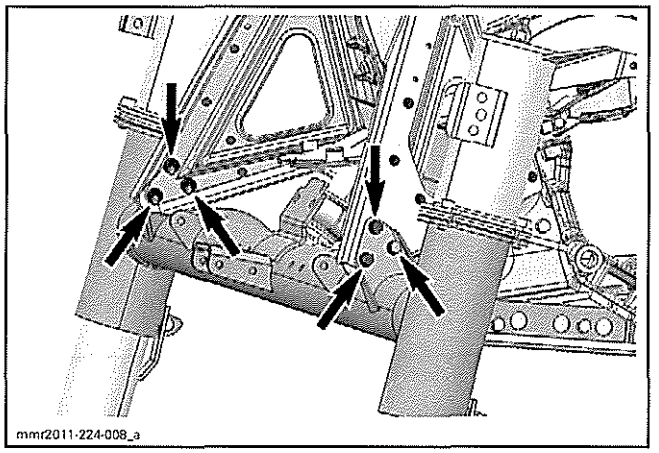
TYPICAL - 600 HO E-TEC MODEL ILLUSTRATED
1. *Inner tie-rod end bolt*
2. *Lower steering mounting bolts*
3. *Tuned pipe mount*
4. *LTS center tube*

9. Remove rivets that secure the aluminum front bottom plate to the LTS using the appropriate procedure explained in the beginning of this subsection.



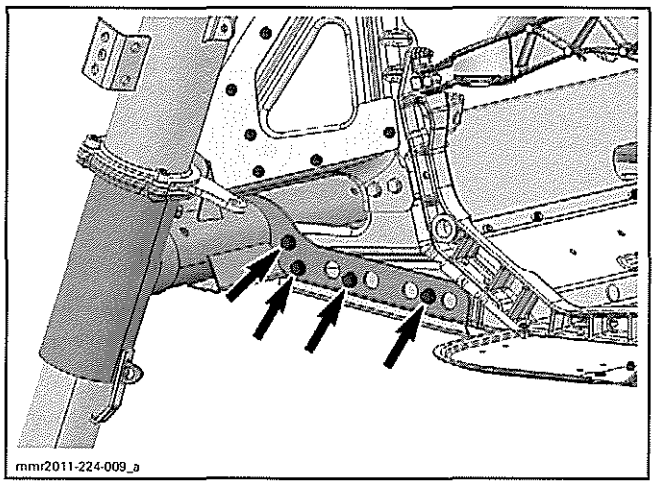
TYPICAL - TOP VIEW OF 600 HO E-TEC MODEL
1. *Front bottom plate*
2. *LTS center tube*
3. *Rivets to remove*

10. Remove the bolts (3 each side) that secure the LTS to the lower portion of the front frame member.



TYPICAL

11. Remove the bolts (4 each side) that secure the LTS to sides of the front bottom plate reenforcements.



TYPICAL - LEFT SIDE VIEW

12. Pull LTS from the front bottom plate.

Front Suspension Module Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

Expedition Series

1. Replace the HUCK rivets with the following parts.

NEW FASTENERS	
Hexagonal flanged bolt M6 x 20	(P/N 207 662 044)
Hexagonal flanged elastic stop nut M6	(P/N 233 261 414)
TORQUE	
10 N•m (89 lbf•**in**)	

NOTE: Unless otherwise stated, install bolt heads toward outside of the vehicle. All bolts should be installed loosely before any torque is applied.

All Models

2. Replace all removed elastic nuts with new ones.
3. Reinstall all removed parts by using the applicable installation procedure.

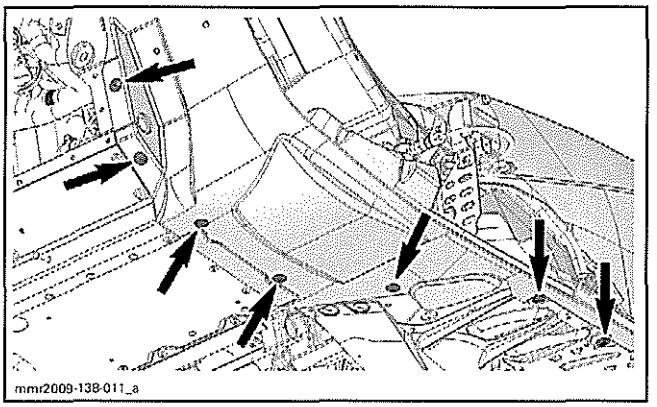
ENGINE MODULE

Engine Module Removal

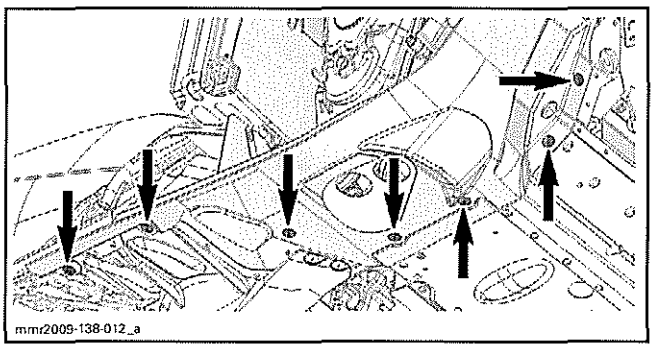
1. Refer to *ENGINE REMOVAL AND INSTALLATION* subsection and remove the following:
   - Engine
   - RH rear engine mount.
2. Remove track, refer to *TRACK* subsection.
3. Remove the *FRONT SUSPENSION MODULE*, see procedure in this subsection.

Expedition Series

4. Remove both side bottom pans by removing the following rivets.



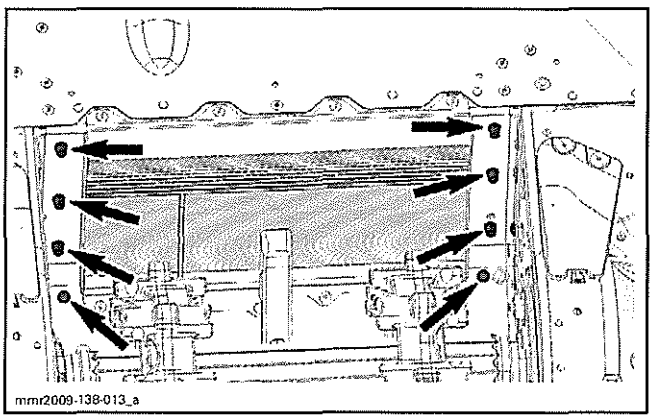
TYPICAL - LH SIDE BOTTOM PAN



TYPICAL - RH SIDE BOTTOM PAN

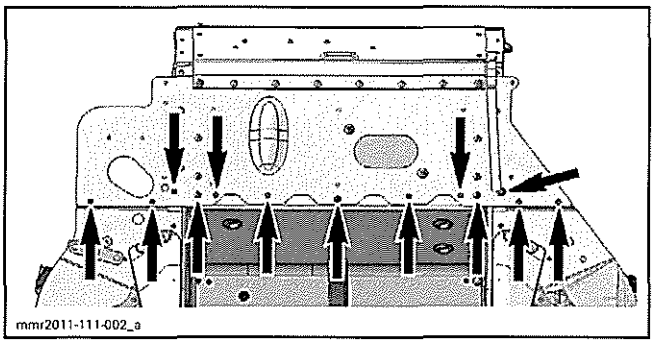
All Models

5. From underneath tunnel, remove HUCK rivets securing LH and RH frame members, refer to *HUCK RIVET REMOVAL* procedure at the beginning of this subsection.



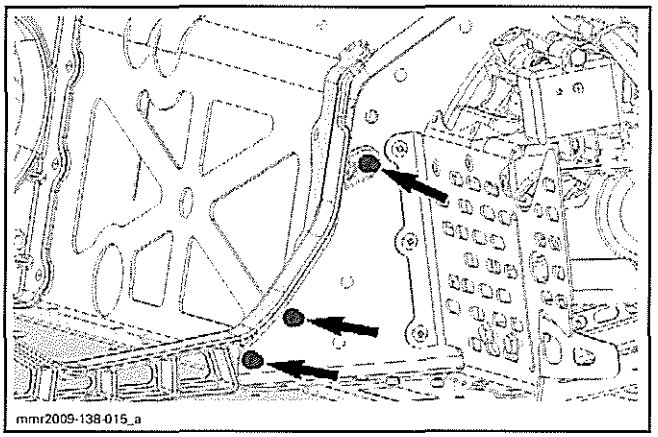
TYPICAL

6. Remove rivets that secure the engine module to the frame as applicable to model.

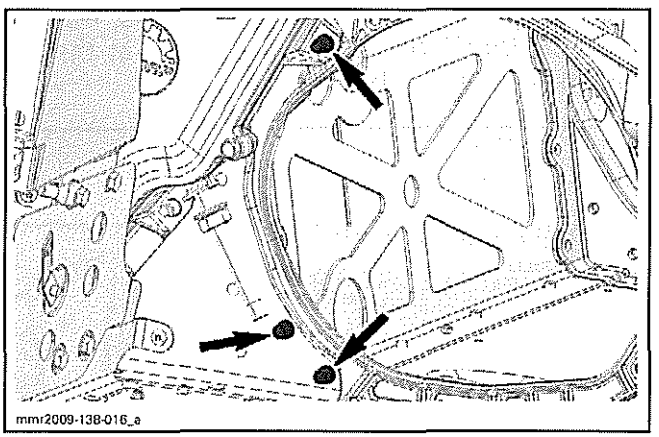


TYPICAL

7. Remove rivets located on both sides of frame.



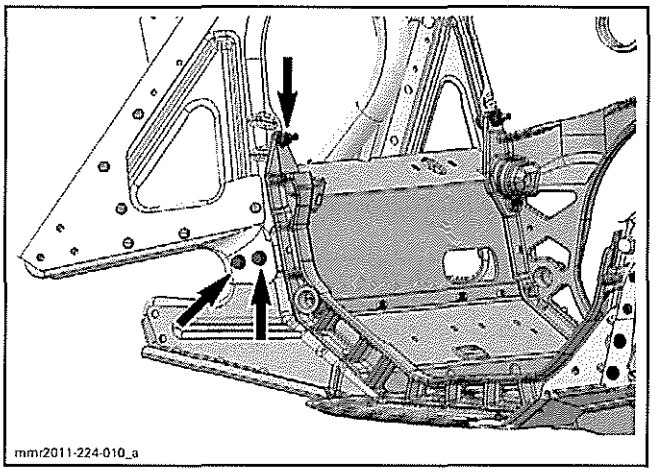
TYPICAL - LH SIDE



TYPICAL - RH SIDE

Skandic WT Series

8. Remove bolts (3 each side) that secure front frame member to engine module.



TYPICAL - LEFT SIDE ILLUSTRATED

All Models

9. Remove the engine module.

Engine Module Installation

The installation is the reverse of the removal procedure. However, pay attention to the following.

1. Replace rivets that secured the engine module to the frame with the following parts.

NEW FASTENERS	
Hexagonal flanged bolt M6 x 20	(P/N 207 662 044)
Hexagonal flanged elastic stop nut M6	(P/N 233 261 414)
TORQUE	
10 N•m (89 lbf•**in**)	

NOTE: Unless otherwise stated, install bolt heads toward outside of the vehicle.

2. Reinstall all removed parts by using the applicable installation procedure.

EXPEDITION (600 HO E-TEC)

ENGINE			
Engine type			Rotax 593 E-TEC, liquid cooled w/Reed valve, 3D-RAVE
Number of cylinder			2
Bore			72 mm (2.835 in)
Stroke			73 mm (2.874 in)
Displacement			594.4 cm³ (36.27 in³)
Compression ratio			12.25 : 1
Maximum power engine speed			8100 ± 100 RPM
3D RAVE spring	Compression spring	Color	Red
		Wire diameter	0.8 mm (.031 in)
		Minimum free length	45 mm (1.772 in)
	Valve springs	Color	Red
		Wire diameter	0.7 mm (.0276 in)
		Minimum free length	35 mm (1.378 in)
Piston ring type			Semi-trapezoidal
Ring end gap		New	0.4 mm to 0.55 mm (.016 in to .022 in)
		Wear limit	1 mm (.039 in)
Ring/piston groove clearance		New	0.05 mm to 0.1 mm (.002 in to .0039 in)
		Wear limit	0.2 mm (.0079 in)
Piston/cylinder wall clearance		New	0.108 mm to 0.152 mm (.0043 in to .006 in)
		Wear limit	0.2 mm (.0079 in)
Piston projection		Minimum	0.9 mm (.035 in)
		Maximum	1.1 mm (.043 in)
Piston skirt wear		Wear limit	0.15 mm (.006 in)
Cylinder head warpage		Wear limit	0.5 mm (.0197 in)
Cylinder taper		New (max.)	0.05 mm (.002 in)
		Wear limit	0.1 mm (.0039 in)
Cylinder out of round		New (max.)	0.012 mm (.0005 in)
		Wear limit	0.08 mm (.0031 in)
Crankshaft end play		New	MIN.: 0.10 mm (.0039 in) MAX.: 0.30 mm (.0118 in)
Crankshaft deflection		MAX.	MAG: 0.06 mm (.0024 in) CENTER: 0.08 mm (.0031 in) PTO: 0.06 mm (.0024 in)
Connecting rod big end axial play		New	0.28 mm to 0.68 mm (.011 in to .0268 in)
		Wear limit	1.2 mm (.0472 in)

Section 10 TECHNICAL SPECIFICATIONS
Subsection 01 (EXPEDITION (600 HO E-TEC))

COOLING SYSTEM			
Coolant		Type	Ethyl glycol and distilled water (50%/50%). Use BRP premix coolant (P/N 219 700 362) or coolant specifically formulated for aluminum engines
		Quantity	4.5 L (1.19 U.S. gal.)
Thermostat opening temperature			37°C (99°F)
Radiator cap opening pressure			90 kPa (13 PSI)
LUBRICATION SYSTEM			
Oil injection pump type			Electronic oil injection pump
Injection oil		Type	XPS synthetic blend 2-stroke oil (P/N 293 600 100)
		Quantity	2.9 L (98 U.S. oz)
FUEL SYSTEM			
Fuel delivery			E-TEC direct injection
Throttle body			Dell'Orto 46 mm
Fuel pump			In-tank electrical fuel pump
Idle speed (not adjustable)			1200 ± 200 RPM
Fuel	Type		Premium unleaded gasoline
	Octane rating	Inside North America ((R+M)/2)	Recommended: 91 Accepted: 87
		Outside North America (RON)	Recommended: 95 Accepted: 92
Fuel tank capacity			45 L (11.9 U.S. gal.)
ELECTRICAL SYSTEM			
Lightning system output			1200 W (12V and 55V/60V)
Ignition type			Inductive
Spark plug		Make and type	NGK PZFR6F (engine and spark plug threads are indexed)
		Gap	Not adjustable 0.7 mm to 0.8 mm (.028 in to .031 in)
Ignition timing BTDC @ 3500 ± 500 RPM			28°
			5.38 mm (.212 in)
Crankshaft position sensor (CPS)			190 to 290 Ω
Stator			0.63 ± 0.03 Ω
Battery			12 V, 18 A•h
Headlamp			2 x 60/55 W (H4)
Taillight and stoplight			P 21/5 W
Fuses		F1: Battery	30 A
		F2: Start	5 A
		F3: Horn (optional)	10 A
		F4: Fan	15 A
Relays		Relay 1	Run relay
		Relay 2	Fan relay

DRIVE SYSTEM			
Gearbox oil	Type		XPS synthetic chaincase oil (P/N 413 803 300)
	Quantity		700 ml (24 U.S. oz)
Gear ration	1st		3.23 : 1
	2nd		1.98 : 1
	R		3.76 : 1
Drive pulley type			TRA III
Drive pulley calibration	Clutch engagement		3000 ± 100 RPM
	Spring color		Yellow/Red
	Spring length		94.61 mm (3.725 in)
	Pin		Solid (long)
	Ramp		600
	Screw position		2
Driven pulley type	Type		QRS
	Spring color		White/White
	Spring preload	New	7.5 kg ± 0.7 kg (16.5 lb ± 1.5 lb)
		After break-in	6.8 kg ± 0.7 kg (15 lb ± 1.5 lb)
	Cam angle		40°
Pulley distance	Z		21 mm (.827 in) (not adjustable)
Offset	X		36.4 mm ± 1.8 mm (1.433 in ± .071 in) (not adjustable)
Drive belt	Width		38.5 mm (1.516 in)
	Wear limit		36.1 mm (1.421 in)
Track	Width		500 mm (20 in)
	Length		3.9 m (154 in)
	Profile height		31.8 mm (1-1/4 in)
Track adjustment	Deflection		4.2 cm (1-21/32 in)
	Force		6.0 kgf to 8.5 kgf (13 lbf to 19 lbf)
BRAKE SYSTEM			
Brake lining minimum thickness			1 mm (.039 in)
Brake disk minimum thickness			4.5 mm (.177 in)
Brake fluid	Type		DOT 4
	Quantity		65 ml (2.2 U.S. oz)

SUSPENSION			
FRONT			
Suspension type			REV-XP
Suspension maximum travel			210 mm (8.3 in)
Shock absorber type			Motion control
REAR			
Suspension type			SC-5U
Suspension maximum travel			340 mm (13.4 in)
Shock absorber type	Center		Motion control
	Rear		HPG
STEERING SYSTEM			
Ski type			Pilot 6.9
Toe-out			5 mm (.197 in)
Camber			0°
WEIGHT AND DIMENSIONS			
Mass (dry)		Expedition LE	278 kg (613 lb)
		Expedition SE	298 kg (657 lb)
Length		Expedition LE	323 cm (127 in)
		Expedition SE	324 cm (128 in)
Width			115 cm or 119.2 cm (45.3 in or 46.9 in)
Height			133 cm (52.4 in)
Ski stance (carbide to carbide)			97.5 cm or 101.8 cm (38.4 in or 40.1 in)
MATERIAL			
Frame			Aluminum
Bottom pans, gauge support and side panels			Polypropylene
Hood and console			Surlyn

EXPEDITION (1200 4-TEC)

ENGINE			
Engine type			ROTAX® 1203 4-stroke, Double Over Head Camshaft (DOHC), liquid cooled
Number of cylinders			3
Number of valves			12 valves (mechanical adjustment)
Bore			91 mm (3.58 in)
Stroke			60 mm (2.36 in)
Displacement			1 171 cm³ (71.46 in³)
Compression ratio			11.0:1
Decompressor type			N.A.
Maximum HP RPM			7800 ± 100 RPM
Intake valve opening			0° BTDC
Intake valve closing			40° ABDC
Exhaust valve opening			60° BBDC
Exhaust valve closing			5° BTDC
Valve clearance	Intake		0.10 mm to 0.20 mm (.0039 in to .0079 in)
	Exhaust		0.30 mm to 0.40 mm (.0118 in to .0157 in)
Valve stem diameter	Intake	New	5.471 mm to 5.486 mm (.2154 in to .216 in)
		Service limit	5.450 mm (.2146 in)
	Exhaust	New	5.461 mm to 5.476 mm (.215 in to .2156 in)
		Service limit	5.440 mm (.2142 in)
Valve guide diameter		New	5.506 mm to 5.518 mm (.2168 in to .2172 in)
		Service limit	5.568 mm (.2192 in)
Valve spring free length		New	36.70 mm (1.445 in)
		Service limit	35.50 mm (1.398 in)
Valve seat contact width	Intake	New	1.6 mm to 1.8 mm (.063 in to .0709 in)
		Service limit	2.2 mm (.0866 in)
	Exhaust	New	1.4 mm to 1.8 mm (.0551 in to .0709 in)
		Service limit	2.4 mm (.0945 in)
Cam follower bore diameter		New	8.013 mm to 8.049 mm (.3155 in to .3169 in)
		Service limit	8.060 mm (.3173 in)
Cam follower shaft diameter		New	7.972 mm to 7.980 mm (.3139 in to .3142 in)
		Service limit	7.960 mm (.3134 in)
Piston measurement		New	90.950 mm to 90.966 mm (3.5807 in to 3.5813 in)
		Service limit	90.900 mm (3.579 in)
Piston/cylinder wall clearance		New	0.027 mm to 0.057 mm (.0011 in to .0022 in)
		Service limit	0.100 mm (.0039 in)
Piston ring type		1st	Upper compression ring, rectangular
		2nd	Lower compression ring, tapered face
		3rd	Oil scraper ring

ENGINE (cont'd)			
Ring end gap	Rectangular	New	0.25 mm to 0.40 mm (.0098 in to .0157 in)
		Service limit	0.60 mm (.0236 in)
	Taper-face	New	0.20 mm to 0.40 mm (.0079 in to .0157 in)
		Service limit	0.70 mm (.0276 in)
	Oil scraper ring	New	0.20 mm to 0.70 mm (.0079 in to .0276 in)
		Service limit	1.0 mm (.0394 in)
Ring/piston groove clearance	Rectangular	New	0.030 mm to 0.070 mm (.0012 in to .0028 in)
		Service limit	0.150 mm (.0059 in)
	Taper-face	New	0.020 mm to 0.060 mm (.0008 in to .0024 in)
		Service limit	0.150 mm (.0059 in)
	Oil scraper ring	New	0.010 mm to 0.180 mm (.0004 in to .0071 in)
		Service limit	0.250 mm (.0098 in)
Cylinder bore		New	90.993 mm to 91.007 mm (3.5824 in to 3.583 in)
Cylinder taper		Maximum New	0.030 mm (.0012 in)
		Service limit	0.090 mm (.0035 in)
Cylinder out of round		Maximum New	0.008 mm (.0003 in)
		Service limit	0.050 mm (.002 in)
Camshaft bearing journal diameter	PTO/MAG	New	23.967 mm to 23.980 mm (.9436 in to .9441 in)
		Service limit	23.950 mm (.9429 in)
	Center	New	32.959 mm to 32.975 mm (1.2976 in to 1.2982 in)
		Service limit	32.942 mm (1.2969 in)
Camshaft holder bore diameter	PTO/MAG	New	24.007 mm to 24.020 mm (.9452 in to .9457 in)
		Service limit	24.070 mm (.948 in)
Camshaft lobe height	Intake	New	38.12 mm to 38.32 mm (1.5008 in to 1.5087 in)
		Service limit	38.09 mm (1.4996 in)
	Exhaust	New	37.86 mm to 38.06 mm (1.4906 in to 1.4984 in)
		Service limit	37.83 mm (1.4894 in)
Crankshaft bearing journal diameter		New	35.984 mm to 36.000 mm (1.4167 in to 1.4173 in)
		Service limit	35.970 mm (1.4161 in)
Crankshaft radial play		Service limit	0.10 mm (.0039 in)
Crankshaft axial play		New	0.080 mm to 0.313 mm (.0031 in to .0123 in)
		Service limit	0.350 mm (.0138 in)
Balancer shaft bearing journal diameter		New	35.984 mm to 36.000 mm (1.4167 in to 1.4173 in)
		Service limit	35.970 mm (1.4161 in)
Balancer shaft radial play		Service limit	0.10 mm (.0039 in)
Balancer shaft axial play		New	0.10 mm to 0.23 mm (.0039 in to .0091 in)
		Service limit	0.350 mm (.0138 in)
Crankshaft pin diameter		New	37.984 mm to 38.000 mm (1.4954 in to 1.4961 in)
		Service limit	37.970 mm (1.4949 in)
Crankshaft deflection	MAG	Maximum	0.050 mm (.002 in)
	Center	Maximum	0.050 mm (.002 in)
	PTO	Maximum	0.030 mm (.0012 in)

ENGINE (cont'd)			
Crankshaft/balancer shaft plain bearing inside diameter		Service limit	36.100 mm (1.4213 in)
Connecting rod big end diameter		Service limit	38.060 mm (1.4984 in)
Connecting rod big end radial play		Service limit	0.08 mm (.0031 in)
Connecting rod big end axial play		New	0.100 mm to 0.352 mm (.0039 in to .0139 in)
		Service limit	0.400 mm (.0157 in)
Connecting rod small end diameter		New	22.010 mm to 22.020 mm (.8665 in to .8669 in)
		Service limit	22.040 mm (.8677 in)
Piston pin diameter		New	21.991 mm to 21.996 mm (.8658 in to .866 in)
		Service limit	21.985 mm (.8656 in)
Connecting rod small end radial play		Service limit	0.045 mm (.0018 in)
COOLING SYSTEM			
Coolant	Type		Ethyl glycol and distilled water (50%/50%). Use BRP premixed coolant (P/N 219 700 362) or coolant specifically formulated for aluminum engines
	Quantity		6.6 L (1.74 U.S. gal.)
Thermostat opening temperature			65°C (149°F)
Radiator cap opening pressure			110 kPa (16 PSI)
LUBRICATION SYSTEM			
Lubrication	Type		Dry sump. Replaceable oil filter
	Oil filter		BRP Rotax paper type, replaceable
	Engine oil pressure	Minimum	60 kPa (8.7 PSI) @ 1100 RPM
			350 kPa (50.8 PSI) @ 7700 RPM
	Engine oil	Capacity (oil change with filter)	3.5 L (3.7 qt (U.S. liq.))
		Recommended	XPS Synthetic 4-Stroke oil (All climate) (P/N 293 600 112) or a SAE 0W 40 API service SM synthetic oil
FUEL SYSTEM			
Throttle body type			Multi point EFI, 52 mm heated Dell'Orto throttle body
Idle speed	Normal idle		1100 RPM (starting at 70°C (158°F) oil temperature)
	Fast idle		1500 RPM at -40°C (-40°F)
Gasoline type			Unleaded
Minimum octane rating	Inside North America ((R+M)/2)		87
	Outside North America (RON)		92
Fuel tank capacity			45 L (11.89 U.S. gal.)
ELECTRICAL SYSTEM			
Magneto generator output			500 W @ 5000 RPM @ 14 V
Magneto stator resistance (between any pair of yellow wires)			0.1 to 1 Ohm @ 20°C (68°F)
Ignition type			IDI (Inductive Digital Ignition)
Spark plug	Make and type		NGK CR8EKB
	Gap		.70 mm to 0.80 mm (.028 in to .031 in)
Ignition timing			Not adjustable
Battery			12 volt 18 A.h. YTX20HL-BS
Headlamp			2 X 55/60 W (H4)
Taillight and stoplight			2 X P 5/21 W

ELECTRICAL SYSTEM (cont'd)			
Fuses	F 1: HIC/CDI		5 A
	F 2: Fuel pump		10 A
	F 3: HIC		5 A
	F 4: HIC		5 A
	F 5: HIC		5 A
	F 6: Rear light		10 A
	F 7: Headlights		15 A
	F 8: Relay/Gauge		10 A
	F 9: Relay/Gauge		7.5 A
	F 10: Fan		15 A
	F 11: Rear power outlet		5 A (10 A with optional horn)
	F 12: Unused		–
	F 13: Charging		30 A
Relays	Relay 1		Load relay
	Relay 2		Fan relay
	Relay 3		Run relay
DRIVE SYSTEM			
Gearbox oil	Type		XPS synthetic chaincase oil
	Quantity		700 ml (23.67 U.S. oz)
Gear ratio	1st		3.23 : 1
	2nd		1.98 : 1
	R		4.06 : 1
Drive pulley	Type		TRA IV LD
	Calibration	Clutch engagement	2500
		Spring color	Red/Orange
		Spring length	90.70 mm (3.571 in)
		Pin	Solid long
		Ramp	617
		Screw position	2
Driven pulley	Type		QRS
	Calibration	Spring preload (New)	8.3 kgf ± 0.7 kgf (18.3 lbf ± 1.5 lbf)
		Spring preload (After break-in)	7.5 kgf ± 0.7 kgf (16.5 lbf ± 1.5 lbf)
		Spring color	Beige
		Cam angle	44°/40°
	Offset	Z	21.40 mm (.843 in)
		X	36.90 mm ± 0.5 mm (1.453 in ± .02 in)
Drive belt	Width		38.3 mm (1.508 in)
	Wear limit		35.90 mm (1.413 in)
Track	Width		500 mm (20 in)
	Length		3.92 m (154 in)
	Profile height		31.8 mm (1-1/4 in)
Track adjustment	Deflection		4.2 cm (1-21/32 in)
	Force		6 kgf to 8.5 kgf (13 lbf to 19 lbf)

BRAKE SYSTEM			
Brake lining minimum thickness			1 mm (.039 in)
Brake disk minimum thickness			4.5 mm (.177 in)
Brake fluid	Type		DOT 4
	Quantity		65 ml (2.2 U.S. oz)
FRONT SUSPENSION			
Suspension type			Double A-arms
Suspension maximum travel			210 mm (8.3 in)
Shock absorber type			Motion control
Stabilizer bar type			Link
REAR SUSPENSION			
Suspension type			SC-5U
Suspension maximum travel			340 mm (13.4 in)
Shock absorber type	Center		Motion control
	Rear		HPG
Stroke limiter standard position			3
STEERING SYSTEM			
Ski type			Pilot 6.9
Toe-out			5 mm (.197 in)
Camber			0°
WEIGHT AND DIMENSIONS			
Dry weight		Expedition LE	302 kg (666 lb)
		Expedition SE	322 kg (710 lb)
Length		Expedition LE	323 cm (127 in)
		Expedition SE	324 cm (128 in)
Width			115 cm - 119.2 cm (45.3 in - 46.9 in)
Height			133 cm (52.4 in)
Ski stance (carbide to carbide)			97.5 cm - 101.8 cm (38.4 in - 40.1 in)

SKANDIC WT (600 HO E-TEC)

ENGINE			
Engine type			Rotax 593 E-TEC, liquid cooled w/Reed valve, 3D-RAVE
Number of cylinder			2
Bore			72 mm (2.835 in)
Stroke			73 mm (2.874 in)
Displacement			594.4 cm³ (36.27 in³)
Compression ratio			12.25 : 1
Maximum power engine speed			8100 ± 100 RPM
3D RAVE spring	Compression spring	Color	Red
		Wire diameter	0.8 mm (.031 in)
		Minimum free length	45 mm (1.772 in)
	Valve springs	Color	Red
		Wire diameter	0.7 mm (.0276 in)
		Minimum free length	35 mm (1.378 in)
Piston ring type			Semi-trapezoidal
Ring end gap		New	0.4 mm to 0.55 mm (.016 in to .022 in)
		Wear limit	1 mm (.039 in)
Ring/piston groove clearance		New	0.05 mm to 0.1 mm (.002 in to .0039 in)
		Wear limit	0.2 mm (.0079 in)
Piston/cylinder wall clearance		New	0.108 mm to 0.152 mm (.0043 in to .006 in)
		Wear limit	0.2 mm (.0079 in)
Piston projection		Minimum	0.9 mm (.035 in)
		Maximum	1.1 mm (.043 in)
Piston skirt wear		Wear limit	0.15 mm (.006 in)
Cylinder head warpage		Wear limit	0.5 mm (.0197 in)
Cylinder taper		New (max.)	0.05 mm (.002 in)
		Wear limit	0.1 mm (.0039 in)
Cylinder out of round		New (max.)	0.012 mm (.0005 in)
		Wear limit	0.08 mm (.0031 in)
Crankshaft end play		New	MIN.: 0.10 mm (.0039 in) MAX.: 0.30 mm (.0118 in)
Crankshaft deflection		MAX.	MAG: 0.06 mm (.0024 in) CENTER: 0.08 mm (.0031 in) PTO: 0.06 mm (.0024 in)
Connecting rod big end axial play		New	0.28 mm to 0.68 mm (.011 in to .0268 in)
		Wear limit	1.2 mm (.0472 in)

COOLING SYSTEM			
Coolant		Type	Ethyl glycol and distilled water (50%/50%). Use BRP premix coolant (P/N 219 700 362) or coolant specifically formulated for aluminum engines
		Quantity	4.5 L (1.19 U.S. gal.)
Thermostat opening temperature			37°C (99°F)
Radiator cap opening pressure			90 kPa (13 PSI)
LUBRICATION SYSTEM			
Oil injection pump type			Electronic oil injection pump
Injection oil		Type	XPS synthetic blend 2-stroke oil (P/N 293 600 100)
		Quantity	2.9 L (98 U.S. oz)
FUEL SYSTEM			
Fuel delivery			E-TEC direct injection
Throttle body			Dell'Orto 46 mm
Fuel pump			In-tank electrical fuel pump
Idle speed (not adjustable)			1200 ± 200 RPM
Fuel	Type		Premium unleaded gasoline
	Octane rating	Inside North America ((R+M)/2)	Recommended: 91 Accepted: 87
		Outside North America (RON)	Recommended: 95 Accepted: 92
Fuel tank capacity			45 L (11.9 U.S. gal.)
ELECTRICAL SYSTEM			
Lightning system output			1200 W (12V and 55V/60V)
Ignition type			Inductive
Spark plug		Make and type	NGK PZFR6F (engine and spark plug threads are indexed)
		Gap	Not adjustable 0.7 mm to 0.8 mm (.028 in to .031 in)
Ignition timing BTDC @ 3500 ± 500 RPM			28°
			5.38 mm (.212 in)
Crankshaft position sensor (CPS)			190 to 290 Ω
Stator			0.63 ± 0.03 Ω
Battery			12 V, 18 A•h
Headlamp			2 x 60/55 W (H4)
Taillight and stoplight			P 21/5 W
Fuses		F1: Battery	30 A
		F2: Relay 2, start button, gauge	5 A
		F3: Horn (optional)	10 A
		F4: Relay 2 power (cooling fan)	15 A
Relays		Relay 1	Fuse 1, fuse2 and fuse 4
		Relay 2	Coolant fan relay

DRIVE SYSTEM			
Gearbox oil	Type		XPS synthetic chaincase oil (P/N 413 803 300)
	Quantity		700 ml (24 U.S. oz)
Gear ration	1st		3.23 : 1
	2nd		1.98 : 1
	R		3.76 : 1
Drive pulley type			TRA III
Drive pulley calibration	Clutch engagement		3000 ± 100 RPM
	Spring color		Yellow/Red
	Spring length		94.61 mm (3.725 in)
	Pin		Solid (long)
	Ramp		600
	Screw position		2
Driven pulley type	Type		QRS
	Spring color		White/White
	Spring preload	New	7.5 kg ± 0.7 kg (16.5 lb ± 1.5 lb)
		After break-in	6.8 kg ± 0.7 kg (15 lb ± 1.5 lb)
	Cam angle		40°
Pulley distance	Z		21 mm (.827 in) (not adjustable)
Offset	X		36.4 mm ± 1.8 mm (1.433 in ± .071 in) (not adjustable)
Drive belt	Width		38.5 mm (1.516 in)
	Wear limit		36.1 mm (1.421 in)
Track	Width		500 mm (20 in)
	Length		3.9 m (154 in)
	Profile height		38.1 mm (1-1/2 in)
Track adjustment	Deflection		4.2 cm (1-21/32 in)
	Force		6.0 kgf to 8.5 kgf (13 lbf to 19 lbf)
BRAKE SYSTEM			
Brake lining minimum thickness			1 mm (.039 in)
Brake disk minimum thickness			4.5 mm (.177 in)
Brake fluid	Type		DOT 4
	Quantity		65 ml (2.2 U.S. oz)

SUSPENSION		
FRONT		
Suspension type		LTS
Suspension maximum travel		150 mm (6 in)
Shock absorber type		Motion control
REAR		
Suspension type		SC-5U
Suspension maximum travel		340 mm (13.4 in)
Shock absorber type	Center	Motion control
	Rear	HPG
STEERING SYSTEM		
Ski type		Pilot 6.9
Toe-out		5 mm (.197 in)
Camber		0°
WEIGHT AND DIMENSIONS		
Mass (dry)		282 kg (622 lb)
Length		324 cm (127.6 in)
Width		107.6 cm (42.4 in)
Height		133 cm (52.4 in)
Ski stance (carbide to carbide)		90 cm (35.4 in)
MATERIAL		
Frame		Aluminum
Bottom pans, gauge support and side panels		Polypropylene
Hood and console		Surlyn

SKANDIC WT (600 ACE)

ENGINE			
Engine type			ROTAX® 602 ACE 4-stroke, Double Over Head Camshaft (DOHC), dry sump, liquid cooled
Number of cylinders			2
Number of valves			8 valves (self adjusting hydraulic valve lifters)
Bore			74 mm (2.91 in)
Stroke			69.7 mm (2.74 in)
Displacement			600 cm³ (36.61 in³)
Compression ratio			12.0 : 1
Decompressor type			N.A.
Maximum HP RPM			7250 (± 100) RPM
Intake valve opening			3° BTDC
Intake valve closing			37° ABDC
Exhaust valve opening			44° BBDC
Exhaust valve closing			6° ATDC
Valve stem diameter	Intake	New	4.958 mm to 4.972 mm (.1952 in to .1957 in)
		Service limit	4.94 mm (.1945 in)
	Exhaust	New	4.956 mm to 4.970 mm (.1951 in to .1957 in)
		Service limit	4.94 mm to 5.012 mm (.1945 in to .1973 in)
Valve guide diameter		New	5.0 mm to 5.012 mm (.1969 in to .1973 in)
		Service limit	5.05 mm (.1988 in)
Valve spring free length		New	31.35 mm (1.2343 in)
		Service limit	29.50 mm (1.1614 in)
Valve seat contact width	Intake	New	1.05 mm to 1.35 mm (.0413 in to .0531 in)
		Service limit	1.7 mm (.0669 in)
	Exhaust	New	1.25 mm to 1.45 mm (.0492 in to .0571 in)
		Service limit	1.8 mm (.0709 in)
Piston measurement		New	73.95 mm to 73.966 mm (2.9114 in to 2.912 in)
		Service limit	73.92 mm (2.91 in)
Piston/cylinder wall clearance		New	0.037 mm to 0.067 mm (.0015 in to .0026 in)
		Service limit	0.08 mm (.0031 in)
Piston ring type		1st	Upper compression ring, rectangular
		2nd	Lower compression ring, tapered face
		3rd	Oil scraper ring
Ring end gap	Rectangular	New	0.20 mm to 0.35 mm (.0079 in to .0138 in)
		Service limit	1.2 mm (.0472 in)
	Taper-face	New	0.30 mm to 0.50 mm (.0118 in to .0197 in)
		Service limit	1.2 mm (.0472 in)
	Oil scraper ring	New	0.20 mm to 0.70 mm (.0079 in to .0276 in)
		Service limit	1.2 mm (.0472 in)

ENGINE (cont'd)			
Ring/piston groove clearance	Rectangular	New	0.030 mm to 0.066 mm (.0012 in to .0026 in)
		Service limit	0.12 mm (.0047 in)
	Taper-face	New	0.020 mm to 0.056 mm (.0008 in to .0022 in)
		Service limit	0.12 mm (.0047 in)
	Oil scraper ring	New	0.010 mm to 0.040 mm (.0004 in to .0016 in)
		Service limit	0.15 mm (.0059 in)
Cylinder bore		New	74.003 mm to 74.017 mm (2.9135 in to 2.9141 in)
Cylinder taper		Maximum New	0.030 mm (.0012 in)
		Service limit	0.05 mm (.002 in)
Cylinder out of round		Maximum New	0.008 mm (.0003 in)
		Service limit	0.03 mm (.0012 in)
Camshaft bearing journal diameter	PTO	New	25.947 mm to 25.960 mm (1.0215 in to 1.022 in)
		Service limit	25.92 mm (1.0205 in)
	MAG/Center	New	22.947 mm to 22.960 mm (.9034 in to .9039 in)
		Service limit	22.92 mm (.9024 in)
Camshaft holder bore diameter	PTO	New	26.00 mm to 26.021 mm (1.0236 in to 1.0244 in)
		Service limit	26.05 mm (1.0256 in)
	MAG/Center	New	23.00 mm to 23.021 mm (.9055 in to .9063 in)
		Service limit	23.05 mm (.9075 in)
Camshaft lobe height	Intake	New	38.70 mm to 38.90 mm (1.5236 in to 1.5315 in)
		Service limit	38.68 mm (1.5228 in)
	Exhaust	New	39.40 mm to 39.60 mm (1.5512 in to 1.5591 in)
		Service limit	39.38 mm (1.5504 in)
Crankshaft bearing journal diameter		New	35.990 mm to 36.006 mm (1.4169 in to 1.4176 in)
		Service limit	35.960 mm (1.4157 in)
Crankshaft radial play		Service limit	0.09 mm (.0035 in)
Crankshaft axial play		New	0.120 mm - 0.392 mm (.0047 in - .0154 in)
		Service limit	0.450 mm (.0177 in)
Crankshaft deflection	MAG	Maximum	0.050 mm (.002 in)
	Center	Maximum	0.050 mm (.002 in)
	PTO	Maximum	0.050 mm (.002 in)
Crankshaft plain bearing inside diameter		Service limit	36.08 mm (1.4205 in)
Connecting rod big end diameter		Service limit	36.06 mm (1.4197 in)
Connecting rod big end radial play		Service limit	0.08 mm (.0031 in)
Connecting rod big end axial play		New	0.100 mm to 0.352 mm (.0039 in to .0139 in)
		Service limit	0.450 mm (.0177 in)
Connecting rod small end diameter		New	17.010 mm to 17.020 mm (.6697 in to .6701 in)
		Service limit	17.060 mm (.6717 in)
Piston pin diameter		New	16.996 mm to 17.000 mm (.6691 in to .6693 in)
		Service limit	16.986 mm (.6687 in)
Connecting rod small end radial play		Service limit	0.04 mm (.0016 in)

COOLING SYSTEM			
Coolant	Type		Ethyl glycol and distilled water (50%/50%). Use BRP premixed coolant (P/N 219 700 362) or coolant specifically formulated for aluminum engines
	Quantity		5.0 L (1.32 U.S. gal.)
Thermostat opening temperature			75°C (167°F)
Radiator cap opening pressure			110 kPa (16 PSI)
LUBRICATION SYSTEM			
Lubrication	Type		Dry sump. Replaceable oil filter
	Oil filter		BRP Rotax paper type, replaceable
	Engine oil pressure	Minimum	60 kPa (8.7 PSI) @ 1400 RPM
			400 kPa (58 PSI) @ 4000 RPM
	Engine oil	Capacity (oil change with filter)	2.1 L (2.22 qt (U.S. liq.))
		Recommended	XPS Synthetic 4-Stroke oil (All climate) (P/N 293 600 112) or a SAE 0W 40 API service SM synthetic oil
FUEL SYSTEM			
Throttle body type			Dell'Orto 46mm heated
Idle speed	Normal idle		1400 ± 100 RPM
	Fast idle		2100 ± 100 RPM
Gasoline type			Unleaded
Minimum octane rating	Inside North America ((R+M)/2)		87
	Outside North America (RON)		92
Fuel tank capacity			45 L (12 U.S. gal.)
ELECTRICAL SYSTEM			
Magneto generator output			650 W @ 6000 RPM @ 14 V
Magneto stator resistance (between any pair of yellow wires)			0.1 to 1 Ohm @ 20°C (68°F)
Ignition type			IDI (Inductive Digital Ignition)
Spark plug	Make and type		NGK CR7EB
	Gap		.70 mm to 0.80 mm (.028 in to .031 in)
Ignition timing			Not adjustable
Battery			12 volt 18 A.h. YTX20HL-BS
Headlamp LOW/HI beam			2 X 55/60 W (H4)
Taillight and stoplight			2 X P 5/21 W
Fuses	F 1: Fuse 2, fuse 4, relay 1, relay 2, relay 3, voltage regulator		30 A
	F 2: Relay coils, start button, gauge		5 A
	F 3: Fuel pump, starter solenoid		10 A
	F 4: Relay 4		15 A
	F 5: Fuel injectors, ignition coils		10 A
	F 6: Gauge, ECM, camshaft position sensor		10 A
	F 7: 12-volt power outlet, heated grips, heated throttle lever		10 A
	F 8: Lights		20 A
	F 9: Horn (optional)		5 A
	F 10: Rear 12-volt power outlet (optional)		5 A

ELECTRICAL SYSTEM (cont'd)			
Relays	Relay 1		Fuse 3, fuse 5, fuse 6, communication connector
	Relay 2		Fuse 8, fuse 9, fuse 10
	Relay 3		Fuse 7
	Relay 4		Cooling fan
DRIVE SYSTEM			
Gearbox oil	Type		XPS synthetic chaincase oil
	Quantity		700 ml (23.67 U.S. oz)
Gear ratio	1st		3.86 : 1
	2nd		2.3 : 1
	R		4.06 : 1
Drive pulley	Type		eDrive
	Clutch engagement		2200
	Spring color		Red/White
	Spring length		115 mm (4.528 in)
	Pin		N.A.
	Ramp		716
	Screw position		N.A.
Driven pulley	Type		QRS
	Spring preload (New)		7.0 kgf ± 0.7 kgf (15.4 lbf ± 1.5 lbf)
	Spring preload (After break-in)		6.4 kgf ± 0.7 kgf (14.1 lbf ± 1.5 lbf)
	Spring color		Pink 2
	Cam angle		37°/45°
	Offset	Z	21.40 mm (.843 in)
		X	37.2 mm ± 0.5 mm (1.465 in ± .02 in)
Drive belt	Width		34.5 mm (1.358 in)
	Wear limit		32.10 mm (1.264 in)
Track	Width		50.8 cm (20 in)
	Length		392 cm (154 in)
	Profile height		38.1 mm (1-1/2 in)
Track adjustment	Deflection		4.2 cm (1-21/32 in)
	Force		6.0 kgf to 8.5 kgf (13 lbf to 19 lbf)
BRAKE SYSTEM			
Brake lining minimum thickness			1 mm (.039 in)
Brake disk minimum thickness			4.5 mm (.177 in)
Brake fluid	Type		DOT 4
	Quantity		65 ml (2.2 U.S. oz)
FRONT SUSPENSION			
Suspension type			LTS
Suspension maximum travel			150 mm (6 in)
Shock absorber type			Motion control

REAR SUSPENSION		
Suspension type		SC-5U
Suspension maximum travel		34 cm (13.4 in)
Shock absorber type	Center	Motion control
	Rear	HPG
Stroke limiter standard position		3
STEERING SYSTEM		
Ski type		Pilot 6.9 Eur: ADJ
Toe-out		5 mm (.197 in)
Camber		0°
WEIGHT AND DIMENSIONS		
Dry weight		278 kg (613 lb)
Length		324 cm (127.6 in)
Width		107.6 cm (42.4 in)
Height		133 cm (52.4 in)
Ski stance (carbide to carbide)		90 cm (35.4 in)

WIRING DIAGRAMS

GENERAL

WIRING DIAGRAM LOCATION

Wiring diagram are in the manual back cover pocket.

WIRE COLOR CODES

The first color of a wire is the main color, the second color is the stripe color.

Example: YE/BK is a YELLOW wire with a BLACK stripe.

COLOR CODE	
BE — BEIGE	LBN — LIGHT BROWN
BK — BLACK	OR — ORANGE
BL — BLUE	RD — RED
BN — BROWN	RS — ROSA (PINK)
GN — GREEN	VI — VIOLET
GR — GRAY	WH — WHITE
LBL — LIGHT BLUE	YE — YELLOW

CONNECTOR INFORMATION

SERVICE TOOLS

Description	Part Number	Page
CRIMPING TOOL (HEAVY GAUGE WIRE)	529 035 730	913
CRIMPING TOOL (KOSTAL)	529 035 909	912
ECM ADAPTER TOOL	420 277 010	909
ECM ADAPTER TOOL	529 036 166	907
ECM TERMINAL REMOVER 2.25	529 036 175	908
ECM TERMINAL REMOVER 3.36	529 036 174	908
KOSTAL DIE	529 035 906	912

SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
AMP EXTRACTION TERMINAL TOOL	726503-1	905
SNAP-ON SCREWDRIVER	TT600-5	901
TOOL	AMP-755430-2	903–904

SERVICE PRODUCTS

Description	Part Number	Page
DEOXIT LUBRICANT	293 550 034	909

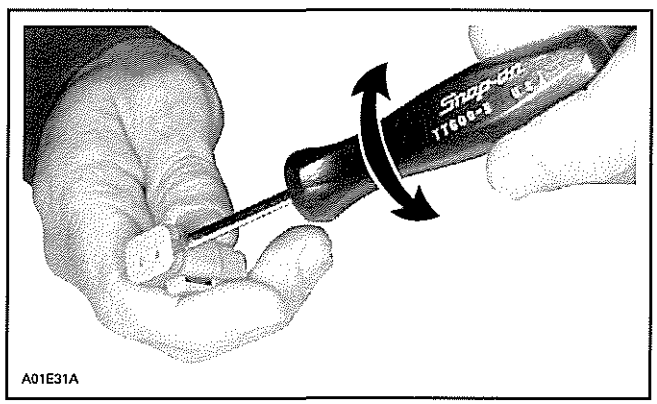
GENERAL

DEUTSCH CONNECTOR

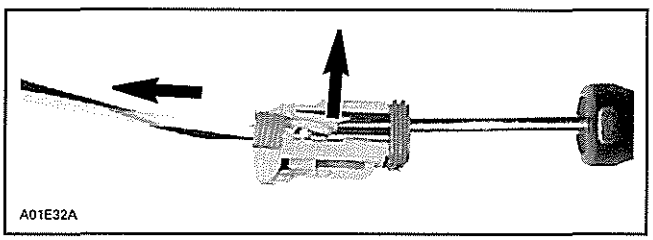
Connector Disassembly

Male Housing

Insert SNAP-ON SCREWDRIVER (P/N TT600-5) under lock and twist to lift it.



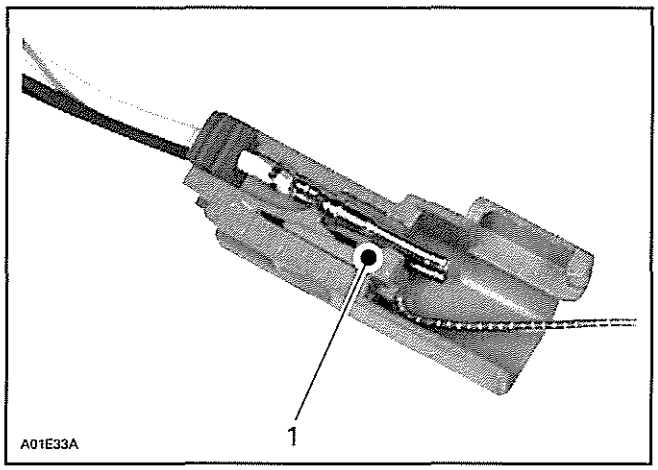
Pry tab to free connector then pull wire out of housing.



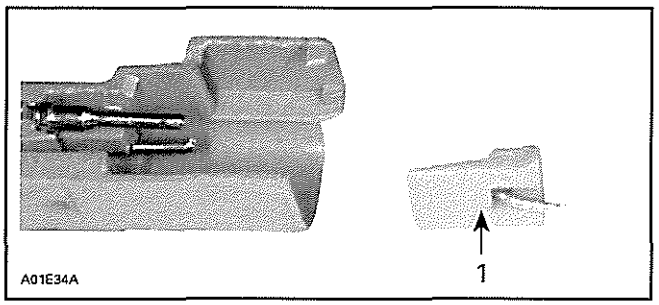
FEMALE CONNECTOR HOUSING — CUT-AWAY

Female Housing

Using a small hook, pull out the lock.

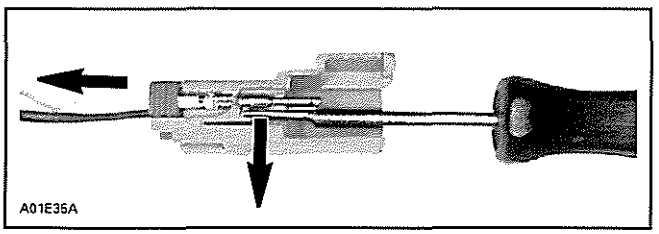


1. Lock



1. Lock

Pry tab to free connector then pull wire out of housing.

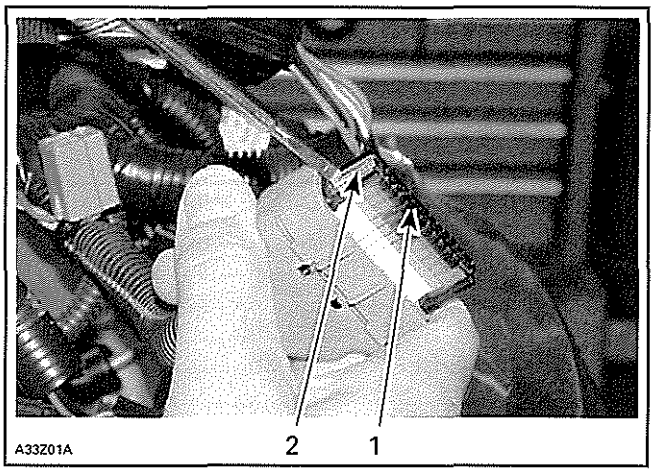


FEMALE HOUSING — CUT-AWAY

PACKARD CONNECTOR (GAUGE)

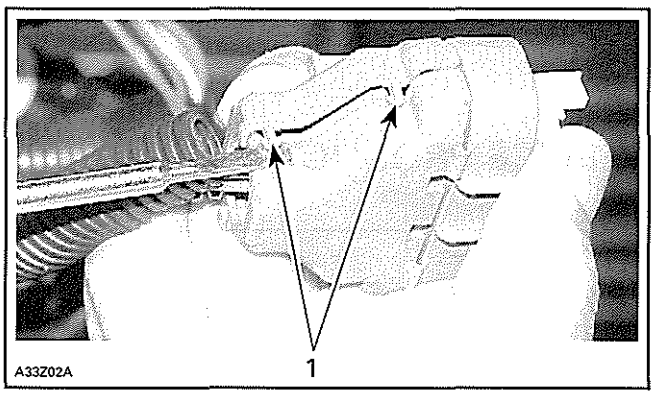
Connector Disassembly

Push on both tabs to remove retainer.



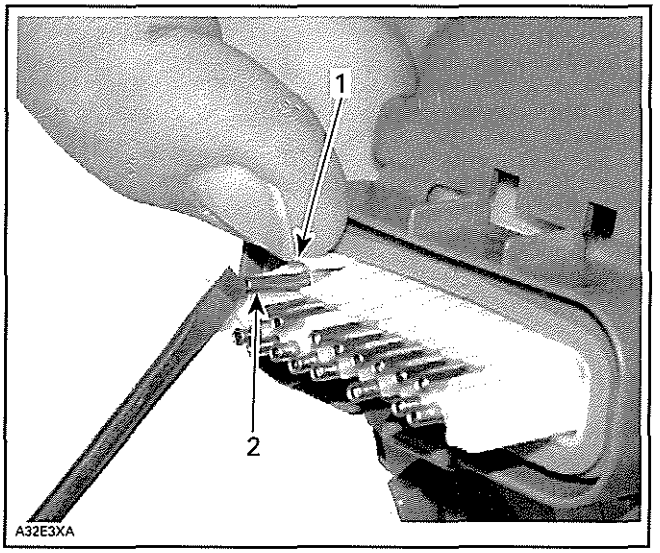
TYPICAL
1. Retainer
2. Tab (one on each side)

Open housing by lifting 4 tabs.



TYPICAL
1. Tabs (2 on each side)

Lift the top plastic lock of the female terminal to be removed and hold in position. Lift the female terminal to unlock from the housing and push out of housing.

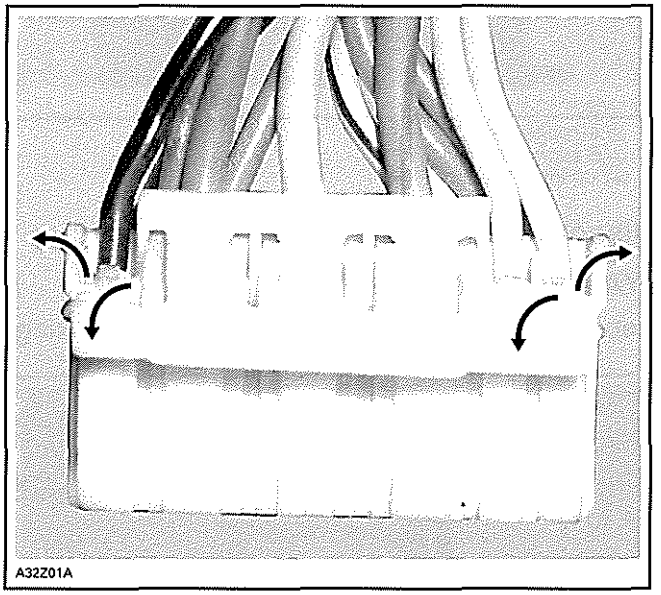


1. Lift and hold plastic lock
2. Lift to unlock and push out

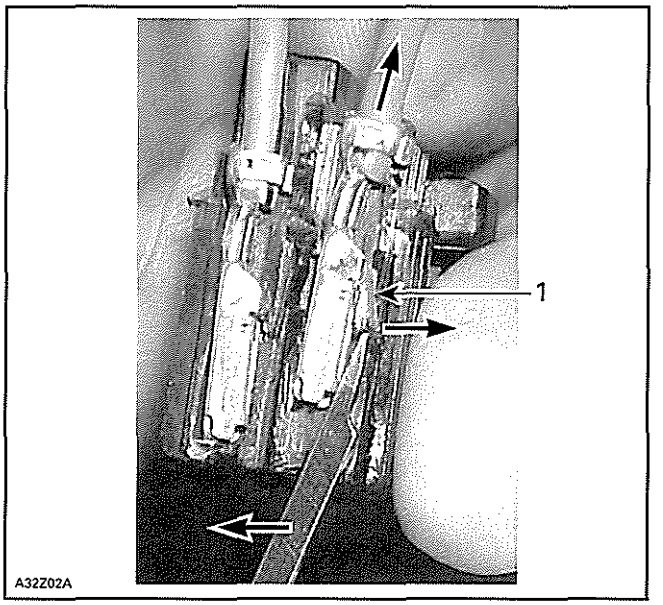
AMP MULTILOCK CONNECTOR

Connector Disassembly

Male Housing



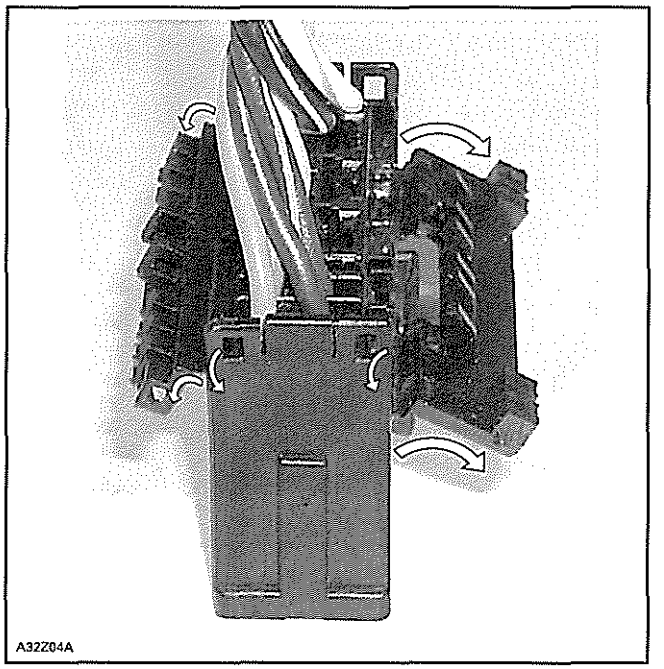
Insert TOOL (P/N AMP-755430-2) under lock and twist to lift it.



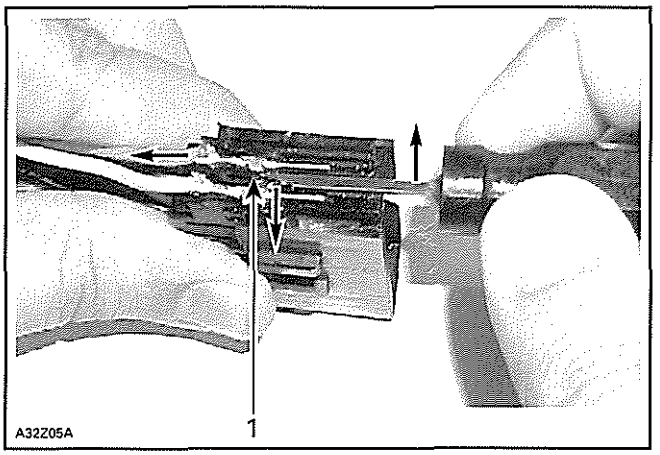
MALE HOUSING — CUT-AWAY
1. Lock

Female terminals can be removed from housing with sharp head pin.

Female Housing



Insert TOOL (P/N AMP-755430-2) under lock and twist to lift it.



FEMALE HOUSING — CUT-AWAY
1. Lock

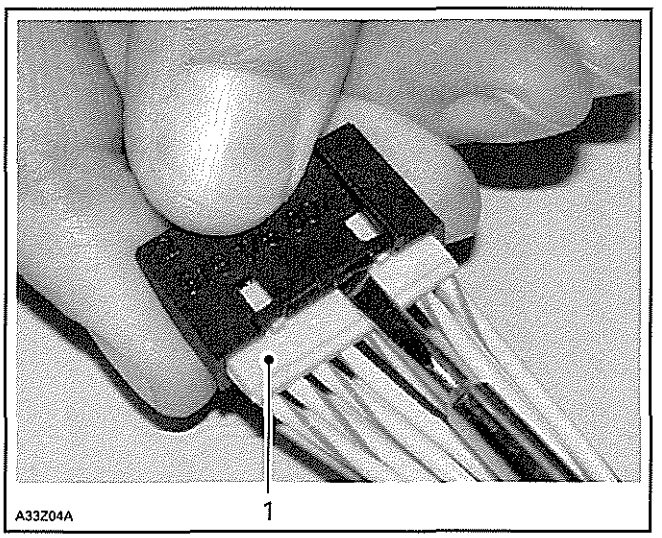
Terminal Crimping

Refer to *KOSTAL CONNECTORS (ECM)* for procedure.

AMP CONNECTOR (8-CIRCUIT)

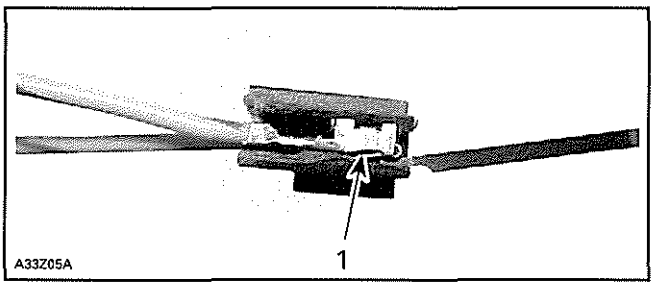
Connector Disassembly

Pry housing to release lock.



1. Lock

Insert TOOL (P/N AMP-755430-2) under tab and pry it to free connector. Pull on the female terminal wire to remove female terminal from housing.



AMP 8-CIRCUIT CONNECTOR — CUT-AWAY
1. Tab

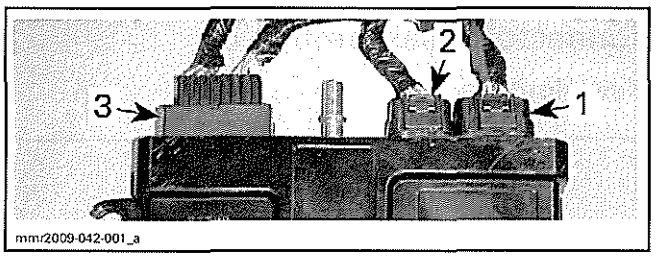
Terminal Crimping

Refer to *KOSTAL CONNECTORS (ECM)* for procedure.

AMP CONNECTOR

600 HO E-TEC Models

Connector Identification

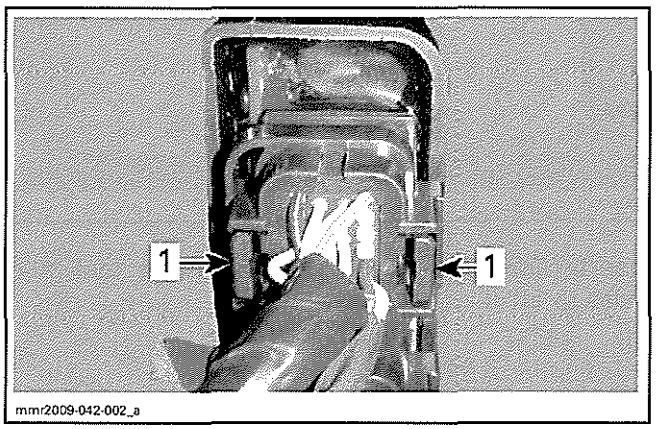


1. J1A connector
2. J1B connector
3. J2 connector

Disconnecting the Connectors

J1A and J1B Connectors

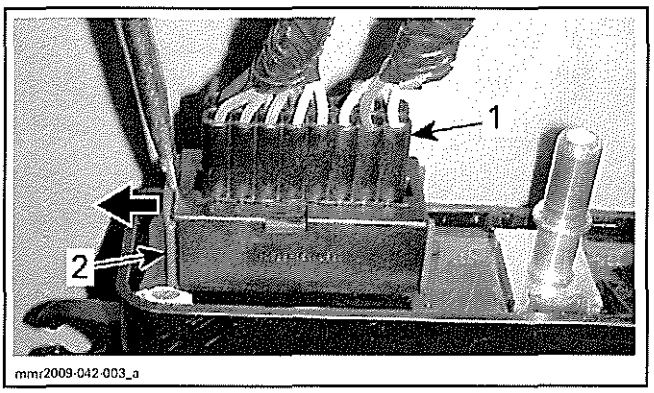
Depress both latches and pull connector housing.



1. Latches

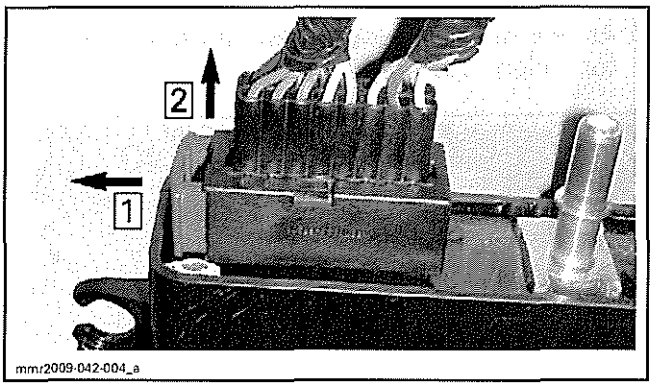
J2 Connector

Using a small screwdriver, open the connector lock.



1. *Connector*
2. *Connector lock*

Pull the lock approximately 20 mm (3/4 in)to remove the connector.

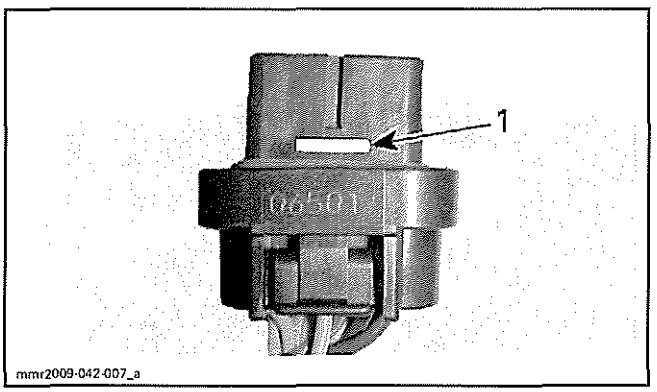


Step 1: Pull lock
Step 2: Lift the connector

Connector Disassembly

J1A and J1B Connectors

Push the lock mechanism to open it.

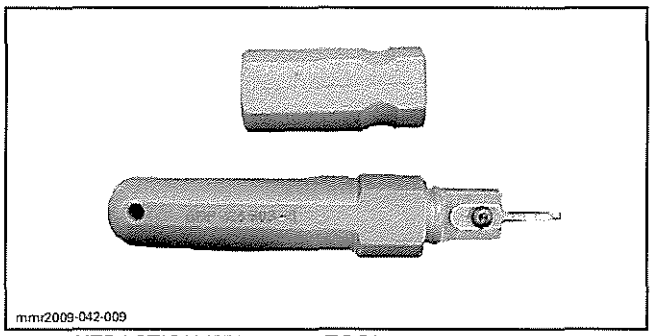


1. *Lock mechanism*

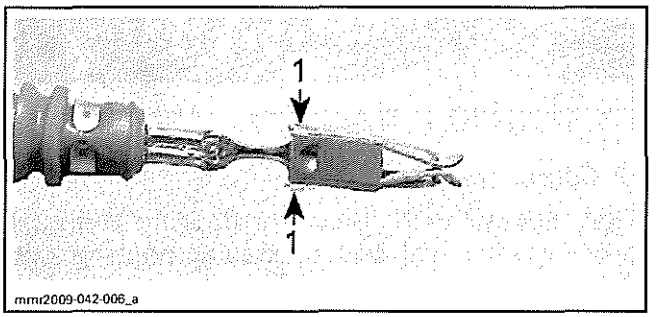
Pull on wire to extract terminal from connector housing.

J2 Connector

Using the AMP EXTRACTION TERMINAL TOOL (P/N 726503-1), release both locking tabs of connector. Pull terminal from housing.



AMP EXTRACTION TERMINAL TOOL



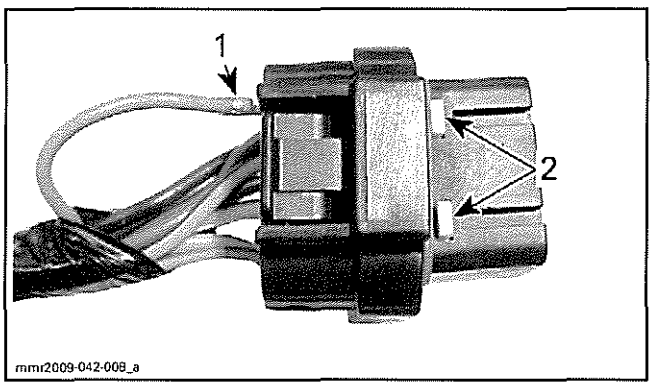
1. *Locking tabs*

Connector Assembly

J1A and J1B Connectors

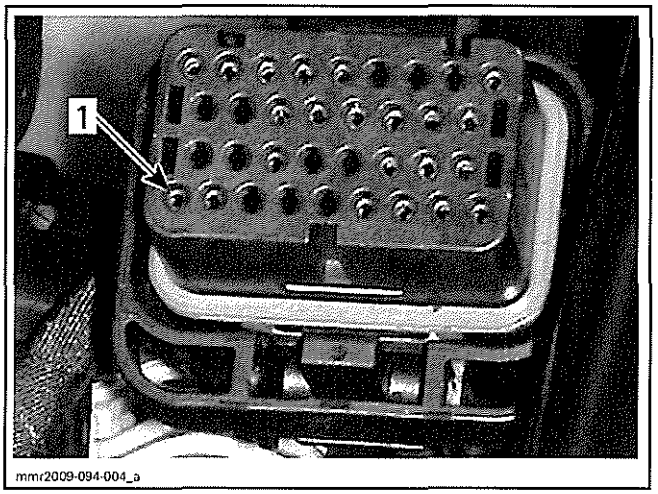
Push terminal through seal until it is seated in connector housing.

Close the lock mechanism.



1. *Insert terminal into housing*
2. *Push here to close the lock mechanism*

NOTE: If the locking mechanism does engage, it is likely due to an improperly inserted terminal. Look at the end of connector to see if a terminal is partially out. If, so push the corresponding wire fully into connector then lock mechanism.



1. Terminal fully inserted in connector

J2 Connector

Align terminal with connector housing and push terminal with seal into connector housing until seated.

MOLEX CONNECTOR

600 ACE Models

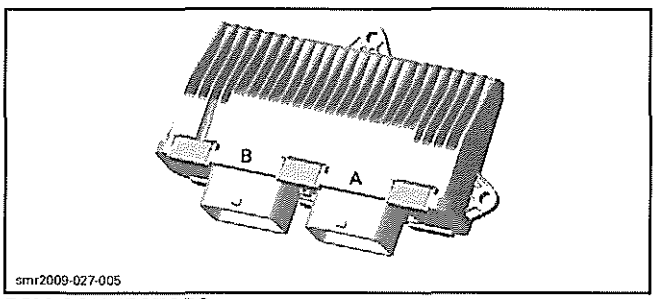
Molex Connector Application

The Molex connector is used on the ECM.

There are 2 MOLEX connectors on the ECM.

The engine wiring harness connector is connected to ECM connector "A". The vehicle wiring harness connector is connected to ECM connector "B".

Each ECM connector has 48 pins.

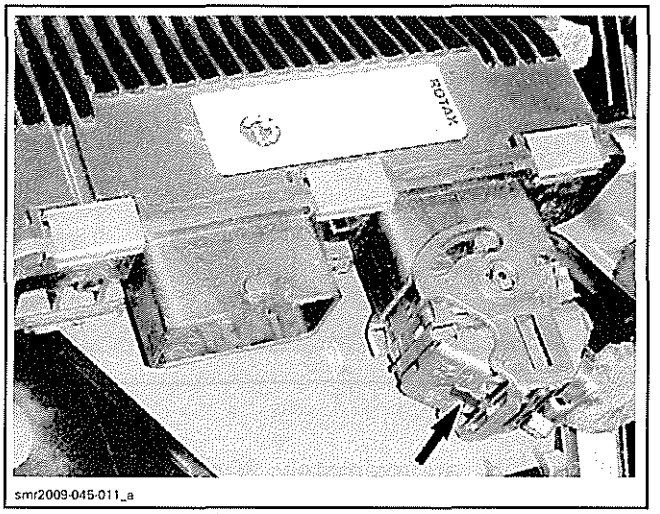


ECM CONNECTORS

Do not apply any product to the pins in the ECM connector.

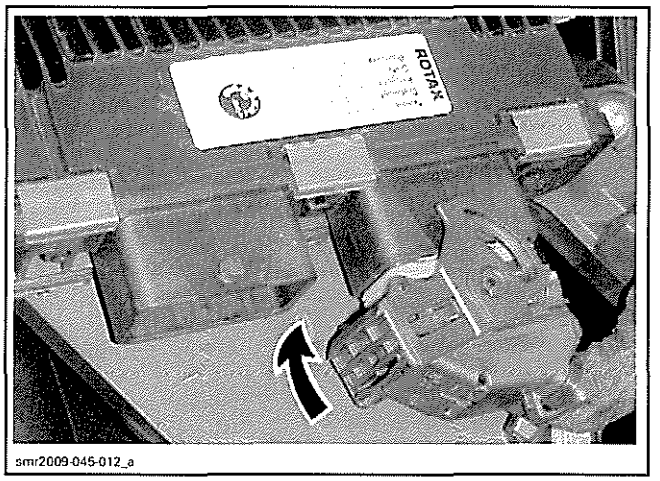
Connector Removal

1. To access the ECM, refer to *ELECTRONIC FUEL INJECTION* subsection.
2. Press and hold the locking tab on the connector to be disconnected.



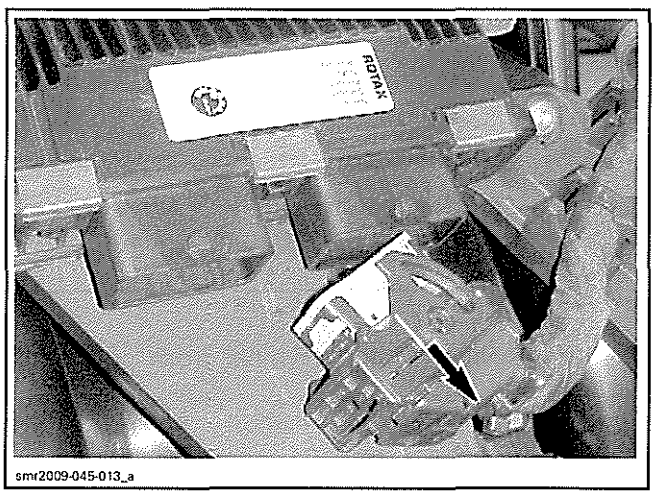
TYPICAL — LOCKING TAB TO PRESS AND HOLD

3. As you hold the locking tab, rotate the connector locking cam until it stops.



TYPICAL — CONNECTOR LOCKING CAM ROTATION TO RELEASE

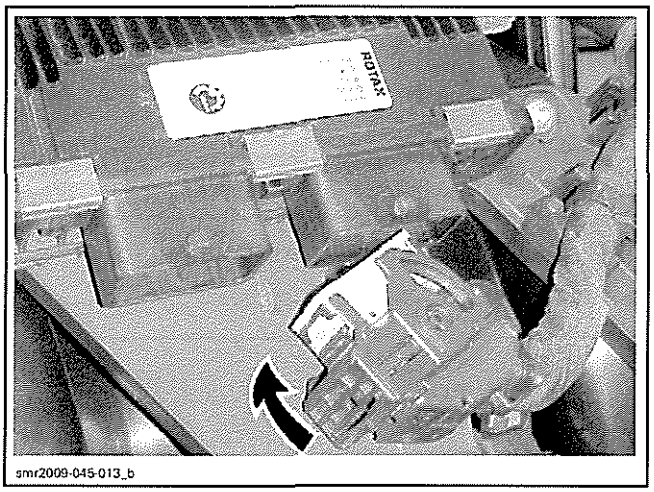
4. Pull connector off ECM.



TYPICAL

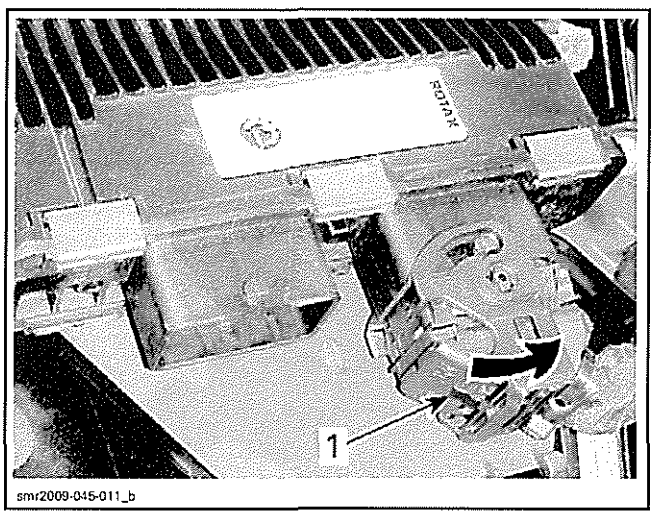
Connector Installation

1. Fully open connector locking cam.



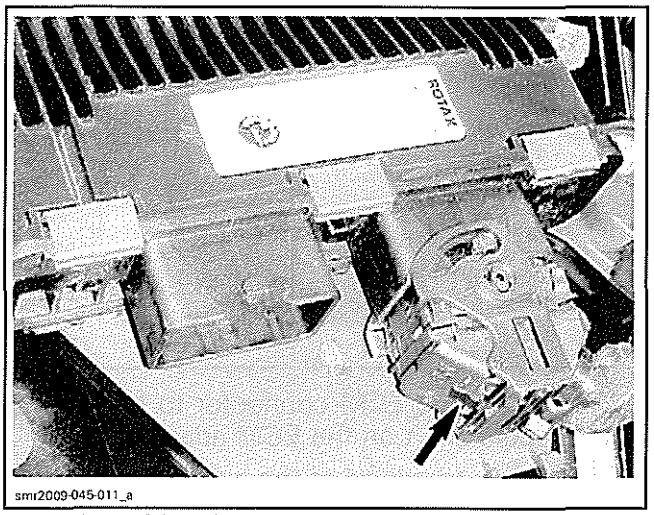
TYPICAL — CONNECTOR LOCKING CAM IN RELEASE POSITION

2. Insert connector on ECM.
3. As you push the connector onto the ECM, rotate the connector locking cam until it snaps locked.



TYPICAL
1. Locked here

4. Ensure the locking tab is fully out.



TYPICAL — LOCKING TAB FULLY OUT

Connector Inspection

Before replacing an ECM, always check electrical connections.

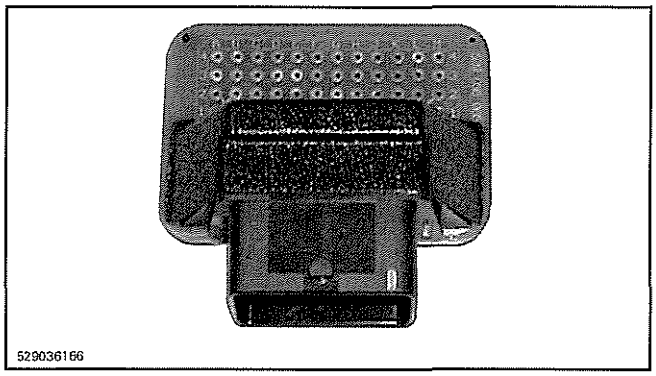
1. Ensure connector locking mechanism is functioning properly.
2. Ensure all wire terminals (pins) are properly locked in the connector.
3. Ensure they are very tight, make good contact with the pins in the ECM.
4. Ensure the pins in the harness connector and the ECM connector are clean, shiny and corrosion-free.
5. Check wiring harness for signs of scoring.

NOTE: A "defective ECM module" could possibly be repaired simply by disconnecting and reconnecting it.

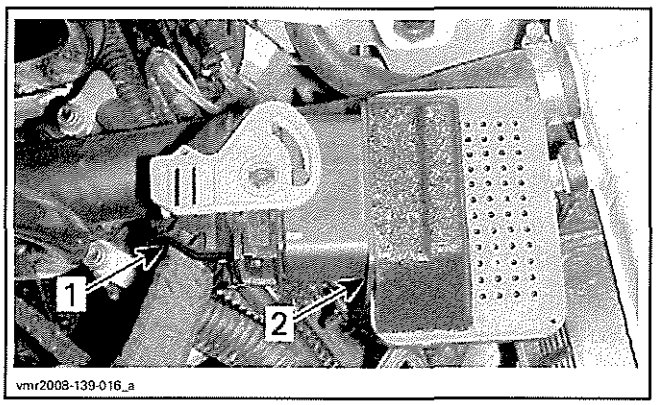
NOTICE **Do not apply any lubricant, liquid, spray or any grease inside the connector of the ECM.**

Connector Probing

The most recommended and safest method to probe the MOLEX (ECM) connector terminals is to use the ECM ADAPTER TOOL (P/N 529 036 166). This tool will prevent deforming or enlarging of the terminals, which would lead to bad ECM terminal contact creating intermittent or permanent problems.



1. Disconnect the ECM connector to be probed, and reconnect it on the ECM adapter.
2. Probe wire terminals of the circuit to be tested directly in the adapter holes.



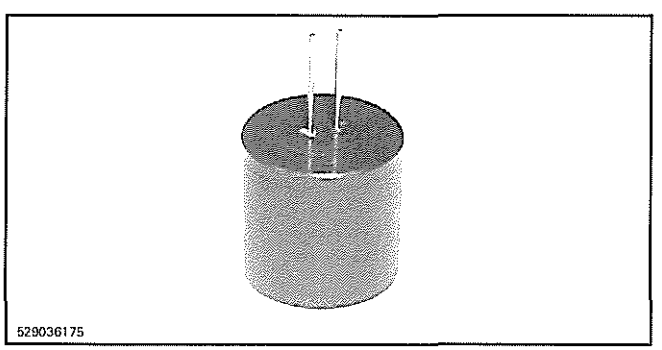
TYPICAL
1. ECM connector
2. ECM adapter

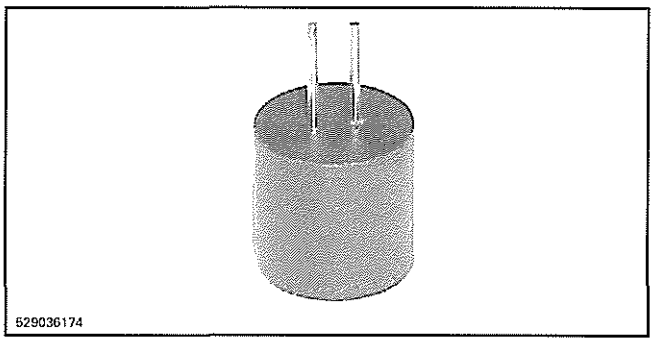
NOTICE Never probe directly on the ECM harness connector. This could change the shape or enlarge the terminals and create intermittent or permanent contact problems.

Connector Terminal Removal (Harness Connector)

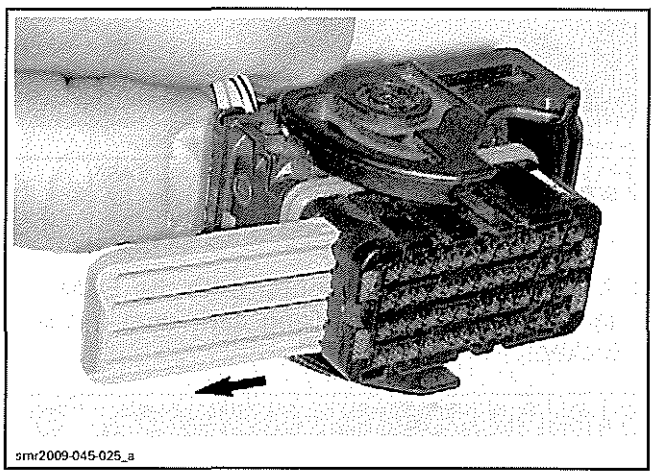
To remove a signal terminal from the ECM harness connector, use the ECM TERMINAL REMOVER 2.25 (P/N 529 036 175).

To remove a power terminal, use the ECM TERMINAL REMOVER 3.36 (P/N 529 036 174).

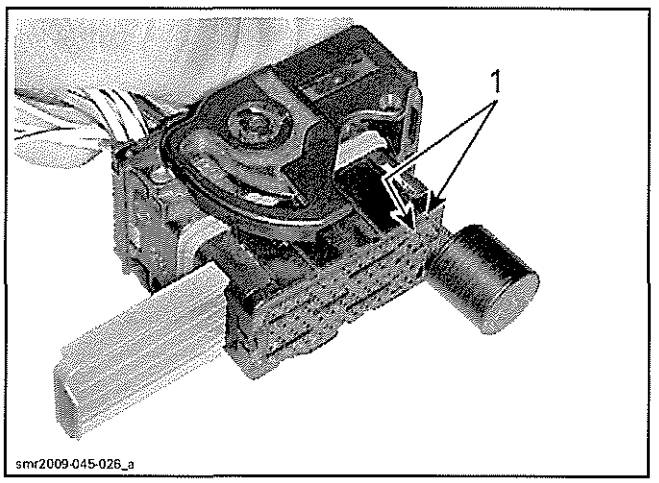




1. Remove rear protector from connector.
2. Pull out the connector lock.

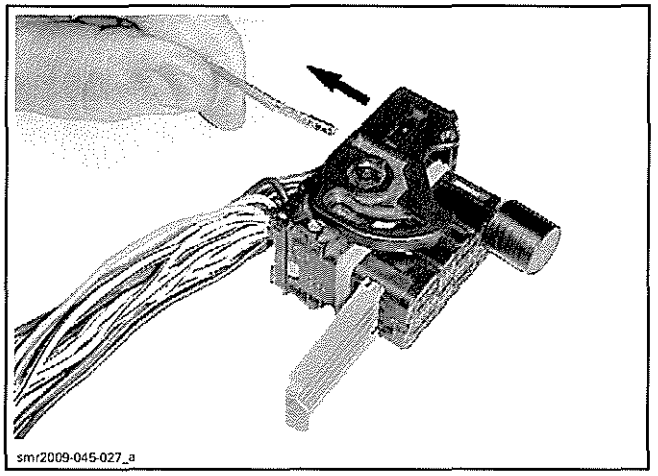


3. Insert tool to unlock terminal.



1. Unlock here

4. Gently pull on the wire to extract the terminal out the back of the connector.



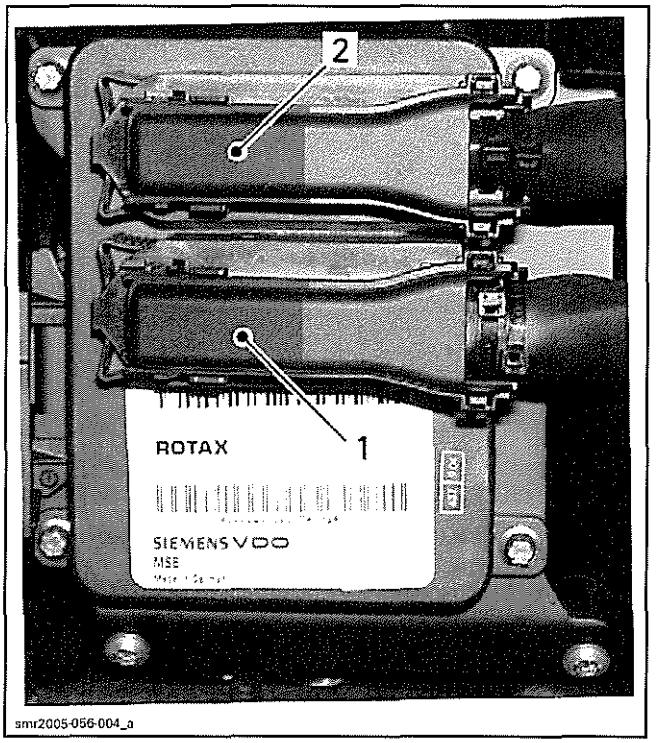
NOTICE Before installing wire terminals in the connector, ensure all terminals are properly crimped on wires. After installation of wire terminals in the connectors, ensure they are properly locked by gently pulling on them as if to extract them.

KOSTAL CONNECTOR (ECM)

1200 4-TEC Models

ECM Connector Identification

There are two Kostal connectors used and they are connected on the ECM. The engine harness female connector is connected on the module male connector A and the vehicle system control harness female connector is connected to the module male connector B. The ECM connectors have 41 pins.



ECM
1. *Connector A (engine harness)*
2. *Connector B (vehicle harness)*

NOTICE Do not disconnect the ECM connectors needlessly. They are not designed to be disconnected/reconnected frequently.

ECM Connector Cleaning

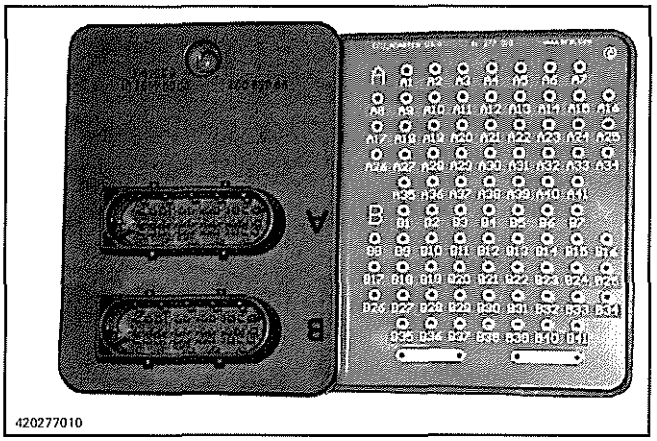
To clean oxidized ECM terminals, use a contact cleaner such as DEOXIT LUBRICANT (P/N 293 550 034).

NOTICE Remove connector seal prior to applying the product. Otherwise, the seal will swell and will let water enter inside connector. Dry out connector with compressed air prior to reinstalling the seal.

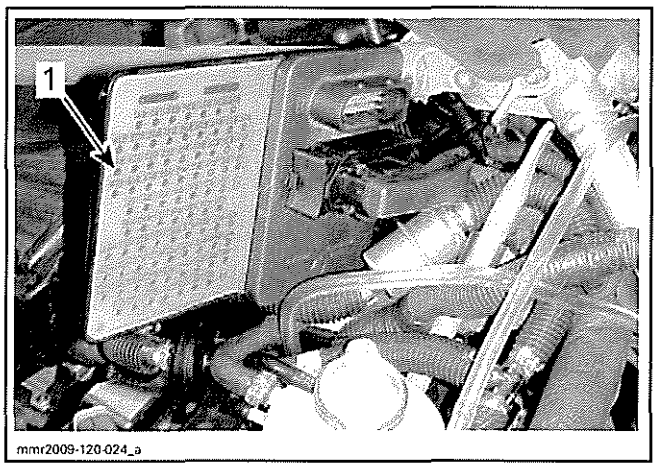
Do not apply any lubricant product to the pins of the connector on the ECM.

ECM Connector Probing

The most recommended and safest method to probe ECM connector terminals is to use the ECM ADAPTER TOOL (P/N 420 277 010). This tool will prevent deforming or enlarging terminals which would lead to bad ECM terminal contact creating intermittent or permanent problems.



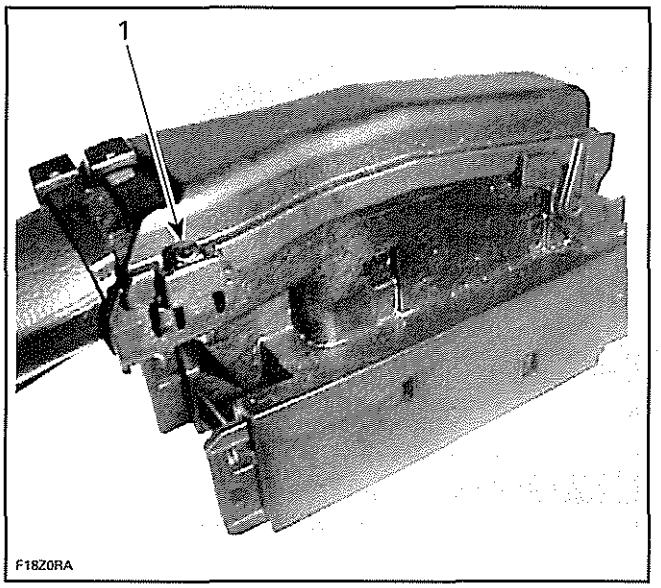
Disconnect the desired connector (A or B) from ECM and reconnect on the matching tool connector. Probe required terminals directly in the tool pins.



1. Probe copper ring

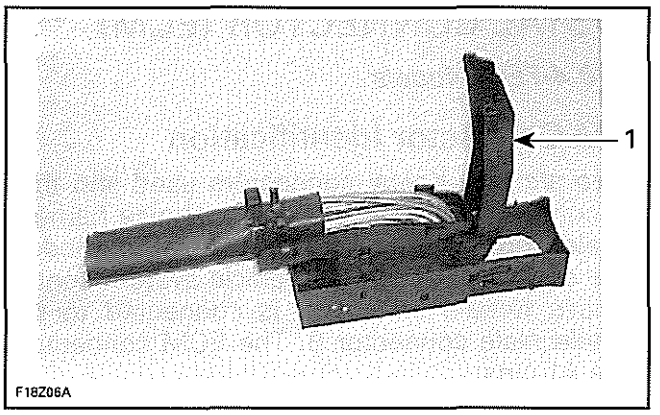
Terminal Removal

Unlock the connector housing cover by pushing in the tabs on top of the housing with a flat screwdriver to be able to flip the top cover up.



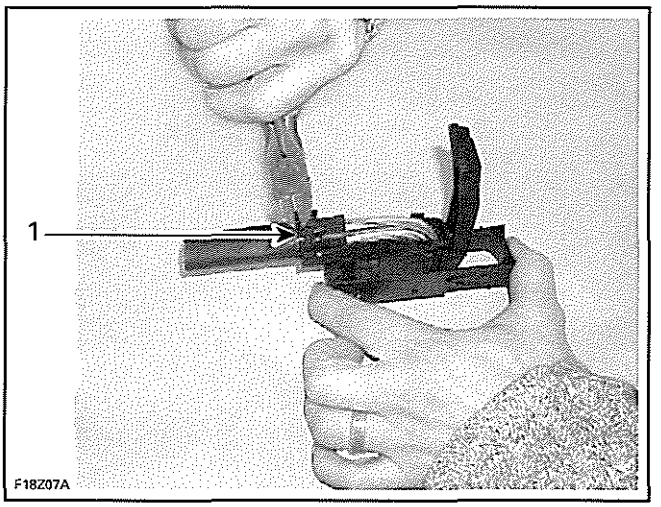
1. Push in tab

Lift the cover by pushing it forward.



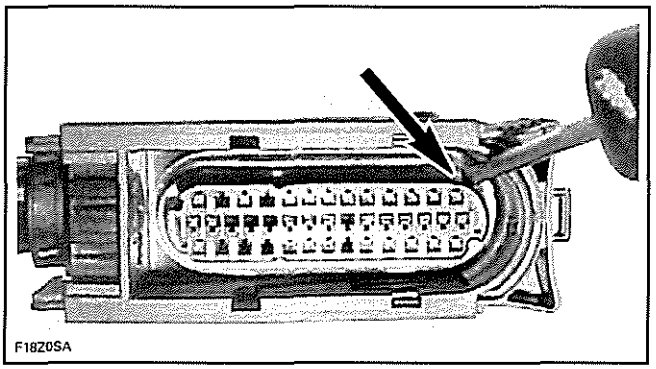
1. Cover

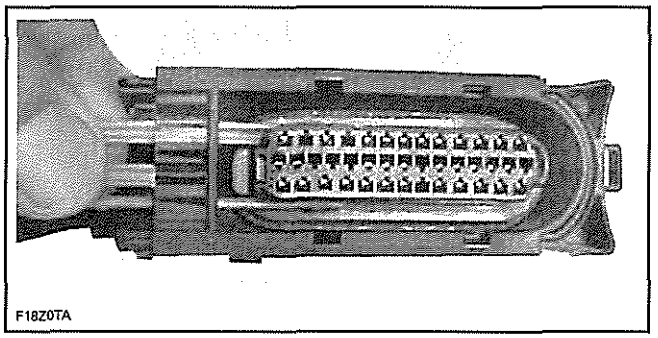
Cut both locking ties that secure the harness to the housing.



1. Locking ties

Turn the housing over and remove the lock by pushing and then pulling toward the wire harness.

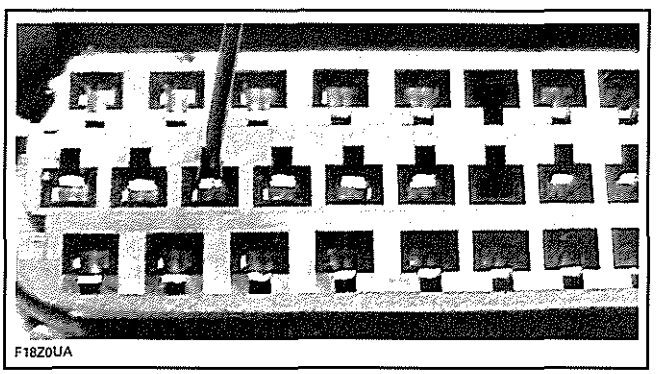

F18Z0SA

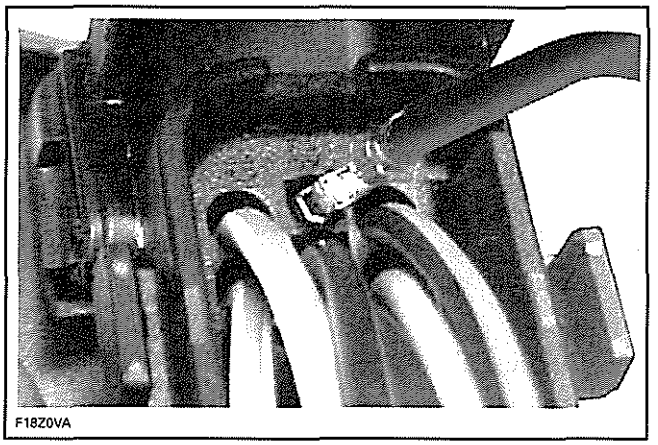

F18Z0TA

Use a 0.76 mm (.030 in) oxyacetylene torch tip cleaner or a no. 68 drill bit inserted down into the housing to release the locking tab on the connector.

NOTICE Using a probe larger than 0.76 mm (.030 in) may damage the terminal.

Insert the probe into the housing as shown, and locate the appropriate wire in the back of the housing. You may have to slightly cam the probe against the locking tab to release it, then remove the terminal from the housing.


F18Z0UA

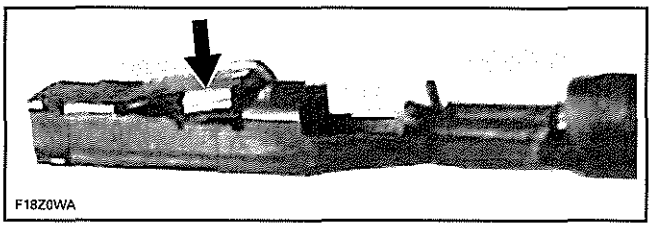

F18Z0VA

If the wire is in good condition but the terminal is rusted or corroded, remove defective terminal and crimp a new one. If wire and terminal are defective, acquire a new genuine wire and new terminal and crimp them together as explained below.

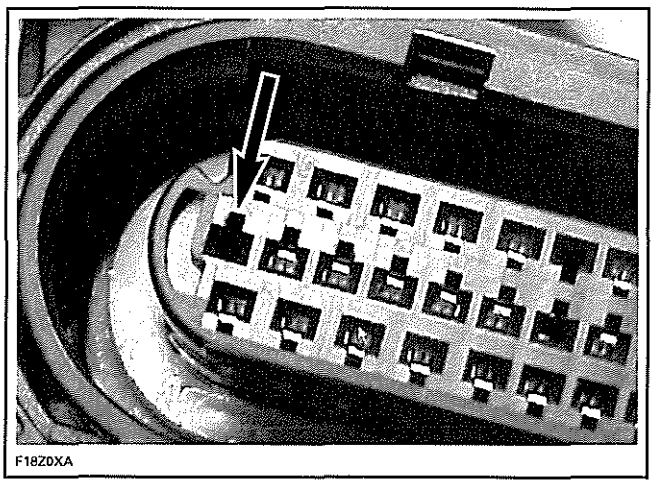
IMPORTANT: Use genuine wires only. Otherwise wires will not fit properly.

Terminal Installation

The locking tab on the connector may have to be bent out a little so it will lock in the housing when it's re-inserted.


F18Z0WA

When re-inserting the connector, the locking tab must be installed facing the smaller cutout of the connector cavity.

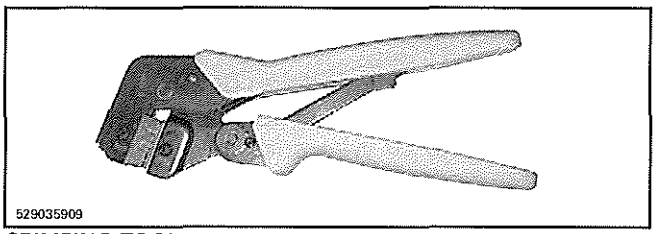

F18Z0XA

Insert the terminal, ensuring the locking tab snaps into the housing.

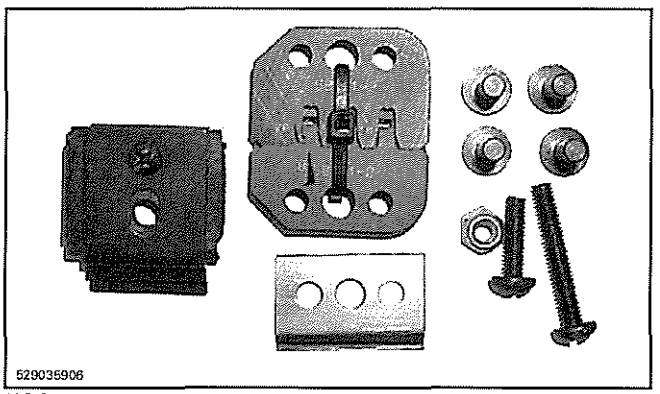
Re-install the lock, attach the 2 tie raps, and close the housing cover.

Terminal Crimping (Kostal and AMP 8-circuits and Multilock)

To crimp a new connector terminal, use the CRIMPING TOOL (KOSTAL) (P/N 529 035 909) and the KOSTAL DIE (P/N 529 035 906).



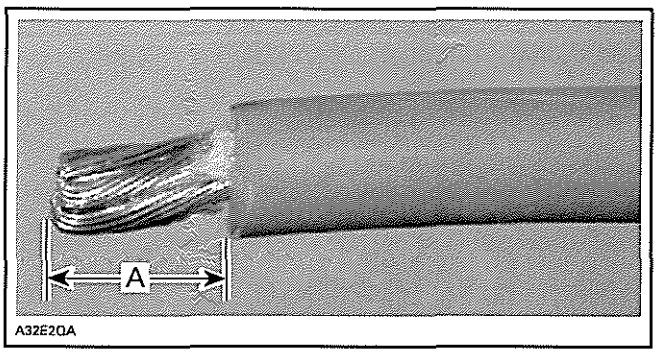
CRIMPING TOOL



KOSTAL DIE

To properly crimp the wires, strictly follow this procedure.

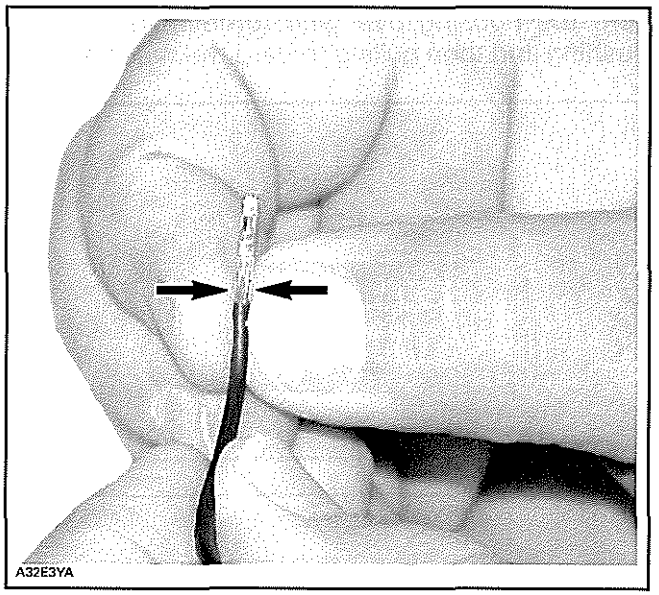
Strip the wire to a maximum of 3 mm (1/8 in).



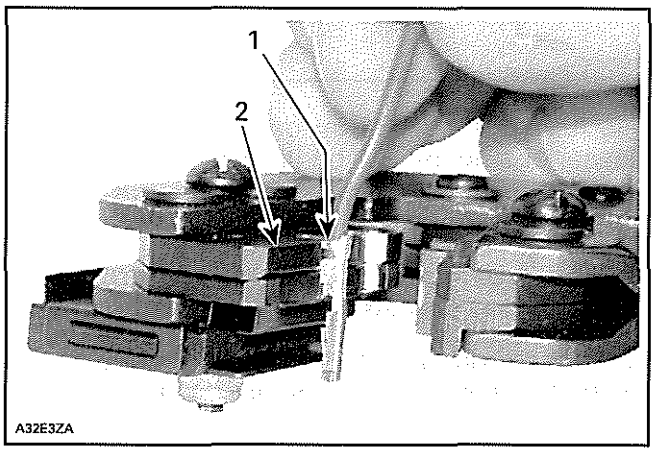
TYPICAL
A. 3 mm (1/8 in) max.

Position wire in terminal.

Squeeze the terminal tabs with your fingers to temporarily retain terminal in place.



Insert terminal with wire in crimping pliers and position so that top of terminal tabs are flush with pliers edge or a little bit lower as shown.



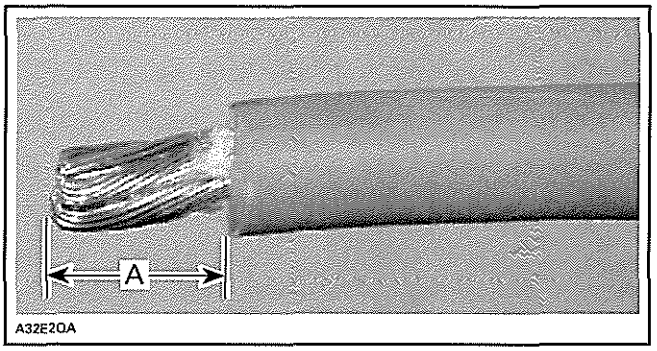
1. Top of terminal tabs
2. Align tabs with pliers edge

Crimp terminal. Ensure no tiny wire goes out of terminal. This might cause strange problems of the electrical system.

BATTERY CABLE TERMINAL

Terminal Installation

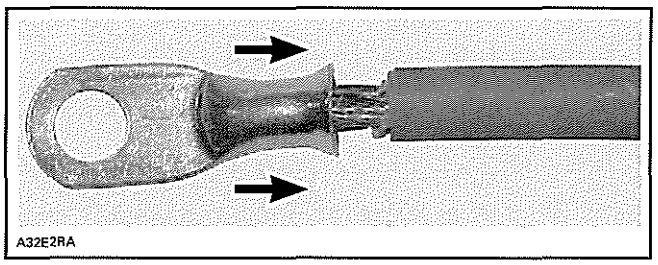
Carefully strip the wire approximately to 10 mm (1/2 in) in length, using a wire stripping tool or sharp blade/knife.



A. 10 mm (1/2 in)

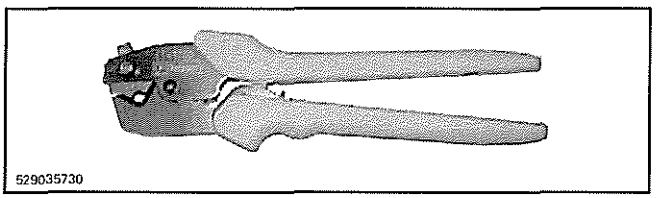
NOTE: Make sure not to cut wire strands while stripping the wire.

Install the appropriate terminal on the wire according to the requirement. Refer to appropriate *PARTS CATALOG*.

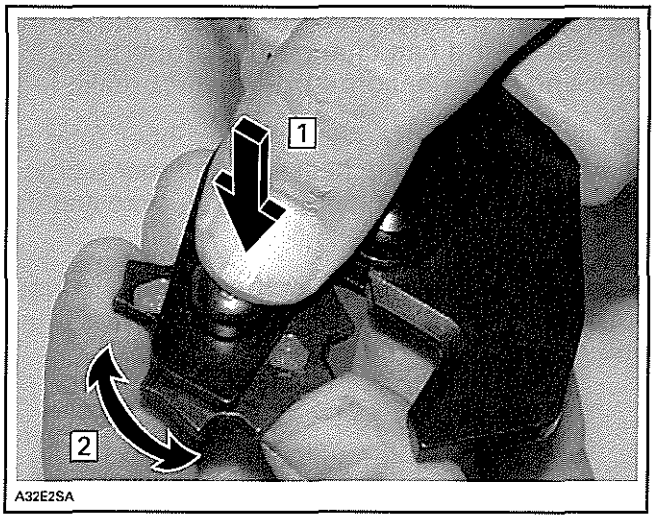


INSTALLATION OF TERMINAL

Follow the instructions provided with the CRIMPING TOOL (HEAVY GAUGE WIRE) (P/N 529 035 730) to select the proper position of the tool.

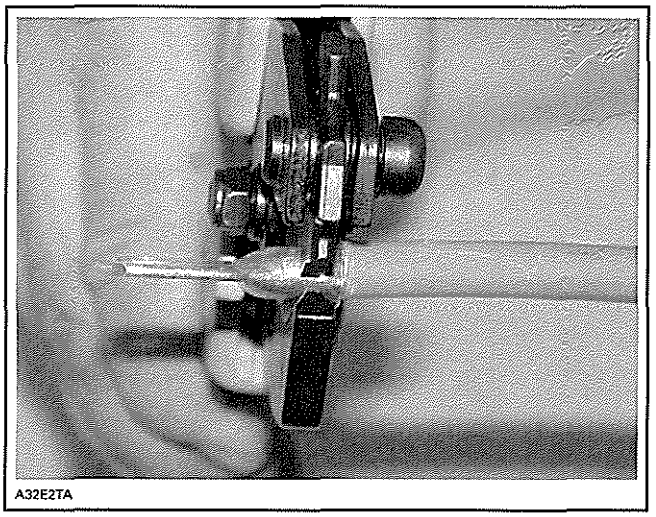


NOTE: Different wires require different crimp pliers settings, so make sure to follow the instruction supplied with the tool.

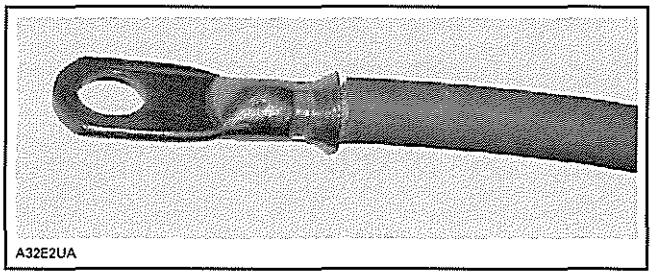


POSITIONING THE CRIMP PLIERS
Step 1: Press
Step 2: Rotate

After positioning the crimp pliers, crimp the terminal already installed on wire.



CRIMPING OF WIRE



PROPERLY CRIMPED WIRE

To verify, if the wire is properly crimped, apply some pulling force on wire and the terminal at the same time from both directions.

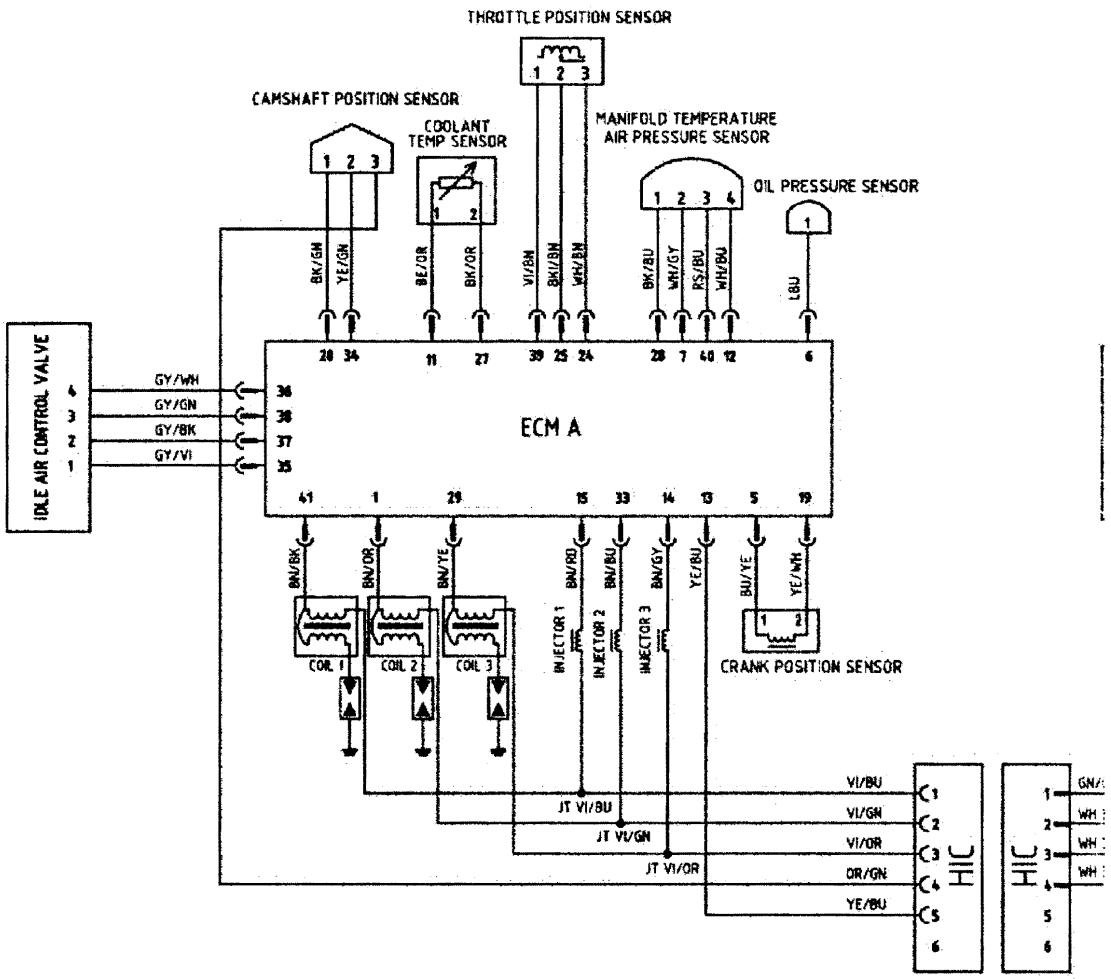
NOTICE Never solder the wire to the terminal. Soldering can change the property of the wire and it can become brittle and break.

Install the protective heat shrink rubber tube on the terminal. Heat the heat shrink rubber tube using the heat gun so that it grasps the wire and the terminal.

NOTICE Make sure that the protective heat shrink rubber tube has been properly installed and no part of wire is exposed.

REV-XU 1200 4-TEC

COLOUR	CODE	COLOUR	CODE
BEIGE	BE	LIGHT BROWN	LT BR
BLACK	BK	ORANGE	OR
BLUE	BU	RED	RD
BROWN	BR	PINK (ROSA)	PK
GREEN	GN	VIOLET	VI
GRAY	GY	WHITE	WH
LIGHT BLUE	LT BU	YELLOW	YE



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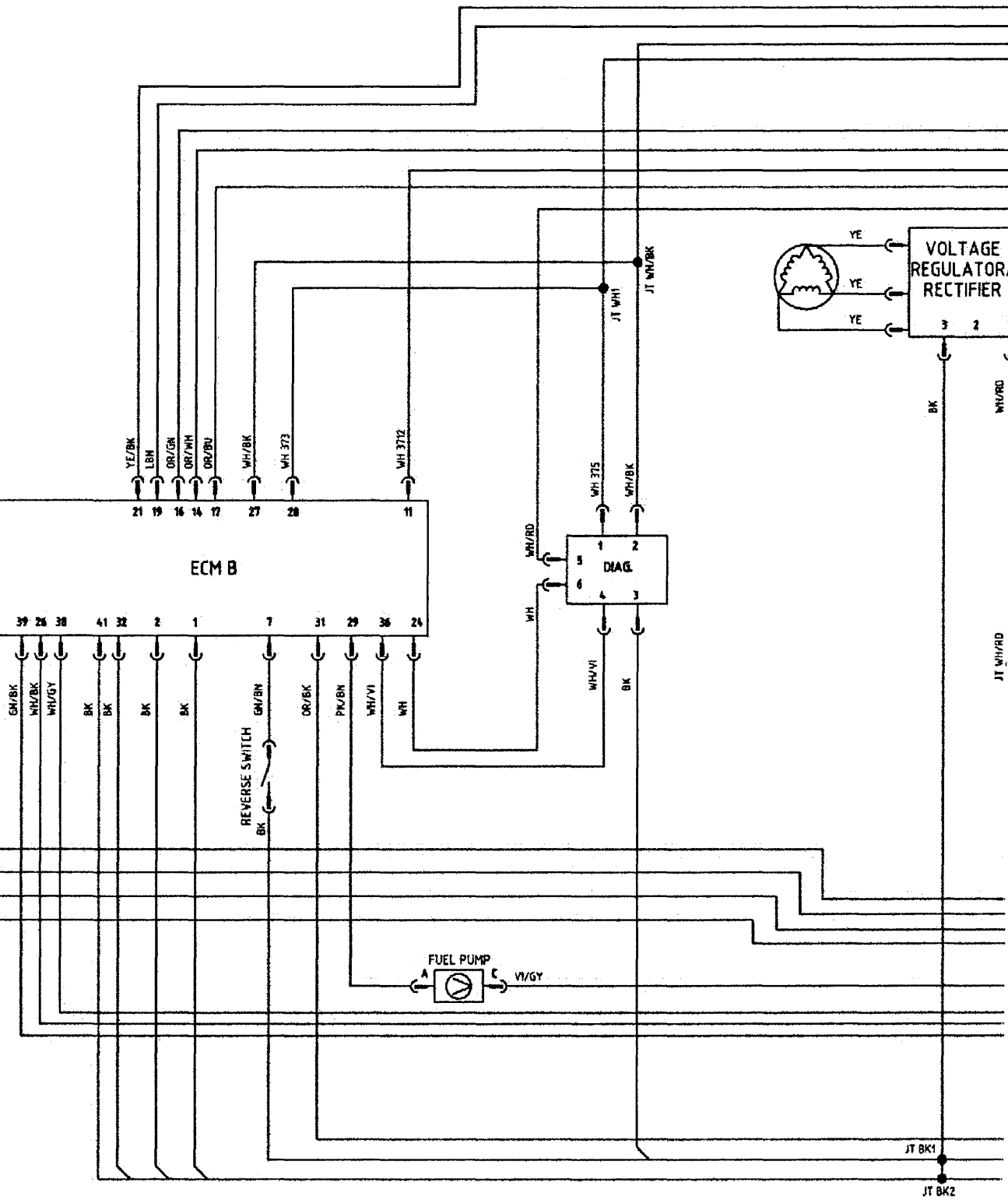
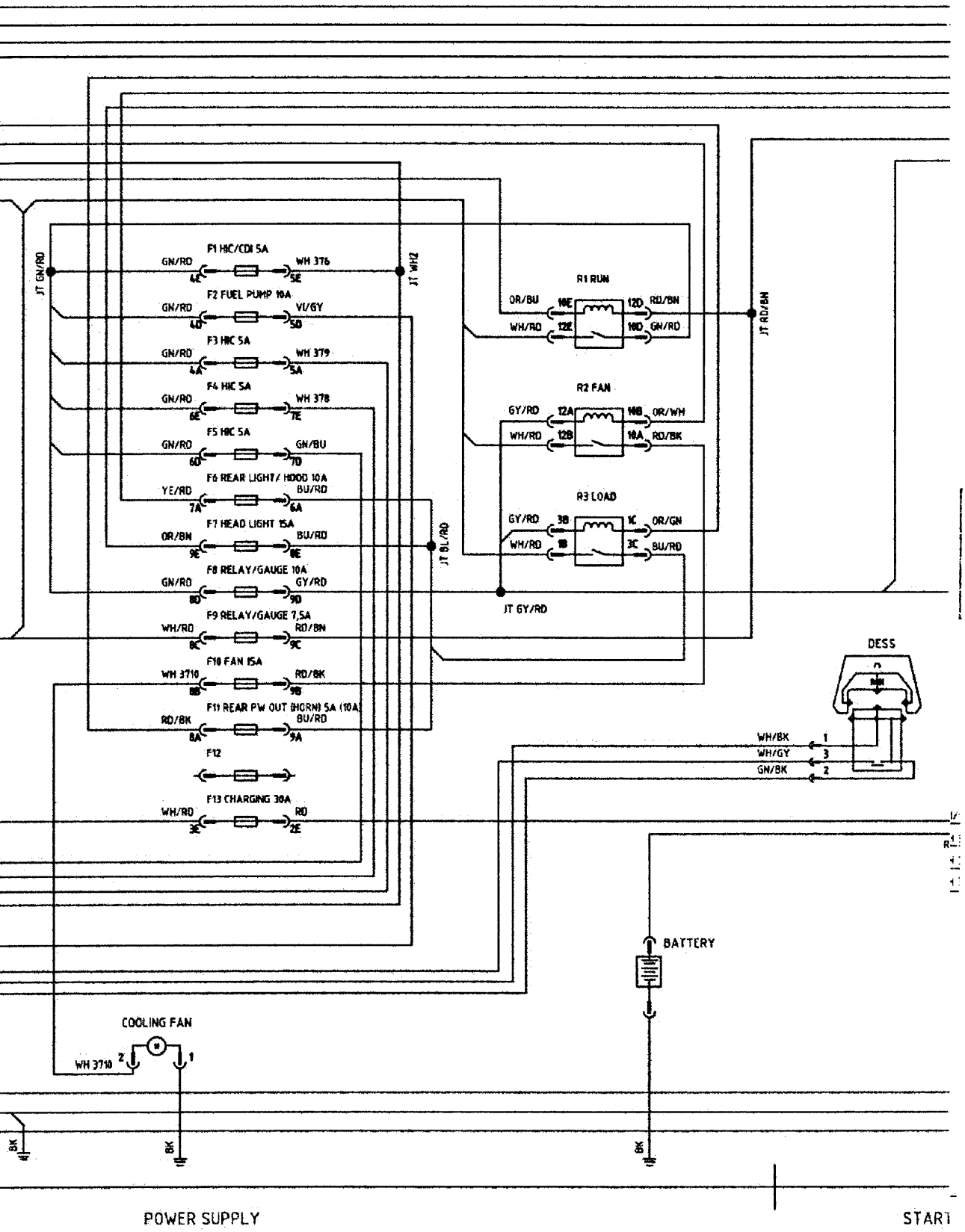
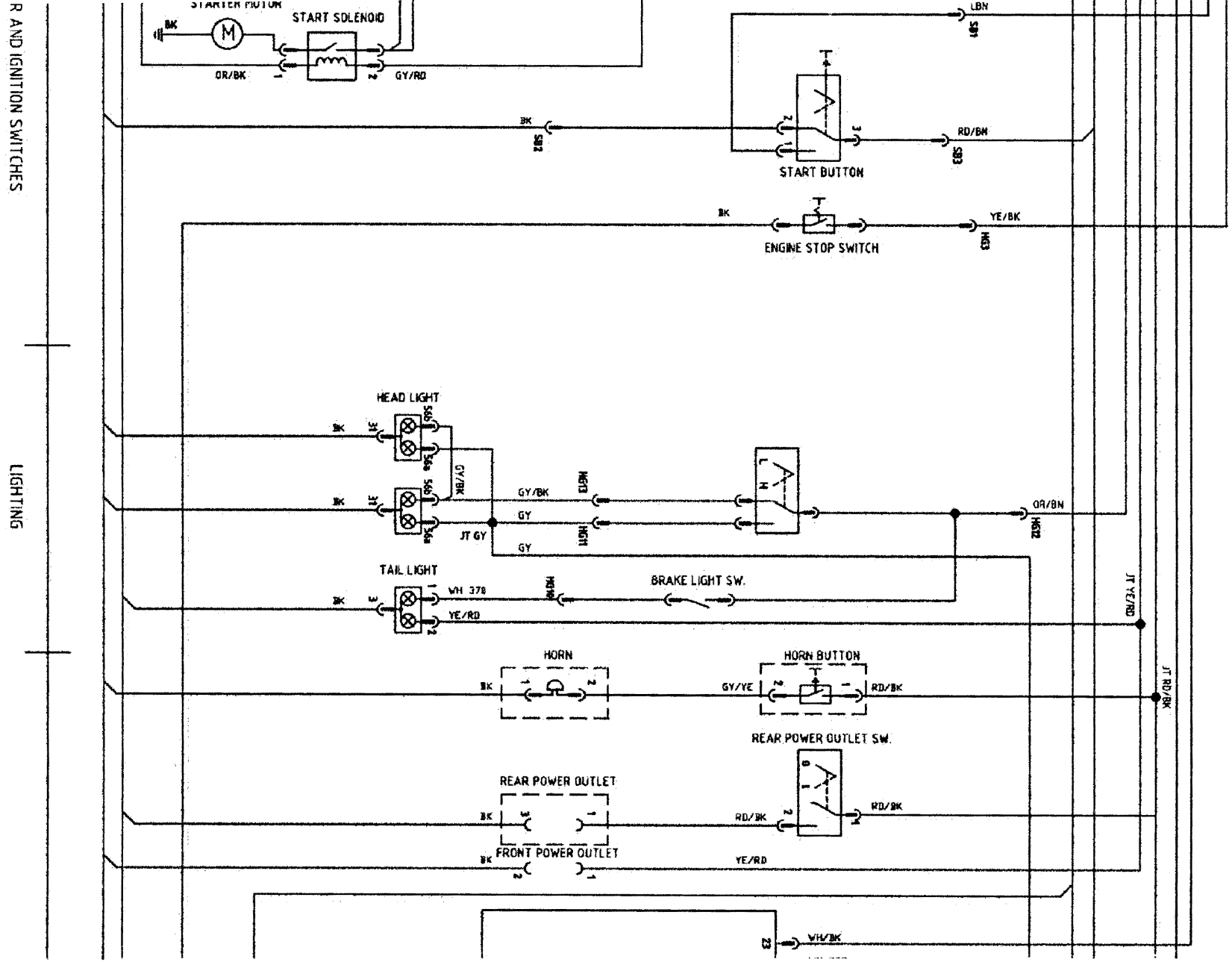
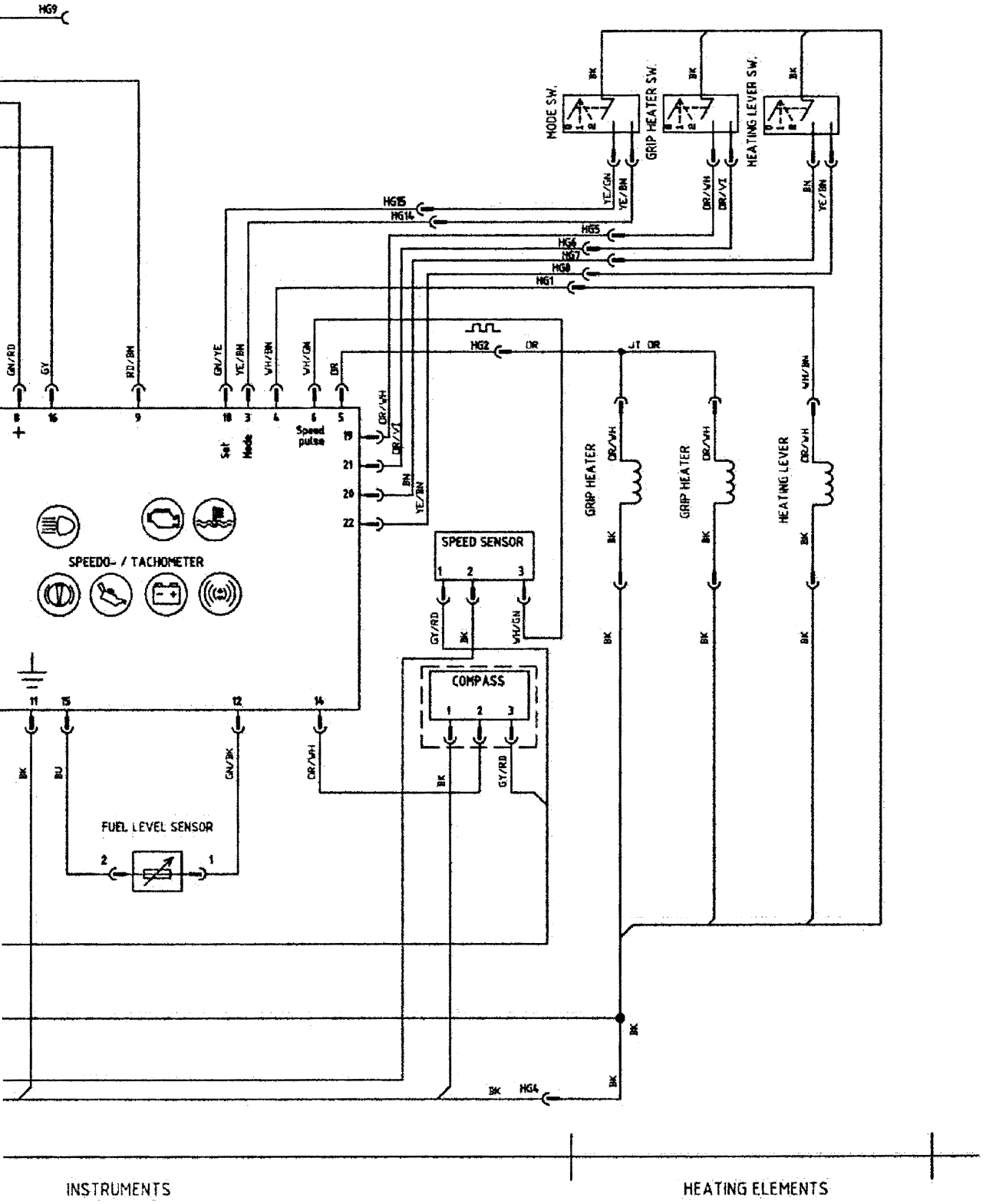
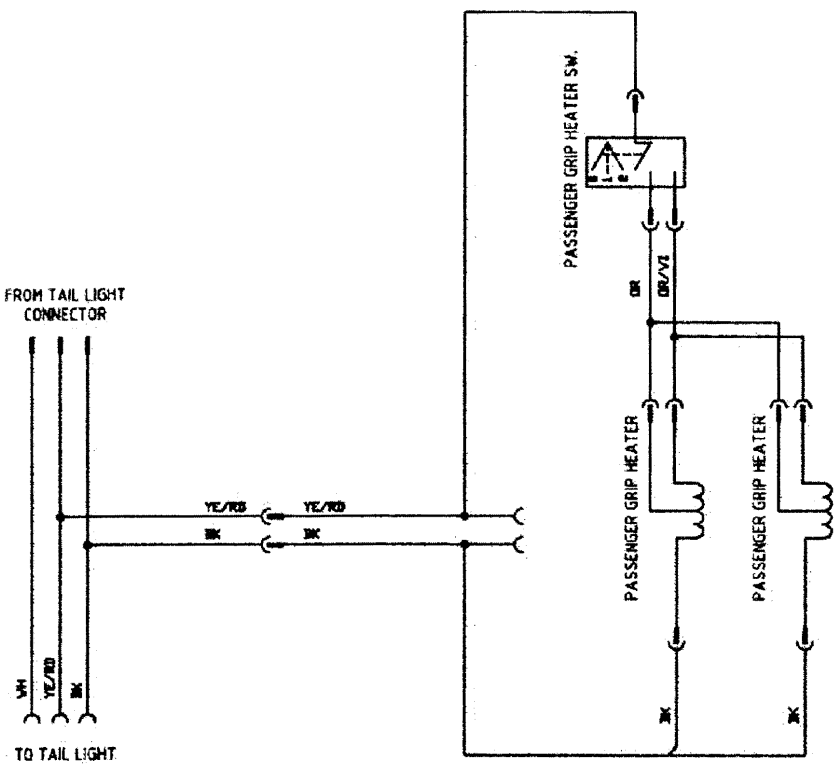
ENGINE CONTROL


VOLTAGE REGULATOR/ RECTIFIER
YE
YE
YE
3
2
JT WH/BK
JT WH1
YE/BK
LBN
OR/GN
OR/WH
OR/BU
WH/BK
WH 373
WH 3712
WH 375
WH/BK
21
19
16
14
17
27
28
11
ECM B
WH/RD
WH
DIAG.
1
2
5
6
4
3
39
26
38
41
32
2
1
7
31
29
36
24
GN/BK
WH/BK
WH/GY
BK
BK
BK
BK
GN/BN
OR/BK
PK/BN
WH/VI
WH
WH/VI
BK
REVERSE SWITCH
BK
FUEL PUMP
A
C
VI/GY
BK
JT WH/RD
JT BK1
JT BK2


F1 HIC/CDI 5A
GN/RD
WH 376
F2 FUEL PUMP 10A
GN/RD
VI/GY
F3 HIC 5A
GN/RD
WH 379
F4 HIC 5A
GN/RD
WH 378
F5 HIC 5A
GN/RD
GN/BU
F6 REAR LIGHT/ HOOD 10A
YE/RD
BU/RD
F7 HEAD LIGHT 15A
OR/BN
BU/RD
F8 RELAY/GAUGE 10A
GN/RD
GY/RD
F9 RELAY/GAUGE 7,5A
WH/RD
RD/BN
F10 FAN 15A
WH 3710
RD/BK
F11 REAR PW OUT (HORN) 5A (10A)
RD/BK
BU/RD
F12
F13 CHARGING 30A
WH/RD
RD
JT GN/RD
JT WH2
JT BL/RD
JT GY/RD
JT RD/BN
R1 RUN
OR/BU
RD/BN
WH/RD
GN/RD
R2 FAN
GY/RD
OR/WH
WH/RD
RD/BK
R3 LOAD
GY/RD
OR/GN
WH/RD
BU/RD
DESS
WH/BK
WH/GY
GN/BK
BATTERY
COOLING FAN
WH 3710
BK
POWER SUPPLY
START


R AND IGNITION SWITCHES
LIGHTING
STARTER MOTOR
START SOLENOID
BK
OR/BK
GY/RD
LBN
SB1
BK
SB2
RD/BK
SB3
START BUTTON
BK
YE/BK
HS3
ENGINE STOP SWITCH
HEAD LIGHT
BK
GY/BK
GY
JT GY
HS13
HIGH
OR/BN
HS12
TAIL LIGHT
WH 378
YE/RD
BRAKE LIGHT SW.
JT YE/RD
HORN
BK
HORN BUTTON
GY/YE
RD/BK
JT RD/BK
REAR POWER OUTLET SW.
REAR POWER OUTLET
BK
RD/BK
FRONT POWER OUTLET
YE/RD
WH/BK

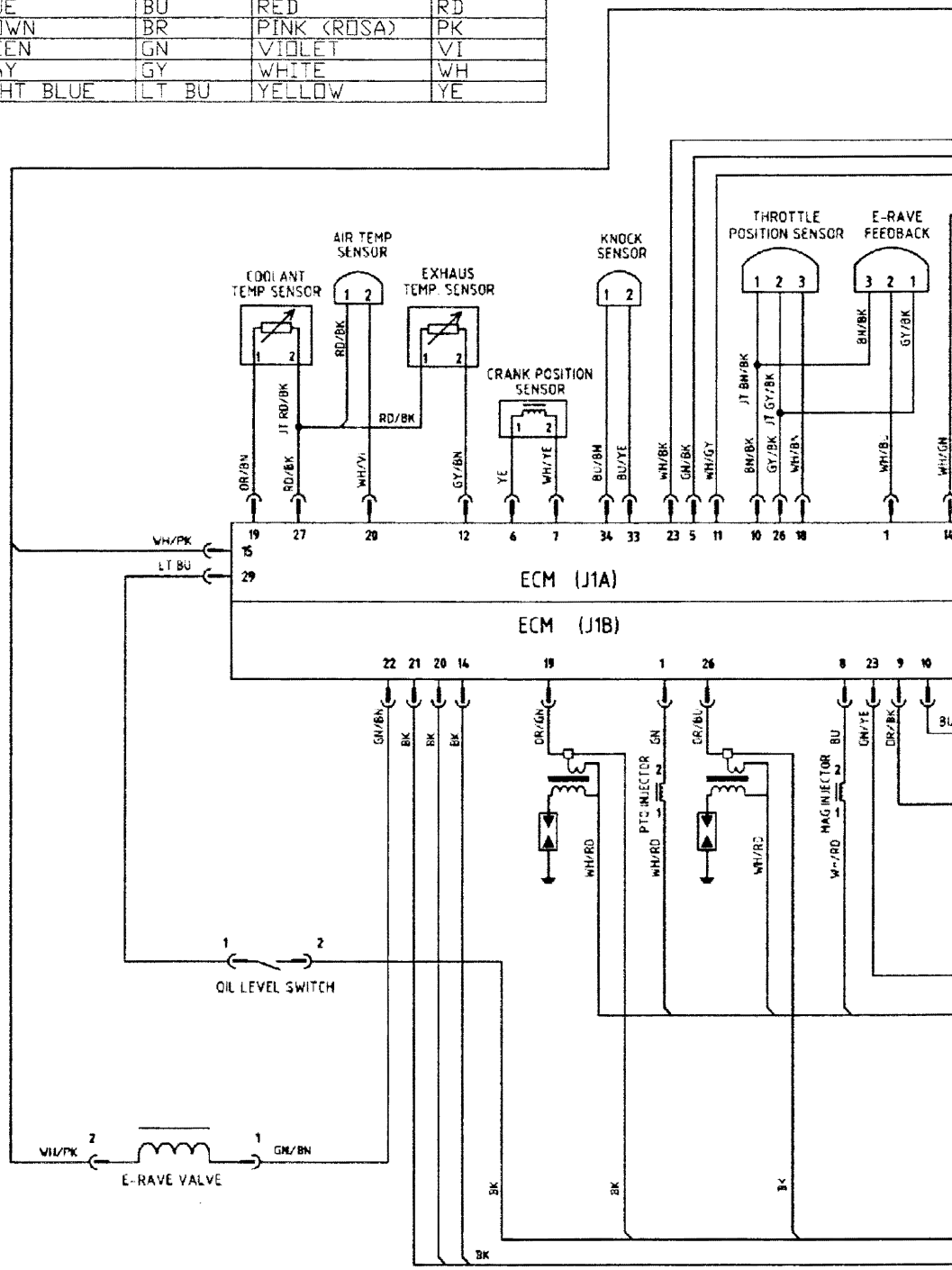

HG9
MODE SW.
GRIP HEATER SW.
HEATING LEVER SW.
BK
YE/GN
YE/BN
DR/VH
DR/VI
BN
HG15
HG14
HG5
HG6
HG7
HG8
HG1
HG2
DR
LT DR
GN/RD
GY
RD/BN
GN/YE
YE/BN
VH/BN
VH/GN
DR
Set
Mode
Speed pulse
DR/VH
DR/VI
BN
YE/BN
SPEEDO- / TACHOMETER
SPEED SENSOR
GRIP HEATER
GRIP HEATER
HEATING LEVER
GY/RD
VH/GN
COMPASS
BU
GN/BK
FUEL LEVEL SENSOR
HG4
INSTRUMENTS
HEATING ELEMENTS



OPTIONAL/EXTRA

REV-XU 600 HO E-TEC

COLOUR	CODE	COLOUR	CODE
BEIGE	BE	LIGHT BROWN	LT BR
BLACK	BK	ORANGE	OR
BLUE	BU	RED	RD
BROWN	BR	PINK (ROSA)	PK
GREEN	GN	VIOLET	VI
GRAY	GY	WHITE	WH
LIGHT BLUE	LT BU	YELLOW	YE



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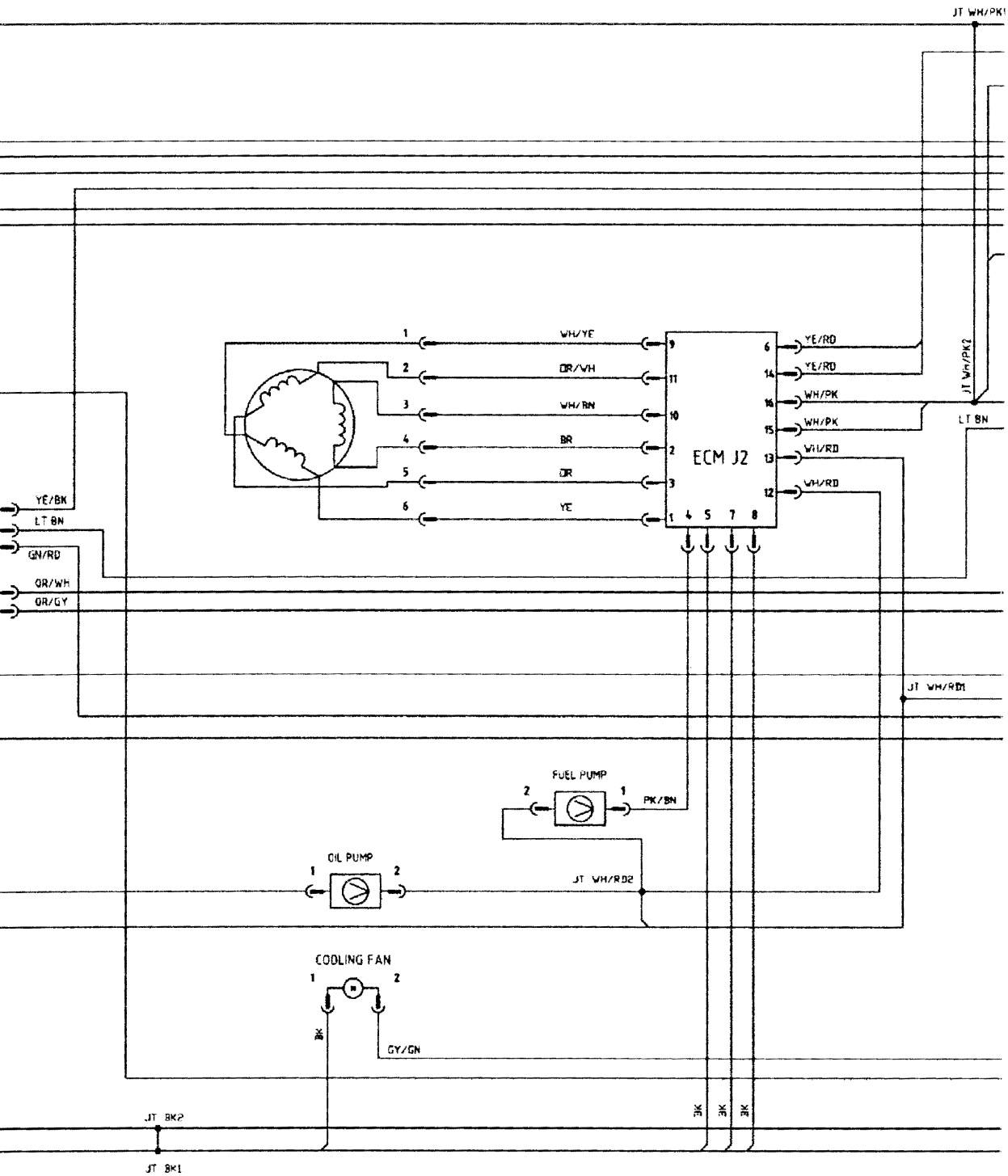
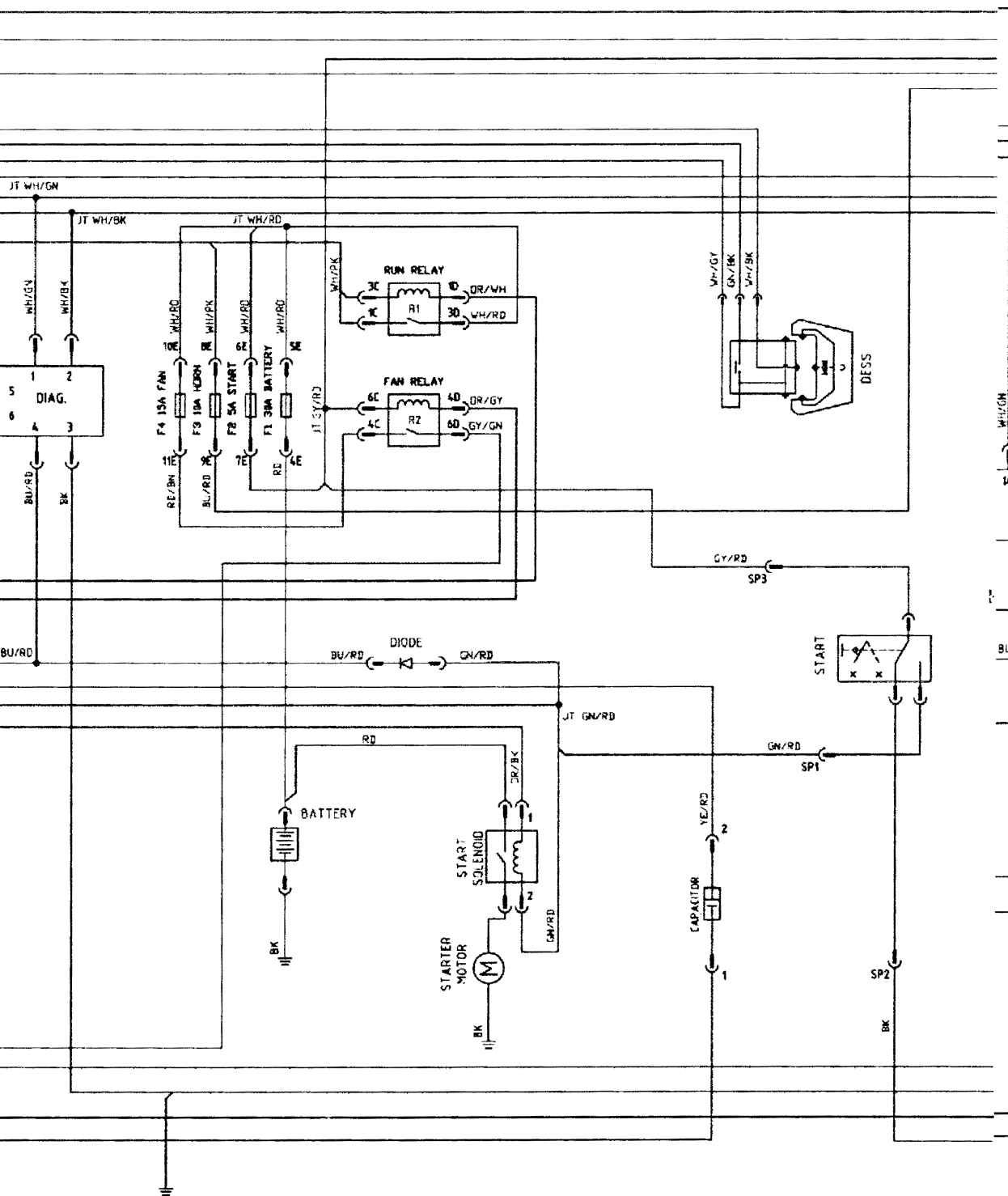
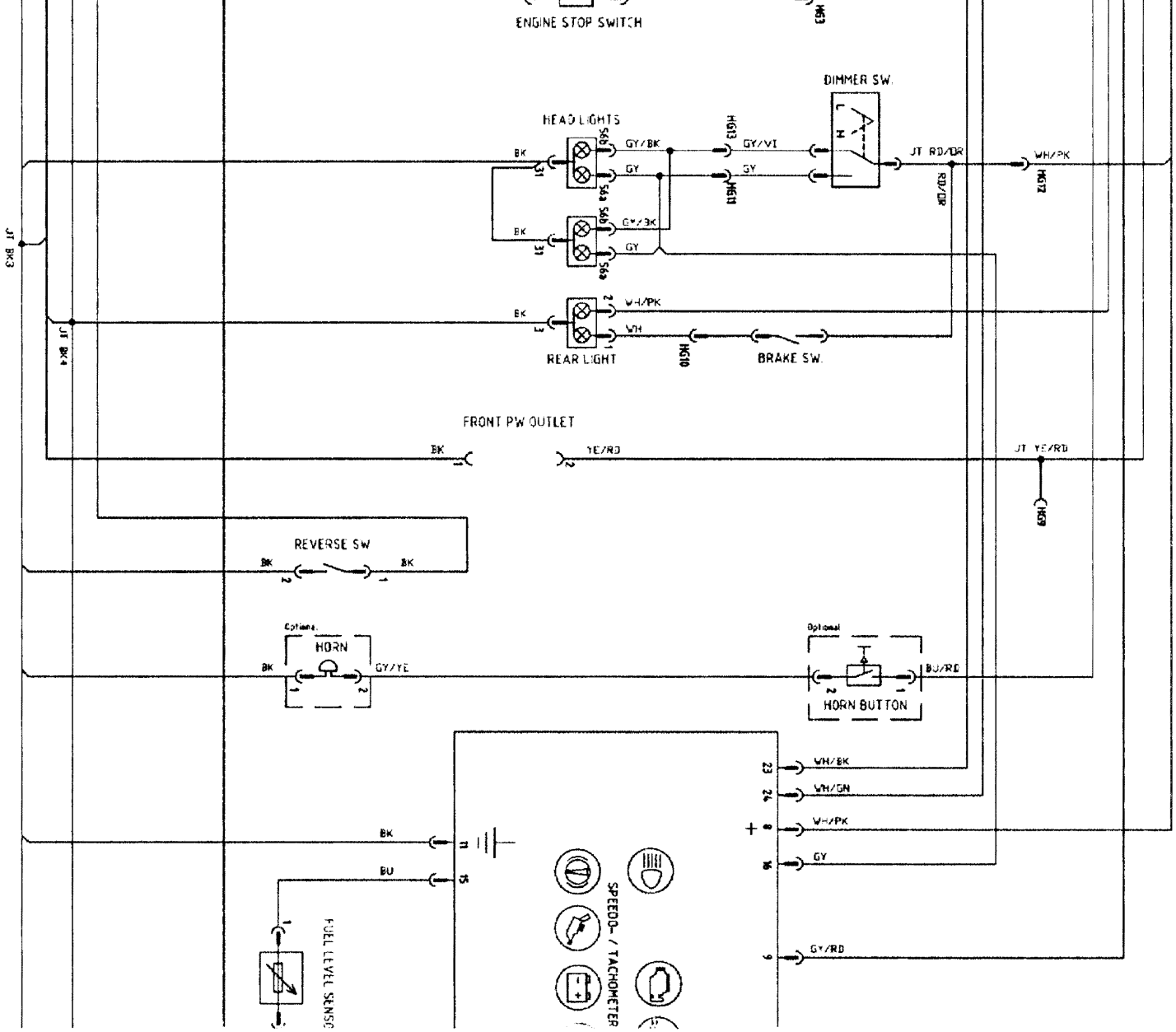
ENGINE CONTROL

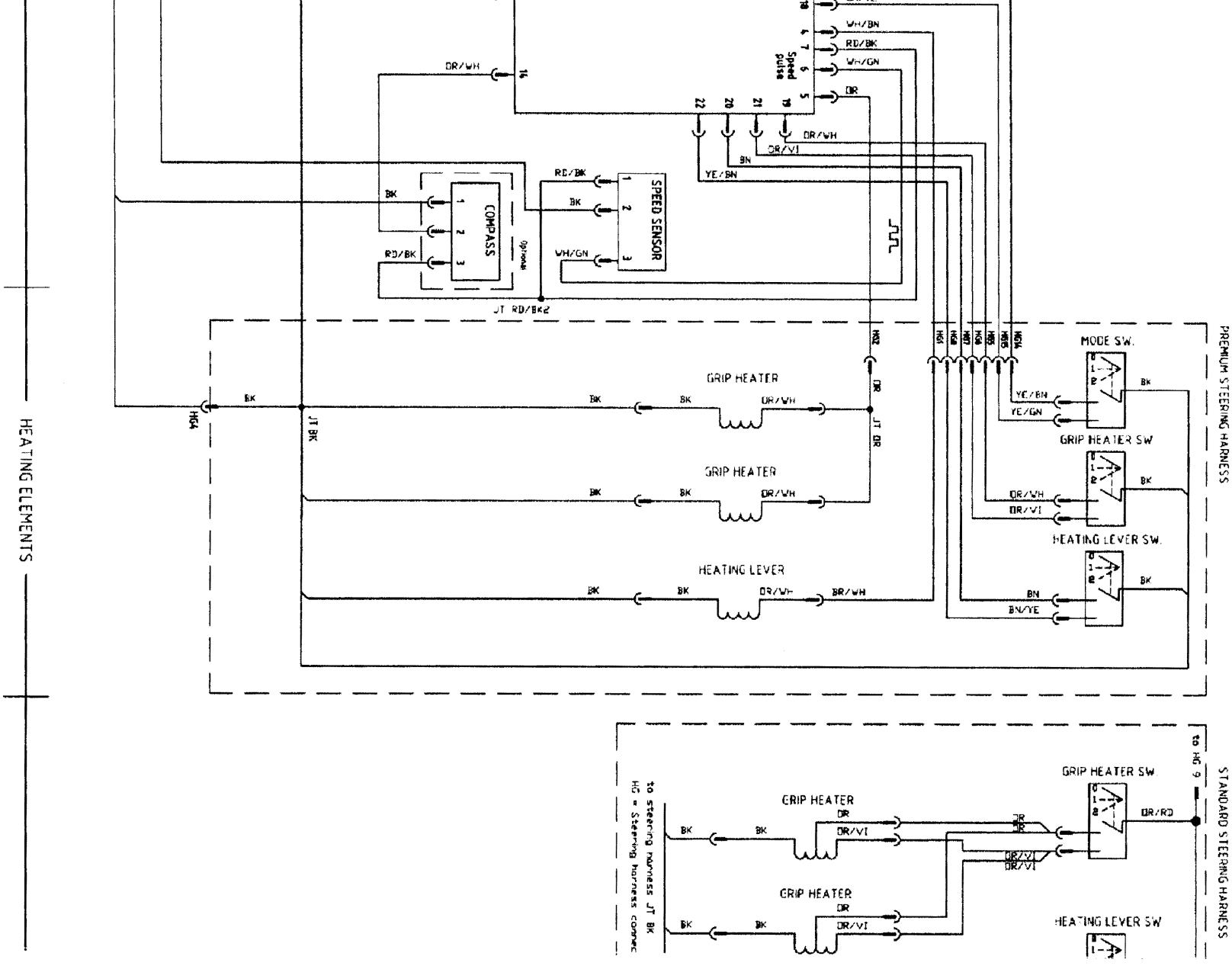
mmr2011-226-050

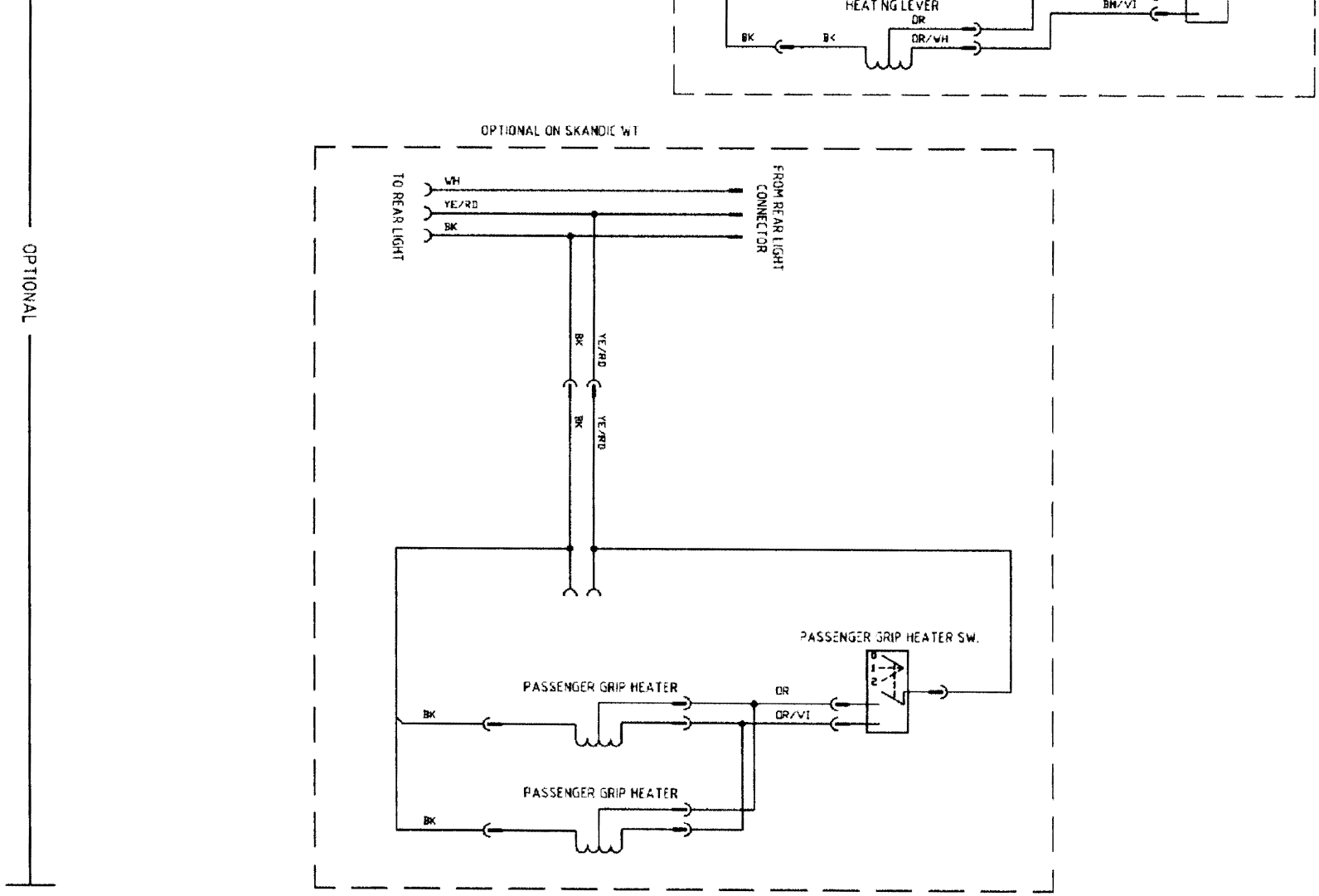

JT WH/PK1
JT WH/PK2
LT BN
1 WH/YE
2 OR/WH
3 WH/RN
4 BR
5 OR
6 YE
ECM J2
9
11
10
2
3
1 4 5 7 8
6 YE/RD
14 YE/RD
16 WH/PK
15 WH/PK
13 WH/RD
12 WH/RD
YE/BK
LT BN
GN/RD
OR/WH
OR/GY
JT WH/RD1
FUEL PUMP
2
1
PK/BN
OIL PUMP
1
2
JT WH/RD2
COOLING FAN
1
2
M
3K
GY/GN
3K
3K
3K
JT BK2
JT BK1



STARTER AND IGNITION SWITCHES

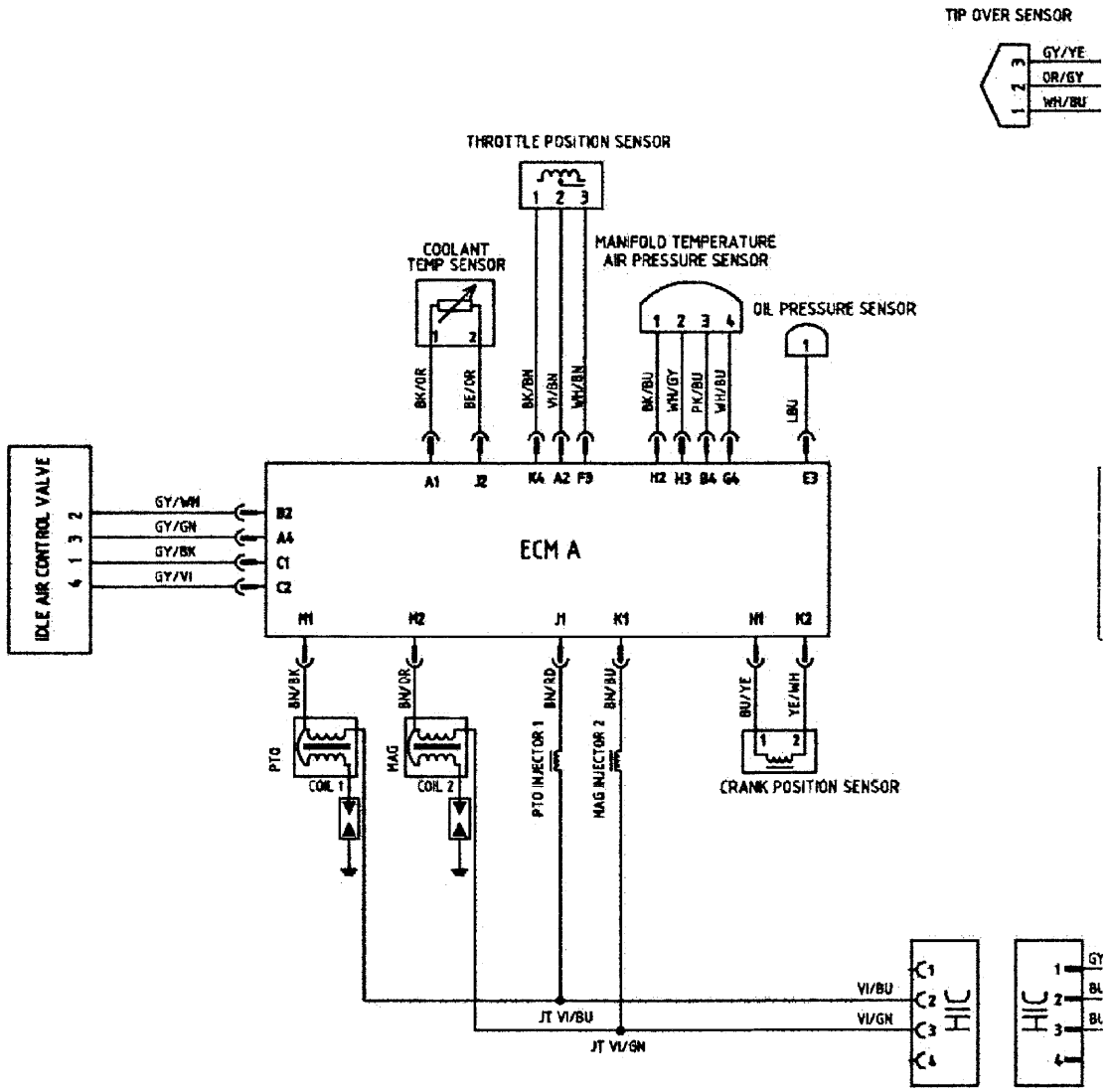

ENGINE STOP SWITCH
DIMMER SW.
HEAD LIGHTS
REAR LIGHT
BRAKE SW.
FRONT PW OUTLET
REVERSE SW
HORN
HORN BUTTON
SPEEDO- / TACHOMETER
FUEL LEVEL SENSOR


HEATING ELEMENTS
DR/WH
14
Speed pulse
WH/BN
RD/BK
WH/GN
DR
22
20
21
18
DR/WH
DR/VI
BN
YE/BN
COMPASS
Option
SPEED SENSOR
RD/BK
BK
WH/GN
JT RD/BK2
PREMIUM STEERING HARNESS
HG4
JT BK
HG2
DR
JT DR
GRIP HEATER
BK
DR/WH
HG1
HG8
HG7
HG6
HG5
HG3
MODE SW.
YE/BN
YE/GN
GRIP HEATER SW
DR/VI
HEATING LEVER SW.
HEATING LEVER
BR/WH
BN
BN/YE
STANDARD STEERING HARNESS
to HG 9
DR/RD
to steering harness JT BK
HG = Steering harness connec


OPTIONAL
HEATING LEVER
DR
BK
BK
OR/WH
BR/VI
OPTIONAL ON SKANDIC WT
TO REAR LIGHT
FROM REAR LIGHT CONNECTOR
WH
YE/RD
BK
BK
YE/RD
BK
YE/RD
PASSENGER GRIP HEATER SW.
PASSENGER GRIP HEATER
DR
BK
OR/VI
PASSENGER GRIP HEATER
BK

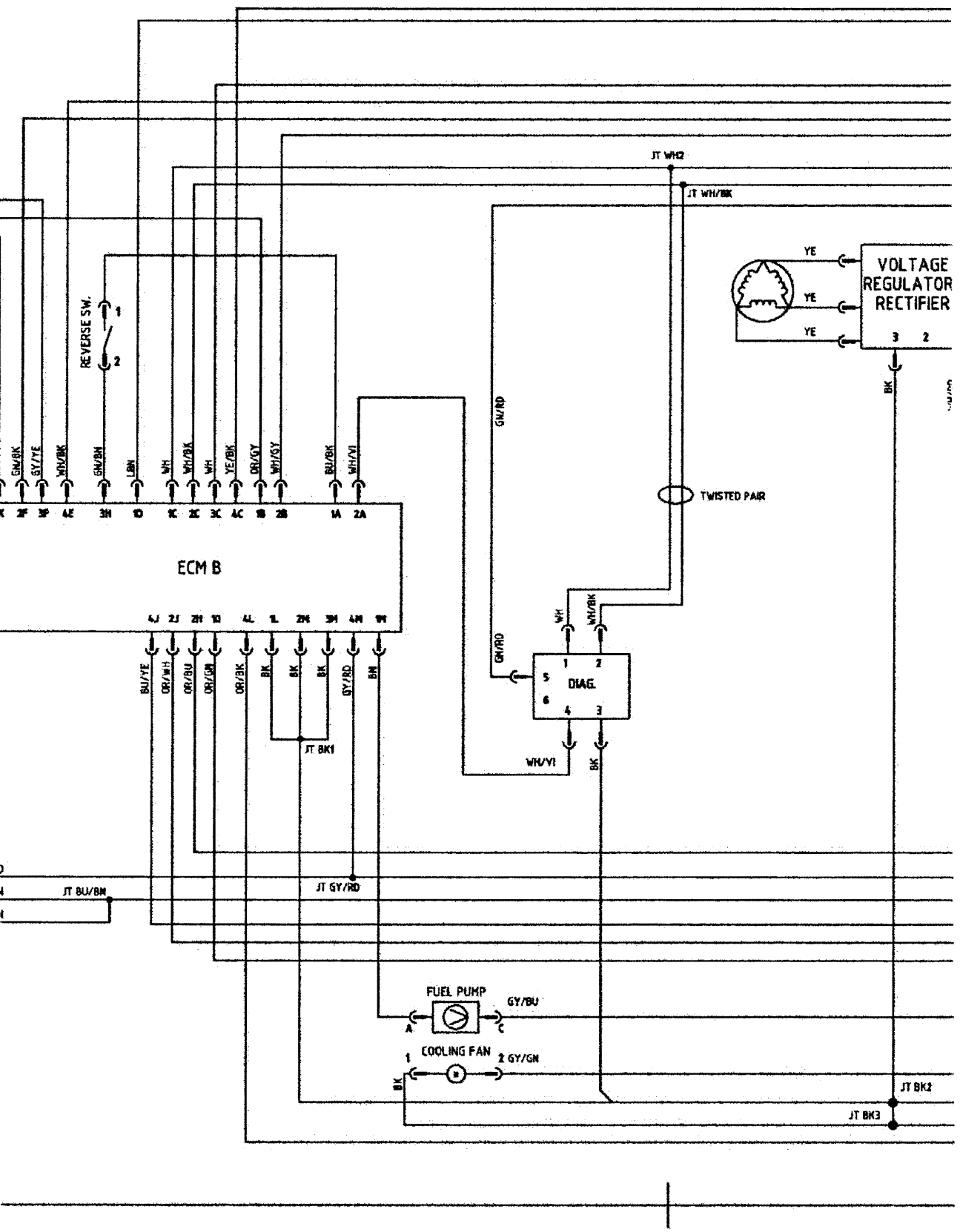
REV-XU 600 ACE

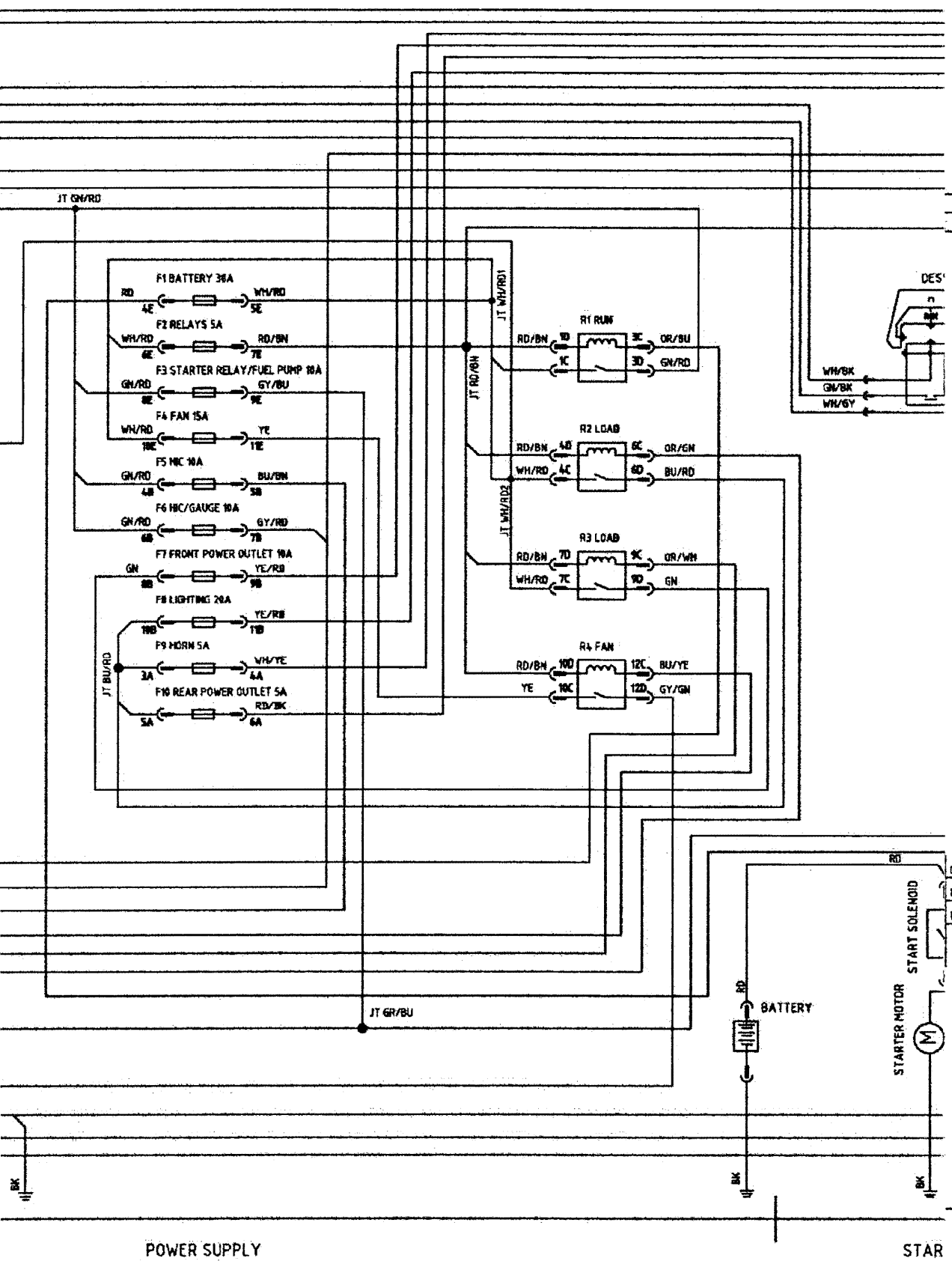
COLOUR	CODE	COLOUR	CODE
BEIGE	BE	LIGHT BROWN	LBN
BLACK	BK	ORANGE	OR
BLUE	BU	RED	RD
BROWN	BN	ROSA (PINK)	RS
GREEN	GN	VIOLET	VI
GRAY	GR	WHITE	WH
LIGHT BLUE	LBL	YELLOW	YE

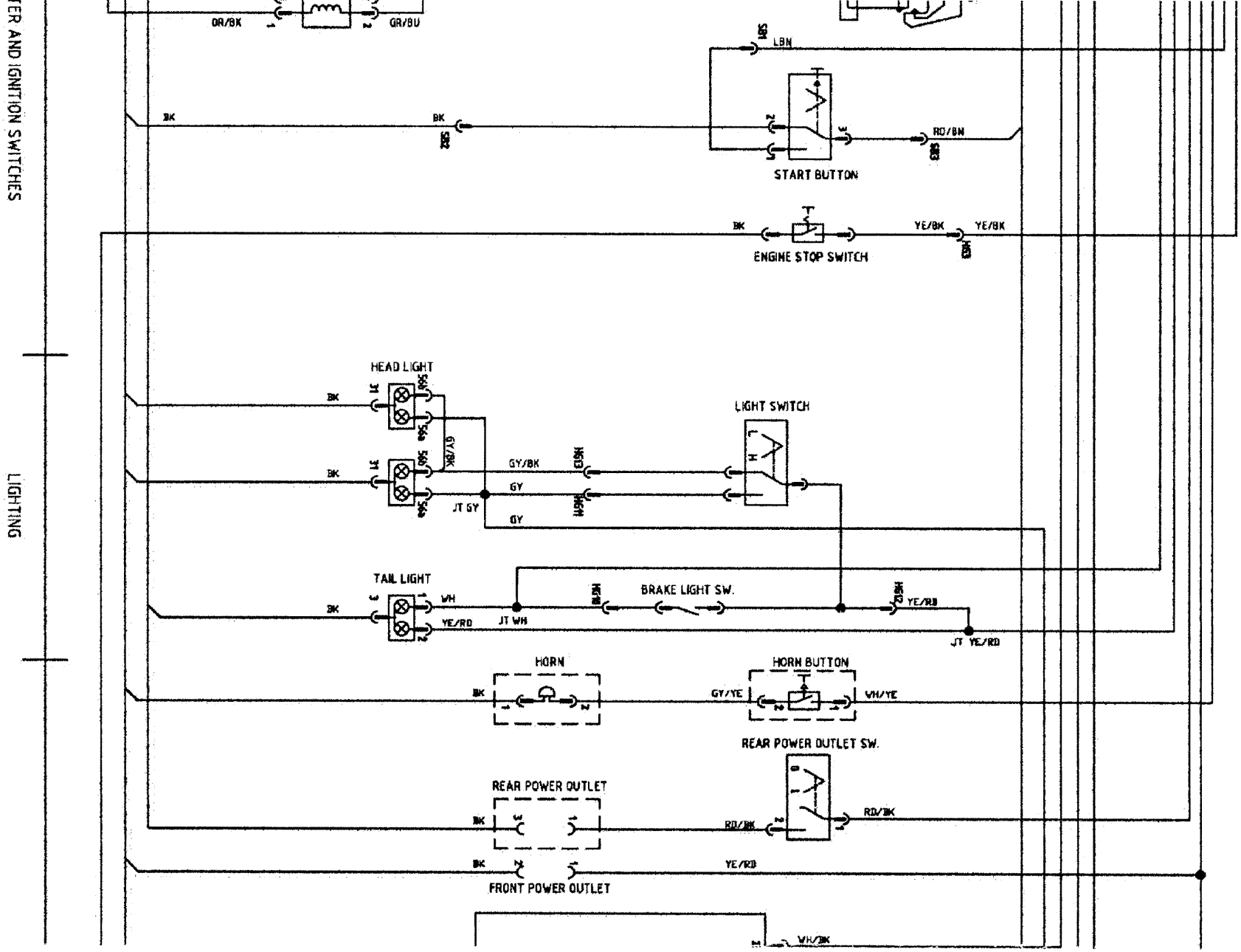


515 176 932

ENGINE CONTROL


JT WH2
JT WH/BK
YE
YE
YE
VOLTAGE REGULATOR RECTIFIER
3
2
BK
REVERSE SW.
1
2
GW/BK
GY/YE
WH/BK
GN/BN
LBN
WH
WH/BK
WH
YE/BK
OR/GY
WH/GY
BU/BK
WH/YE
3F
4E
3H
1D
1C
2C
3C
4C
1B
2B
1A
2A
GN/RD
TWISTED PAIR
ECM B
4J
2J
2H
1D
4L
1L
2M
3M
4M
1M
WH
WH/BK
GN/RD
DIAG.
1
2
5
6
4
3
BU/YE
OR/WH
OR/BU
OR/GN
OR/BK
BK
BK
BK
GY/RD
BN
JT BK1
WH/YE
BK
JT BU/BN
JT GY/RD
FUEL PUMP
GY/BU
A
C
COOLING FAN
1
2 GY/GN
BK
JT BK2
JT BK3


JT GN/RD
F1 BATTERY 30A
RD
4E
WH/RD
5E
F2 RELAYS 5A
WH/RD
6E
RD/BN
7E
F3 STARTER RELAY/FUEL PUMP 10A
GN/RD
8E
GY/BU
9E
F4 FAN 15A
WH/RD
10E
YE
11E
F5 MIC 10A
GN/RD
4B
BU/BN
5B
F6 MIC/GAUGE 10A
GN/RD
6B
GY/RD
7B
F7 FRONT POWER OUTLET 10A
GN
8B
YE/RD
9B
F8 LIGHTING 20A
10B
YE/RD
11B
F9 HORN 5A
3A
WH/YE
4A
F10 REAR POWER OUTLET 5A
5A
RD/BK
6A
JT BU/RD
JT WH/RD1
JT RD/BN
JT WH/RD2
R1 RUN
RD/BN
1D
1C
3C
OR/BU
3D
GN/RD
R2 LOAD
RD/BN
4B
WH/RD
4C
6C
OR/GN
6D
BU/RD
R3 LOAD
RD/BN
7D
WH/RD
7C
9C
OR/WH
9D
GN
R4 FAN
RD/BN
10D
YE
10C
12C
BU/YE
12D
GY/GN
DES
WH/BK
GN/BK
WH/GY
JT GR/BU
RD
BATTERY
BK
START SOLENOID
STARTER MOTOR
M
POWER SUPPLY
STAR


POWER AND IGNITION SWITCHES
LIGHTING
OR/BK
GR/BU
LBN
BK
RD/BN
START BUTTON
YE/BK
ENGINE STOP SWITCH
HEAD LIGHT
LIGHT SWITCH
GY/BK
GY
JT GY
TAIL LIGHT
WH
YE/RD
JT WH
BRAKE LIGHT SW.
JT YE/RD
HORN
HORN BUTTON
GY/YE
WH/YE
REAR POWER OUTLET SW.
REAR POWER OUTLET
RD/BK
FRONT POWER OUTLET
WH/BK

INSTRUMENTS

HEATING ELEMENTS

SPEEDO- / TACHOMETER

FUEL LEVEL SENSOR

COMPASS

SPEED SENSOR

GRIP HEATER

GRIP HEATER

HEATING LEVER

GRIP HEATER SW.

HEATING LEVER SW.

BK

BU

GY/RD

GY

RD/BN

RD/BK

VI/BK

DR/WH

VH/GN

DR

DR/VI

DR/RD

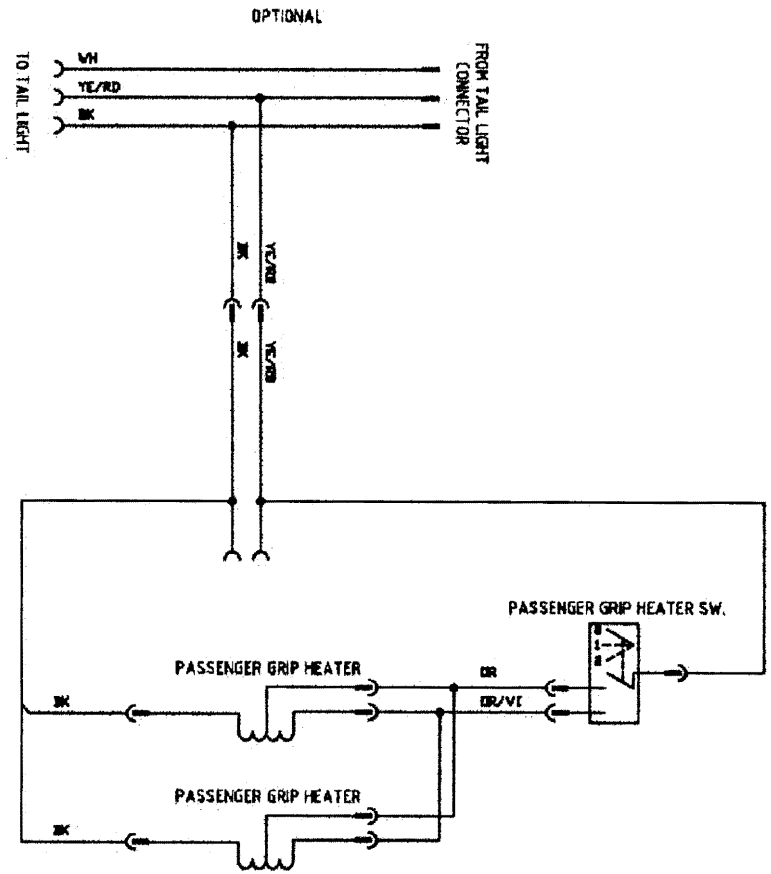
BN

BN/VI

JT BK

JT RD/BK

JT VI/BK

JT DR/RD

OPTIONAL/EXTRA