

EVINRUDE[®]
E-TEC[®]



2011 Service Manual

115, 130, 150, 175, 200 HP

60° V4 / V6

BRP US Inc.
Technical Publications
250 Sea Horse Drive
Waukegan, Illinois 60085 United States



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<i>Evinrude</i> ® / <i>Johnson</i> ® <i>XD100</i> ™ Outboard Oil	<i>HPF PRO</i> ™ Gearcase Lubricant
<i>Gel-Seal II</i> ™	

SERVICE MANUAL

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IMPORTANT: For complete outboard rigging and control installation information, refer to the **Predelivery and Installation Guide** included with the service manual set.

All special tools referenced in this manual can be found in the **Special Tools Guide**, P/N 5008526.

REFERENCE INFORMATION

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SAFETY NOTICE

Before working on any part of the outboard, read the **SAFETY** section at the end of this manual.

This publication is written for qualified, factory-trained technicians who are already familiar with the use of *Evinrude/Johnson* Special Tools. The included information is not a substitute for work experience. It is an organized guide for reference, repair, and/or maintenance.

The following symbols and/or signal words may be used in this document:



DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.



WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury



CAUTION

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

NOTICE Indicates an instruction which, if not followed, could severely damage engine components or other property.

These safety alert signal words mean:

ATTENTION!

BECOME ALERT!

YOUR SAFETY IS INVOLVED!

IMPORTANT: Identifies information that controls correct assembly and operation of the product.

DO NOT perform any work until you have read and understood these instructions completely.

Torque wrench tightening specifications must strictly be adhered to.

Should removal of any locking fastener (lock tabs, locknuts, or patch screws) be required, always replace with a new one.

When replacement parts are required, use *Evinrude/Johnson Genuine Parts* or parts with equivalent characteristics, including type, strength and material. Use of substandard parts could result in injury or product malfunction.

Always wear EYE PROTECTION AND APPROPRIATE GLOVES when using power tools.

Unless otherwise specified, engine must be OFF when performing this work.

Always be aware of parts that can move, such as flywheels, propellers, etc.

Some components may be HOT. Always wait for engine to cool down before performing work.

If you use procedures or service tools that are not recommended in this manual, YOU ALONE must decide if your actions might injure people or damage the outboard.

This document may be translated into other languages. In the event of any discrepancy, the English version shall prevail.

**DANGER**

Contact with a rotating propeller is likely to result in serious injury or death. Assure the engine and prop area is clear of people and objects before starting engine or operating boat. Do not allow anyone near a propeller, even when the engine is off. Blades can be sharp and the propeller can continue to turn even after the engine is off. Remove propeller before servicing and when running the outboard on a flushing device.

DO NOT run the engine indoors or without adequate ventilation or permit exhaust fumes to accumulate in confined areas. Engine exhaust contains carbon monoxide which, if inhaled, can cause serious brain damage or death.

**WARNING**

Wear safety glasses to avoid personal injury, and set compressed air to less than 25 psi (172 kPa).

The motor cover and flywheel cover are machinery guards. Use caution when conducting tests on running outboards. **DO NOT** wear jewelry or loose clothing. Keep hair, hands, and clothing away from rotating parts.

During service, the outboard may drop unexpectedly. Avoid personal injury; always support the outboard's weight with a suitable hoist or the tilt support bracket during service.

To prevent accidental starting while servicing, disconnect the battery cables at the battery. Twist and remove all spark plug leads.

The electrical system presents a serious shock hazard. **DO NOT** handle primary or secondary ignition components while outboard is running or flywheel is turning.

Gasoline is extremely flammable and highly explosive under certain conditions. Use caution when working on any part of the fuel system.

Protect against hazardous fuel spray. Before starting any fuel system service, carefully relieve fuel system pressure.

Do not smoke, or allow open flames or sparks, or use electrical devices such as cellular phones in the vicinity of a fuel leak or while fueling.

Keep all electrical connections clean, tight, and insulated to prevent shorting or arcing and causing an explosion.

Always work in a well ventilated area.

Replace any locking fastener (locknut or patch screw) if its locking feature becomes weak. Definite resistance to tightening must be felt when reusing a locking fastener. If replacement is indicated, use only authorized replacement or equivalent.

ABBREVIATIONS USED IN THIS MANUAL

Units of Measurement

A	Amperes
amp-hr	Ampere hour
fl. oz.	fluid ounce
ft. lbs.	foot pounds
HP	horsepower
in.	inch
in. Hg	inches of mercury
in. lbs.	inch pounds
kPa	kilopascals
ml	milliliter
mm	millimeter
N·m	Newton meter
P/N	part number
psi	pounds per square inch
RPM	revolutions per minute
°C	degrees Celsius
°F	degrees Fahrenheit
ms	milliseconds
μs	microseconds
Ω	Ohms
V	Volts
VAC	Volts Alternating Current
VDC	Volts Direct Current

List of Abbreviations

ABYC	American Boat & Yacht Council
ATDC	after top dead center
AT	air temperature sensor
BPS	barometric pressure sensor
BTDC	before top dead center
CCA	cold cranking amps
CFR	Code of Federal Regulations
CPS	crankshaft position sensor
EMM	Engine Management Module
EPA	Environmental Protection Agency
ICOMIA	International Council of Marine Industry Associations
ID	Inside dimension
MCA	marine cranking amps
MWS	modular wiring system
NMEA	National Marine Electronics Assoc.
ROM	read only memory
S.A.F.E.	speed adjusting failsafe electronics
SAC	start assist circuit
SAE	Society of Automotive Engineers
SYNC	synchronization
TDC	top dead center
TPS	throttle position sensor
USCG	United States Coast Guard
WOT	wide open throttle
WTS	water temperature sensor

EMISSION-RELATED INSTALLATION INSTRUCTIONS

Failing to follow these instructions when installing a certified engine in a vessel violates federal law (40 CFR 1068.105 (b)), subject to fines or other penalties as described in the Clean Air Act.

Maintenance, replacement, or repair of the emission control devices and systems may be performed by any marine SI (spark ignition) engine repair establishment or individual.

Manufacturer's Responsibility

Beginning with 1999 model year outboards, manufacturers of marine outboards must determine the exhaust emission levels for each outboard horsepower family and certify these outboards with the United States of America Environmental Protection Agency (EPA). An emissions control information label, showing emission levels and outboard specifications, must be placed on each outboard at the time of manufacture.

Dealer's Responsibility

When performing service on all 1999 and more recent *Evinrude/Johnson* outboards 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 outboard 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's Responsibility

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

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

Tampering with the fuel system to change horsepower or modify emission levels beyond factory settings or specifications will void the product warranty.

EPA Emission Regulations

All new 1999 and more recent *Evinrude/Johnson* outboards are certified to the EPA as conforming to the requirements of the regulations for the control of air pollution from new watercraft marine spark ignition outboards. 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 practical, 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 marine products. For more detailed information on this subject, you may contact the following locations:

VIA U.S. POSTAL SERVICE:

Office of Mobile Sources
Engine Programs and Compliance Division
Engine Compliance Programs Group (6403J)
401 M St. NW
Washington, DC 20460

VIA EXPRESS or COURIER MAIL:

Office of Mobile Sources
Engine Programs and Compliance Division
Engine Compliance Programs Group (6403J)
501 3rd St. NW
Washington, DC 20001

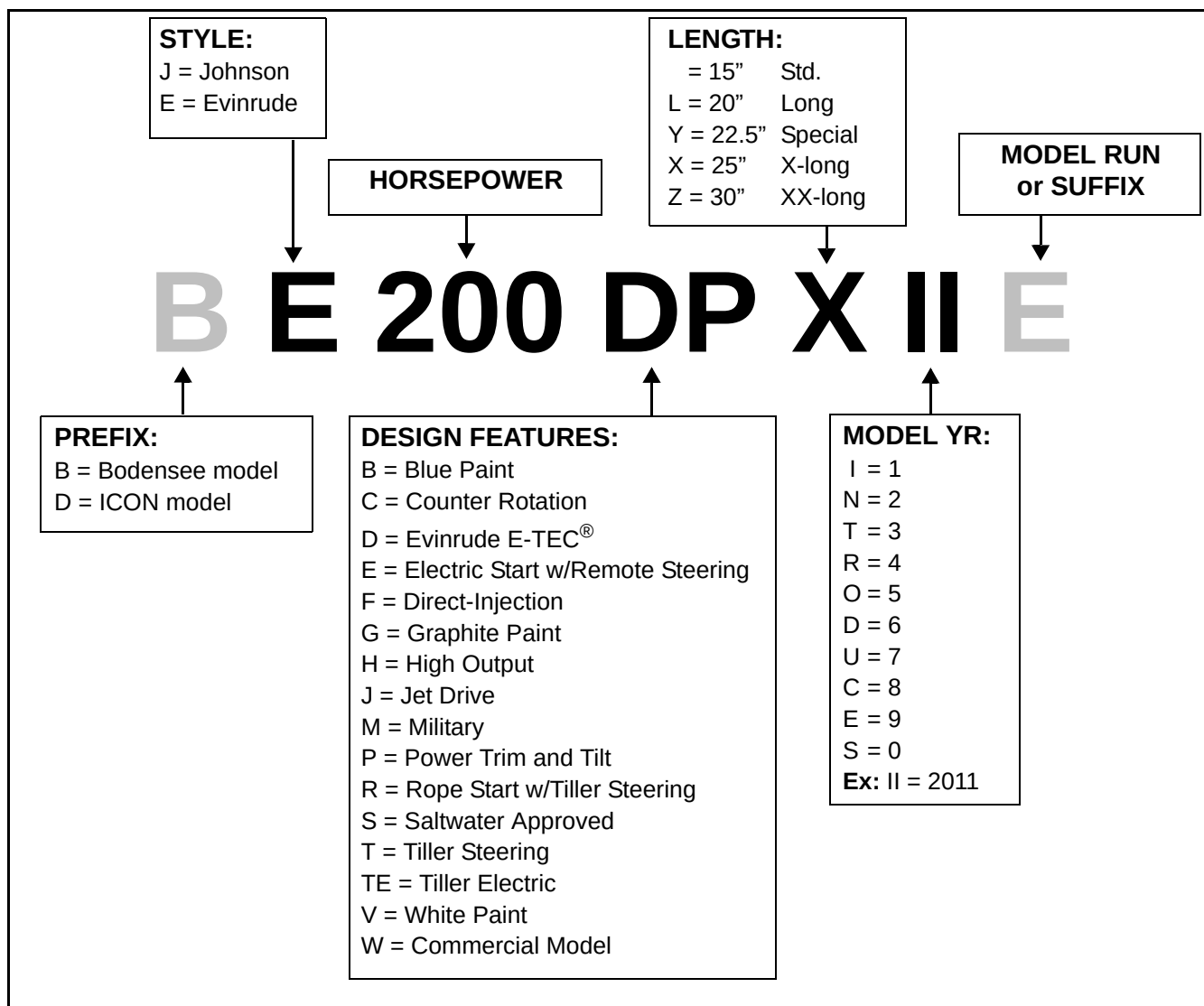
EPA INTERNET WEB SITE:

www.epa.gov

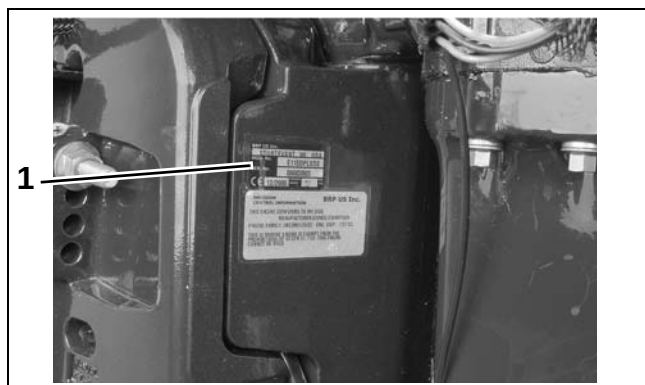
REFERENCE INFORMATION

MODEL DESIGNATION

MODEL DESIGNATION

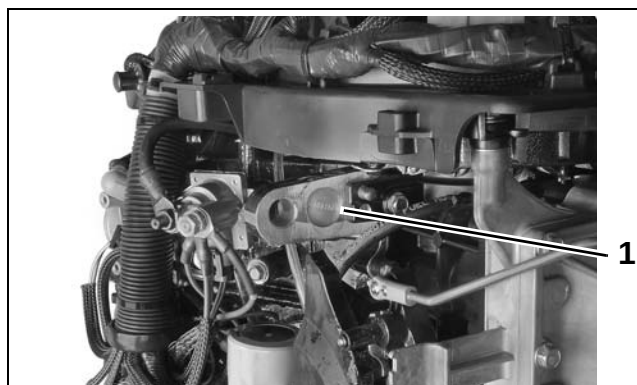


Model and serial numbers are located on the swivel bracket and on the powerhead.



1. Model and serial number

005231



1. Serial number

005232

MODELS COVERED IN THIS MANUAL

This manual covers service information on all 105.4 cubic inch (1.7 L) and 158.2 cubic inch (2.6 L), 60° V *Evinrude E-TEC* models.

1

Model	Displacement	Gearcase	Height	Color	Description
E115DPLIIB	1.7 L, 105.4 ci	.500 S2	20"	Blue	Steel Steering Arm, Standard Styling
E115DSLIIIB	1.7 L, 105.4 ci	.500 S2	20"	White	Stainless Steering Arm, Standard Styling
E115DBXIIB	1.7 L, 105.4 ci	.444 O	25"	Blue	Stainless Steering Arm, Standard Styling
E115DPXIIB	1.7 L, 105.4 ci	.444 O	25"	White	Stainless Steering Arm, Standard Styling
E115DCXIIB	1.7 L, 105.4 ci	.444 O CR	25"	White	Stainless Steering Arm, Standard Styling
E115DHLIIR	1.7 L, 105.4 ci	.500 S2	20"	Blue	Steel Steering Arm, H.O. Styling
E115DHXIIR	1.7 L, 105.4 ci	.444 O	25"	White	Stainless Steering Arm, H.O. Styling
E115HSLIIR	1.7 L, 105.4 ci	.500 S2	20"	White	Stainless Steering Arm, H.O. Styling
E130DPLIIR	1.7 L, 105.4 ci	.500 S2	20"	Blue	Steel Steering Arm, Standard Styling
E130DSLIIIR	1.7 L, 105.4 ci	.500 S2	20"	White	Stainless Steering Arm, Standard Styling
E130DPXIIR	1.7 L, 105.4 ci	.444 O	25"	White	Steel Steering Arm, Standard Styling
E130DCXIIR	1.7 L, 105.4 ci	.444 O CR	25"	White	Stainless Steering Arm, Standard Styling
E150DPLIIB	2.6 L, 158.2 ci	.538 O	20"	Blue	Steel Steering Arm, Standard Styling
E150DHLIIB	2.6 L, 158.2 ci	.538 L2	20"	Blue	Steel Steering Arm, H.O. Styling
E150HSLIIB	2.6 L, 158.2 ci	.538 L2	20"	White	Stainless Steering Arm, H.O. Styling
E150DSLIIIB	2.6 L, 158.2 ci	.538 O	20"	White	Stainless Steering Arm, Standard Styling
E150DBXIIB	2.6 L, 158.2 ci	.542 M2	25"	Blue	Stainless Steering Arm, Standard Styling
E150DPXIIB	2.6 L, 158.2 ci	.542 M2	25"	White	Stainless Steering Arm, Standard Styling
E150DCXIIB	2.6 L, 158.2 ci	.542 M2 CR	25"	White	Stainless Steering Arm, Standard Styling
E175DPLIIB	2.6 L, 158.2 ci	.538 O	20"	Blue	Steel Steering Arm, Standard Styling
E175DSLIIIB	2.6 L, 158.2 ci	.538 O	20"	White	Stainless Steering Arm, Standard Styling
E175DPXIIB	2.6 L, 158.2 ci	.542 M2	25"	White	Stainless Steering Arm, Standard Styling
E175DCXIIB	2.6 L, 158.2 ci	.542 M2 CR	25"	White	Stainless Steering Arm, Standard Styling
E200DPLIIE	2.6 L, 158.2 ci	.538 O	20"	Blue	Steel Steering Arm, Standard Styling
E200DSLIIIE	2.6 L, 158.2 ci	.538 O	20"	White	Stainless Steering Arm, Standard Styling
E200DPXIIE	2.6 L, 158.2 ci	.542 M2	25"	White	Stainless Steering Arm, Standard Styling
E200DCXIIE	2.6 L, 158.2 ci	.542 M2 CR	25"	White	Stainless Steering Arm, Standard Styling

REFERENCE INFORMATION
SERVICE SPECIFICATIONS

SERVICE SPECIFICATIONS

ENGINE	HP	115, 130	150, 175, 200
	Full Throttle Operating Range	5500–6000 RPM	4850–5850 RPM
	Power	115 HP: (85.8 kw) @ 5750 RPM 130 HP: (96.9 kw) @ 5750 RPM	150 HP: (111.9 kw) @ 5350 RPM 175 HP: (130.5 kw) @ 5350 RPM 200 HP: (149.1 kw) @ 5350 RPM
	Idle RPM in Gear	115: 625 ± 50 115 HO, 130: 580 ± 50	500 ± 50
	Test Propeller	V4 20 in. (L) Models: P/N 386246 or P/N 433068 V4 25 in. (X) and V6 Standard Rotation Models: P/N 387388 V6 Counter Rotation Models: P/N 398673	
	Weight (may vary depending on model)	115-20 in. (L): 375 lbs. (170 kg) 115 HO, 130-20 in. (L): 390 lbs. (177 kg) 115-25 in. (X): 390 lbs. (177 kg) 115 HO, 130-25 in. (X): 405 lbs. (184 kg)	20 in. (L): 418 lbs. (190 kg) 25 in. (X): 433 lbs. (196 kg)
	Lubrication	<i>Evinrude/Johnson XD100 Oil or Evinrude/Johnson XD50 Oil</i> Refer to Recommended Lubricants on p. 168	
	Engine Type	60° V 4-Cylinder Loop-Charged	60° V 6-Cylinder Loop-Charged
	Displacement	105.4 cu. in. (1727 cm ³)	158.2 cu. in. (2592 cm ³)
	Bore	3.601 in (91.47 mm)	
	Stroke	2.588 in. (65.74 mm)	
	Standard Bore	3.6005 to 3.6015 in. (91.45 to 91.48 mm)	
	Top Crankshaft Journal	2.1870 to 2.1875 in. (55.55 to 55.56 mm)	
	Center Crankshaft Journals	2.1870 to 2.1875 in. (55.55 to 55.56 mm)	
	Bottom Crankshaft Journal	1.5747 to 1.5752 in. (40.0 to 40.01 mm)	
	Rod Crankpin	1.3757 to 1.3762 in. (34.94 to 34.96 mm)	
	Piston Ring End Gap, Both	0.011 to 0.023 in. (0.28 to 0.58 mm)	
FUEL	Fuel/Oil Ratio	EMM Controlled	
	Starting Enrichment	EMM Controlled	
	Preferred Fuel	Regular unleaded gasoline	
	Acceptable Fuel	See Fuel Requirements on p. 137 for additional information.	
	Minimum (High) Fuel Pressure @ IDLE RPM – 500 ± 50	22 to 28 psi (152 to 193 kPa)	
	Minimum Fuel Lift Pump Pressure @ IDLE RPM – 500 ± 50	3 to 4 psi (21 to 28 kPa)	
	Maximum Fuel Inlet Vacuum	4 in. Hg. (13.5 kPa)	
	Minimum Octane	87 AKI (R+M)/2 or 90 RON	
	Additives	<i>2+4[®] Fuel Conditioner, Fuel System Cleaner</i> Use of other additives may result in engine damage. See Fuel Requirements on p. 137 for additional information.	

REFERENCE INFORMATION SERVICE SPECIFICATIONS

1

ELECTRICAL	HP	115, 130	150, 175, 200
	Minimum Battery Requirements	675 CCA (845 MCA); or 750 CCA (940 MCA) below 32°F (0°C) (Use a 107 amp-hr battery for extreme applications.)	
	Alternator	Dual Voltage 50 Amp with Voltage Regulator and Battery Isolation. Refer to Predelivery and Installation Guide for multiple battery applications.	
	Tachometer Setting	6 pulse (12 pole)	
	Charging Isolator	Integral, Terminal on Engine Harness	
	Engine Fuse	P/N 967545 – 10 A	
COOLING	Thermostat	143°F (62°C)	
	Maximum Temperature	230°F (110°C) Below 3000 RPM and 194°F (90°C) Above 3000 RPM	
	Water pressure	V4: 21 to 23 psi @ 5000 RPM V6: 23 to 25 psi @ 5000 RPM	
IGNITION	Type	Capacitor Discharge	
	Firing Order	1-2-3-4	1-2-3-4-5-6
	Ignition Features	EMM Controlled	
	RPM Limit	6250	
	Crankshaft Position Sensor Air Gap	Fixed	
	Spark Plug	Refer to Emission Control Information Label Champion [†] QC10WEP @ 0.028 ± 0.003 in. (0.76 mm) Refer to Emission Control Information Label	
GEARCASE	Gear Ratio	V4 “S2” Type Gearcase: 13:26 (.500) (2:1) V4 “O” Type Gearcase: 12:27 (.444) (2.25:1) V6 “O” Type Gearcase: 14:26 (.538) (1.86:1) V6 “M2” Type Gearcase: 13:24 (.542) (1.85:1) V6 “L2” Type Gearcase: 14:26 (.538) (1.86:1) Refer to GEARCASE TYPES on p. 263	
	Lubricant	HPF XR Gearcase Lubricant	
	Capacity	“S2” Type Gearcase: 31.6 fl. oz. (935 ml) V4 “O” Type Gearcase: 32.8 fl. oz. (970 ml) V6 “O” Type Gearcase: 33.1 fl. oz. (980 ml) “M2” Type Gearcase: 38.9 fl. oz. (1150 ml) “M2” Type – Counter Rotation: 35.8 fl. oz. (1060 ml) “L2” Type Gearcase: 32.5 fl. oz. (960 ml)	
	Shift Rod Height	20 in. (L) Models: 20.945 (532 mm) ± one-half turn 25 in. (X) Models: 25.945 (659 mm) ± one-half turn	
	Shift Cable Stroke	1.125 to 1.330 in. (28.6 to 33.8 mm) measured between NEUTRAL and FORWARD	
	Lubrication	(Single Piston style): Evinrude/Johnson Biodegradable TNT Fluid (Three Piston style): Evinrude/Johnson Power Trim/Tilt & Power Steering Fluid or GM Dextron [†] II Automatic Transmission Fluid	
POWER TRIM/TILT	Fluid Capacity	21 fl. oz. (622ml)	
	Trim Range	0° to 21°	
	Tilt Range	22° to 75°	

REFERENCE INFORMATION

STANDARD TORQUE SPECIFICATIONS

STANDARD TORQUE SPECIFICATIONS

Size	In. Lbs.	Ft. Lbs.	N·m
No. 6	7–10	0.58–0.83	0.8–1.1
No. 8	15–22	1.25–1.83	1.7–2.5
No. 10	24–36	2–3	2.7–4.0
No. 12	36–48	3–4	4.0–5.4
1/4 in.	60–84	5–7	7–9.5
5/16 in.	120–144	10–12	13.5–16.5
3/8 in.	216–240	18–20	24.5–27
7/16 in.	336–384	28–32	38–43.5
M3	15–22	1.25–1.83	1.7–2.5
M4	24–35	2–2.9	2.7–4.0
M5	35–60	2.9–5	4.0–6.8
M6	84–106	7–8.8	9.5–12
M8	177–204	14.7–17	20–23
M10	310–336	25.8–28	35–38

IMPORTANT: These values apply only when a specific torque for a specific fastener is not listed in the appropriate section. When tightening two or more screws on the same part, **DO NOT** tighten screws completely, one at a time.

WARNING

Torque wrench tightening specifications must be strictly adhered to. Replace any locking fastener (locknut or patch screw) if its locking feature becomes weak. Definite resistance to turning must be felt when reusing a locking fastener.

If replacement is specified or required because the locking fastener has become weak, use only authorized *Evinrude/Johnson Genuine Parts*.

PRODUCT REFERENCE AND ILLUSTRATIONS

BRP US Inc. reserves the right to make changes at any time, without notice, in specifications and models and also to discontinue models. The right is also reserved to change any specifications or parts, at any time, without incurring any obligation to equip same on models manufactured prior to date of such change. Specifications used are based on the latest product information available at the time of publication.

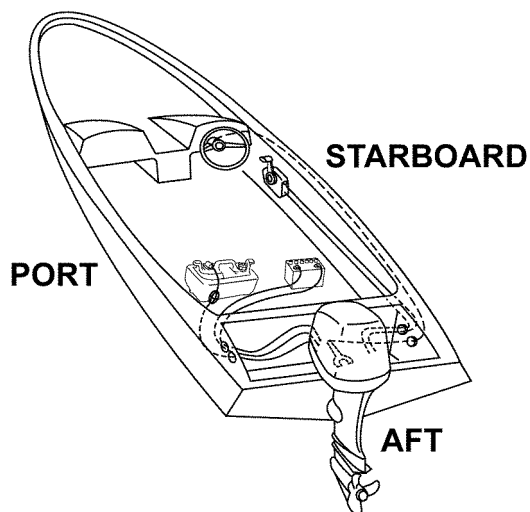
The continuing accuracy of this manual cannot be guaranteed.

All photographs and illustrations used in this manual may not depict actual models or equipment, but are intended as representative views for reference only.

Certain features or systems discussed in this manual might not be found on all models in all marketing areas.

All service technicians must be familiar with nautical orientation. This manual often identifies parts and procedures using these terms.

FORWARD



Nautical Orientation

006411

ROUTINE SERVICE

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ROUTINE SERVICE INSPECTION AND MAINTENANCE SCHEDULE

INSPECTION AND MAINTENANCE SCHEDULE

Routine inspection and maintenance is necessary to prolong outboard life. The following chart provides guidelines for inspection and maintenance to be performed by an authorized Dealer.

IMPORTANT: Outboards used in rental, commercial, or other high hour applications require more frequent inspections and maintenance. Adjust schedule for operating and environmental conditions.

Description	Engine Care Product	Routine Inspection	Every 300 hours or every three years ⁽¹⁾
Engine Monitor self-test and warning horn, check		✓	
Emergency stop circuit and lanyard, check operation		✓	
Controls, steering and tilting; check operation		✓	
Engine mounting hardware, re-tighten (40 ft. lbs.)		✓	
Fasteners, tighten any loosened components		✓	
Water intake screens, check condition		✓	
Cooling system; check water pump indicator / water pressure		✓	
Anticorrosion anodes, check condition		✓	
Gearcase, check condition		✓	
Propeller, check condition		✓	
Fuel and oil systems, inspect and repair leaks ⁽²⁾		✓	
Check battery connections and condition		✓	
Access <i>EMM</i> information, resolve any service codes			✓
Electrical and ignition wires, inspect for wear or chafing			✓
Fuel filter, replace			✓
Oil filters, replace			✓
Gearcase lubricant, replace	A		✓
Spark plugs, inspect or replace ⁽²⁾			✓
Thermostats, inspect and check operation ⁽²⁾			✓
Grease fittings, lubricate ⁽³⁾	C		✓
Power trim/tilt and fluid level, inspect	B		✓
Propeller shaft splines, inspect and lubricate ⁽³⁾	C		✓
Starter pinion shaft, inspect and lubricate ⁽³⁾	D		✓
Control cables, inspect and adjust			✓
Steering cable, inspect and lubricate	C		✓
Water pump, inspect / replace (more often if water pressure loss or overheating occurs)			✓

(1) Average recreational use. Commercial use, heavy use, or use in salt or polluted water requires more frequent inspection and maintenance.

(2) Emission-related component

(3) Annually in salt water applications

- A *HPF Pro* Gearcase Lubricant
- B Power Trim/Tilt Fluid (Three ram hydraulic systems)
Biodegradable TNT Fluid (Single ram hydraulic systems)
- C *Triple-Guard* Grease
- D Starter Bendix Lube Only

LIFTING THE OUTBOARD



WARNING

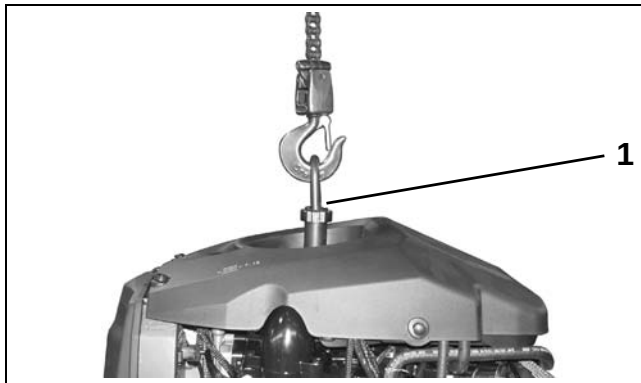
To avoid personal injury, make sure the lifting capacity of the hoist is at least twice the weight of the outboard.

DO NOT allow the lift hook or chain from the hoist to come in contact with any part of the engine during lifting.

Use correct Lifting Fixture to lift outboard:

Model	Lifting Fixture
60° V4-V6	P/N 342672

Install Lifting Fixture, P/N 342672, on crankshaft. Tighten mounting screw securely using an Allen 1/4 in. hexagonal wrench.



1. Center retaining screw

004945

Fasten appropriate chain hook to eye of tool. Carefully hoist outboard with chain and unbolt outboard mounting brackets from frame.

OUTBOARD RIGGING CONNECTIONS

IMPORTANT: For complete outboard rigging and remote control installation information, refer to the **Predelivery and Installation Guide** included with the service manual set.

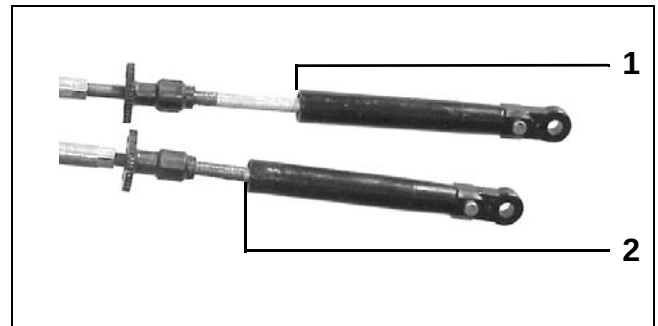
Common Practices – All Models

Control Cable Identification

IMPORTANT: Control cable function must be identified before rigging outboard.

Identify each control cable:

- Put the control handle into NEUTRAL position. The throttle cable casing guide will retract completely and the shift cable casing guide will go to the midpoint of its travel.



- Shift cable casing guide extended to midpoint
- Throttle cable casing guide retracted

DP0811

Extend the control cables and lubricate them with **Triple-Guard** grease.



30501

ROUTINE SERVICE

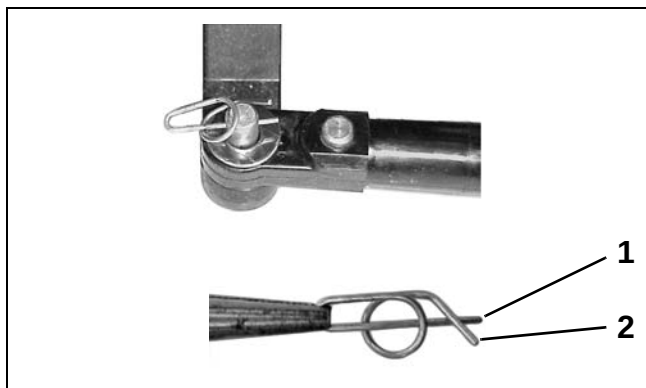
OUTBOARD RIGGING CONNECTIONS

Cable Retainer Clip Installation

When installing retainer clips on control arm linkage pins, clips should be locked and **must not** be bent or deformed.

For proper installation, review the following steps:

- Place washer on pin.
- Position retainer clip with straight section on the bottom and angled section on the top.
- Use long nose pliers to insert straight section of clip into linkage pin hole.



1. Straight section
2. Angled section

DP0818
DP0817

- Push the clip towards the hole while lifting on the curved end with the pliers.
- Be sure retainer clip fully engages the pin.
- Lock the retainer by moving the angled section **behind** the straight section.



Locked Retainer Clip

1. Angled section behind straight section

DP0817A

Cable, Hose, and Wire Routing

⚠ CAUTION

To prevent accidental starting while servicing, disconnect the battery cables at the battery. Twist and remove all spark plug leads.

Refer to **Control Cable Identification** on p. 15.

Remove two screws and bracket that fasten the grommet to lower motor cover.



1. Grommet retaining bracket

003964

Route all hoses, control cables, and wiring through a protective sleeve or conduit into the boat and through the grommet.

The fuel hose may be routed through the protective sleeve or through an alternate hole in the lower motor cover grommet.

To route the fuel hose outside the sleeve, trim the material covering the alternate fuel hose slot in the grommet.

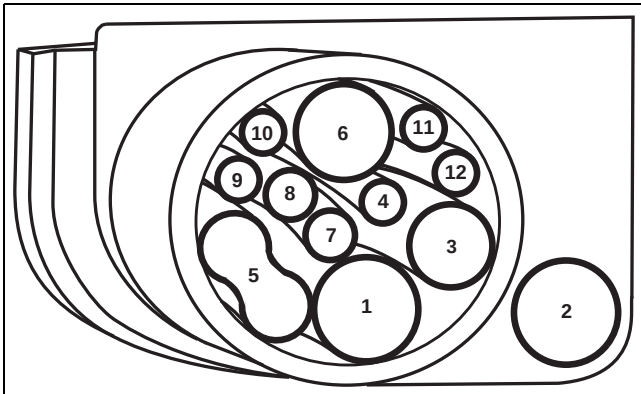


1. Alternate fuel hose location

003970

ROUTINE SERVICE OUTBOARD RIGGING CONNECTIONS

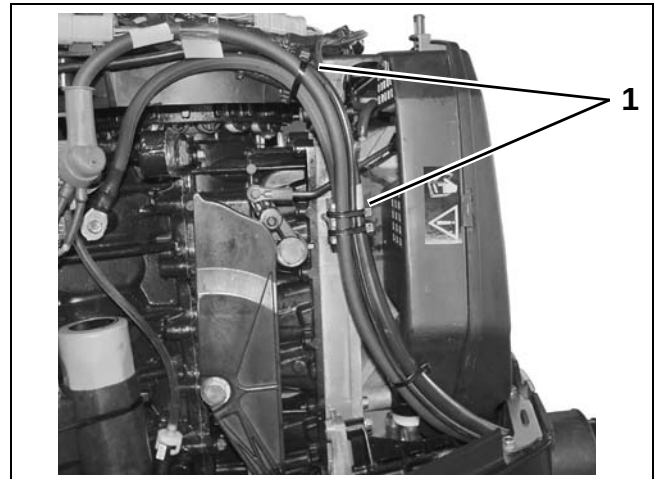
Refer to the following diagram to ensure proper positioning of rigging components in grommet.



1. Fuel supply hose
2. Fuel supply hose--alternate location
3. Oil supply hose
4. Oil tank sending unit harness
5. Battery cables
6. Main wire harness (MWS)
7. Shift cable
8. Throttle cable
9. Accessory charge wires
10. CANbus harness
11. Water pressure hose
12. Speedometer hose

000095c

same path to the starboard side of the powerhead. Secure all cables with clamps.



1. Anchor points

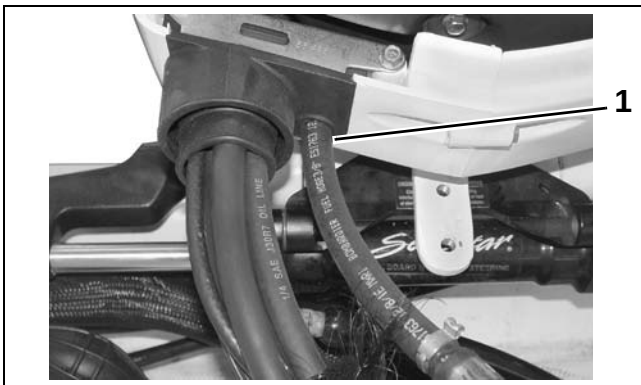
004949

NOTICE After installation, make sure there is enough clearance for all cables to avoid binding or chafing through all engine steering and tilting angles.

Control Cable Installation

Refer to **Control Cable Identification** on p. 15.

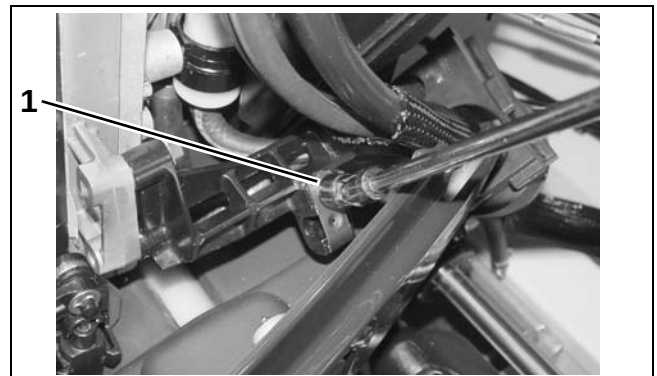
Remove control cable trunnion covers and cable attachment hardware.



1. Alternate fuel hose location

004946

The main wiring harness, battery cables, oil tank sending unit harness, and any *ICON* or *I-Command* network cables should be routed along the



1. Trunnion covers

004955

ROUTINE SERVICE

OUTBOARD RIGGING CONNECTIONS

Shift Cable Installation and Adjustment

Place the shift cable on the shift lever pin and install the washer and retainer clip. Refer to **Cable Retainer Clip Installation** on p. 16.

IMPORTANT: Do not bend or deform clip.

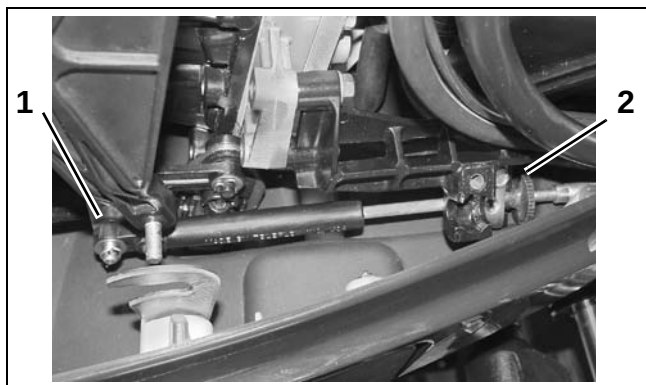
Make sure the remote control, gearcase, shift linkage, and shift cable are in NEUTRAL.

Hold the shift linkage in NEUTRAL.

Push and pull on the shift cable and observe the cable slack. Hold the casing guide in the center of the slack.

Adjust shift cable trunnion to align with center of the trunnion block. Place cable trunnion in trunnion block.

Install trunnion cover and screw. Tighten screw to a torque of 60 to 80 in. lbs. (7 to 9 N·m).



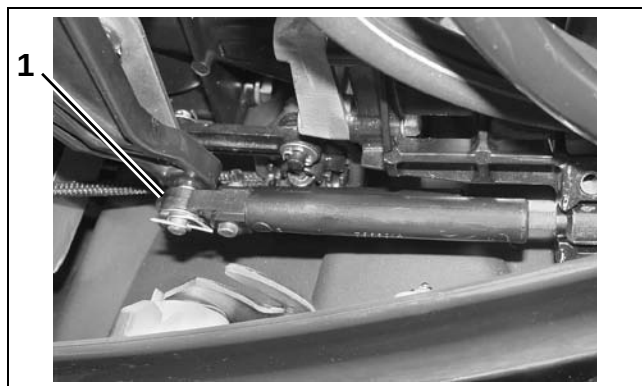
1. Shift cable retainer clip and washer
2. Shift cable trunnion

004956

Throttle Cable Installation and Adjustment

With remote control lever in NEUTRAL, pull firmly on throttle cable casing to remove slack.

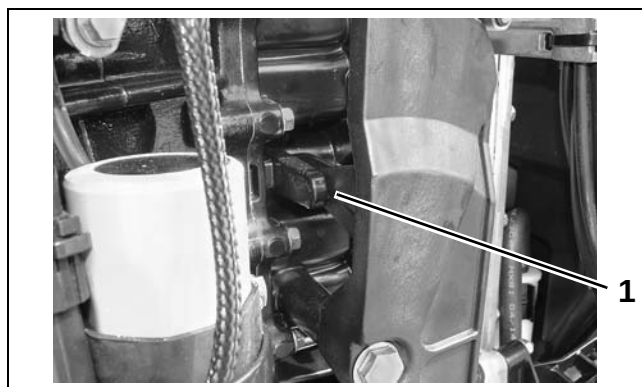
Place throttle cable on throttle lever pin and install washer and retainer clip. Refer to **Cable Retainer Clip Installation** on p. 16.



1. Throttle cable retainer clip and washer

004957

Make sure that idle stop of the throttle lever is against the crankcase.



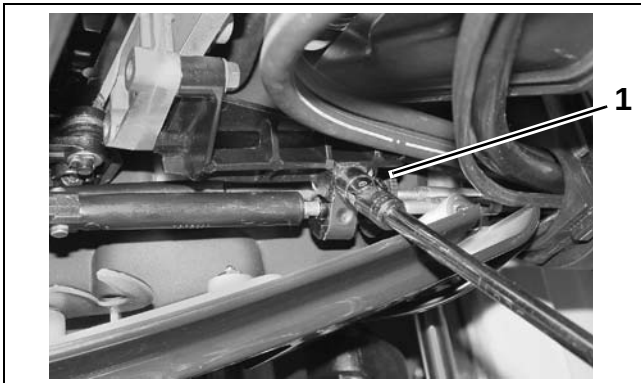
1. Throttle linkage, idle stop against crankcase

004947

Adjust the throttle cable trunnion to align with the trunnion block. Place the cable trunnion in the trunnion block.

IMPORTANT: Move control handle to FORWARD and pull back slowly to NEUTRAL. Make sure the engine throttle lever is against the stop. If not, remove slack by adjusting cable trunnion.

Install trunnion cover and screw. Tighten screw to a torque of 60 to 80 in. lbs. (7 to 9 N·m).

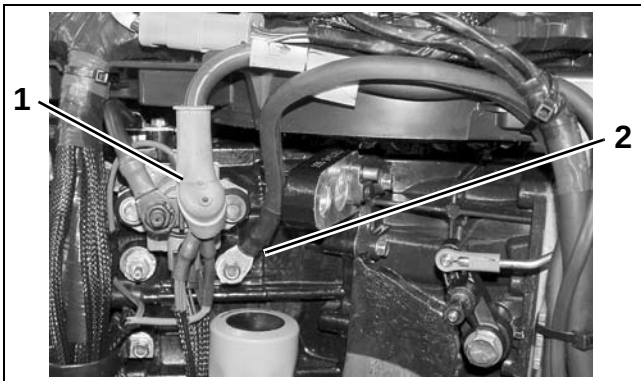


1. Trunnion cover and screw, throttle cable

004958

Battery Cable Connections

Install battery cables on starter solenoid and main ground stud.

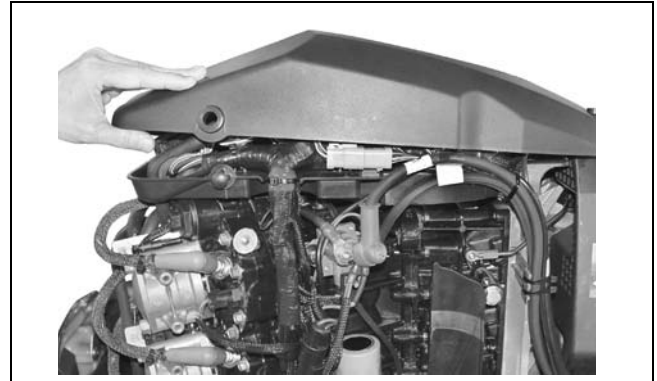


1. Positive (+) battery connection
2. Ground (-) connection

004953

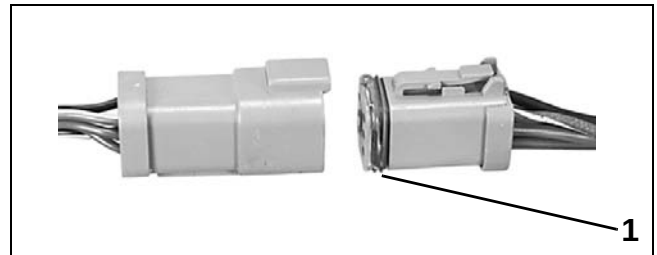
SystemCheck Harness Connections

Remove flywheel/harness connector cover.



004954

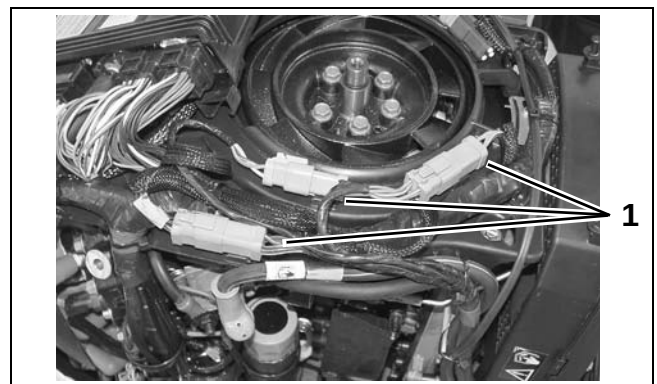
Before installing electrical connectors, check that the seal is in place. Clean off any dirt from connectors. Apply a light coat of *Electrical Grease* to the seal only. DO NOT fill connectors with *Electrical Grease*.



1. Seal

42079A

Connect outboard main wire harness to boat wire harness. Secure connectors in brackets.



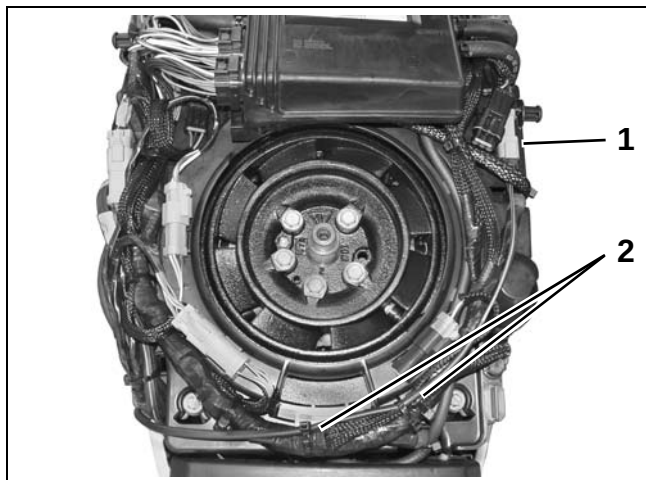
1. Harness connections

004951

ROUTINE SERVICE

OUTBOARD RIGGING CONNECTIONS

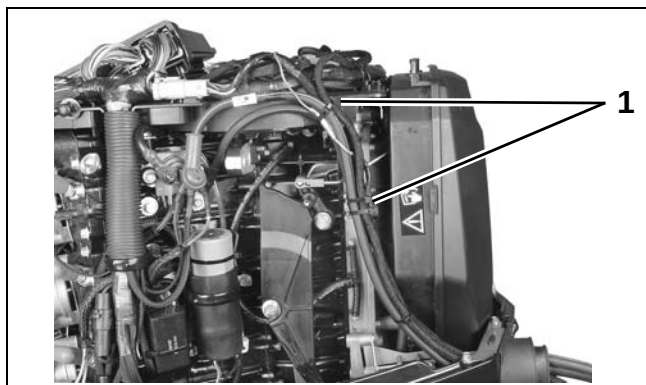
Route oil tank sending unit harness around the front to the port side. Secure all cables with tie straps.



1. Low oil sender connection
2. Tie straps

004952

Secure all cables with tie-straps.



1. Anchor points

005270

NOTICE BE SURE all harnesses and wires are not pinched, cannot contact flywheel, and do not interfere with moving throttle or shift linkages.

Replace flywheel/harness connector cover.

I-Command Network Connections

If the outboard will be used with *I-Command*, or other *NMEA 2000* compliant CANbus instruments, use the following connections to supply information to the network:

If using an *Evinrude ICON* control system, the *I-Command* Engine Interface Cable, Power Supply Kit, and Ignition and Trim Harness are not required. Connect the *I-Command* network directly to the *ICON* gateway module. Refer to the **ICON Remote Control System Installation Guide**.

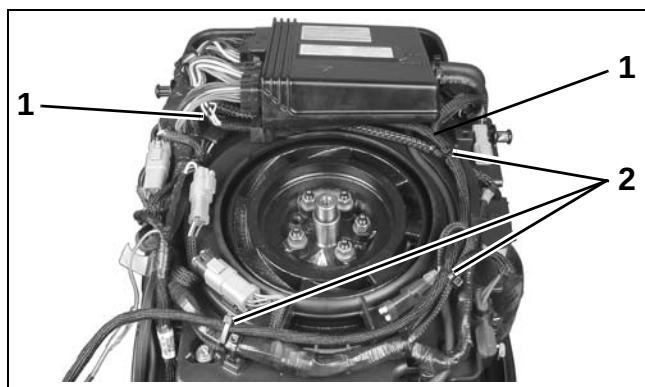
If using a mechanical control system, connect the *I-Command* Engine Interface Cable to the *EMM* CANbus connector.



1. EMM CANbus connector

005267

Route the harness under the front of the *EMM* and around the port side of the powerhead. Secure with tie straps.

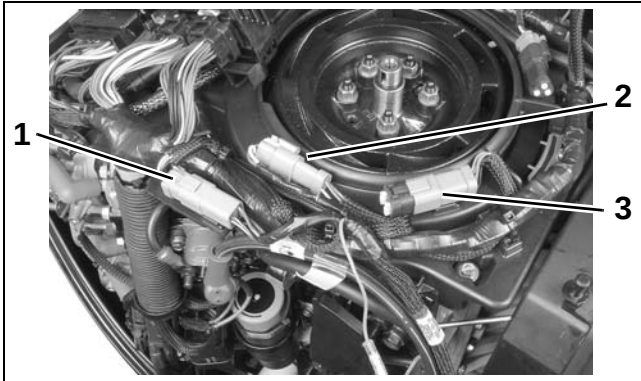


1. Harness routing
2. Tie straps

005268

ROUTINE SERVICE OUTBOARD RIGGING CONNECTIONS

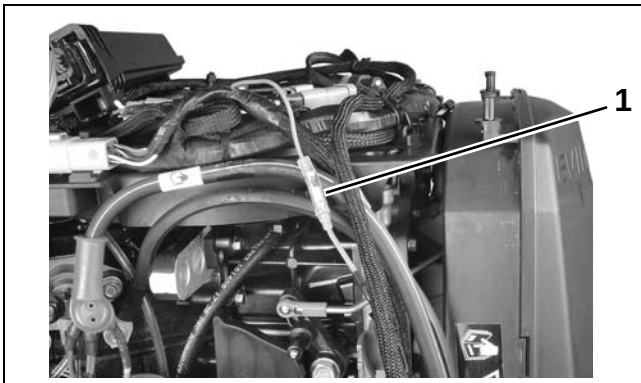
Use an *I-Command* Ignition and Trim Harness to connect the outboard to the key switch and trim/tilt control. Seal unused *SystemCheck* connector with 6-Pin Connector Seal, P/N 586076.



1. CANbus Ignition connector
2. Trim/Tilt connector
3. SystemCheck connector (with seal)

005266

If connecting to an existing *I-Command* Classic network, connect the purple wires between the *I-Command* Ignition and Trim Harness and the *I-Command* Engine Interface Cable. This connection supplies power to the network when the key switch is on. *I-Command* Digital networks do not use this connection.

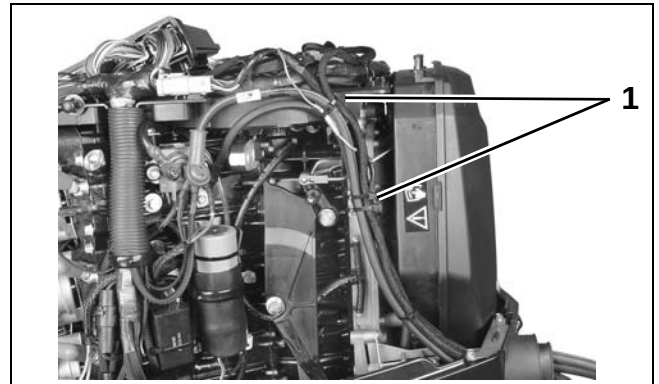


1. CANbus power supply connector

005269

Route the harnesses around the starboard side of the powerhead along the same path as the battery cables.

Secure all cables with tie-straps.

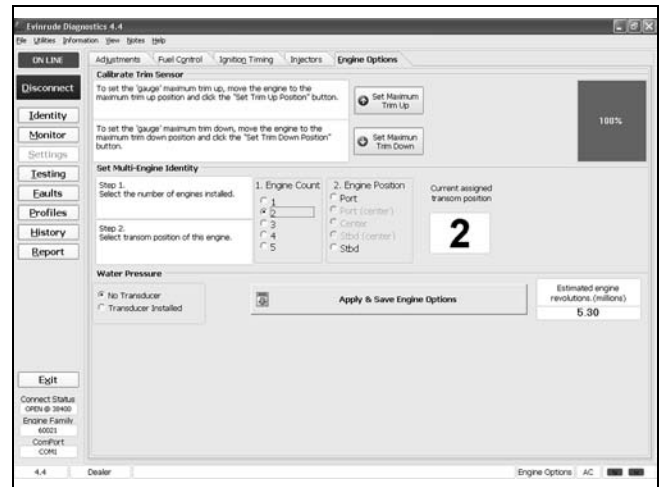


1. Anchor points

005270

For an *I-Command* oil level display, an accessory CANbus oil level sender must be installed in the oil tank. Connect the sender to the *I-Command* network. Refer to the ***I-Command* Digital Network Guide**.

Use *Evinrude Diagnostics* software to adjust network settings in the EMM. From the *Settings* screen, select *Engine Options*.



Engine Options Screen

008013

ROUTINE SERVICE

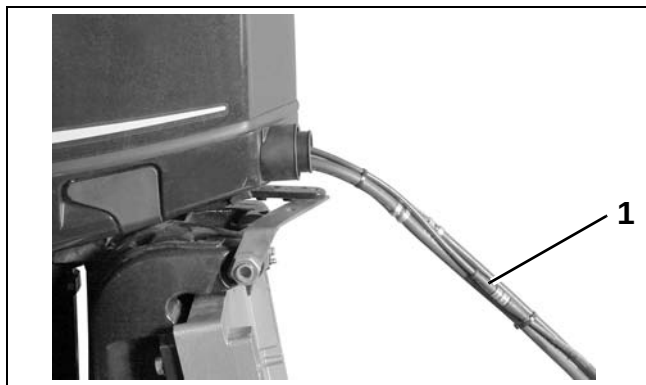
OUTBOARD RIGGING CONNECTIONS

ICON Network Connections

If the outboard is equipped for an *Evinrude ICON* control system, connect the outboard to the network as follows.

Refer to the **ICON Remote Control System Installation Guide**.

Connect the buss cable from the rear network hub to the outboard's network harness.



1. ICON network connector

008157

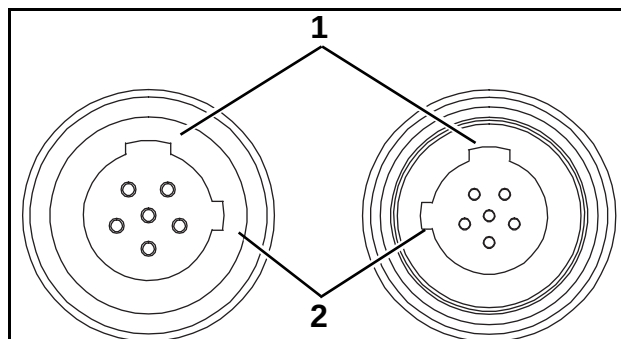
IMPORTANT: Do not force connectors or locking rings. Properly aligned connectors should assemble easily.

Do not use *Electrical Grease* on *ICON* buss cable connectors.

To assemble the connectors:

- Use the large tabs and small tabs to carefully align buss cable connectors.
- Carefully align pins and sockets of connectors. Do NOT force connectors together.

- Tighten locking rings of buss connectors finger tight. Do NOT use locking rings to force connectors together.



1. Large tabs
2. Small tabs

007883

Do not rotate connectors until they align. This could result in a mismatched connection. It is possible for each pin to enter a socket even if the tabs are misaligned. Look at the tabs to ensure connector alignment prior to making the connection.

Engine Monitor information is distributed to an *ICON* or *I-Command* network through the *ICON* gateway module. Refer to the **I-Command Digital Network Guide**.

The *ICON* Harness and Relay Kit, P/N 765296, must be used to provide power to boat accessories that require switched B+. This kit is used in place of connecting accessories to the "A" terminal of the key switch. Accessories connected to the accessory power relay should not exceed 7 amps.

NOTICE Do not connect boat accessories to the key switch of an *ICON* system. Connecting accessories to the key switch can cause low current, resulting in erratic operation of the remote control system.

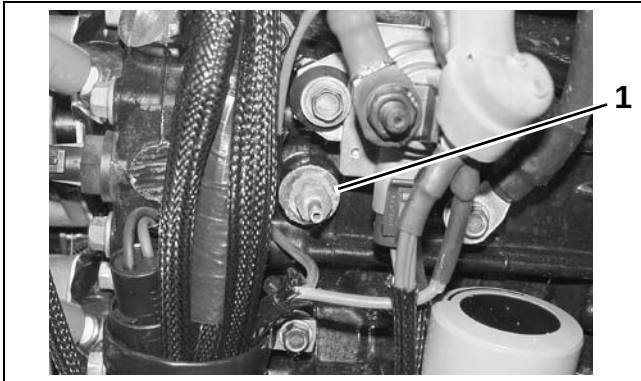
For more information, refer to the **ICON Remote Control System Installation Guide**.

Water Pressure Gauge

To display engine water pressure, install a water pressure hose fitting in the cylinder block as shown.

Use *Pipe Sealant with Teflon* on the threads of the hose fitting. Refer to installation instructions supplied with gauge.

Route the water pressure hose around the starboard side of the powerhead along the same path as the battery cables.

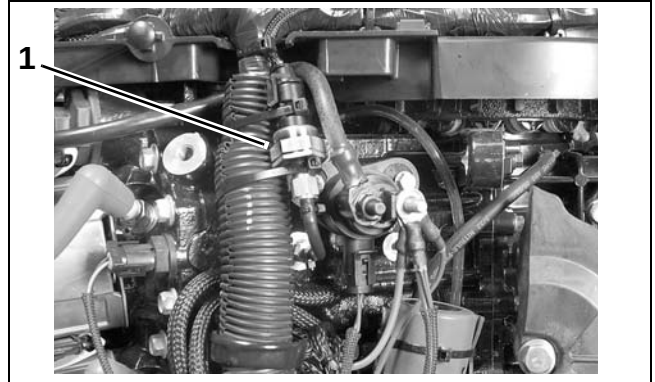


1. Water pressure hose fitting

004959

For an *I-Command* water pressure display, several water pressure sensor kits are available. Refer to the ***Evinrude/Johnson Genuine Parts and Accessories*** catalog.

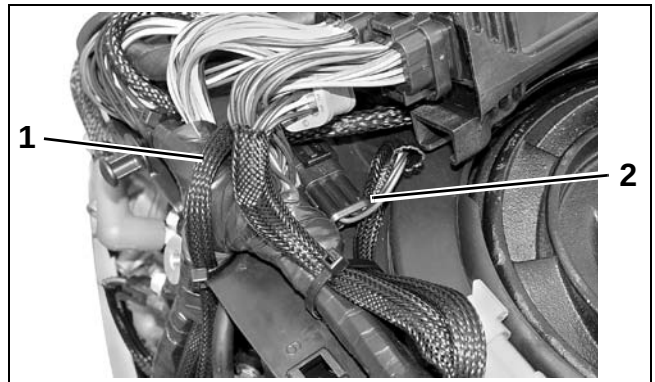
To send water pressure data to the *EMM*, along with an *I-Command* display, install Water Pressure Transducer Kit, P/N 5008300.



1. Water pressure transducer

008129

Connect the transducer lead to the engine wiring harness connector.



1. Water pressure transducer lead
2. Engine harness connector

004962

BATTERY AND BATTERY CONNECTIONS

WARNING

Keep the battery connections clean, tight, and insulated to prevent their shorting or arcing and causing an explosion. If the battery mounting system does not cover the connections, install protective covers. Check often to see that connections stay clean and tight.

Check battery connections frequently. Periodically remove battery to clean and service connections.

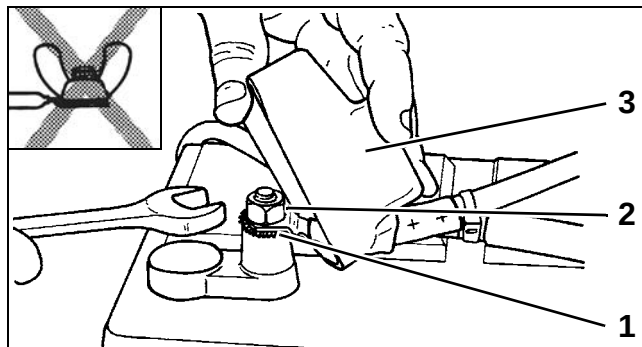
- Confirm that battery meets the minimum engine requirements.
- Connections must be clean and tight.
- Observe all wiring connections prior to disassembly.

Disconnect battery negative (–) cable **first** and the battery positive (+) cable last.

Clean all terminals, battery posts, and connectors with a solution of baking soda and water. Use a wire brush or battery terminal tool to remove corrosion buildup. Rinse and clean all surfaces.

IMPORTANT: Connect the battery positive (+) cable to the battery positive (+) post **FIRST**. Connect the battery negative (–) cable to the battery negative (–) post **LAST**.

Install a starwasher on the threaded battery post. Stack cables from the outboard, then cables from accessories. Finish this connection with a hex nut.



Marine Style Battery Post

DR5103

1. Starwasher
2. Hex nut
3. Terminal Insulator

NOTICE Do not use wing nuts to fasten **ANY** battery cables. Wing nuts can loosen and cause electrical system damage not covered under warranty.

Tighten all connections securely. Apply *Triple-Guard* grease to prevent corrosion.

WARNING

Battery electrolyte is acidic—handle with care. If electrolyte contacts any part of the body, immediately flush with water and seek medical attention.

OETIKER CLAMP SERVICING

Clamp Identification

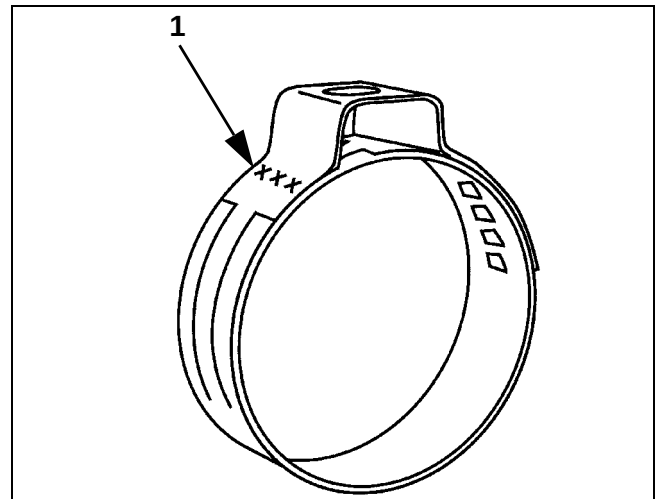
Use *Oetiker* clamps for making hose connections. These clamps provide corrosion resistance, minimize the potential for abrasion of rigging components, and provide solid, permanent connections.

The selection and installation of an *Oetiker* clamp is essential in the proper sealing of hose connections. The clamp identification numbers appear on the side of the clamp, near the top of the ear. Refer to **Clamp Selection** chart for dimensions.



WARNING

DO NOT re-use *Oetiker* clamps. Fuel leakage could contribute to a fire or explosion.



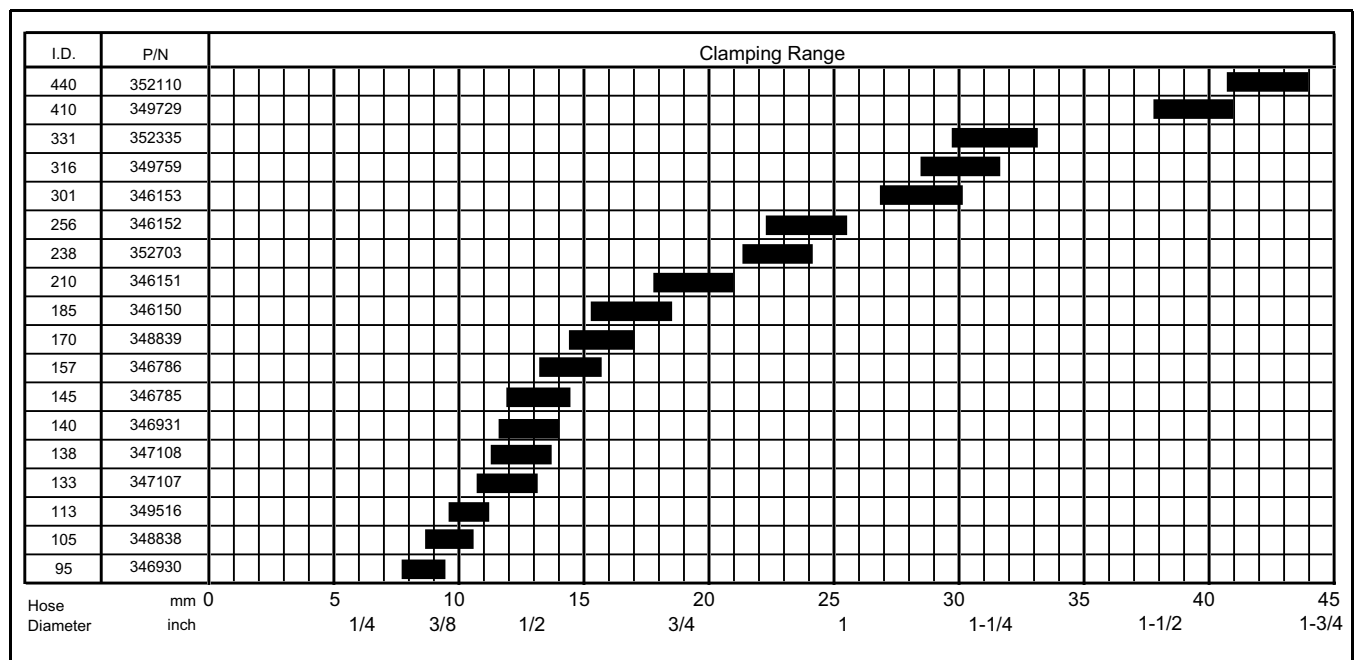
1. Clamp identification numbers

000093

Clamp Selection

To select the correct size *Oetiker* clamp, measure the outside diameter of the hose when installed on the fitting.

Chose a clamp so that the outside diameter of the hose is approximately in the middle of the clamping range of the clamp.



008458

ROUTINE SERVICE

OETIKER CLAMP SERVICING

Clamp Installation

A constant stress should be applied to close the ear clamps. This method ensures a positive stress on the hose and does not result in excessive compression or expansion of the band material.

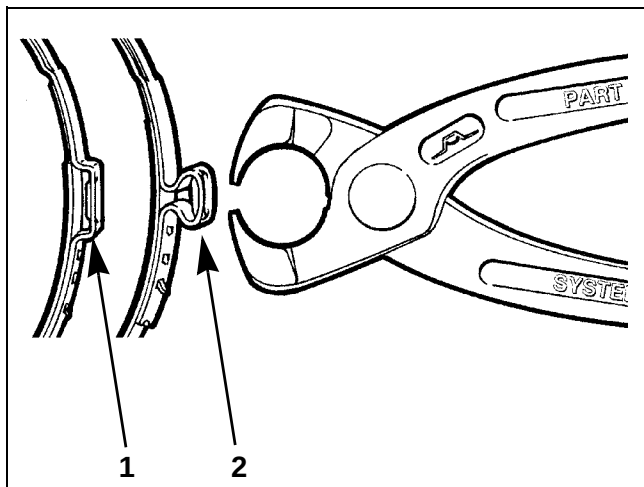
IMPORTANT: Use only *Oetiker* recommended tools to close *Oetiker* stepless clamps.

Oetiker pincers are available in the *Evinrude/Johnson Genuine Parts and Accessories Catalog*.



DP0886

- Position correct size clamp over hose.
- Install hose on fitting.
- Close clamp ear fully with *Oetiker* pincers (pliers).

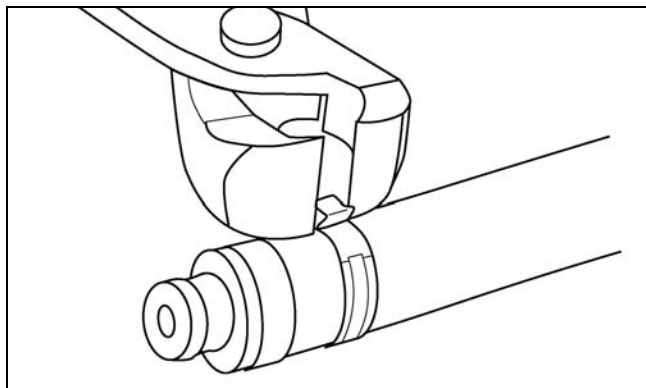


1. Open clamp
2. Closed clamp

000092

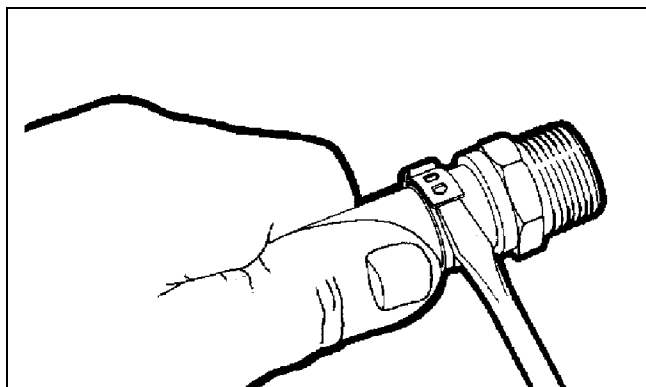
Clamp Removal

Method 1: Position *Oetiker* pincers across clamp ear and cut clamp.



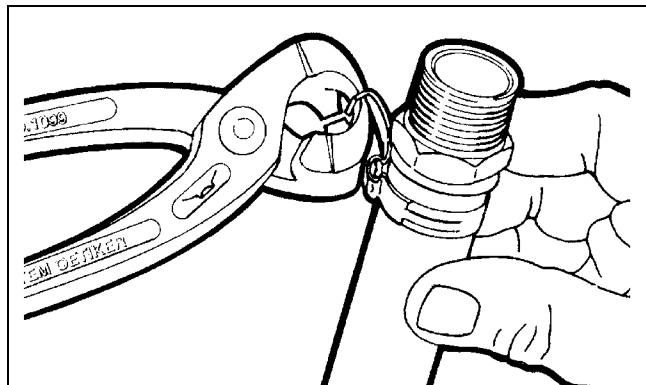
000108

Method 2: Lift end of stepless clamp with screwdriver.



000090

Method 3: Use *Oetiker* pincers (pliers) to grip clamp. Pull clamp off of connection and discard.



000091

ADJUSTMENTS

Tilt Limit Switch Adjustment



WARNING

If the outboard does not clear all boat parts when tilted fully or turned side to side, safety related parts could be damaged in the course of such outboard movement. Injuries could result from loss of boat control.

Adjust the tilt limit switch on all new outboard installations.

Check the clearance between outboard(s) and the boat's motor well and transom area. Tilt outboard(s) to highest point of clearance and turn the steering system lock to lock.

If the outboard contacts the boat's motor well when fully tilted, adjust the tilt limit cam to reduce full-tilt position.

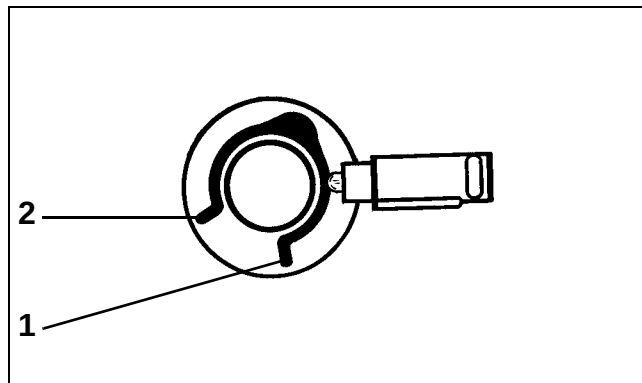
NOTICE The tilt limit cam will not prevent the outboard from overriding the adjustment if the outboard is tilted manually.



DR3916

Place the outboard in normal operating position.

Rotate the LOWER adjustment tab UP to reduce the maximum tilt. Rotate the UPPER adjustment tab DOWN to increase the maximum tilt position.



1. Lower adjustment tab
2. Upper adjustment tab

DR4268

Check the adjustment by tilting the outboard fully.

Repeat this procedure until the tilt limit switch stops the outboard's upward travel before it contacts the motor well.

To prevent damage to equipment, provide additional motor well clearance when needed. Consider either changing the outboard mounting position or modifying the boat if the possibility for interference and damage exists.



WARNING

Adjusting the tilt limit cam will NOT prevent the outboard from tilting fully and contacting the motor well if the gearcase hits an object at high speed. Such contact could damage the outboard and boat and injure boat occupants.

ROUTINE SERVICE ADJUSTMENTS

Trim Sending Unit Adjustment

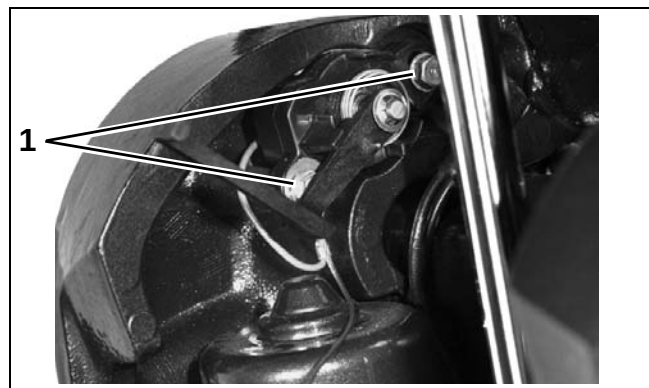
Tilt the outboard and engage the tilt support.

Temporarily install a thrust rod, P/N 436541, in the number 3 hole.



29072

Loosen the sending unit screws, to allow the sending unit to pivot.



1. Screws

27339

Disengage the tilt support. Lower the outboard against the thrust rod.

Observe the trim gauge. If the needle does not show center position, tilt the outboard up and adjust the sending unit by pivoting it up or down.



1. Needle at center position

000662

Lower the outboard against the thrust rod to check adjustment. Repeat adjustment, if necessary.

After adjustment is correct, tilt the outboard up, tighten the two sending unit screws, and remove the thrust rod.

Trim Limiter Rod

The trim limiter rod prevents excessive trim down.

As the engine is trimmed to the full down position, the bow of the boat goes deeper into the water.

- If the trim limiter rod is left out, the bow could plow into the water causing the boat to “bow steer” resulting in a loss of control.
- If the trim limiter rod is set too far out, the propeller could ventilate, resulting in poor acceleration when the boat is coming onto plane.

Set the trim limiter rod to prevent excessive trim down and provide good acceleration. The trim limiter rod can be used to prevent the gearcase or spray deflector from contacting the transom.



WARNING

When the outboard is returned to the customer, the trim limiter rod must be installed and in the same location as it was when the motor was brought in for service. Leaving the trim limiter rod out, or changing the adjustment, could allow the motor to unexpectedly trim in too far and cause loss of control.

Trim Tab Adjustment

WARNING

Improper trim tab adjustment can cause difficult steering and loss of control.

A propeller will generate steering torque when the propeller shaft is not running parallel to the water's surface. The trim tab is adjustable to compensate for this steering torque.

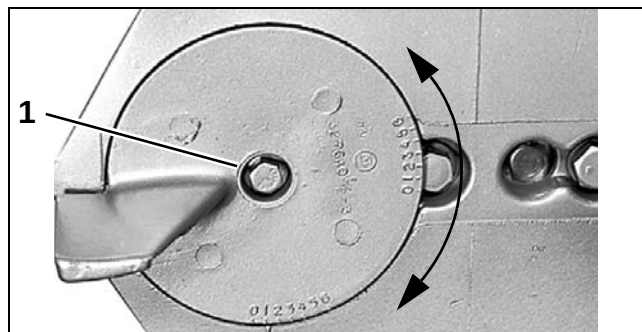
IMPORTANT: A single trim tab adjustment will relieve steering effort under only one set of speed, outboard angle and load conditions. No single adjustment can relieve steering effort under all conditions.

If the boat pulls to the left or right when its load is evenly distributed, adjust the trim tab as follows:

- With the remote control in NEUTRAL and the engine OFF, loosen the trim tab screw.
- If the boat pulled to the right, move rear of the trim tab slightly to the right.
- If the boat pulled to the left, move rear of the trim tab slightly to the left.

Tighten the trim tab screw as follows:

- **115 – 200 HP:** 35 to 40 ft. lbs. (47 to 54 N·m).



1. Trim tab screw

COA3663

Test the boat and, if needed, repeat the procedure until steering effort is as equal as possible.

Outboards with High Transom Heights

The trim tab may be above the surface of the water when the outboard is trimmed out. Steering effort might increase. Lower the trim setting to submerge the trim tab and to reduce steering effort.

Dual Standard Rotation Outboards

Move both trim tabs equally and in the same direction.

Dual Outboards, One Counter and One Standard Rotation

Set both trim tabs to the center position.

ROUTINE SERVICE

ADJUSTMENTS

Dual-Outboard Alignment

Dual outboards must be connected with a tie bar and adjusted to align the outboards for correct water flow to the gearcases and propellers.

Incorrect outboard alignment could cause one or more of the following:

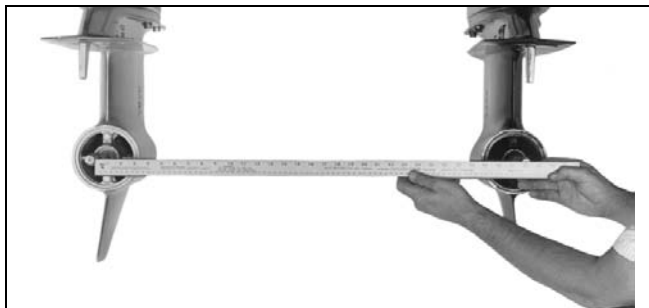
- Propeller ventilation
- Reduction of top speed
- Improper boat tracking
- Engine overheat and powerhead damage

Follow the instructions provided by the tie-bar manufacturer for tie bar installation and adjustment.

Measure Alignment

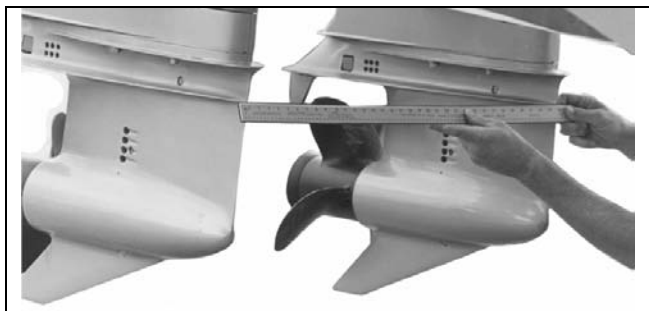
The “toe-in” (gearcase leading edges closer together than propeller shaft centers) or “toe-out” (gearcase leading edges farther apart than propeller shaft centers) is determined as follows:

- Position outboards straight with the anti-ventilation plates parallel with the bottom of the boat.
- Measure between propeller shaft centers.



6365

- Measure between leading edges of gearcase.



6340

Alignment Adjustment

Various boat/motor combinations respond differently to dual-outboard alignments. Each application must be thoroughly tested until the ideal combination of performance, steering, and cooling is found.

A common practice is to set-up the outboards parallel, or with a small amount of “toe-out,” and adjust inward until best results are achieved.

- A typical set-up with 2-stroke outboards mounted directly on the transom often runs best with a slight amount of “toe-in.”
- Outboards mounted behind the transom on motor brackets usually require “parallel” alignment or “toe-out.”

Adjust the outboard alignments by adjusting tie bar. Follow the tie bar manufacturer's adjustment procedures.

Check steering operation. Make sure that the steering system operates properly at various trim angles.

Confirm Alignment

To confirm proper alignment, perform the following steps:

- Water test the boat.
- Monitor the water pressure for both outboards.
- Run the boat at various trim angles.
- Perform steering maneuvers and vary the throttle settings.
- Monitor boat and outboard performance.

A sudden loss of water pressure or excessive propeller ventilation on one or both outboards may indicate a misalignment of the gearcases. Reset the outboard alignment and retest.

OPERATIONAL CHECKS

DANGER

DO NOT run the engine indoors or without adequate ventilation or permit exhaust fumes to accumulate in confined areas. Engine exhaust contains carbon monoxide which, if inhaled, can cause serious brain damage or death.

WARNING

Contact with a rotating propeller is likely to result in serious injury or death. Assure the engine and prop area is clear of people and objects before starting engine or operating boat. Do not allow anyone near a propeller, even when the engine is off. Blades can be sharp and the propeller can continue to turn even after the engine is off.

CAUTION

DO NOT run outboard without a water supply to the outboard's cooling system. Cooling system and/or powerhead damage could occur.

Engine Monitoring System

Attach emergency stop lanyard.

SystemCheck

Turn key switch to ON. Warning horn should sound for 1/2 second.

All *SystemCheck* warning lights should turn on at the same time, then turn off one at a time.

I-Command

Turn key switch to ON.

The *Evinrude E-TEC* screen should appear, followed by the tachometer display.

Fuel System

Perform running checks of the fuel system by following these steps:

- Squeeze fuel primer bulb until hard or activate electric primer. Observe all fuel hoses and connections. Repair any leaks.
- Start outboard. Inspect all hoses and connections. Repair any leaks or misrouted hoses immediately.

Emergency Stop / Key Switch

Check emergency stop function. With outboard running at IDLE, pull safety lanyard from emergency stop switch. Outboard must stop immediately.

Remote Control Operation

Make sure that control can be easily moved into all gear and throttle settings. Do not shift remote control when outboard is not running.

Start-In-Gear Prevention

WARNING

Make certain that the starter will not operate when the outboard is in gear. The start-in-gear prevention feature is required by the United States Coast Guard to help prevent personal injuries.

Start outboard and shift to FORWARD.

Turn outboard OFF while control is in FORWARD.

Try to restart the outboard. Outboard should not start.

Shift back to NEUTRAL and restart outboard.

Shift to REVERSE. Turn outboard OFF while control is in REVERSE.

Try to restart the outboard. Outboard should not start.

ROUTINE SERVICE

COOLING SYSTEM

Tachometer Pulse Setting

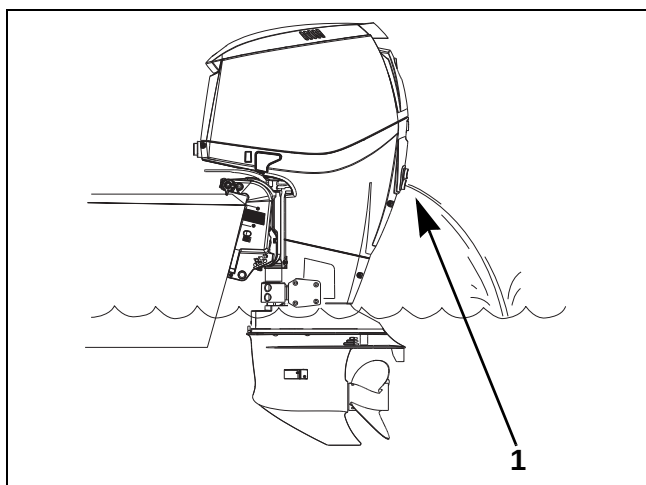
Confirm accuracy of tachometer reading.

- Adjust dial on back of tachometer to required setting (the outboard should not be running).

Outboard Model	Tachometer Setting
115–200 HP	6 Pulse or 12 Pole

Water Pump Overboard Indicator

A steady stream of water should flow from the overboard indicator.



1. Water pump overboard indicator

008469A

Operating Temperature

An outboard run at idle speed should achieve a temperature based on the engine's thermostatic control. In general, the powerhead temperature should reach at least 104°F (40°C) after five minutes of idling. Check that the powerhead reaches idle temperature. Refer to **SERVICE SPECIFICATIONS** on p. 10.

Idle Speed

Make sure the outboard idles within the specified idle RPM range. If the outboard is run on a flushing device, the idle speed and quality may not be representative of actual in water use.

COOLING SYSTEM

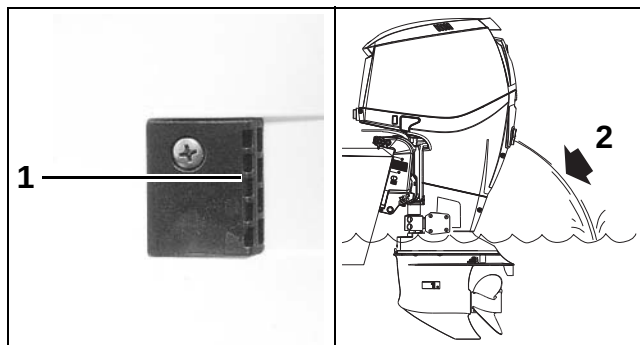
Check the condition of cooling system components regularly:

- water intake screens
- water pump
- all internal water passages
- thermostats
- all external water hoses and fittings
- vapor separator cooling passages and fittings
- EMM cooling passages and fittings
- overboard water pressure indicator.

Water Intake Screens

Inspect condition of water intake screens. Clean or replace as needed.

Confirm function of overboard water pressure indicator.



1. Water intake screen
2. Overboard indicator

DSC02220a
008470A

Engine Flushing

Flush the outboard with fresh water following each use in brackish, salt, or polluted water to minimize the accumulation of scale and silt deposits in cooling system passages.

The outboard can be flushed on the trailer or at dockside; running or not running.

IMPORTANT: The outboard must be located in a well ventilated area with appropriate ground drainage during the flushing procedures.

Keep water inlet pressure between 20 to 40 psi (140 to 275 kPa).

Flushing — Outboard Running

WARNING

To prevent injury from contact with rotating propeller, remove the propeller before flushing.

Place outboard in VERTICAL (DOWN) position in a well ventilated area.

Thread garden hose into flushing port.



004264

Turn water supply on.

Run outboard at IDLE only until full operating temperature is reached.

Leave the outboard in VERTICAL (DOWN) position long enough for the powerhead to drain completely.

Reinstall propeller.

Flushing — Outboard Not Running

Outboard can be in VERTICAL (DOWN) or TILTED (UP) position.

Thread garden hose into flushing port.

Turn water supply ON.

Flush outboard for at least five minutes.

Turn off water supply and remove garden hose.

Leave the outboard in VERTICAL (DOWN) position long enough for the powerhead to drain completely.

Running the Outboard Using a Hose and Flushing Adapter

WARNING

To prevent injury from contact with rotating propeller, remove the propeller before running engine with a flushing adapter.

A flushing adapter may be used to provide cooling water when running the outboard to:

- Flush the engine
- Run for an extended period of time, such as when performing diagnostic work
- Run the engine on a dynamometer
- Prepare the outboard for storage.

IMPORTANT: The outboard must be located in a well ventilated area with appropriate ground drainage.

Keep water inlet pressure between 20 to 40 psi (140 to 275 kPa).

Be sure water supply is sufficient to run the engine above idle speed.

Water Supply Requirements

Model	Water Flow @ WOT
115–130 HP 60° V4	11.5 to 13 GPM ¹ (43 to 49 LPM ²)
150–200 HP 60° V6	15 to 20 GPM ¹ (56 to 75 LPM ²)

1. GPM: Gallons per minute

2. LPM: Liters per minute

Install flushing adapter onto gearcase water inlet screens.

ROUTINE SERVICE

LUBRICATION

NOTICE Temporarily cover the small holes on the front of M2-Type gearcases with water-proof tape to make sure enough water travels to the powerhead. Water can drain from auxiliary inlets, resulting in engine overheat.



M2-Type Gearcase
1. Water-proof tape
2. Flushing adapter

008358

A steady stream of water should flow from the overboard indicator while the engine is running.

Monitor engine water pressure gauge when:

- Engine speed is above 3000 RPM
- Running engine on a dynamometer.

Refer to **SERVICE SPECIFICATIONS** on p. 10 for water pressure requirements.

NOTICE Engine will overheat if normal water pressure is not maintained. Temporarily install an engine water pressure gauge if not equipped with one.

Be sure to remove waterproof tape from auxiliary water inlets.

NOTICE Engine will overheat if auxiliary water inlets are restricted when outboard is back in service.

LUBRICATION

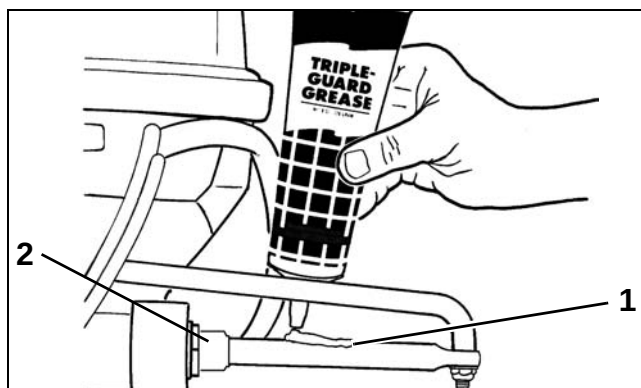
Steering System

WARNING

Failure to regrease as recommended could result in steering system corrosion. Corrosion can affect steering effort, making operator control difficult.

Grease the stainless steel output end of the steering cable with *Triple-Guard* grease.

Use an appropriate cleaning solvent to remove corrosion and dirt from output end of cable prior to coating it with grease. Make sure wiper nut is installed and not damaged.

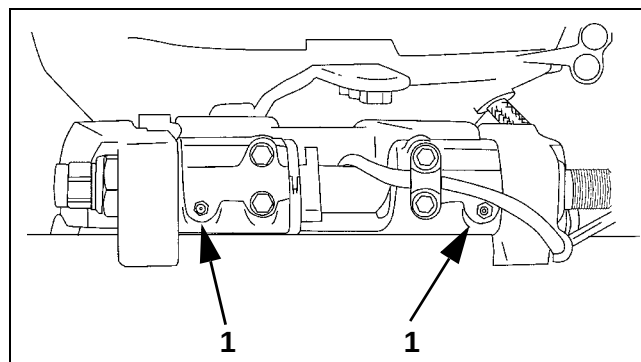


1. Steering cable
2. Wiper nut

DR29546

Tilt Tube

Lubricate the tilt tube grease fittings with *Triple-Guard* grease.



1. Tilt tube fittings

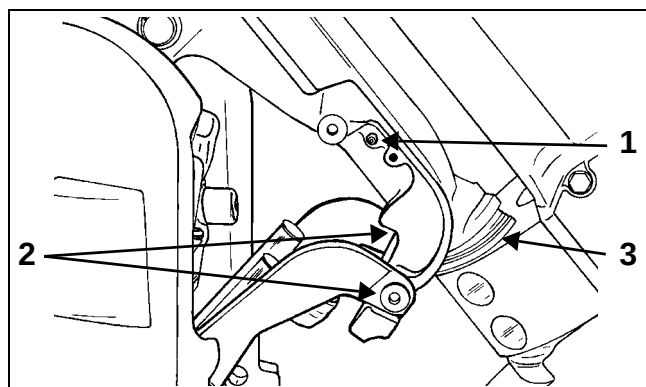
DR38798

Swivel Bracket and Trailing Bracket

Lubricate the swivel bracket with *Triple-Guard* grease.

Apply grease until the grease begins to flow from the upper or lower swivel bracket areas.

Coat the pivot points of the trailing bracket with *Triple-Guard* grease.



1. Grease fitting
2. Pivot points
3. Lower swivel bracket area

DR5073

Throttle and Shift Linkage

Disconnect the battery cables at the battery.

Remove cable trunnion cover. Carefully, remove throttle and shift cables from trunnion block.

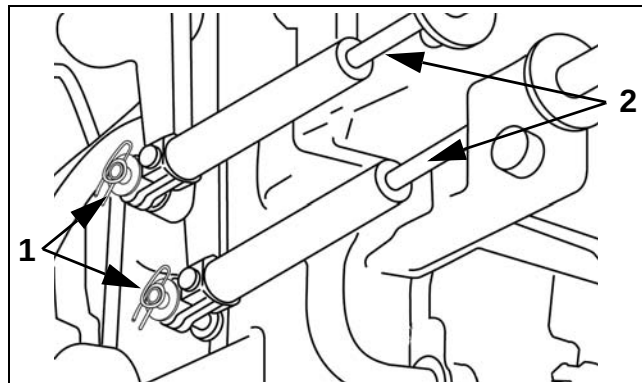
IMPORTANT: DO NOT disturb cable trunnion adjustments.

Shift remote control into FULL THROTTLE/REVERSE position to fully extend the plastic casing guides.

Apply *Triple-Guard* grease to:

- Cable attachment pins of both the throttle and shift levers

- Inner casings of both the throttle and shift cables.



1. Attachment pins, throttle and shift cables
2. Inner casings, throttle and shift cables

DRC6500GE

Shift the remote control to the NEUTRAL/IDLE position.

Install control cables.

Check proper throttle and shift function.

Propeller Shaft

Debris from the water can become lodged around propeller shaft. Frequent inspection can minimize potential gearcase damage.



WARNING

When servicing the propeller, always shift the outboard to NEUTRAL, turn the key switch OFF, and disconnect the battery cables at the battery.

Remove propeller. Refer to **Propeller Hardware Installation** on p. 266.

Inspect bushing and blade surfaces. Replace damaged or worn propellers.

Clean propeller shaft. Inspect propeller shaft seals. Replace damaged or worn seals.

Apply *Triple-Guard* grease to entire length of propeller shaft prior to installing propeller.

Reinstall propeller hardware and propeller.

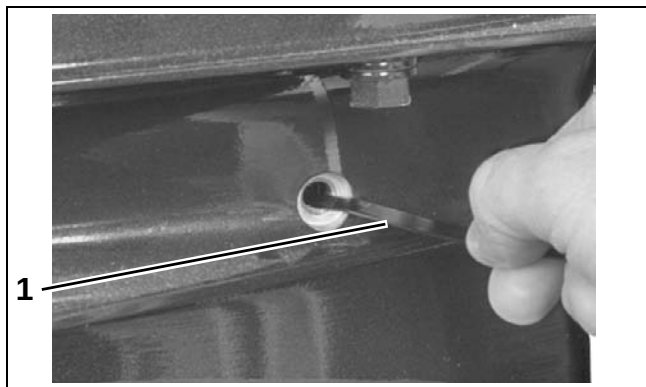
Gearcase Lubricant

Draining

WARNING

Gearcase lubricant may be under pressure and/or hot. If plug is removed from a recently operated outboard, take precautions to avoid injury.

IMPORTANT: Always check the fill level of the gearcase lubricant at the upper plug before removing the lower, drain/fill plug. A tie strap can be used to check lubricant level.

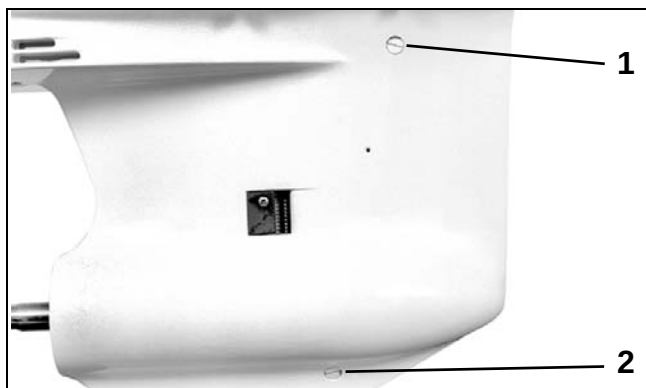


1. Tie strap

000072

If lubricant level is low, refer to **GEARCASE LEAK TEST** on p. 267.

Remove the lubricant level plug, then the lubricant drain/fill plug, and drain the lube from the gearcase into a container.



1. Lubricant level plug
2. Lubricant drain/fill plug

39514

Inspection

Inspect the lubricant and the magnets on the plugs for metal chips. The presence of metal **fuzz** can indicate normal wear of the gears, bearings, or shafts within the gearcase. Metal **chips** can indicate extensive internal damage.

Inspect the lubricant for water contamination. Water can make the lubricant milky in appearance. However, normal aeration can also cause the same appearance.

To check for water contamination, put lubricant into a glass container. Allow the oil to settle for a minimum of one hour to determine if there is an abnormal amount of water in the oil.

If water is present, refer to **GEARCASE LEAK TEST** on p. 267.

Overheated lubricant will have a black color and burned odor.

Internal gearcase inspection is recommended when lubricant is contaminated or shows signs of failure.

Filling

Refer to the **INSPECTION AND MAINTENANCE SCHEDULE** on p. 14 for service frequency and recommended lubricants.

Secure the gearcase in a vertical position.

Remove the lubricant level plug and the lubricant drain/fill plug.

Use Gearcase Filler, P/N 501882, to slowly fill the gearcase with *HPF PRO* lubricant through the drain/fill hole until it appears at the oil level hole.

IMPORTANT: Filling the gearcase too quickly can cause air pockets and the gearcase may not fill completely.

Clean plug seal area and install the lubricant level plug and **new** seal, then the lubricant drain/fill plug and **new** seal. Tighten plugs to a torque of 60 to 84 in. lbs. (7 to 9.5 N·m).



1. Lubricant level plug
2. Lubricant drain/fill plug

002386

IMPORTANT: The recommended gear lubricants are formulated for marine applications. Do not use automotive gear lubricants, engine oils, or any other oil or grease.

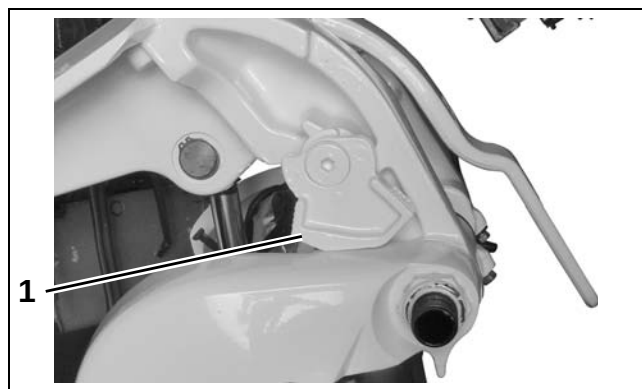
Trim and Tilt

⚠ CAUTION

Correct fluid level must be maintained to ensure operation of the impact protection built into the unit.

Check reservoir fluid level every three years or every 300 operating hours.

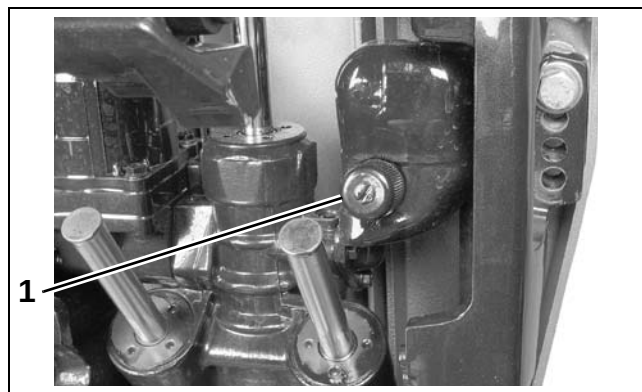
- System capacity is approximately 21 fl. oz. (620 ml).
- Tilt the outboard and engage the tilt support.



1. Tilt support bracket

002279

- Remove filler cap and check fluid level.
- **Three Ram System**—Add *Power Trim/Tilt Fluid* or *GM Dexron II*, as needed, to bring level to the bottom of the fill plug threads.



Three Ram System, 115 - 200 HP

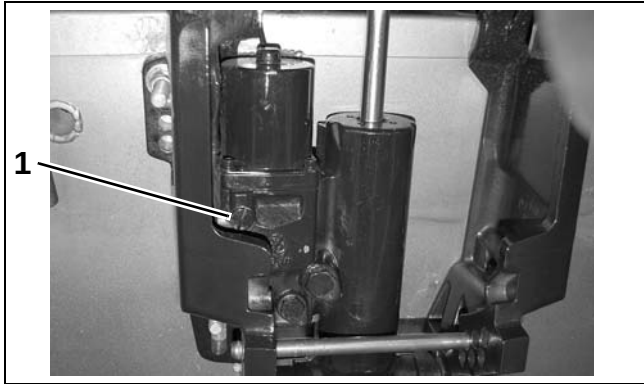
1. Fill cap

004277

ROUTINE SERVICE

SPARK PLUGS

- **Single Ram System**—Add *Evinrude/Johnson* Biodegradable TNT Fluid, as needed, to bring level to the bottom of the fill plug threads.



Single Ram System, 115 - 130 HP
1. Fill cap

008017

Install the filler cap and tighten to a torque of 45 to 55 in. lbs. (5 to 6 N·m).

- Disengage tilt support.
- Cycle the unit at least five complete cycles to purge all air from the system. When cycling the unit, hold the trim switch ON an additional 5 to 10 seconds after the unit reaches the end of its travel before activating the switch in the opposite direction.

SPARK PLUGS

Spark plugs should be removed and examined periodically. Replace worn, fouled or damaged spark plugs.

Use only recommended spark plugs with the correct gap setting.

Spark Plug, <i>Champion</i>
QC10WEP @ 0.028 ± 0.003 in. (0.71 mm)

- Remove spark plugs and inspect condition.
- Set spark plug gap on new, replacement spark plugs.
- Mark spark plugs for ground electrode orientation.
- Apply *Electrical Grease* to the ribbed portion of the spark plug ceramic and to the opening of the spark plug cover to prevent corrosion.
- Install spark plugs using “indexing” procedure.

Indexing

Spark plug indexing positions the ground electrode of the spark plug opposite the fuel injector nozzle.

Put an ink mark on the ceramic of the spark plug in line with the OPEN side of the ground electrode. This mark will be used to orient the spark plug with the OPEN side of the ground electrode facing the fuel injector.

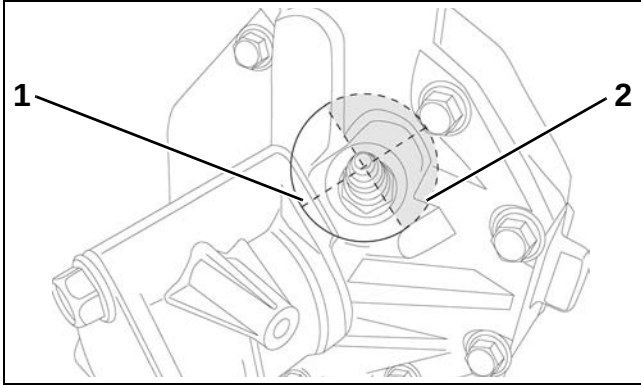


1. Ink mark
2. Open side

000758

Apply *Triple-Guard* grease to the gasket surface of the spark plug. Install spark plug and tighten to a torque of 15 ft. lbs. (20 N·m).

If the mark is in unshaded area do not tighten any more.



Spark Plug Indexing Diagram

004294

1. Unshaded area
2. Shaded area

If the mark is in the shaded area, reset torque wrench to 30 ft. lbs. (41 N·m) and continue to turn until the mark is in the unshaded area.

If the mark does not reach the unshaded area before the torque of 30 ft. lbs. (41 N·m) is reached, the spark plug cannot be indexed for that cylinder. Try another spark plug and repeat the steps above.

FUEL AND OIL SYSTEMS

Routine replacement of filters reduces the possibility of foreign material restricting the incoming fuel or oil supplies.

Replacement filter elements are available through *Evinrude/Johnson Genuine Parts*.

Fuel Filter

Evinrude E-TEC V-model outboards are equipped with a water-sensing, water-separating fuel filter. Refer to **FUEL COMPONENT SERVICING** on p. 146.



1. Water-separating fuel filter

005237

ROUTINE SERVICE

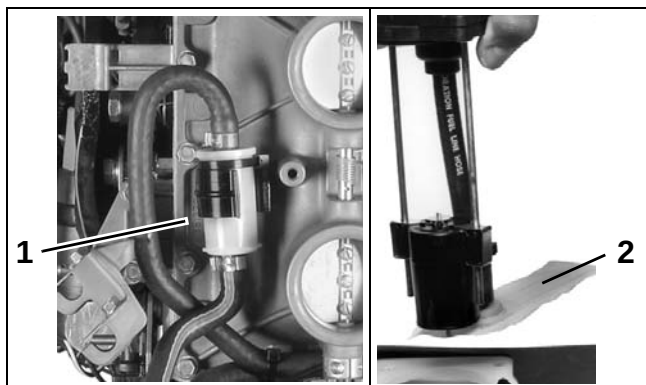
FUEL AND OIL SYSTEMS

Oil Filters and Oil Reservoir

Perform visual inspections to identify oiling system leaks. Make certain the oil tank is filled and oil supply is not contaminated.

Evinrude E-TEC V-model outboards are equipped with two serviceable oil filters: one is located in the oil injection tank, and one is located in the oil supply line before the oil lift pump.

Sample oil from bottom of oil injection tank. Confirm that oil is free of water or other contaminants.

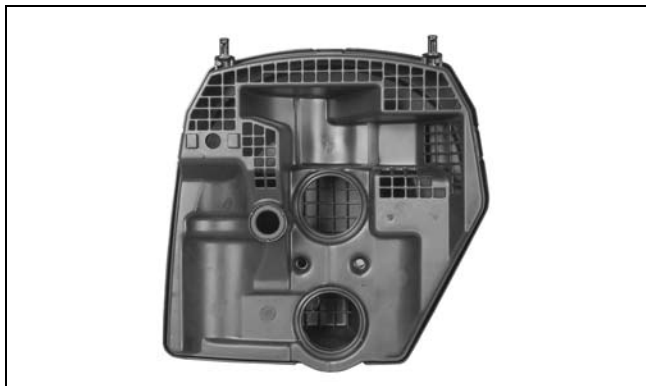


1. Filter, oil supply line
2. Filter, oil injection tank

005233
42785

Air Silencer

The air silencer on *Evinrude* outboards maximizes air flow while minimizing noise.



005238

Routine cleaning of the air silencer is recommended to remove any accumulation of debris.

Hoses and Connections

Check condition of all hoses and connections in both the fuel and oil systems:

- Visually inspect all components.
- Observe all clamps, hoses, and connections while outboard is running.
- Replace all damaged components.
- Repair all leaks.

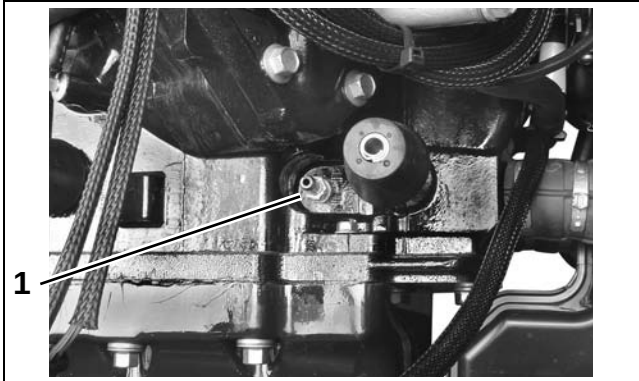


WARNING

Failure to check for fuel leakage could allow a leak to go undetected, resulting in fire or explosion.

EXHAUST PRESSURE FITTING

The exhaust pressure fitting is threaded into the cylinder/crankcase assembly and protrudes into the inner exhaust.



1. Exhaust pressure fitting

005236

A hose is routed from this fitting to the *EMM*. Due to carbon accumulation in the exhaust, this fitting must be periodically de-carbonized or replaced.

Operation Test

Use the *Evinrude Diagnostics* software *Monitor* screen to confirm:

- barometric pressure reading; and
- changes in exhaust pressure reading.

With key ON, outboard NOT running, make sure the barometric pressure reading reflects actual atmospheric conditions.

If barometric pressure reading is inaccurate, remove exhaust/barometric pressure hose from *EMM*. Retest and observe engine *Monitor* screen. If barometric pressure reading is accurate with hose removed, replace hose and diaphragm assembly. and inspect exhaust fitting for restriction.

With key ON, outboard NOT running, the exhaust pressure sensor reading should be close to zero. With the outboard running, make sure the exhaust pressure reading changes with throttle setting. This reading will vary, based on actual outboard exhaust pressure conditions.

If the exhaust pressure readings are not as described, clean or replace exhaust pressure fittings.



Engine Monitor Screen

1. Barometric pressure reading
2. Exhaust pressure reading

008094

Cleaning

Cleaning with *Engine Tuner* maintenance product can dissolve carbon build-up.

Spray *Engine Tuner* through the fitting and allow it to soak for four to six hours.



WARNING

Wear safety glasses to avoid personal injury, and set compressed air pressure to less than 25 psi (172 kPa).

Use compressed air to blow through the fitting. Limit the air pressure to 25 psi (170 kPa). Confirm movement of air through fitting.

IMPORTANT: Fitting does restrict air movement.

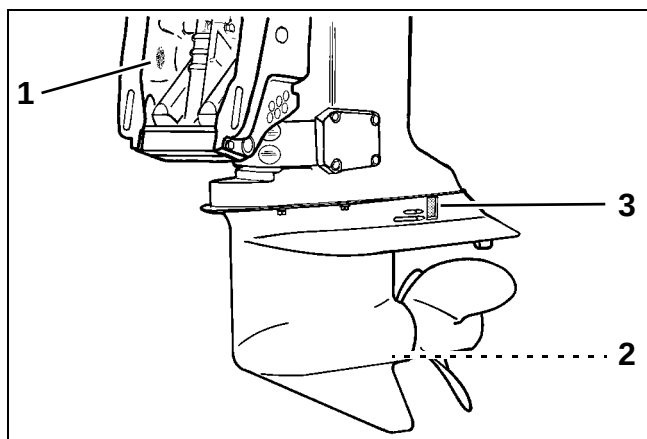
Replace exhaust pressure fittings that are blocked and cannot be decarbonized.

ANTI-CORROSION PROTECTION

Sacrificial Anodes

Galvanic corrosion occurs in fresh or salt water. Salt, brackish, and polluted water can accelerate corrosion. "Sacrificial" anodes are intended to protect the underwater metal components of the outboard from galvanic corrosion.

Outboards are equipped with three sacrificial anodes.



1. Stern bracket anode
2. Propeller shaft bearing housing anode (inside of gearcase housing)
3. Gearcase housing anode

DR5082

Visually inspect anodes and metal components below water level. Erosion of anodes is normal and indicates the anodes are functioning properly.

IMPORTANT: Anodes that are not eroding may not be properly grounded. Anodes and the mounting screws must be clean and tight for effective corrosion protection.

For best anode performance:

- Replace all anodes that have eroded or disintegrated to two-thirds of their original size
- Do not paint or apply protective coatings to anodes or anode fasteners
- Avoid using metal-based antifouling paint on the boat or outboard.

Testing Procedure – Continuity

Connect ohmmeter leads between engine ground and anode surface.



1. Meter lead to anode

000677

The meter should show little or no resistance. If resistance is high, check the following:

- Remove the anode and clean the area where the anode is installed
- Clean the mounting screws
- Install the anode and test again.

Metallic Component Protection

Protect metal components on outboards from corrosion. Use the following products to minimize corrosion:

- *Anti-Corrosion Spray* provides a heavy, waxy coating to protect components
- *"6 in 1" Multi-Purpose Lubricant* provides a thin film of anti-corrosion protection.

Exterior Finishes

Maintain the outboard's exterior finish to prevent corrosion and reduce oxidation:

- Use automotive wax to protect the outboard's exterior finish from oxidation
- Clean regularly using clean water and mild detergent soap
- Touch-up damage to painted surfaces promptly.

STORAGE

IMPORTANT: DO NOT start outboard without a water supply to the outboard's cooling system. Cooling system and/or powerhead damage could occur.

Fuel System Treatment

Stabilize the boat's fuel supply with *Evinrude/Johnson 2+4 Fuel Conditioner* following the instructions on the container.

Internal Engine Treatment

Remove the propeller, attach garden hose to flushing port and turn on water.

Evinrude E-TEC models are designed to be self-winterizing using either of the following methods:

IMPORTANT: Engine **MUST** be in **NEUTRAL** throughout these procedures.

Throttle Control Method

- Advance throttle control to 1/2 throttle (50%) position and then start the outboard. All four - *SystemCheck* lights will turn on and the outboard will run at idle speed.
- After approximately 15 seconds, the *System-Check* lights will go off. Move throttle to IDLE position. *SystemCheck* lights will light again.
- Wait another 15 seconds. *SystemCheck* lights will go off. At this point, advance throttle to FULL (in neutral). *SystemCheck* lights will flash, indicating that outboard is in winterize mode.
- Outboard will automatically go to fast idle and fog itself. Allow outboard to run until it shuts itself off (about one minute).

IMPORTANT: If *SystemCheck* lights do not flash, or outboard runs above fast idle, immediately turn off outboard and start the procedure again.

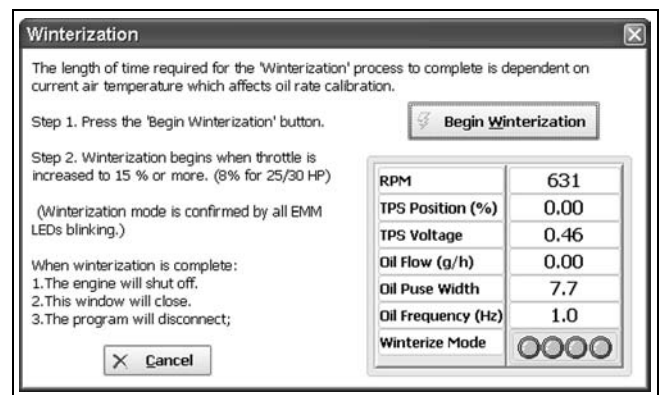
Software Control Method

Winterization can also be run using *Evinrude Diagnostics* software. With the outboard running, start the process at the *Settings/Adjustments* screen and follow the instructions.



1. Winterization start button

008077



008119

After the outboard shuts itself off, turn key switch OFF, then detach garden hose.

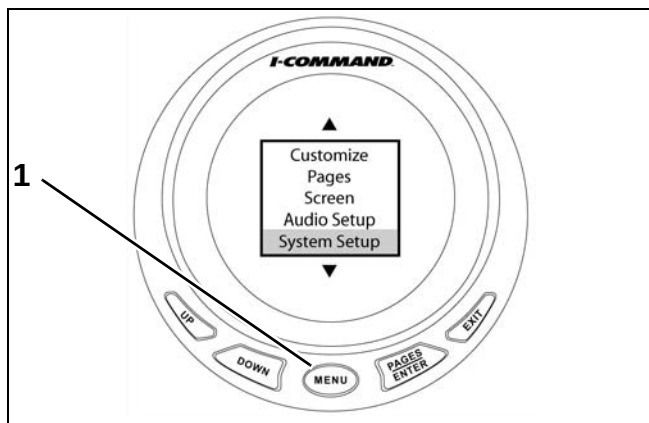
IMPORTANT: When finished, leave the outboard in vertical position long enough to completely drain the powerhead.

ROUTINE SERVICE

STORAGE

I-Command Method

I-Command 3.5 inch digital gauges (with software version 1.4.0 or higher) provide a winterize feature for 2008 and newer V4 and V6 models.



I-Command 3.5 inch Digital Gauge

008191

1. Menu button

Start the engine:

- Press the MENU button. Use the UP or DOWN buttons and select SYSTEM SETUP. Press the ENTER button.
- Use the UP or DOWN buttons and select BUS DEVICES. Press the ENTER button. The gauge will search for devices.
- Use the UP or DOWN buttons and select engine to winterize. Press the ENTER button.
- The gauge will display WINTERIZE menu. Press the ENTER button. Press ENTER button again.
- The gauge will display WINTERIZATION message.
- When prompted, engage NEUTRAL only button on throttle and advance THROTTLE ONLY to at least 50%.
- Gauge will display WINTERIZATION IN PROGRESS message. Outboard will automatically go to fast idle and fog itself. Allow outboard to run until it shuts itself off (about one minute)
- Gauge will display WINTERIZATION IS COMPLETE message.
- Press EXIT to return to BUS DEVICES menu. Repeat steps 3 through 8 for other engines (multi-engines set up only).

Additional Recommendations

- Top off oil reservoir.
- inspect the fuel filter. If there is debris in the fuel filter, it must be replaced.
- Replace gearcase lubricant.
- Remove and inspect propeller.
- Clean and grease propeller shaft.
- Blow water from gearcase speedometer pickup system (gearcase speedometer models only).
- Lubricate all grease fittings and linkages.
- Inspect outboard, steering system, and controls. Replace all damaged and worn components. Refer to manufacturer's and lubrication recommendations.
- Touch up painted surfaces as needed. Coat outer painted surfaces with automotive wax.
- Remove battery(s) from boat. Store in a cool, dry location. Periodically charge battery(s) while stored. Refer to manufacturer's maintenance recommendations when servicing batteries.
- Store outboard in upright (vertical) position.
- Check for fuel leakage.



WARNING

Failure to check for fuel leakage could allow a leak to go undetected, resulting in fire or explosion.

PRE-SEASON SERVICE

If the outboard was removed from the boat for storage, make sure it is reinstalled with factory specified hardware. Refer to the **Predelivery and Installation Guide**.

Outboard Mounting Bolts

- Check and re-tighten outboard mounting bolts to a torque of 40 ft. lbs. (54 N·m).

Gearcase Lubricant

- Check the lubricant level.
- Inspect gearcase for leaks. If leak is apparent, pressure and vacuum test gearcase.
- Repair gearcase as needed.

Battery(s)

- Replace batteries that cannot be charged.

Power Trim and Tilt

- Remove filler cap and check fluid level.
- Inspect the power trim and tilt unit for leaks. Repair as needed.

Operational Checks

- Refer to **OPERATIONAL CHECKS** on p. 31
- Steering system
- Remote controls
- All other accessories and instrumentation

Check Oil Injection Tank

- Inspect the oil tank for leaks.

Check Fuel System

- Inspect entire fuel system for leaks before starting outboard.
- Repair all leaks.

Water Pump

- Make sure a steady stream of water flows from overboard indicator.



WARNING

Failure to check for fuel leakage could allow a leak to go undetected, resulting in fire or explosion.

SUBMERGED ENGINES

Once an outboard has been submerged in fresh or salt water, it must be serviced within three (3) hours of recovery. Immediate service can minimize the corrosive affect that air has on the polished surfaces of the crankshaft, connecting rods, and internal powerhead bearings.

IMPORTANT: If outboard cannot be started or serviced immediately, it should be resubmerged in fresh water to avoid exposure to the atmosphere.

Engine Dropped Overboard (Not Running)

Disconnect the battery cables at the battery.

Rinse powerhead with clean water.

Remove spark plug leads and spark plugs.

Place outboard in horizontal position (cylinder heads down). Slowly rotate flywheel in a clockwise rotation to work all water out of powerhead.

IMPORTANT: If sand or silt may have entered the outboard, DO NOT attempt to start it. Disassemble and clean.

Disassemble all electrical connectors. Clean connectors and terminals, and treat with water displacing electrical spray. Apply *Electrical Grease* to terminals prior to reassembly. Coat all exposed solenoid terminals and engine grounds with *Black Neoprene Dip*.

Clean and inspect all electrical components. Replace damaged or corroded components prior to returning the outboard to service. Electric starters should be disassembled, cleaned, flushed with clean water, and treated with water displacing electrical spray prior to reassembly.

Disconnect fuel supply hose from outboard. Drain and clean all fuel hoses, filters, and fuel tanks.

Disconnect oil supply hose and oil return hose from outboard. Drain and clean all oil hoses, filters, and oil tank assemblies.

Refill fuel tank with fresh fuel and oil tank with recommended oil.

Prime oil system and fuel system. Refer to **Priming the Fuel System** on p. 141 and **Oil Supply Priming** on p. 173. Make sure all oil injection hoses are clean and filled with oil.

Make sure high pressure fuel system does not contain water. Flush as needed.

Inject a small amount of outboard lubricant into spark plug holes and install new spark plugs. Refer to **Spark Plug Indexing** on p. 38.

Reinstall all removed or disconnected parts.

Use *Evinrude Diagnostics* software to:

- Start break-in oiling
- Check fuel pump operation
- Check injector operation (fuel and oil)
- Check timing (once outboard is running at full operating temperature)

Run outboard below 1500 RPM for one-half hour.

Engine Dropped Overboard (Running)

Follow the same procedures as **Engine Dropped Overboard (Not Running)**. However, if there is any binding when the flywheel is rotated, it may indicate a bent connecting rod and no attempt should be made to start the outboard. Powerhead must be disassembled and serviced immediately.

Engine Dropped Overboard (In Salt Water)

Follow the same procedures used for **Engine Dropped Overboard (Not Running)** and **Engine Dropped Overboard (Running)**. Disassemble and clean outboards that have been submerged in salt water for prolonged periods of time. Clean or replace electrical components as necessary.

Prolonged Submersion (Fresh or Salt Water)

Outboards that have been dropped overboard and not recovered immediately, must be serviced within three hours of recovery. Follow the same procedures used for **Engine Dropped Overboard (Not Running)** and **Engine Dropped Overboard (Running)**.

ENGINE COVER SERVICE

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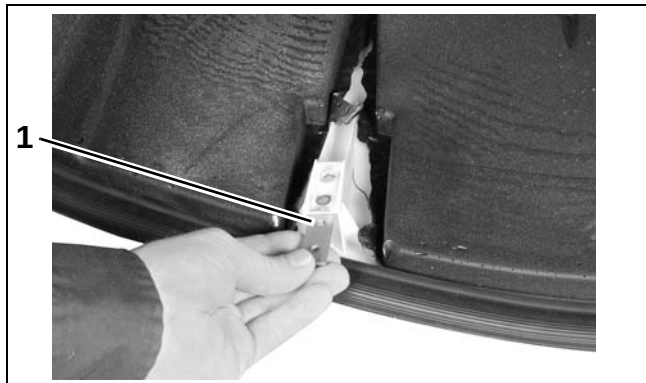
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3

UPPER COVER SERVICE

Latch Hook Installation

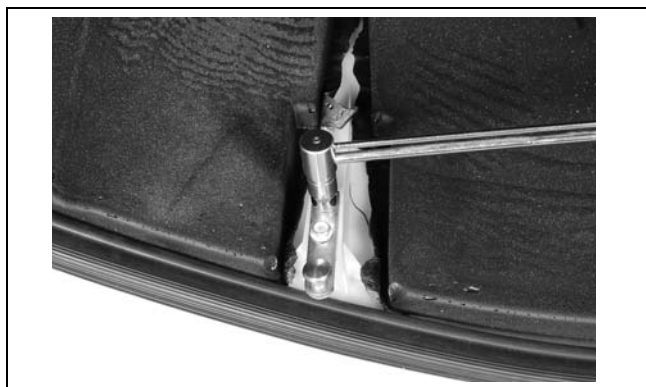
Insert threaded bracket into pocket.



1. Bracket

006826

Apply *Ultra-Lock* to screw threads. Place hook into position. Tighten screws to a torque of 60 to 84 in. lbs. (7 to 9.5 N·m).



006819

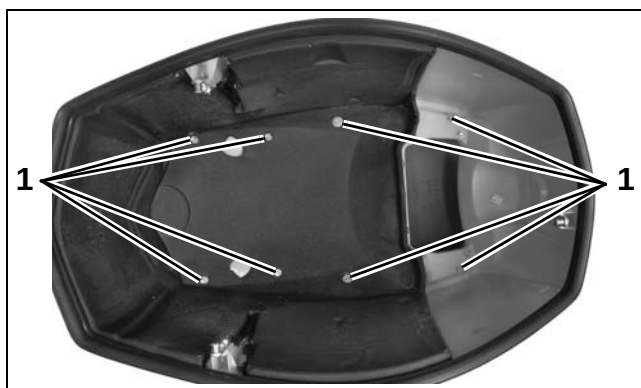
Upper Cover Cap Replacement

Place new upper cap into position.



006815

Tighten self-tapping screws to a torque of 24 to 36 in. lbs. (2.7 to 4 N·m).



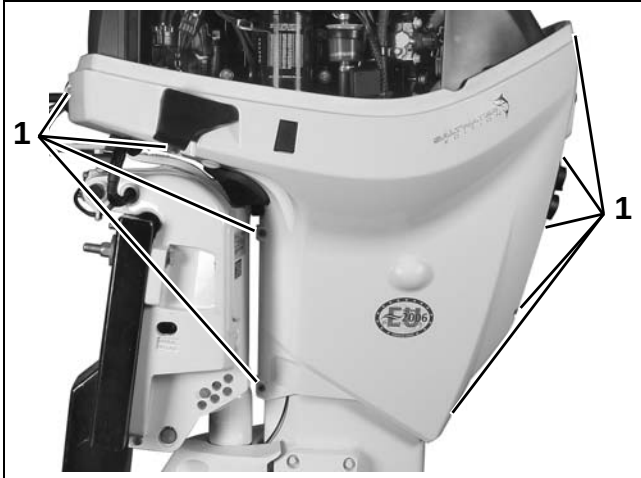
1. Upper cap screws

006820

LOWER COVER SERVICE

Lower Cover Removal

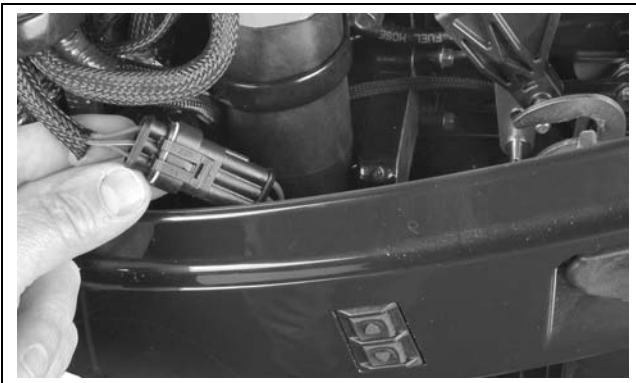
Remove lower engine cover screws.



1. Lower cover screws

005242

Loosen port side cover slightly, and disconnect trim/tilt switch connector. Then, remove port and starboard covers.



005246

Lower Cover Installation

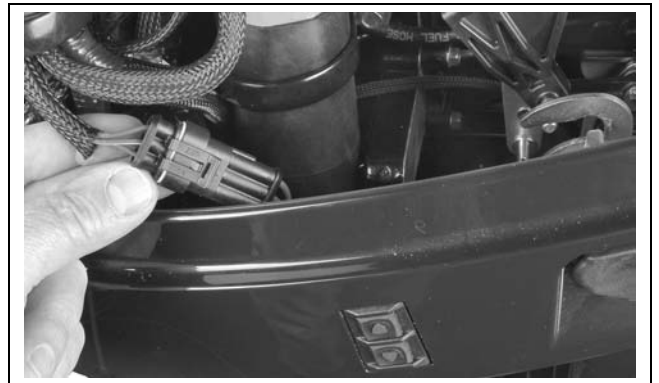
Install the lower engine covers and tighten all screws to a torque of 24 to 36 in. lbs. (3 to 4 N·m).



1. Lower cover screws

005242

Connect trim/tilt switch connector.



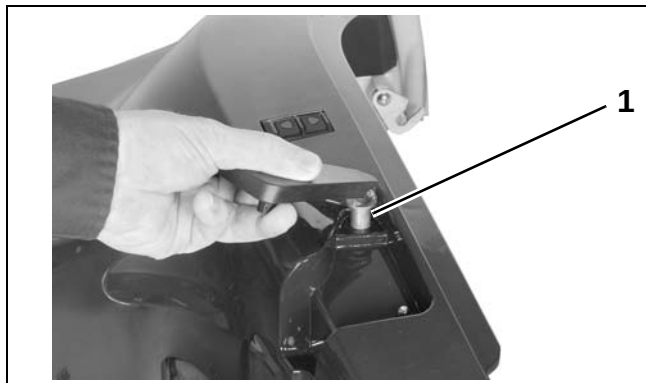
005246

ENGINE COVER SERVICE

LOWER COVER SERVICE

Latch Handle Installation

Apply a light coat of *Triple-Guard* grease to latch handle shaft. Insert handle into lower cover.



1. Triple-Guard grease

006827

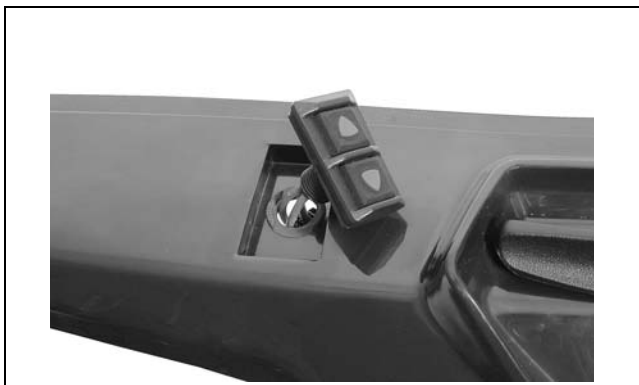
Apply *Ultra-Lock* to screw threads. Place spring washer and hook into position and tighten screw to a torque of 180 in. lbs. (20 N·m).



006821

Trim Switch Installation

Place switch into position through cover.



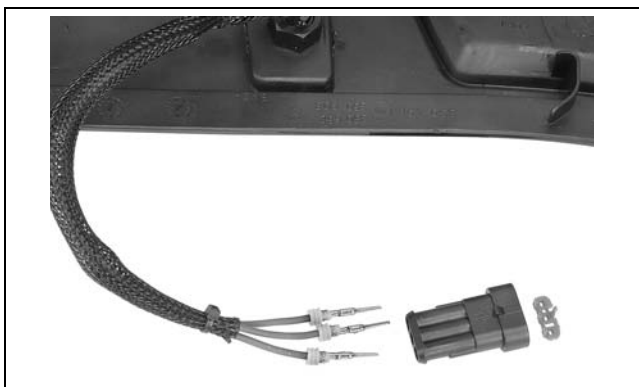
006746

Install nut on switch. Tighten nut to a torque of 10 to 16 in. lbs. (1 to 2 N·m).



006747

Install electrical connector. Refer to **CONNECTOR SERVICING** on p. 123.



006748

ENGINE MANAGEMENT MODULE (*EMM*)

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ENGINE MANAGEMENT MODULE (EMM)

DESCRIPTION

DESCRIPTION

The Engine Management Module (EMM) is a water-cooled engine controller. It controls many outboard systems including alternator output for the 12 V and 55 V circuits. Operating voltage is supplied to the *EMM* by the stator.

This section discusses the functions of the *EMM* and its various internal and external sensors. It also describes using *Evinrude Diagnostics* software to retrieve and adjust service information stored in the *EMM*.

EMM Functions

The *EMM* controls the following processes and functions:

- Alternator output; 55 V and 12 V
- Start Assist Circuit (SAC) voltage boost
- Ignition system primary voltage output (F-suffix)
- Fuel and ignition timing and duration
- Fuel injector activation
- Oil injector pump activation
- Electric fuel pump control
- Idle speed control
- RPM limiter
- Electrical circuit monitoring
- Service code creation and storage
- Warning system activation
- ROM verification, self-test
- Choke-less cold starting
- Output of diagnostic data
- Tachometer signal
- RPM profile and engine hours
- Oiling ratios
- Exhaust valve activation (V4 models)

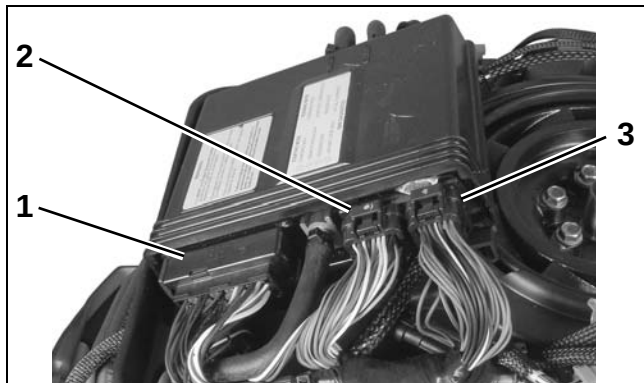
EMM Connections

IMPORTANT: *EMM* connections and wiring must be clean and tight. Improper electrical connections can damage the *EMM*. DO NOT run the outboard with loose or disconnected wiring.

Make sure *EMM* connections are clean and tight.

- Engine wire harness to *EMM* connectors; J1-A, J1-B, J2

- Stator to *EMM* connections; one 6-pin AMP and J2 connector.



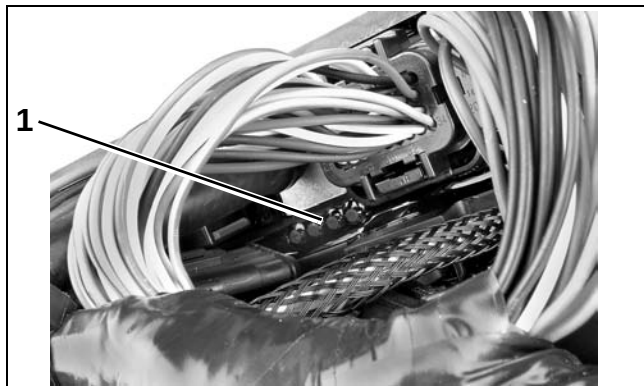
1. J2 connector
2. J1-A connector
3. J1-B connector

005235

LED Indicators

The *EMM* has four LED indicators located next to the electrical connectors that provide useful information about the status of the system.

IMPORTANT: LED 1 is toward the rear of the outboard (Closest to *EMM* J2 connector).



1. LED indicators

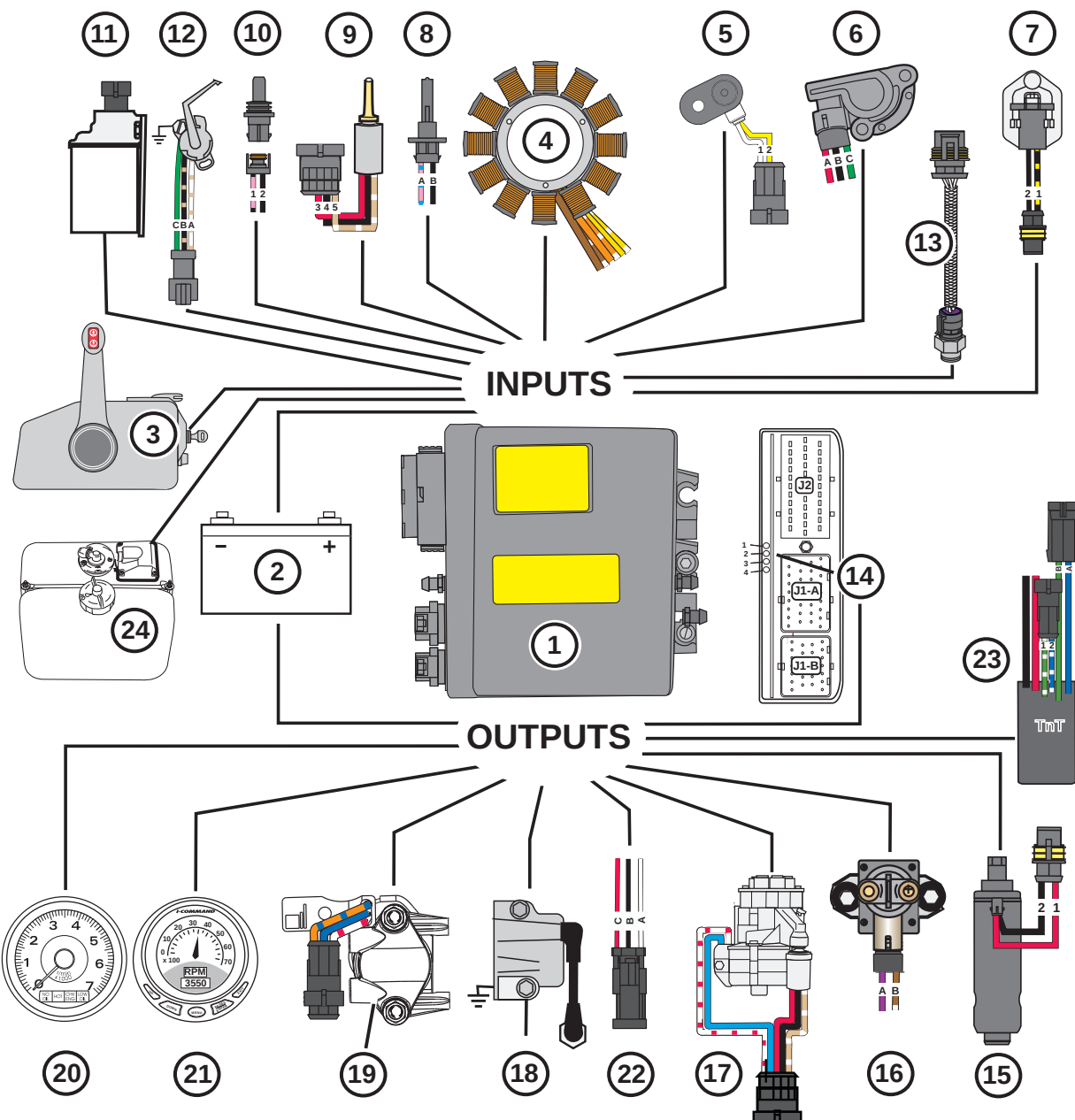
005239

When the ignition key is turned ON, LEDs 1, 3 and 4 should light, indicating that the SAC circuit, sensor circuits, and the stop circuit are working.

As the outboard is being started, all four LEDs should light and then go off in sequence. If any of the LEDs does NOT light during starting, refer to **EMM LED INDICATORS** on p. 75.

When the outboard is running, all LEDs should be off. If any LED is lighted while the outboard is running, refer to **EMM LED INDICATORS** on p. 75.

EMM INPUTS AND OUTPUTS DIAGRAM



008028

- | | | |
|---|---|-------------------------------------|
| 1. Engine Management Module (EMM) | 10. Engine Temperature Sensor(s) | 19. Fuel Injector |
| 2. Battery (12 volt) | 11. Water in Fuel Sensor / Fuel Filter | 20. Tachometer/SystemCheck Gauge |
| 3. Key switch (switched B+, start signal) | 12. Trim / Tilt Sending Unit | 21. I-Command (CANbus) Display |
| 4. Stator | 13. Water Pressure Sensor w/adaptor harness | 22. Diagnostic Connector |
| 5. Crankshaft Position Sensor (CPS) | 14. LED indicators | 23. Trim and Tilt Relay Module |
| 6. Throttle Position Sensor (TPS) | 15. Fuel Pump (high pressure) | 24. Oil Level Switch |
| 7. Neutral Switch | 16. Starter Solenoid | 25. Exhaust Valve Relay Module (V4) |
| 8. Air Temperature Sensor (AT) | 17. Oil Injection Pump and Manifold | |
| 9. Oil Pressure Sensor (component of 17) | 18. Ignition Coil | |

INTERNAL SENSORS

Sensor inputs and internal *EMM* controllers are used to control outboard operation. Use *Evinrude Diagnostics* software to troubleshoot the sensors. Refer to the **EMM Service Code Chart** at the back of this manual for a complete list of all engine fault codes.

Internal sensors are NOT serviceable. Reprogramming or replacement may be required to resolve *EMM* related issues.

EMM Temperature Sensor

Monitors the temperature of the fuel injector driver circuits.

If the *EMM* temperature exceeds 176°F (80°C) or the circuit fails, the *EMM*:

Activates S.A.F.E.
Stores service code 25
EMM LED 4: ON (Running)
Engine Monitor TEMP display: ON

If *EMM* temperature exceeds 212°F (100°C) or the circuit fails, the *EMM*:

Activates SHUTDOWN
Stores service code 29
EMM LED 4: FLASHING
Engine Monitor TEMP display: FLASHING

IMPORTANT: The outboard will not restart until the engine cools below 212°F (100°C) and the *EMM* temperature returns to normal. Refer to **SHUTDOWN MODE** on p. 61.

If *EMM* temperature is less than -22°F (-30°C) or the circuit fails, the *EMM*:

Stores service code 24
EMM LED 3: OFF (Cranking)
EMM LED 3: ON (Running)

If sensor reads less than -67°F (-55°C) or greater than 311°F (155°C) a sensor circuit fault is detected and the *EMM*:

Stores service code 23
EMM LED 3: OFF (Cranking)
EMM LED 3: ON (Running)

55 V Circuit Sensor

Monitors the *EMM*'s 55 V alternator circuit.

If system voltage exceeds 57 volts, the *EMM*:

Activates S.A.F.E.
Stores service code 18
EMM LED 1: ON (Running)
Engine Monitor CHECK ENGINE display: ON

If system voltage is less than 45 V between 500 and 1000 RPM, or is less than 52 V above 1000 RPM, the *EMM*:

Activates S.A.F.E.
Stores service code 17
EMM LED 1: ON (Running)
Engine Monitor CHECK ENGINE display: ON

12 V Circuit Sensor

Monitors the *EMM*'s 12 V alternator circuit.

If battery voltage exceeds 15.5 volts, the *EMM*:

Stores service code 27
EMM LED 1: ON (Running)
Engine Monitor LOW BATTERY display: ON

If battery voltage is less than 12 V below 2000 RPM, or is less than 12.5 V above 2000 RPM, the *EMM*:

Stores service code 26
EMM LED 1: ON (Running)
Engine Monitor LOW BATTERY display: ON

5 V Circuit Sensor

Monitors the *EMM*'s 5 V sensor circuit.

If sensor voltage is less than 4.75 volts, the *EMM*:

Stores service code 78
<i>EMM</i> LED 3: OFF (Cranking)
<i>EMM</i> LED 3: ON (Running)

Barometric Pressure Sensor

Supplies the *EMM* with barometric pressure reading to compensate for changes in altitude and air density.

If the BP sensor reads less than 13 KPa or greater than 119.0 KPa, or the sensor or circuit fails, the *EMM*:

Stores service code 44

If the BP sensor reads less than 70 KPa, the *EMM*:

Stores service code 45

If the BP sensor reads greater than 105 KPa, the *EMM*:

Stores service code 46

Exhaust Pressure Sensor

The exhaust pressure sensor monitors exhaust pressure during all running conditions to compensate for engine loads.

If the sensor reads less than -85 in. water, or greater than 85 in. water, or the sensor or circuit fails, the *EMM*:

Stores service code 87
<i>EMM</i> LED 3: OFF (Cranking)
<i>EMM</i> LED 3: ON (Running)

If exhaust pressure is less than 40 in. water, the *EMM*:

Stores service code 88
<i>EMM</i> LED 3: OFF (Cranking)
<i>EMM</i> LED 3: ON (Running)

If exhaust pressure is greater than 80 in. water, the *EMM*:

Stores service code 89
<i>EMM</i> LED 3: OFF (Cranking)
<i>EMM</i> LED 3: ON (Running)

EXTERNAL SENSORS

Sensor inputs and internal *EMM* controllers are used to control outboard operation. Use *Evinrude Diagnostics* software to troubleshoot the sensors. Refer to the **EMM Service Code Chart** at the back of this manual for a complete list of all engine fault codes.

The *EMM* provides a 5 V DC signal for sensor circuits. It monitors all sensor voltage inputs and compares them to predetermined acceptable ranges. Inputs that fall outside of the acceptable range create service codes.

Air Temperature Sensor

The air temperature sensor monitors the air temperature at the throttle body.

If the AT sensor voltage is out of the expected range, or the sensor or circuit fails, the *EMM*:

Stores service code 47, 48, or 49
<i>EMM</i> LED 3: OFF (Cranking)
<i>EMM</i> LED 3: ON (Running)

Engine Temperature Sensor

Monitors cylinder head temperature.

If cylinder head temperature exceeds 230° F (110° C) below 3000 RPM, the *EMM*:

Activates S.A.F.E.
Stores service code 40 (port sensor)
Stores service code 70 (stbd sensor)
<i>EMM</i> LED 4: ON (Running)
Engine Monitor TEMP display: ON

If cylinder head temperature exceeds 194° F (90° C) above 3000 RPM, the *EMM*:

Activates S.A.F.E.
Stores service code 43 (port sensor)
Stores service code 69 (stbd sensor)
<i>EMM</i> LED 4: ON (Running)
Engine Monitor TEMP display: ON

If cylinder head temperature exceeds 248°F (120°C) for 3 seconds, the *EMM*:

Activates SHUTDOWN
Stores service code 31
<i>EMM</i> LED 4: FLASHING
Engine Monitor TEMP display: FLASHING

The outboard will not restart until the engine temperature returns to normal. Refer to **SHUTDOWN MODE** on p. 61.

If sensor values are less than -13°F (-25°C), or greater than 329°F (165°C), the *EMM*:

Stores service code 41 (port sensor)
Stores service code 67 (stbd sensor)
<i>EMM</i> LED 3: OFF (Cranking)
<i>EMM</i> LED 3: ON (Running)

If sensor values are below -4°F (-20°C), the *EMM*:

Stores service code 42 (port sensor)
Stores service code 68 (stbd sensor)
<i>EMM</i> LED 3: OFF (Cranking)
<i>EMM</i> LED 3: ON (Running)

If cylinder head does not reach operating temperature (122°F / 50°C below 1000 RPM) in 10 minutes, the *EMM*:

Stores service code 58 (port sensor)
Stores service code 59 (stbd sensor)
<i>EMM</i> LED 3: OFF (Cranking)
<i>EMM</i> LED 3: ON (Running)

Oil Pressure Sensor

The oil pressure sensor monitors oil pressure in the oil distribution manifold.

If the sensor does not detect pressure for:

- **V4:** 100 pump cycles
- **V6:** 150 pump cycles

the *EMM*:

Activates <i>S.A.F.E.</i>
Stores service code 38
<i>EMM</i> LED 4: ON (Running)
Engine Monitor NO OIL display: ON

If outboard has been run for more than 5 hours with NO OIL faults (codes 34 & 38), the *EMM*

Activates SHUTDOWN
Stores a service code 33
<i>EMM</i> LED 4: FLASHING
Engine Monitor NO OIL display: FLASHING

IMPORTANT: The outboard will restart for **one minute intervals** until problem is resolved and code is cleared. To clear code use the diagnostic software program.

If the sensor reads out of the expected range, or the sensor or circuit fails, the *EMM*:

Stores service code 71
<i>EMM</i> LED 3: ON (Running)

If the sensor circuit indicates below expected range (<.4 V), the *EMM*:

Stores service code 72
<i>EMM</i> LED 3: ON (Running)

If the sensor circuit indicates above expected range (> 4.6 V), the *EMM*:

Stores service code 73
<i>EMM</i> LED 3: ON (Running)

Throttle Position Sensor

The throttle position sensor receives a voltage signal from the *EMM*. As the throttle lever is rotated, the *EMM* receives a return voltage signal through a second wire. This signal increases as the TPS lever is advanced. A third wire provides a ground circuit back to the *EMM*.

If TPS voltage is greater than 0.65 V when the key is turned to ON, the *EMM*:

Creates service code 11

If the outboard is started, the code is stored.

If the key ON voltage is greater than 0.78 V when the engine is started, speed is limited to idle.

If code 11 is present as both a Hard Fault and a Stored Fault, refer to **Control Cable Installation** on p. 17.

If the TPS or TPS circuit fails (less than 0.14 volts or greater than 4.92 volts), the *EMM*:

Stores service code 12
Limits engine RPM to IDLE
<i>EMM</i> LED 3: OFF (Cranking)
<i>EMM</i> LED 3: ON (Running)
Engine Monitor CHECK ENGINE display: ON

IMPORTANT: When a TPS circuit fault has been detected, the outboard will not accelerate above idle speed. To reset, stop the outboard and correct the fault.

If the TPS circuit reads below 0.2 volts, the *EMM*:

Stores service code 13
<i>EMM</i> LED 3: OFF (Cranking)
<i>EMM</i> LED 3: ON (Running)
Engine Monitor CHECK ENGINE display: ON

If the TPS circuit reads above 4.85 volts, the *EMM*:

Stores service code 14
<i>EMM</i> LED 3: OFF (Cranking)
<i>EMM</i> LED 3: ON (Running)
Engine Monitor CHECK ENGINE display: ON

ENGINE MANAGEMENT MODULE (EMM)

EXTERNAL SENSORS

Crankshaft Position Sensor

Ribs spaced on the flywheel mark crankshaft position. As the ribs pass the magnetic field of the CPS, an AC voltage signal is generated. The *EMM* uses this signal to identify crankshaft position and speed, generate a tachometer signal, and control fuel and ignition timing.

If the sensor is damaged or the signal is intermittent:

- **Below 2000 RPM:** 5 occurrences
- **Above 2000 RPM:** 1 occurrences

the *EMM*:

Stores service code 16
<i>EMM</i> LED 2: OFF (Cranking)
<i>EMM</i> LED 3: ON (Running)

Approximate air gap between CPS and flywheel encoder ribs is 0.073 (1.85 mm).

Use the *Evinrude Diagnostics* software *Monitor* screen to check CPS operation. The software should show an RPM reading while the outboard is cranking. If the CPS or its circuit fails, no RPM reading will appear and the outboard cannot run.

Neutral Switch (V4 Models)

The powerhead mounted neutral switch controls a ground signal from the *EMM* to indicate shift linkage position when a tiller kit has been installed. This allows the *EMM* to provide start in gear protection. Fuel and ignition functions are turned off on tiller models if the neutral switch is not closed.

If the starter is cranked while the outboard is in gear, or if the switch fails, the *EMM*:

Stores service code 19
<i>EMM</i> LED 3: OFF (Cranking)
Engine Monitor CHECK ENGINE display: ON

The *Monitor* screen of the diagnostics software displays switch position, NEUTRAL or IN GEAR. Make sure switch is operating properly.

INTERNAL *EMM* FUNCTIONS

Start Assist Circuit (SAC)

When the ignition key is ON, the *EMM* Start Assist Circuit (SAC) boosts battery voltage (12 V) to 30 V on the system (55 V) circuit.

If the SAC circuit current exceeds 2 Amps, or if the SAC voltage is less than 20 V, the *EMM*:

Stores service code 77
<i>EMM</i> LED 1: ON (Running)

ROM Verification

The *EMM* performs a self-test of programming every time it is turned ON. Service code 15 indicates a programming (software) issue. Reprogram the *EMM* with the correct software program to correct the problem.

Idle Controller

The idle controller reacts to engine operating conditions. Fuel and ignition timings are altered to maintain a specific RPM when engine is cold or warm. The controller is inactive when TPS is advanced from idle position.

RPM Limiter

This feature of *EMM* programming prevents engine damage due to excessive RPM. At 6250 RPM, fuel and ignition to the cylinders is shut off. Normal operation resumes when engine RPM returns to the specified range.

Exhaust Valve (V4 Models)

The *EMM* controls a valve that switches between two exhaust paths to provide the best exhaust tuning for various running conditions. At slower speeds and under acceleration, the system opens a longer path, allowing the engine to develop more midrange horsepower as the boat comes on plane. At higher RPMs, the path is shortened for maximum high speed performance.

Engine Monitor and Warning Systems

Refer to **ENGINE MONITOR SYSTEM** on p. 60.

Refer to **S.A.F.E. WARNING SYSTEM** on p. 61.

Refer to **SHUTDOWN MODE** on p. 61.

Fault Code Creation and Storage

Refer to the *EMM Service Code Chart* at the back of this manual for a complete list of all engine fault codes.

ENGINE MONITOR SYSTEM

All remote controlled outboards must be equipped with an engine monitoring system to warn the operator of conditions that could damage the outboard.

The engine monitor system includes sensors on the outboard and oil tank, a warning horn, a dash-mounted display, and related wiring.

The outboard's *EMM* sends information about monitored functions to:

- *SystemCheck* gauges
- An *I-Command* or *ICON* display
- *EMM* LED indicators.

IMPORTANT: Operating the outboard without an engine monitor will void the warranty for failures related to monitored functions. For information about boat mounted Information Display System options, refer to the current **Predelivery and Installation Guide** included with the service manual set.



Typical *I-Command* and *SystemCheck* gauges

007988

The *EMM* activates the warning horn and gauge displays as follows:

- **LOW OIL** means that oil in the tank is at reserve level (about 1/4 full).
- **NO OIL** indicates the oil tank is empty, or the oil system is damaged.
- **WATER TEMP** or **HOT** indicates an engine or *EMM* overheat condition.
- **CHECK ENGINE** or **FAULT** is used to indicate other fault conditions identified by the *EMM*.

Refer to the **EMM Service Code Chart** at the back of this manual for a complete list of all fault codes.

System Self-Test

During engine start-up, pause with the key switch in the ON position. The horn self-tests by sounding a half-second beep. *SystemCheck* gauges self-test by turning the indicator lights on simultaneously, then off in sequence.

Note: The warning horn does NOT sound in an *I-Command* installation.

Service Mode

SystemCheck goes into a service mode if the key is left ON after self-test (engine NOT running). All light circuits and sensors are active, but the horn is not. Grounding the appropriate light circuit wire will turn the light on, but the horn will not sound. Refer to **SystemCheck CIRCUIT TESTS** on p. 107.

Engine Running

All warning circuits are active when the engine is running. The horn circuit is active when engine speed exceeds 500 RPM.

Engine monitor warnings activate the horn for 10 seconds and the appropriate gauge light for a minimum of 30 seconds. If the failure is momentary (for example, oil moving in the tank), the light will remain ON for the full 30 seconds before going out. If the fault continues, the light remains ON until the key is turned OFF or the failure is corrected. The warning will reoccur at the next start-up if the problem is not corrected.

S.A.F.E. WARNING SYSTEM

The S.A.F.E. (*Speed Adjusting Failsafe Electronics*) warning system alerts the operator and protects against engine damage from the following abnormal conditions:

Code 17	Alternator 55 V below expected range
Code 18	Alternator 55 V above expected range
Code 25	EMM temperature above expected range
Code 34	Oil injector open circuit
Code 38	No oil pressure feedback
Code 40	Cylinder head temperature above expected range—low speed
Code 43	PORT Cylinder head temperature above expected range
Code 69	STARBOARD cylinder head temperature above expected range
Code 70	Cylinder head temperature above expected range—low speed

Activation

When one of these conditions occurs, the EMM interrupts fuel injector and ignition operation, reducing engine speed to 1200 RPM. The warning horn sounds and an Engine Monitor message displays. When S.A.F.E. is active, the engine will run normally below 1200 RPM. Above 1200 RPM, the engine will shake excessively.

Recovery

The engine will operate in S.A.F.E. as long as the fault condition exists. To recover normal operation, two conditions must be met:

- Sensor or switch readings must be back within limits
- The EMM must be reset—stop and restart

SHUTDOWN MODE

Outboard “shutdown” will occur if specific faults are detected by the EMM:

Code 29	Excessive EMM temperature
Code 31	Excessive engine temperature
Code 33	Excessive NO OIL condition
Code 57	High RPM with low TPS setting

Code 57 occurs when the EMM detects abnormally high RPM relative to the TPS position. This condition could be caused by uncontrolled fuel entering the combustion cycle. Before removing the code and STARTING the outboard, find and repair the cause.

- Perform **Fuel System Pressure Test** on p. 142. Check for external fuel leakage that could allow fuel and/or vapor to enter the engine through the air intake.
- Check for internal fuel leakage from a leaking injector or vapor separator vent hose.



WARNING

If the engine shuts OFF and the “CHECK ENGINE” light or EMM SENSOR FAULT LED is flashing, the engine cannot be restarted. A hazardous fuel condition may exist which could result in a fire or explosion.

Recovery

To recover from shutdown mode, the EMM must NOT detect the related fault at start-up. The outboard will not restart until the cause of the stored service code is resolved (code 29 and 31) and the code is cleared using diagnostics software (code 33 and 57). Then, the EMM must be turned OFF and ON again.

IMPORTANT: Shutdown related to code 57 or 33 requires the removal of the stored service code. Use *Evinrude Diagnostics* software to clear a code 57 or 33.

ENGINE MANAGEMENT MODULE (EMM) DIAGNOSTIC SOFTWARE FUNCTIONS

DIAGNOSTIC SOFTWARE FUNCTIONS

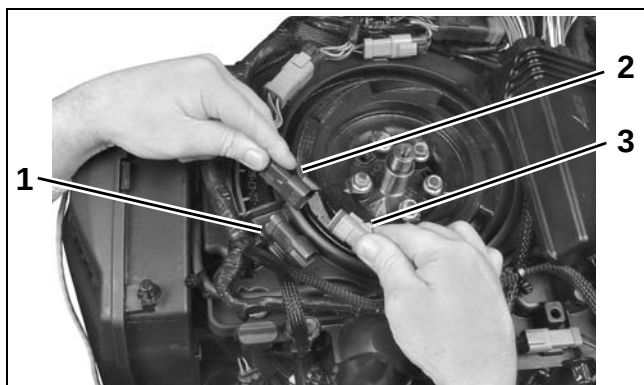
The *EMM* stores valuable information about the outboard and its running history. This information can be used for troubleshooting, for checking parts information, and for making adjustments to the system.

Use *Evinrude Diagnostics* software, version 4.5 or higher, and a laptop computer to access program information.

IMPORTANT: For software help, refer to the “Help” menu in the software.

Communication

Locate the diagnostic connector on the engine. Remove the cover and install the Diagnostic Interface Cable (P/N 437955).



1. Cover
2. Diagnostic interface cable
3. Engine harness diagnostic connector

005240

Connect the 9-pin connector of the interface cable directly to the computer's serial port.

The *EMM* must turn ON before it will communicate with the computer.

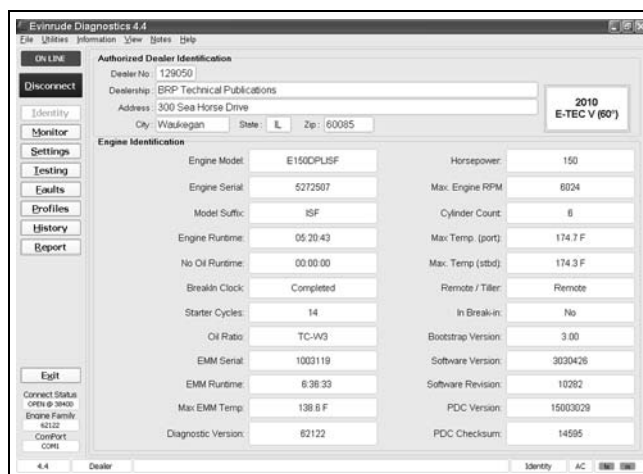
Power is normally supplied to the *EMM* when the key switch is ON. Switched B+ (12 V) enters the *EMM* at pin 21 (purple) of the *EMM* J1-B connector.

The *EMM* is also turned ON when it begins to receive AC voltage from the stator while the outboard is being cranked.

Static Information

Static information is viewed when the outboard is NOT running. This includes manufacturing information.

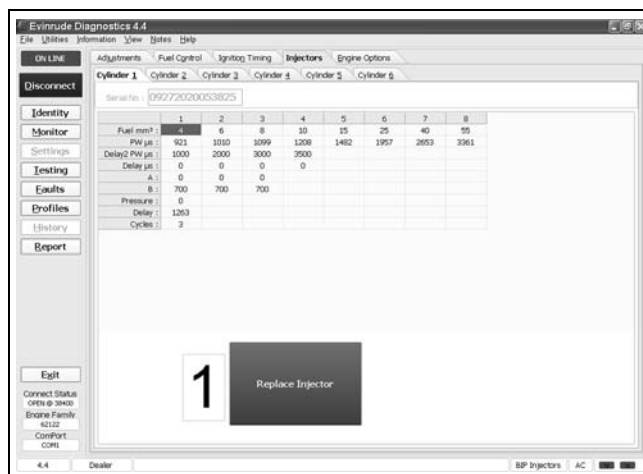
The outboard model and serial numbers displayed on the *Identity* screen must match the identification label on the outboard swivel bracket.



Identity Screen

008102

The serial number and cylinder location displayed on the *Injector Coefficients* screen must match the actual cylinder placement for each injector.



Injector Coefficients Screen

008103

Dynamic Information

Dynamic information is viewed while the outboard is running. Changes in data, such as voltages or temperatures, are shown as they happen.



Engine Monitor Screen

008104

Stored Service Codes (Faults)

Service codes are stored if an abnormal condition occurs while the outboard is running.

The *Stored Faults* screen of the diagnostics software shows the code number, the number of times the event occurred, and operating hours of first and last occurrences.

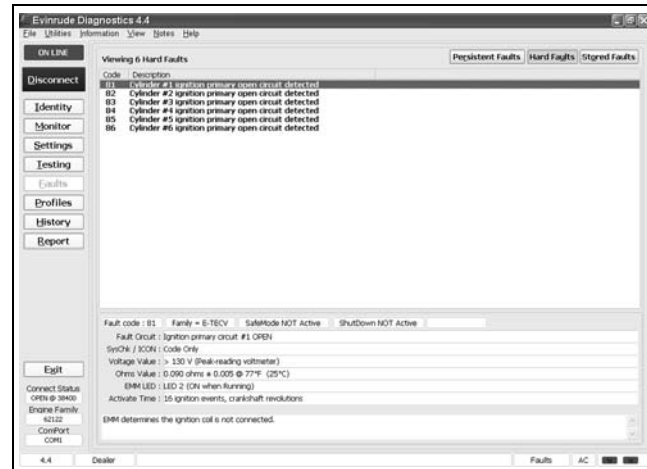


Stored Faults Review Screen

008120

Hard Faults

A hard fault is a service code that currently exists. Hard faults become stored faults only if the outboard is running.



Hard Faults Review Screen

008105

Persistent Faults

The *Persistent Faults* screen keeps a history of all previously stored codes, including code number, the number of times the event occurred, and operating hours of the last occurrence.

Persistent faults cannot be erased.

Static Tests

Static Tests allow diagnostic testing of system components while the outboard is NOT running.



Static Tests Screen

008106

ENGINE MANAGEMENT MODULE (EMM) DIAGNOSTIC SOFTWARE FUNCTIONS

Ignition Test

Use the diagnostics software to test each ignition circuit. Refer to **Static Ignition Test** on p. 79.

Fuel Test

Use the diagnostics software to test each fuel injector circuit. Refer to **Fuel Injector Static Test** on p. 82.

Oil Injector

Use the diagnostics software to test the oil injection pump circuit. Refer to **OILING SYSTEM TESTS** on p. 175.

Fuel Pump

Use the diagnostics software to test the fuel pump circuit. Refer to **Fuel Pump Static Test** on p. 82.

Exhaust Valve (V4)

Use the diagnostics software to check operation of exhaust valve actuator. Refer to **EXHAUST VALVE (V4 MODELS)** on p. 84.

Overheat

This test is used to check the “ENG TEMP” or “HOT” circuit of the Engine Monitoring system.

Oil Fault

This test is used to check the “NO OIL” circuit of the Engine Monitoring system.

Check Engine

This test is used to check the “CHECK ENGINE” circuit of the Engine Monitoring system.

Tachometer

This test is used to check operation of the tachometer circuit.

Dynamic Tests

Dynamic tests are performed with the outboard running.



Dynamic Tests Screen

008107

Ignition Test

This test momentarily disables the ignition and fuel injection circuits to one cylinder. By dropping one cylinder, RPM and running quality changes can be observed. Refer to **DYNAMIC TESTS** on p. 74.

Fuel Test

This test momentarily disables one fuel injector circuit. By dropping one cylinder, RPM and running quality changes can be observed. Refer to **DYNAMIC TESTS** on p. 74.

Prime Oil

This test is used to cycle the oil injection pump for priming the oiling system. Perform this test with outboard running to activate oil injection pump.

Oil Control Settings

Set Oil Type

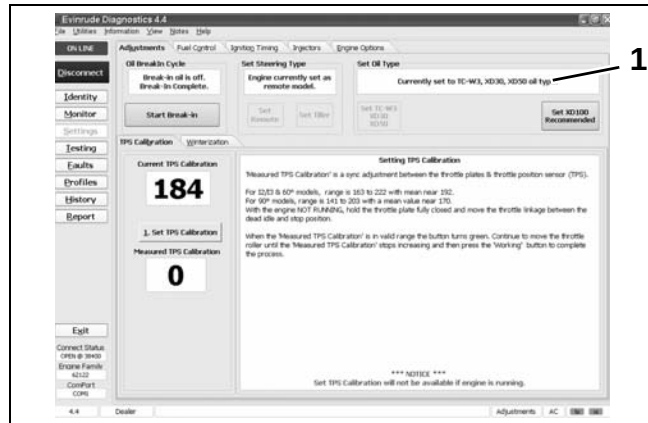
The TC-W3 oil type setting is the standard setting for all outboards. Set TC-W3 for:

- Operation with all TC-W3 outboard oils including XD30, XD50, or XD100.
- Applications requiring maximum lubrication.
- Extreme applications (racing or harsh conditions)

The XD100 setting provides an option to run the outboard at a reduced oil injection rate. This setting **REQUIRES** the use of *Evinrude XD100* outboard lubricant and is not recommended for all applications.

Use the XD100 setting for:

- Conventional use (runabouts, cruisers)
- Moderate applications



1. Oil control setting

008108



CAUTION

Running an *Evinrude E-TEC* outboard on other grades of oil while set to the XD100 oil ratio will result in increased engine wear and shortened outboard life.

Powerhead Break-In

Use the diagnostic software to initiate break-in oiling. Break-in is a predetermined oiling program that runs for five hours of outboard operation, above 2000 RPM.

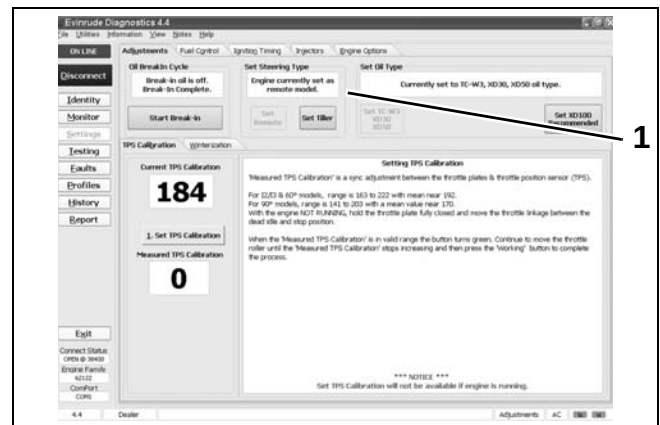


1. Break-in oil setting

008108

Tiller/Remote Programming

This feature controls the start in gear protection function of the neutral switch. Tiller operated models, including remote models with an installed tiller conversion kit, **MUST** be set to TILLER.



1. Starter mode setting

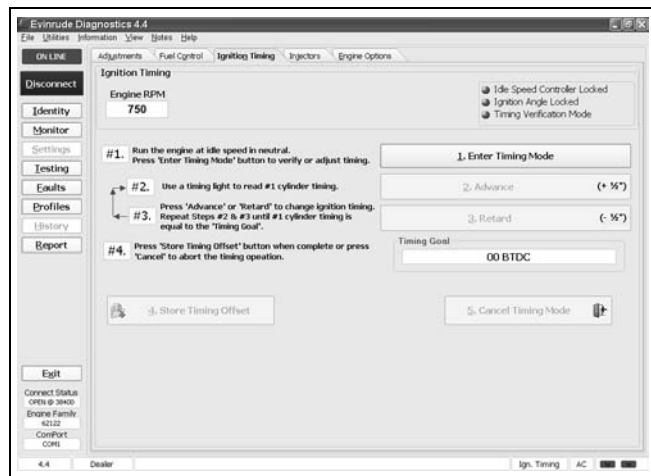
008109

ENGINE MANAGEMENT MODULE (EMM) DIAGNOSTIC SOFTWARE FUNCTIONS

Ignition Timing

Use the *Ignition Timing* screen to check and adjust *EMM* timing. *EMM* timing must be synchronized to crankshaft position.

Refer to **TIMING ADJUSTMENTS** on p. 114.



008110

Check timing after any of the following procedures:

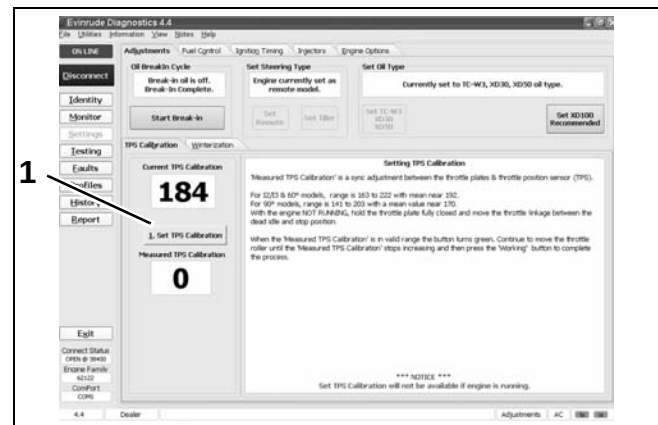
- Powerhead replacement
- Crankshaft replacement
- Flywheel removal or replacement
- CPS replacement
- *EMM* replacement
- *EMM* software replacement

IMPORTANT: Make sure the timing pointer is set and the outboard reaches operating temperature before making adjustments.

TPS Calibration

TPS Calibration synchronizes throttle plate opening with throttle position sensor voltage.

Refer to **TPS Calibration** on p. 116.



1. TPS Calibration button

008108

Perform TPS Calibration after replacing or adjusting any throttle body or throttle linkage parts.

Fuel Injector Servicing

All *E-TEC* fuel injectors use software programming to compensate for variations in fuel flow. Each injector and its location on the outboard is identified by the *EMM*. DO NOT install an injector without updating the compensation software.

To install a service injector, click the "Replace" button on the *Injector Coefficients* screen and select the file for the replacement injector. Refer to **Fuel Injector Service** on p. 150.



008101

ENGINE MANAGEMENT MODULE (EMM) DIAGNOSTIC SOFTWARE FUNCTIONS

Reports

Engine reports provide service records and can be used to document the running history of an outboard. Reviewing this information can help identify or resolve some service issues.

Click the print button in a window of the diagnostics software to print engine data, or to export the information to a computer file.



- 1. Print button
- 2. Print/Export options

008111

Software Replacement

Engine Management Software is loaded into the EMM at the factory. Periodically, a new program may be available to enhance the operation of an outboard. Select *Engine Software Update* from the *Utilities* menu and refer to the instructions provided with the program.



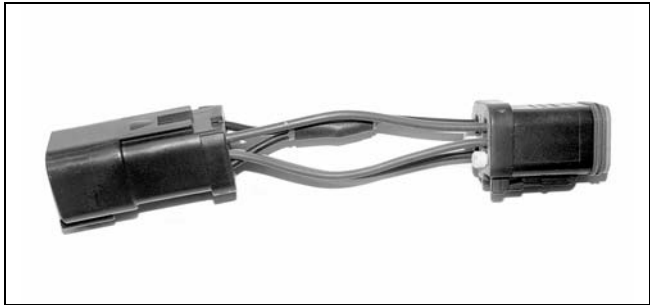
008095



Engine Report data files

008096

IMPORTANT: Software replacement requires the use of Bootstrap Tool, P/N 586551. Install tool between engine and boat harness key/stop switch connectors as instructed by update program.



002383

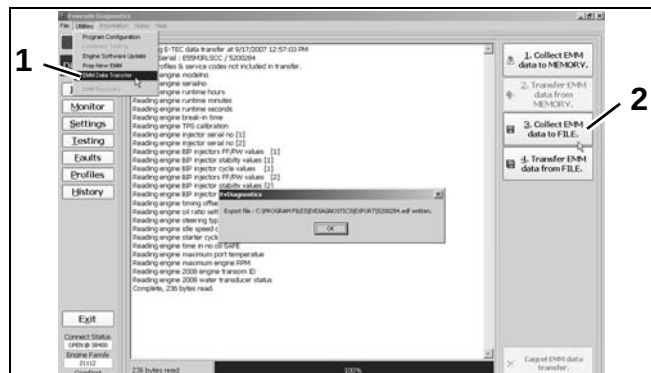
ENGINE MANAGEMENT MODULE (EMM)

EMM SERVICING

EMM Transfer

EMM Transfer is used to save engine history data when the *EMM* must be replaced.

Select *EMM Data Transfer* from the *Utilities* menu. Select the Collect *EMM* data to FILE option and follow the instructions provided with the program.



1. Select *EMM Data Transfer*
2. Select *Collect EMM data to FILE*

006642

IMPORTANT: Whenever the *EMM* is replaced, *EMM* timing must be synchronized to crankshaft position. Refer to **TIMING ADJUSTMENTS** on p. 114.

EMM SERVICING

IMPORTANT: If a new *EMM* is being installed, refer to **EMM Transfer** on p. 68.

Removal

Disconnect exhaust pressure hose and cooling hoses from *EMM*.

Disconnect J1-A and J1-B connectors.

Remove two *EMM* retaining screws. Lift *EMM* up and to the port side.



1. EMM mounting screws

005375

Disconnect J2 connector.



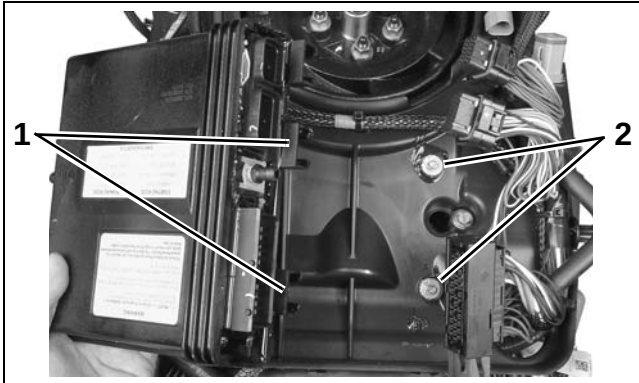
1. J2 Connector

005376

Installation

Install J2 connector

Align slots in starboard side of *EMM* case with isolator mounts on electrical harness base. Slide *EMM* into position.



1. EMM mounting slots
2. Isolator mounts

005377

Install two *EMM* retaining screws. Tighten screws 12 to 16 in. lbs. (1.5 to 2 N·m).



1. EMM mounting screws

005375

Install J1-A and J1-B connectors.

Install exhaust pressure hose and cooling hoses.
Secure with tie straps.

Technician's Notes

[illegible][illegible]

SYSTEM ANALYSIS

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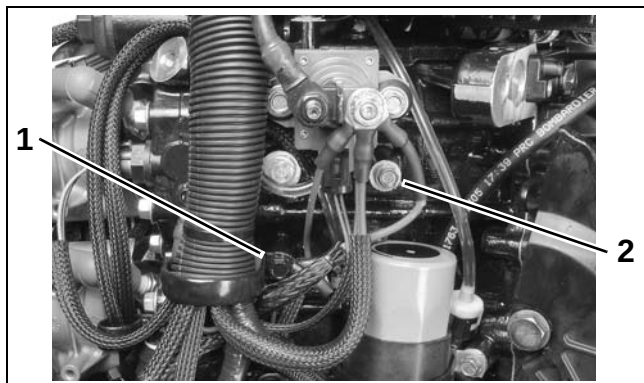
DIAGNOSTIC PROCEDURES

Visual Inspections

Inspect wiring and electrical connections. Disassemble and clean all corroded connections. Replace damaged wiring, connectors, or terminals. Repair any shorted electrical circuits.

- Refer to **ELECTRICAL HARNESS CONNECTIONS** on p. 90.
- Refer to **WIRING DIAGRAM** at the back of this manual.
- Refer to **CONNECTOR SERVICING** on p. 123.

Make sure all ground connections are clean and tight. Refer to **GROUND CIRCUITS** on p. 92.



1. Main engine harness ground
2. Ground stud (battery)

005315

Inspect spark plugs for wear, oil fowling, or damage. A rich or lean running condition or evidence of internal engine damage could be identified by the appearance of the spark plugs.

Check the fuse and the emergency stop switch lanyard.

Operational Inspections

Run the outboard to confirm actual symptoms before performing any unnecessary procedures. Inspection should include the following:

- Make sure the outboard can be cranked easily, with no mechanical binding.
- Check the *EMM* LED Indicators for system status information. Refer to **EMM LED INDICATORS** on p. 75.
- Check the *Evinrude Diagnostics* software *Hard Faults* and *Stored Faults* screens for current service codes. Correct any problems and clear the codes before further troubleshooting. Refer to **Stored Service Codes (Faults)** on p. 63.



Stored Faults Review Screen

008120

Check the diagnostics software *Profiles*, *History*, and *Persistent Faults* screens for evidence of abnormal operation.



Profiles Screen

008112

DYNAMIC TESTS

Cylinder Drop Tests

Use the *Evinrude Diagnostics* software *Dynamic Tests* to momentarily disable one cylinder while the outboard is running.

- The Dynamic Ignition test disables the ignition and fuel injection circuits to a cylinder.
- The Dynamic Fuel test momentarily disables one fuel injector circuit.

By dropping one cylinder, RPM and running quality changes can be compared for each cylinder.

IMPORTANT: Test the outboard at the RPM where the problem is occurring. Use the test procedures to identify inconsistencies in voltages and cylinder performance. Once a circuit has been identified as malfunctioning, inspect all related wiring and connections. Check all voltage inputs and grounds; and perform resistance tests for all circuits before replacing any suspect components.

Dynamic Tests can be used with:

- A timing light to determine how other cylinders are affected by one cylinder being “dropped”; or
- A digital multimeter to check voltage changes on electrical circuits.



Dynamic Tests Screen

008107

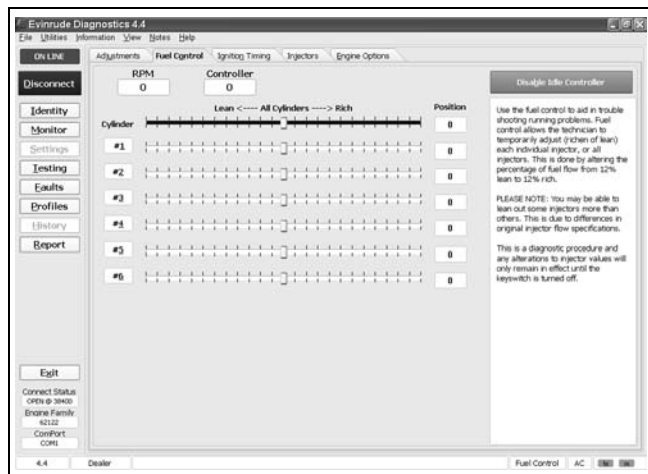
IMPORTANT: DO NOT misinterpret tests run at IDLE. The idle speed controller in the *EMM* compensates to maintain a constant IDLE speed. The *Dynamic Tests* screen includes a function to temporarily disable the idle controller.

Fuel Control Adjustment

Use this test is to help identify a cylinder that may be too rich or too lean. This feature should not be used by itself to identify a faulty injector.

Evinrude Diagnostics software allows temporary adjustments to the fuel flow characteristics of the injectors. Factory fuel flow settings are restored when power to the *EMM* is returned to OFF.

Test the outboard at the RPM where the problem is occurring.



008113

If the outboard run quality improves with a fuel control adjustment, eliminate other possibilities before replacing an injector:

- Refer to **Fuel System Pressure Test** on p. 142.
- Refer to **Running Fuel System Tests** on p. 83.

IMPORTANT: DO NOT misinterpret tests run at IDLE. The idle speed controller in the *EMM* compensates to maintain a constant IDLE speed.

Inductive Amp Meter Test

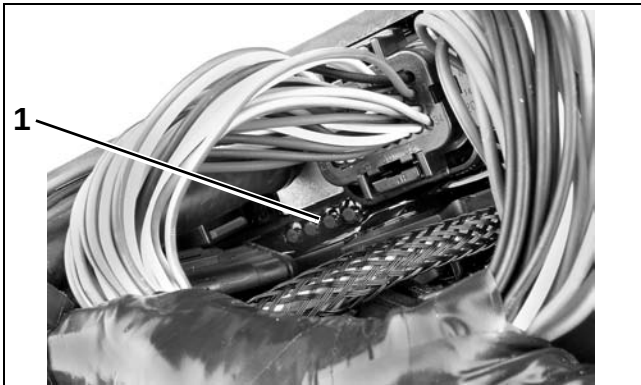
Use an inductive amp meter to monitor battery charging and current flow. Identifying erratic amperage in a circuit can be used to isolate a problem component.

EMM LED INDICATORS

The *EMM* LED indicators provide a quick reference to the status of several outboard systems. Checking the LEDs **FIRST** when diagnosing an engine problem can save time.

For detailed code information, refer to the **EMM Service Code Chart** at the back of this manual.

IMPORTANT: LED 1 is toward the rear of the outboard (Closest to EMM J2 connector).



1. LED indicators

005239

Key ON

When the *EMM* is ON (engine not running), the following LEDs should light:

LED 1 – SAC Circuit working – 30 V present on 55 V circuit.

LED 3 – Sensor Circuits working. FLASHING LIGHT indicates Code 57 – engine will not start.

LED 4 – Stop Circuit not grounded—okay to start. FLASHING LIGHT indicates severe overheat or no oil – engine in SHUTDOWN mode.

Starting

Starting mode occurs from the time the flywheel begins to turn until the outboard is running for 2 seconds. During starting, all four LEDs should light and then go off in sequence.

LED 1 – CHARGING OKAY – Stator signal 30 V or higher. For NO LIGHT, check for:

- Code 77– SAC circuit fault

LED 2 – CRANK POSITION OKAY – input from CPS, *EMM* powered ON. For NO LIGHT, check for:

- Code 16 – CPS, intermittent loss of sync

LED 3 – SENSORS OKAY (5 V). For NO LIGHT, check for:

- Code 12 – TPS circuit fault
- Code 13 – TPS below expected range
- Code 14 – TPS above expected range
- Code 19 – In Gear (tiller models)
- Code 23 – *EMM* temp. sensor circuit fault
- Code 24 – *EMM* temp. below expected range
- Code 37 – Water in fuel
- Code 41 – PORT temp. sensor circuit fault
- Code 42 – PORT temp. below expected range
- Code 47 – AT sensor circuit fault
- Code 48 – AT sensor below expected range
- Code 49 – AT sensor above expected range
- Code 58 – Operating temp. not reached, Port
- Code 59 – Operating temp. not reached, Stbd
- Code 67 – STBD temp. sensor circuit fault
- Code 68 – STBD temp. below expected range
- Code 71 – oil pressure circuit fault detected
- Code 72 – oil pressure below expected range
- Code 73 – oil pressure above expected range
- Code 74 – water pressure circuit fault detected
- Code 75 – water pressure below range
- Code 76 – water pressure above range
- Code 78 – sensor supply voltage fault
- Code 79 – starter solenoid circuit open
- Code 87 – Exhaust pressure circuit fault
- Code 88 – Exhaust pressure low
- Code 89 – Exhaust pressure high

For FLASHING LIGHT, check for Code 57.

LED 4 – LANYARD/STOP OKAY. For NO LIGHT, check for:

- Grounded stop circuit.

For FLASHING LIGHT, check for:

- Code 29 – *EMM* temp. OVER range (flashing)
- Code 31 – Engine temp. OVER range (flashing)
- Code 33 – Engine shutdown, excessive no oil condition

SYSTEM ANALYSIS

EMM LED INDICATORS

Running

When the outboard is running, all of the LEDs should be off. If a light is on, check for:

LED 1 – CHARGING FAULT:

- Code 17 – System voltage (55 V) below range
- Code 18 – System voltage (55 V) above range
- Code 26 – Low battery (12 V) voltage
- Code 27 – High battery (12 V) voltage
- Code 77 – SAC circuit fault

LED 2 – INJECTOR/IGNITION FAULT:

- Code 51 – No. 1 injector circuit open
- Code 52 – No. 2 injector circuit open
- Code 53 – No. 3 injector circuit open
- Code 54 – No. 4 injector circuit open
- Code 55 – No. 5 injector circuit open
- Code 56 – No. 6 injector circuit open
- Code 61 – No. 1 injector circuit short
- Code 62 – No. 2 injector circuit short
- Code 63 – No. 3 injector circuit short
- Code 64 – No. 4 injector circuit short
- Code 65 – No. 5 injector circuit short
- Code 66 – No. 6 injector circuit short
- Code 81 – No. 1 ignition primary circuit open
- Code 82 – No. 2 ignition primary circuit open
- Code 83 – No. 3 ignition primary circuit open
- Code 84 – No. 4 ignition primary circuit open
- Code 85 – No. 5 ignition primary circuit open
- Code 86 – No. 6 ignition primary circuit open
- Code 91 – Fuel pump circuit open
- Code 92 – Exhaust valve circuit open
- Code 94 – Fuel pump circuit short
- Code 101 – No. 1 ignition timing circuit shorted
- Code 102 – No. 2 ignition timing circuit shorted
- Code 103 – No. 3 ignition timing circuit shorted
- Code 104 – No. 4 ignition timing circuit shorted
- Code 105 – No. 5 ignition timing circuit shorted
- Code 106 – No. 6 ignition timing circuit shorted

LED 3 – Sensor circuits (5 V), SENSOR FAULT.

For LIGHT ON, check for possible fault codes:

- Code 12 – TPS circuit fault
- Code 13 – TPS below expected range
- Code 14 – TPS above expected range
- Code 16 – CPS, intermittent loss of sync

- Code 23 – *EMM* temp. sensor circuit fault
- Code 24 – *EMM* temp. below expected range
- Code 37 – Water in fuel
- Code 41 – PORT temp. sensor circuit fault
- Code 42 – PORT temp. below expected range
- Code 47 – AT sensor circuit fault
- Code 48 – AT sensor below expected range
- Code 49 – AT sensor above expected range
- Code 57 – high RPM with low TPS setting
- Code 58 – PORT operating temp. not reached
- Code 59 – STBD operating temp. not reached
- Code 67 – STBD temp. sensor circuit fault
- Code 68 – STBD temp. below expected range
- Code 71 – oil pressure circuit fault detected
- Code 72 – oil pressure below expected range
- Code 73 – oil pressure above expected range
- Code 74 – water pressure circuit fault detected
- Code 75 – water pressure below range
- Code 76 – water pressure above range
- Code 78 – sensor supply voltage fault
- Code 87 – exhaust pressure circuit fault
- Code 88 – exhaust pressure below range
- Code 89 – exhaust pressure above range
- Code 97 – Intermittent switched B+ detected

LED 4 – Engine overheat, *EMM* temperature or sensor, oil injection pump or sensor, NO OIL / OVERHEAT. For LIGHT ON, check for possible fault codes:

- Code 25 – *EMM* temp. above expected range
- Code 29 – *EMM* temp. OVER range (flashing)
- Code 31 – engine temp. OVER range (flashing)
- Code 33 – excessive NO OIL faults
- Code 34 – oil injection pump circuit open
- Code 38 – oil pressure feedback not detected
- Code 40 – engine overheat, low rpm
- Code 43 – PORT temp. above expected range
- Code 69 – STBD temp. above expected range
- Code 70 – engine overheat, low rpm

IGNITION OUTPUT TESTS

DANGER

The electrical system presents a serious shock hazard. Allow outboard to sit for two minutes after running before handling capacitor or 55 V electrical components. Failure to handle capacitor properly can result in uncontrolled electrical discharge and possible electrical shock to humans. DO NOT handle primary or secondary ignition components while outboard is running or flywheel is turning.

Use the *Evinrude Diagnostics* software *Stored Faults* screen to check for current service codes before troubleshooting. Correct any problems and clear the codes FIRST.

Required Ignition Systems

Following is a complete list of circuits required for ignition output:

Stop Circuit

- Black/yellow wire NOT grounded (emergency stop switch lanyard in place).

Battery

- Battery switched B+ input to power up *EMM*
- Battery B+ input to Start Assist Circuit (SAC) of *EMM*

Stator Output Voltage

- Provides A/C voltage to *EMM* J2 connector: Outboard cranking, typical range is 20-40 VAC (AC output voltage is related to cranking RPM); outboard running approximately 55 VAC.

EMM

- Controls ignition grounds, injector grounds, and engine timing.
- Start Assist Circuit (SAC) converts battery voltage (12 V) to 30 V for system circuit (55 V).

Crankshaft Position Sensor

- Provides *EMM* with input.
- Outboard cranking speed exceeds 75 RPM and a steady CPS signal is generated.

Alternator Output/System Voltage

- System voltage from *EMM* (white/red) provides 55 VDC to the oil injection pump, the fuel injectors, and the ignition module of *EMM*.

Capacitor

- Connected to 55 V circuit (white/red) to stabilize current on 55 V circuit
- Negative terminal of capacitor must be grounded.

Ignition Coil

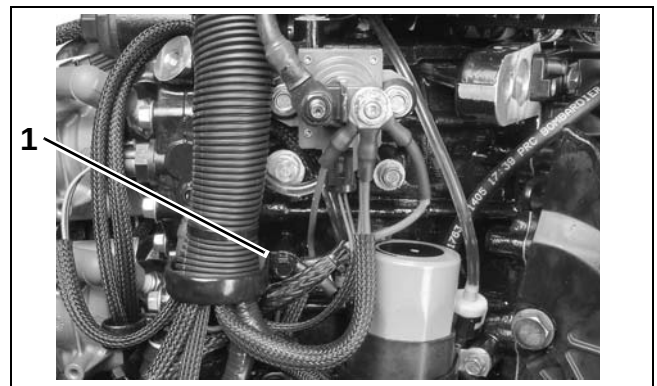
- Primary circuits are powered by system (55 V) voltage
- *EMM* provides control signal to ignition coil
- Output from ignition coil secondary winding and high tension spark plug wire.

Wiring Inspection

Visually inspect all wiring, connections, and grounds.

Use a digital ohmmeter to test resistance on all ground circuits and connections. Ohmmeter readings should be approximately 0.0 W.

Check that all engine wire harness grounds have continuity to the cylinder/crankcase.



1. Main engine harness ground

005315

Clean or repair all ground circuits, wiring, and connections as needed.

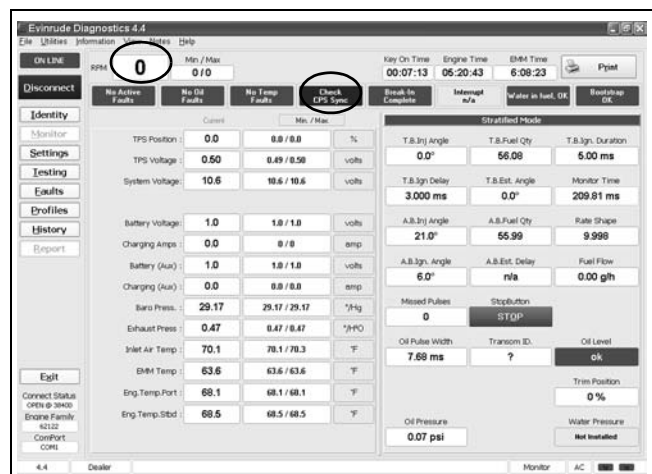
SYSTEM ANALYSIS

IGNITION OUTPUT TESTS

Crankshaft Position Sensor (CPS) Test

When the CPS is working properly, *EMM* LED 2 turns on while the outboard is being started.

Use the *Evinrude Diagnostics* software CPS Sync and engine RPM displays to confirm a valid CPS signal while the outboard is cranking or running. An RPM display higher than zero indicates a CPS signal to the *EMM*.



Engine Monitor Screen, Engine RPM display

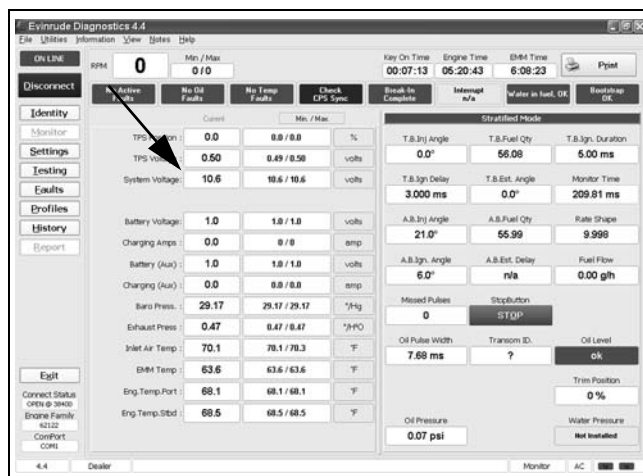
008104

If the *Monitor* screen says “Check CPS Sync,” refer to **Crankshaft Position Sensor (CPS) Test** on p. 93.

System Voltage Test

The ignition system is powered by the 55 V system.

Use the *Evinrude Diagnostics* software *Monitor* screen to check system voltage.



Engine Monitor Screen, System Voltage

008104

Results:

- *EMM* ON (not running) - 30 V $\pm$ 2, system voltage is GOOD.
- *EMM* ON (not running) - less than 30 V $\pm$ 2, check 12 V power to *EMM*. Repair connection or wiring. Possible fault in *EMM* SAC circuit.
- RUNNING - 55 V $\pm$ 2, system voltage is GOOD.
- RUNNING - less than 55 V $\pm$ 2, check stator output to *EMM*. Repair connection or wiring. Possible faulty stator or *EMM*. Refer to **STATOR TESTS** on p. 95.

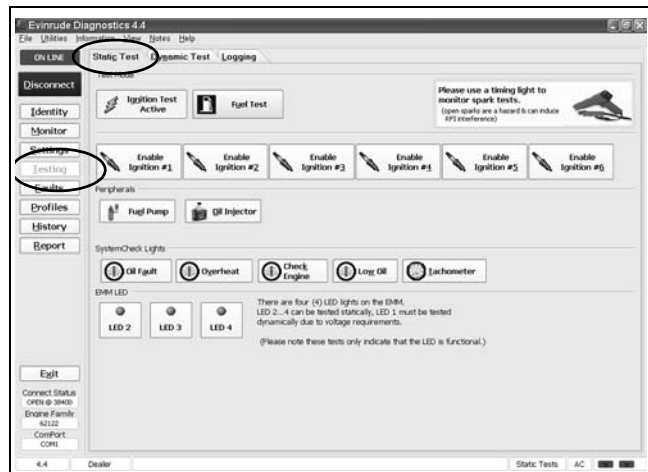
IMPORTANT: The *EMM* must be ON for voltage to be present on the system voltage (55 V) circuit. Power is normally supplied to the *EMM* when the key switch is turned ON. The *EMM* is also turned ON when it begins to receive AC voltage from the stator while the outboard is being cranked.

Static Ignition Test

Perform the static ignition test using *Evinrude Diagnostics* software and an inductive timing light.

IMPORTANT: DO NOT use a spark checker tool. Radio Frequency Interference (RFI) generated by the arcing current can cause erratic *EMM* operation.

The outboard must NOT be running and the emergency stop switch lanyard must be installed.

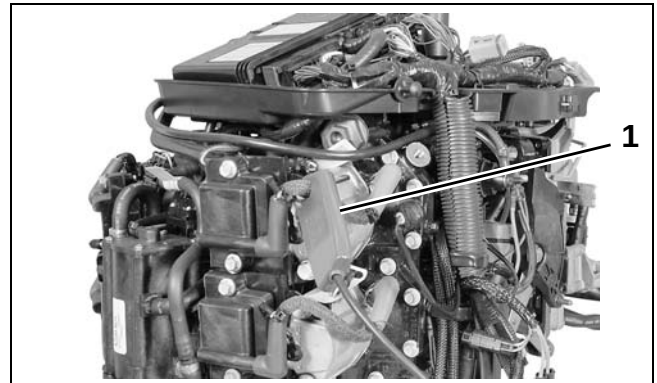


Static Tests Screen

008106

Connect timing light pickup to the secondary circuit (spark plug lead) of the cylinder being tested. Activate test and observe timing light strobe for consistent flash.

IMPORTANT: You may need to remove shielding from wire if pickup does not read signal.



1. Timing light pick-up

007193

Results:

No spark on one or more cylinders:

- Inspect or replace spark plugs
- Refer to **Ignition Control Circuit Tests** on p. 81
- Refer to **Ignition Coil Tests** on p. 81

Steady spark on all cylinders:

- Refer to **Running Ignition Tests** on p. 80 and **DYNAMIC TESTS** on p. 74.

SYSTEM ANALYSIS

IGNITION OUTPUT TESTS

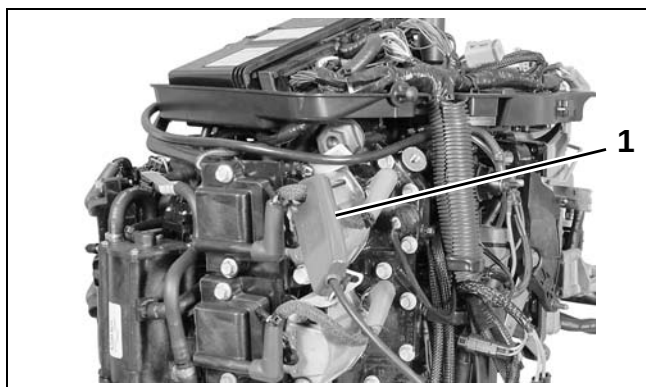
Running Ignition Tests

Use *Evinrude Diagnostics* software to monitor system voltage (55 V).

- Voltage readings at a specific speed (RPM) should be steady
- Refer to **System Voltage Test** on p. 78.

Use an inductive timing light to monitor the spark signal through each of the secondary circuit (spark plug lead) wires.

Start outboard and observe timing light strobe. Look for a consistent flash and only one flash per revolution. The strobe of the timing light should be the same for each cylinder.



1. Timing light pick-up

007193

Results:

Steady voltage and strobe, engine misfires:

- Inspect or replace spark plugs
- Refer to **FUEL DELIVERY TESTS** on p. 82.
- Check for internal engine damage.

Steady voltage, erratic strobe, engine misfires:

- Inspect or replace spark plugs
- Check CPS air gap and resistance.
- Refer to **Ignition Control Circuit Tests** on p. 81
- Refer to **Ignition Coil Tests** on p. 81.

Voltages fluctuate, engine misfires:

- Inspect battery and connections
- Test capacitor and all ground connections
- Refer to **System Voltage Test** on p. 78
- Refer to **Ignition Control Circuit Tests** on p. 81
- Refer to **Ignition Coil Tests** on p. 81.

IMPORTANT: If a running problem occurs at about 1200 RPM, the outboard may be in *S.A.F.E.* Refer to **S.A.F.E. WARNING SYSTEM** on p. 61.

Ignition Control Circuit Tests

Use a digital multimeter to test the following:

- System voltage supply to ignition coil.
- Ignition control signal from *EMM*.
- Engine harness resistance.

Disconnect ignition coil connector.

Supply voltage test:

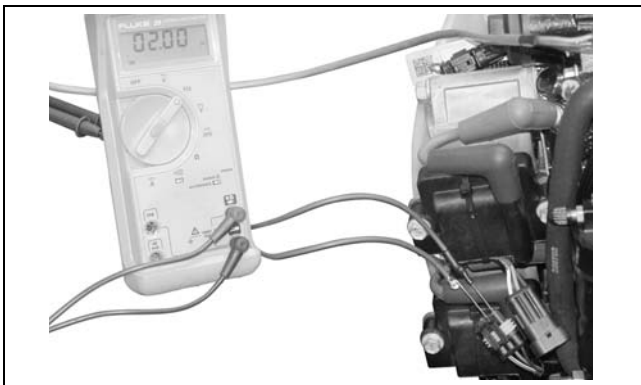
Use an appropriate adapter to connect the red meter lead to pin 3 (white/red) of the engine harness connector and the black lead to ground. With *EMM* ON, voltage should be approximately 30 V.

Control signal test:

Set meter to the Hz scale to check ignition control signal.

Use an appropriate adapter to connect the red meter lead to pin 2 (orange) of the engine harness connector and the black lead to ground. Activate diagnostics software *Static Ignition* test and observe meter for consistent reading (approximately 2 Hz).

If control signal is present, connect black meter lead to pin 1 (black) and repeat test to confirm harness ground.



006609

Harness resistance test:

If control signal is NOT present, calibrate multimeter to low ohms scale. Use appropriate adapters on meter leads to avoid damaging harness connectors.

With *EMM* OFF, remove the *EMM* J1-B connector and test the continuity of each ignition control circuit (orange). Check resistance between J1-B connector and ignition coil connector. Refer to engine wiring diagram.

If circuits test good, replace *EMM*.

Ignition Coil Tests

There are no simple ignition coil tests available. Before replacing an ignition coil, be sure:

- 55 V is supplied to the white/red wire of the ignition coil connector
- A control signal is present on the orange wire of the ignition coil connector. Refer to **Ignition Control Circuit Tests** on p. 81
- The black wire of the ignition coil connector provides continuity to ground
- The secondary spark plug lead provides continuity.

If all of the above tests are good, and a cylinder does not have spark, replace the ignition coil with a known good coil.

Capacitor Test

IMPORTANT: Make sure the capacitor is discharged before testing. Make a momentary connection between the two terminals to ground any stored energy.

Remove capacitor from electrical harness.

Use an ohmmeter set on the high ohms scale to test the capacitor. Connect the meter leads to the capacitor terminals:

- If the capacitor is working correctly, it will store energy from the meter. The resistance reading will increase until it goes to (nearly) infinity.
- If the capacitor is shorted, the reading will immediately show full continuity.
- If there is an open circuit in the capacitor, the meter will show no continuity.

If the resistance reading starts as a negative number, or the reading goes down in value, the capacitor already retains some stored energy. Ground the capacitor and test again.

FUEL DELIVERY TESTS

! WARNING

Protect against hazardous fuel spray.
Before starting any fuel system service,
carefully relieve fuel system pressure.

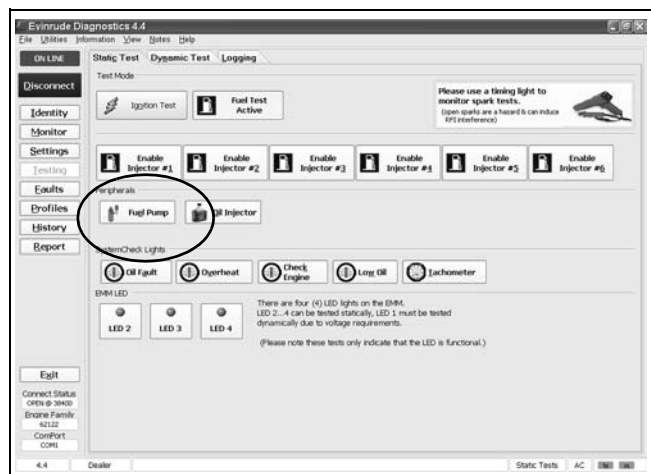
Refer to **Relieving Fuel System Pressure** on p. 146.

Check the *Evinrude Diagnostics* software *Stored Faults* screen for current service codes before troubleshooting. Correct any problems and clear the codes FIRST.

Inspect all fuel hoses, filters, and connections. Check quality of fuel supply.

Fuel Pump Static Test

Use the *Evinrude Diagnostics* software Fuel Pump test to activate the electric fuel pump. If the pump runs, the *EMM* and fuel pump circuit are not at fault.



Static Tests Screen

008114

If the pump does not run:

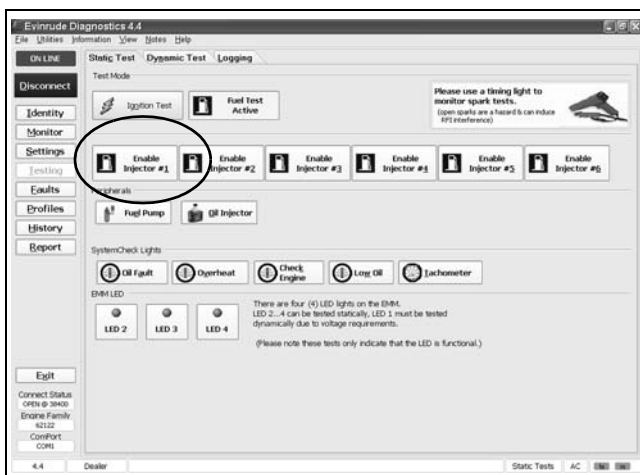
- The *EMM* controls power to the fuel pump (purple/black wire). Check voltage at pin 1 of fuel pump connector. Voltage should be 12 V when KEY is first ON, when fuel pump test activated, or when outboard is cranking or running.
- Use an ohmmeter to check continuity between pin 2 of fuel pump connector and ground.
- Refer to **Circulation Pump Resistance Test** on p. 144.

If the pump runs:

- Refer to **Fuel System Pressure Test** on p. 142.
- Refer to **Running Fuel System Tests** on p. 83.

Fuel Injector Static Test

Use the *Evinrude Diagnostics* software Fuel Injector Static Test to activate each fuel injector. Listen for an audible click from each injector when it is actuated. If the injector activates, the *EMM* and injector circuits are not at fault.



Static Tests Screen

008114

IMPORTANT: This test is operating the injectors with 30 V on the system voltage (55 V) circuit. The start assist circuit (SAC) of the *EMM* converts battery voltage (12 V) to 30 V of system voltage. Battery must be fully charged and connections must be clean and tight. Injector activation should be carefully confirmed.

Results:

No injectors actuate:

- Use the *Monitor* screen of the diagnostics software to make sure voltage is present on the system voltage circuit.
- Refer to **Running Fuel System Tests** on p. 83.

Some injectors actuate; some do not:

- For non-working injectors, test the resistance of individual injector circuits between the injector connector and injector control wire at the *EMM*.
- See **Fuel Injector Resistance Test** on p. 144.

All injectors actuate:

- Refer to **Running Fuel System Tests** on p. 83.

Running Fuel System Tests

Run or crank the outboard.

Use the *Evinrude Diagnostics* software *Monitor* screen to check system voltage. If voltage is low, or drops as RPM increases, refer to **Stator Voltage Output Test** on p. 95.

Use an inductive timing light to monitor the injector control wire (connector pin 2) for each injector. Make sure the pickup is attached to only one wire. Flashes on the timing light indicate current in the circuit is being switched by the *EMM*. The *Dynamic Tests* screen allows the control signal to be turned off to a particular injector.

IMPORTANT: Some timing lights may not flash consistently at cranking speeds. Always check the orientation of the timing light pickup and the operation of the timing light.

Results:

No light activation on any injector wires (outboard cranks and starter turns flywheel):

- Check stator input to *EMM*, CPS operation, and all grounds and wiring connections.
- Eliminate all other possibilities to isolate a faulty *EMM*.

Irregular or no light activation on some injector wires:

- Test the resistance of individual injector circuits between the injector connector and injector control wire at the *EMM*.
- Check battery cable connections.
- Make sure all grounds are clean and tight.
- See **Fuel Injector Resistance Test** on p. 144.

Steady light activation on all injector wires and consistent voltage readings, *EMM* injector control function is good:

- Use the diagnostics software *Dynamic Fuel Test* to isolate a faulty cylinder. See **DYNAMIC TESTS** on p. 74.



Dynamic Tests Screen

008115

- Refer to **Fuel Injector Pressure Test** on p. 143.
- Refer to **Fuel System Pressure Test** on p. 142.

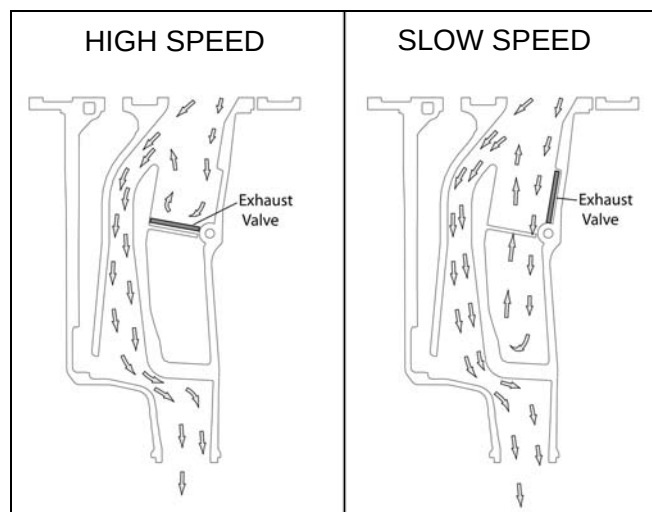
EXHAUST VALVE (V4 MODELS)

The inner exhaust housing on 60° V4 models is designed with two exhaust tuning modes. An *EMM* controlled valve opens and closes a chamber in the inner exhaust to provide the best exhaust tuning for various running conditions. A relay module and actuator motor are used to move the valve.

At slower speeds and under acceleration, the system opens a longer path, allowing the engine to develop more midrange horsepower. This helps heavier boats get on plane quickly. At higher RPMs, the path is shortened for maximum high speed performance.

- At key on, the *EMM* cycles the valve from Low Speed Mode to High Speed Mode as a system self-test.
- The valve remains in High Speed Mode when cranking, starting and idling.
- When TPS% exceeds approximately 2% to 5%, the *EMM* moves the valve to Low Speed Mode.
- When speed exceeds approximately 5000 rpm, the *EMM* moves the valve to High Speed Mode.

The *EMM* controls the timing of the valve based on engine load. Engine load is calculated from sensor inputs.



Exhaust Valve Diagram

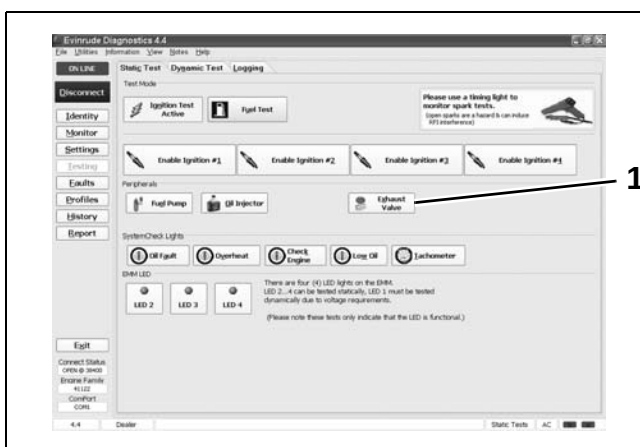
005434

Operational Symptoms:

- If the exhaust valve is stuck in low speed mode, the outboard may lose top speed RPM.
- If the exhaust valve is stuck in high speed mode, the outboard may have poor acceleration.

Exhaust Valve Static Test

Use the *Evinrude Diagnostics* software Static Test to check operation of exhaust valve actuator. Listen for valve to open or close. If actuator does not operate, refer to **Exhaust Valve Relay Module Test** on p. 106.



Static Tests Screen
1. Exhaust valve test button

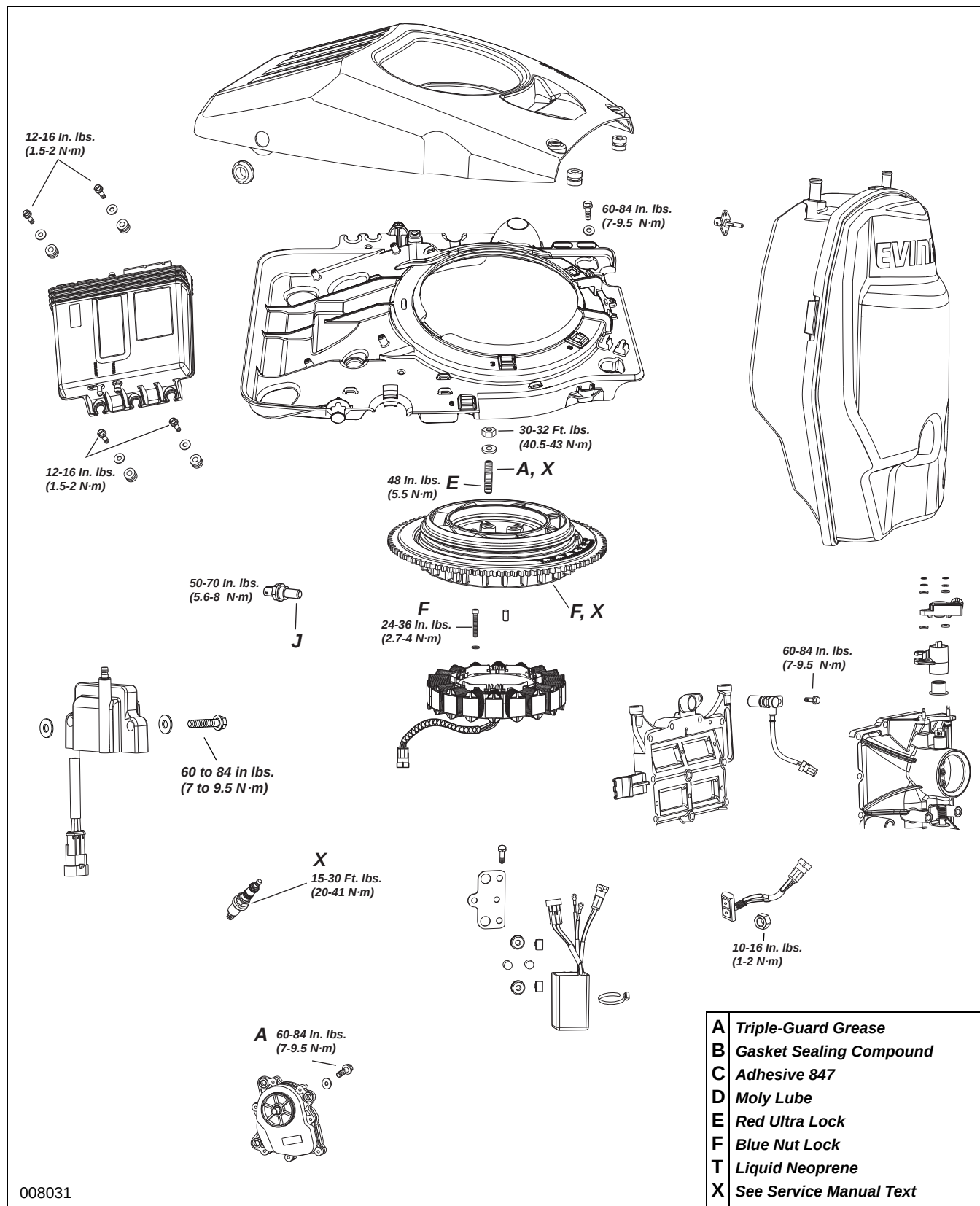
008116

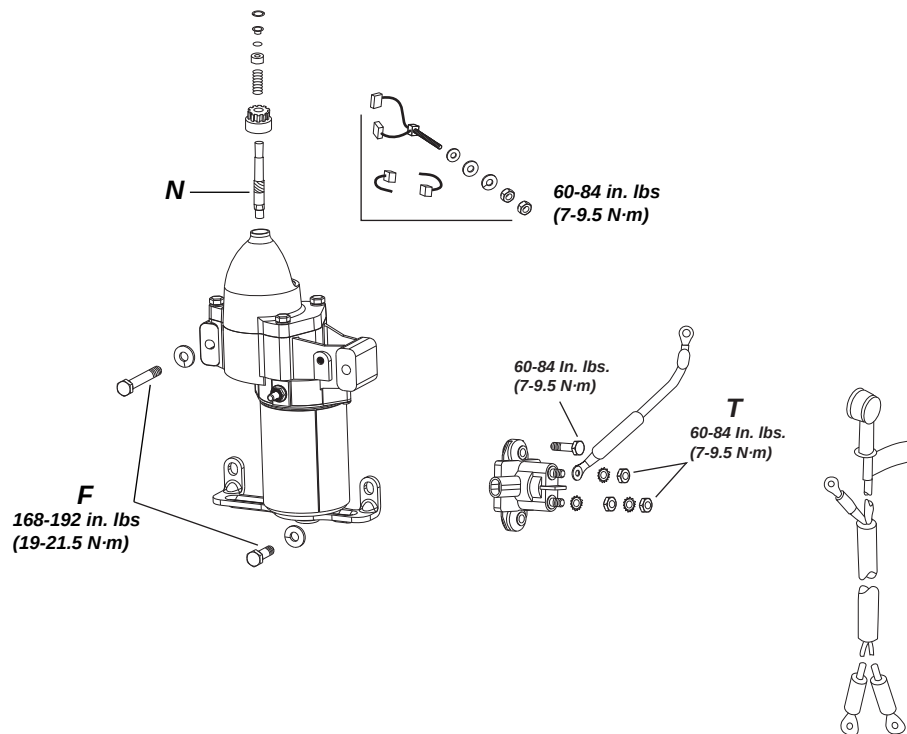
ELECTRICAL AND IGNITION

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SERVICE CHART

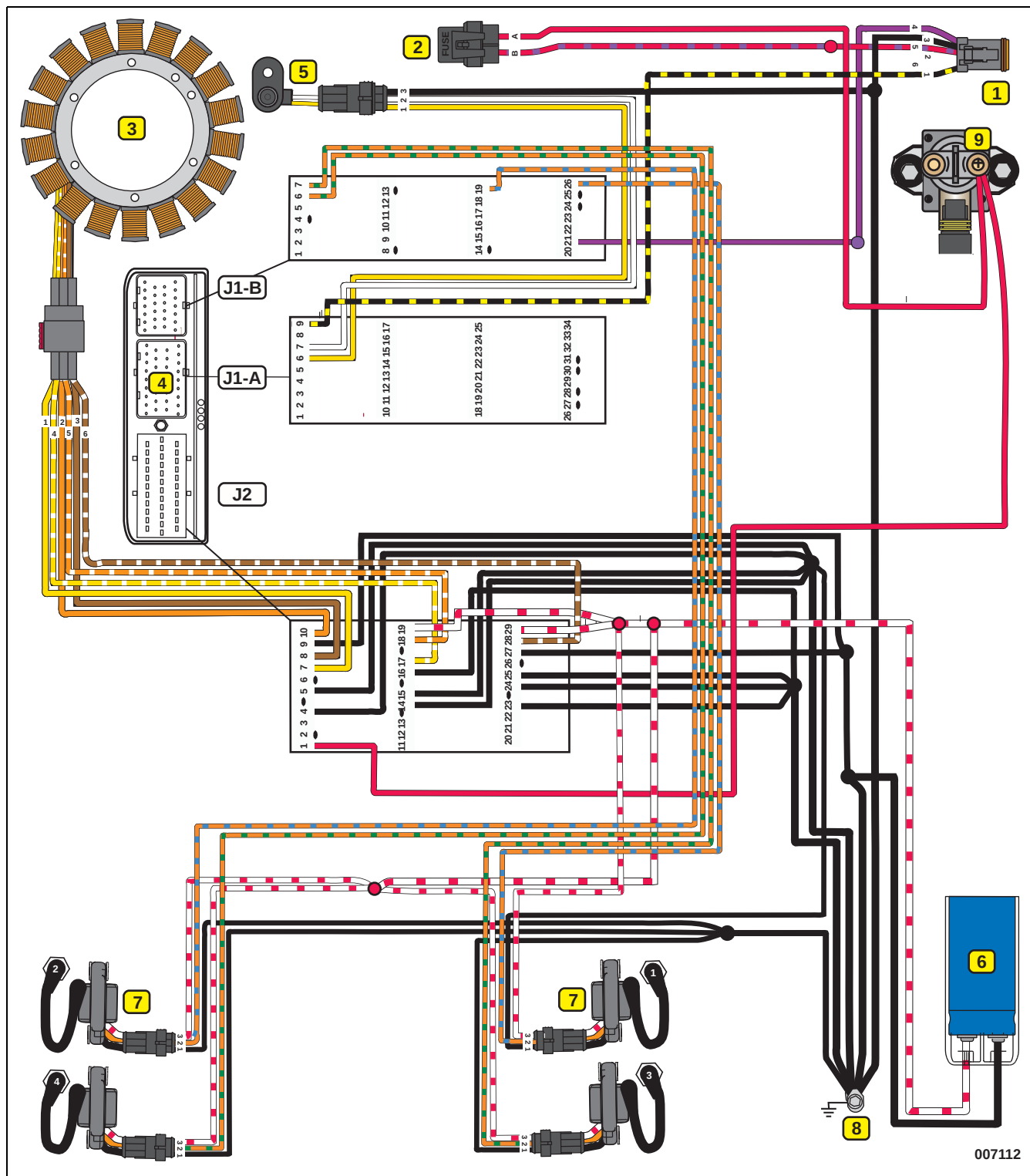




- | | |
|----------|--------------------------------|
| A | <i>Triple-Guard Grease</i> |
| B | <i>Gasket Sealing Compound</i> |
| C | <i>Adhesive 847</i> |
| D | <i>Moly Lube</i> |
| E | <i>Red Ultra Lock</i> |
| F | <i>Blue Nut Lock</i> |
| N | <i>Starter Bendix Lube</i> |
| T | <i>Liquid Neoprene</i> |

008030

IGNITION SYSTEM CIRCUIT DIAGRAM – V4



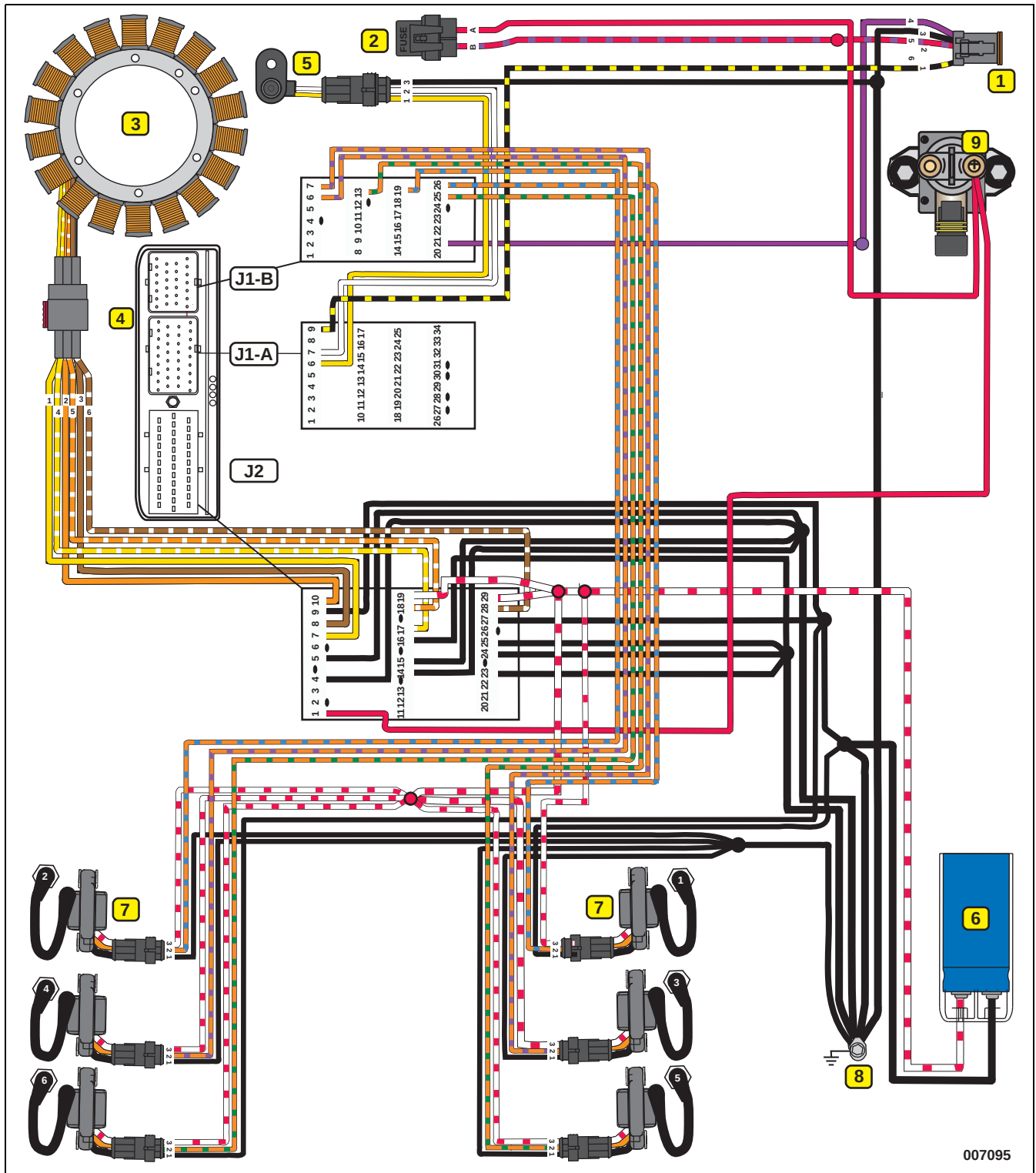
1. Key switch (stop circuit)
2. Fuse
3. Stator

4. EMM
5. Crankshaft position sensor
6. Capacitor

7. Ignition coil
8. Main harness ground
9. +12 V from battery

IGNITION SYSTEM CIRCUIT DIAGRAM – V6

6



1. Key switch (stop circuit)
2. Fuse
3. Stator

4. EMM
5. Crankshaft position sensor
6. Capacitor

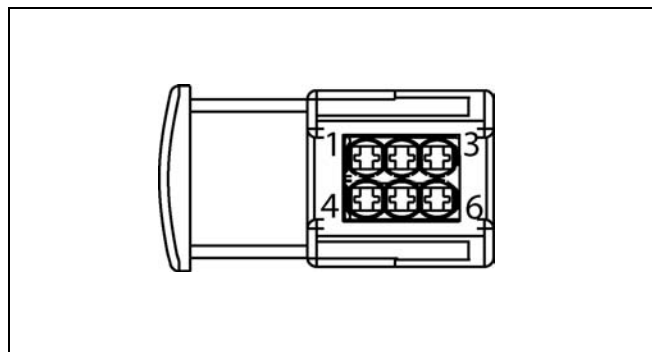
7. Ignition coil
8. Main harness ground
9. +12 V from battery

ELECTRICAL HARNESS CONNECTIONS

Inspect wiring and electrical connections. Disassemble and clean all corroded connections. Replace damaged wiring, connectors, or terminals. Repair any shorted electrical circuits. Refer to wiring diagrams and reference charts for specific wiring details.

Refer to **CONNECTOR SERVICING** on p. 123.

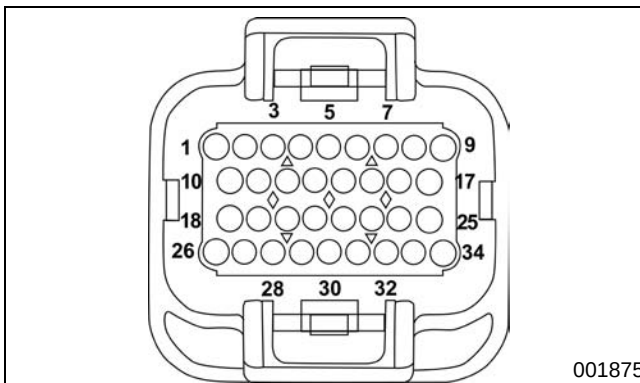
Engine Harness to Stator Connector



004050

Pin No.	Description of Circuit	Wire Color
1	Stator winding (1S)	Yellow
2	Stator winding (3S)	Orange
3	Stator winding (2S)	Brown
4	Stator winding (1F)	Yellow /White
5	Stator winding (3F)	Orange/White
6	Stator winding (2F)	Brown/White

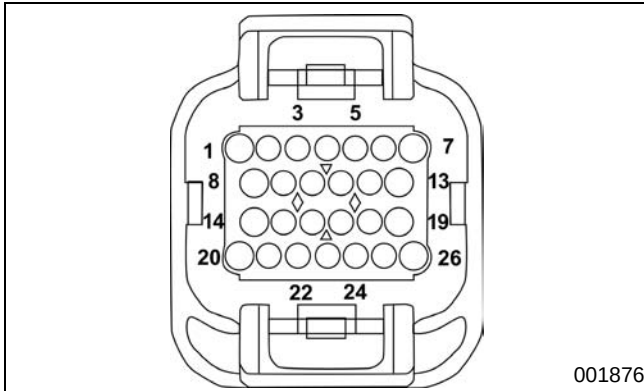
EMM J1-A Connector



001875

Pin No.	Description of Circuit	Wire Color
1	Oil Pressure sensor	Tan/White
2	Diagnostic connector	Red
3	Diagnostic connector	White
4	Ground, water in fuel (digital)	Black
5	Oil level switch	Tan/Black
6	Crankshaft position sensor (CPS)	Yellow
7	Ground, CPS (digital)	White
8	Bootstrap connector (programming)	Blk/Orange
9	Stop circuit	Blk/Yellow
10	Sensors 5 V	Red
11	Ground (analog)	Black
12	Engine temperature sensor, port	Pink/Black
13	CANbus, NET-L	Blue
14	CANbus, NET-H	White
15	Water pressure	Pink
16	Tachometer	Gray
17	CHECK ENGINE signal, <i>SystemCheck</i>	Tan/Orange
18	TPS	Green
19	Engine temperature sensor, starboard	Pink/Black
20	Air temperature sensor	Pink/Blue
21	CANbus, NET-S	Red
22	CANbus, NET-C	Black
23	Water in fuel	Pink/Green
24	NO OIL signal, <i>SystemCheck</i>	Tan/Yellow
25	WATER TEMP signal, <i>SystemCheck</i>	Tan
26	Start signal	Yellow/Red
27	vacant	
28	vacant	
29	Shift switch (shift linkage)	Black/Yellow
30	Trim relay, UP – V4, F suffix	Blue/White
30	vacant – V4, S suffix, V6	
31	Trim relay, DOWN – V4, F suffix	Green/White
31	vacant – V4, S suffix, V6	
32	Trim sender, IN	White/Tan
33	Trim sender, OUT	White/Tan
34	LOW OIL signal, <i>SystemCheck</i>	Tan/Black

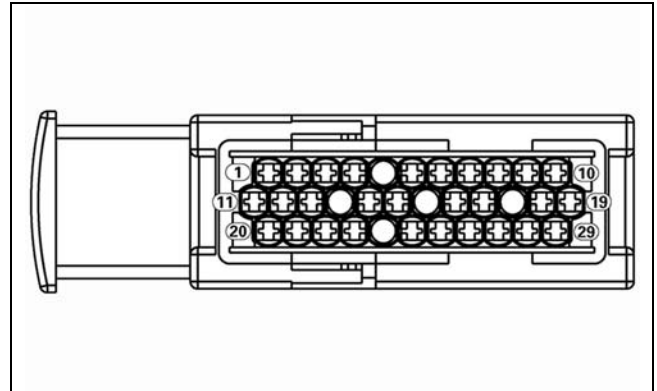
EMM J1-B Connector



001876

Pin No.	Description of Circuit	Wire Color
1	Injector, cylinder 1	Blue
2	Injector, cylinder 2	Blue
3	Injector, cylinder 3	Green V4 Purple V6
4	+55 V, in, (ignition) – V4, F suffix	White/Red
4	vacant – V4, S suffix, V6	
5	Fuel pump	Purple/black
6	Ignition, cylinder 4 – V4	Orange/Green
6	Ignition, cylinder 4 – V6	Orange/Purple
7	Ignition, cylinder 3 – V4	Orange/Green
7	Ignition, cylinder 3 – V6	Orange/Purple
8	Injector, cylinder 6 (vacant V4)	Green V6
9	Injector ground	Black
10	Injector ground	Black
11	Starter solenoid OUT	Brown/White
12	Exhaust valve control (vacant V6)	Blue/Black V4
13	Ignition, cylinder 5 (vacant V4)	Orange/Green V6
14	Injector, cylinder 5 (vacant V4)	Green V6
15	Injector ground	Black
16	Injector ground	Black
17	Ignition ground – V4, F suffix	Black
17	Trim relay, UP – V4, S suffix, V6	Blue/White
18	Ignition ground – V4, F suffix	Black
18	Trim relay, DOWN – V4, S suffix, V6	Green/White
19	Ignition, cylinder 2	Orange/Blue
20	Injector, cylinder 4	Green V4 Purple V6
21	Switched B+ (12V)	Purple
22	Injector ground	Black
23	Oil solenoid	Blue
24	Ignition ground – V4, F suffix	Black
24	vacant – V4, S suffix, V6	
25	Ignition, cylinder 6 (vacant V4)	Orange/Green V6
26	Ignition, cylinder 1	Orange/Blue

EMM J2 Connector



004046

Pin No.	Description of Circuit	Wire Color
1	B+	Red
2	vacant	
3	Isolated B+	Red/Black
4	Battery ground	Black
5	Battery ground	Black
6	vacant	
7	Winding 1S	Yellow
8	Winding 2S	Brown
9	Injector, generator ground	Black
10	Winding 3S	Orange
11	B+	Red
12	B+	Red
13	Isolated B+	Red/Black
14	Battery ground	Black
15	Battery ground	Black
16	Battery ground	Black
17	Winding 1F	Yellow/White
18	Winding 3F	Orange/White
19	+55V	White/Red
20	B+	Red
21	Isolated B+	Red/Black
22	Isolated B+	Red/Black
23	Battery ground	Black
24	Battery ground	Black
25	Battery ground	Black
26	vacant	
27	Injector, generator ground	Black
28	Winding 2F	Brown/White
29	+55V	White/Red

GROUND CIRCUITS

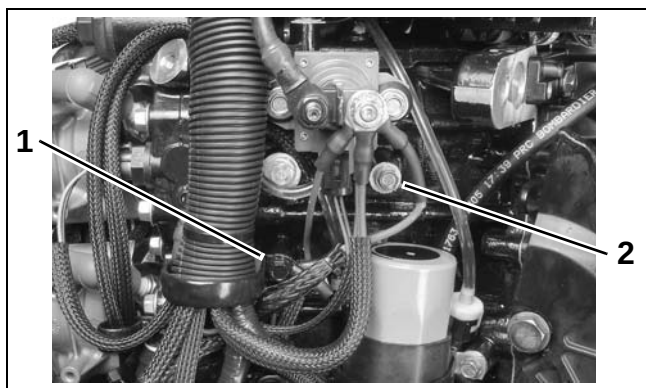
All ground circuits are essential to reliable out-board performance. Make sure all ground connections are clean and tight. Refer to wiring diagrams for specific wiring details.

EMM Ground Tests

Disconnect the battery cables at the battery.

Use an ohmmeter to check continuity of ground circuits. Calibrate the ohmmeter on the high ohms scale. Resistance readings for all ground circuits should be 0 W.

- System/power supply grounds: Check continuity between terminal pins 4, 5, 9, 14, 15, 16, 23, 24, 25 and 27 of *EMM* J2 connector and the main harness ground.
- Injector circuit grounds: Check continuity between terminal pins 9 and 27 of the *EMM* J2 connector and the main harness ground; and between terminal pins 9, 10, 15, 16 and 22 of the *EMM* J1-B connector and the main harness ground.
- Sensor circuit grounds: Check continuity between terminal pins 4 and 11 of the *EMM* J1-A connector and the appropriate sensor ground connections. Refer to wiring diagrams.



1. Main engine harness ground
2. Ground stud (battery)

005315

Additional Ground Tests

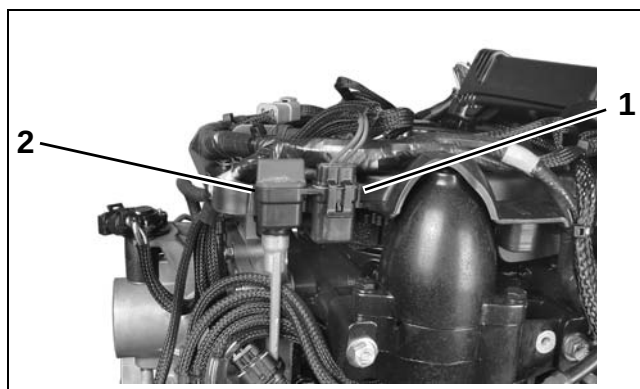
Check connections and continuity at the following locations:

- Trim and Tilt module ground at main ground terminal.

FUSE

The engine harness 12 V (B+) circuit is protected by one automotive style 10 amp minifuse.

The fuse is located on the port side of the power-head, in the flywheel cover.



1. Fuse
2. Spare fuse

005317

IMPORTANT: Repeat failures of fuse could be the result of faulty connections or accessories. The 12 V accessory circuit (purple wire from terminal "A" of key switch) is often used to power accessories.

SENSOR TESTS

All sensor circuits are dependent on wiring and connections, *EMM* supplied current (5 V), and sensor resistance. The supplied current flows through the wiring circuit and sensor before returning to the *EMM*.

IMPORTANT: Use *Evinrude Diagnostics* software to monitor sensor circuit voltages or values.

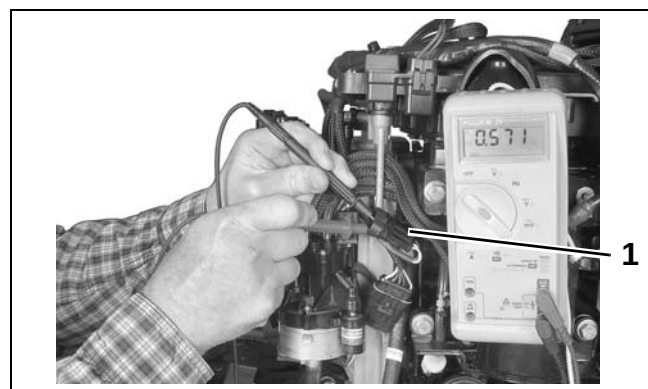
Crankshaft Position Sensor (CPS) Test

Use the *Evinrude Diagnostics* software CPS Sync and engine RPM displays to confirm a valid CPS signal while the outboard is cranking or running. An RPM display higher than zero indicates a CPS signal to the *EMM*.

Disconnect the crankshaft position sensor.

Use a digital multimeter to measure sensor resistance between the yellow and white wires. The complete circuit can be tested by measuring between pins 6 and 7 of the *EMM* J1-A connector.

Sensor Resistance
560 $\Omega \pm 10\%$ @ 77°F (25°C)

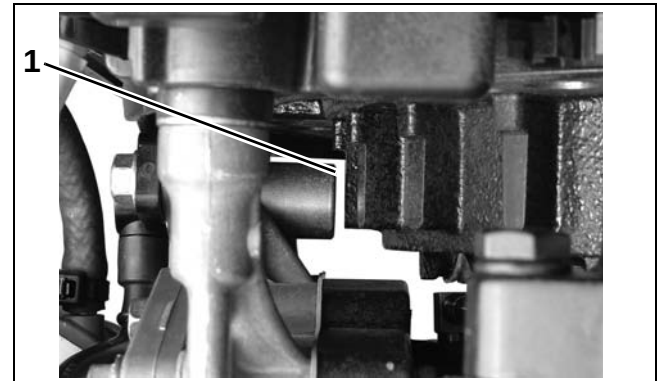


1. CPS Connector

005431

The CPS is mounted to throttle body housing and requires no adjustment. Air gap or clearance to flywheel is fixed at approximately 0.073 in.

(1.85 mm). The acceptable clearance is 0.036 to 0.110 in. (1 to 2.8 mm).



1. CPS gap

005321

Throttle Position Sensor (TPS) Test

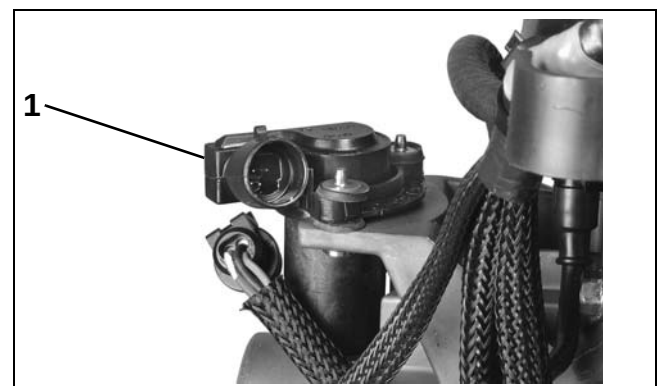
Use *Evinrude Diagnostics* software to monitor TPS voltage while the outboard is running. Voltage should change evenly as sensor lever is moved.

Remove the electrical connector from the throttle position sensor.

Use a digital multimeter to measure sensor resistance.

Sensor Resistance (between "A" and "B")
3000 to 7000 Ω @ 77°F (25°C)

Sensor Resistance (between "A" and "C")
4000 to 8000 Ω @ 77°F (25°C)



1. TPS

005430

ELECTRICAL AND IGNITION
SENSOR TESTS

Connect red meter lead to terminal “A” and black meter lead to terminal “C.” Rotate the sensor lever through its range of travel. Resistance reading must change evenly as the sensor lever is moved.

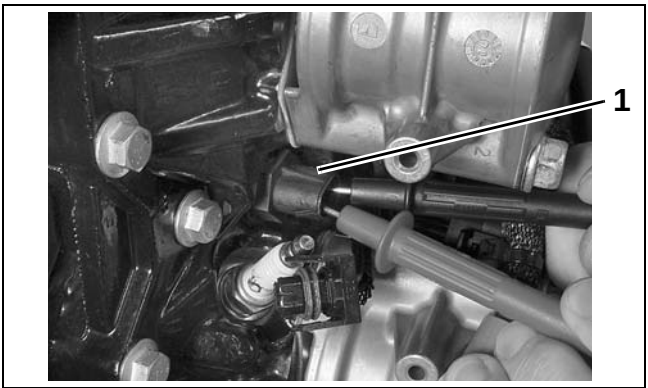
Connect red meter lead on terminal “B” and black meter lead to terminal “C.” Rotate the sensor lever. Resistance reading must change evenly as the sensor lever is moved.

Engine Temperature Sensor Test

Remove the electrical connector from the engine temperature sensor.

Use a digital multimeter to measure sensor resistance.

Engine Temperature Sensor Resistance
680 Ω ± 5% @ 212°F (100°C)
10000 Ω ± 1% @ 77°F (25°C)
32654 Ω ± 2.5% @ 32°F (0°C)



1. Engine temperature sensor (2) 004196

Air Temperature Sensor (AT) Test

Remove the electrical connector from the air temperature sensor.

Use a digital multimeter to measure sensor resistance.

AT Sensor Resistance
680 Ω ± 5.25% @ 212°F (100°C)
10000 Ω ± 1.5% @ 77°F (25°C)
32654 Ω ± 3.0% @ 32°F (0°C)



1. AT sensor 004216

STATOR TESTS

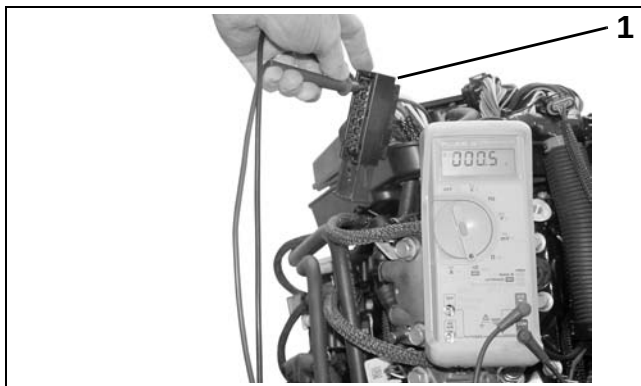
The stator consists of 3 windings (6 poles each) on a 7 inch diameter core and generates an output voltage of 55 VAC (1700 watts maximum). This voltage is converted by the *EMM* to provide 12 VDC for battery charging (10 A at 500 RPM and 50 A from 2000 RPM to WOT) and 55 VDC for fuel injector and oil pump operation. The ignition module of the *EMM* is also powered by the 55 VDC output.

Stator Resistance Tests

Use a digital multimeter to check resistance of stator windings.

Disconnect *EMM* J2 connector from *EMM*.

Stator Winding Resistance
Yellow & Yellow / white .512 ± .020 Ω @ 73°F (23°C)
Brown & Brown / white .512 ± .020 Ω @ 73°F (23°C)
Orange & Orange / white .512 ± .020 Ω @ 73°F (23°C)



1. EMM J2 Connector

005434

Connect meter leads to the following pins:

- Yellow/white and yellow (pins 17 and 7)
- Brown/white and brown (pins 28 and 8)
- Orange/white and orange (pins 18 and 10)

IMPORTANT: A reading of less than 2 ohms is acceptable. Make sure meter is calibrated to read 1 ohm or less.

To check for a grounded winding, connect one meter lead to ground and alternately connect the other meter lead to each stator wire. Meter should read no continuity. If meter reads continuity, replace stator.

Stator Voltage Output Test

Use a digital multimeter to check stator output voltage. Set meter to read 110 VAC output.

⚠ WARNING

To prevent accidental starting of outboard, disconnect crankshaft position sensor (CPS).

Disconnect CPS.

Disconnect stator (6-pin) connector from the engine harness (6-pin) connector.

Connect Stator Test Adaptor tool, P/N 5006211, to stator connector.

Connect meter leads to terminals of adaptor tool.

With a fully charged battery, crank outboard (100 RPM minimum) and observe meter reading:

- 20 VAC at 100 RPM
- 30 VAC at 150 RPM
- 42 VAC at 200 RPM
- 52 VAC at 250 RPM
- 62 VAC at 300 RPM



1. Stator Test Adaptor

005436

CHARGING SYSTEM TESTS

12 V Charging Circuit

To test the operation of the regulator in the *EMM*, you must be able to run the outboard continuously at approximately 5000 RPM, such as in a test tank or on a marine dynamometer.

The test consists of monitoring the system's response to a partially discharged battery. Use a variable load tester to discharge the battery.

IMPORTANT: The regulator requires voltage to operate. Before proceeding, make sure there is at least 7 V on the positive terminal of the starter solenoid.

Disconnect the battery cables at the battery.

Use an inductive amp meter or connect a 0 to 50 A ammeter in series between the red wire(s) of engine wire harness (alternator output from *EMM*) and the positive (B+) battery cable terminal of starter solenoid.

IMPORTANT: This outboard has dual output charging. Each output is isolated and regulated. Each output is 25 A. Combined output is approximately 50 A. Refer to engine wiring diagram.

Fluke[†] model 334 or 336, *Snap-On*[†] model MT110 or EETA501, and various other amp meters should be available through local tool suppliers.

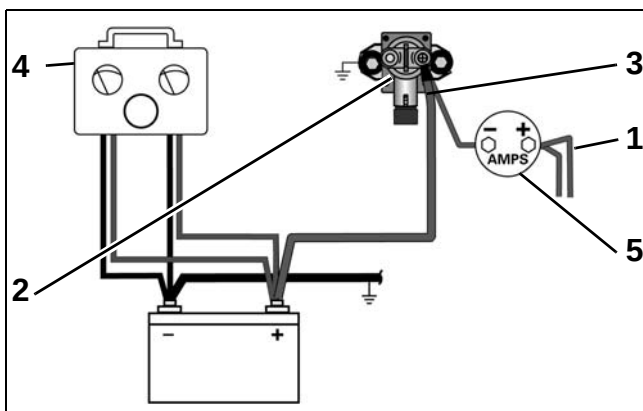
Reconnect the battery cables.

Following the manufacturer's directions, connect the variable load tester (carbon pile) across the battery terminals. *Stevens* model LB-85 and *Snap-On* model MT540D are examples of testers available.



WARNING

Excessive battery discharge rates might overheat battery causing electrolyte gas-ing. This might create an explosive atmosphere. Always work in a well ventilated area.



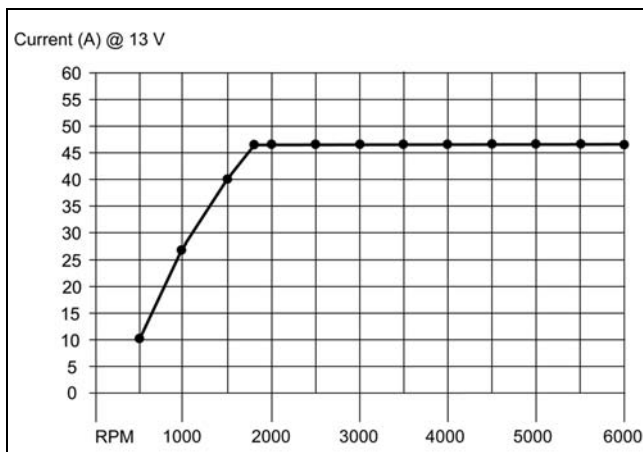
Variable Load Test Diagram

002077

1. Red wire (alternator output from *EMM*)
2. Starter solenoid
3. Battery cable terminal (B+)
4. Variable load tester
5. Ammeter

Start and run the outboard at approximately 5000 RPM. Use the variable load tester to draw the battery down at a rate equivalent to the stator's full output.

- The ammeter should indicate nearly full output, Approximately 50 A (or 25 A for each output) @ 5000 RPM.



Battery Charging Graph

005193

Decrease the battery load toward 0 A.

- Ammeter should show a reduced output. As the current draw decreases, the battery voltage should stabilize at approximately 14.5 V.
- If results vary, check stator BEFORE replacing the *EMM*. See **STATOR TESTS** on p. 95.

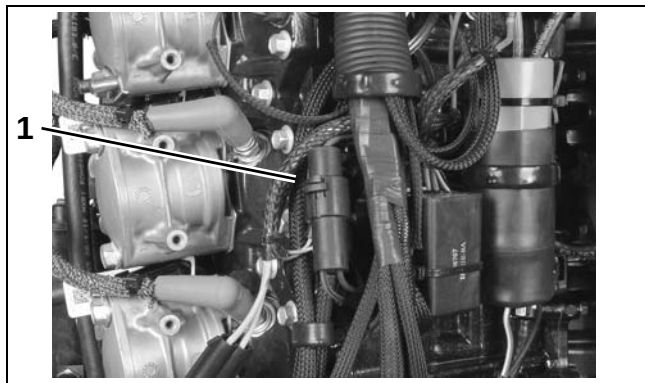
Auxiliary Battery Charge Wire

The auxiliary battery charge feature requires auxiliary battery charge kit, P/N 5006253 (or equivalent).

IMPORTANT: Disconnect all accessories from the auxiliary battery. Auxiliary battery must read a minimum of 8.5 V at the beginning of these tests and remain connected to the outboard during the tests.

Check battery ground cable for continuity.

With the key switch OFF, check battery voltage at auxiliary battery, then check voltage at auxiliary battery connection. If the readings are not the same, replace wire to auxiliary battery. The auxiliary battery wire must be at least 10-gauge and it must be protected by a 50 A fuse or circuit breaker at the battery.



1. Accessory battery charge connector

004944

With outboard running at 1000 RPM, voltage must read higher than with key OFF and increase steadily to approximately 14.5 V as the outboard RPM increases.

If there is no increase, turn the key switch to OFF and test red/black wire between the *EMM* and auxiliary battery connection.

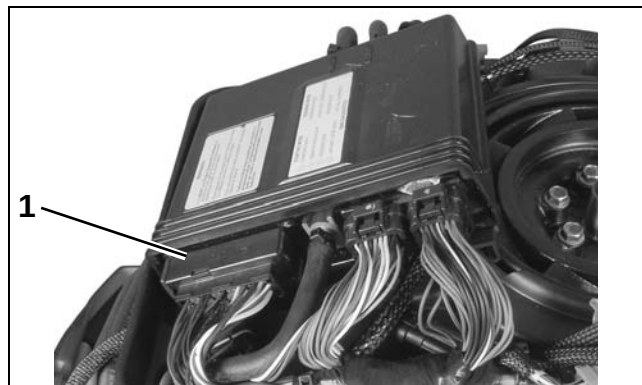
- Continuity indicates faulty output from *EMM*. Check 12 V alternator output BEFORE replacing *EMM* for faulty auxiliary battery charge circuit.
- No continuity indicates faulty wiring.

55 V Alternator Circuit

Check battery ground cable for continuity.

With the key switch ON, check battery voltage at battery (12 V).

Then, use Electrical Test Probe Kit, P/N 342677, and a digital multimeter set to read 55 VDC to check voltage on white/red wires at J2 connector of *EMM*. Voltage at *EMM* connector should be approximately 30 V.



1. J2 connector

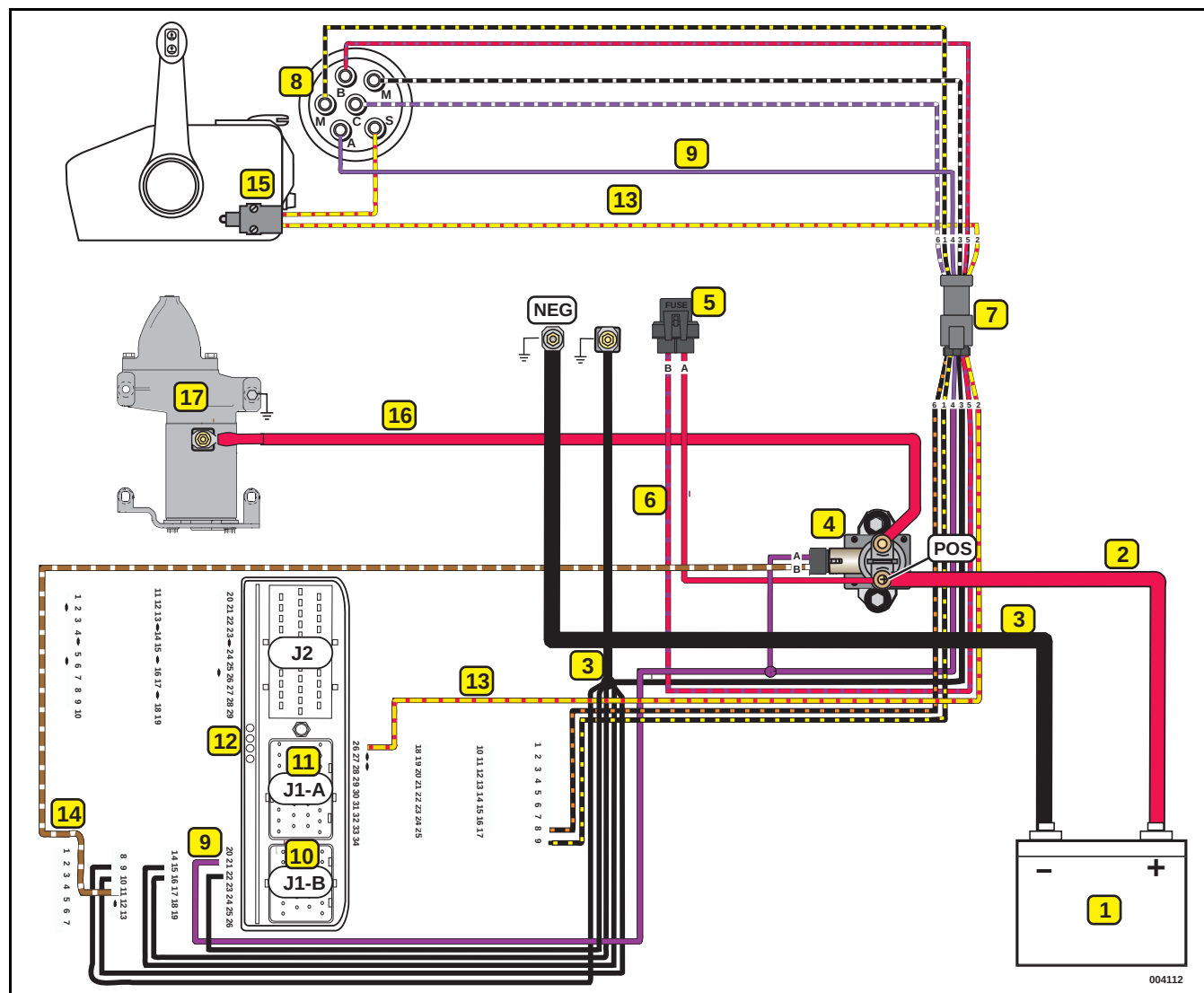
005235

With outboard running at 1000 RPM, voltage on white/red wires should increase to 55 V. Voltage readings at a specific speed (RPM) should be steady.

If there is any other reading, refer to **STATOR TESTS** on p. 95. Inspect the stator wiring and connections. Inspect the capacitor wiring, connections, and capacitor. Repair the wiring or replace a faulty capacitor, stator, or *EMM*.

ELECTRIC START CIRCUIT

Start Circuit Diagram



- | | |
|------------------------------|--|
| 1. Marine battery | 10. 26-pin J1-B EMM connector |
| 2. RED wire (POS) | 11. 34-pin J1-A EMM connector |
| 3. BLACK wire (NEG) | 12. Engine Management Module (EMM) |
| 4. Starter solenoid | 13. YELLOW/RED wire, start |
| 5. Fuse (10 amp) | 14. BROWN/WHITE wire, start signal |
| 6. RED/PURPLE wire | 15. Neutral Safety Switch (remote control) |
| 7. 6-pin connectors | 16. RED starter motor cable |
| 8. Ignition switch | 17. Electric starter motor |
| 9. PURPLE wire (switched B+) | |

Start Circuit Operation

The starter must engage and turn the flywheel. The outboard must crank a minimum of 100 RPM to start. Normal cranking speed is approximately 175 RPM.

Starter performance depends on the following:

- Proper battery and cable capacity.
- Clean, tight cable connections.
- Solenoid activation through the key switch, neutral safety switch, and *EMM*.

Refer to **Predelivery and Installation Guide** for battery, terminal, and cable requirements.

Solenoid Wiring

The positive (B+) battery cable connects to a large terminal of the starter solenoid. This terminal also provides the 12 V power supply to the engine harness (red wire) and the 10 A fuse. The red/purple wire from the fuse holder (10 A) provides 12 V to terminal “B” of key switch.

The negative (B–) battery cable connects to the main ground stud next to starter solenoid.

Engine Wire Harness

Contains the following circuits:

- Red/purple output wire from fuse provides 12 V to instrument harness.
- Purple wire provides switched 12 V to solenoid (terminal “A”) and *EMM*.
- Yellow/red wire provides switched 12 V to *EMM*.
- Brown/white wire from terminal 11 of *EMM* J1-B connector provides switched ground (NEG) to starter solenoid (terminal “B”).

Instrument Wire Harness

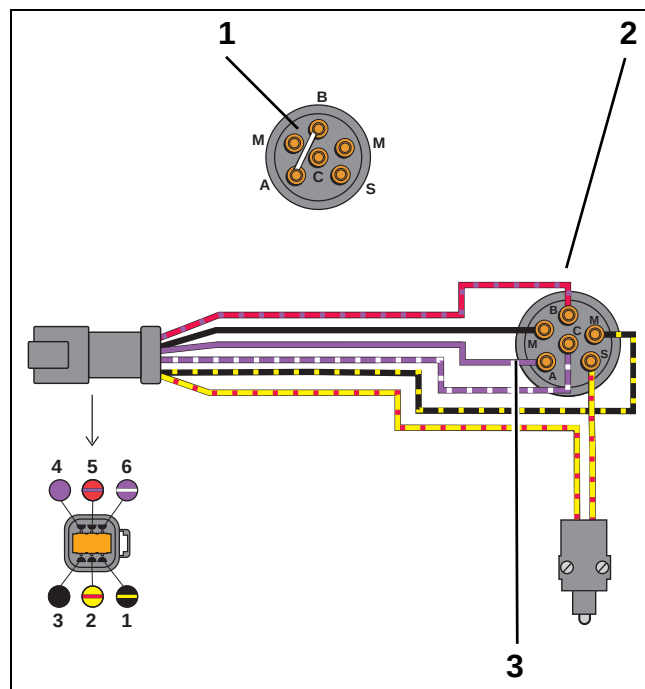
Contains the following circuits:

- Red/purple wire provides 12 V to key switch terminal “B”.
- Purple wire provides switched 12 V to engine wire harness.
- Yellow/red wire from terminal “S” of key switch provides switched 12 V to *EMM* (key switch in START position).

Key Switch, ON position

12 V is applied to the accessory circuit. Key switch ON:

- Switches 12 V to terminal “A” of key switch and to the purple wires of the wire harnesses.
- Provides 12 V input to terminal 21 of *EMM* J1-B connector. *EMM* turns ON.
- *EMM* provides 12 V to terminal “A” of starter solenoid.



1. Key switch, ON position – Continuity between terminals “B” and “A”
2. Terminal “B”, 12 V (Red/purple)
3. Terminal “A”, 12 V (Purple)

000691

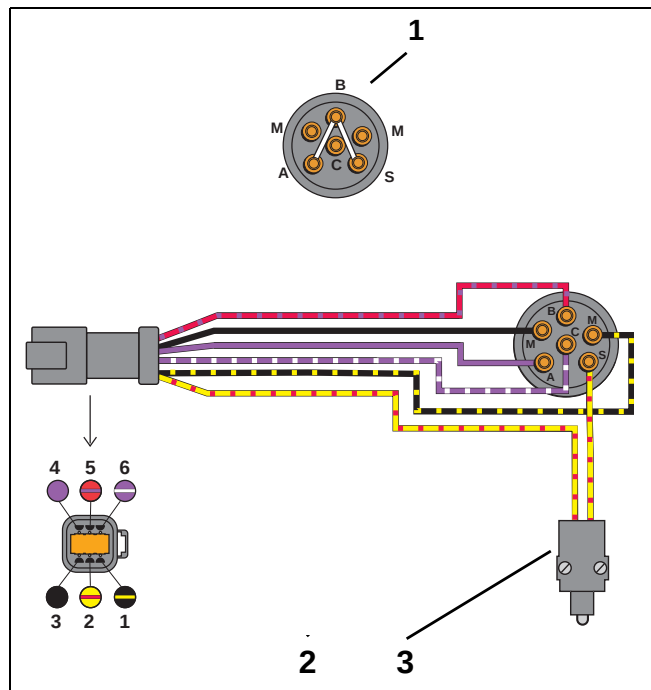
ELECTRICAL AND IGNITION

ELECTRIC START TESTS

Key Switch, START Position

Key switch START:

- Switches 12 V to terminal “S” of key switch and to the neutral safety switch (in remote control).
- A closed neutral safety switch provides 12 V to the engine wire harness yellow/red wire and terminal 26 of EMM J-1A connector.
- EMM grounds brown/white wire to activate solenoid.



000691R

ELECTRIC START TESTS

Starter Solenoid Test

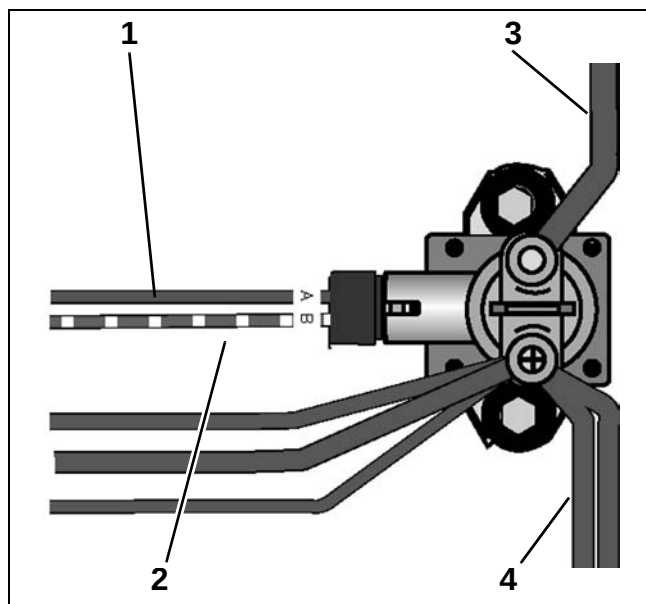
Disconnect the B+ (POS) battery cable at the battery.

IMPORTANT: Disconnect all wiring from solenoid terminals before proceeding with this test.

Use a digital multimeter to measure resistance.

Put one meter lead on the starter positive (+) cable terminal and the other lead on the battery positive (+) cable terminal:

- Meter must not show continuity (high reading).
- If meter shows continuity (low reading), replace the solenoid.



004121

Apply B+ to terminal “A” of solenoid and ground (NEG) to terminal “B” of solenoid. Measure resistance between the starter positive (+) cable terminal and the positive battery (+) cable terminal.

- The solenoid must close with an audible click.
- Meter must show continuity (low reading).
- If meter shows no continuity (high reading), replace the solenoid.

After re-installing the solenoid, coat all wires and terminals with *Black Neoprene Dip*.

Starter Voltage Drop Test

⚠ WARNING

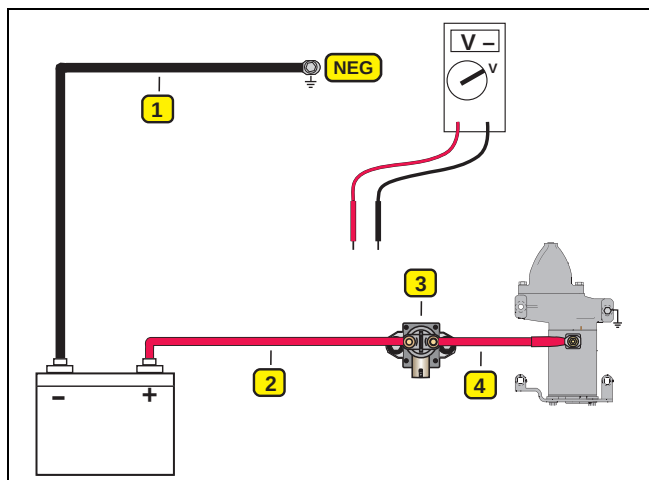
To prevent accidental starting of outboard, disconnect crankshaft position sensor (CPS).

Use a digital voltmeter to measure the voltage drop on each section of the start circuit.

If any voltage reading is greater than 0.5 VDC check that connections are clean, tight and free of corrosion. Clean or replace any corroded or damaged cables or connections.

STEP 1: Connect voltmeter positive (+) lead to the terminal for the negative (–) battery cable at powerhead. Connect voltmeter negative (–) lead to negative (–) battery post.

- Activate starter motor and observe voltage reading.



1. Negative battery cable
2. Positive battery cable
3. Solenoid
4. Starter cable

008464

STEP 2: Connect positive (+) lead to battery positive (+) terminal. Connect negative (–) lead to starter solenoid terminal.

- Activate starter motor and observe voltage reading.

STEP 3: First, activate starter motor. Connect positive (+) lead to starter solenoid terminal. Connect negative (–) lead to opposite starter solenoid terminal.

- Observe voltage reading.

STEP 4: Connect positive (+) lead to starter cable of solenoid terminal. Connect negative (–) lead to starter motor terminal.

- Activate starter motor and observe voltage reading.

No Load Current Draw Test

Securely fasten starter in a vise or suitable fixture before proceeding with this check.

Use a battery rated at 500 CCA (60 amp-hr) or higher that is in good condition and fully charged.

IMPORTANT: The driven gear and pinion assembly must be removed for this test.

Use an inductive ammeter or connect a 0 to 100 amp ammeter in series with a heavy jumper between the battery positive (+) terminal and the starter positive (+) terminal.

Fluke model 334 or 336, Snap-On model MT110 or EETA501, and various other ammeters should be available through local tool suppliers.

Attach or hold a vibration tachometer, such as a *Frahm⁺ Reed* tachometer, to the starter.



TYPICAL

24083

Complete the circuit with a heavy jumper between the battery negative (–) terminal and the starter frame.

Monitor the starter RPM and current draw.

- At 10,500 RPM the ammeter should show a maximum of 30 A.

REMOTE CONTROL SWITCH TESTS

Key Switch Test

Refer to **Wiring Diagrams** at back of manual.

Use an ohmmeter or a continuity light to test key switch operation. Replace switch if results are incorrect with any of the following tests.

IMPORTANT: Disconnect battery and key switch wiring before proceeding with the following tests.

Stop/Ground Terminals (M) – Connect meter between the two “M” terminals. Meter must indicate NO continuity at START or ON.

Turn key switch OFF. Meter must indicate continuity.

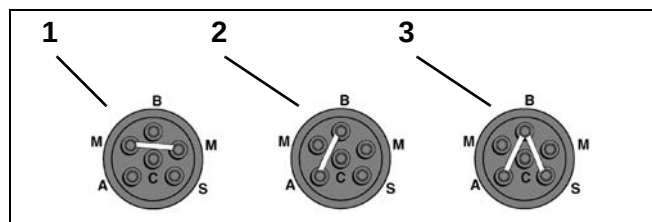
Accessory Terminal (A) – Make sure the key switch is OFF. Connect the ohmmeter or continuity light between terminals “B” (battery) and “A” (accessory) of key switch. Meter must indicate NO continuity.

Turn switch ON. Meter must indicate continuity.

Turn key switch to START. Meter must continue to indicate continuity.

Starter Terminal (S) – Hold key switch at START. Connect meter between terminal “B” and terminal “S.” Meter should indicate continuity.

IMPORTANT: The choke function or terminal “C” of the key switch is NOT used.



1. OFF
2. ON
3. START

000443

Neutral Start Circuit Test

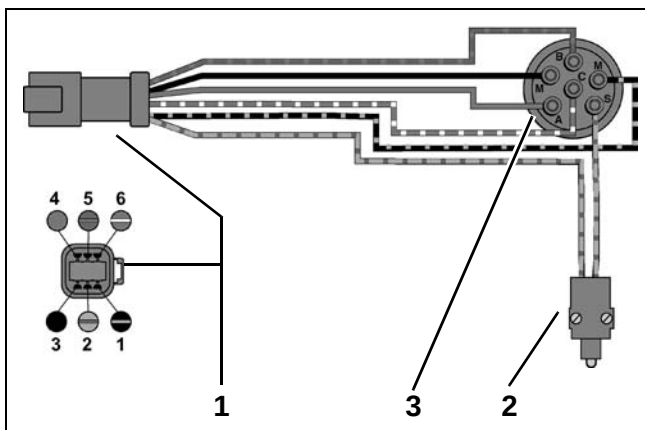
Use an ohmmeter or continuity light to test the continuity of the circuit while positioning the remote control in NEUTRAL, FORWARD, and REVERSE.

IMPORTANT: Turn propeller shaft or disconnect shift cable to allow proper remote control shift action while outboard is not running. Disconnect the instrument harness connector from the key switch harness connector.

Make sure the remote control handle is in NEUTRAL. Connect meter between terminal 5 (red/purple wire) and terminal 2 (yellow/red wire). Turn the key switch to START. Meter must indicate continuity.

Move the remote control handle to FORWARD and turn the key switch to START. Meter must NOT indicate continuity.

Move the remote control handle to REVERSE and turn the key switch to START. Meter must NOT indicate continuity.



1. Key switch harness connector
2. Neutral start switch
3. Key switch

000443

IMPORTANT: Reconnect shift cable and MWS instrument harness connector to key switch harness connector.

Neutral Start Switch Test

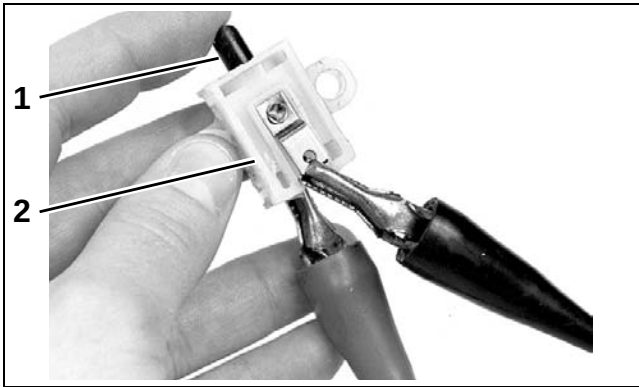
Use an ohmmeter or a continuity light to test neutral start switch operation.

IMPORTANT: All wiring must be disconnected from the switch before proceeding with this test.

Disassemble the remote control and remove the neutral start switch.

Connect one meter lead to each terminal of the switch.

- Meter must indicate continuity when the plunger is depressed
- Meter must indicate no continuity when the plunger is released.



TYPICAL

1. Plunger
2. Neutral start switch

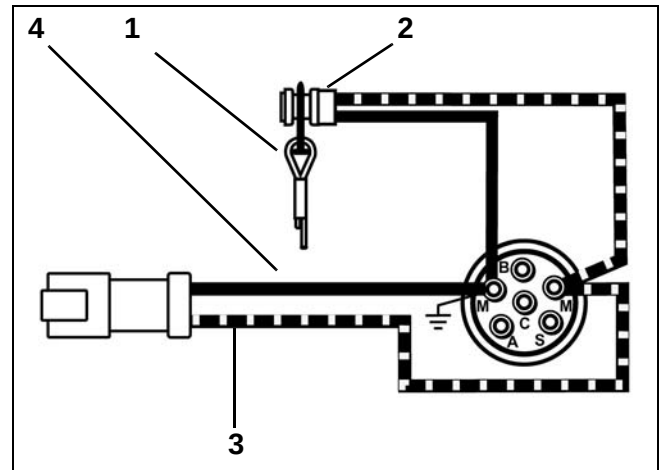
3224

Replace switch if results are incorrect.

Emergency Stop Switch Test

This switch can be part of the key switch or installed as a separate switch. Either style connects the "M" terminals of the key switch.

The emergency stop switch function grounds the stop circuit wire (black/yellow) when the lanyard clip is removed. One "M" terminal is the ground wire (black) and one "M" terminal is the stop circuit wire (black/yellow).



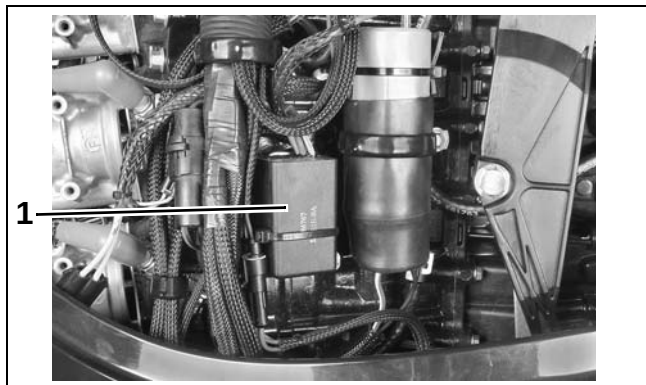
1. Lanyard and clip assembly
2. Emergency stop switch, separate from key switch
3. Stop circuit wire (black/yellow)
4. Ground wire (black)

000444

Install the clip on the emergency stop switch or key switch. Start the outboard. Pull the clip from the switch. The outboard must stop running.

TILT/TRIM RELAY TEST

The tilt and trim (TNT) module contains the circuitry and relays required for power trim and tilt operation.



1. Tilt and trim module

005372

The tilt and trim switch provides B+ input to green/white or blue/white wire of the TNT module.

Operation

The relay activates when B+ input from the switch is supplied to terminal 86 of the internal relays.

Terminal 87a connects to ground (B-).

Terminal 87 connects to B+.

Terminal 30 connects TNT motor.

Terminals 87a and 30 are connected when relay is not activated. This supplies ground (B-) connection to TNT motor.

Terminals 87 and 30 are normally open. B+ is applied to terminal 30 when relay is activated. This supplies ground B+ connection to TNT motor.

Refer to **Tilt and Trim Module Diagram**.

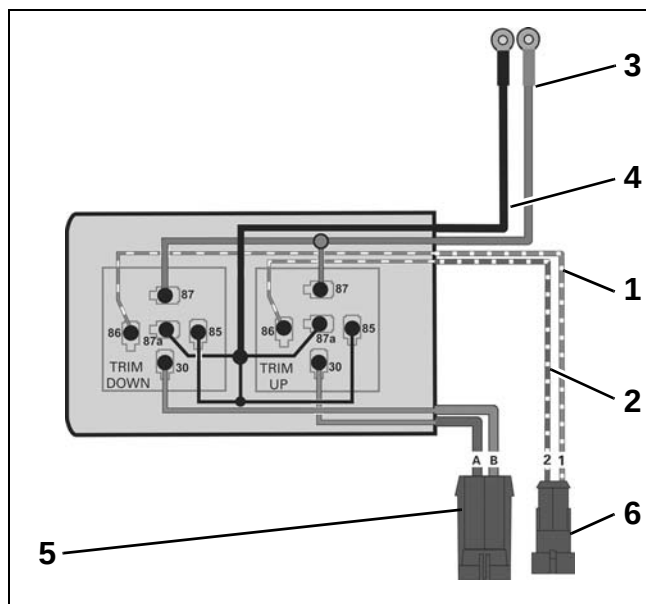
Test Procedure

Make sure red and black wires are connected to 12 V battery power supply.

Set voltmeter to 12 VDC scale. Connect test leads to terminals "A" and "B" of TNT motor connector.

Use a wire jumper to alternately connect B+ to terminals "1" and "2" of tilt and trim switch connector.

The meter must indicate battery voltage (12 V) with B+ connected to either terminal.



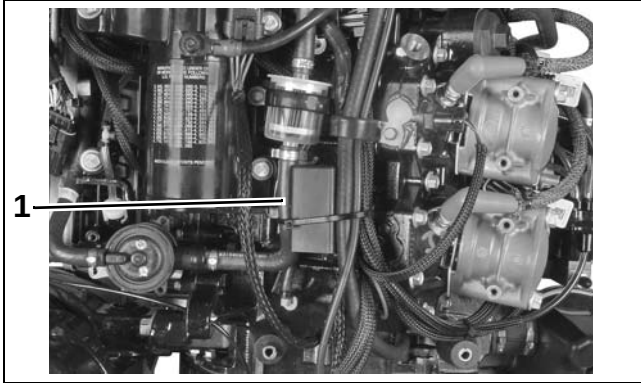
Tilt and Trim Module Diagram

002063

1. Green/white wire
2. Blue/white wire
3. B+, red wire
4. B-, black wire
5. TNT motor connector
6. TNT switch connector

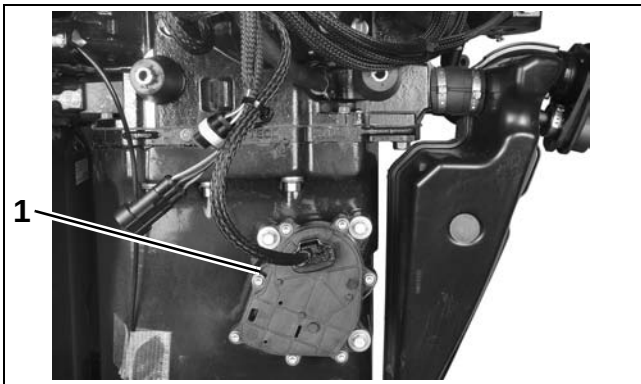
EXHAUST VALVE RELAY TESTS

The exhaust valve relay module controls the exhaust valve actuator.



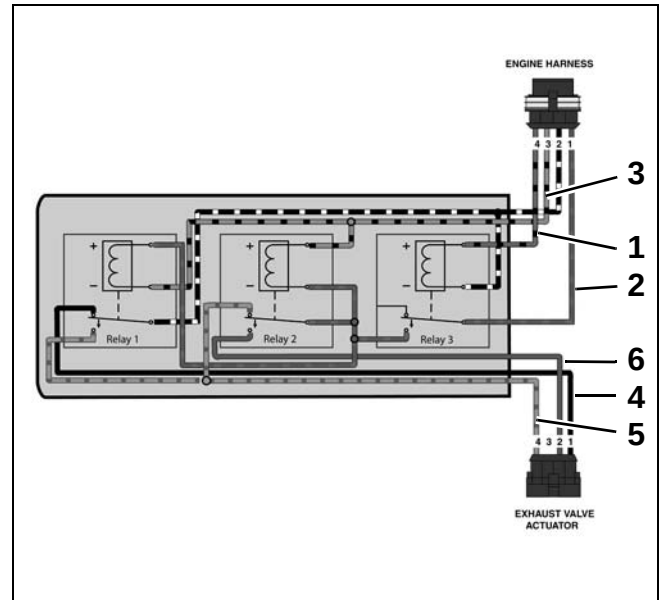
1. Exhaust valve relay module

005374



1. Exhaust valve actuator

005247



Exhaust Valve Relay Module Diagram

005429

1. Purple/Black wire
2. Red/Purple wire
3. Blue/Black wire
4. Black wire
5. Orange/Red wire
6. Red wire

Operation

When the outboard is running, the fuel pump circuit (purple/black wire) provides 12V to activate relay 3. Relay 3 provides fused 12V (red/purple wire) to relay 1 and relay 2.

The *EMM* controls the exhaust valve by grounding the blue/black wire.

When the blue/black wire is NOT grounded, fused 12V is supplied to the exhaust valve actuator through the orange/red wire and the actuator is grounded through the black wire on relay 1.

When the blue/black wire IS grounded, relay 1 and relay 2 are activated. Relay 2 supplies fused 12V to the exhaust valve actuator through the red wire and the actuator is grounded through the orange/red wire.

ELECTRICAL AND IGNITION

EXHAUST VALVE RELAY TESTS

Exhaust Valve Relay Module Test

High speed operation test:

- Disconnect exhaust valve actuator connector from relay module
- Start and run engine at idle
- Set multimeter to DC volts, check voltage with red meter lead to pin 4 (orange/red wire) and black meter lead to pin 1 (black wire)
- Result should be 12 VDC

Low speed operation test:

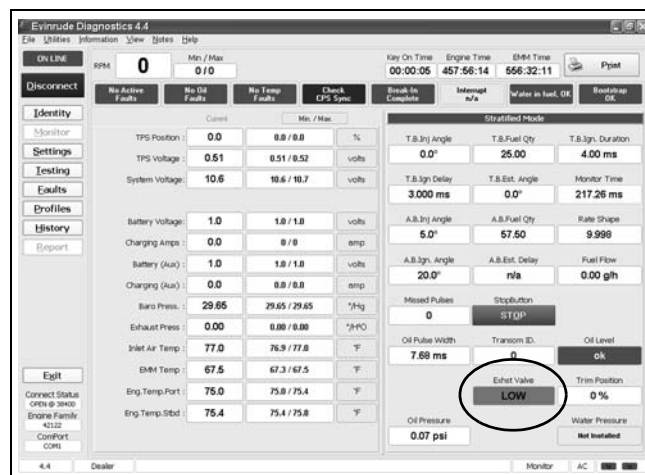
- Advance throttle until TPS exceeds 2 to 5%.
- Observe Monitor screen for Exhaust Valve Indicator to switch "LOW"
- Check voltage with red meter lead to pin 2 (red wire), black meter lead to pin 4 (orange/red wire)
- Result should be 12 VDC

If results are correct, problem is in actuator or linkage.

If results are not correct, refer to **EMM Outputs to Relay Module Test** on p. 106.

EMM Outputs to Relay Module Test

Use back-probe to obtain results at engine harness connector. Start and run engine. Use the *Evinrude Diagnostics* software Monitor screen to observe exhaust valve position indicator (High / Low).



Engine Monitor Screen

008117

- **Supply voltage:** Check for voltage, red meter lead to pin 1 (red/purple wire), black meter lead to pin 2 (black/white). Result should be 12 VDC.
- **High speed mode:** Check for voltage, red meter lead to pin 4 (purple/black wire), black meter lead to pin 2 (black/white). Result should be 12 VDC.
- **Low speed mode:** Check for voltage, red meter lead to pin 4 (purple/black wire), black meter lead to pin 3 (blue/black), result should be no / low voltage. Increase engine rpm and observe Monitor screen for Exhaust Valve Indicator to switch "LOW." When indicator switches "LOW," result should be 12 VDC.

If results are correct, replace Relay Module.

If results are not correct, check engine electrical harness before replacing *EMM*.

SystemCheck CIRCUIT TESTS

Make sure the *SystemCheck* engine monitor can alert the operator during a “NO OIL,” “WATER TEMP” or “HOT,” “CHECK ENGINE,” or “LOW OIL” condition. Check the condition of the warning system and associated wiring and connections. Test the engine monitor regularly and anytime you suspect an alert situation has been missed.

The instrument harness must be connected to the outboard before performing the following tests. Refer to the **Engine Wiring** diagram and the **MWS Instrument Wiring** diagram in the back of this manual.

IMPORTANT: Use jumper wires made with the appropriate terminals to test the warning circuits.



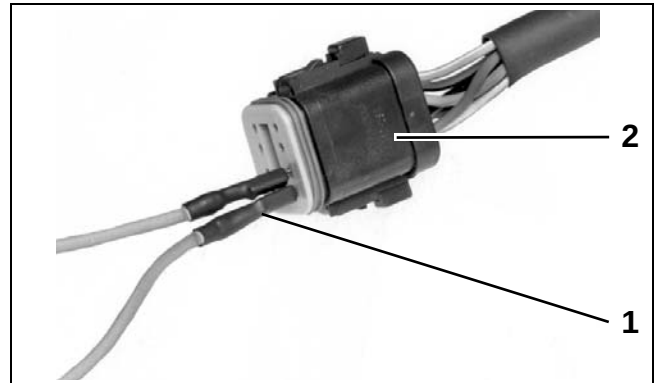
42811

Gauge Self-Test Check

Turn the key switch to ON with the outboard NOT running. The gauge warning lights for NO OIL, WATER TEMP, CHECK ENGINE, and LOW OIL must all light at once, then turn off in sequence, and the warning horn must sound for one-half second.

If the gauge lights do not turn on, turn the key switch OFF. Disconnect the gauge 8-pin connector from the back of the gauge and turn the key switch ON. Test for battery voltage between

instrument harness terminal 1 (purple wire) and terminal 2 (black wire).



1. Test adapter(s)
2. Connector, SystemCheck gauge

42761

- If battery voltage is present, replace the gauge.
- If there is no battery voltage, check that 12 V is present at terminal “B” of the key switch. Check condition of the instrument harness, key switch, and connections.

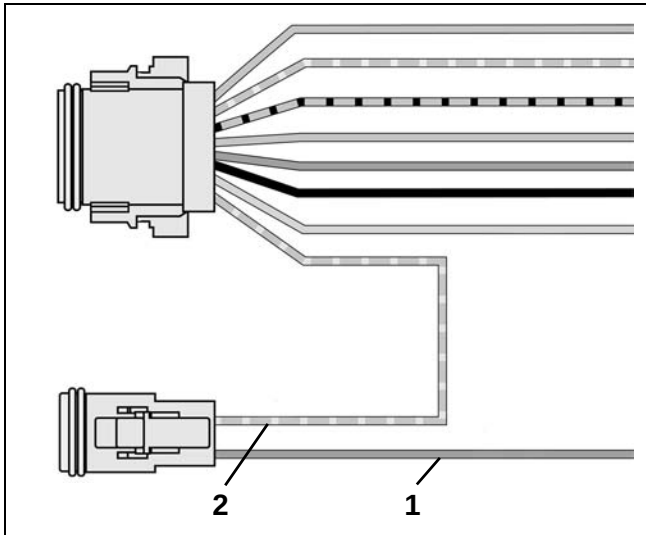
If the lights worked, but the warning horn did not sound for one-half second, turn the key switch OFF. Disconnect the warning horn 2-pin connector. Substitute a known good warning horn. Turn the key switch ON.

- If the substitute horn beeps, the original horn is defective and must be replaced.
- If the substitute horn does not beep, check for battery voltage between instrument harness 2-pin connector, terminal 2 (purple wire) and ground with the key switch ON. Also, check the tan/blue wire for continuity between pin 8 of the 8-pin connector and pin 1 of the 2-pin connector.
- If battery voltage is present at the purple wire and the tan/blue wire has continuity between

ELECTRICAL AND IGNITION

SystemCheck CIRCUIT TESTS

the two connectors, replace *SystemCheck* gauge.



1. Purple wire
2. Tan/blue wire

DRC6280

Turn the key switch OFF and reconnect all disconnected circuits.

CHECK ENGINE Circuit Test

Separate the 6-pin *SystemCheck* connector of MWS instrument harness from engine harness. Black wire (pin 3) must be grounded.

Using a jumper wire, connect tan/orange wire (pin 2) to a clean engine ground.

Turn the key switch ON. After the normal self-test sequence, the CHECK ENGINE light should stay on.

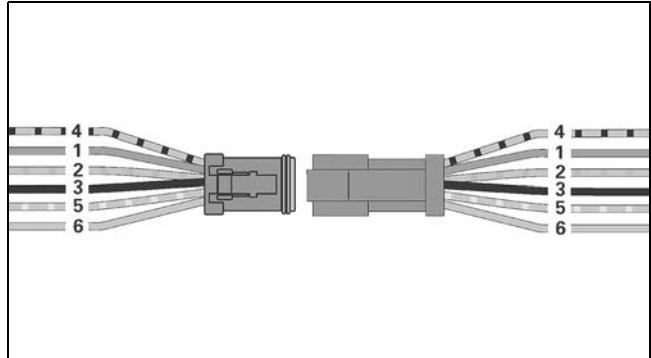
- If the CHECK ENGINE light is not on, test circuit for continuity. Check continuity of the MWS instrument harness (tan/orange wire).
- Check continuity of the engine wire harness between terminal 2 (tan/orange wire) of the *SystemCheck* connector and pin 17 of the *EMM* J1-A connector.

Turn the key switch OFF and reconnect all disconnected circuits.

WATER TEMP/ HOT Circuit Test

The tan wire of engine harness and the MWS harness receives a signal from the *EMM*. The *EMM* receives information from the temperature sensor on the cylinder head.

Using a jumper wire, connect tan wire (pin 6) of the engine harness connector to a clean engine ground.



002079

Turn the key switch ON. After the normal self-test sequence, the gauge WATER TEMP / HOT indicator should stay on.

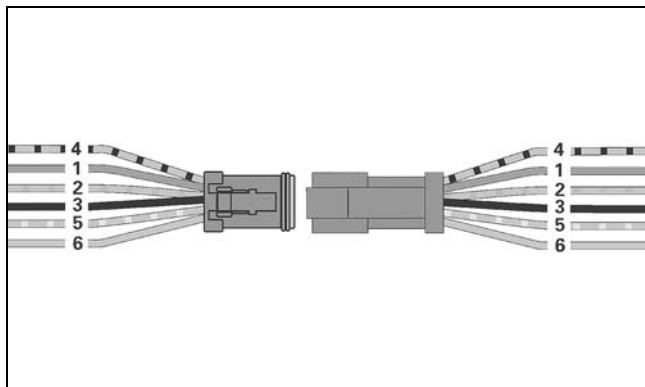
- If LED is not on, test circuit for continuity. Test for continuity of both the engine harness (tan wire) and the MWS instrument harness (tan wire).

Turn the key switch OFF and reconnect all disconnected circuits.

IMPORTANT: To test the temperature sensor itself, refer to **Engine Temperature Sensor Test** on p. 94.

LOW OIL Circuit Test

Turn the key switch ON. Using a jumper wire, connect tan/black wire (pin 4) of the engine harness connector to a clean engine ground. The LOW OIL light should turn on after 40 seconds.



002079

If the LOW OIL light does not turn on after connecting the terminal to ground, test circuit for continuity.

Turn the key switch OFF and reconnect all disconnected circuits.

NO OIL Circuit

Separate the 6-pin *SystemCheck* connector of MWS instrument harness from engine harness. Black wire (pin 3) must be grounded.

Using a jumper wire, connect tan/yellow wire (pin 5) to a clean engine ground.

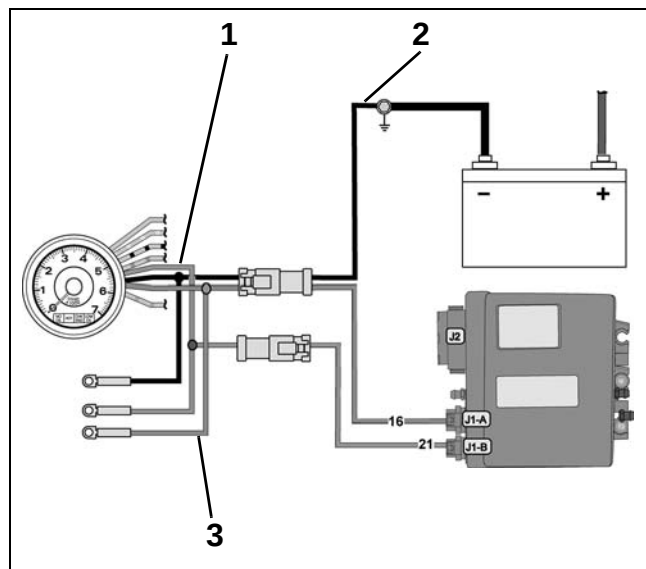
Turn the key switch ON. After the normal self-test sequence, the NO OIL light should stay on.

- If the NO OIL light is not on, test circuit for continuity. Test for continuity of the MWS instrument harness (tan/yellow wire).
- Test for continuity of the engine wire harness between terminal 5 (tan/yellow wire) of the *SystemCheck* connector and pin 24 of the *EMM* J1-A connector.

Turn the key switch OFF and reconnect all disconnected circuits.

TACHOMETER CIRCUIT TESTS

Check voltage at the battery. Use this reading as a reference for battery voltage.



1. Purple lead
2. Black lead
3. Gray lead

004287

Connect the red meter lead to the tachometer purple wire and the black meter lead to the tachometer black wire (key ON, outboard NOT running).

- If meter shows battery voltage, go to next step.
- If meter shows less than battery voltage, check the purple, red/purple, and black wiring circuits; fuse, key switch, and battery connections.

Disconnect gray and black wires at tachometer. Set *Fluke* 29 Series II meter, or equivalent, to Hz scale. Connect meter between gray wire and black wire. With outboard running at 1000 RPM, meter should indicate 90 to 105 Hz.

- If meter reads 90 to 105 Hz, replace tachometer.
- If meter reads low or no signal, confirm output on gray wire at pin 16 of *EMM* J1-A connector.
 - Reading OK – Check condition of tachometer circuit (gray wire). Repair as needed.
 - Reading not OK – Check connection at *EMM*; replace faulty *EMM*.

FLYWHEEL AND STATOR SERVICING

IMPORTANT: Weak flywheel magnets can cause low alternator output and affect outboard performance. Weak flywheel magnets can also cause low readings on ignition test equipment, such as a peak-reading voltmeter, which might cause unnecessary parts replacement.

An accurate test of alternator output can help determine the flywheel's condition. Refer to **CHARGING SYSTEM TESTS** on p. 96.

Flywheel Removal

WARNING

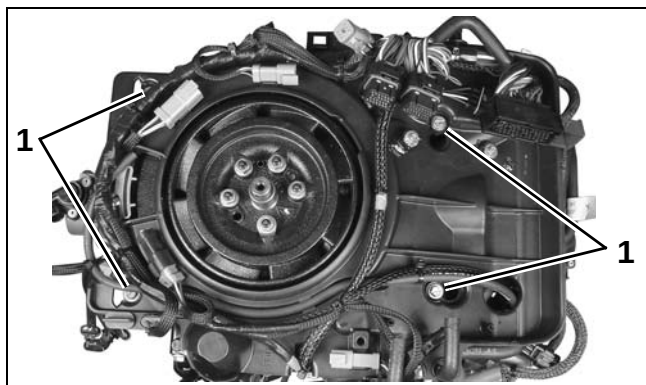
To prevent accidental starting while servicing, disconnect battery cables at the battery.

Remove the *EMM*. Refer to **EMM SERVICING** on p. 68.

Disconnect the vapor separator vent hose, crankshaft position sensor, throttle position sensor, air temperature sensor, and oil pump electrical connectors.

Disconnect the stator connector, two port side trim system connectors, port engine temperature sensor, and the port ground terminal.

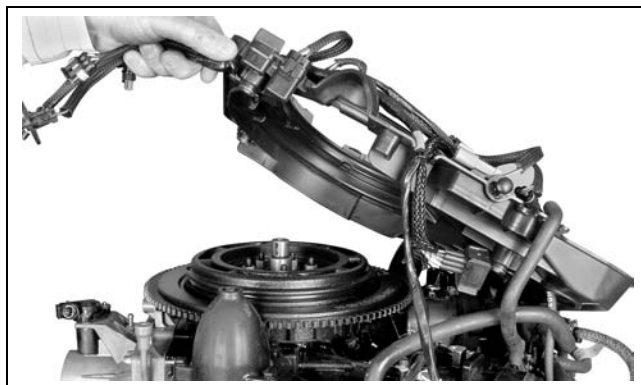
Remove the four screws holding the electrical harness base.



1. Harness base screws

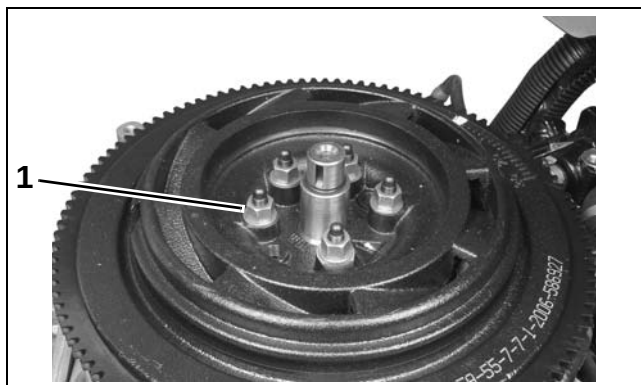
005378

Lift the electrical harness base out of the way.



005379

Use Flywheel Holder, P/N 771311, or equivalent, and a socket to remove the five flywheel retaining nuts and washers. Discard flywheel nuts.



1. Flywheel retaining nuts

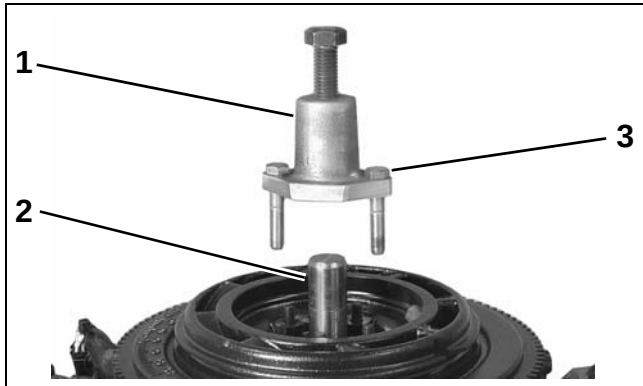
005380

CAUTION

To avoid damage to flywheel magnets, or injury to fingers, Flywheel service kits, P/N 434649 and P/N 5007181, must be used to remove or install the flywheel.

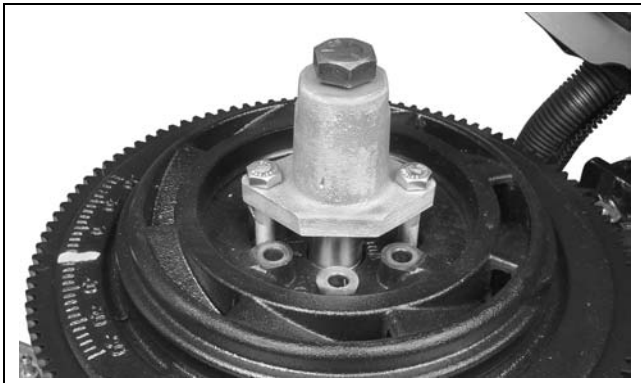
Install bushing from Flywheel Puller Adaptor Kit, P/N 5007181, on top of crankshaft. Place puller from Flywheel Service Kit, P/N 434649, over bushing.

Use two 3/8-24x2 in. screws from the adaptor kit to attach the tool to the flywheel. Two holes are tapped in the flywheel for the tool.



1. Puller
2. Bushing
3. Screws - 3/8 - 24 x 2 in. (2)
- 005369

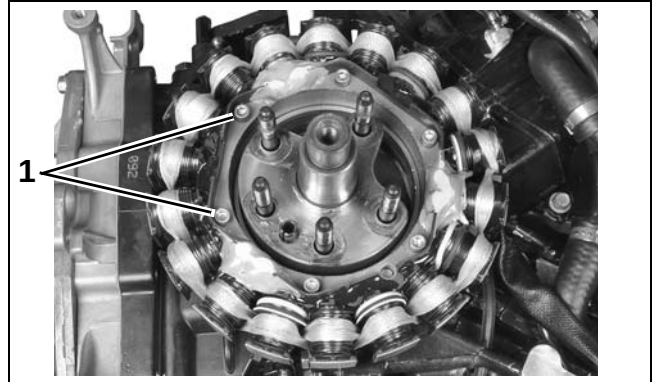
Turn the center screw of the puller in to lift the flywheel off of the crankshaft.



005381

Stator Service

Remove six allen head screws to remove stator.



1. Stator screws

005382

To install stator, position stator on cylinder block. Apply *Nut Lock* to screw threads. Install screws and tighten in crossing pattern to a torque of 24 to 36 in. lbs. (3 to 4 N·m).

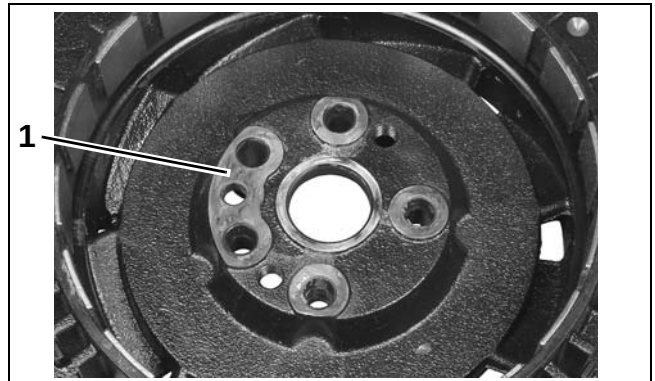
Flywheel Installation

IMPORTANT: Check ignition timing after flywheel removal or replacement. Refer to **TIMING ADJUSTMENTS** on p. 114.

If studs must be replaced in crankshaft, apply *Ultra Lock* to threads and tighten by hand, no more than 48 in. lbs. (5.5 N·m).

Remove any debris from the flywheel magnets and the flywheel and crankshaft mating surfaces.

Apply *Nut Lock* to the raised mounting bosses on the bottom of the flywheel.



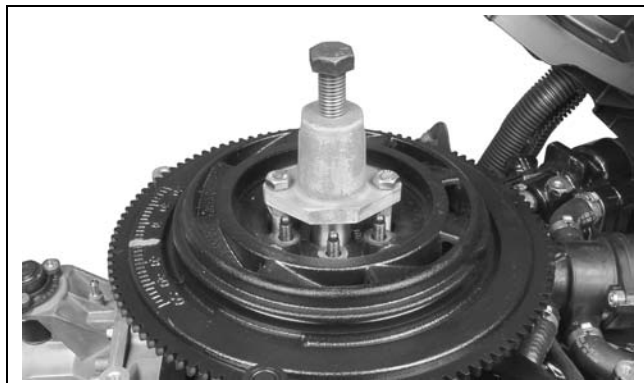
1. Flywheel mounting bosses

005370

ELECTRICAL AND IGNITION

FLYWHEEL AND STATOR SERVICING

Use Flywheel Puller Adaptor Kit, P/N 5007181, and Flywheel Service Kit, P/N 434649, to position flywheel on top of crankshaft. Align the alignment hole in flywheel with alignment pin of crankshaft. Turn center screw counterclockwise to lower flywheel onto crankshaft. Remove tools from the flywheel and crankshaft.



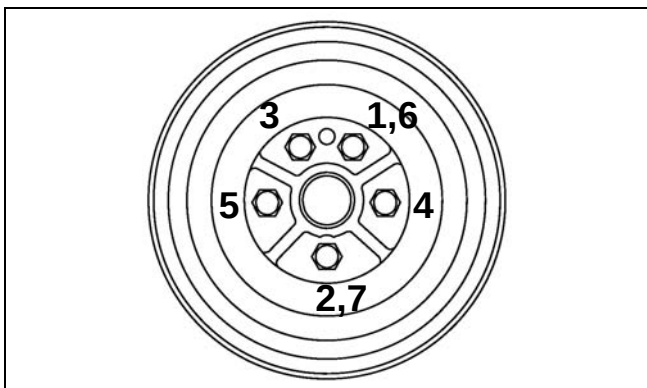
005383



CAUTION

To avoid damage to flywheel magnets, or injury to fingers, Flywheel service kits, P/N 434649 and P/N 5007181, must be used to remove or install the flywheel.

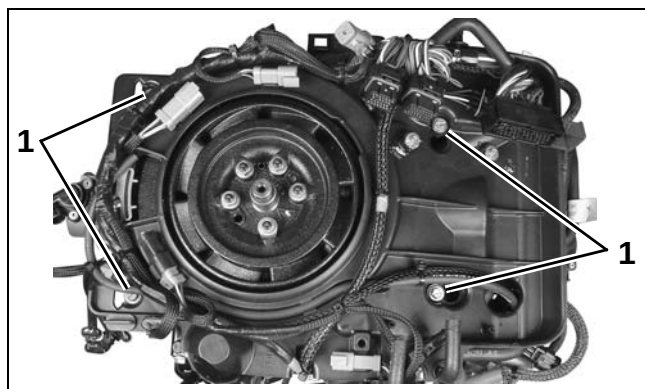
Apply *Triple-Guard* grease to studs and install five **new** flywheel retaining nuts and washers. Follow torque sequence below. Tighten nuts to a torque of 30 to 32 ft. lbs. (40.5 to 43 N·m).



Flywheel Torque Sequence

DRC3737

Install the electrical harness base and secure with four screws. Tighten screws to a torque of 60 to 84 in. lbs (7 to 9.5 N·m).



1. Harness base screws

005378

Reconnect the stator connector, two port side trim system connectors, port engine temperature sensor, and the port ground terminal.

Reconnect the crankshaft position sensor, throttle position sensor, air temperature sensor, and oil pump electrical connectors.

Install the *EMM*. Refer to **EMM SERVICING** on p. 68.

IGNITION COIL SERVICING

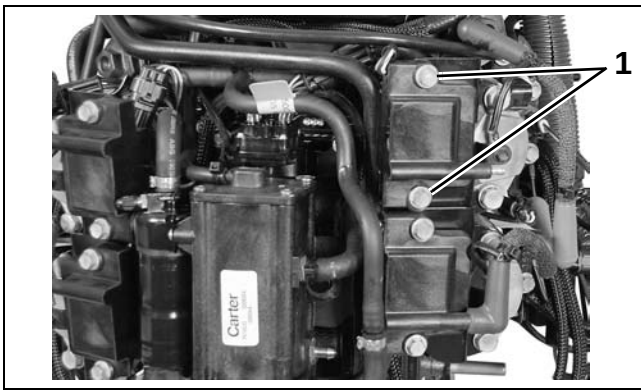
Ignition Coil Removal

Remove spark plug lead from ignition coil.

Disconnect ignition coil electrical connector.

Remove two ignition coil retaining screws.

Do not lose the rubber washers between coil and bracket.



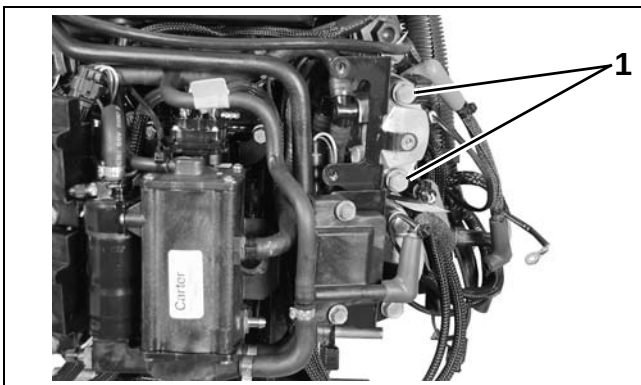
1. Screws

007187

Ignition Coil Bracket Removal

Remove spark plug lead ground screw.

Remove injector screws and bracket.



1. Injector screws

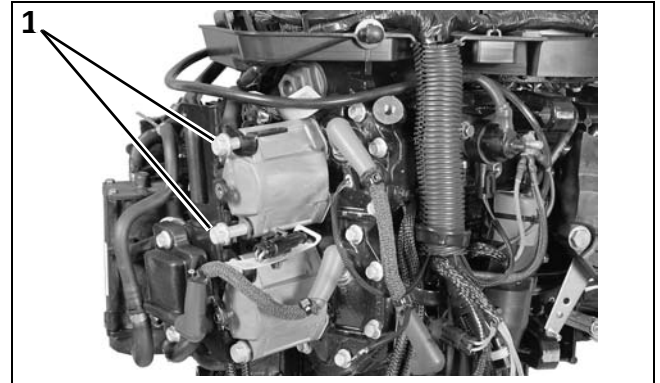
007188

IMPORTANT: All injectors must be installed in the correct cylinder by serial number. If removed, mark fuel injectors to show cylinder locations.

Ignition Coil Bracket Installation

Install injector screws through bracket.

Refer to **Fuel Injector Service** on p. 150 for proper injector installation procedure.



1. Injector screws

007189

Install spark plug leads with ground screw. Tighten screw securely.

Ignition Coil Installation

Install one rubber washer on each screw. Install screw through ignition coil.

Install remaining rubber washers on screws between coil and bracket.



1. Rubber washers

007186

Install coil with washers on bracket.

Tighten screws to a torque of 60 to 84 in. lb. (7 to 9.5 N·m).

Install spark plug lead on ignition coil.

Connect ignition coil electrical connector.

TIMING ADJUSTMENTS

Timing Pointer

WARNING

To prevent accidental starting while servicing, disconnect the battery cables at the battery. Twist and remove all spark plug leads.

The timing pointer must be adjusted to indicate top dead center (TDC) of the number 1 piston. This reference to the position of the number 1 piston is used to synchronize the electronic timing controlled by the *EMM* with the mechanical position of the number 1 piston.

Always check timing pointer adjustment before using the *Evinrude Diagnostics* software Timing Verification procedure.

IMPORTANT: The pointer on these models has two indicator points. The point labeled “V4” is used for 60° V4 models. The unlabeled point is used for 60° V6 models.



1. V4 pointer
2. V6 pointer

005385

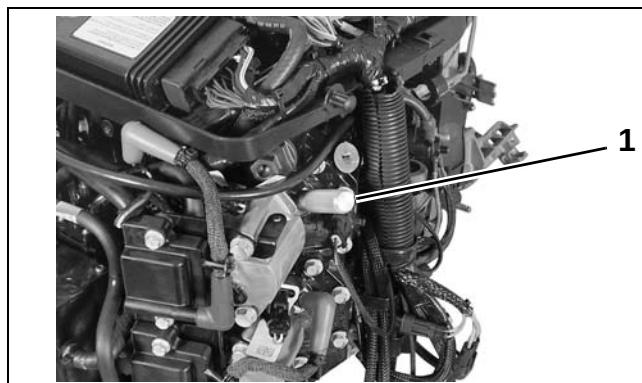
Disconnect the battery cables at the battery.

Remove spark plugs. Rotate the flywheel clockwise to approximately 30° ATDC.



005384

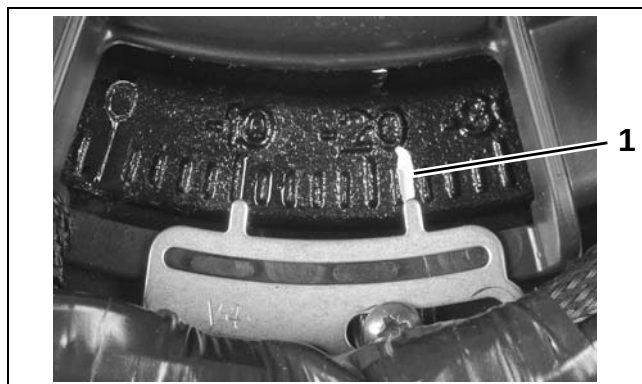
Install Piston Stop Tool, P/N 342679, into the spark plug hole of the number 1 cylinder.



1. Piston stop tool

007190

Rotate flywheel **counterclockwise** until the number 1 piston contacts the tool. Keep pressure on the flywheel to position the piston firmly against the tool. Mark the flywheel directly across from the pointer. Label this mark “A.”



1. Mark A

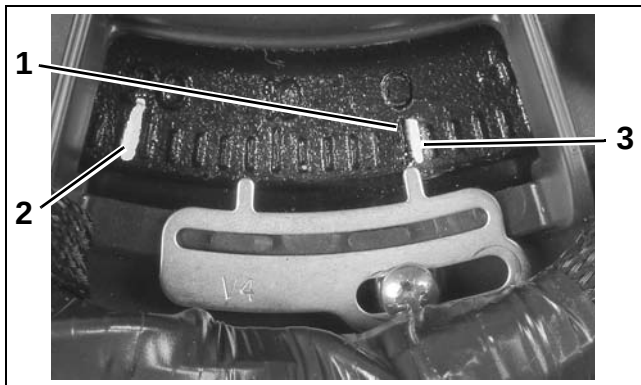
005387

Rotate the flywheel **clockwise** until the piston contacts the tool. Mark the flywheel directly across from the pointer. Label this mark "B." Rotate flywheel **counterclockwise** slightly to release tool then remove it from spark plug hole.

Use the cast in markers on the flywheel to calculate the exact center between marks "A" and "B." Mark and label the center point "C."

If mark "C" and the cast-in TDC boss on flywheel are in alignment, the timing pointer is in the correct location.

If the pointer alignment is NOT correct, rotate the flywheel **clockwise** to align the mark "C" with the pointer. Hold the flywheel in this position. Loosen the pointer retaining screw and adjust the pointer location to align with the cast-in TDC boss on the flywheel. Tighten retaining screw.



1. Cast in TDC mark
2. Mark B
3. Mark C

005388

Repeat the entire adjustment process to make sure pointer is aligned correctly.

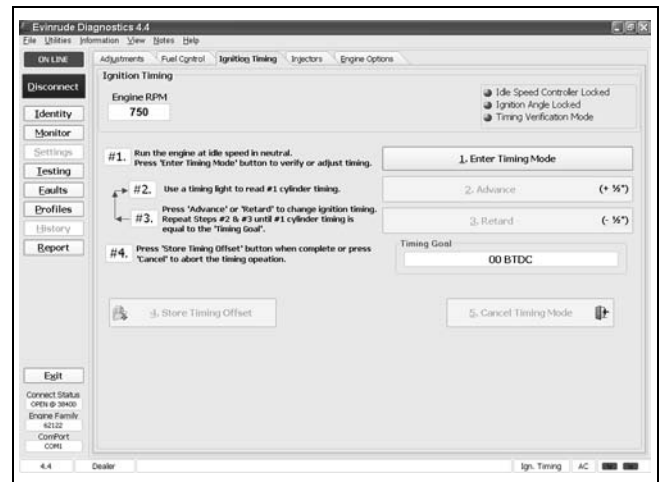
Install spark plugs. Refer to Spark Plug **Indexing** on p. 38.

Timing Verification

Use *Evinrude Diagnostics* software to synchronize the mechanical timing of the outboard with the electronic timing of the *EMM*.

Start the outboard.

Use the *Settings/Ignition Timing* screen of the diagnostics software and follow the on-screen instructions.



Timing Adjustment Screen

008110

Check ignition timing after any of the following procedures:

- Powerhead replacement
- Crankshaft replacement
- Flywheel removal or replacement
- CPS replacement
- *EMM* replacement
- *EMM* software replacement (reprogramming)

IMPORTANT: Make sure the timing pointer is set and the outboard reaches operating temperature before making any timing adjustments.

ELECTRICAL AND IGNITION

ELECTRIC STARTER SERVICING

TPS Calibration

Use *Evinrude Diagnostics* software to tell the *EMM* what throttle position sensor voltage is when the throttle plates begin to open.

Set TPS Calibration after replacing or adjusting any throttle body or throttle linkage parts.

Remove the air silencer.

Do NOT start the outboard.

On the *Settings/Adjustments* screen of the diagnostics software, click the “Set TPS Calibration” button.



1. TPS Calibration button

008108

While holding the throttle plates closed, advance the throttle linkage until it stops. The “Measured TPS Calibration” field on the screen will increase.

Click the “Working” button in the software to calibrate the TPS.

Install the air silencer.

ELECTRIC STARTER SERVICING

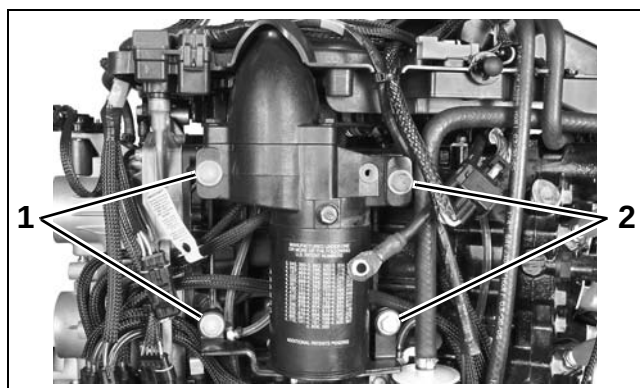
Starter Removal

IMPORTANT: Do not clean the starter drive while the starter motor and drive are installed on the powerhead. The cleaning agent could drain into the starter motor, washing dirt from the drive into the starter bearings and commutator.

Disconnect the battery cables at the battery.

Remove the starter positive (+) cable from post on starter.

Remove the four frame and bracket mounting screws. Remove the starter.



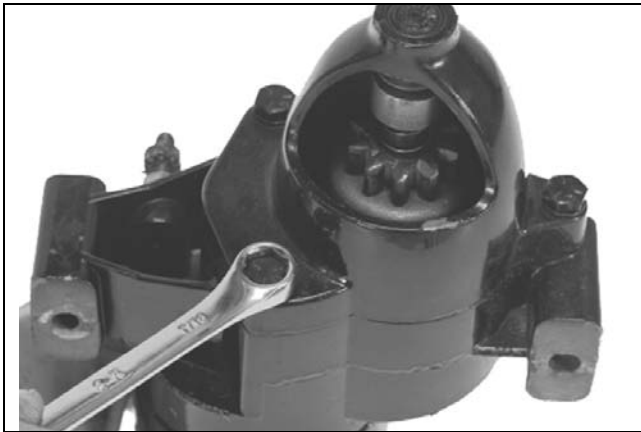
005373

Loosen the two nuts used to fasten the starter bracket. Remove the nuts and bracket.



30374

Remove the screws, lock washers, and pinion housing.



30373

Hit the socket with a mallet to lower the spacer and expose the retaining ring under the spacer.



30371

Starter Disassembly

Lift and remove the wave washer and bushing.



30372

Place an appropriate-sized deep socket on the spacer.



30360

Remove the retaining ring, spacer, and spring from pinion shaft.



30369

ELECTRICAL AND IGNITION

ELECTRIC STARTER SERVICING

Remove pinion and plastic weather cover from pinion shaft.



30368

Remove the two thru-bolts. Mark the end cap orientation, and remove the cap.



30365

Remove the driven gear and thrust washer.



30367

Gently tap the starter frame with a rubber mallet to loosen it.

Find the insulator cap (end of the shaft or inside the end cap). Inspect and replace, if necessary.



30354B

Using No. 2 external retaining ring pliers, remove the retaining ring and drive gear from the armature shaft.



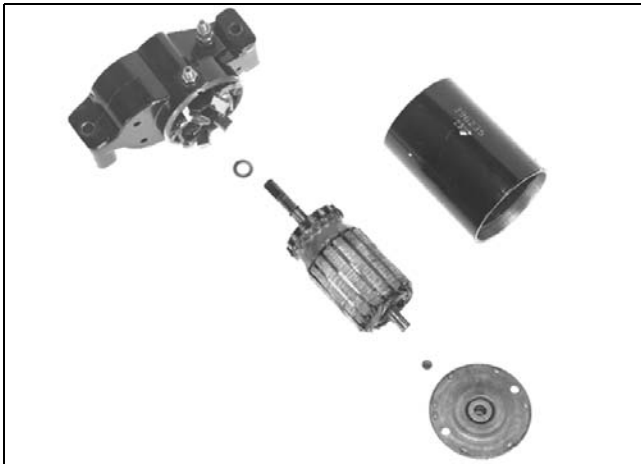
30366

Note the alignment marks by the positive terminal stud. Hold the armature in place, and slide the frame away from the gear housing.



30352

Slowly remove the armature and thrust washer. Do not lose the brush springs.



30351

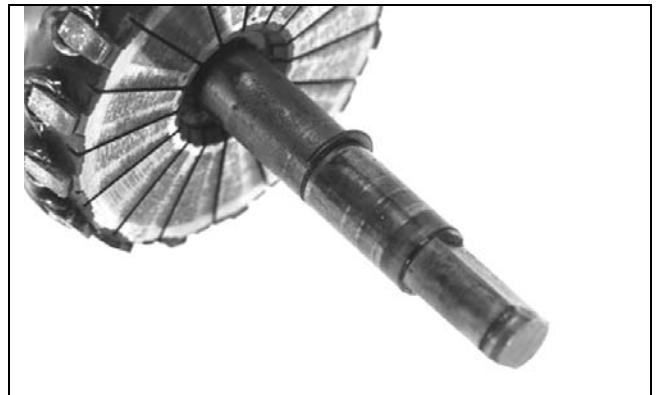
Starter Cleaning and Inspection

Inspect the brushes for wear and damage. Replace brushes if damaged or worn. Replace weak brush springs.



30349

Inspect and replace locating ring on armature shaft, if necessary.



30345

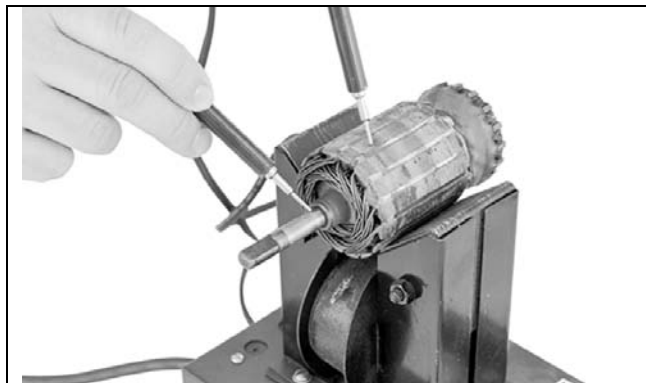
Clean the commutator with 300-grade emery cloth. If commutator surface is unevenly worn or pitted, turn it on a lathe. Remove any trace of oil or metal dust from the commutator.

Check the armature on a growler for shorted turns using a test light or meter. Inspect armature insulation for indications of overheating or damaged windings. Clean off any carbon deposits or foreign

ELECTRICAL AND IGNITION

ELECTRIC STARTER SERVICING

matter which could contribute to failure of windings.



TYPICAL

24058

Check permanent magnets. Make sure they strongly attract any steel or iron object held inside frame. Weak magnetism could cause excessive RPM on **No Load Current Draw Test** on p. 101.



TYPICAL

24057

After disassembling the drive, clean each part with *Cleaning Solvent* and inspect for wear and distortion.

If the pinion does not properly engage the fly-wheel, the pinion and screw shaft assembly could be worn, distorted, or dirty. Locate the cause of binding and correct it before completing the assembly.

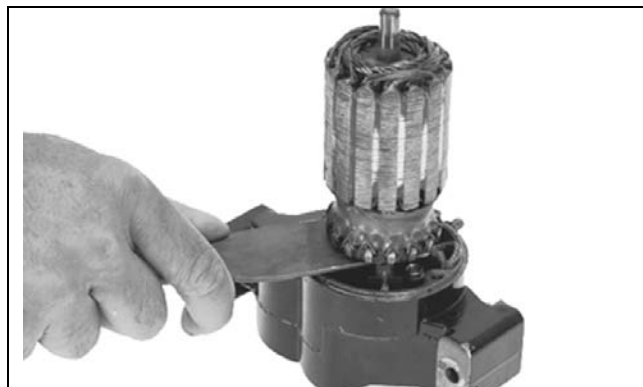
Inspect and replace end cap thrust washer if distorted or worn excessively.

Inspect and replace armature shaft snap ring if worn or distorted.

Starter Assembly

IMPORTANT: If removed, apply *Locquic Primer* and *Screw Lock* to the brush card screws before installing.

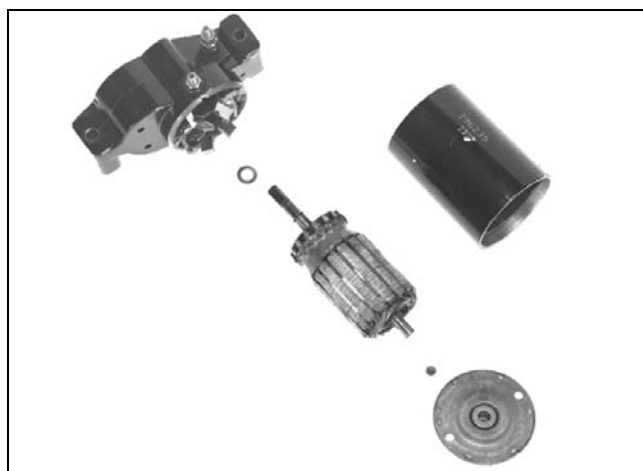
Route the brush leads and install the springs and brushes. Compress the spring with a modified putty knife.



30364

IMPORTANT: Incorrect orientation of the brushes could damage the starter or cause reverse rotation.

Apply *Moly Lube* to the armature bushing. Install the thrust washer and armature.



30351

ELECTRICAL AND IGNITION

ELECTRIC STARTER SERVICING

Align the starter frame and make sure the long alignment mark matches the mark next to the positive terminal stud on the gear housing.

Push the armature down firmly and slide the frame into place. Align the notches in the gear housing and frame.



30352

Install insulator cap on end of shaft.



30354B

Apply a light coat of *Moly Lube* to the end cap bearing, and install the end cap.

Install the two thru-bolts. Tighten to a torque of 50 to 65 in. lbs. (5.6 to 7.3 N·m).



30363

Lightly coat the drive gear with *Triple-Guard* grease, and install it on the armature shaft. Install the retaining ring (flat side up) with No. 2 external retaining ring pliers.



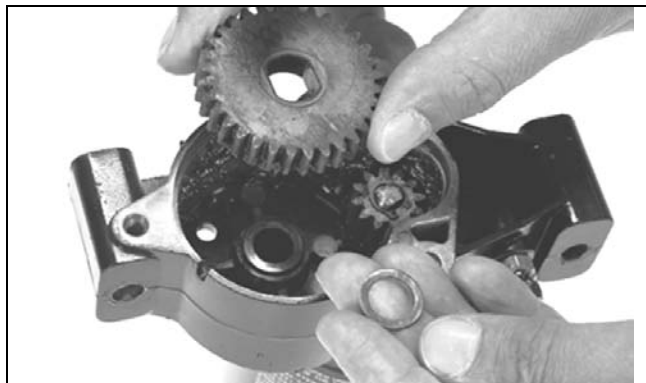
30366

Lightly coat the gear housing bearing with *Moly Lube*. Lightly coat the driven gear with *Triple-*

ELECTRICAL AND IGNITION

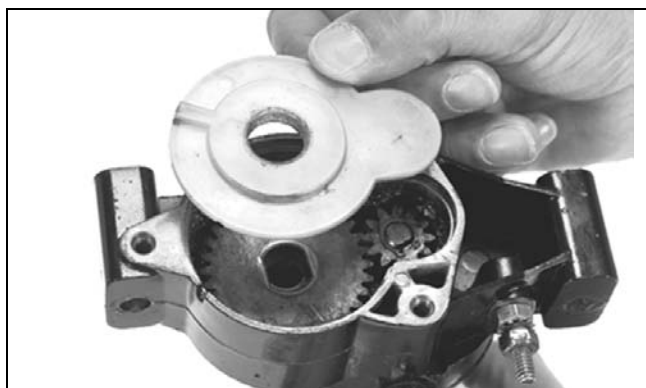
ELECTRIC STARTER SERVICING

Guard grease. Install the thrust washer and driven gear.



30362

Install the weather cover.



30361

If removed, install the spring and spacer (large diameter up) on the pinion shaft. Secure with retaining ring. Install bushing and wave washer (convex side down).



30369

Lightly coat the pinion shaft splines (helix) with *Starter Bendix Lube*. Lower the pinion into place without displacing the driven gear or thrust washer.



30359

Lightly coat the pinion housing bearing with *Starter Bendix Lube*, and install the pinion housing screws and lock washers. Tighten the screws to a torque of 60 to 84 in. lbs. (7 to 9.5 N·m).



30358

Install the bracket. Apply *Nut Lock* to the thru-bolts. Install the nuts and tighten to a torque of 50 to 65 in. lbs. (5.6 to 7.3 N·m).



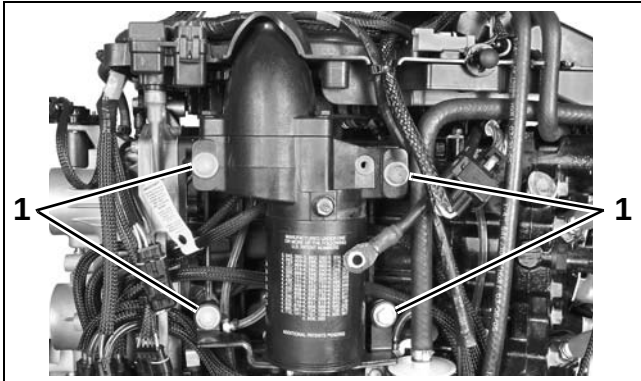
30357

To test the assembly and operation of the starter, refer to **No Load Current Draw Test** on p. 101.

Starter Installation

Apply *Locquic Primer* and *Nut Lock* to the threads of the four starter mounting screws. Position the starter and install the screws and lock washers.

First, tighten the top two screws, then the bottom two screws, to a torque of 168 to 192 in. lbs. (19.0 to 21.5 N·m).



1. Screws

005373

Attach starter positive (+) cable to post with lock washer and nut; tighten securely. Coat connections with *Black Neoprene Dip*.

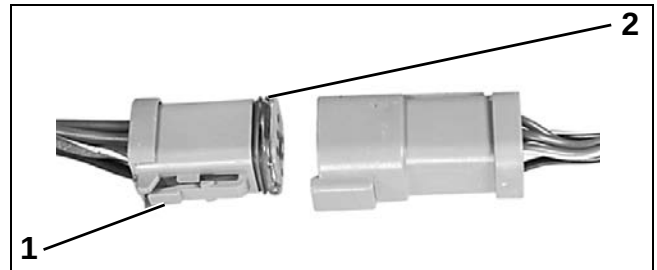
CONNECTOR SERVICING

DEUTSCH Connectors

IMPORTANT: *Electrical Grease* is recommended. Incorrect grease application can cause electrical or warning system problems.

To disconnect the connector, press the latch and pull the connectors apart.

To connect the connector, confirm that the seal is in place. Clean off any old grease and dirt from connectors. Apply a light coat of *Electrical Grease* to seal only. Push connectors together until latched.

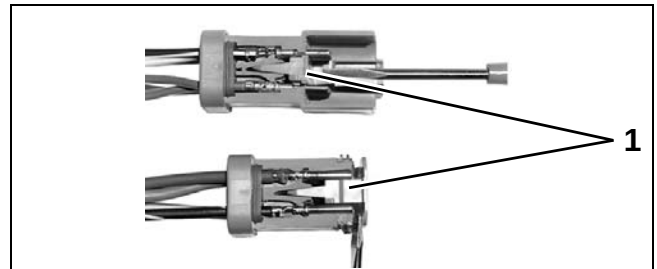


1. Latch
2. Seal

42079A

Terminal Removal

Use hook-end of Connector Service Tool, P/N 342667, to pull out wedge from receptacle, or use other end of tool to pry out wedge from plug. Use needle-nose pliers to remove wedge from 3-pin receptacle.

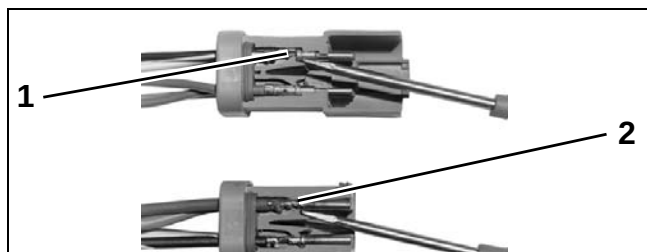


1. Wedge

42327

ELECTRICAL AND IGNITION CONNECTOR SERVICING

Release terminal latch and gently pull on wire.

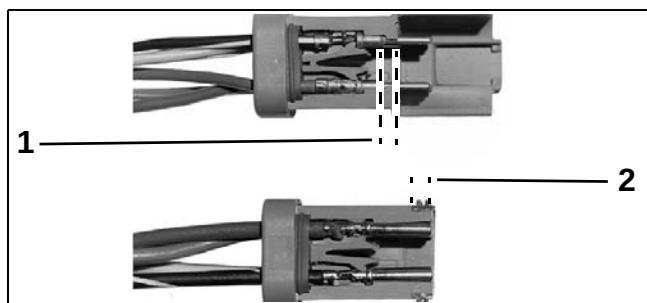


1. Terminal latch (receptacle)
2. Terminal latch (plug)

42329

Terminal Installation

Push terminal through seal until it locks into place. Fill connector with *Electrical Grease* to 1/32 in. (0.8 mm) below ledge or end of plug.



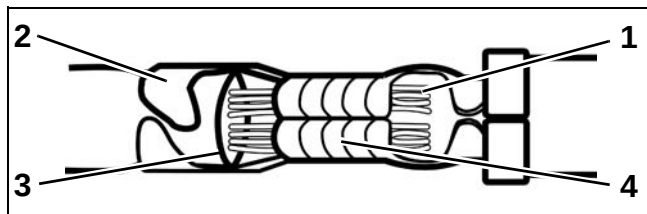
1. Ledge of plug
2. End of plug

42330

Push wedge in until latched. Wedge in 2-pin receptacle is not symmetrical; position latch shoulders next to terminals.

Crimping Terminals

Strip insulation back 3/16 in. (5 mm). Place terminal in 18-gauge notch of Crimping Pliers, P/N 322696. Position end of wire strands in terminal past wire crimp area, and position end of insulation past insulation crimp area. Capture all wire strands in crimp; leave no loose strands. Crimp wire securely. Do not solder. Crimp insulation in 14/16-gauge notch of crimping pliers.



1. End of wire strands
2. Insulation crimp area
3. End of insulation
4. Wire crimp area

DRC6205

AMP Connectors

IMPORTANT: Always use the appropriate meter test probes and adapters when testing components fitted with these terminals. Electrical grease is NOT used on AMP connectors.

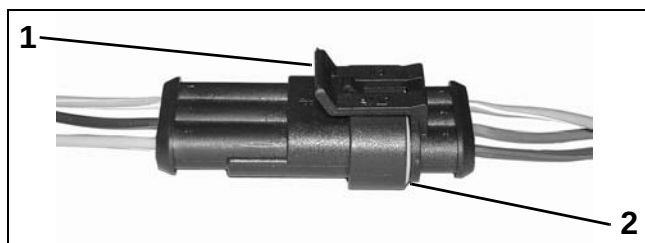
SUPERSEAL 1.5

Disconnect

Lift latch. Pull connectors apart.

Connect

Confirm the seal is in place. Push connectors together until latched.

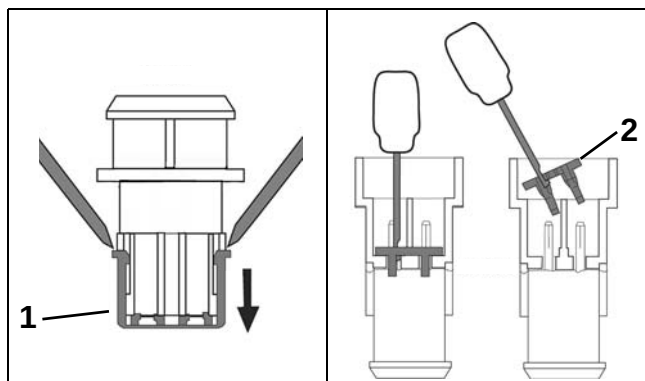


1. Latch
2. Seal

002448

Terminal Removal

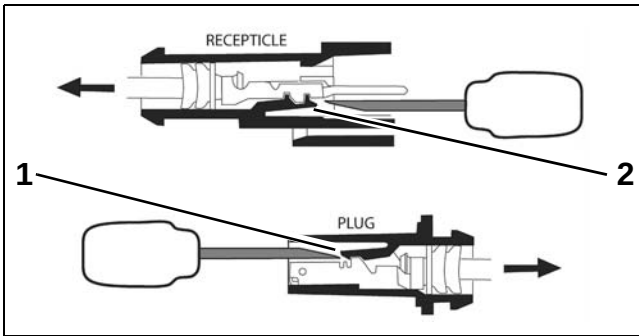
Use Secondary Lock Tool, P/N 777078, to release anti-backout device of connector housing. Next, use Primary Lock Tool, P/N 777077, to release locking tab of connector housing. Release locking tab and pull on wire to remove from connector housing.



1. Anti backout device, plug
2. Anti backout device, receptacle

002449

002450



1. Locking tab, plug
2. Locking tab, receptacle

002447

Terminal Installation

Align terminal with connector housing. Push connector and seal into housing until seated.



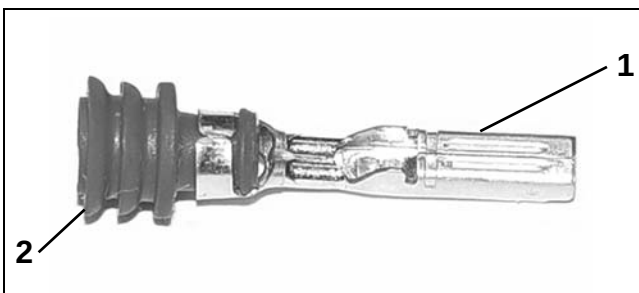
1. Terminal and seal

002451

Align anti-backout device with connector housing and terminals. Use Secondary Lock Installer, P/N 777079, to seat device in connector.

Crimping Terminals

Crimping *Superseal 1.5* terminals requires AMP Crimp Tool with dies, P/N 777281.



1. Terminal
2. Seal

002452

SUPER SEAL

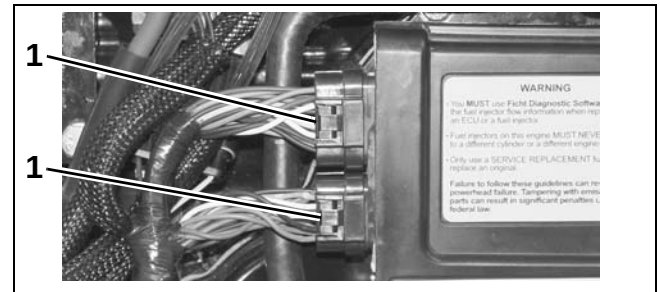
The J1-A and J1-B connectors of the *EMM* are AMP Super Seal connectors.

Disconnect

Depress BOTH latches and pull connector from plug.

Connect

Push connector into plug until latches engage.

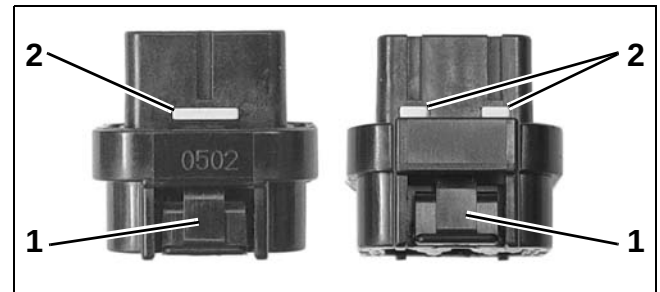


1. Latch

002118

Terminal Removal

Open lock mechanism and remove terminal from connector housing.

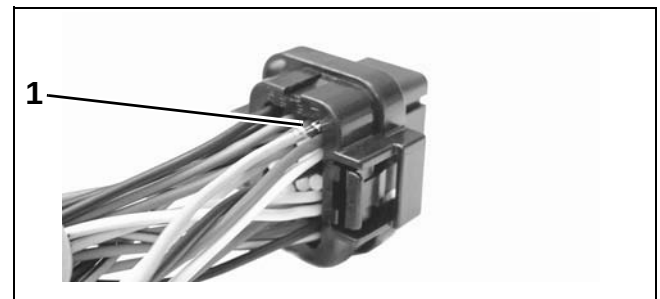


1. Latch
2. Lock mechanism

002453

Terminal Installation

Push terminal through seal until it is seated in connector housing. Close lock mechanism.



1. Terminal

002454

ELECTRICAL AND IGNITION CONNECTOR SERVICING

POWER TIMER SERIES

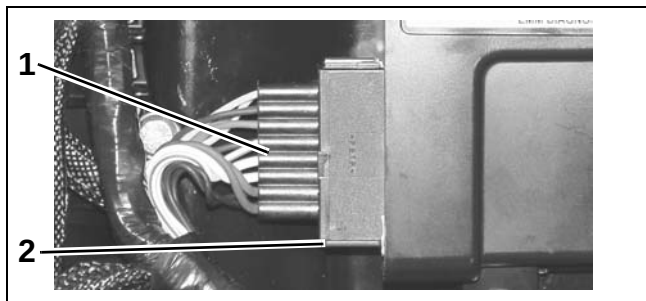
The J2 connector of the *EMM* is a *AMP Power Timer Series* connector.

Disconnect

Use a screw driver to open latch. Pull connector from plug.

Connect

Push connector until seated in plug. Close latch completely.

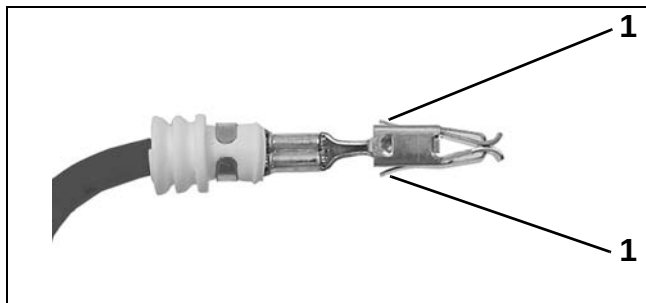


1. J2 connector
2. Latch (closed)

002120

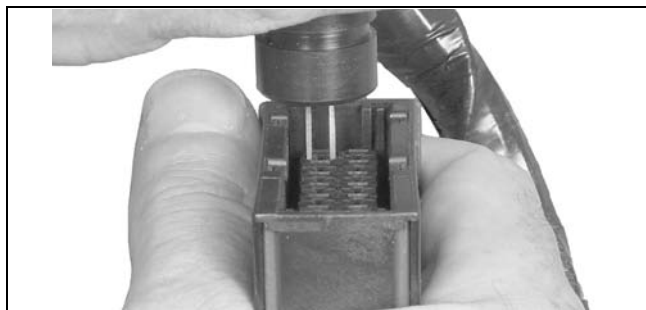
Terminal Removal

Use Terminal Release Tool, P/N 351413, to release BOTH locking mechanisms of connector. Pull terminal from housing.



1. Locking mechanism(s)

002455

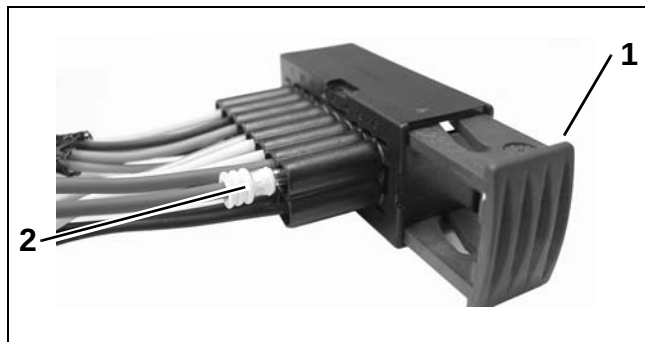


1. Terminal release tool

002313

Terminal Installation

Align terminal with connector housing and push terminal with seal into connector housing until seated.



1. Latch
2. Terminal with seal

002456

Packard Connectors

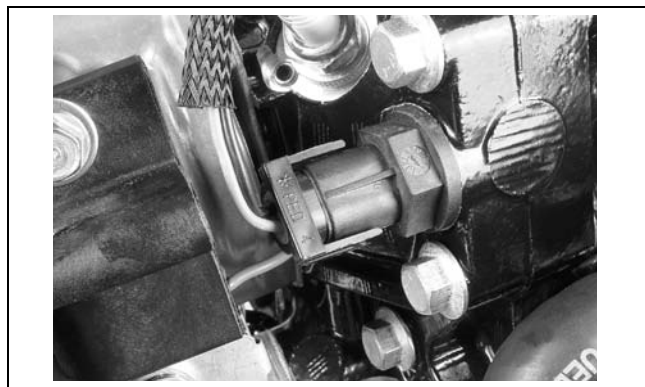
IMPORTANT: Always use the appropriate meter test probes and adapters when testing components fitted with these terminals.

Disconnect

Lift latch(s). Remove connector.

Connect

Confirm the seal is in place. Push connector onto housing until latched.

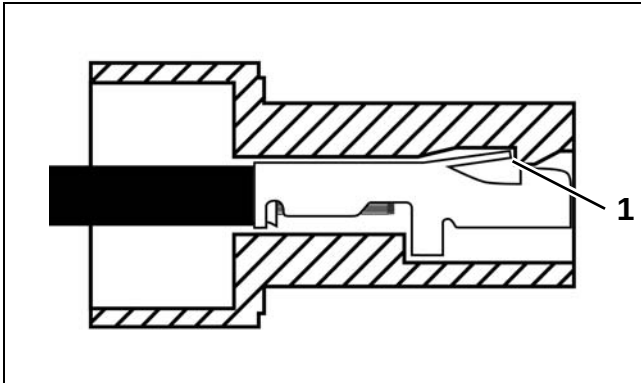


DSC02124

Terminal Removal

A tab on the back side of the terminal engages a shoulder in the connector housing to hold the terminal in place. The terminal is removed by releasing the tab and then pushing the terminal and wire through connector housing.

Insert a thin tool into the connector above the terminal to release tab.



1. Tab

DRC5940a

Terminal Installation

Install wire gasket on wires and feed wires through the correct terminal position of the connector housing. Terminal is crimped onto wire and then pulled back into connector housing until locking tab engages and terminal is seated.



002304

Crimping Terminals

Strip insulation back 3/16 in. (5 mm). Position end of wire strands in terminal past the wire crimp area and the end of insulation in the insulation crimp area of the terminal.

Capture all wire strands in crimp; leave no loose strands. Crimp wire and insulation securely using crimping pliers.

NOTES

Technician's Notes

[illegible]

Related Documents

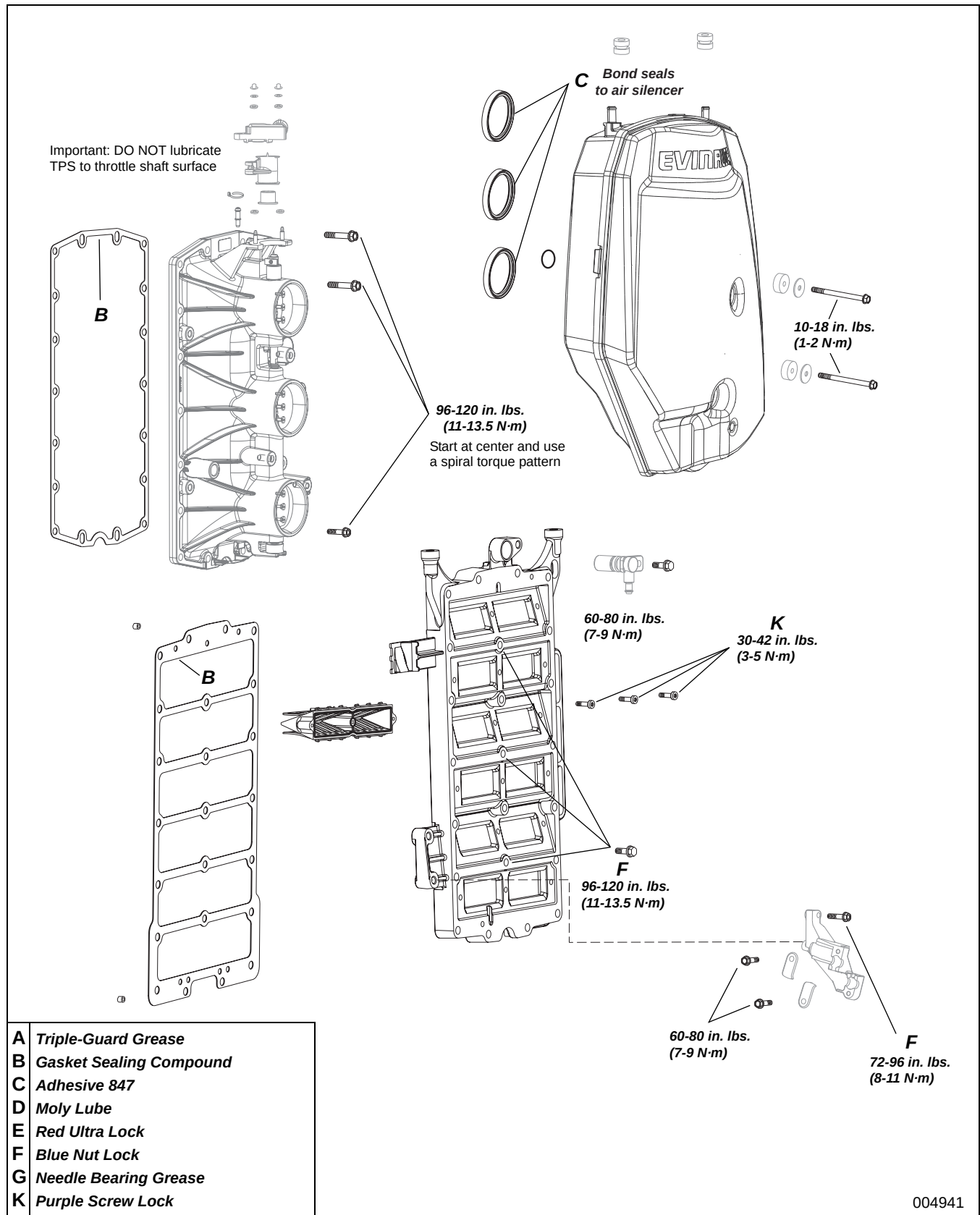
[illegible]

FUEL SYSTEM

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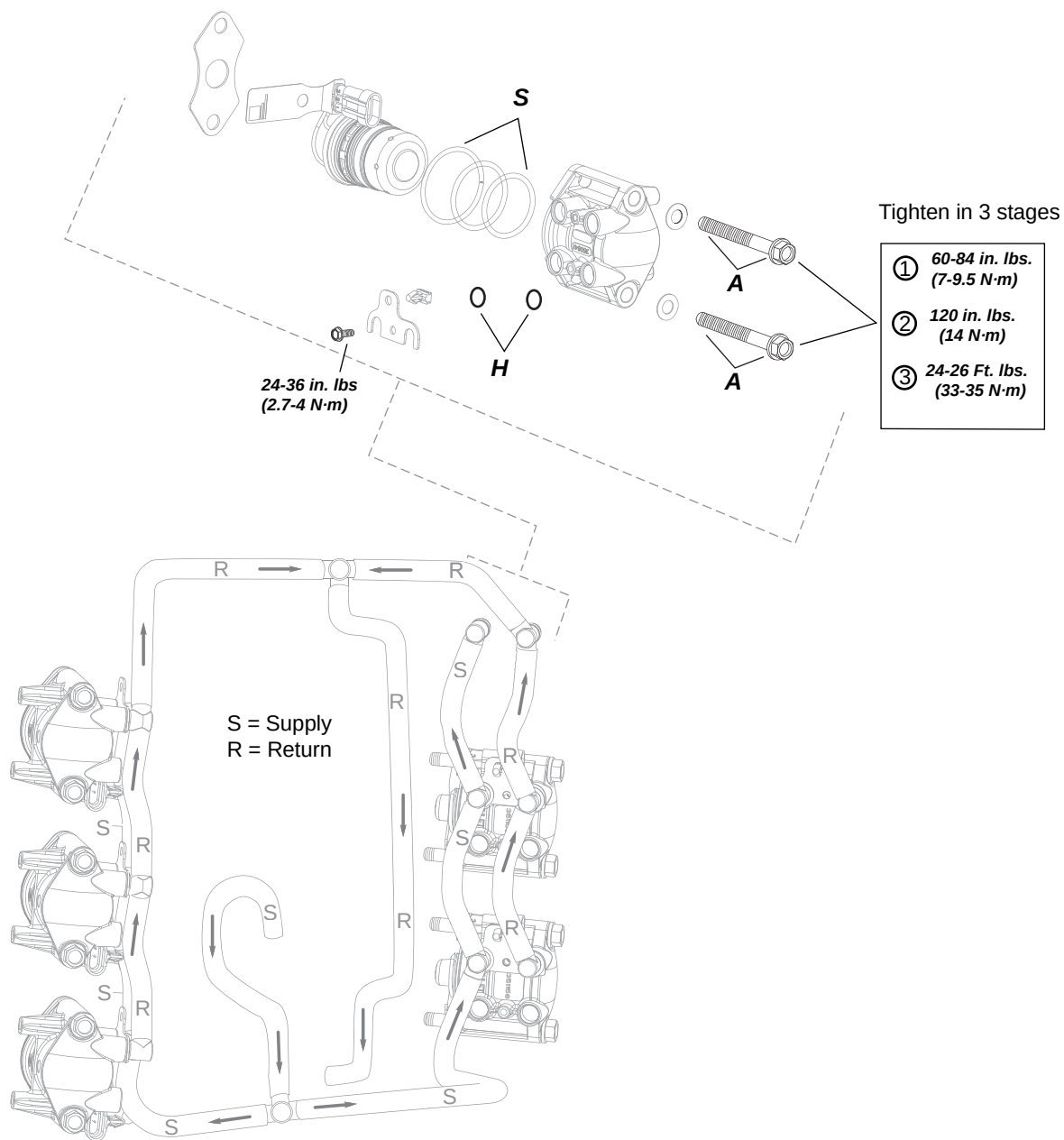
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REED PLATE ASSEMBLY AND THROTTLE BODY



FUEL SYSTEM SERVICE CHART

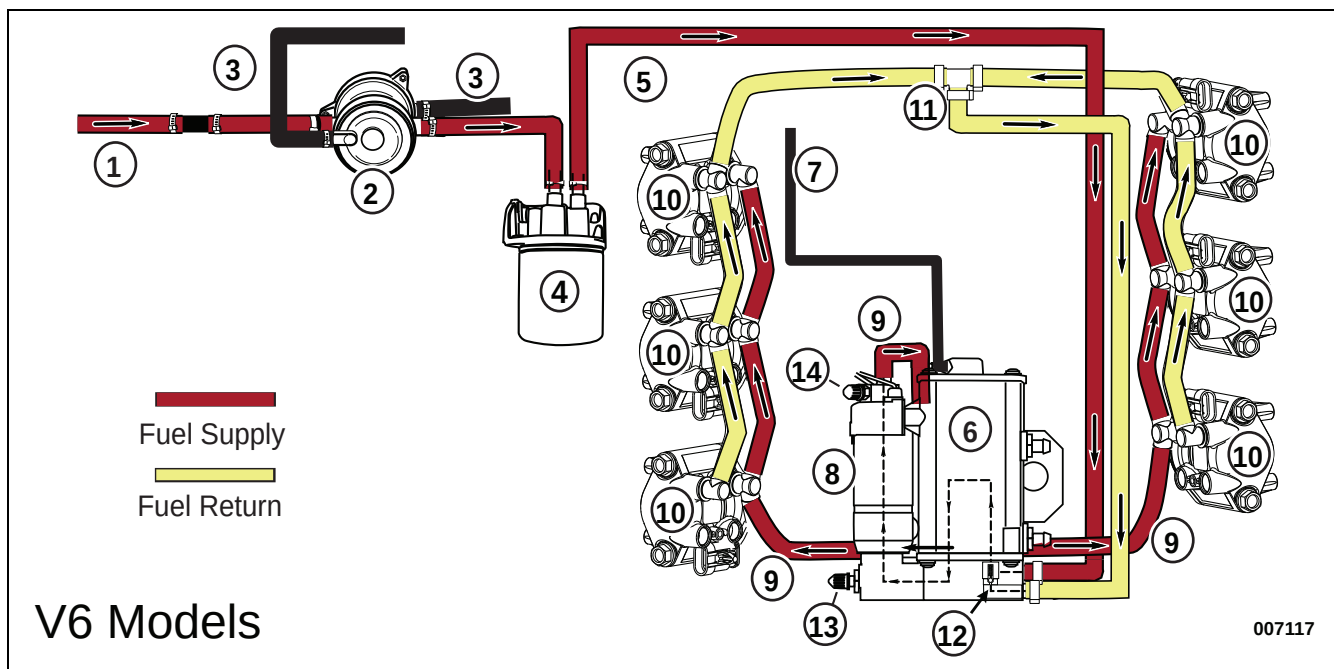
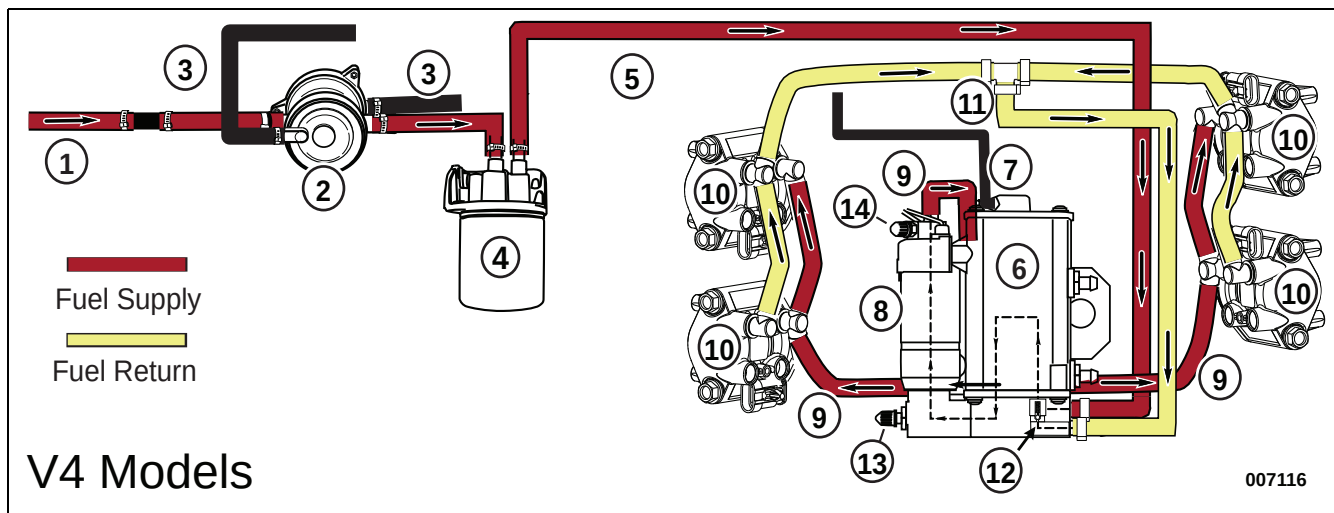
FUEL MANIFOLDS AND INJECTOR



- A** Triple-Guard Grease
- B** Gasket Sealing Compound
- C** Adhesive 847
- D** Moly Lube
- E** Red Ultra Lock
- F** Blue Nut Lock
- G** Needle Bearing Grease
- H** Outboard Engine Lubricant
- S** STP Oil Treatment

004942

FUEL SYSTEM HOSE ROUTING

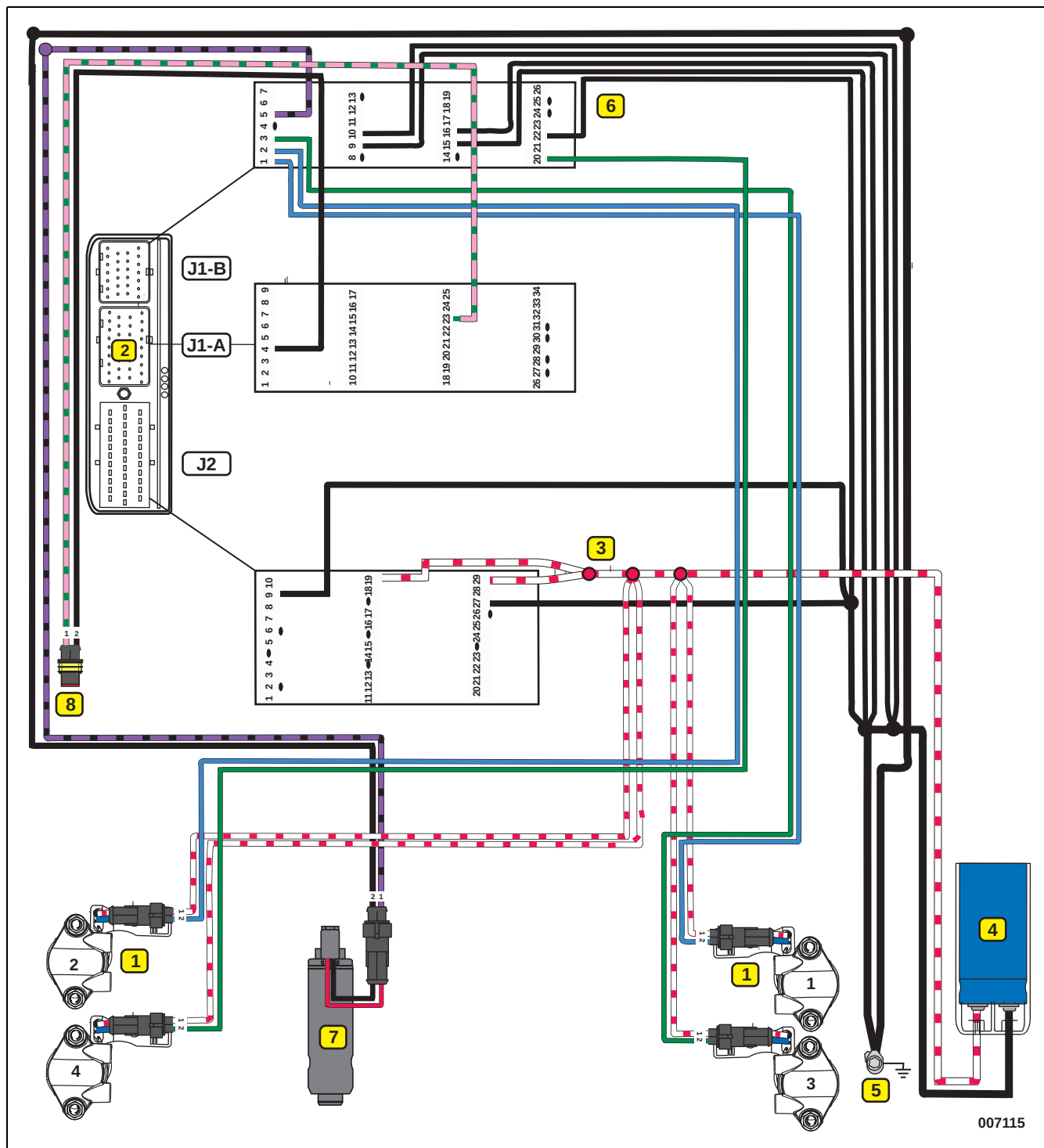


- | | |
|--|--|
| 1. Fuel supply from boat fuel system | 8. Electric fuel circulation pump (20 to 35 psi) |
| 2. Fuel lift pump (2 to 8 psi) | 9. Fuel supply manifold |
| 3. Pulse hose(s) from cylinder/crankcase | 10. Fuel injector(s) |
| 4. Fuel filter | 11. Fuel return manifold |
| 5. Fuel supply to vapor separator | 12. Pressure regulator (high pressure) |
| 6. Vapor separator | 13. Test fitting (low pressure) |
| 7. Vent hose to throttle body | 14. Test fitting (high pressure) |

FUEL SYSTEM

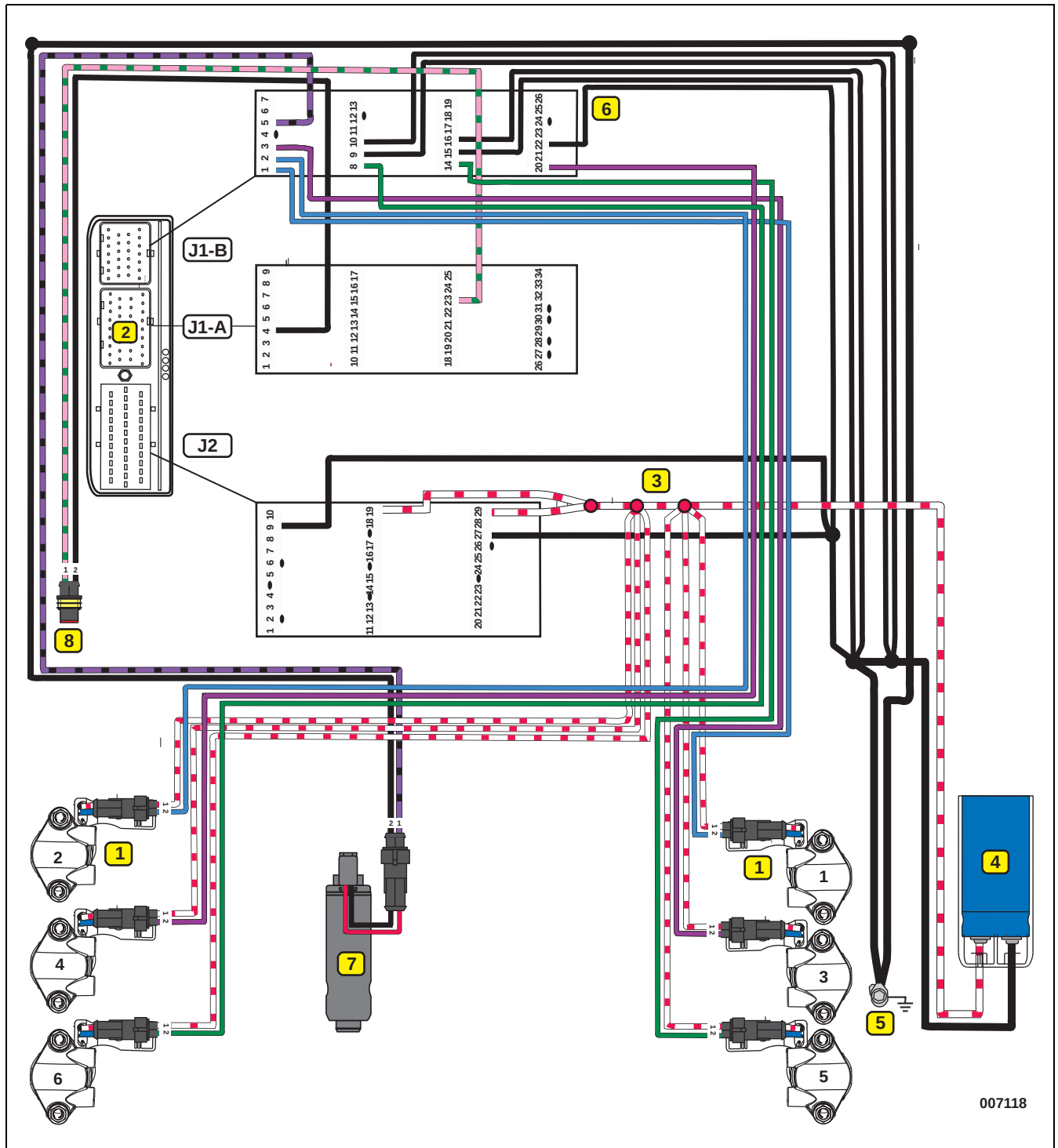
FUEL SYSTEM CIRCUIT DIAGRAM – V4

FUEL SYSTEM CIRCUIT DIAGRAM – V4



- | | | |
|-----------------------------|--------------------------|--------------------------------|
| 1. Injectors | 4. Capacitor | 7. High pressure fuel pump |
| 2. EMM | 5. Grounds (neg) | 8. Fuel filter/water separator |
| 3. 55 V circuit (white/red) | 6. Fuel Injector grounds | |

FUEL SYSTEM CIRCUIT DIAGRAM – V6



- | | | |
|-----------------------------|--------------------------|--------------------------------|
| 1. Injectors | 4. Capacitor | 7. High pressure fuel pump |
| 2. <i>EMM</i> | 5. Grounds (neg) | 8. Fuel filter/water separator |
| 3. 55 V circuit (white/red) | 6. Fuel Injector grounds | |

FUEL SYSTEM REQUIREMENTS

Regulations and Guidelines

Vessel manufacturer, and/or installer of an EPA certified outboard, must meet minimum specifications for boat fuel systems established by:

- U.S. Environmental Protection Agency (EPA)
 - 40 CFR 1045.112
 - 40 CFR 1060
- U.S. Coast Guard (USCG)
 - 33 CFR 183
- American Boat & Yacht Council (ABYC)
 - Standard H-24
 - Standard H-25.

Portable Fuel Tanks

WARNING

If engine is equipped with a quick-disconnect fuel hose, you **MUST** disconnect the fuel hose from the engine and the fuel tank to prevent fuel leaks:

- Whenever the engine is NOT being used
- Whenever the engine is being trailered
- Whenever the engine is in storage.

NOTE: A small amount of fuel may be released when the fuel connector is disconnected.

Store portable fuel tanks in well-ventilated areas, away from heat sources and open flames. Close the vent screw of the fuel tank cap, if equipped, to prevent escape of fuel or fuel vapors which could accidentally ignite. Do not allow disconnected fuel hoses to leak fuel.

NOTICE Do not use portable fuel tanks for outboards larger than 115 HP. Inadequate fuel flow to high horsepower outboards can result in serious powerhead damage.

Fuel Flow Requirements

	15 – 30 HP	40 – 90 HP	115 – 300 HP
Fuel tank pickup tube	1/4 in. (6.4 mm) min. ID	5/16 in. (7.9 mm) min. ID	3/8 in. (9.5 mm) min. ID
Fuel fittings	5/32 in. (4.1 mm) min. ID	1/4 in. (6.4 mm) min. ID	9/32 in. (7.1 mm) min. ID
Fuel supply hoses	1/4 in. (6.4 mm) min. ID	3/8 in. (9.5 mm) min. ID	3/8 in. (9.5 mm) min. ID
	ALL MODELS		
Fuel tank pickup screen	100 mesh, 304 grade stainless steel wire, 0.0045 in. wire diameter, 1 in. (25 mm) long		
Antisiphon valve	2.5 in. (63.5 mm) Hg maximum pressure drop at 20 gph (76 l/hr) flow		
Remote fuel filter	0.4 in. Hg maximum pressure drop at 20 gph (76 l/hr) flow, 150 in. ² (1290 cm ²) of filter area		
Maximum fuel pump lift height	Fuel pump should not be located more than 30 in. (76.2 cm) above bottom of fuel tank		

Fuel Requirements

WARNING

Gasoline is extremely flammable and highly explosive under certain conditions. Improper handling of fuel could result in property damage, serious injury or death.

Always turn off the outboard before fueling.

Never permit anyone other than an adult to refill the fuel tank.

Do not fill the fuel tank all the way to the top or fuel may overflow when it expands due to heating by the sun.

Remove portable fuel tanks from the boat before fueling.

Always wipe off any fuel spillage.

Do not smoke, allow open flames or sparks, or use electrical devices such as cellular phones in the vicinity of a fuel leak or while fueling.

Minimum Octane

Evinrude/Johnson outboards are certified to operate on unleaded automotive gasoline with an octane rating equal to or higher than:

- 87 (R+M)/2 AKI, or
- 90 RON

Use unleaded gasoline that contains methyl tertiary butyl ether (MTBE) **ONLY** if the MTBE content does not exceed 15% by volume.

Use alcohol-extended fuels **ONLY** if the alcohol content does not exceed:

- 10% ethanol by volume
- 5% methanol with 5% cosolvents by volume

When using alcohol-extended fuels, be aware of the following:

- The boat's fuel system may have different requirements regarding the use of alcohol fuels. Refer to the boat's owner guide.
- Alcohol attracts and holds moisture that can cause corrosion of metallic parts in the fuel system.
- Alcohol blended fuel can cause engine performance problems.
- All parts of the fuel system should be inspected frequently and replaced if signs of deterioration or fuel leakage are found. Inspect at least annually.

IMPORTANT: Always use fresh gasoline. Gasoline will oxidize, resulting in loss of octane and volatile compounds, as well as the production of gum and varnish deposits which can damage the outboard.

Additives

IMPORTANT: The only fuel additives approved for use in *Evinrude* outboards are 2+4® fuel conditioner and *Evinrude/Johnson* Fuel System Cleaner. **Use of other fuel additives can result in poor performance or engine damage.**

***Evinrude/Johnson* 2+4 Fuel Conditioner** will help prevent gum and varnish deposits from forming in fuel system components and will remove moisture from the fuel system. It can be used continuously and should be used during any period when the outboard is not being operated on a regular basis. Its use will reduce spark plug fouling, fuel system icing, and fuel system component deterioration.

***Evinrude/Johnson* Fuel System Cleaner** will help keep fuel injectors in optimal operating condition.

FUEL SYSTEM COMPONENTS

COMPONENTS

The fuel system includes the following components:

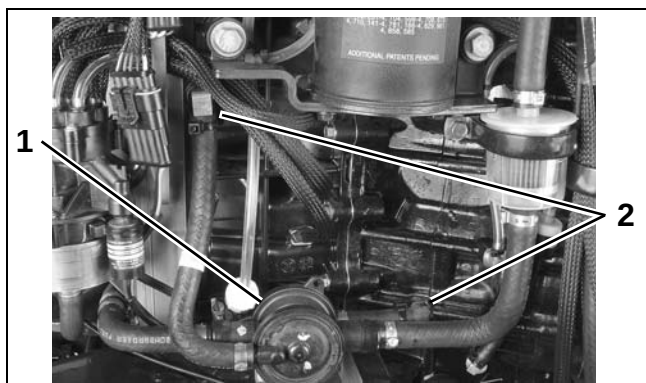
- Fuel Lift Pump
- Fuel Filter
- Vapor Separator
- Fuel Circulation Pump
- Fuel Supply Manifolds
- Fuel Injectors
- Fuel Return Manifolds

Fuel Lift Pump

The fuel lift pump is a mechanical, pressure-pulse pump. The diaphragm of the pump is driven by two pulse hoses that connect to the cylinder/crankcase assembly.

Fuel lift pump pulse hose locations:

- **V4 models:** Cylinders 2 and 4
- **60° V6 models:** Cylinders 4 and 6



1. Fuel lift pump
2. Pulse hose fittings

005261

Vacuum from the fuel lift pump pulls fuel from the fuel tank. Once fuel reaches the pump, internal pump pressure forces the fuel from the pump through the fuel filter and into the vapor separator.

Fuel Filter

The fuel filter protects the vapor separator and the high-pressure components of the fuel system from contaminants. Refer to **INSPECTION AND MAINTENANCE SCHEDULE** on p. 14 for service frequency.



1. Water-separating fuel filter

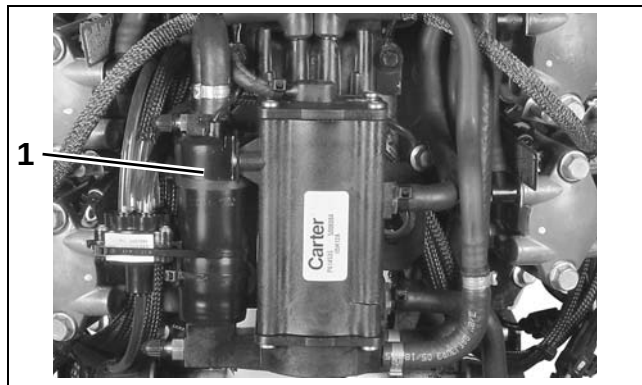
005237

Vapor Separator

The vapor separator:

- Serves as a water-cooled fuel reservoir to accumulate incoming fuel from the fuel lift pump and from the fuel return manifold
- Contains a float controlling the venting of fuel vapors
- Contains a fuel pressure regulator for the high pressure fuel system.

The vapor separator is serviced as an assembly and includes the fuel circulation pump.



Vapor Separator Assembly

1. Circulation pump

005322

Fuel Reservoir

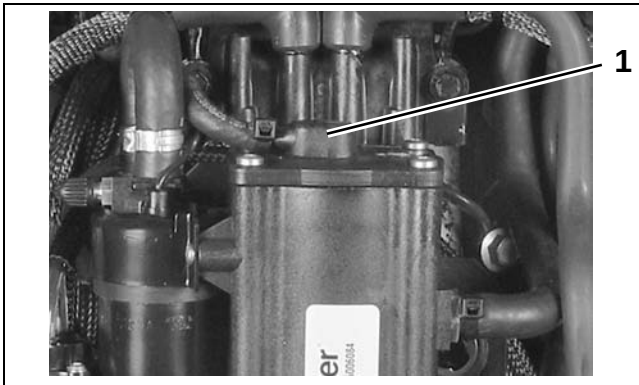
The vapor separator accumulates fuel in an internal fuel reservoir and supplies fuel to the electric circulation pump. It is water-cooled to enhance vapor separating capabilities.

Cooling

Water is used to cool the fuel as it flows through the vapor separator. The cooling passage of the separator self-drains when the outboard is stored vertically. Refer to **HOSE ROUTING AND WATER FLOW DIAGRAMS** on p. 184.

Venting

The fuel vapor vent regulates fuel vapor pressure in the reservoir.



1. Vent

005323



1. Vent hose connection to intake

005326

The vapor separator vent is opened and closed by a float valve. The float valve moves relative to the fuel level in the fuel chamber. Hot fuel causes an increase in vapor pressure. This results in a lower fuel level in the vapor separator. The float valve drops and the vent opens. This allows fuel vapor

to flow to the intake manifold through the vent hose.

As the vapor pressure in the vapor separator decreases, the fuel level begins to increase. An increase in the fuel level raises the float valve and the vent closes.

Pressure Regulator

The fuel pressure regulator helps maintain consistent fuel pressure in the fuel system.

Fuel returning from the injectors enters the fuel chamber of the vapor separator through a pressure regulator. The pressure regulator maintains approximately 20 to 30 psi (138 to 207 kPa) of fuel pressure in the high pressure side of the fuel system.

Fuel Circulation Pump

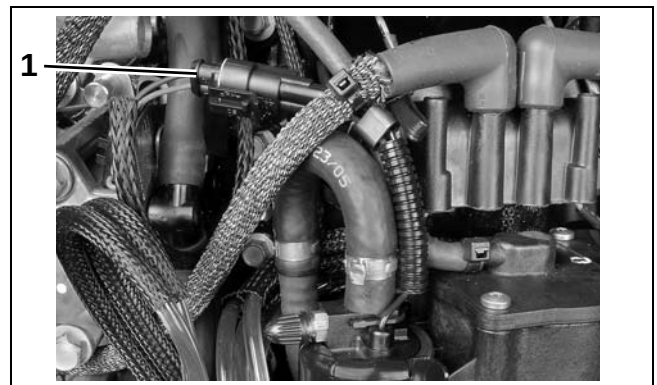
The fuel circulation pump is an electric high pressure fuel pump.

Fuel Supply

The pump is mounted to the vapor separator and draws fuel from the fuel chamber. It pumps pressurized fuel through a fuel supply manifold connected to the fuel injectors.

Electrical Circuit

The circulation pump is controlled by the *EMM* and operates on the 12 V circuit. The circulation pump is activated momentarily when the *EMM* powers up. The *EMM* controls pump operation by rapidly connecting and disconnecting the pump's internal coil to ground.



1. Fuel pump electrical connector

005327

FUEL SYSTEM COMPONENTS

Fuel Manifolds

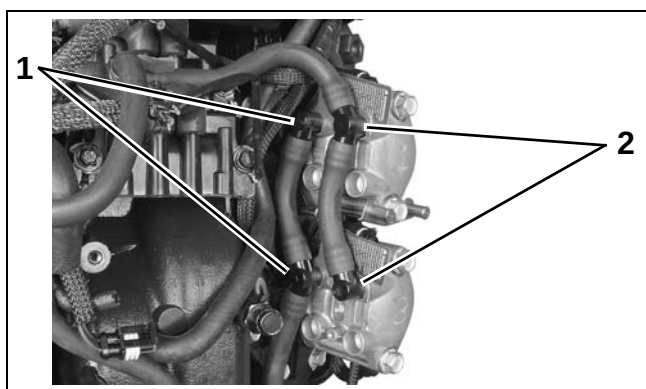
The fuel supply and return manifolds route fuel through the high pressure side of the fuel system.

Fuel Supply Manifold

The fuel supply manifold supplies pressurized fuel to the inlet port of each fuel injector.

Fuel Return Manifold

The fuel return manifold provides a route for fuel passing through the fuel injectors to flow back to the fuel chamber of the vapor separator.



1. Fuel supply
2. Fuel return

005332

Fuel Injectors

Fuel injectors are fuel metering, electric solenoids (55 V) bolted directly to the cylinder head. The *EMM* controls the activation of each injector by rapidly connecting and disconnecting the injector's internal coil to ground.

Fuel Flow Compensation

The flow rate of each injector is measured as part of the manufacturing process. This information is recorded and assigned to the injector by serial number.

The *EMM* is programmed to compensate for variations in fuel flow. Each injector and its location on the outboard is identified by the *EMM*. DO NOT install an injector without updating the compensation software.

Each service injector includes its fuel flow information on a 3.5 in. floppy disk. This software allows the *EMM* to be reprogrammed for this injector's unique fuel flow characteristics.

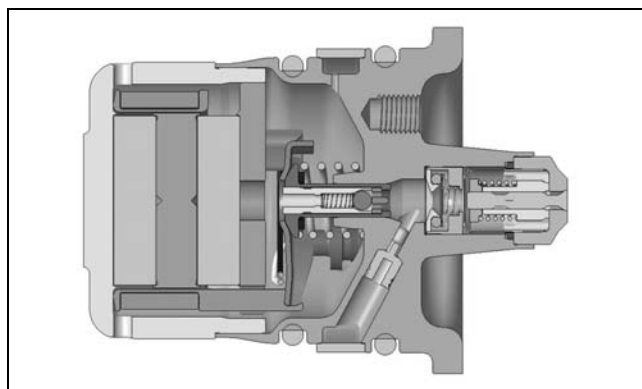
NOTICE Fuel injectors **MUST NOT** be moved from one cylinder to another. *EMM* programming is associated with the cylinder location of each injector. Installing an injector on the wrong cylinder can result in powerhead failure.

Injector Fuel Supply

Fuel is supplied to the injectors by the fuel circulation pump and the fuel supply manifold.

Each injector has internal fuel passages. These passages are designed to:

- Provide fuel to the injector's injection chamber
- Route fuel through the injector housing to cool the injector coil and armature

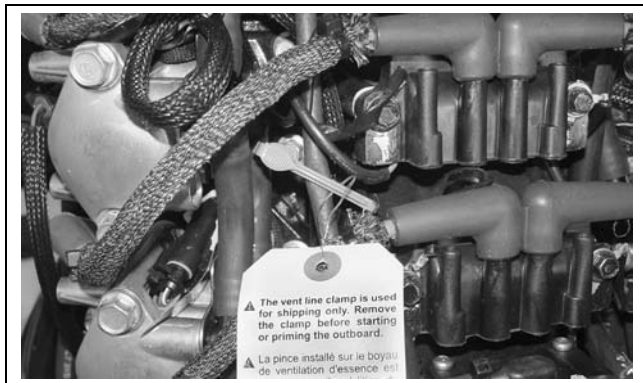


006619

FUEL SYSTEM PRIMING

Vent Line Clamp

Federal Regulations require that all outboards with a fuel vapor separator must be shipped with a vent line clamp installed. This clamp must be removed before priming the fuel system or starting the outboard for the first time.



004963

IMPORTANT: Failure to remove the clamp may cause fuel starvation and poor running qualities.

Priming the Fuel System

WARNING

Fuel vapors are highly flammable. Perform the following procedure in a well ventilated area. Extinguish all smoking materials and make certain no ignition sources are present.

Insert the fuel supply hose from the fuel tank into a suitable container. Squeeze the fuel primer bulb or activate the boat-mounted electric fuel primer until fuel flows from the fuel hose.

Once fuel flow is observed, connect fuel supply hose from fuel tank to hose fitting on outboard. Secure hose with *Oetiker* clamp.

Use the primer to fill the vapor separator.

The high-pressure fuel circuits and injectors will prime as the outboard is cranked with the starter.

Observe all fuel lines, both in the boat and on the outboard. Repair any fuel leaks.

WARNING

Failure to check for fuel leaks could allow a leak to go undetected, resulting in fire or explosion and may cause personal injury or property damage.

FUEL SYSTEM TESTS

⚠ WARNING

Use caution when working on any pressurized fuel system. Wear safety glasses and work in a well ventilated area. Extinguish all smoking materials and make certain no open flames or ignition sources exist. Before starting any fuel system service, carefully relieve fuel system pressure. Failure to properly relieve fuel system pressure can result in spraying fuel and/or excessive fuel spillage during servicing. Fuel is flammable and can be explosive under certain conditions.

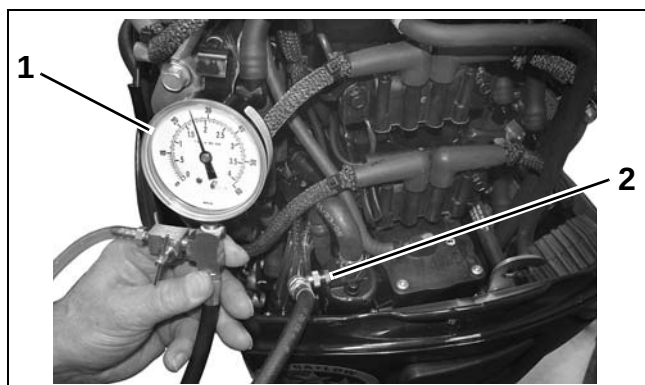
Fuel System Pressure Test

Relieve fuel system pressure. See **Relieving Fuel System Pressure** on p. 146.

⚠ WARNING

Protect against hazardous fuel spray. Before starting any fuel system service, carefully relieve fuel system pressure.

After relieving fuel system pressure, install a 0 to 60 psi (0 to 415 kPa) Fuel Pressure Gauge, P/N 5007100 or equivalent, to the upper fuel pressure test fitting.



1. Fuel pressure gauge
2. Test fitting

005432

START outboard and check pressure. System pressure should be 20 to 35 psi (138 to 241 kPa).

Shut OFF outboard. Monitor pressure gauge. Pressure should not drop below 15 psi (103 kPa).

IMPORTANT: If outboard does not run, prime fuel system and crank outboard; check circulation pump operation; check fuel system pressure.

Results:

Normal pressure

- Observe pressure reading after outboard is shut OFF.
- Refer to **Lift Pump Pressure Test** on p. 144.

Pressure drops after outboard is shut OFF:

- Check for leaking fuel injector.
- Check for leaking pressure regulator.
- Check for external fuel system leak.

High pressure:

- Check for restricted filter or fuel return fitting of vapor separator, damaged pressure regulator in vapor separator, or restricted fuel return manifold.

Low pressure

- Check fuel supply to fuel lift pump. Refer to **Lift Pump Vacuum Test** on p. 145. Higher vacuum readings indicate restrictions in the fuel supply. Repair or replace as needed.
- Restricted fuel filter/water separator assembly.
- Lift pump not supplying enough fuel to vapor separator. Refer to **Lift Pump Pressure Test** on p. 144.
- If the above tests are good and vapor separator remains full of fuel, check for damaged circulation pump. Replace vapor separator assembly.

No pressure:

- Check electrical circuit and ground connections for circulation pump.
- If voltage is present and pump does not run, repair connection or replace vapor separator assembly.

Relieve fuel system pressure before removing fuel pressure gauge. Refer to **Relieving Fuel System Pressure** on p. 146.

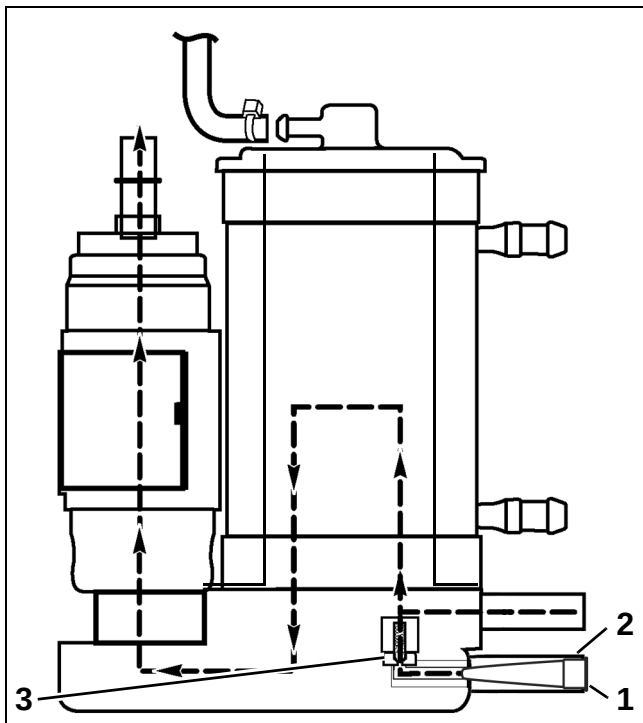
Pressure Regulator Test

Refer to **Vapor Separator Service** on p. 148 to remove vapor separator.

Make sure filter is not clogged. Clean or replace as needed.

Apply oil to valve and connect pressure pump and hose to the fuel return fitting of vapor separator.

Apply pressure to check regulator operation. The pressure should open check valve at approximately 15 psi (103 kPa).



1. Filter
2. Fuel return fitting
3. Pressure regulator

000249r

Vapor Separator Vent Check

Monitor the vapor separator vent hose. No fuel or a trace of fuel is acceptable. Excessive fuel discharge indicates a vapor separator vent malfunction. Monitor vent for presence of fuel during testing. Temporarily install clear tubing for monitoring. Replace vapor separator if the venting of fuel is continuous.

Fuel Injector Pressure Test

This test requires Injector Test Fitting kit, P/N 5005844.

Disconnect the battery cables at the battery.

Relieve fuel system pressure. Refer to **Relieving Fuel System Pressure** on p. 146.

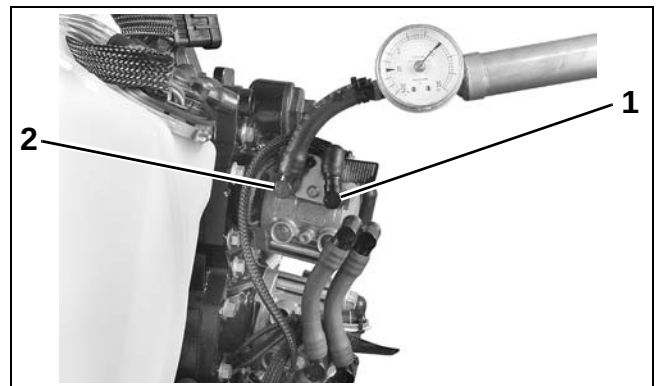


WARNING

Protect against hazardous fuel spray. Before starting any fuel system service, carefully relieve fuel system pressure.

IMPORTANT: Perform test with injector mounted to cylinder head and fittings installed with manifold retainer.

Use cap and tie strap to seal off outlet fitting. Connect a 0 to 30 psi (0 to 207 kPa) pressure tester to the inlet fitting. Pressurize the injector to 30 psi (207 kPa). Pressure must hold for at least five minutes.



1. Outlet fitting
2. Inlet fitting

002379

Refer to **FUEL DELIVERY TESTS** on p. 82 for additional test procedures.

FUEL SYSTEM

FUEL SYSTEM TESTS

Fuel Injector Resistance Test

Disconnect the battery cables at the battery.

Use a digital multimeter to measure the injector coil resistance.

Fuel Injector Coil Resistance
2 to 3 Ω @ 72°F (22°C)



006817

Use a digital multimeter with appropriate adapter leads to measure resistance of the complete injector circuit, including injector and associated wiring.

Measure resistance between pin 1 (white/red) of injector connector (connected) and the appropriate pin location of *EMM* J1-B connector (disconnected). Refer to engine wiring diagram for specific *EMM* J1-B connector pin location for the injector circuit being tested (blue, purple or green).



005437

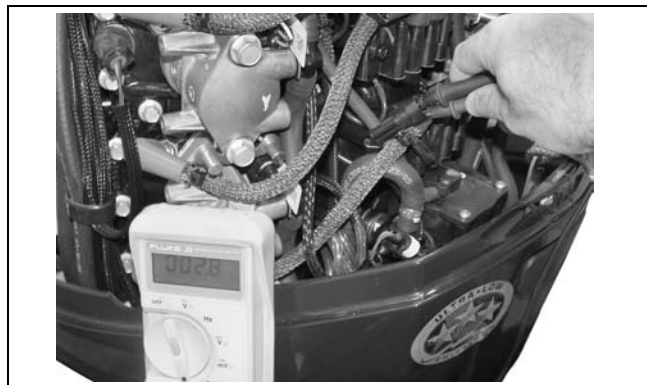
Resistance should be the same as, or slightly higher than, the injector alone.

Circulation Pump Resistance Test

Disconnect the battery cables at the battery.

Use a digital multimeter with appropriate adapter leads to measure the fuel pump circuit and coil resistance.

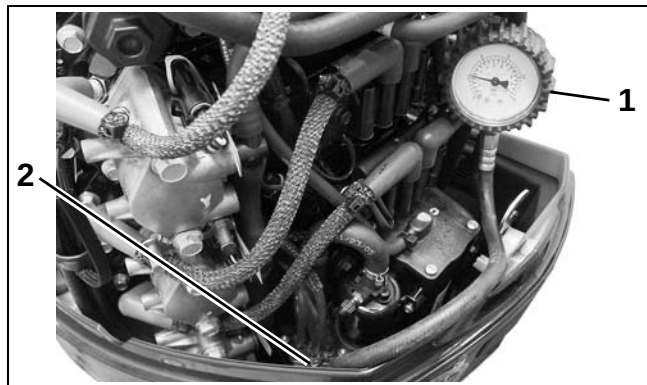
Fuel Pump Resistance
3 Ω @ 77°F (25°C)



005438

Lift Pump Pressure Test

Install a 0 to 15 psi (0 to 103 kPa) Fuel Pressure Gauge, P/N 5006397 or equivalent, to the lower fuel pressure test fitting.



1. Fuel pressure gauge
2. Test fitting

005439

Prime the fuel system and check for leaks. START outboard and run at idle speed. Hold gauge level with inlet fitting and monitor gauge for pressure reading.

Pressure should stabilize and gauge must not indicate less than 3 psi (21 kPa).

Results:

Normal pressure

- Perform the **Lift Pump Vacuum Test** on p. 145. Make sure no air leaks or restrictions exist in the fuel supply hose or boat fuel system.

Low pressure:

- Check pulse hoses and fittings for restrictions.
- Perform the **Lift Pump Vacuum Test** on p. 145. Make sure no air leaks or restrictions exist in the fuel supply hose or boat fuel system.
- Check fuel flow through fuel lift pump. Use fuel primer bulb to force fuel through pump.

No pressure:

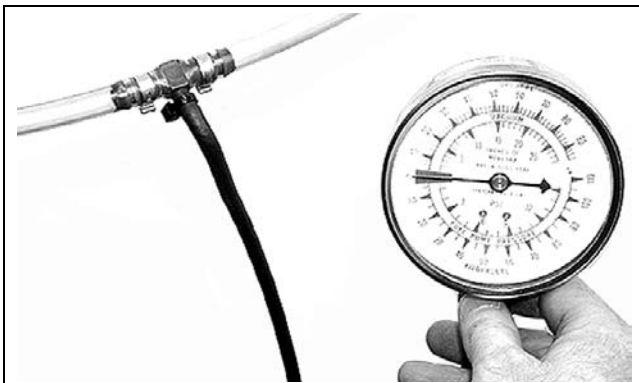
- Check pulse hoses and fittings restrictions.
- Check fuel flow through fuel lift pump. Use fuel primer or primer bulb to force fuel through pump.
- Momentarily prime or squeeze primer bulb to check gauge operation.
- Check pulse hose and fittings for restrictions.

Lift Pump Vacuum Test

Confirm fuel supply to the fuel lift pump.

Temporarily install a vacuum gauge, T-fitting, and 8 in. (20.3 cm) of clear vinyl hose between the fuel supply hose and fuel lift pump (inlet). Secure connections with tie straps to prevent fuel or air leaks.

NOTICE Do not use fuel primer bulb, manual fuel primer, or electric fuel pump primer to restart outboard. A positive pressure in the fuel supply could damage some vacuum gauges.



000243

START outboard and run at FULL THROTTLE for at least two minutes. Monitor clear vinyl hose for the presence of air. Air bubbles indicate a faulty hose, connection, or fuel tank pick-up. Repair, if necessary, before proceeding.

There should be no air or vapor bubbles visible in the clear hose. The maximum inlet fuel vacuum should not exceed 4 in. Hg. (13.5 kPa) at the inlet to the fuel lift pump under any operating conditions (IDLE to WOT).

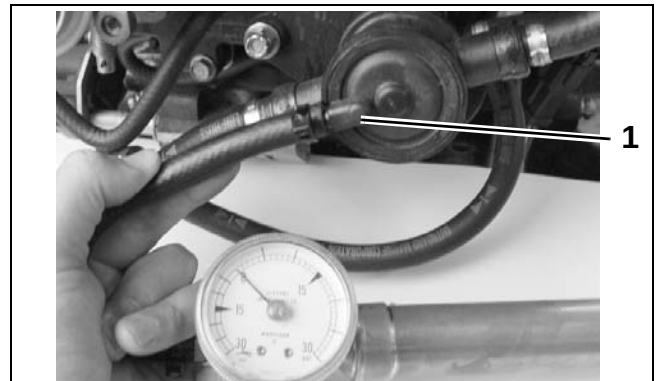
A higher vacuum indicates an excessive restriction in the fuel supply. Repair as needed. Refer to **FUEL SYSTEM REQUIREMENTS** on p. 136 for fuel supply component requirements.

Lift Pump Diaphragm Test

Perform this test only if a damaged pump is suspected. This test does not check the performance of internal fuel pump check valves.

Remove both pulse hoses from the crankcase fittings.

Apply 15 psi (103 kPa) to each of the pulse hoses of the pump. Replace lift pump if either side of pump fails to hold pressure.

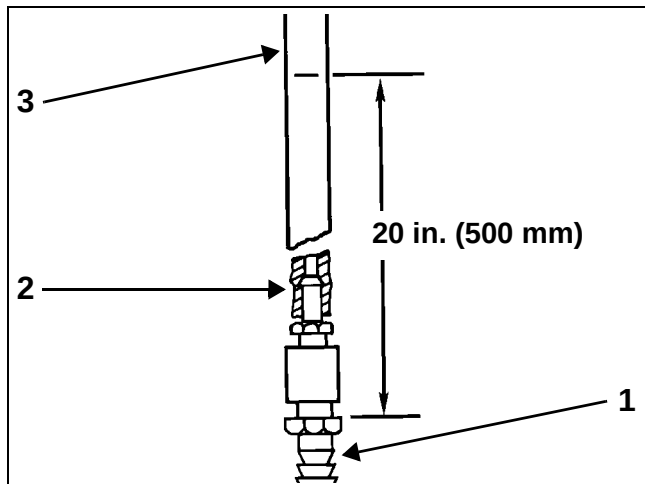


1. Pulse fitting

000670

Anti-Siphon Valve Test

Remove anti-siphon valve from fuel tank. Install adapter fittings and a 36 in. (91.4 cm) length of clear hose to the inlet side (tank end) of valve.



- 1. Anti-siphon valve
- 2. Adapter fitting
- 3. Clear hose

DR2277

Fill clear hose with water to a height of 20 in. (500 mm). Water must NOT flow through valve. An occasional drip is acceptable. Replace valve if water drips continuously.

Increase height of water to 25 in. (630 mm). Water should flow through valve as water level reaches 25 in. (630 mm). Replace the anti-siphon valve if test results are different.

FUEL COMPONENT SERVICING

WARNING

Gasoline is extremely flammable and highly explosive under certain conditions. Use caution when working on any part of the fuel system.

Protect against hazardous fuel spray. Before starting any fuel system service, carefully relieve fuel system pressure. Refer to Relieving Fuel System Pressure.

Always disconnect the battery cables at the battery before servicing the fuel system unless instructed to do otherwise.

Always work in a well ventilated area and wipe off any fuel spillage.

DO NOT smoke and make certain no open flames or ignition sources exist.

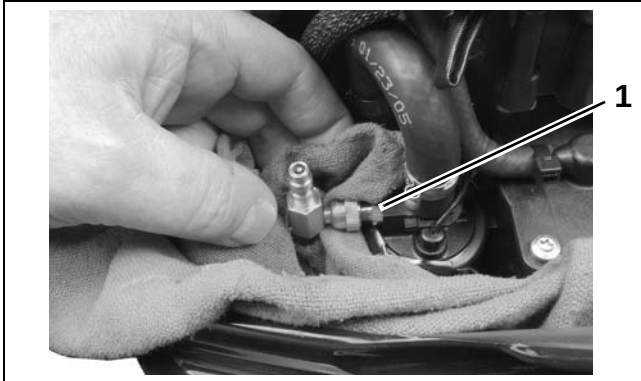
After servicing the fuel system check for leaks. Failure to check for fuel leakage could allow a leak to go undetected, resulting in fire or explosion.

Relieving Fuel System Pressure

IMPORTANT: Minimize fuel system pressure prior to disassembly. Temporarily restrict the fuel supply hose from fuel tank with hose pincer. Remove propeller and disconnect circulation fuel pump electrical connector. If outboard runs, start and run at IDLE for 5 seconds and STOP outboard. If outboard does NOT run, crank for 10 seconds.

Disconnect the battery cables at the battery.

Wrap a shop towel completely around the pressure test valve while connecting fitting from Fuel Pressure Gauge, P/N 5007100, to top test fitting of fuel pump/vapor separator assembly.



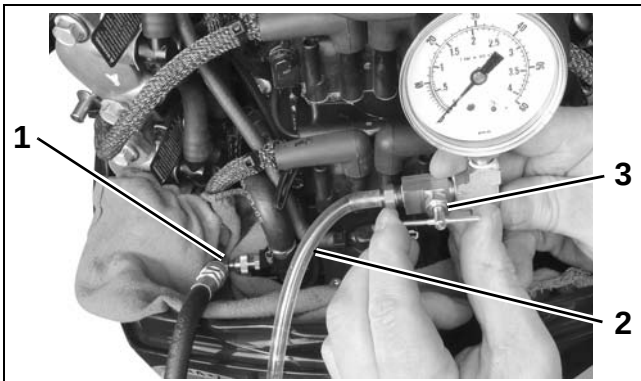
1. High pressure test fitting

005334

Insert venting hose of gauge into a suitable container.

Slowly open gauge's venting valve.

Clean up any spilled fuel.



1. Test fitting
2. Venting hose
3. Venting valve

005335

Fuel Filter Service

Removal

Disconnect the battery cables at the battery.

Use an appropriate filter wrench to turn the filter in a counterclockwise direction. Remove filter carefully to prevent spilling contents.

Inspect contents for any presence of water. If water is present, identify the source and correct the problem. Take additional fuel samples and drain fuel tank(s), if necessary.



1. Water-separating fuel filter

005237

Installation

Lubricate filter seal with outboard lubricant and position filter on threaded mounting tube of filter bracket. Take care not to damage water in fuel sensor probe. Turn filter clockwise onto the tube until seated against the bracket.

Tighten filter approximately 3/4 turn after the gasket contacts the bracket.

Squeeze primer bulb to prime fuel system. Hold pressure on bulb and check for fuel leaks.

Connect battery cables.

Run outboard and check for fuel leaks.

FUEL SYSTEM

FUEL COMPONENT SERVICING

Fuel Lift Pump Service

The fuel lift pump is serviceable as a complete assembly. Refer to parts catalog for service parts.

Removal

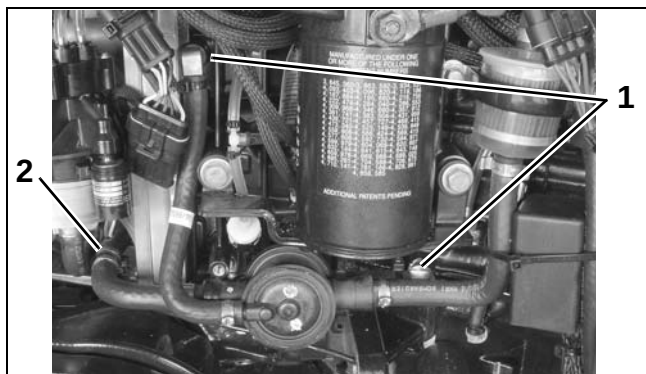
Disconnect the battery cables at the battery.

Disconnect the fuel supply hose from the in-line fitting.

Disconnect the fuel outlet hose from the fuel filter housing.

Disconnect the fuel lift pump pulse hoses at the crankcase fittings.

Remove the fuel lift pump and hoses as an assembly.



1. Pulse hose crankcase fitting
2. Fuel supply fitting

005336

Installation

Connect the fuel lift pump pulse hoses to the crankcase. Secure with tie straps.

Connect the fuel outlet hose to the fuel filter. Secure with *Oetiker* clamp.

Connect the fuel supply hose to the in-line fitting. Secure with *Oetiker* clamp.

Squeeze primer bulb to prime fuel system. Hold pressure on bulb and check for fuel leaks.

Connect battery cables.

Run outboard and check for fuel leaks.

Vapor Separator Service

Removal

Disconnect the battery cables at the battery.

Relieve fuel system pressure. Refer to **Relieving Fuel System Pressure** on p. 146.

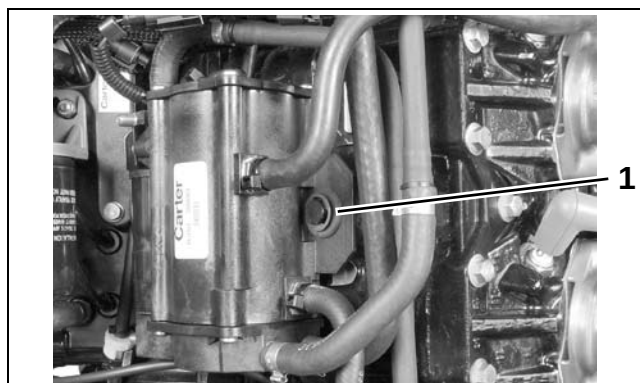
Disconnect circulation pump electrical connector.

Remove clamp and fuel supply manifold from top of circulation pump. Remove clamp and vapor vent hose from separator cover.

Remove clamps and vapor separator cooling water hoses.

Remove clamps and fuel return manifold and fuel supply hose from bottom of vapor separator.

Remove the vapor separator housing retainer clip.



1. Retainer clip

004189

Remove vapor separator/fuel pump from the mounting stud and slide vapor separator housing from the grooves of the isolator mounts.

Installation

Slide the vapor separator bracket notches into grooves of the isolator mounts. Install forward isolator of vapor separator on mounting stud and secure with retainer clip.

Install all hoses and manifolds in original locations and secure with appropriate clamps. Squeeze primer bulb to prime fuel system. Hold pressure on bulb and observe for fuel leaks.

Connect battery cables.

Run outboard and check for fuel leaks.

Fuel Manifold Service

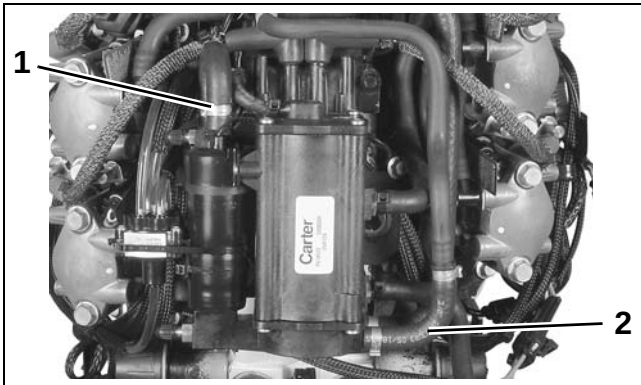
Removal

Disconnect the battery cables at the battery.

Relieve fuel system pressure. Refer to **Relieving Fuel System Pressure** on p. 146.

Remove clamps and disconnect the fuel manifolds as follows:

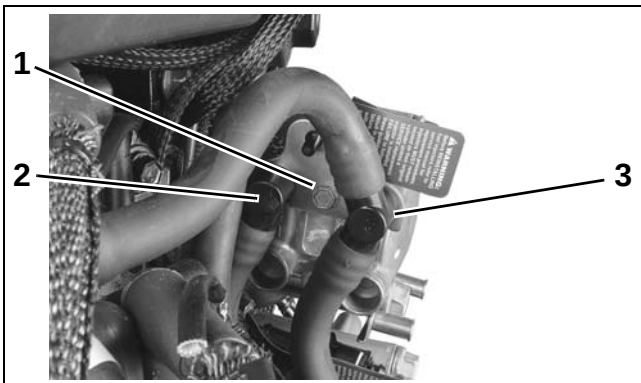
- Fuel supply manifold to circulation pump
- Fuel return manifold to vapor separator



1. Fuel supply manifold
2. Fuel return manifold

005341

Remove fuel manifold retainer screws and remove retainers from fuel injectors.



1. Retainer screw
2. Fuel supply manifold fitting
3. Fuel return manifold fitting

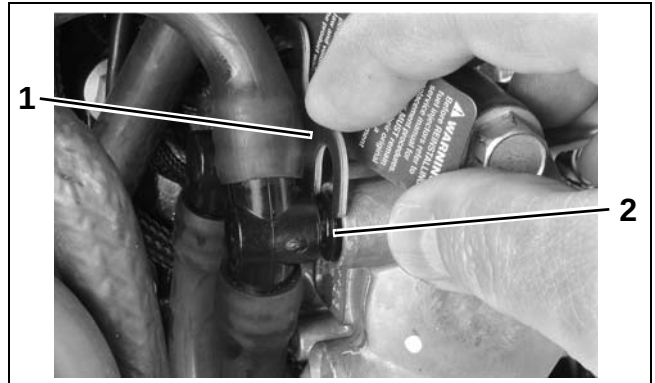
005337

Disconnect fuel manifold fittings from fuel injector ports, then remove the manifold assemblies.

Installation

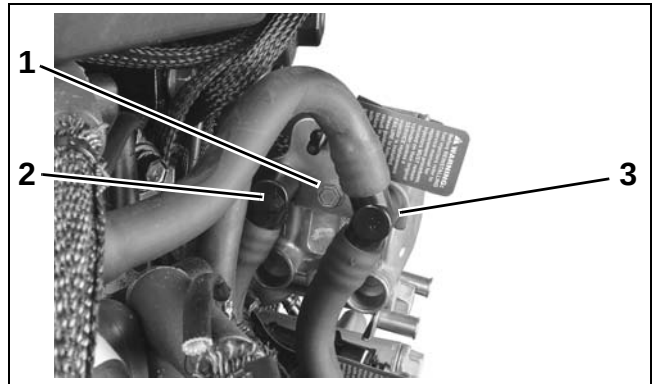
Check condition of sealing O-rings on fuel manifold fittings. Lubricate O-rings with outboard lubricant and insert fuel manifold fittings into injector. Both fittings must be fully seated into the injector fuel ports.

Install retainer in the outer groove of the manifold fittings. Install and tighten screw to a torque of 24 to 36 in. lbs. (2.7 to 4 N·m).



1. Retainer
2. Manifold fitting groove

005342



1. Retainer screw
2. Fuel supply manifold fitting
3. Fuel return manifold fitting

005337

Install the fuel manifolds to the fuel pump assembly and secure with clamps:

- Fuel supply manifold to circulation pump.
- Fuel return manifold to vapor separator.

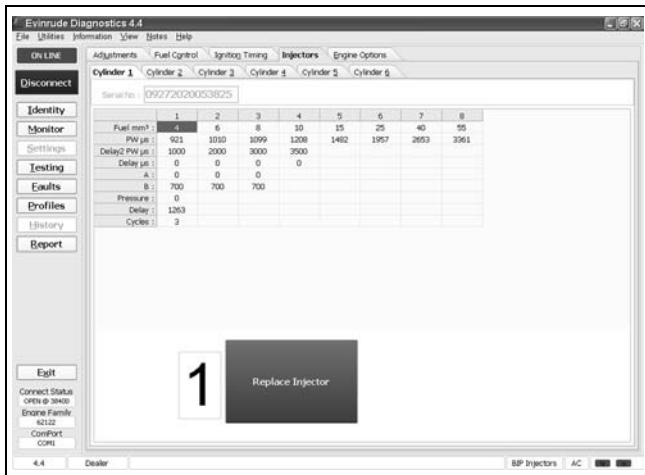
FUEL SYSTEM

FUEL COMPONENT SERVICING

Fuel Injector Service

Mark fuel injectors to show cylinder locations.

NOTICE Fuel injectors must be installed in the correct cylinder locations. Use *Evinrude Diagnostics Software* to make sure that *EMM* programming matches injector positioning. The *Injector Coefficients* screen displays injector serial numbers.



Injector Coefficients Screen

008118

Use caution when handling fuel injectors. Prevent dirt and debris from entering fuel inlet and outlet ports of injectors or fuel manifolds. Cover the injector nozzle port in cylinder head to prevent contamination of combustion chamber.

Removal

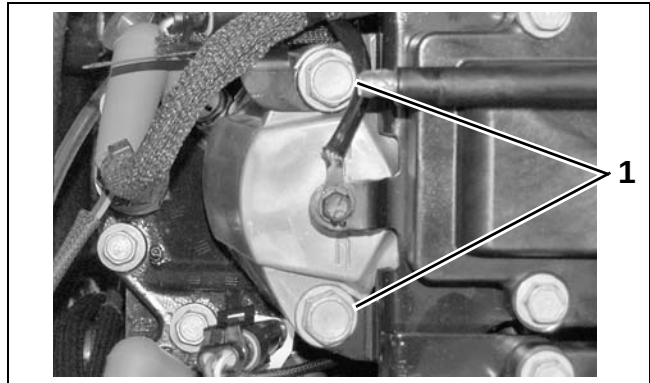
Disconnect the battery cables at the battery.

Relieve fuel system pressure. Refer to **Relieving Fuel System Pressure** on p. 146.

Remove fuel manifolds. Refer to **Fuel Manifold Service** on p. 149.

Disconnect the fuel injector electrical connector.

Remove injector screws.



1. Injector screws

008194

Remove fuel injector and insulator.

Crush Ring Replacement

NOTICE Injector crush rings must be replaced if injector is installed in a different head or cylinder location.

Use Slide Hammer assembly, P/N 391008, with Slide Hammer Adaptor kit, P/N 390898, to remove injector from mounting cup.

Thread adaptor and stud into face of injector. Hold mounting cup securely. Work slide hammer to separate injector from mount housing.



002345

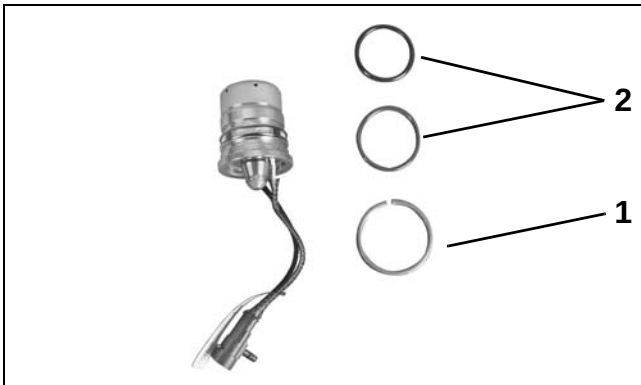
Remove adaptor from injector. Remove crush ring and O-rings from injector. Inspect and clean injec-

tor filter. Install new crush ring and O-rings. Lubricate O-rings with *STP⁺ Oil Treatment*.



1. Adaptor

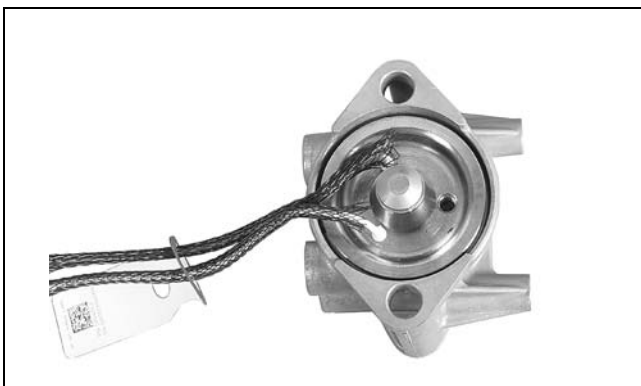
002196



1. Crush ring
2. O-rings

002317

Install injector into mount housing. Press on injector face until injector seats in mount housing.



002318

Installation

NOTICE All injectors must be installed in the correct cylinder by serial number. Improper injector installation can result in powerhead failure.

Installation of a replacement injector requires that coefficient data for the new injector is uploaded to the *EMM*.

Coefficient data for some replacement injectors is supplied on a computer disk shipped with the injector. If a disk is not included with the injector, coefficient data can be downloaded from the *Evinrude/Johnson* dealer website. Refer to the instructions provided with the injector kit.

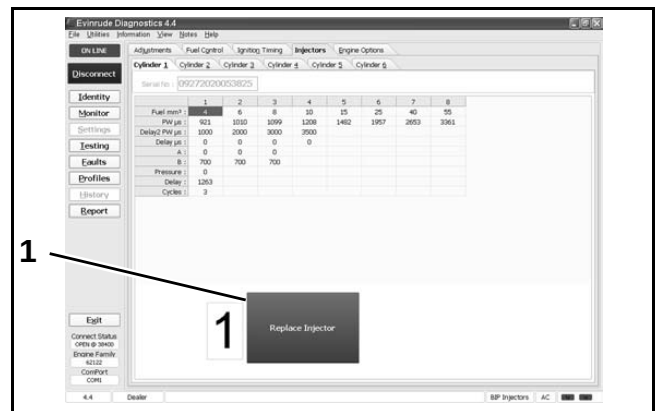
Upload Coefficient Files to *EMM*

Use the *Evinrude Diagnostics* software *Settings* screen to upload the coefficient file to the *EMM*.

Select the *Injectors* tab.

Select the cylinder tab for injector being replaced.

Select the *Replace Injector* button.



1. "Replace Injector" button

008118

FUEL SYSTEM

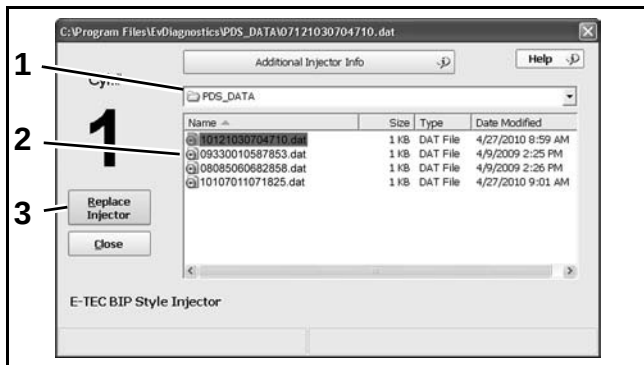
FUEL COMPONENT SERVICING

Use the drop down menu to navigate to the saved coefficient file location.

The coefficient file name must match the serial number of the injector.

Select the correct file for the injector.

Select the *Replace Injector* button.

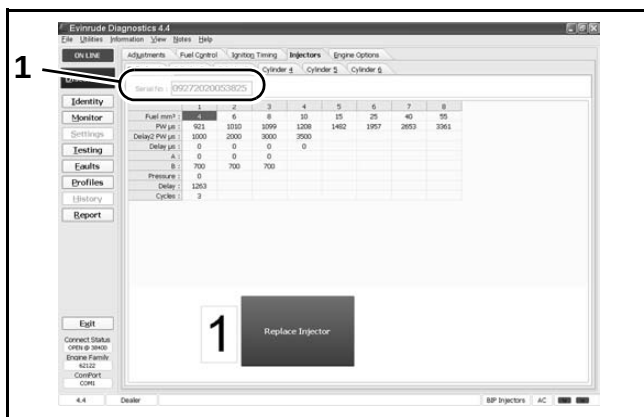


1. Navigation menu
2. Injector coefficient file
3. "Replace Injector" button

008335

After the upload is complete, the program will return to the *Cylinder* tab.

Make sure the serial number displayed on the screen matches the serial number printed on the serial number label of the replacement injector.



1. Serial number

008118

Install Injector

The following items and their mating surfaces must be cleaned before reassembly:

- Injector
- Cylinder head
- Adapter
- Screws
- Threaded areas



CAUTION

All injector components must be clean to ensure correct torque tightening specifications. To prevent fuel leakage, carefully follow these installation instructions.

Place injector and insulator in the proper cylinder location.

IMPORTANT: Be careful not to pinch any wiring or hoses during assembly.

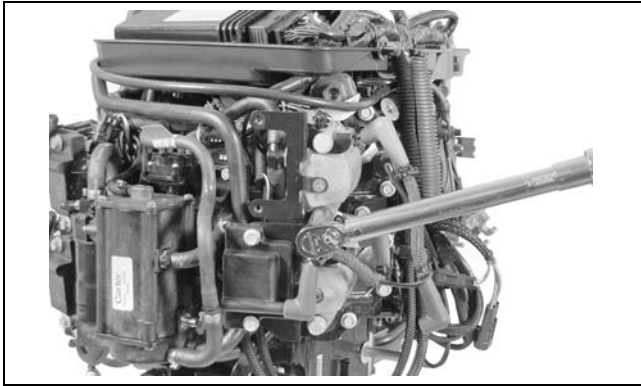
Lubricate mounting screw threads and under the head of the screw with a light coat of *Triple-Guard* grease. Install washers (one per screw) on injector retaining screws. Install screws and washers through ignition coil brackets, injector cup, and insulator. Thread into cylinder head.



002316

Tighten screws in stages, starting with the lower screw.

- First torque is 5 ft. lbs. (7 N·m)
- Second torque is 10 ft. lbs. (14 N·m)
- Final torque is 24 to 26 ft. lbs. (33 to 35 N·m).



Tighten Screws in Stages

007195

Reconnect fuel injector/coil electrical connectors.

Install fuel manifolds. Refer to **Fuel Manifold Service** on p. 149.

Intake Manifold Service

Removal

Disconnect vapor separator vent hose, throttle position sensor connector, and throttle link arm.

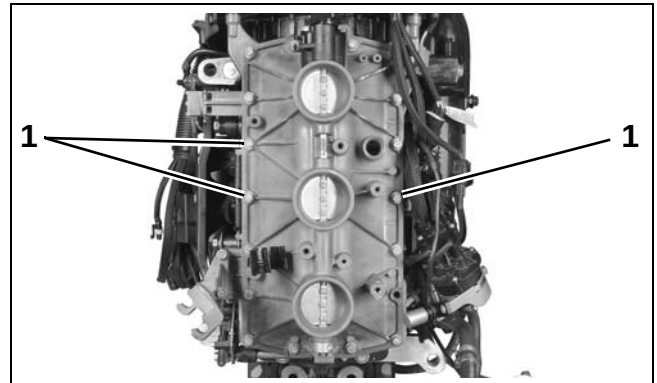
Use Ball Socket Remover Tool, P/N 342226, to remove throttle link arm.

Remove crankshaft position sensor from reed plate assembly.

Remove oil filter from retainer.

Remove oil pump bracket screws.

Remove throttle body screws and throttle body assembly.



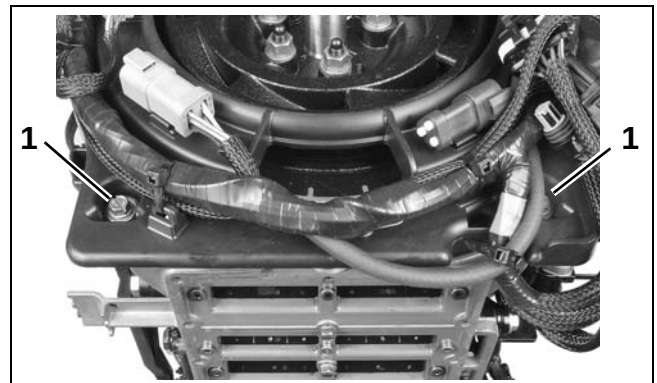
1. Throttle body screws (14 on V4, 18 on V6)

005368

Remove gasket from throttle body.

Remove tie straps holding connectors to side of reed plate assembly.

Remove two screws holding electrical harness base to reed plate assembly.



1. Harness base screws

005345

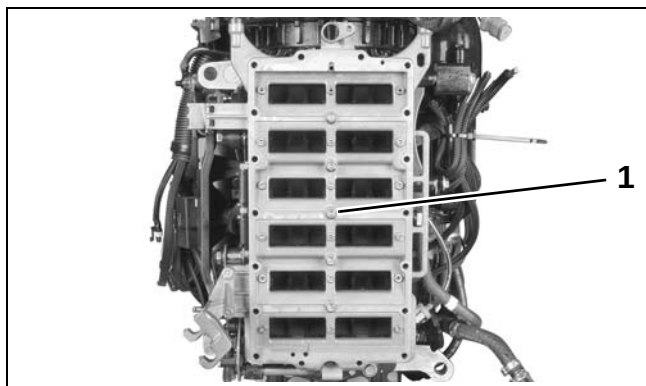
FUEL SYSTEM

FUEL COMPONENT SERVICING

Remove oil distribution hoses from oil pump/manifold and reed plate bracket. Refer to **OIL COMPONENT SERVICING** on p. 179.

Remove oil recirculation hose from starboard side of reed plate assembly.

Remove screws and reed plate assembly from the crankcase.



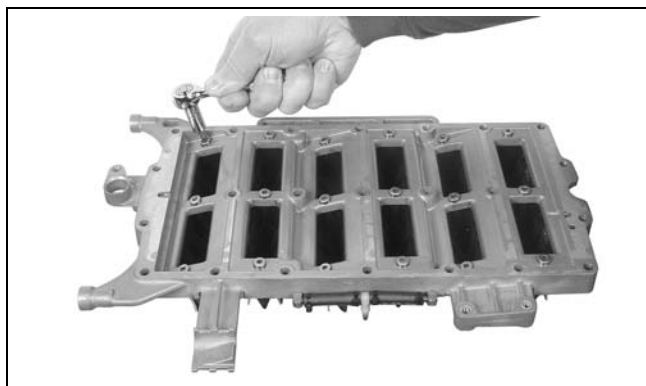
1. Reed plate screws (3 on V4, 5 on V6)

005367

Disassembly

All reed plate assembly and reed valve assemblies must be cleaned before reassembly. DO NOT use strong carburetor cleaner or the hot soaking tank method for cleaning.

Remove the reed valve retainer screws and remove the assembly.



005366

Use caution to prevent damaging reed valve assemblies.



005364

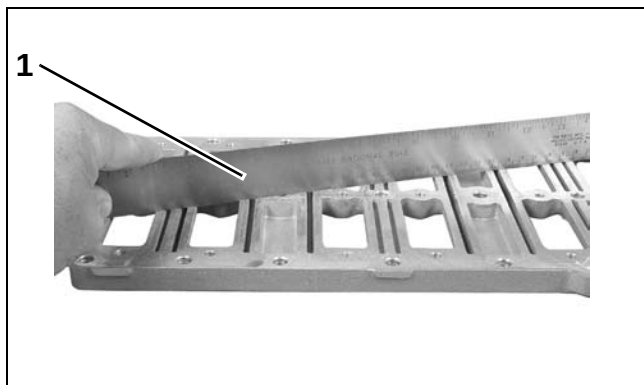
NOTICE DO NOT disassemble reed valve assemblies. Damaged reed plates are not serviceable and are replaced as an assembly.

Inspection

Inspect the leaf plate assemblies for damage or contamination:

- Leaf plates must not be distorted.
- Leaf valve must not be cracked or chipped.
- Leaf plate stops must not be distorted or loose.
- Leaf plate assemblies must be clean.

Inspect the intake manifold. All gasket surfaces must be cleaned, smooth, and free of nicks. Use a machinist's straight-edge and a feeler gauge to check flatness in all directions. Surface must be flat, ± 0.004 in. (0.10 mm).



1. Straight-edge

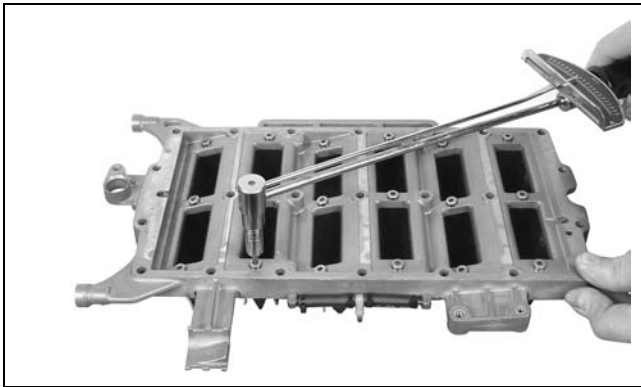
004193

Assembly

Remove old adhesive from reed valve retaining screws.

Install gasket on reed plate assembly. **DO NOT** use sealer on the gasket.

Prime screw threads with *Locquic Primer* and let dry. Apply *Nut Lock* to threads. Position reed valve on reed plate and install screws. Tighten screws to a torque of 30 to 42 in. lbs. (3.5 to 4.7 N·m).



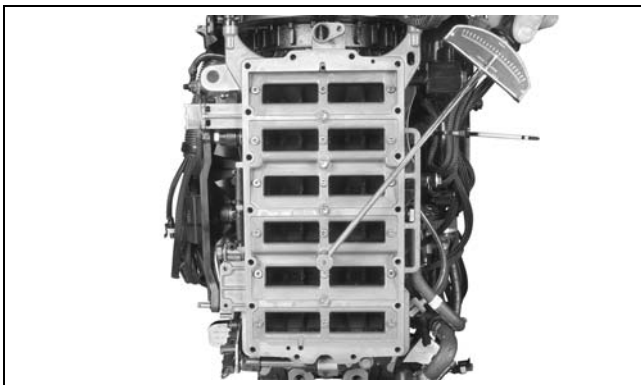
005365

Installation

Place reed plate assembly on cylinder/crankcase.

Apply *Nut Lock* to screws. Install all screws.

Tighten the center screws first and expand outward. Tighten in stages to a final torque of 96 to 120 in. lbs. (11 to 13.5 N·m).



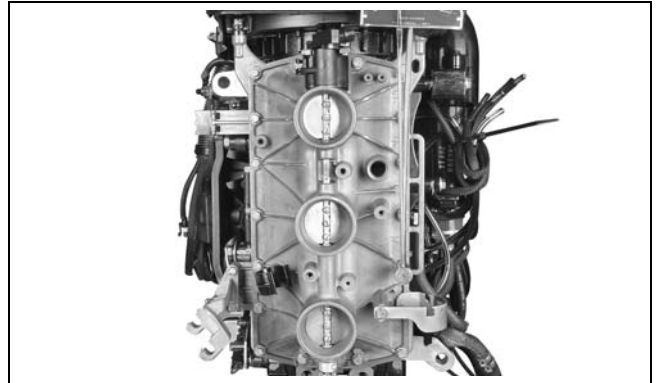
005363

Install electrical harness base screws.

Place gasket on throttle body. Install throttle body, with oil pump bracket, on reed plate and install screws.

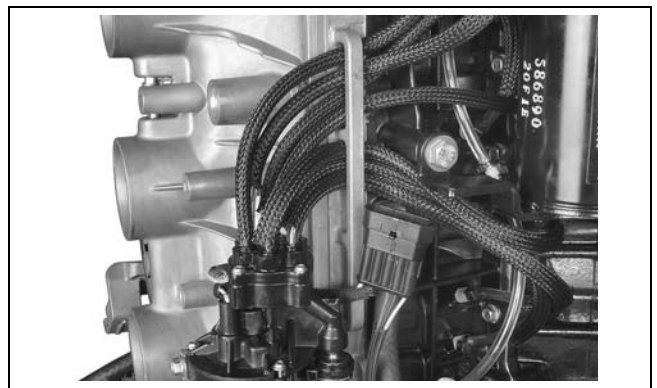
Tighten the center screws first and expand outward. Tighten in stages to a final torque of 96 to 120 in. lbs. (11 to 13.5 N·m).

Tighten small oil pump bracket screw 24 to 36 in. lbs. (3 to 4 N·m).



005362

Install oil pump in bracket and secure with *Oetiker* clamp. Route oil distribution hoses through reed plate bracket and install in oil pump manifold. Refer to **OIL SUPPLY DIAGRAMS – V4** on p. 160 or **OIL SUPPLY DIAGRAMS – V6** on p. 162.

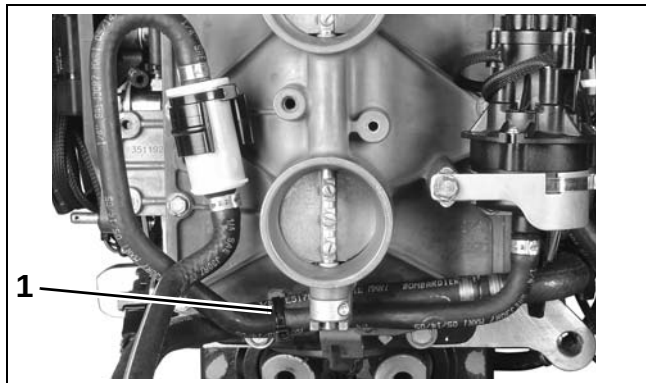


005344

FUEL SYSTEM

FUEL COMPONENT SERVICING

Install oil filter and oil and fuel supply hoses.



1. Tie strap

005343

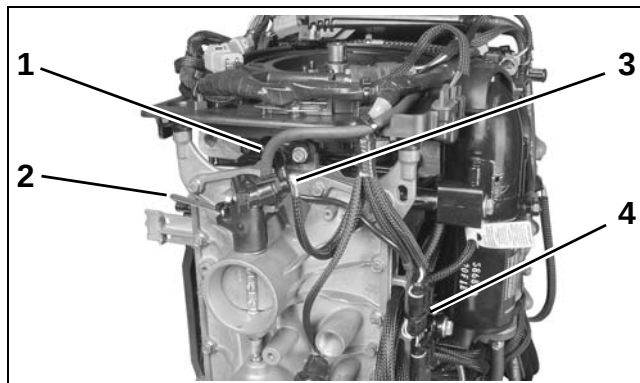
Install crankshaft position sensor.

Install vapor separator vent hose and oil recirculation hose. Secure with tie straps.

Connect throttle linkage and throttle position sensor connector.

Secure connector to reed plate bracket with tie strap.

IMPORTANT: DO NOT lubricate throttle linkages.



1. Vapor separator vent hose
2. Throttle linkage
3. TPS electrical connector
4. Tie strap

005361

Refer to **TPS Calibration** on p. 116.

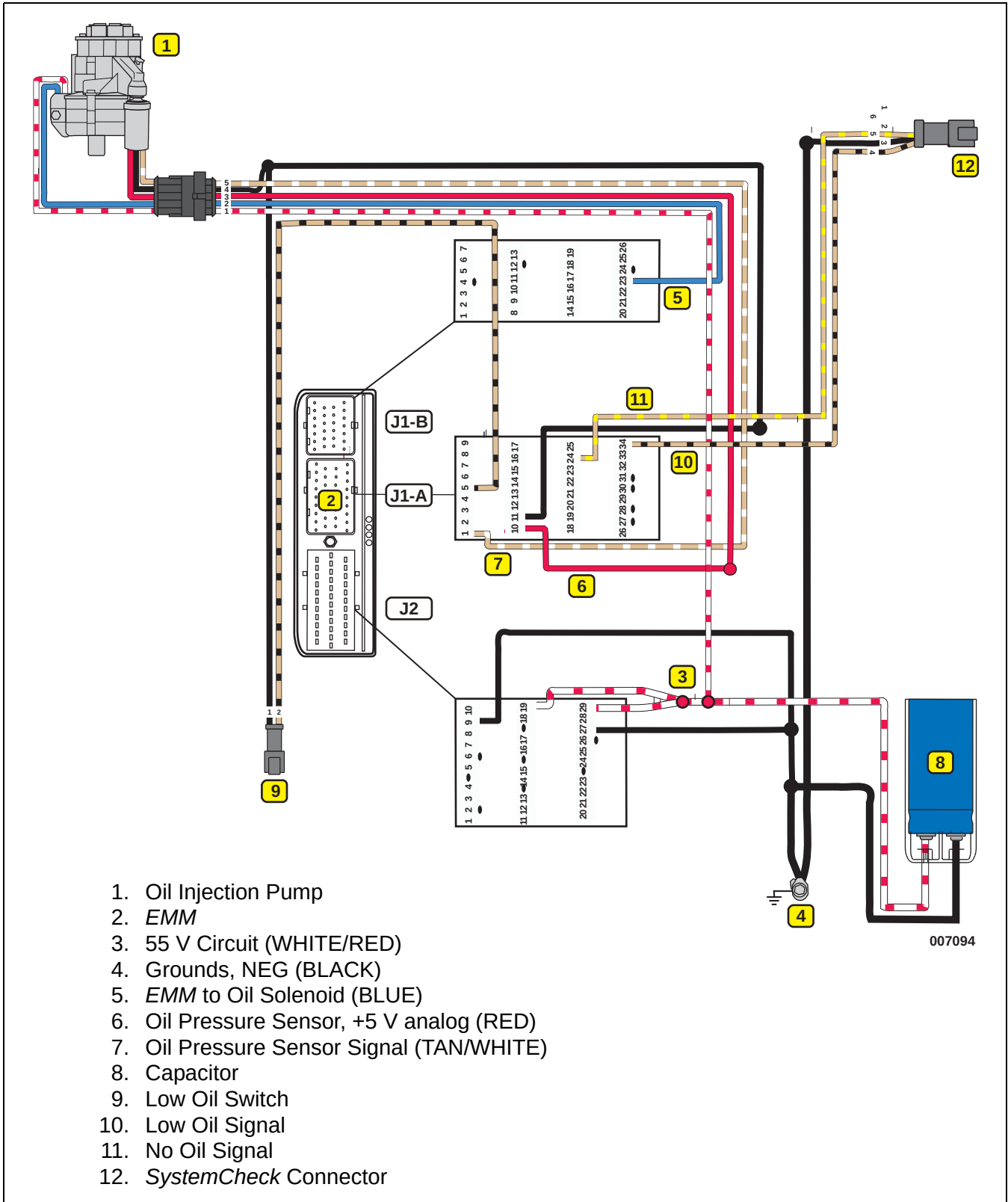
OILING SYSTEM

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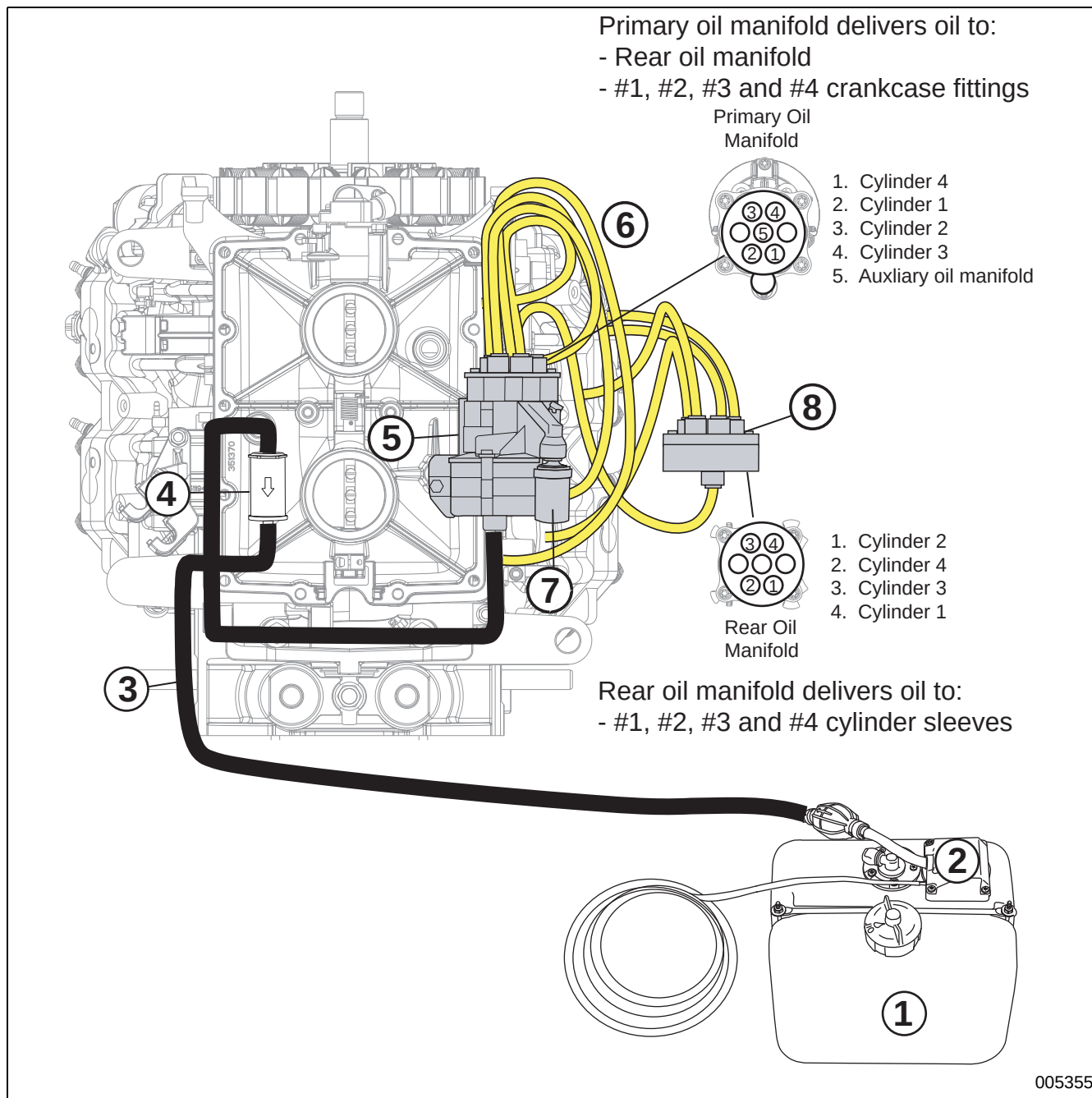
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OILING SYSTEM CIRCUIT DIAGRAM

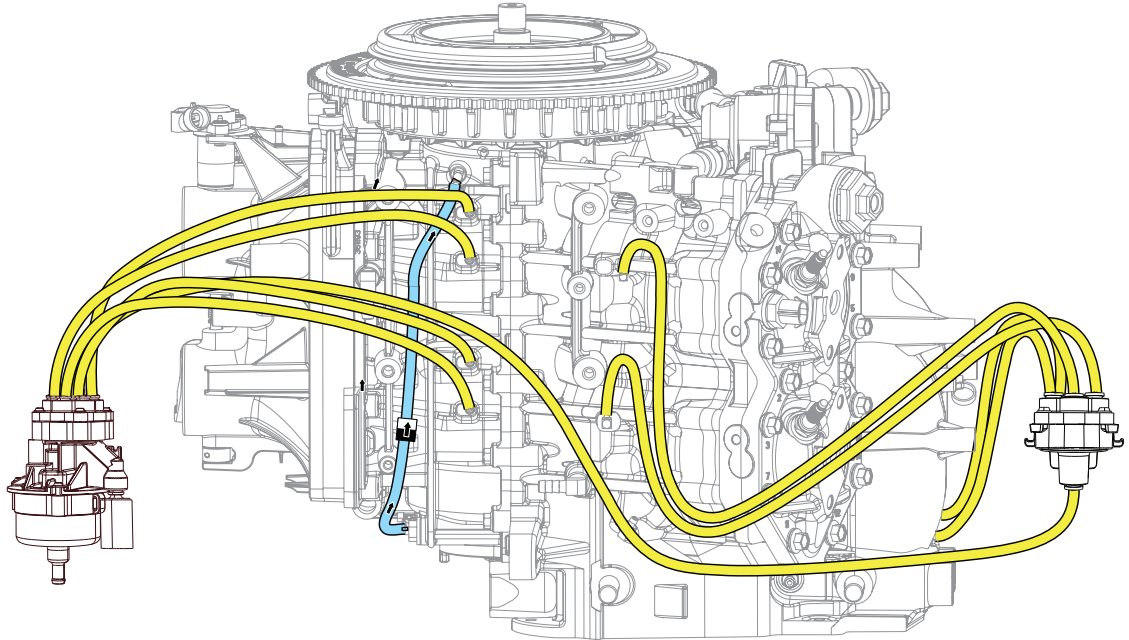


OIL SUPPLY DIAGRAMS – V4

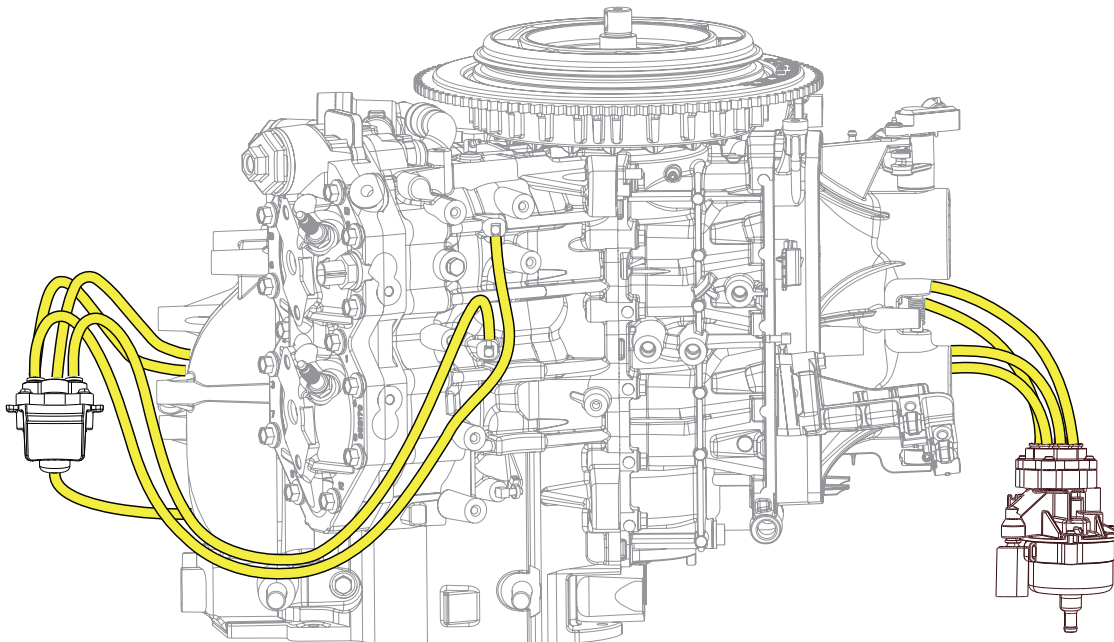


1. Oil tank assembly
2. Oil pick-up
3. Oil supply hose
4. In-line oil filter
5. Oil injector assembly
6. Oil distribution hoses
7. Oil pressure sensor
8. Rear oil manifold

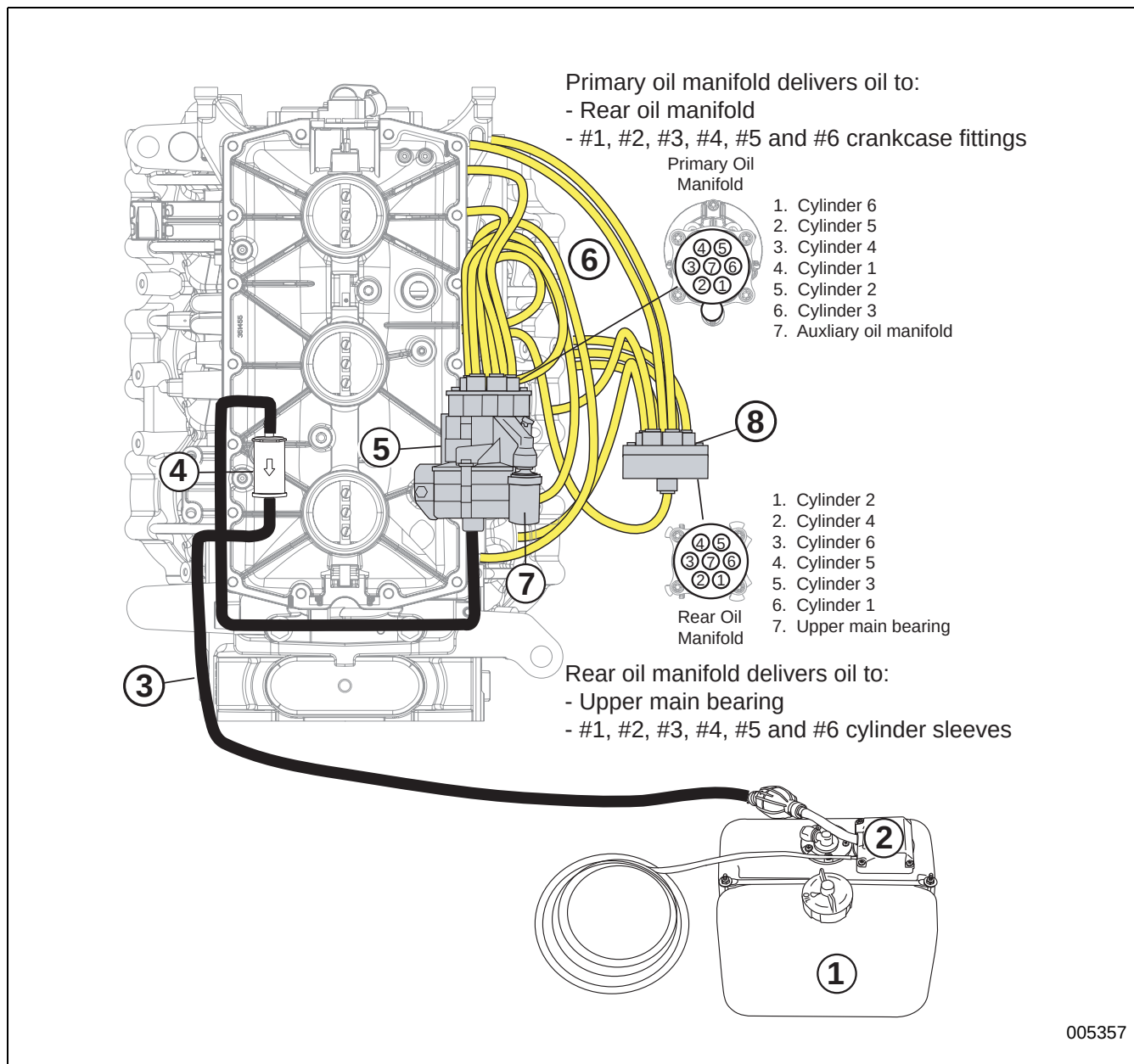
Port Side View



Starboard Side View

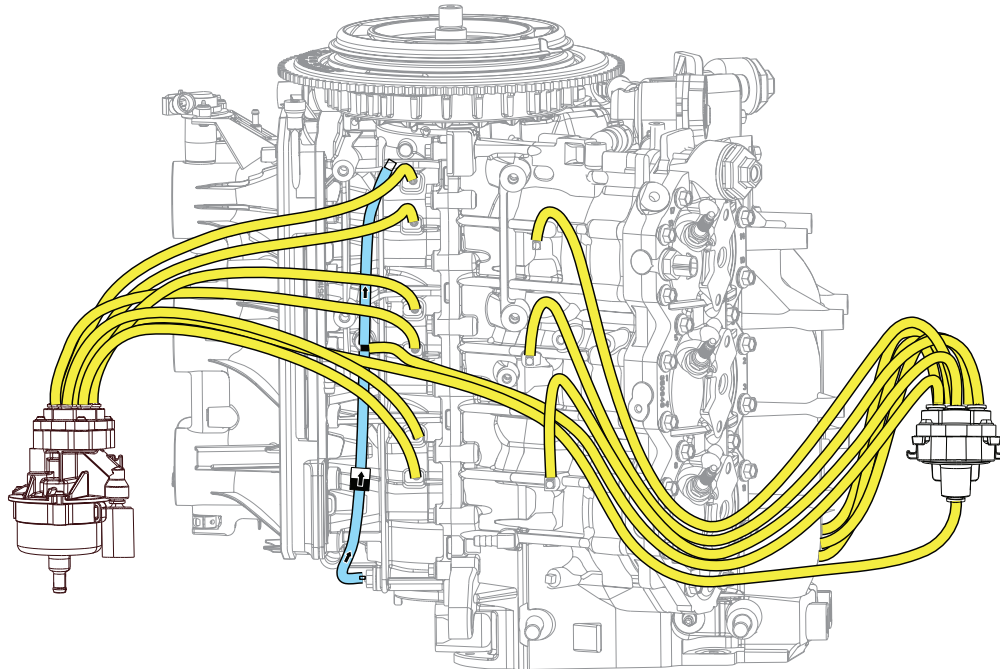


OIL SUPPLY DIAGRAMS – V6

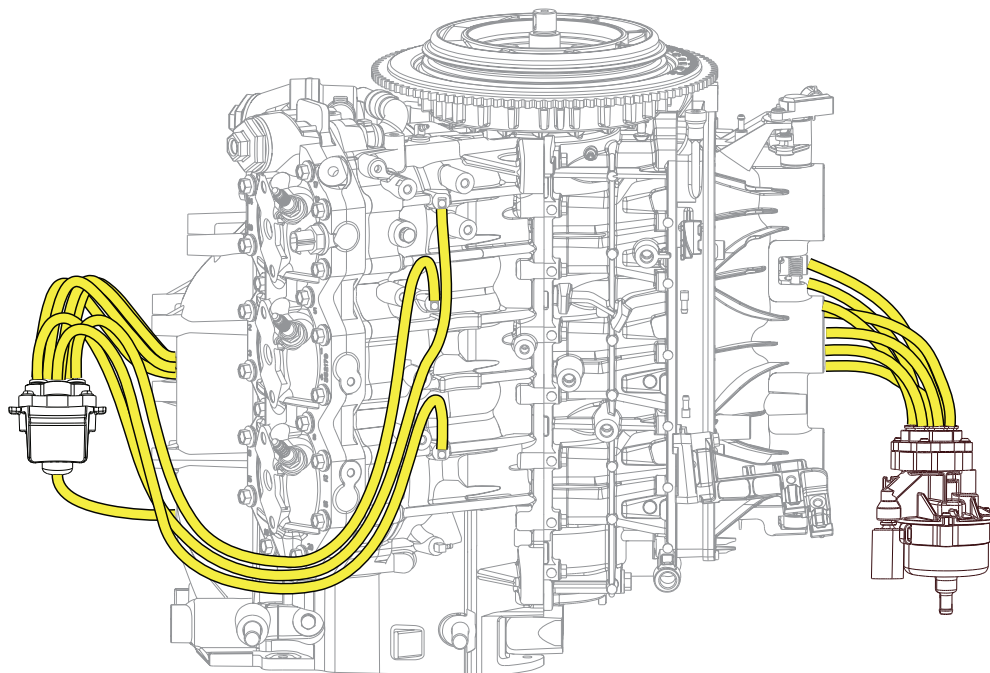


1. Oil tank assembly
2. Oil pick-up
3. Oil supply hose
4. In-line oil filter
5. Oil injector assembly
6. Oil distribution hoses
7. Oil pressure sensor
8. Rear oil manifold

Port Side View

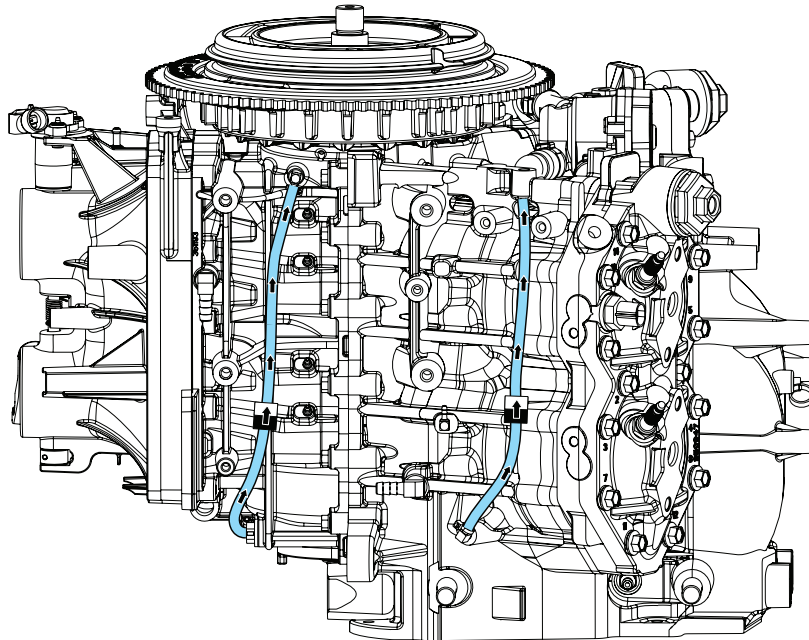


Starboard Side View

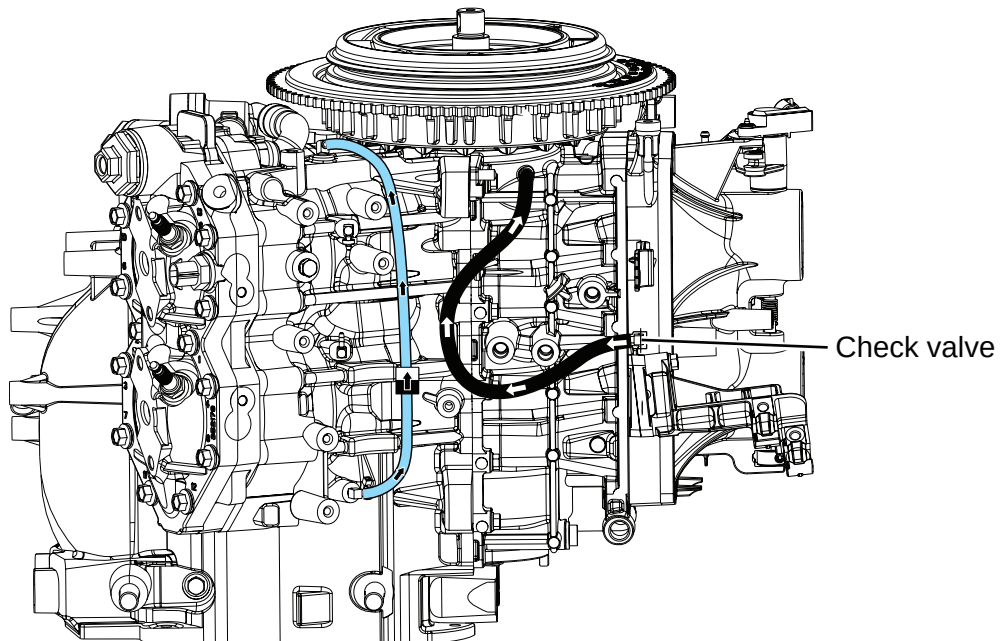


OIL RECIRCULATION DIAGRAMS – V4

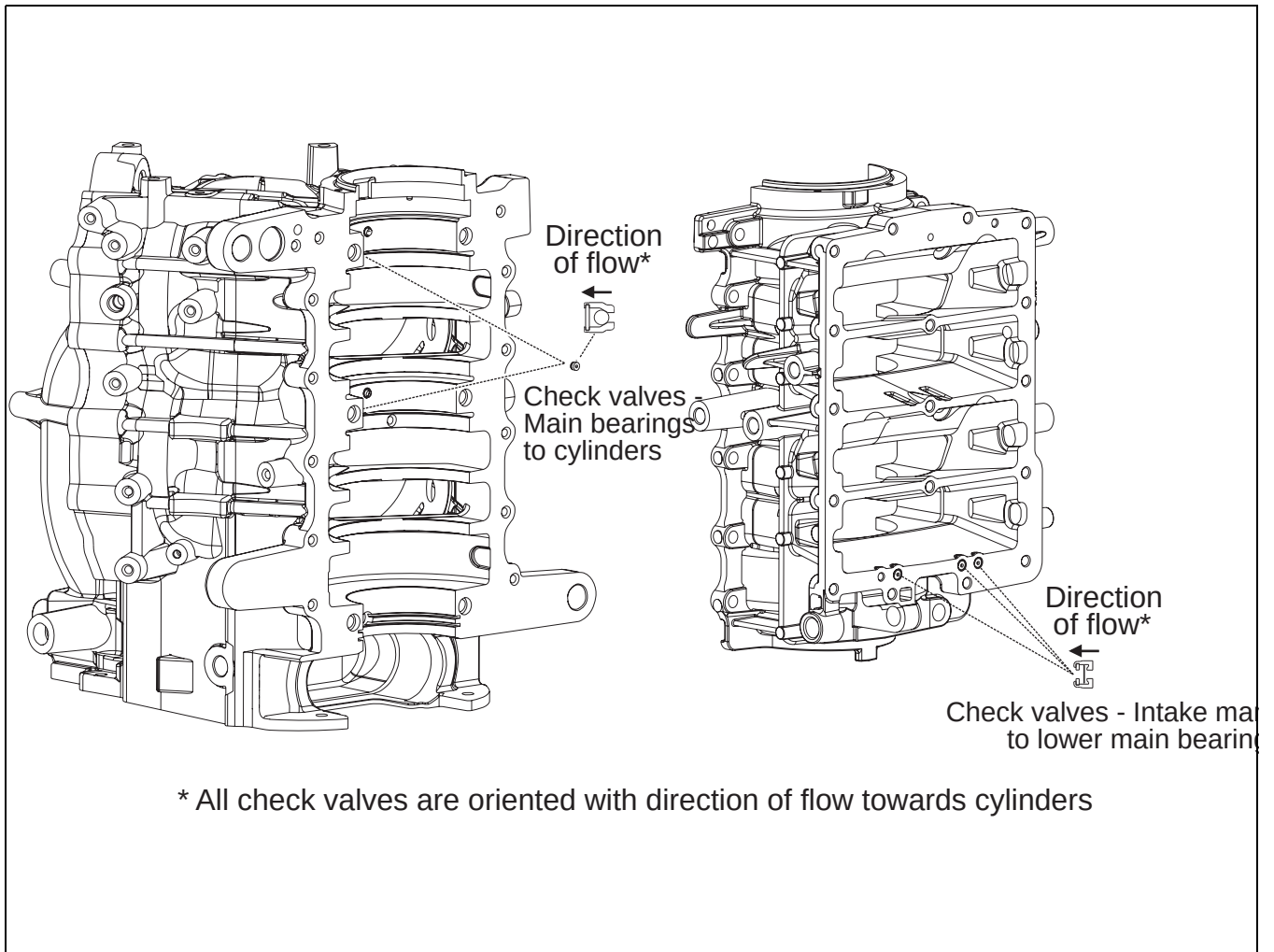
Port Side View



Starboard Side View



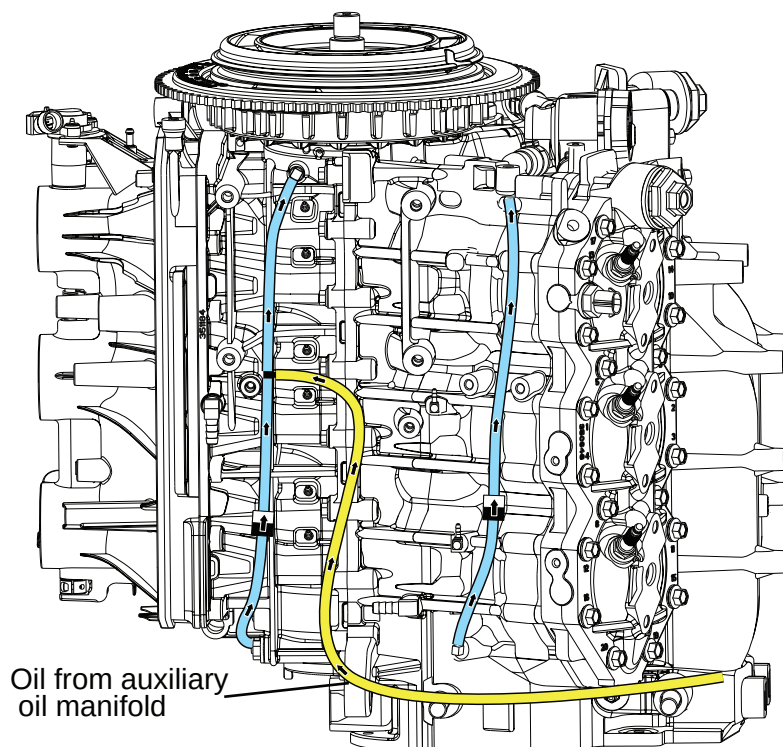
005351



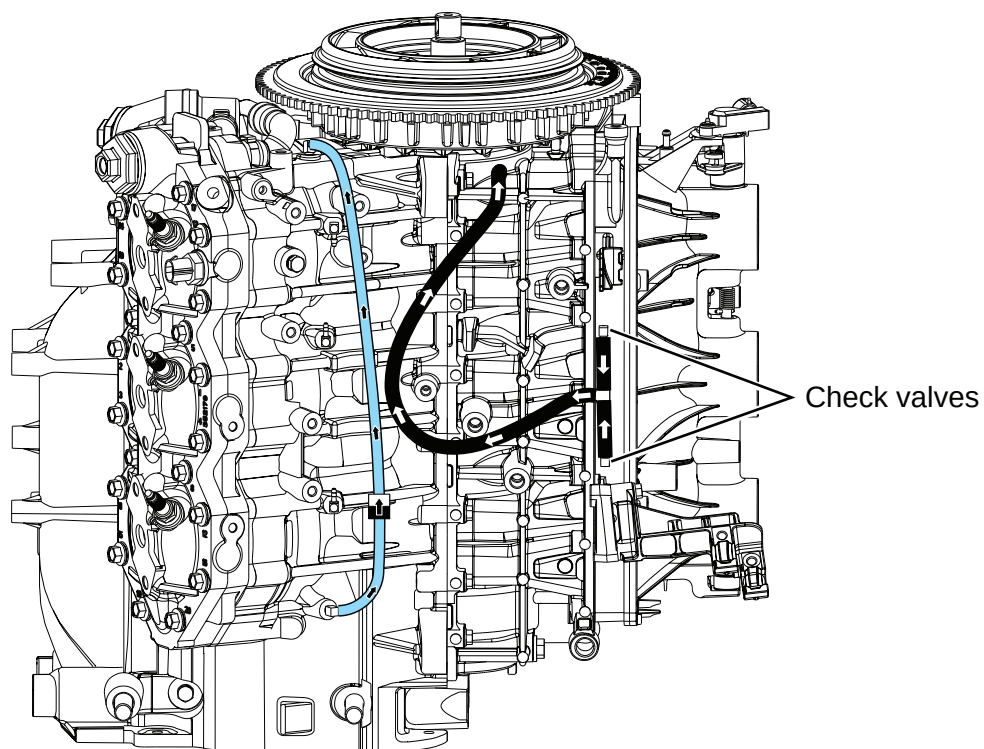
005350

OIL RECIRCULATION DIAGRAMS – V6

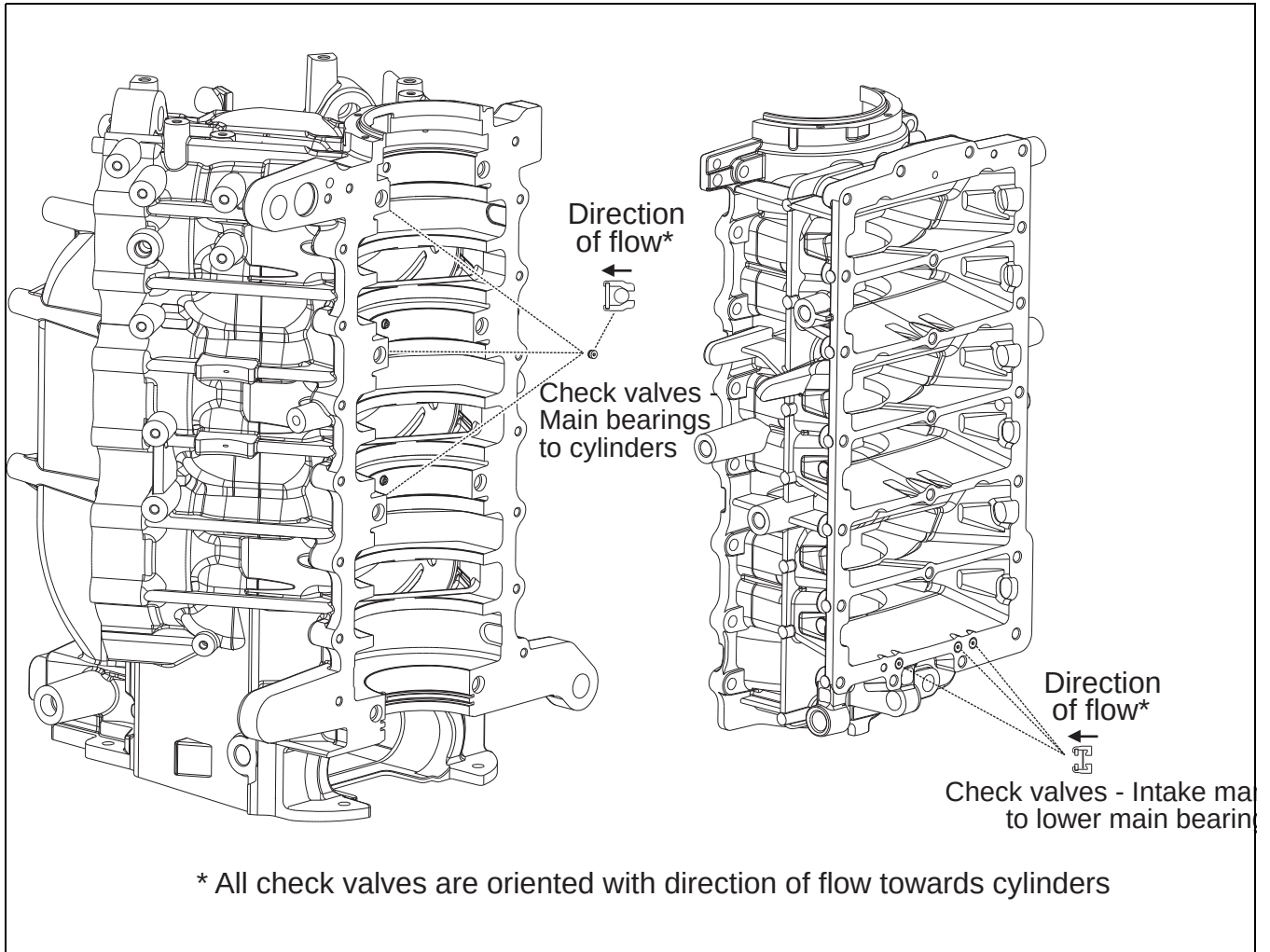
Port Side View



Starboard Side View



005353



005352

OIL SYSTEM REQUIREMENTS

Recommended Lubricants

Evinrude/Johnson XD100, XD50, or XD30 outboard oils are recommended for use in *Evinrude E-TEC* outboards. If these oils are not available, you must use a TC-W3 certified oil.

Evinrude/Johnson XD100 outboard oil is highly recommended for all conditions and applications.

Engine Lubricant Below 32°F (0°C)

If the outboard will be operated in temperatures below freezing (32°F, 0°C), use *Evinrude/Johnson XD100*.

IMPORTANT: For new outboards, test low oil warning before filling oil tank.

Turn key switch to ON. The engine monitor warning display should show "LOW OIL."

Add enough oil to raise level to at least one-quarter capacity.

The "LOW OIL" warning should not display.

NOTICE Failure to follow these recommendations could void the outboard warranty if a lubrication-related failure occurs.

COMPONENTS

The oiling system consists of the following components:

- Oil tank
- Oil injection pump and manifold assembly
- Rear oil manifold assembly
- Oil pressure sensor
- Electrical circuit
- LOW OIL and NO OIL warning systems
- Cylinder and crankcase
- Oil recirculation system

Oil Tank Assembly

The oil tank must be properly positioned and the oil level must be monitored. Refer to the **Predelivery and Installation Guide**.

Oil Tank Components:

- Tank, 1.8 or 3.0 gallon capacity
- Oil pickup and filter assembly
- LOW OIL sending unit
- Mounting bracket and hardware
- Protective cover (1.8 gallon tank only)
- Primer bulb and supply hose.

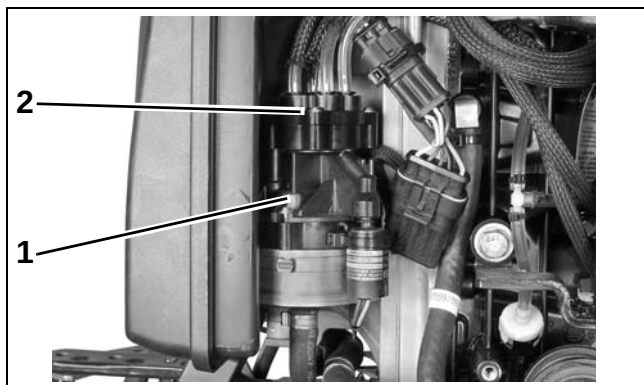


1.8 Gallon Oil Tank Kit

44839B

Oil Injection Pump

The oil injection pump is an electric (55 V) actuator style pump. It draws oil from the oil tank through the oil supply hose (25 ft. [7.6 m] maximum) and supplies pressurized oil to the oil manifold. The *EMM* supplies 55 V and controls activation of the pump.



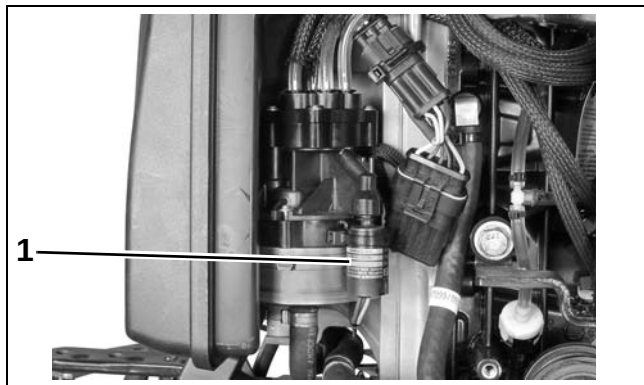
1. Oil injection pump
2. Oil manifold

005371

The oil manifold distributes the oil supplied by the oil injection pump to the crankcase and to the rear oil manifold.

Oil Pressure Sensor

The oil pressure sensor reacts to changes in oil manifold pressure. The *EMM* supplies and monitors electrical current to the sensor.



1. Oil pressure sensor

005371

The sensor provides an output voltage to the *EMM* based on oil manifold pressures.

- 5 VDC Input on RED wire
- 0.5 - 4.5 V Output on TAN / WHITE wire
- Ground on BLACK wire

The *EMM* monitors the oil pressure sensor's electrical circuit. If circuit voltage is beyond the specified range (< 0.15 V, > 4.85 V), the *EMM*:

Stores service code 71
<i>EMM</i> LED 3: ON (Running)

If oil pressure is below expected range (< 0.4 V), the *EMM*:

Stores service code 72
<i>EMM</i> LED 3: ON (Running)

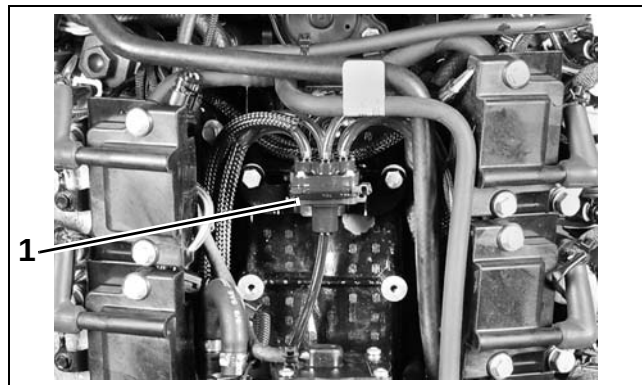
If oil pressure is above expected range (> 4.6 V), the *EMM*:

Stores service code 73
<i>EMM</i> LED 3: ON (Running)

Refer to **Oil Pressure Sensor** on p. 57.

Rear Oil Manifold

The rear oil manifold receives oil from the primary manifold and distributes it to the cylinder sleeves.



1. Rear oil manifold

008362

OILING SYSTEM COMPONENTS

Electrical Circuit (55 V)

The oil injector is powered by the 55 V electrical circuit. The *EMM* controls pump operation by rapidly connecting and disconnecting the pump's internal coil to ground.

The *EMM* monitors the oil injection pump electrical circuit. If circuit voltage is beyond the specified range (open circuit), the *EMM*:

Activates <i>S.A.F.E.</i>
Stores service code 34
<i>EMM</i> LED 4: ON (Running)
Engine Monitor NO OIL display: ON

LOW OIL Warning

A sending unit in the oil tank pick-up assembly monitors the oil level in the oil tank.

If the oil level falls below one-quarter capacity, the *EMM* signals:

Engine Monitor LOW OIL display: ON

An optional oil tank sending unit kit is available to display actual oil level through an *I-Command* network.

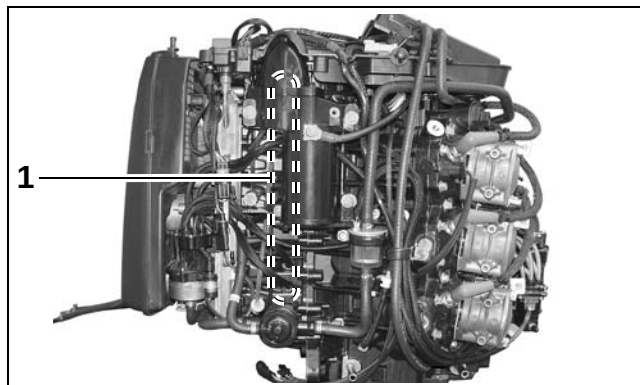
NO OIL Warning

The *EMM* monitors the electrical circuit of the oil pressure sensor. If the sensor or circuit fails, or if there is a lack of oil pressure in the oil distribution manifold, the *EMM*:

Activates <i>S.A.F.E.</i>
Stores service code 38
<i>EMM</i> LED 4: ON (Running)
Engine Monitor NO OIL display: ON

Cylinder and Crankcase

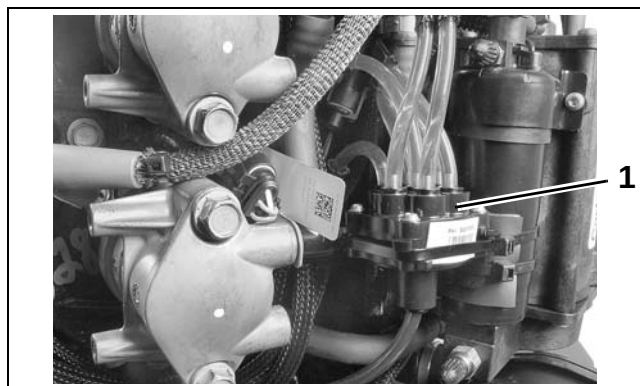
The primary oil distribution manifold provides crankcase lubrication through oil distribution hoses and pressed-in fittings at the front of the crankcase, port side.



1. Pressed-in fittings

005359

The rear oil distribution manifold provides lubrication for each cylinder. Each cylinder of the cylinder/crankcase has a pressed-in fitting which is connected to an oil distribution hose.



1. Rear oil manifold

005347

Oil Recirculation System

External hoses and fittings, internal cylinder/crankcase passages, and intake manifold passages are used to recirculate any accumulation of oil from various locations in the powerhead. The movement of oil is controlled by check valves.

Cylinder Recirculation

Internal powerhead oil drain passages connect the intake port areas of the cylinders to circulate residual oil in the block.

External fittings and in-line check valves on each side of the cylinder block control the movement of oil from the lower cylinder port to the upper cylinder port.

Crankcase / Main Bearing Recirculation

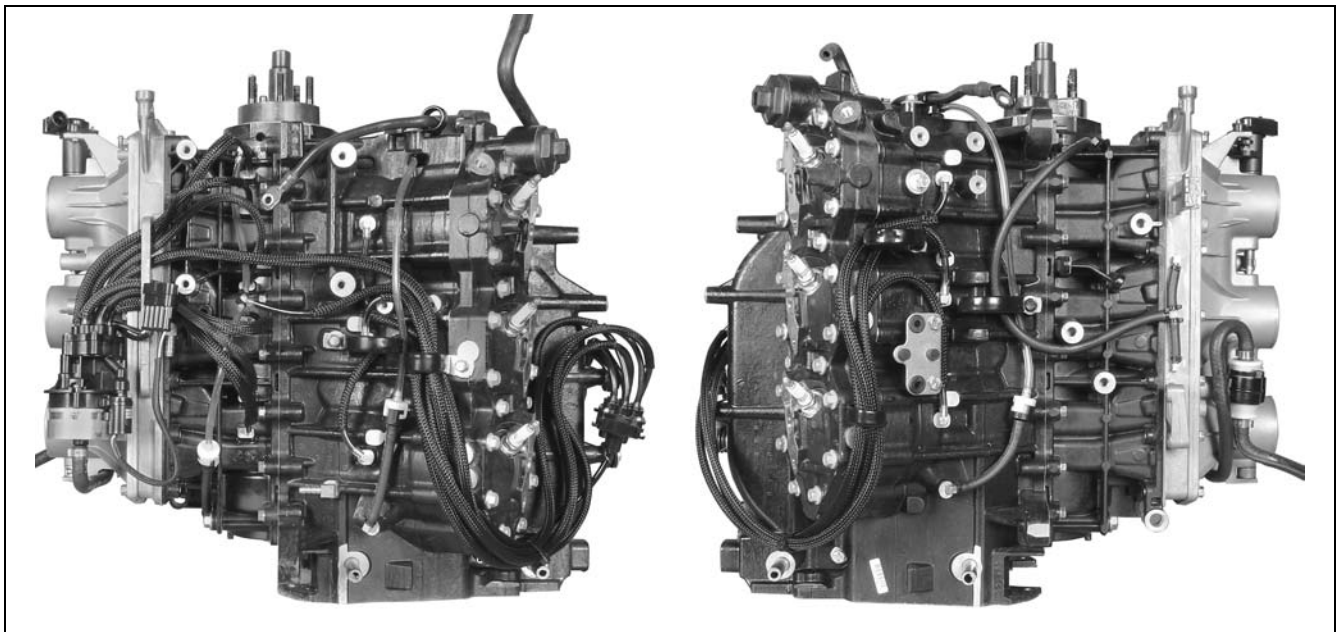
The movement of oil through the main bearings is controlled by internal passages, external fittings and hoses, and check valves.

Oil moves from the crankcase areas of the higher cylinders through grooved passages in the crankcase to the center and lower main bearings. Additional oil moves through intake manifold passages to the crankcase and lower main bearing.

Lower to upper main bearing oil flow:

Oil moves from the lower main bearing cavity to an external hose with in-line check valve and to the upper main bearing. Additional oil from the rear oil manifold is supplied to this oil circuit on V6 models.

Oil moves from Intake manifold passages to external check valve fittings and hoses and to the upper main bearing.



006788
006789

OIL CONTROL SETTINGS

Oil Injection Rate

The Engine Management Module (EMM) controls the oil injection rate based on engine RPM. This rate can be adjusted for the type of oil being used, and also for powerhead break-in. Use *Evinrude Diagnostics* software to access these features.

The Set Oil Type option controls the injection rate for the oil being used and typical operating conditions.

The TC-W3 oil type setting is the standard setting for all outboards. Set TC-W3 for:

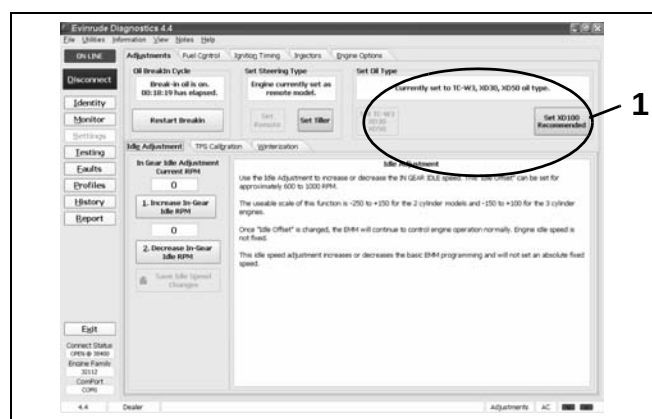
- Operation with all TC-W3 outboard oils including *XD30*, *XD50*, or *XD100*.
- Applications requiring maximum lubrication.
- Extreme applications (commercial or harsh conditions, racing or other high performance operation).
- Use this setting with *XD100* outboard oil in extreme applications

The *XD100* setting provides an option to run the outboard at a reduced oil injection rate. This setting **REQUIRES** the use of *Evinrude XD100* outboard lubricant and is not recommended for all applications.

IMPORTANT: The *XD100* setting is not available on all models.

Use the *XD100* setting for:

- Conventional use (runabouts, cruisers)
- Moderate applications



1. Oil control setting

008084

CAUTION

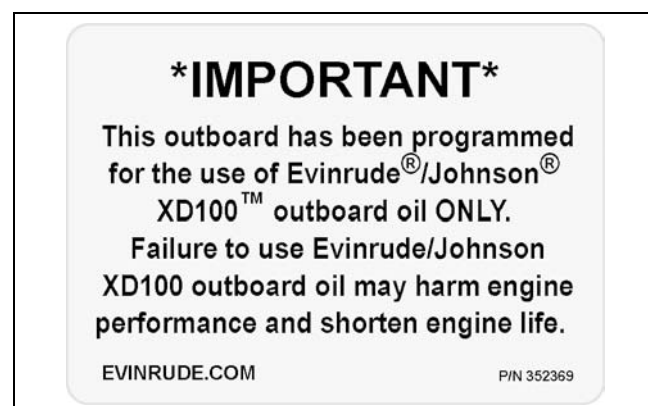
Running an *Evinrude E-TEC* outboard on other grades of oil while set to the *XD100* oil ratio will result in increased engine wear and shortened outboard life.

Powerhead oil programming labels are provided to identify *EMM* oil programming. Install the correct label to alert user to specific oil requirements.



1. Evinrude/Johnson *XD30* outboard lubricant (TC-W3) **YELLOW label** 004964
2. Evinrude/Johnson *XD100* outboard lubricant (Premium) **BLUE label (Installed)**

An *XD100* Outboard Oil Decal, P/N 352369, is available to label boats equipped with outboards that have been programmed for the reduced oil injection ratio.



XD100 Outboard Oil Decal

004522

Install decals in a highly visible location, such as one of the following:

- Dashboard/deck of boat, next to key switch
- Deck of boat, next to the remote oil fill
- Deck of boat, next to oil tank assembly
- Oil tank cover
- Cover of oil tank compartment
- Attach to oil tank or oil fill cap.

IMPORTANT: Make sure the engine label and boat decals match *EMM* programming.

Break-In Oiling

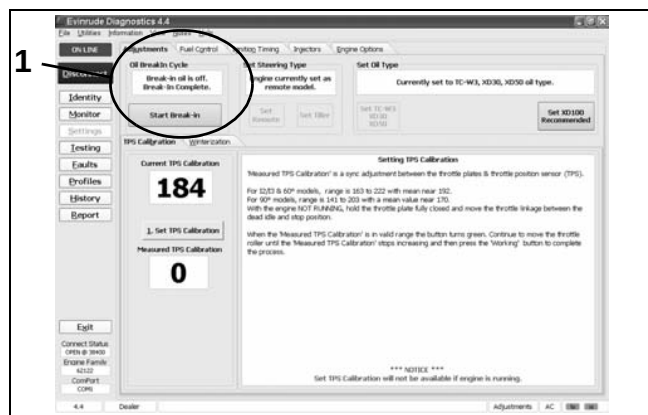
IMPORTANT: DO NOT add oil in the fuel tank on *Evinrude E-TEC* models.

The *EMM* automatically supplies extra oil to the engine as follows:

- 60° V4 & V6: First five hours above 2000 RPM

Follow these steps for outboard set-up:

- Use *Evinrude Diagnostics* software to make sure the break-in program has been started on a new outboard.
- Use the diagnostics software to start break-in oiling after a powerhead rebuild.



1. Break-in oil setting

008108

NOTICE The operator must monitor the oil tank level to confirm oil consumption. This may require several hours of operation above idle.

Oil Supply Priming



WARNING

Always use caution while working around machinery with moving parts. The following set-up procedures require running tests that are performed with the outboard's motor cover removed.

Oil Hose Priming

Insert the oil supply hose from the oil tank into a suitable container. Squeeze the oil primer bulb until oil flows from the oil tank into the container.

Once oil supply hose from the oil tank is filled with oil, connect the hose to the oil supply fitting on outboard and secure with *Oetiker* clamp.

Oil Pump Priming

Squeeze the oil primer bulb until oil flows from the oil supply hose, through the oil filter, and into the oil pump assembly.

IMPORTANT: Inspect oil filter to make sure it is filled with oil. All air must be eliminated from the oil filter during priming procedure.

IMPORTANT: Arrow on oil filter faces incoming oil.

Continue to squeeze the oil primer bulb until oil flows through the oil pump, into the oil distribution hoses, and to the crankcase fittings.

Use *Evinrude Diagnostics* software to make sure the *EMM* is programmed for the type of oil being used.

Start the outboard. Use the oil priming function in the software to make sure the system is completely primed.

OILING SYSTEM

OIL CONTROL SETTINGS

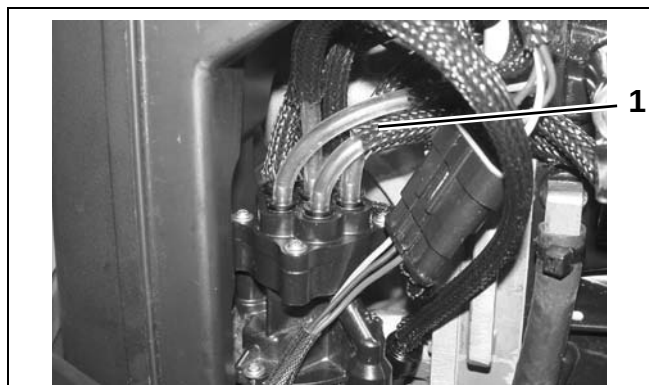
Use the *Prime Oil System* button of the *Dynamic Test* screen to prime the oil pump.



Dynamic Test Screen
1. Prime Oil System button

008092

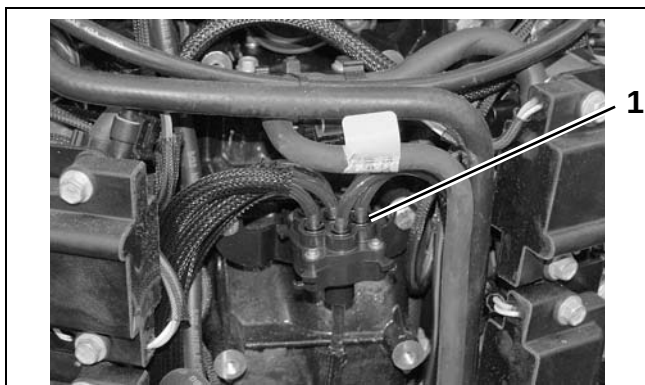
Observe oil flow through all oil distribution hoses. Air must be purged during the priming procedure.



60° V4-V6 Models
1. Oil distribution hoses

004965

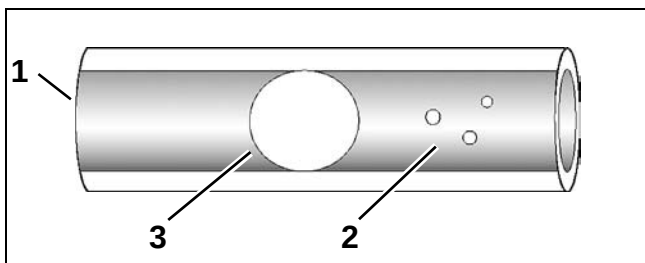
Make sure that oil flows through the rear oil distribution manifold to the cylinder block fittings.



1. Rear oil distribution manifold

008016

Small bubbles are acceptable. Large bubbles must be eliminated through continued priming.



1. Oil distribution hose
2. Small bubbles
3. Large bubbles

004398

Repair any fuel or oil leaks.

The oiling system on these models can also be primed using the Self-Winterizing feature if diagnostics software is not available. Refer to **STORAGE** on p. 43.

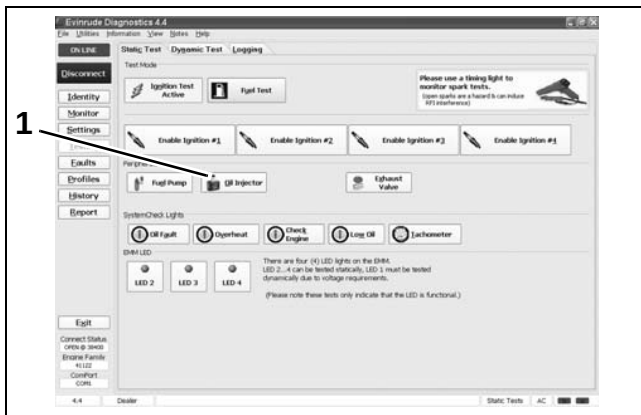
OILING SYSTEM TESTS

IMPORTANT: Always perform visual inspections to identify oiling system leaks. Make sure the oil tank is filled and oil supply is not contaminated.

Oil Injection Pump Static Test

The *EMM* controls the pump by providing ground through pin 23 (blue wire) of the J1-B connector and pin 2 (blue wire) of the oil pump connector.

Use *Evinrude Diagnostics* software to activate the *Oil Injector* test. This test starts the *EMM* control function for the oil injection pump.



Static Tests Screen
1. Oil injector test button

008116

IMPORTANT: This test is operating the pump with 30 V on the system voltage (55 V) circuit. The start assist circuit (SAC) of the *EMM* converts battery voltage (12 V) to 30 V of system voltage. Battery must be fully charged and connections must be clean and tight. Pump activation should be carefully confirmed. Listen for an audible click from the oil injection pump when it is activated.

Use an inductive timing light to monitor current flow through the ground circuit (blue wire) at the oil pump connector (pin 2).

If the light flashes, the *EMM* and oil injection circuits are not at fault.

Refer to **Oil Injection Pump Voltage Tests** on p. 175.

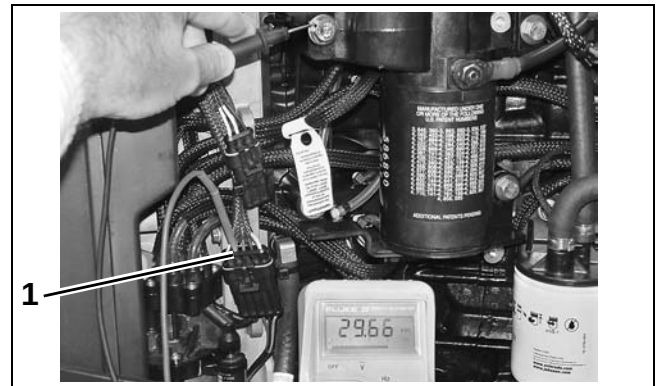
Oil Injection Pump Voltage Tests

Use a digital multimeter calibrated to a scale that reads 55 V (DC) to measure voltage between the oil pump electrical connector and engine ground.

Acceptable Oil Injection Pump Test Readings	
Key switch ON	approximately 30 VDC
Control signal	approximately 10 Hz
Engine running	approximately 55 VDC

Connect negative meter lead to ground.

Use an appropriate test probe to connect positive meter lead to pin 2 (blue wire) of oil injection pump electrical connector.



1. Oil injection pump connector (pin 2)

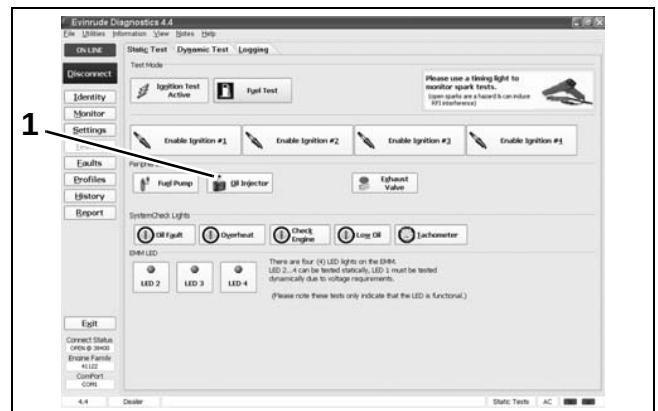
005442

8

Turn the key switch to the ON position. Observe voltage at pin 2.

- Voltage at pin 2 should be approximately 30 V.

Use the *Oil Injector* test of *Evinrude Diagnostic* software *Static Test* screen to activate the oil pump.



Static Tests Screen
1. Oil injector test button

008116

OILING SYSTEM

OILING SYSTEM TESTS

Observe voltage at pin 2.

- Voltage at pin 2 should drop as the oil pump cycles.

Check the control signal while the *Oil Injector* test is running. Set the digital multimeter to the Hertz (Hz) scale.

- Meter should read approximately 10 Hz.

Results:

- If voltage and control signal readings (Hz) at pin 2 are within range, the *EMM* and wiring are not at fault.
- If voltage at pin 2 is not within range, check voltage at pin 1 (white/red wire) of oil pump electrical connector.

Connect positive meter lead to pin 1 (white/red wire) of oil injection pump electrical connector. Observe voltage at pin 1.

- Voltage at pin 1 should be approximately 30 V.

Start the engine. Observe voltage at pin 1.

- Voltage at pin 1 should be approximately 55 V.
- If voltage is not within range, refer to **Oil Injection Pump Circuit Resistance Test** on p. 176.
- No voltage reading, refer to **System Voltage Test** on p. 78.

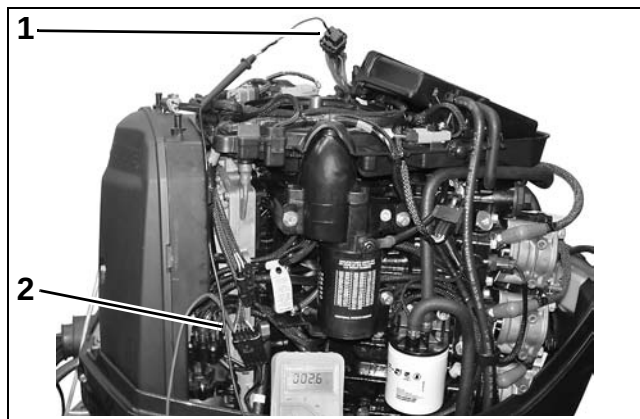
Oil Injection Pump Circuit Resistance Test

IMPORTANT: The complete oil injection pump electrical circuit includes *EMM* alternator output, the engine wire harness, the injection pump winding and connectors, and the oil injector control circuit of the *EMM*. Check continuity of all wiring and connections.

Disconnect the battery cables at the battery.

Use a digital multimeter with appropriate adapter leads to measure the resistance between pin 23 (blue) of the *EMM* J1-B connector and pin 1 (white/red) of the oil injection pump connector. Calibrate the meter to the LOW OHMS scale.

Oil Injection Pump Circuit Resistance
2 to 3 Ω



1. EMM J1-B connector (pin 23)
2. Oil injection pump connector (pin 1)

005443

- An infinite reading (∞) indicates an open circuit. Isolate the faulty component. Check continuity of wiring, connections, or injection pump winding. Repair faulty wiring or replace faulty pump.
- For a higher than expected reading, test resistance of the injection pump. If injection pump resistance reading is within range, injection pump winding is good. Isolate faulty component. Repair faulty wiring or replace faulty component and retest.

Oil Supply Vacuum Test

WARNING

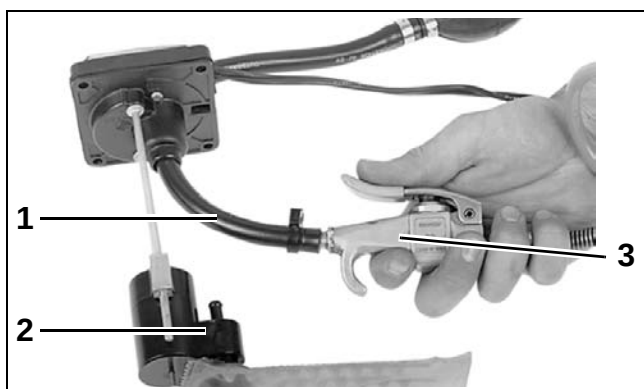
Wear safety glasses to avoid personal injury, and set compressed air pressure to less than 25 psi (172 kPa).

Remove the oil pick-up assembly from the oil tank.

Carefully remove the pickup filter and flush with a mild solvent to remove any contamination. Reinstall filter.

Carefully remove the oil hose from the oil pickup and remove the oil supply hose from the oil injection pump.

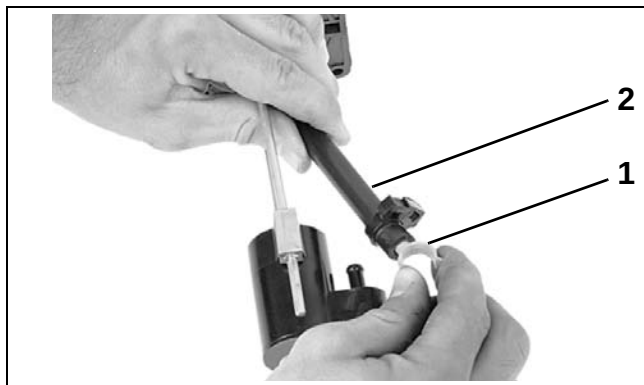
Use low pressure air to purge oil from hose.



1. Oil hose
2. Oil pickup
3. Low pressure air

12306

Use Plug/Holder, P/N 329661, and clamp to plug the pickup end of the hose.



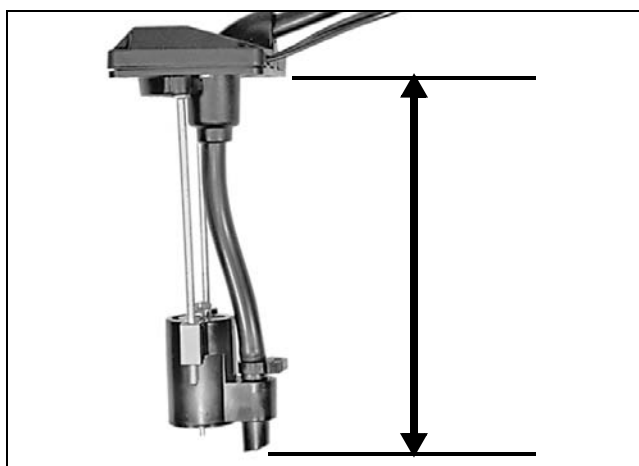
1. Plug/holder
2. Oil hose

12307

Attach a vacuum tester to the outboard side of oil supply hose and draw 7 in. Hg (24 kPa) vacuum on the hose for at least five minutes. Repair or replace any leaking components. Reinstall the oil hose.

Check height of pickup assembly.

Pickup Assembly Height	
1.8 gallon tank	6.84 to 6.96 in. (174 to 177 mm)
3.0 gallon tank	8.74 to 8.86 in. (222 to 225 mm)



Height of Oil Pickup Assembly

COB5657A

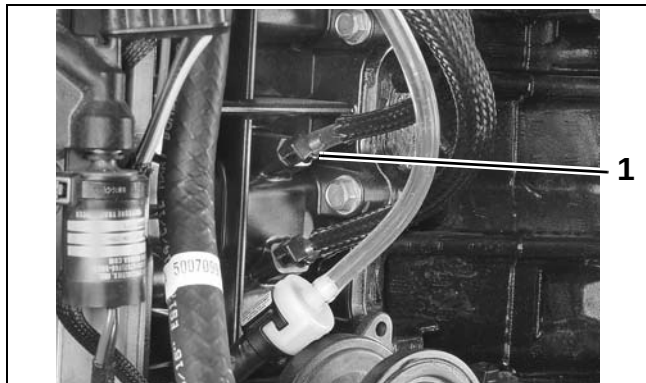
Place a **new** seal on oil tank and reinstall pickup with filter into oil tank. Install and tighten screws.

OILING SYSTEM

OILING SYSTEM TESTS

Oil Injection Pump Function Test

Remove oil distribution hose from fitting at crankcase. Squeeze oil supply primer bulb to provide oil to injection pump.



1. Crankcase fitting

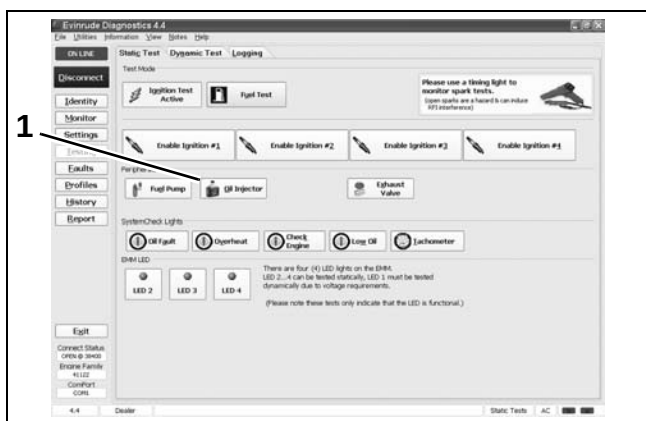
005348

Running Test

Start the outboard and observe oil flow. Confirm that a small amount of oil is discharged while injection pump is activated.

Static Test

Use the *Evinrude Diagnostics* software oil injector test to activate injector. Confirm that a small amount of oil is discharged while injection pump is activated.



Static Tests Screen

1. Oil injector test button

008116

Results:

- Oil flows from hose, compare to oil flow at other distribution hoses
- If one or more hoses fail to discharge oil, check for a kinked or restricted hose before replacing the oil injection pump assembly.

Oil Injection Fittings Flow Test

Make sure the oil injection fittings of the cylinder and crankcase assembly allow fluid to move.

Remove oil distribution hose from crankcase fitting. Temporarily install a length of oil hose on the fitting.

Use a Syringe, P/N 346936, filled with isopropyl alcohol to force fluid through hose and fitting.

LOW OIL Sending Unit Test

Remove oil from the oil tank

Turn the key switch ON. The dash mounted Engine Monitor system should show a LOW OIL warning.

Once the warning has been confirmed, refill the oil tank. The LOW OIL warning should stop when the oil level exceeds one-quarter of oil tank's capacity.

OIL COMPONENT SERVICING

! WARNING

To prevent accidental starting while servicing, twist and remove spark plug leads.

Oil Distribution Hoses

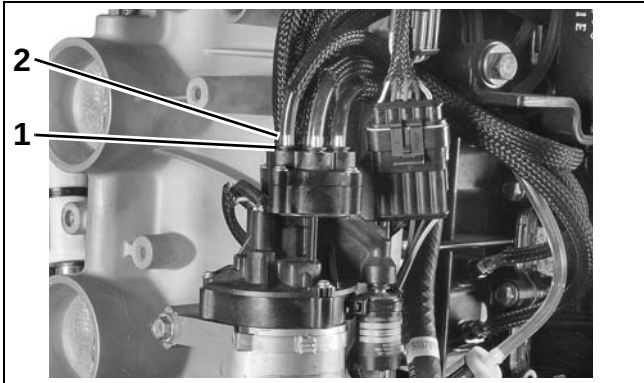
The oil distribution hoses from each manifold **MUST** be the same length. **DO NOT** alter the length of any hoses.

Oil Distribution Hose Length	
Primary oil manifold to cylinder block fitting	12 in. (305 mm)
Rear oil manifold to cylinder block fitting	32 in. (812 mm)
Primary oil manifold to rear oil manifold*	32 in. (812 mm)

*Primary oil manifold to rear oil manifold hose has a 0.160 in. I.D. and does **NOT** use a hose support.

Removal

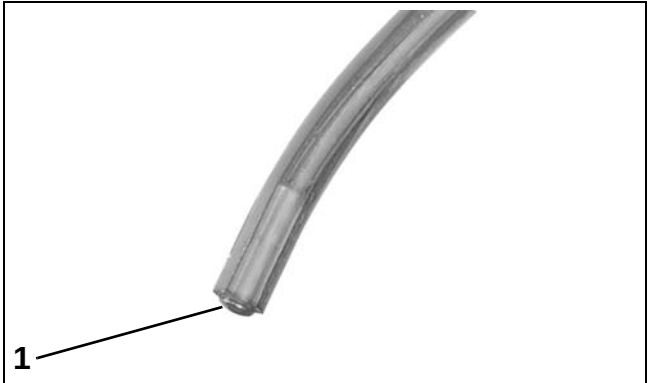
Release the hose by depressing the outer ring of the hose retaining mechanism.



1. Retainer mechanism
2. Hose support

005349

Once hose is removed from the manifold, make sure hose support is in the end of the hose.



1. Hose support

008070

Installation

Cut Replacement Oil Hose, P/N 778708, to the correct length. Insert hose support in manifold end of hose. (Primary manifold to rear manifold hose does not use a hose support.)

IMPORTANT: **DO NOT** insert distribution hoses into manifold without a hose support.

Be sure the hose is fully inserted into manifold. Insertion depth is 5/8 in. (16 mm). Visually inspect for hose supports.

OILING SYSTEM

OIL COMPONENT SERVICING

Oil Injection Pump

Removal

Disconnect the battery cables at the battery.

Remove engine cover and air silencer.

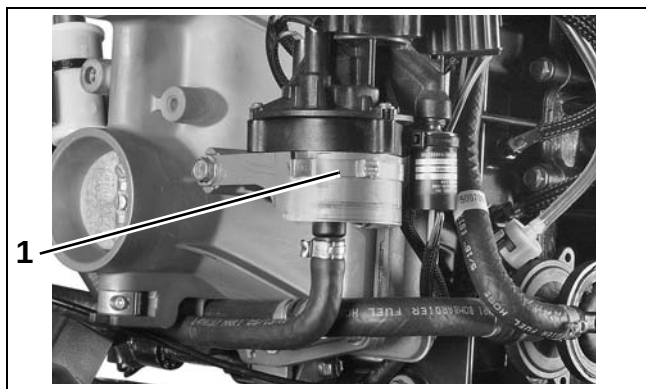
Remove the oil supply hose from the fitting (inlet) of the oil injection pump.

Disconnect the electrical connector.

IMPORTANT: Note oil distribution hose routings before proceeding with disassembly. Center hose from primary oil manifold connects to oil to inlet of rear oil manifold.

Remove oil distribution hoses from the crankcase fittings.

Remove oil injection pump screws, bracket, and clamps.



Oil Injector-Manifold Bracket

005346

1. Clamp

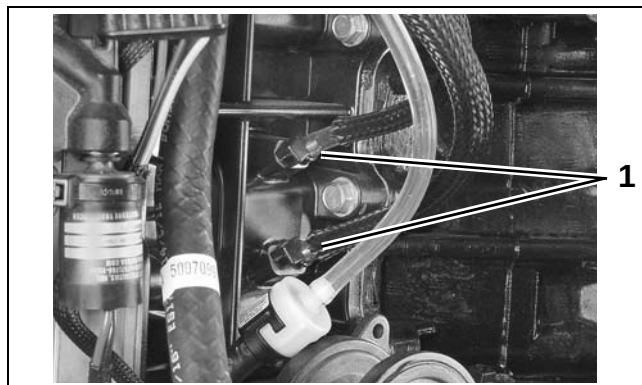
Remove the oil injection pump assembly.

IMPORTANT: The oil injection pump and manifold is an assembly and cannot be serviced as individual components.

Installation

Route oil distribution hoses from the oil distribution manifold to the crankcase oil delivery fittings as they were before removal. Refer to **OIL SUPPLY DIAGRAMS – V4** on p. 160 and **OIL SUPPLY DIAGRAMS – V6** on p. 162.

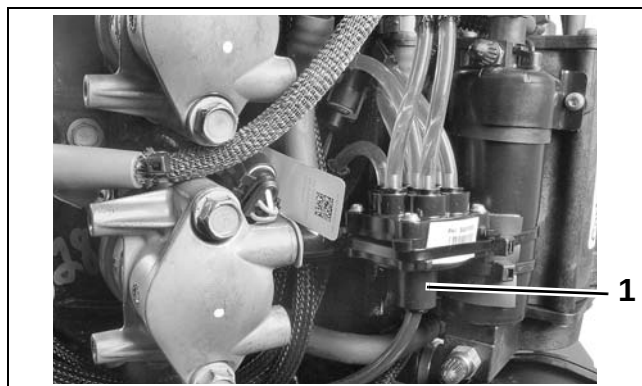
Connect oil hoses to crankcase fittings and fasten with tie straps.



1. Crankcase fitting

005348

Connect oil hose to rear oil manifold.

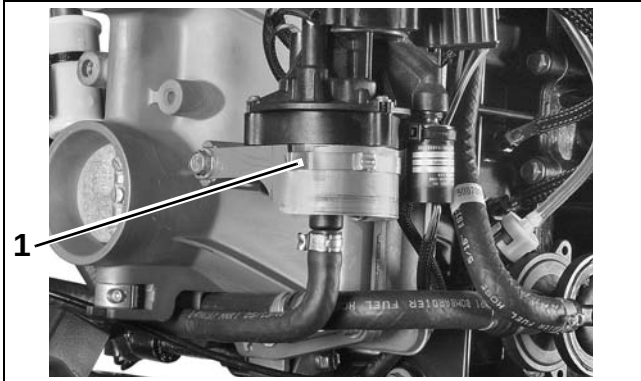


1. Oil to rear manifold

005347

Install oil pump bracket and retaining screws. Tighten small screw to a torque of 24 to 36 in. lbs. (3 to 4 N·m) and longer screw to 96 to 120 in. lbs. (11 to 13.5 N·m).

Position the oil injection pump assembly on bracket and install clamp.



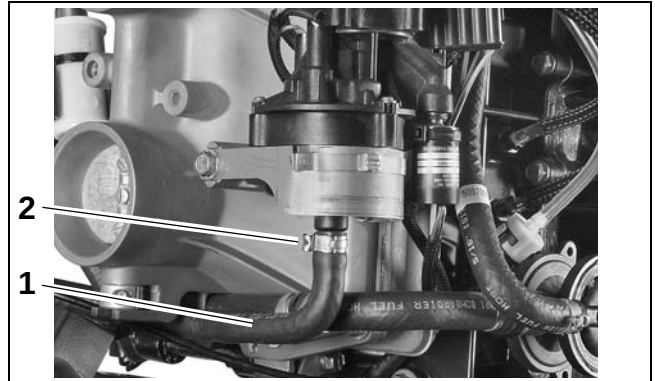
1. Clamp

005346

Reconnect the electrical connector.

IMPORTANT: Use oil primer bulb to purge air from oil supply hose before reconnecting hose to oil pump.

Reconnect oil supply hose to the inlet fitting of oil pump. Fasten with *Oetiker* clamp.



1. Oil supply hose
2. Oetiker clamp

005346

Make sure oiling system is primed. Check oil flow through oil distribution hoses. Check oil system operation and routing of oil hoses. Refer to **Oil Supply Priming** on p. 173.

Run the outboard and check for leaks.

Repair any oil leaks and any kinked or misrouted hoses.

NOTES

Technician's Notes

[illegible]

Related Documents

[illegible]

COOLING SYSTEM

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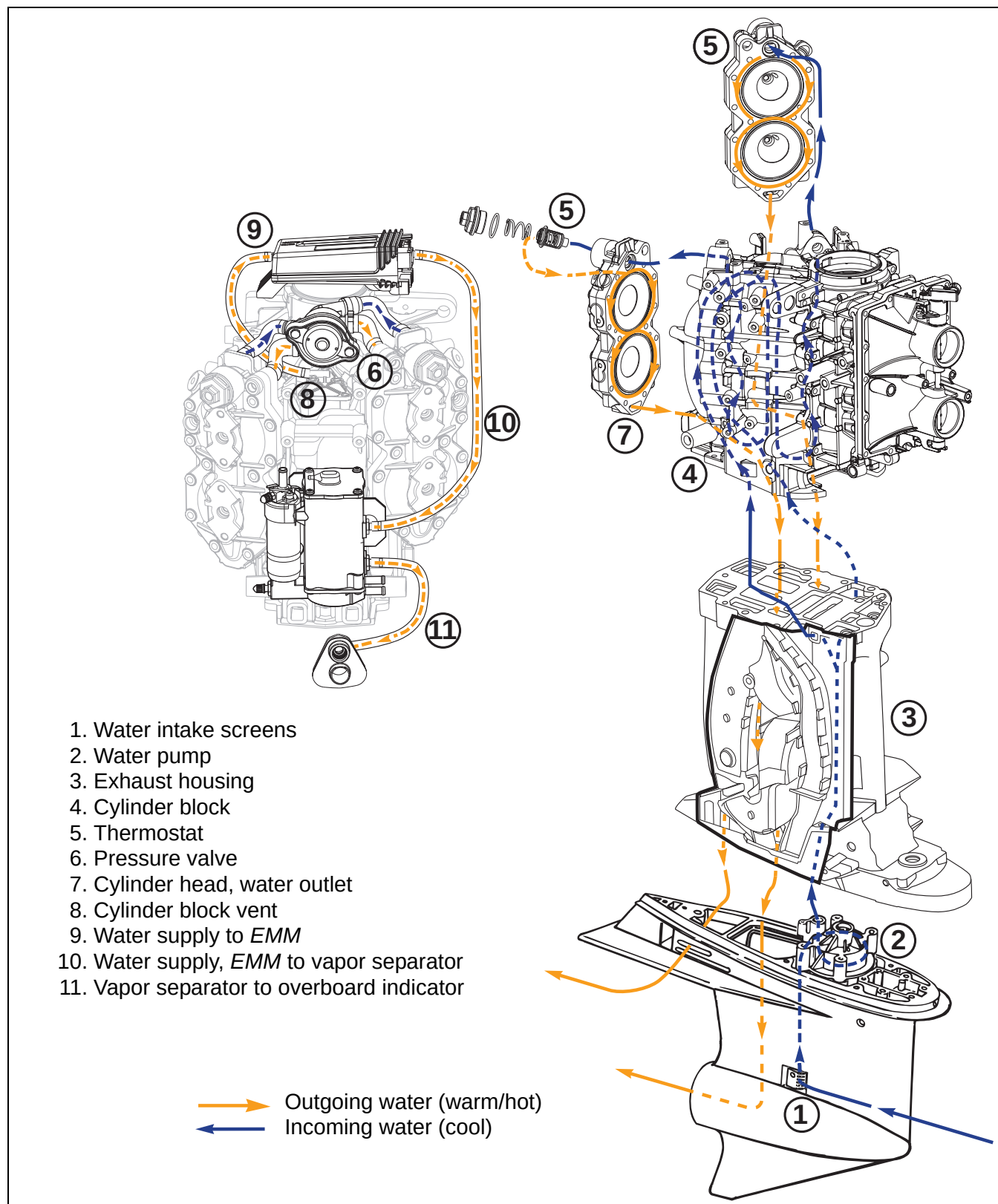
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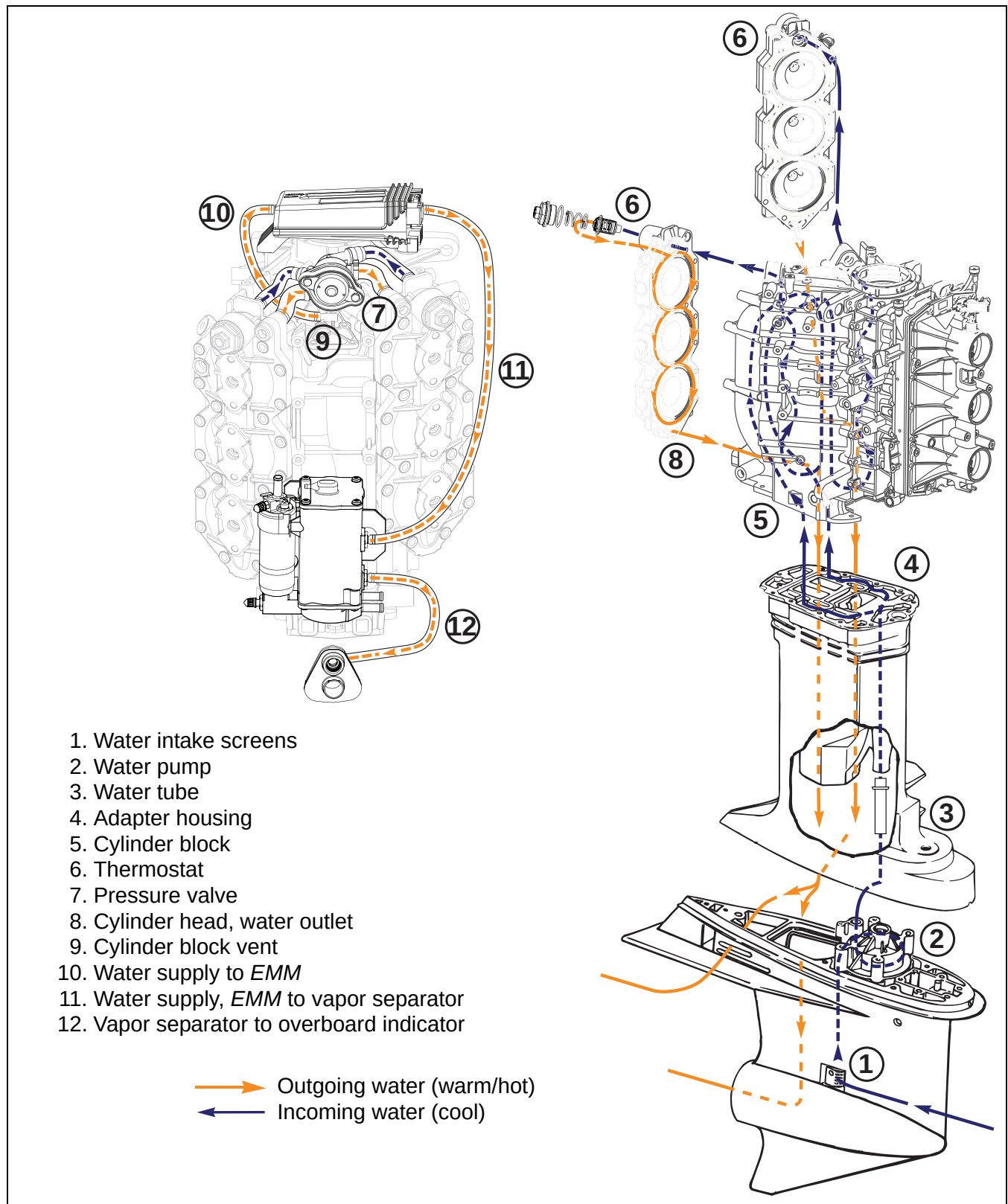
HOSE ROUTING AND WATER FLOW DIAGRAMS

V4 MODELS



HOSE ROUTING AND WATER FLOW DIAGRAMS

V6 MODELS



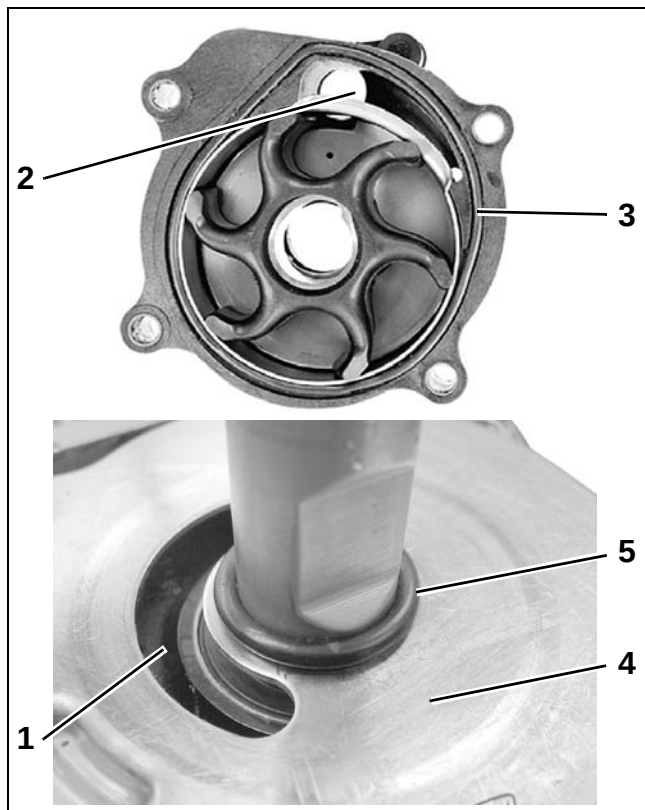
COMPONENTS

Water Pump and Intakes

External water intakes mounted in the gearcase housing collect water and must supply the inlet side of the water pump with an unrestricted and unaerated water supply. Water is drawn into the water pump through a hole in the lower plate of the water pump assembly. All cooling water to the powerhead is provided by the water pump.

- A nylon wedge (impeller key) is used to engage the impeller bushing and driveshaft.
- The nylon impeller housing with liner must seal against a separate water pump plate.
- The bottom plate **MUST** seal to gearcase.
- The pump operates as a positive displacement pump at **LOW** speeds (below 1500 RPM) and as a centrifugal pump at **HIGHER** speeds.

Refer to **WATER PUMP SERVICE** on p. 271 for water pump servicing.



(Impeller key removed for clarity)

1. Water inlet
2. Water outlet
3. Seal
4. Plate
5. O-ring

000697
DSC02328

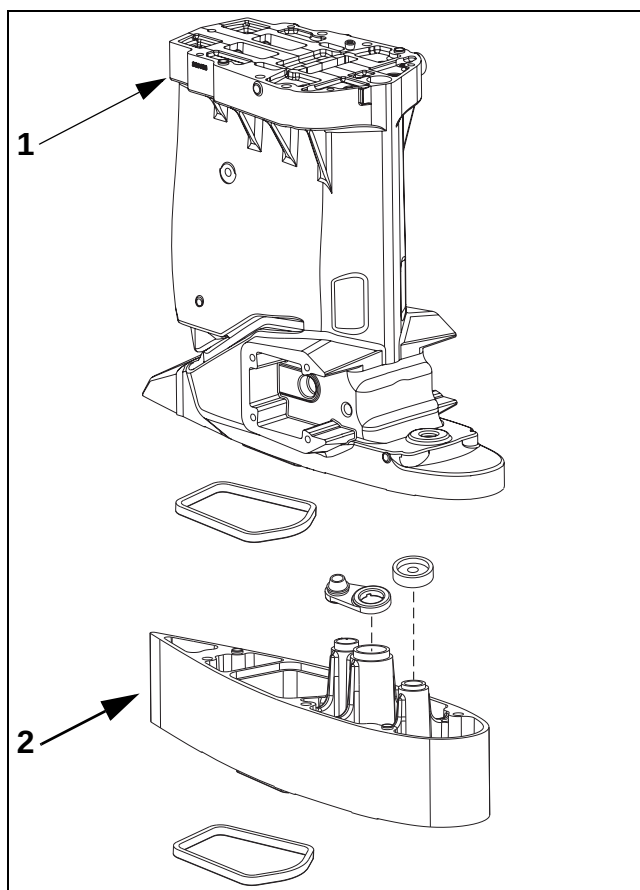
Water Supply Tube

The water pump outlet connects with the water supply tube located in the outboard's midsection. Grommets seal the water tube to the water pump housing and the inner exhaust housing.

Water supplied to the water tube provides all cooling water to the adapter housing and cylinder block.

Adapter/Inner Exhaust Housing

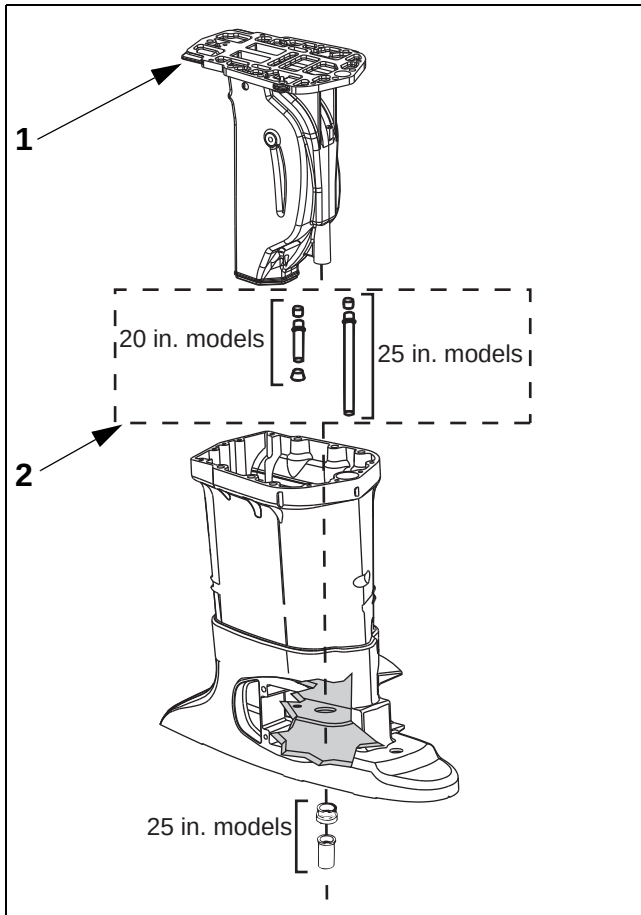
- Adapts the cylinder/crankcase assembly (powerhead) to the exhaust housing and the water tube.
- Provides water passages which route incoming and outgoing cooling water.
- Provides exhaust passages which connect to the gearcase.



V4 models

1. Exhaust housing
2. Extension (25 inch models only)

007197



V6 models

1. Adapter/inner exhaust housing
2. Water tube(s)

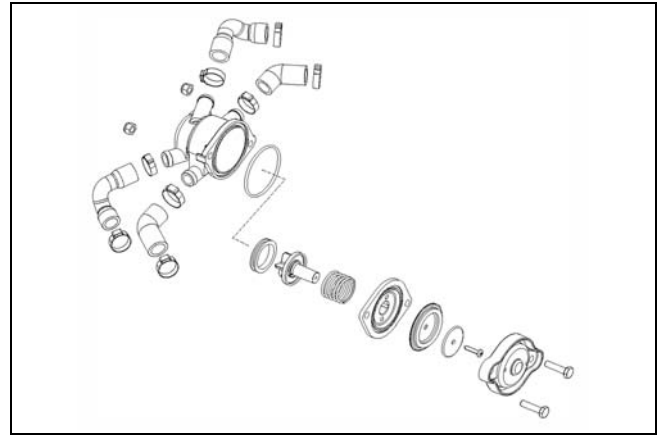
005396

Pressure Relief Valve

A pressure relief valve is used to control water flow and operating temperature at higher speeds (above approximately 2500 RPM / 21 PSI). The pressure relief valve opens as water pressure increases. Spring tension sets the opening pressure.

Overheating: A restricted or faulty valve typically results in HIGH SPEED overheating.

Overcooling: Debris may prevent the valve from closing completely.



Pressure Relief Valve Components

005391

Thermostats

Thermostats control water flow and operating temperature at lower speeds (below 2500 RPM).

Overheating: A restricted or faulty thermostat typically results in LOW SPEED overheating.

Overcooling: Debris may prevent the thermostat from closing completely.



Thermostat

005392

Block Venting

A fitting and hose from the top of the block allows the constant movement of water and/or air from the block. Circulated water flows through the EMM and Vapor Separator before exiting through the overboard indicator.

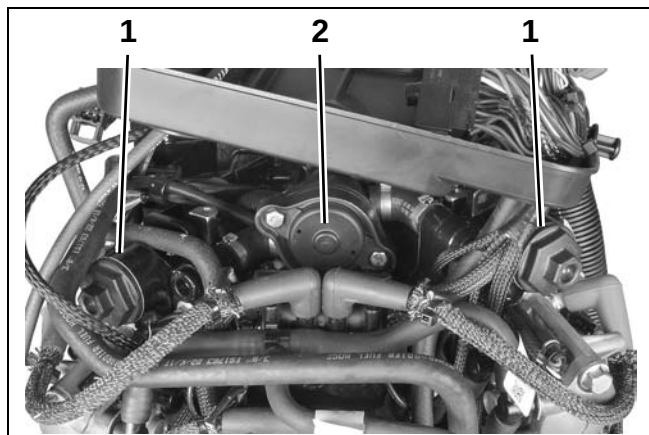
OPERATION

All models use a two-stage cooling system design. The cooling system is dependent on water pump pressure and controlled by thermostat and pressure valve operation.

NOTICE Restricted or inadequate water flow through the outboard reduces cooling system performance and may lead to severe power-head damage.

Cylinder Block / Cylinder Head Cooling

The flow of water through the cylinder block and cylinder heads is controlled by two thermostats and one external pressure valve. The pressure valve is connected by hoses to the top of the block and each cylinder head.



1. Thermostats
2. Pressure valve assembly

005393

The thermostats and pressure valve control the flow of water entering the vertical water passages of the cylinder heads.

At low speed, the pressure valve is against the seat and the thermostats are closed. Warm water from the cylinder block gradually migrates to the thermostat pocket at the top of each cylinder head.

The thermostat opens when the water temperature reaches approximately 143°F (62°C).

When the thermostat opens, water flows down through the cylinder head to a passage in the cylinder block. Water flows through the block to the exhaust housing and then out of the outboard.

At higher speeds, water pressure opens the pressure relief valve at approximately 2500 RPM. Water flows through the valve and bypasses the thermostats. Hoses route the water flow from the pressure valve to the vertical water passages below the thermostats. All water flows through the cylinder heads to the outlet passages of the block and then exits through the adapter housing.

This pressure controlled water outlet circuit provides a “high flow” discharge of water during high speed operation.

This cooling system configuration provides “balanced cooling” at higher RPM by using one pressure valve to control the discharge of water through both cylinder heads.

EMM and Vapor Separator Cooling

Cooling water is routed from the top of the cylinder block to the inlet fitting of the *EMM* water cavity. Cooling of the *EMM* helps to stabilize the temperatures of internal components.

IMPORTANT: Improper *EMM* cooling will activate service codes 25 and 29 and the Engine Monitor warning system. Refer to the **EMM Service Code Chart** at the back of this manual for specific service code information.

Cooling water from the *EMM* is routed to the water inlet fitting of the vapor separator water cavity. Cooling the vapor separator fuel chamber minimizes fuel vaporization.

Cooling water from the vapor separator is routed to the overboard indicator.

ENGINE TEMPERATURE CHECK

IMPORTANT: The engine temperatures listed below are based on an intake water temperature of $70^{\circ} \pm 10^{\circ}\text{F}$ ($21^{\circ} \pm 3^{\circ}\text{C}$).

Install correct test propeller and place outboard in a test tank or in the water. Start outboard and run at 3000 RPM in FORWARD gear for at least five minutes. Remember, running outboards at high speeds in test tanks may disrupt water flow to gearcase water intakes. Make sure the outboard has adequate water flow.



CAUTION

When servicing the propeller, always shift the outboard to NEUTRAL, turn the key switch OFF, and twist and remove all spark plug leads so the engine cannot be started accidentally.

Reduce speed to IDLE for five minutes. Check IDLE operating temperature.

Increase speed to 5000 RPM and check temperature.

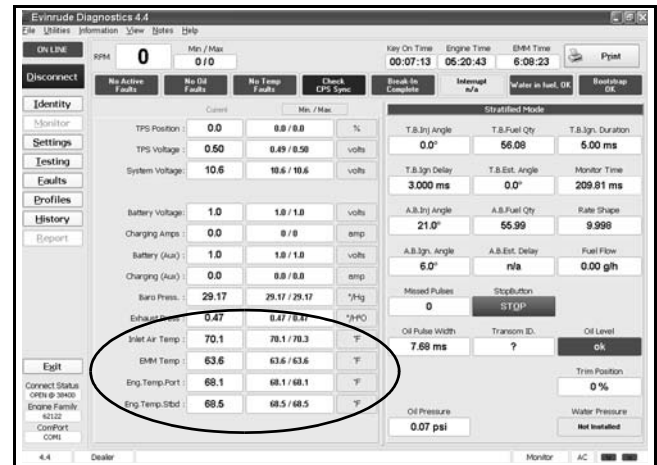
Check temperature on both sides of powerhead.

If engine temperature is not within range, troubleshoot cooling system.

If engine temperature tests within range, but the engine monitor display indicates a "WATER TEMP" warning, refer to **WATER TEMP/ HOT Circuit Test** on p. 108.

Software Method

Use *Evinrude Diagnostics* software to read temperature displays.



Engine Monitor Screen

008104

Typical temperature displays at IDLE speed should be $160^{\circ}\text{F} \pm 20^{\circ}\text{F}$ ($71^{\circ}\text{C} \pm 11^{\circ}\text{C}$).

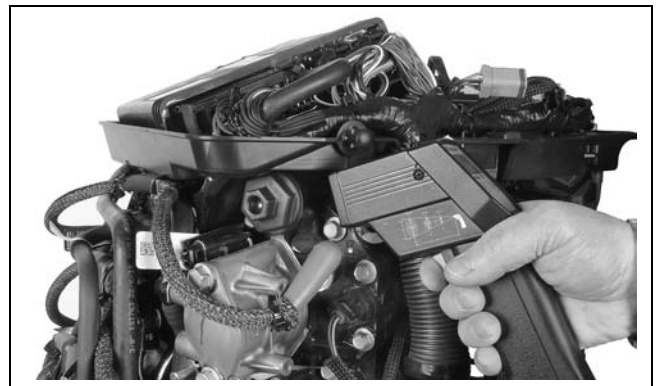
Typical temperature displays at WOT speed should be $120^{\circ}\text{F} \pm 20^{\circ}\text{F}$ ($50^{\circ}\text{C} \pm 11^{\circ}\text{C}$).

Operating temperature must not exceed 194°F (90°C).

Pyrometer Method

Use a Temperature Gun, P/N 772018, or a digital pyrometer to measure the outboard's operating temperatures.

Measure temperature of the thermostat housing at the top of each cylinder head.

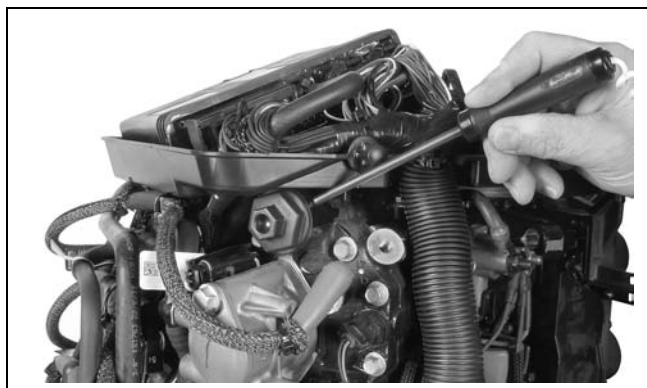


Temperature Gun, P/N 772018

005389

COOLING SYSTEM

ENGINE TEMPERATURE CHECK



005390

Typical pyrometer readings at IDLE speed should be $150^{\circ}\text{F} \pm 20^{\circ}\text{F}$ ($66^{\circ}\text{C} \pm 11^{\circ}\text{C}$).

IMPORTANT: If you get low or inaccurate readings with a digital pyrometer, coat the probe location with *Thermal Joint Compound*, P/N 322170.

Idle Operating Temperature Troubleshooting (Below Range)

If engine IDLE temperature is below operating range $160^{\circ}\text{F} \pm 20^{\circ}\text{F}$ ($71^{\circ}\text{C} \pm 11^{\circ}\text{C}$), check thermostat and pressure relief valve operation.

Pressure Relief Valve Inspection

The pressure relief valve should be closed at IDLE speed. Water should not flow past the plunger and seal.

Start the outboard and check IDLE operating temperature.

If IDLE temperature is too low, check pressure relief valve plunger and seal for damage or debris that could prevent the valve from closing completely.

If IDLE temperature is still below operating range, replace pressure relief valve assembly and plunger seal.

To test pressure relief valve operation, monitor temperature at the thermostat housing with Temperature Gun, P/N 772018, or digital pyrometer.

Confirm normal IDLE operating temperature.

Slowly increase engine speed from IDLE, up through 3000 RPM.

Engine temperature should decrease from normal IDLE temperatures as pressure relief valve opens. Valve should open at approximately 2500 RPM.

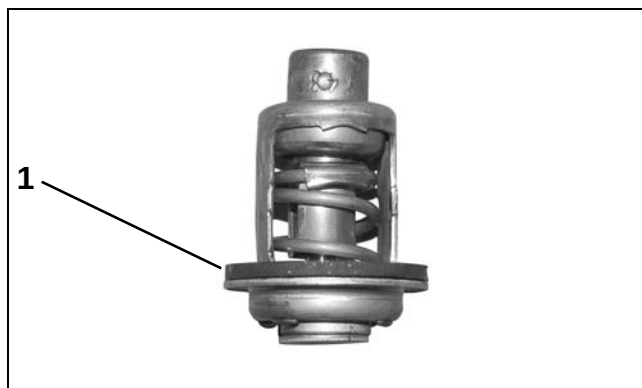
If temperature decreases at a lower RPM, replace pressure relief valve assembly.

Refer to **PRESSURE RELIEF VALVE SERVICING** on p. 192.

Thermostat Inspection

If IDLE temperature is still below operating range, inspect thermostats and thermostat seals.

Check position of thermostat seal and how thermostat seals against cylinder head. Seal must be properly fitted to flange of thermostat.



1. Thermostat seal

006401

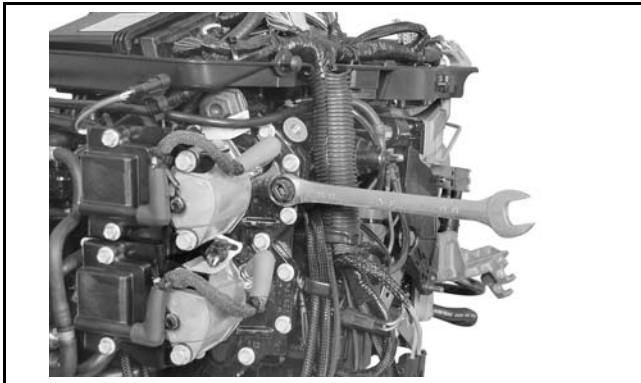
Check thermostat for cracks, heat damage, or signs of corrosion. Check for proper operation. Thermostat opens at 143°F (62°C).

Refer to **THERMOSTAT SERVICING** on p. 191.

TEMPERATURE SENDER SERVICING

Removal

Loosen sensor and remove by hand. Use care to avoid breaking threads.



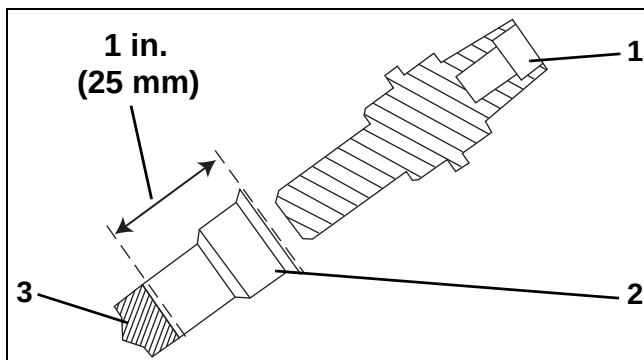
007196

Clean sensor threads, sensor, and sensor cavity.

Installation

Fill bottom of sensor cavity with 0.7 cc of *Thermal Joint Compound*, P/N 322170. Sensor cavity should be filled to 1 inch (25 mm) below the top edge of the cavity.

Install sensor. DO NOT use gasket sealing compound. SLOWLY tighten temperature sensor to a torque of 50 to 70 in. lbs. (5.6 to 8.0 N·m).



1. Temperature sensor
2. Sensor cavity
3. Thermal joint compound

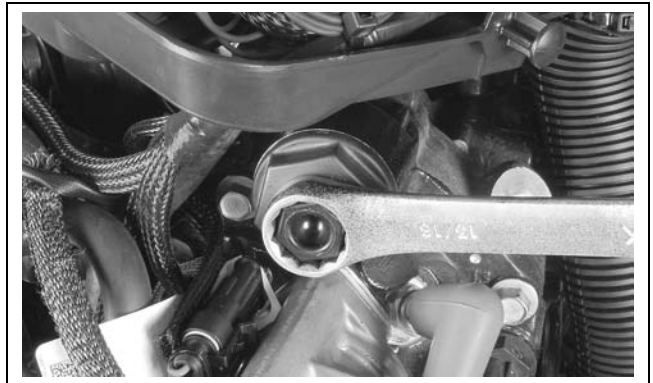
007049

Wait 10 minutes for trapped air to bleed from cavity. Thermal compound may seep past threads. Retighten sensor.

THERMOSTAT SERVICING

Disassembly

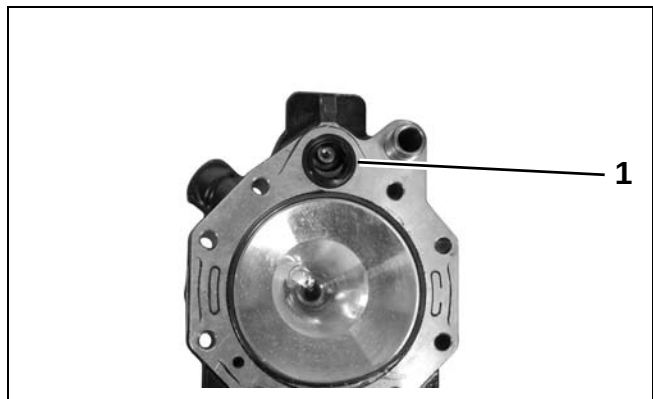
Remove the thermostat cover and O-ring from cylinder head.



005394

Remove spring, thermostat, and gasket.

Remove the cylinder head if cylinder head thermostat seal requires replacement. Place new seal in the cylinder head with side marked "TO CYL HEAD" facing thermostat. Refer to **Cylinder Head Installation** on p. 211.



1. Cylinder head seal

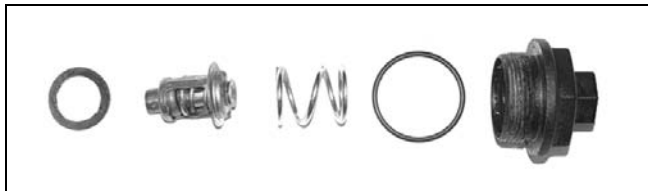
006816

COOLING SYSTEM

PRESSURE RELIEF VALVE SERVICING

Inspection

Inspect all parts for cracks, heat damage, or signs of corrosion. Replace damaged parts. Clean debris from housing and parts.



000756

Assembly

Assembly is the reverse of disassembly. Pay close attention when performing the following **additional** tasks.

Coat threads of each cylinder head thermostat cover with *Gasket Sealing Compound*. Install and tighten the cover to a torque of 120 to 144 in. lbs. (13.5 to 16.5 N·m).

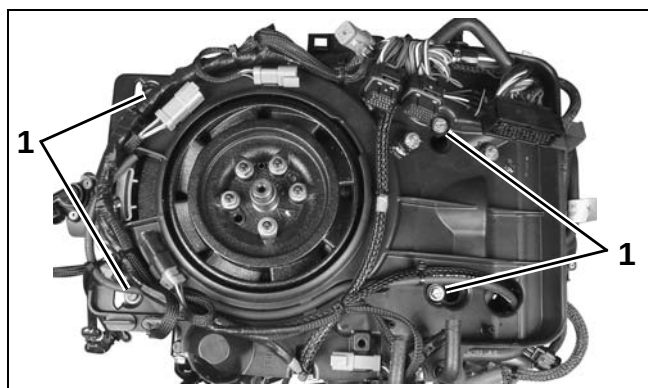
PRESSURE RELIEF VALVE SERVICING

The pressure relief valve assembly should be serviced at the same time as the thermostat.

Disassembly

Remove the *EMM*. Refer to **EMM SERVICING** on p. 68.

Remove the four screws holding the electrical harness base.

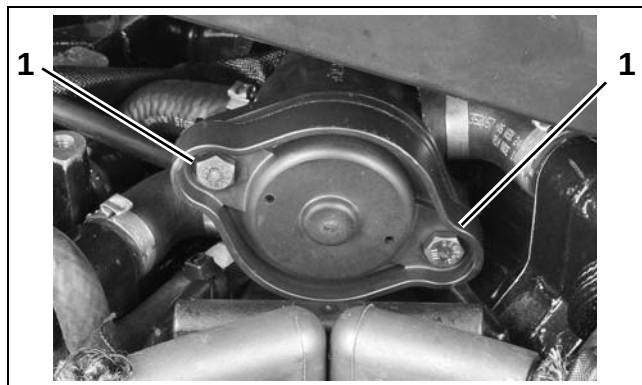


1. Harness base screws

005378

Loosen electrical harness connections as necessary to lift harness base away from the pressure relief valve.

Remove screws and cover from pressure valve assembly.



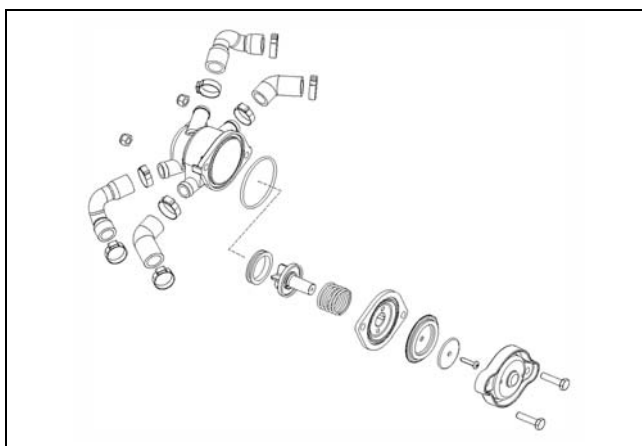
1. Pressure valve cap screws

005395

Remove the pressure relief valve assembly.

Inspection

Inspect all parts for cracks, heat damage, or signs of corrosion. Replace damaged parts. Clean debris from housing and parts.



Pressure relief valve assembly components

005391

Assembly

Assembly is the reverse of disassembly. Pay close attention when performing the following **additional** tasks.

Tighten cover screws to a torque of 60 to 84 in. lbs. (7 to 9.5 N·m).

POWERHEAD

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SERVICE CHART

60-84 In. lbs.
(7-9.5 N-m)

B 120-144 In. lbs.
(13.5-16.5 N-m)

A 168-192 In. lbs.
(19-21.7 N-m)

50-70 In. lbs.
(5.6-8 N-m)

J

A, X

15-30 Ft. lbs.
(20-41 N-m)

T 60-84 In. lbs.
(7-9.5 N-m)

L 40-50 In. lbs.
(4.5-5.5 N-m)

60-84 In. lbs.
(7-9.5 N-m)

H 31-35 Ft. lbs.
(42-47.5 N-m)

A 60-84 In. lbs.
(7-9.5 N-m)

P

A 20-22 Ft. lbs.
(27-30 N-m)

B

F 120-144 In. lbs.
(14-16 N-m)

F 120-144 In. lbs.
(13.5-16.5 N-m)

A 60-84 In. lbs.
(7-9.5 N-m)

E 18-20 Ft. lbs.
(24-27 N-m)

D 15-20 Ft. lbs.
(20-27 N-m)

A 110-130 Ft. lbs.
(149-176 N-m)

A Triple-Guard Grease
B Gasket Sealing Compound
D Moly Lube
E Red Ultra Lock
F Blue Nut Lock
H Outboard Engine Lubricant
J Thermal Grease
L Pipe Thread Sealing Compound
M RTV Sealant
Q Gel Seal II
T Liquid Neoprene
X See Service Manual Text

008376

10

COMPRESSION TESTING

Start and run outboard until it achieves operating temperature, then shut OFF.

Disconnect crankshaft position sensor (CPS) connector. Remove all spark plugs.

Advance throttle linkage to WOT.

Install compression tester's hose attachment into spark plug hole (14 mm threads).

While cranking outboard with starter, note maximum pressure reading on gauge. Repeat procedure for each cylinder.

If engine shows a variation greater than 15 psi (100 kPa) between cylinders, check for:

- damaged cylinder head
- damaged pistons
- broken or stuck piston rings
- scored cylinder walls

Return throttle to idle position and reconnect CPS connector. Replace spark plugs. Refer to Spark Plug **Indexing** on p. 38.

POWERHEAD REMOVAL

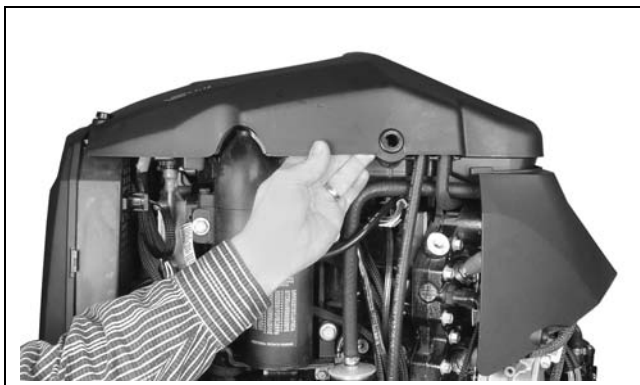
WARNING

Protect against hazardous fuel spray. Before starting any fuel system service, carefully relieve fuel system pressure. Refer to Relieving Fuel System Pressure on p. 146.

To prevent accidental starting while servicing, twist and remove spark plug leads.

Remove lower motor covers. Refer to **Lower Cover Removal** on p. 49.

Remove flywheel cover and rear shroud.



005248

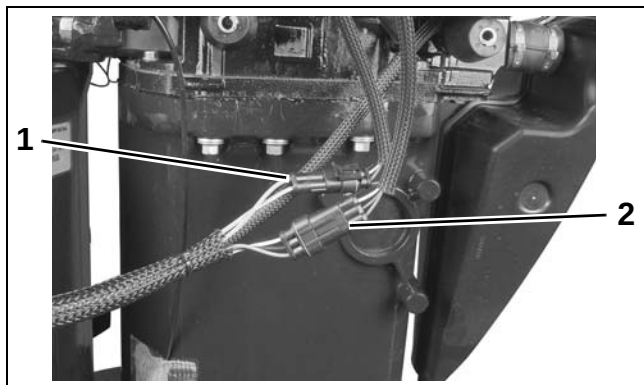
Remove air temperature sensor from air silencer. Remove the air silencer.



005272

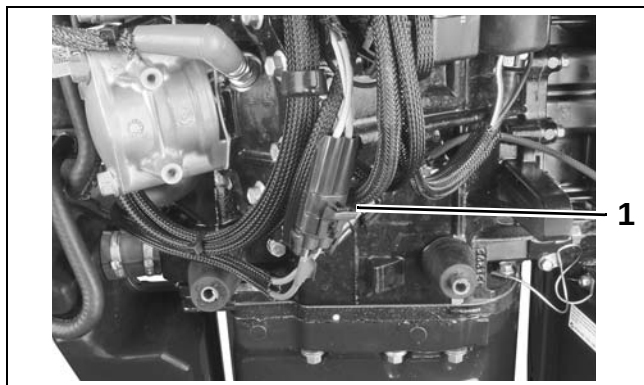
POWERHEAD POWERHEAD REMOVAL

Disconnect power trim connectors.



1. Tilt limit switch connector
2. Sending unit connector

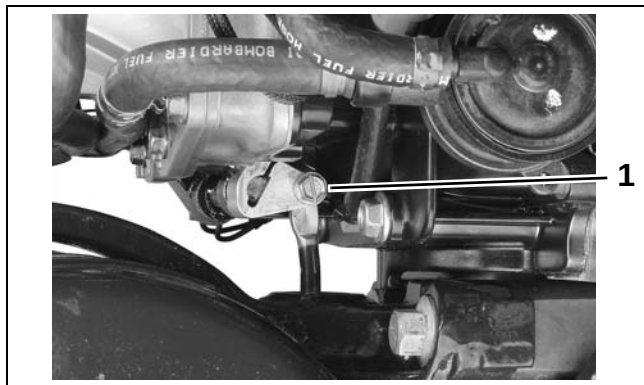
005254



1. Tilt relay connector

005255

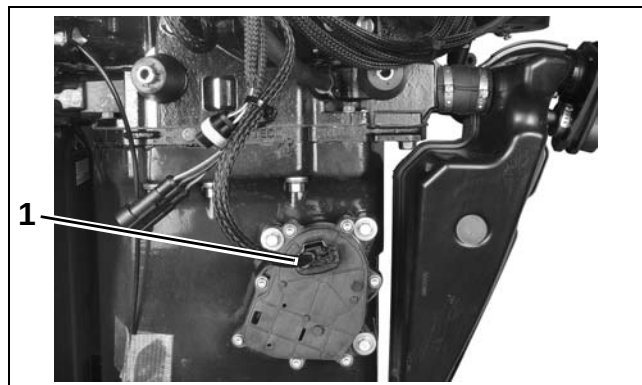
Remove pin and washer from shift rod lever to release the lower shift rod.



1. Shift rod pin

005253

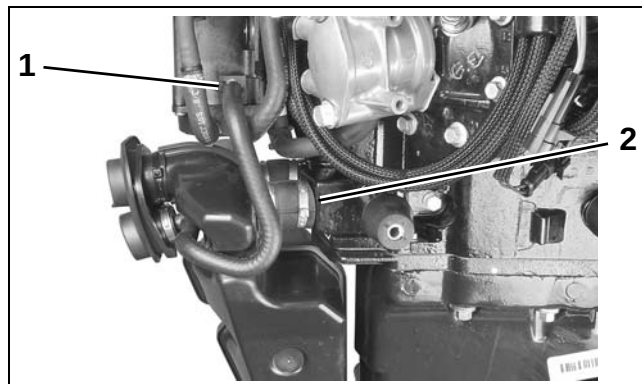
Disconnect electrical harness from exhaust valve actuator (V4 models). It is not necessary to remove actuator from exhaust housing.



1. Actuator connector

005247

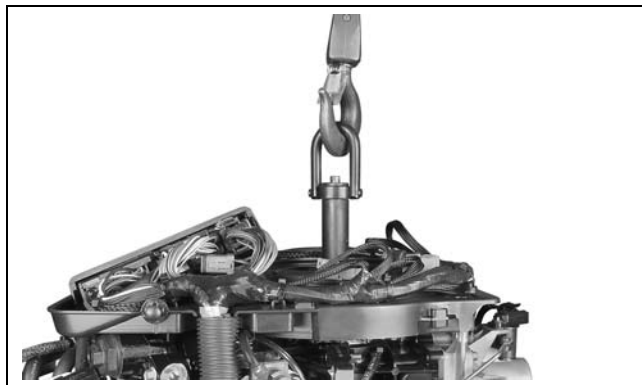
Disconnect water overflow hose from vapor separator. Remove clamps and muffler assembly from rear of powerhead.



1. Overflow indicator hose
2. Muffler clamps

005243

Install Lifting Fixture, P/N 342672, on crankshaft. Tighten mounting screw securely using an Allen 1/4 in. hexagonal wrench.



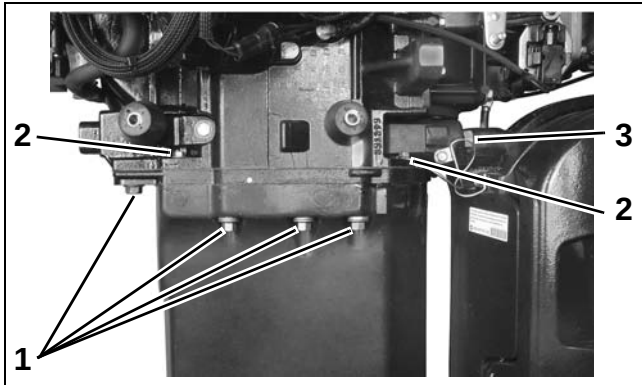
005260

POWERHEAD

POWERHEAD DISASSEMBLY

Fasten appropriate chain hook to eye of tool and support weight of powerhead with hoist.

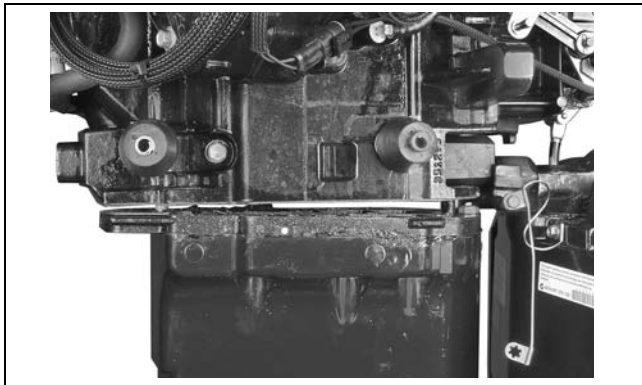
Remove the four small powerhead screws, seven large powerhead screws, and the upper mount screws.



- 1. Large powerhead screws
- 2. Small powerhead screws
- 3. Upper mount screws

005273

Use a suitable tool to carefully separate the powerhead from exhaust housing.



005259

IMPORTANT: Do not damage the powerhead or adapter mating surfaces.

POWERHEAD DISASSEMBLY

Systems Removal

To simplify reassembly and wiring installation, lay out the various screws and clamps in the order of their proper location.

Remove the electric starter. Refer to **Starter Removal** on p. 116.

Remove fuel pump assemblies, fuel manifolds, and filter. Refer to **FUEL COMPONENT SERVICING** on p. 146.

Remove *EMM* and electrical harness with flywheel cover base, starter solenoid, and trim relay module. Refer to **EMM SERVICING** on p. 68.

Remove flywheel and stator. Refer to **FLYWHEEL AND STATOR SERVICING** on p. 110.

Remove oil pump, rear oil manifold, and oil circulation hoses. Refer to **OIL COMPONENT SERVICING** on p. 179.

Remove ignition coils and fuel injectors. Refer to **Fuel Injector Service** on p. 150.

IMPORTANT: Mark injectors for cylinder location before removal. All injectors must be installed in their original location. Improper injector installation can result in powerhead failure.

Remove throttle linkage. Refer to **Throttle Linkage Removal** on p. 199.

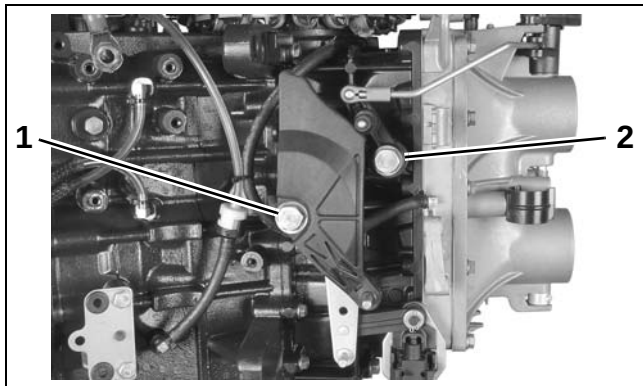
Remove shift linkage. Refer to **Shift Linkage Removal** on p. 199.

Remove the throttle body and reed plate assemblies. Refer to **Intake Manifold Service** on p. 153.

Remove pressure valve assembly. Refer to **PRESSURE RELIEF VALVE SERVICING** on p. 192.

Throttle Linkage Removal

Remove throttle cam and throttle lever.

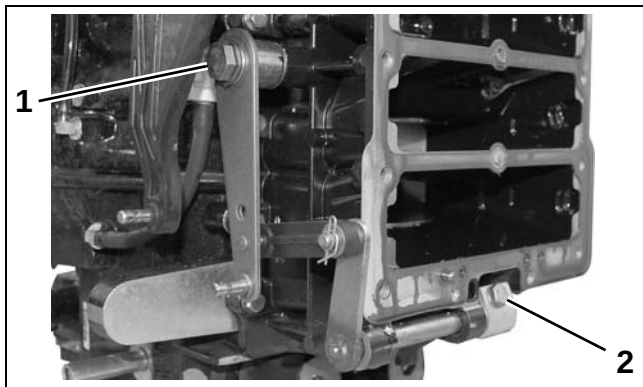


1. Throttle cam screw
2. Throttle lever screw

005293

Shift Linkage Removal

Remove shoulder screw from shift arm and retaining screw from shift rod lever.



1. Shift arm screw
2. Shift lever screw

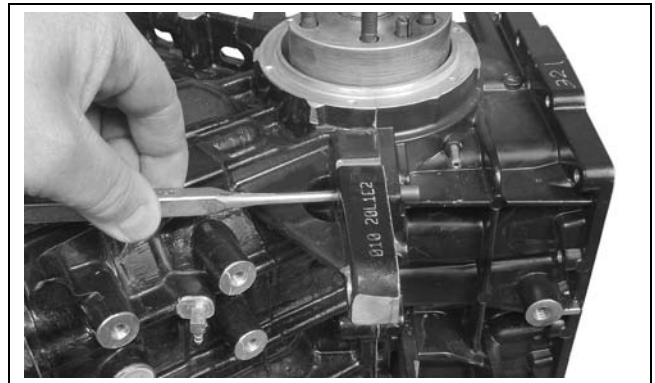
008454

Slide entire shift linkage assembly from crankcase.

Crankcase Disassembly

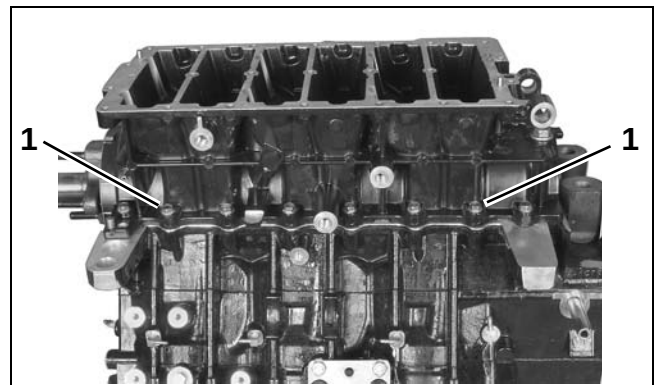
Use a 1/8 in. diameter pin punch to push crankcase taper pin toward the front side of the engine.

IMPORTANT: Do not use a tapered punch or any other tool that could jam in or damage the taper bore when removing the pin.



005305

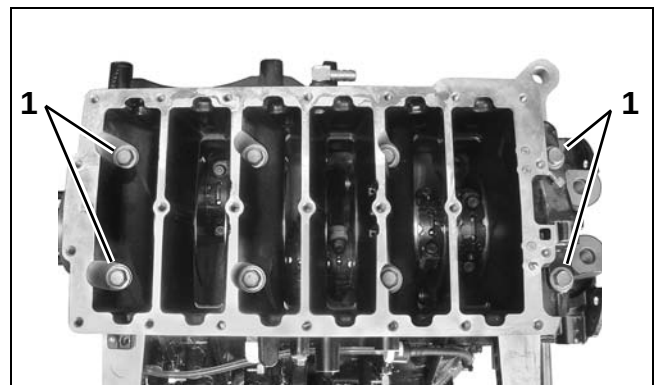
Remove crankcase flange screws.



1. Flange screws (12 on V4; 16 on V6)

005306

Loosen **in stages** and remove the main bearing screws.



1. Main bearing screws (6 on V4; 8 on V6)

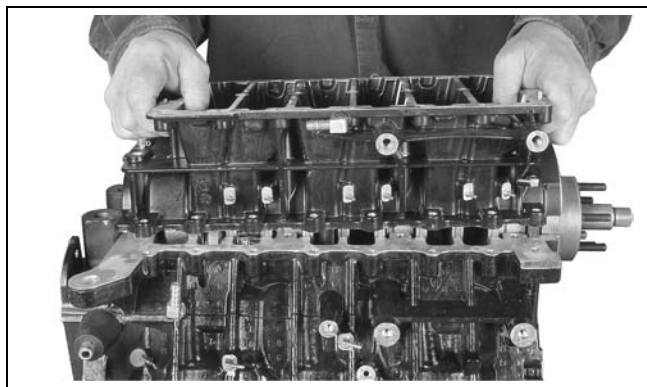
005313

POWERHEAD

POWERHEAD DISASSEMBLY

Separate crankcase and cylinder block. It may be necessary to tap on crankshaft with a rawhide or rubber mallet to loosen.

Carefully remove the crankcase from the cylinder block to avoid damaging the crankshaft seal rings.



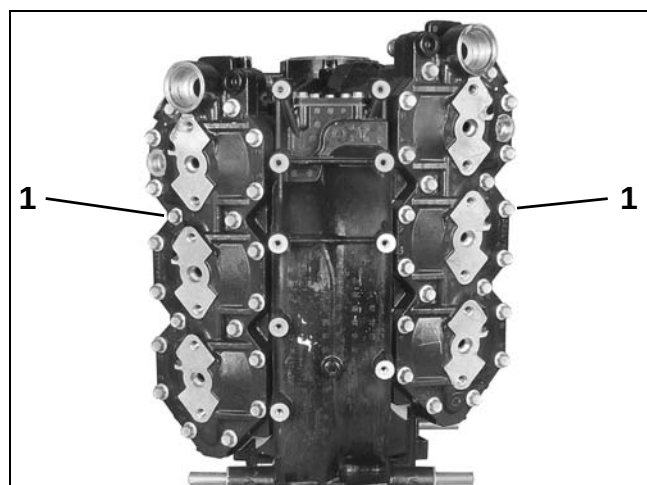
005304

Cylinder Head Removal

Remove thermostat cover and thermostat assembly. Refer to **THERMOSTAT SERVICING** on p. 191.

Loosen **in stages** and remove cylinder head retaining screws. Remove the cylinder head.

Discard thermostat seal and O-rings.

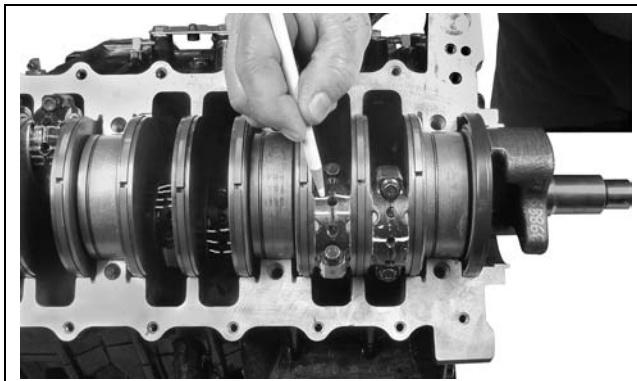


1. Cylinder head screws (28 on V4; 40 on V6)

005302

Connecting Rods and Pistons

Use a permanent marker to identify each connecting rod cap, connecting rod, and piston by cylinder number. Number 1 is closest to the flywheel.



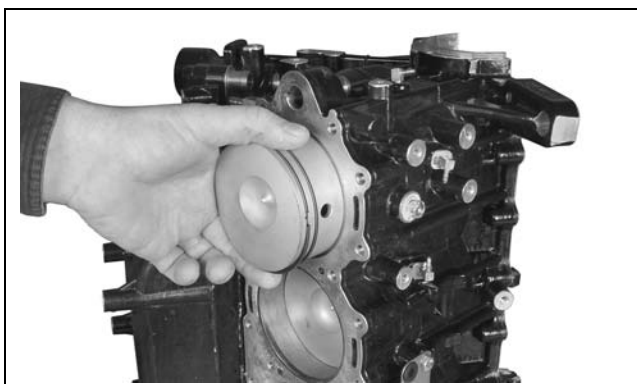
005292

Use Torquing Socket, P/N 331638, to loosen **in stages** the rod cap retaining screws. **DO NOT** remove the screws.



005303

Use one hand to support the piston, and remove the rod cap screws with your other hand. Remove each piston and rod assembly.



005301

NOTICE Reattach each rod cap to its rod as soon as the piston is removed. Each cap is unique and can only be installed on its mated rod. Do not allow rod to contact inside surface of cylinder or crankshaft.

IMPORTANT: Identify all internal components so that if reused, they can be reinstalled in their original positions.

Repeat steps for each remaining piston and connecting rod.

Use an appropriate ring expander to remove all piston rings from pistons. Discard the rings.



WARNING

Wear safety glasses to avoid injury.



002054

Remove wrist pin retaining rings. Discard retaining rings.



46524

The wrist pin fit is loose on both sides. Push the wrist pin through to free the piston from the connecting rod. If necessary, use Wrist Pin Pressing Tool, P/N 326356, to remove the wrist pin bearing.



46520

Be careful not to lose any of the 28 needle bearings or the two wrist pin washers. If any of the bearings are worn or lost, replace all 28 bearings during reassembly.

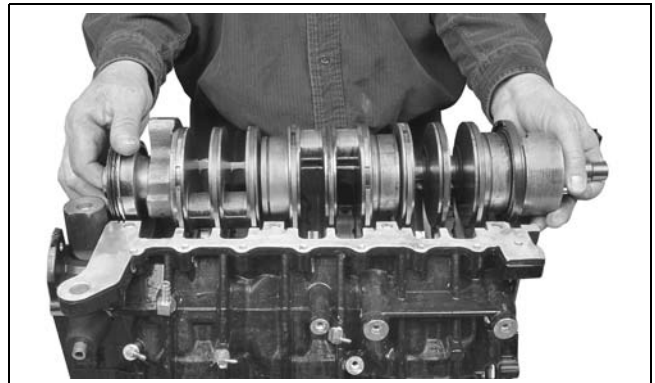
Crankshaft Removal



WARNING

Wear safety glasses to avoid injury.

Carefully lift crankshaft straight up and remove from crankcase.



005285

POWERHEAD

POWERHEAD DISASSEMBLY

Remove upper seal from crankshaft. Discard the seal. A new upper seal must be installed on assembly.



49068

Remove the lower bearing seal housing.



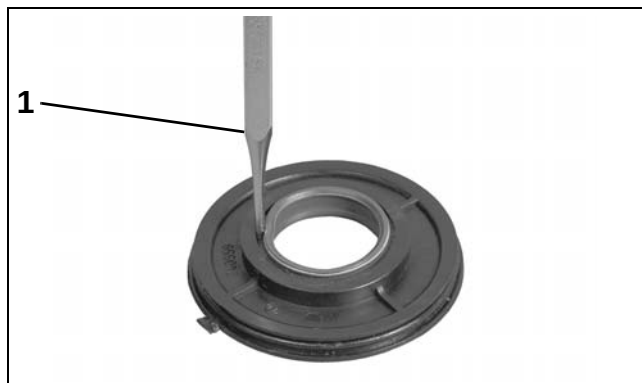
005280

Remove the housing O-ring. Discard O-ring.



002044

Use a punch to remove the housing seal. Discard seal.



1. Punch

002053

Inspect housing and replace if necessary.

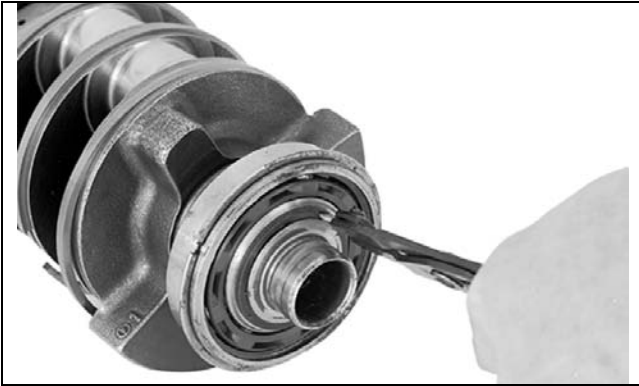
Remove the O-ring from crankshaft sleeve and inspect it. Replace the O-ring if it is not in good condition.



29019

Inspect the crankshaft sleeve and replace if necessary. To remove the sleeve, use Slide Hammer, P/N 432128, and Large Puller Jaws, P/N 432129.

Remove the lower main bearing only if it needs to be replaced. Use external retaining ring pliers to remove the lower bearing retaining ring.



24384

IMPORTANT: If the lower main bearing is removed from the crankshaft, it must be discarded. DO NOT reuse it.

Use a bearing separator to support the bearing, and press off the crankshaft.



24383

Remove and inspect crankcase seal rings. Identify each ring for installation in original location.



49069

Remove center main bearings and split sleeves for inspection. Do not mix parts. Note location of bearings for reassembly.



24381

CYLINDER BLOCK CLEANING

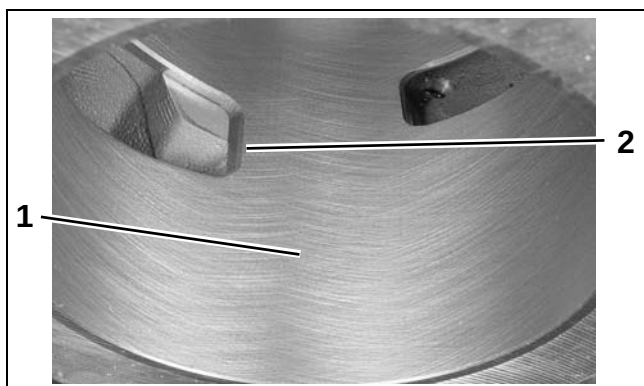
IMPORTANT: Before inspecting or assembling powerhead, all internal components must be completely clean and free of contaminants.

Remove any carbon accumulation from exhaust port areas.

Remove any carbon accumulation from cylinder head combustion chambers.

If cylinder walls are glazed from extended use, use a rigid, medium grit cylinder hone to resurface walls. Use slow RPM for best oil retention and ring sealing. When finished, a cross hatch pattern of 22 to 32° should be visible in the cylinder wall. The pattern should be uniform in both directions.

IMPORTANT: To avoid piston or cylinder block damage, restore the chamfer to all port edges using a ball hone or other suitable tool.



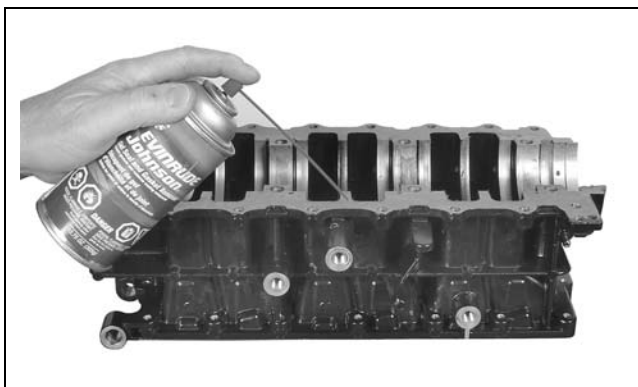
1. Crosshatch pattern in cylinder wall
2. Chamfered port edge

002067

Use *Gel Seal and Gasket Remover* to remove all traces of gaskets, adhesives, and *Gel-Seal II™* sealant from the cylinder block and crankcase.

! WARNING

To avoid personal injury, wear eye protection and rubber gloves when using *Gel Seal and Gasket Remover*.



005296

Carefully remove any carbon accumulation from the tops and ring grooves of the piston using *Engine Tuner*. A ring groove cleaning tool can be made by breaking an old ring and grinding an angle on its end. Do not damage ring grooves while cleaning.

Thoroughly wash entire cylinder block and crankcase with warm, soapy water to remove all traces of contaminants.

Air dry cylinder block and crankcase. Blow all holes and passageways with compressed air.

! WARNING

To avoid personal injury, wear eye protection and set compressed air pressure at less than 25 psi (172 kPa).

Cover the cylinder walls with a liberal amount of outboard lubricant to prevent corrosion.

POWERHEAD INSPECTION

For dimensions, refer to **SERVICE SPECIFICATIONS** on p. 10.

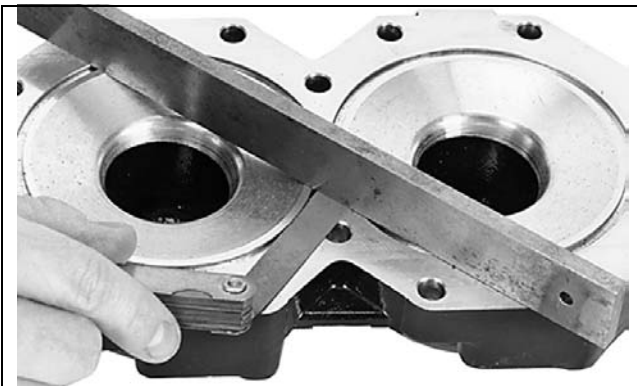
IMPORTANT: Before any inspection process can begin, all internal components must be completely clean and free of contaminants.

Visually inspect all parts. Check for unusual wear patterns, scuffing, or deterioration of aluminum parts, heat-related discoloration of bearings and bearing surfaces, and broken components.

Cylinder Head

Check for cylinder head warpage using a piece of bar stock or machinist's straightedge and a feeler gauge set.

Cylinder head warpage must not exceed 0.003 in. (0.08 mm) per inch of measurement. Replace head if warpage exceeds this dimension.



46517

Crankshaft

Measure the diameter of each crankpin and main bearing journal. The lower main bearing journal would only be measured if the bearing was removed for another reason.



005281

Visually inspect crankcase seal rings for wear, grooves, or chipping. If rings appear worn, use a micrometer to measure ring thickness.

Replace rings that are less than 0.154 in. (3.9 mm) thick.

Install seal rings in their original positions on crankshaft after inspection.



1936

Cylinder Bore

Use a Cylinder Bore Gauge to inspect each cylinder bore for an out-of-round, oversize, or tapered condition. Be sure the gauge is perfectly square in the bore when measuring.



Measure as shown

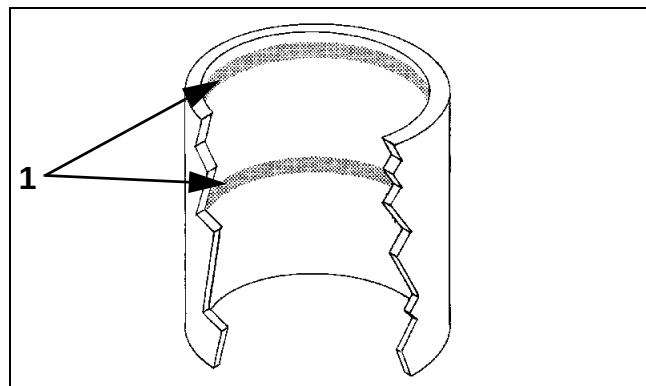
46528

Measure each cylinder in at least two areas. Each area should be measured twice. The difference between the two measurements in each area is the cylinder out-of-round dimension.

- The cylinder must not be out-of-round by more than 0.004 in. (0.10 mm).

The dimensional difference between the two areas is cylinder taper.

- The cylinder taper must not exceed 0.002 in. (0.05 mm).



1. Cylinder taper

DR3482

The difference between the measurements and standard bore is cylinder oversize. For dimensions, refer to **SERVICE SPECIFICATIONS** on p. 10.

- The cylinder must not be oversized by more than 0.004 in. (0.10 mm).

Pistons

Visually inspect pistons for signs of abnormal wear, scuffing, cracks, or burning.

Piston Rings

For new ring sets, place each ring separately in its respective bore. Use a piston to square the ring in the cylinder. Use a feeler gauge to measure the ring end gap.



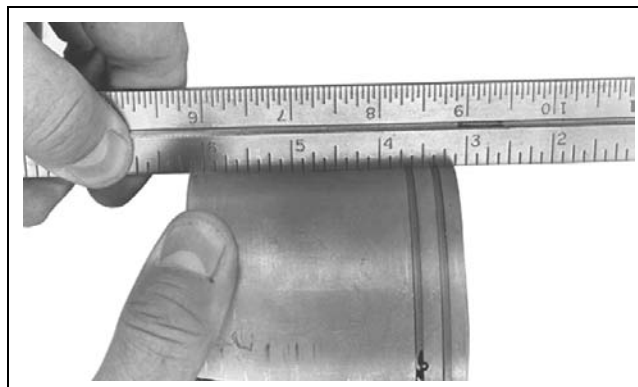
002143

Ring end gap should be:

- 0.011 to 0.023 in. (0.28 to 0.58 mm)

IMPORTANT: Ring end gap increases approximately 0.003 in. (0.08 mm) for each 0.001 in. (0.025 mm) increase in cylinder bore diameter. **DO NOT** exceed cylinder oversize dimension.

Use a machinist's straightedge to check for proper ring clearance. Position piston rings on piston. Push rings into groove and hold straightedge against the side of the piston. Rings must be even or just below the surface of piston. Rings must move freely in piston ring groove.



31796

Bearings

Inspect center main bearing and split sleeves for excess wear, nicks, or scratches. Replace, if necessary.



24381

Inspect crankshaft rod bearings for excess wear, nicks, or scratches. Replace, if necessary.



24377

POWERHEAD ASSEMBLY

IMPORTANT: Proceed slowly. Make no forced assemblies unless a pressing operation is called for. All internal components must be perfectly clean and lightly coated with outboard lubricant.

IMPORTANT: Use new wrist pin retaining rings, gaskets, seals, and O-rings during assembly.

Crankshaft Assembly

Oil the end of the crankshaft. Use Crankshaft Bearing/Sleeve Installer, P/N 338647, and place a new lower main bearing onto crankshaft with lettered side facing the tool. Install bearing until it seats on the crankshaft.



29020

Oil the end of the crankshaft. Use Crankshaft Bearing/Sleeve Installer, P/N 338647, to drive a new sleeve onto the crankshaft until the installer contacts the lower main bearing.



29021

POWERHEAD

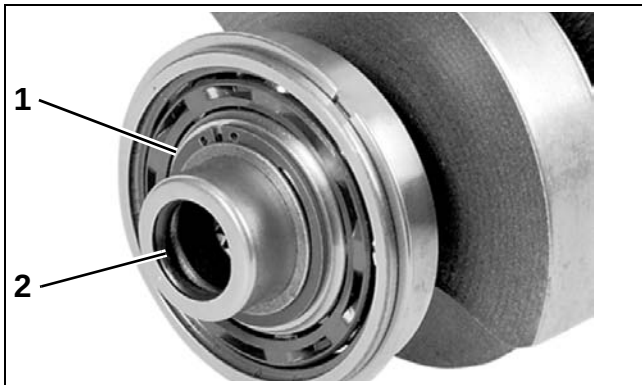
POWERHEAD ASSEMBLY

If the installer sticks on the sleeve after installation, thread Slide Hammer, P/N 391008, into installer and pull it off.

IMPORTANT: Inspect sleeve after installation. Sleeve must not be used if surface is damaged.

Use retaining ring pliers to install bearing retaining ring with sharp edge facing away from bearing.

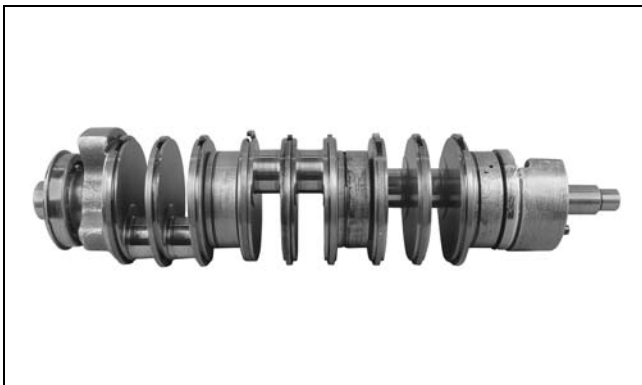
Lubricate a new driveshaft O-ring and lightly lubricate crankshaft splines with *Moly Lube*. Install O-ring in sleeve.



1. Bearing retaining ring
2. O-ring

29022

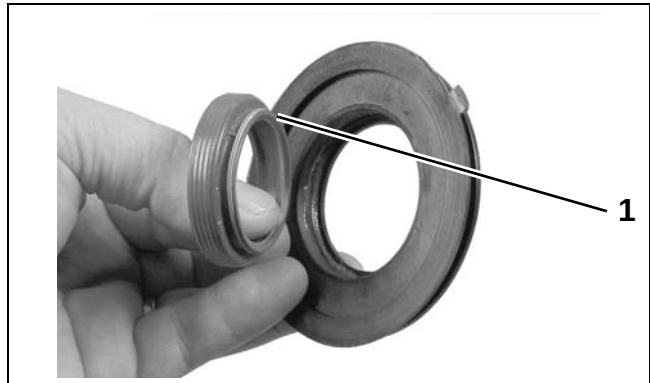
Lubricate the center main bearings and split sleeves with outboard lubricant and install them in their original positions. The split sleeve ring grooves must face toward driveshaft (lower) end of crankshaft when installed.



005282

Lightly coat the outside edge of a new lower housing seal with *Gasket Sealing Compound*. Press against outer case of the seal to install seal in the

lower housing with extended lip facing down. Lubricate seal lip with *Triple-Guard* grease.



1. Extended lip

002036

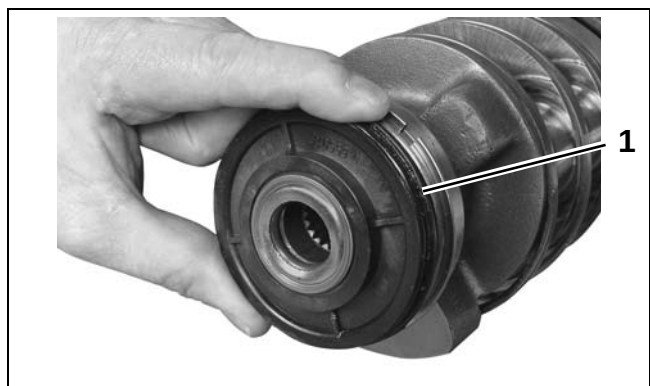


1. Seal lip

002037

Install a new O-ring on the lower housing. Before installing crankshaft into cylinder block, apply a thin coat of *Gasket Sealing Compound* to outer edge of O-ring.

Place lower seal housing on crankshaft.



1. O-ring

005280

Thoroughly clean upper seal area of the crankshaft. Install new upper seal on crankshaft. Do not apply sealer to outside edge of the seal.



49068

Pistons and Connecting Rods

NOTICE It is very important that the pistons in this engine are installed in the correct location and direction. Engine damage will occur if installed incorrectly.

New pistons are stamped "PORT" or "STBD," and "EXH." These markings should be turned toward the exhaust side (center) of the block. The splash bowl on the dome of the piston will be located toward the flywheel and opposite the exhaust port.

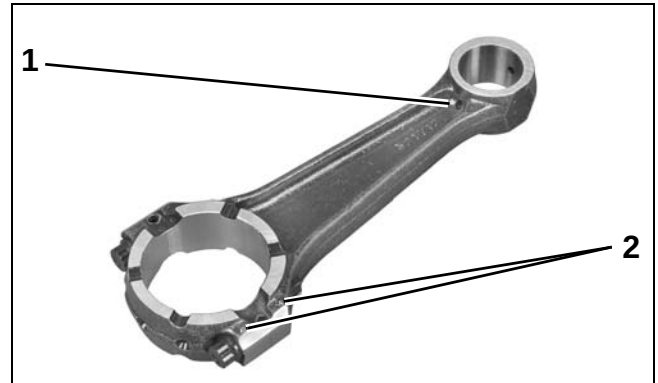


1. Stamped markings

005283

NOTICE It is also very important that the connecting rods are installed with the align-

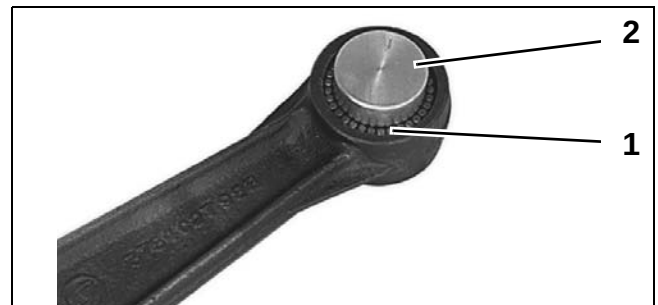
ment dots and the diagonal oil hole facing up, toward the flywheel.



1. Oil hole
2. Raised dots

002055

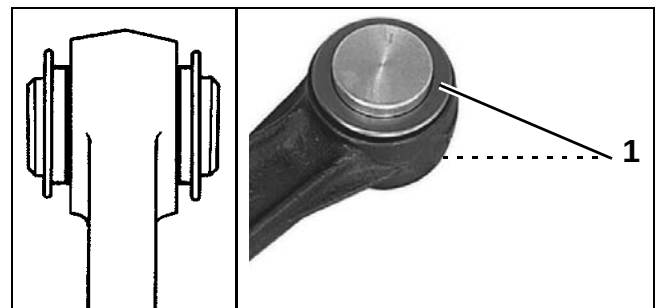
Apply *Needle Bearing Grease* to the wrist pin bearings. Install the bearings in the small end of the connecting rod. Align bearings with Wrist Pin Bearing Tool, P/N 336660.



1. Wrist pin bearings
2. Tool, P/N 336660

31794

Place the two wrist pin thrust washers on the tool with flat side of the washers facing out.



1. Wrist pin thrust washers

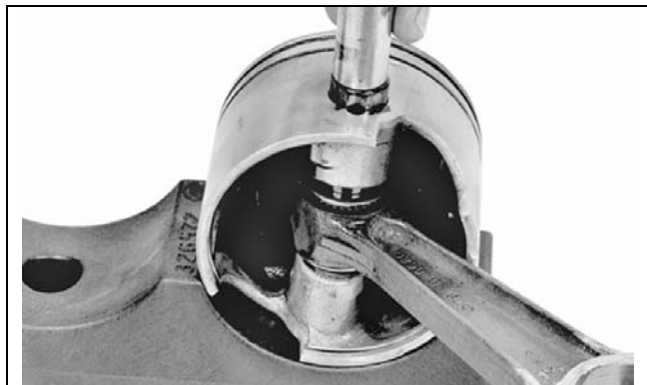
DR3480
31793

Oil the wrist pin bore and wrist pin. Place connecting rod, with bearings, washers, and tool, into the piston with the alignment dots facing the top of the piston.

POWERHEAD

POWERHEAD ASSEMBLY

Install wrist pin through piston and connecting rod, pushing bearing tool out through the piston.

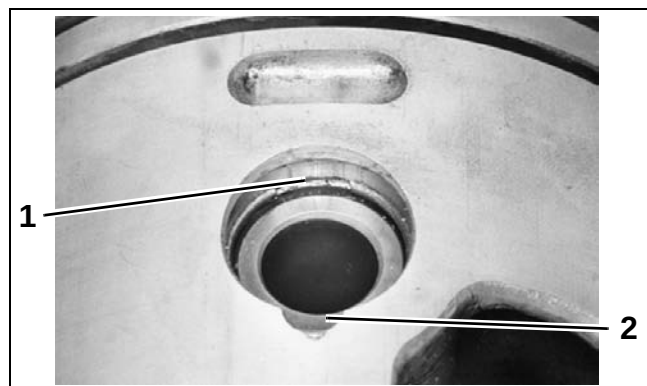


46521

Use Wrist Pin Cone, P/N 318600, and Driver, P/N 318599, to install new wrist pin retaining rings in each wrist pin hole. Gap of retaining ring faces away from notch in piston.



46522



1. Gap of retaining ring
2. Notch in piston

46523

Installing Pistons

When all pistons and connecting rods are assembled, install piston ring sets. Be sure rings are installed in the cylinder used to test ring end gap. Refer to **POWERHEAD INSPECTION** on p. 205.

IMPORTANT: Be sure gap of ring fits squarely around dowel pin.



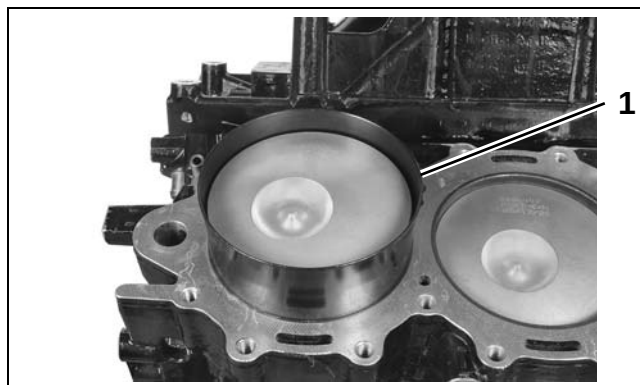
002048

NOTICE Before continuing, make sure that all *Gel-Seal II* has been removed from the cylinder block and crankcase mating flanges. If traces of hardened *Gel-Seal II* are left, main bearings could be misaligned. Refer to **CYLINDER BLOCK CLEANING** on p. 204.

Coat pistons, rings, cylinder walls, and an appropriate ring compressor with outboard lubricant.

Center connecting rod in piston and locate piston rings on dowel pins. Place appropriate ring compressor on piston.

Slide piston and rod assembly into the correct cylinder, as marked during disassembly. Guide connecting rod through cylinder block to avoid scratching cylinder wall.



1. Ring compressor

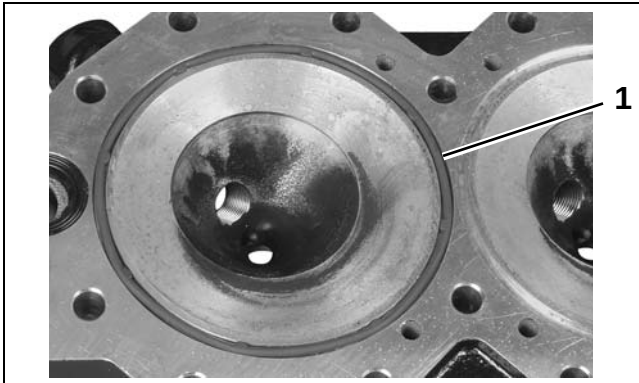
005284

Cylinder Head Installation

Install a new thermostat seal in cylinder head with side marked "TO CYL HEAD" facing toward thermostat.

Refer to **THERMOSTAT SERVICING** on p. 191 before installing cylinder head.

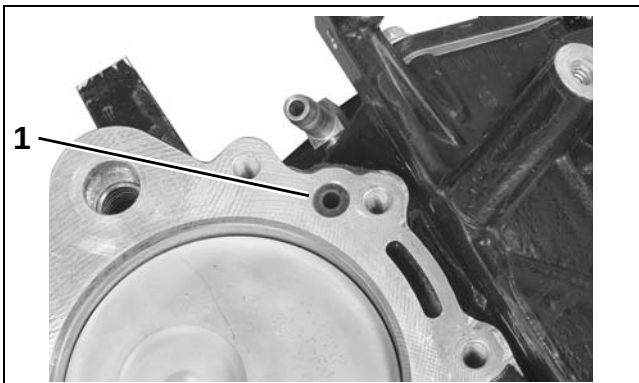
Lightly lubricate new cylinder head O-rings with *Triple-Guard* grease and install in cylinder head.



1. O-Ring

005286

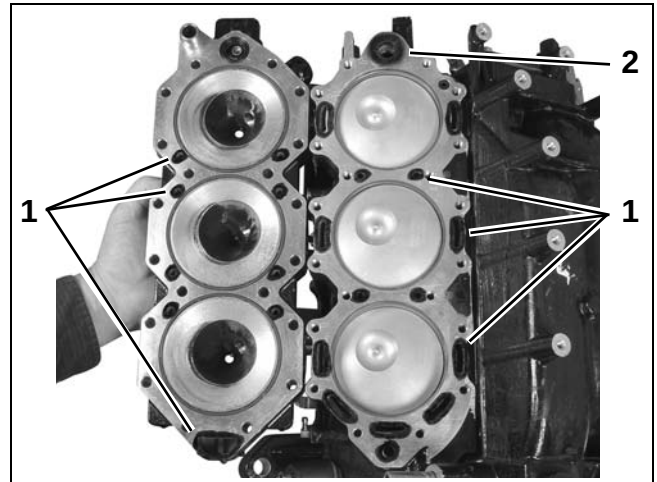
Apply soapy water to water dam and insert into block.



1. Water dam

005287

Apply a 1/16 in. (2 mm) bead of *RTV* adhesive around each water passage on the block and cylinder head as shown.

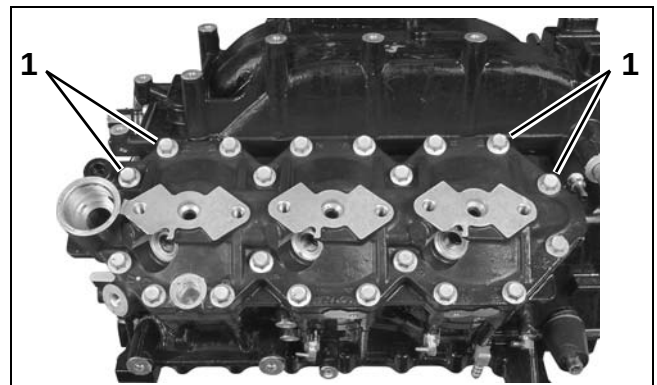


1. RTV adhesive (24 locations)
2. Thermostat seat area

005288

Install cylinder head with the thermostat toward the top. Apply outboard lubricant to screw threads and install the cylinder head screws. **DO NOT** use any sealant on threads

Following sequence stamped on cylinder head, tighten all screws **in stages** to a torque of 168 to 192 in. lbs. (19 to 21.5 N·m).



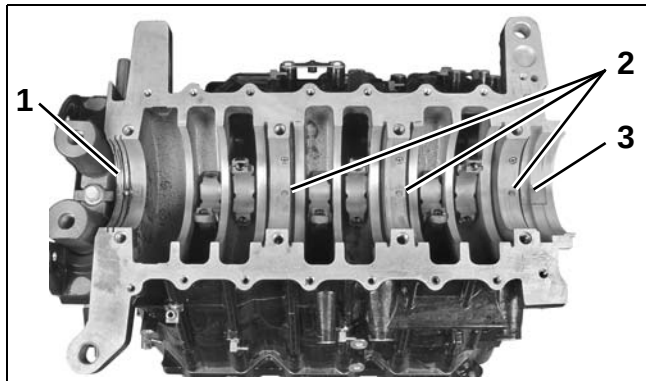
1. Cylinder head screws

005289

Crankshaft and Connecting Rods

Apply *Gasket Sealing Compound* to lower oil seal groove in cylinder block. DO NOT put any sealer in upper seal groove.

Check that main bearing alignment dowel pins are seated in the block.



1. Gasket Sealing Compound
2. Dowel pins
3. No sealer here

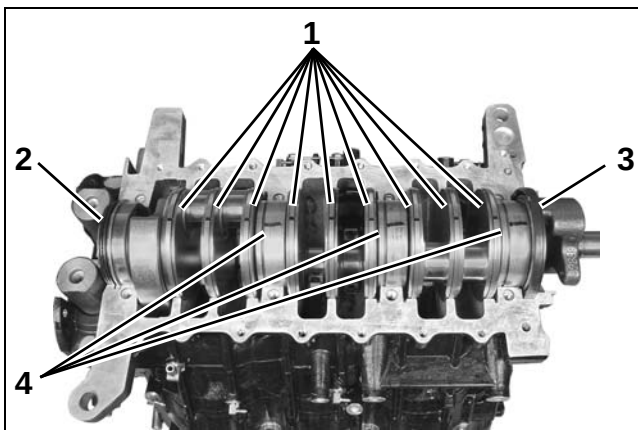
005290

Push all pistons to the top of cylinders. Remove numbered connecting rod caps.

Gently lower crankshaft into place.

- Turn all crankcase seal ring gaps to face up.
- Align tab on lower bearing seal housing with hole in crankcase.
- Align upper oil seal in groove.
- Locate each main bearing on its dowel pin. A mark placed on the bearing race opposite the

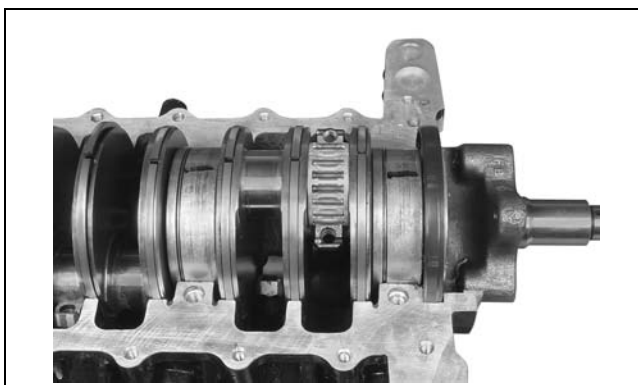
dowel pin hole will help in the alignment process.



1. Gaps (up)
2. Lower seal housing
3. Upper oil seal
4. Alignment marks

005291

Lubricate each crankpin and bearing assembly with outboard lubricant. Slowly pull connecting rod up to crankshaft and install bearing halves.

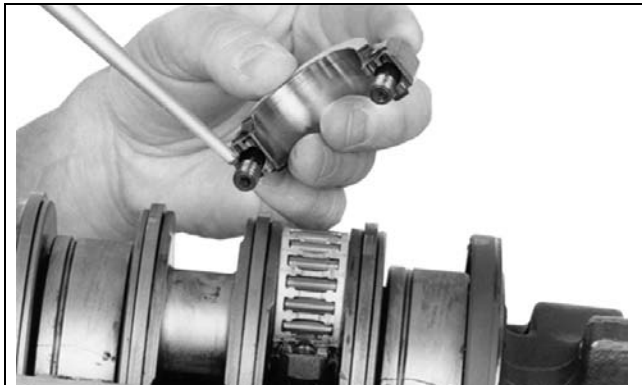


005298

Lubricate rod cap screw threads and under screw head mating surface with outboard lubricant.

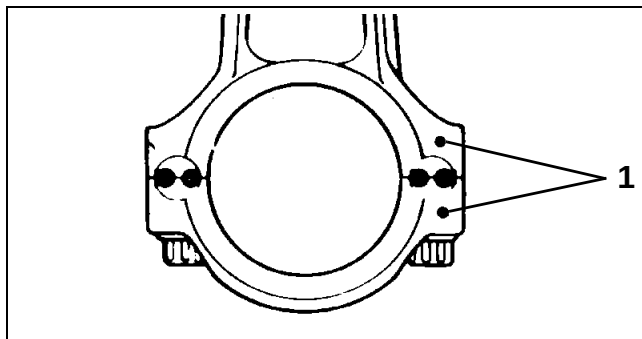
Align dot on rod cap with dot on the connecting rod.

Install rod cap screws finger tight (NO MORE than 6 in. lbs. (1 N·m) maximum).



49080

IMPORTANT: Be sure alignment dot on rod cap matches dot on rod and that both dots face fly-wheel.



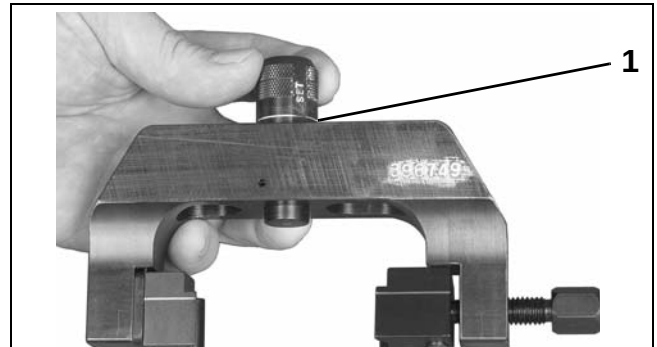
1. Alignment dots

53628

NOTICE Tightening rod cap screws without Alignment Fixture, P/N 396749, or using an incorrect procedure could cause permanent damage to the connecting rod and crankshaft. To maintain accurate torque values, keep torque wrench extension length to a minimum.

Install Rod Cap Alignment Fixture, P/N 396749, **before** tightening rod cap screws. Align the flat marked "SET" on the rod adjustment stop with the arrow on the frame. Position stop at the center

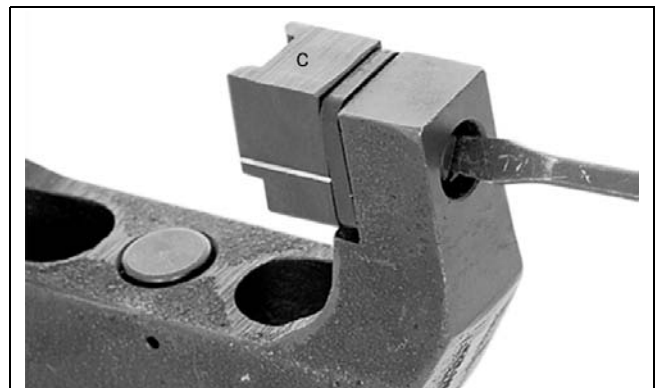
setting (one line showing). Rotate adjustment knob 180° to lock in position.



1. Center position, one line showing

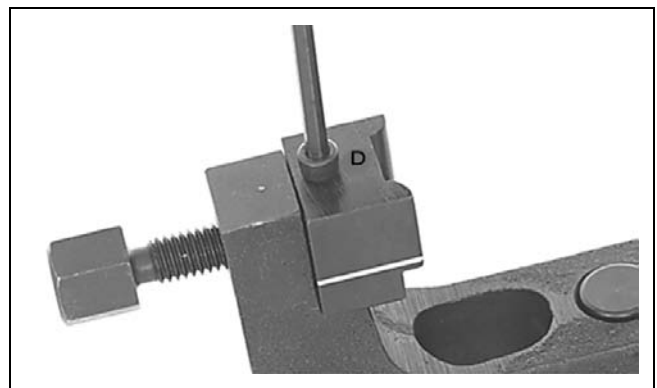
002484

Secure restraining jaw "C" and forcing jaw "D" to frame.



Restraining Jaw "C"

21591c



Forcing Jaw "D"

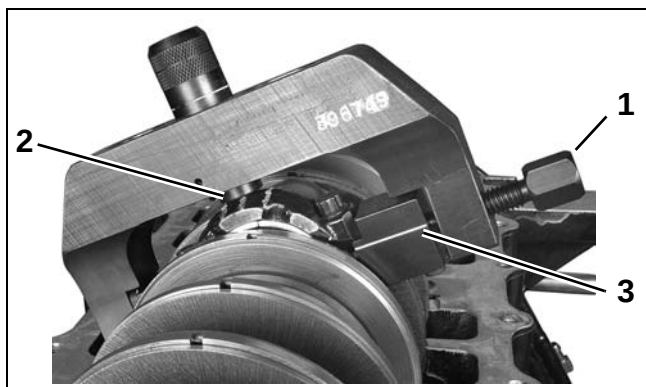
21594c

POWERHEAD

POWERHEAD ASSEMBLY

Apply a light coat of outboard lubricant to the corners of the connecting rod and rod cap. Place frame on connecting rod using the following procedure:

- Position frame onto the connecting rod so the contact area of the jaw is centered on the side of the rod.
- Tighten forcing screw until jaws contact connecting rod.
- Slide frame down until adjustment stop contacts the rod cap. The groove lines on the jaws must be centered on the rod/crankpin diameter.
- Tighten the forcing screw to a torque of 14 to 16 in. lbs. (1.6 to 1.8 N·m).



1. Forcing screw
2. Adjustment stop
3. Groove line

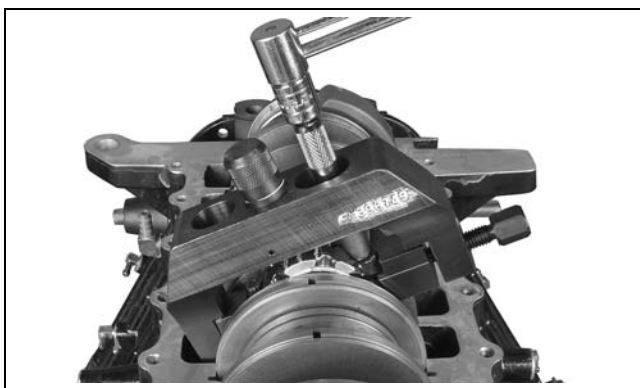
005297

IMPORTANT: Make sure that frame is squarely in position and that rod and cap are aligned.

Loosen both rod cap screws one-quarter turn.

Use Torquing Socket, P/N 331638, to tighten rod cap screws in three stages:

- Apply first torque of 40 to 60 in. lbs. (5 to 7 N·m) to both rod cap screws.
- Tighten screws to a torque of 14 to 16 ft. lbs. (19 to 21.7 N·m).
- Apply final torque of 30 to 32 ft. lbs. (41 to 43 N·m).

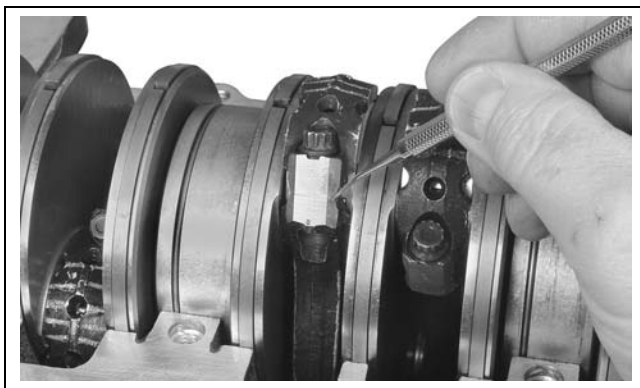


005299

IMPORTANT: If a new screw is used, it must be installed as above. Then, it must be removed, re-lubricated, and installed again.

Loosen forcing screw and remove the frame.

Test at least three corners of the rod and cap joint with a pick. Joint must be smooth with no step.



005300

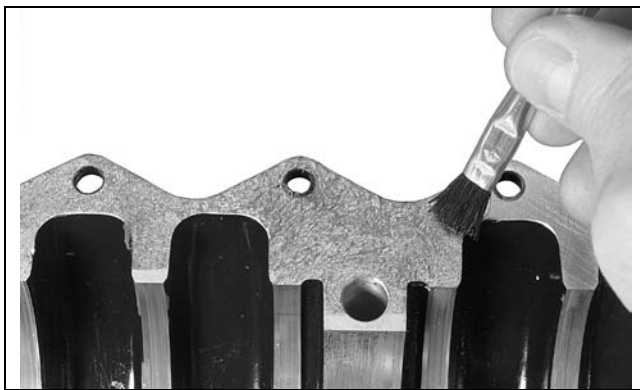
Crankcase Assembly

Thoroughly clean and degrease the mating flanges of the crankcase and cylinder block with a non-petroleum based solvent, such as isopropyl alcohol or acetone, and let air dry.

IMPORTANT: DO NOT allow solvent to get on internal components. Clean only the mating flanges.

Apply *Gasket Sealing Compound* to lower oil seal groove in crankcase. DO NOT put any sealer in upper seal groove.

Use a small brush with a tapping motion to apply a thin, even coat of *Gel-Seal II* sealant to the crankcase mating flange. The sealer must not come within 1/4 in. (6.4 mm) of bearings.



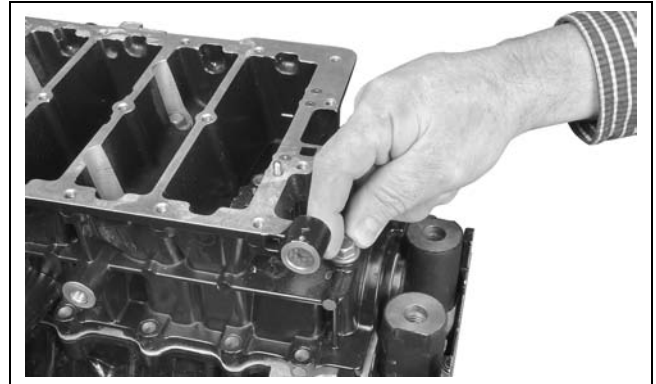
003874

IMPORTANT: *Gel-Seal II* has a shelf life of at least one year when stored at room temperature. Test the *Gel-Seal II* or replace it if the age of the tube cannot be determined. Using old *Gel-Seal II* could cause crankcase air leaks.

IMPORTANT: The use of *Locquic Primer* is NOT recommended. If primer is used, crankcase halves must be assembled and tightened within ten minutes after the *Gel-Seal II* has been applied.

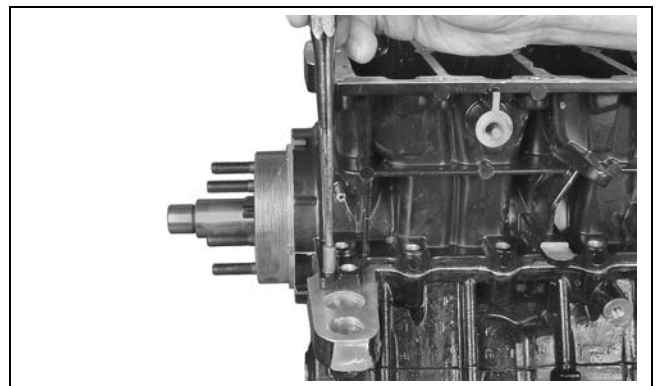
Lower the crankcase into place. Make sure that upper oil seal and lower seal housing are seated in grooves.

Apply outboard lubricant to the main bearing screws. Install screws finger tight, no more than 60 in. lbs. (7 N·m).



005308

When the crankcase is seated, install and firmly seat the crankcase taper pin.



005307

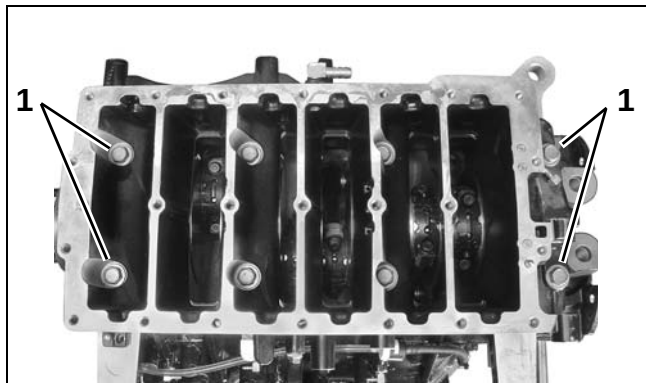
Tighten main bearing screws **in stages** to a final torque of:

- 31 to 35 ft. lbs. (42 to 47.5 N·m).

POWERHEAD

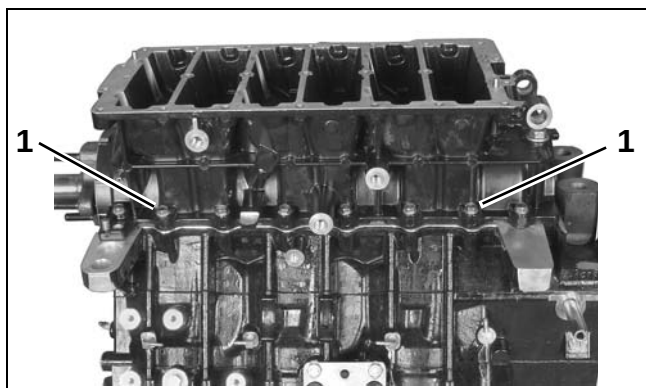
POWERHEAD ASSEMBLY

Start in the center and work outward in a spiral pattern.



005313

Apply *Nut Lock* to crankcase flange screws. Install screws and tighten to a torque of 60 to 84 in. lbs. (7 to 9.5 N·m).



005306

Test that the crankshaft spins freely without binding.

IMPORTANT: After powerhead has been assembled, allow at least two hours for *Gel-Seal II* to cure before running outboard.

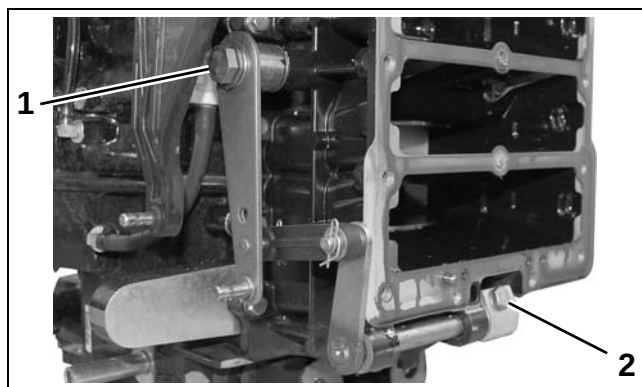
Shift Linkage Installation

Lubricate shift linkage bosses at the base of the crankcase with *Triple-Guard* grease. Insert bushings into bosses.

Apply *Triple-Guard* grease to the shaft of the shift lever assembly. Guide shaft through bushings in crankcase.

Apply *Triple-Guard* grease to shoulder of shift arm screw and *Nut Lock* to threads. Install arm, screw, and washer and tighten screw to a torque of 120 to 144 in. lbs. (13.5 to 16.5 N·m).

Install shift rod lever and tighten retaining screw 60 to 84 in. lbs. (7 to 9.5 N·m).



1. Shift arm screw
2. Shift lever screw

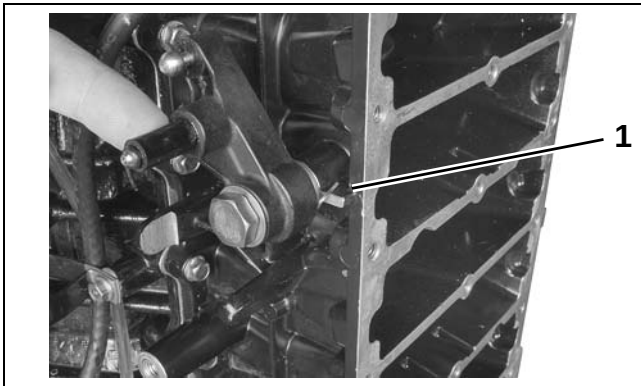
008454

Throttle Linkage Installation

Apply *Nut Lock* to threads of throttle lever screw.

Insert spring into cavity of throttle lever.

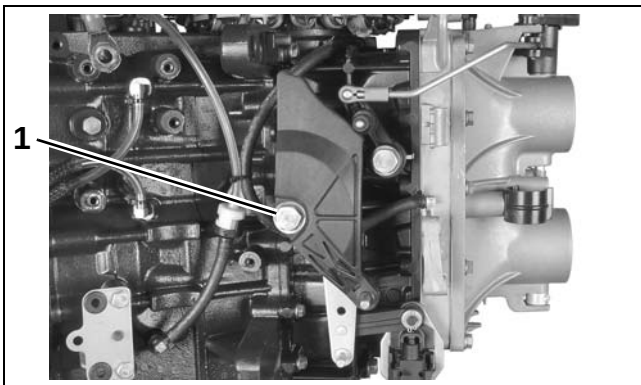
Install lever, screw, and washer on crankcase and hook spring on rib as shown. Tighten screw to a torque of 120 to 144 in. lbs. (13.5 to 16.5 N·m).



1. Throttle lever spring

005259

Apply *Nut Lock* to threads of throttle cam screw. Install cam, screw, and washer on cylinder block and tighten screw to a torque of 120 to 144 in. lbs. (13.5 to 16 N·m).



1. Throttle cam screw

005293

IMPORTANT: Do not lubricate throttle levers or shoulder screws.

Final Powerhead Assembly

Install the reed plate and throttle body assemblies. Refer to **Intake Manifold Service** on p. 153.

Install oil recirculating hoses and check valves. Refer to **OIL RECIRCULATION DIAGRAMS – V4** on p. 164, **OIL RECIRCULATION DIAGRAMS – V6** on p. 166, or **POWERHEAD VIEWS** on p. 223.

Install pressure valve assembly. Refer to **PRESSURE RELIEF VALVE SERVICING** on p. 192.

Install shift linkage. Refer to **Shift Linkage Installation** on p. 216.

Install throttle linkage. Refer to **Throttle Linkage Installation** on p. 217.

Install fuel injectors and ignition coils. Refer to Fuel Injector **Installation** on p. 151.

IMPORTANT: All injectors must be reinstalled in their original location. Improper injector installation can result in powerhead failure.

Install oil pump, rear oil manifold, and oil injection hoses. Refer to **OIL COMPONENT SERVICING** on p. 179.

Install flywheel and stator. Refer to **FLYWHEEL AND STATOR SERVICING** on p. 110.

Install electrical harness with flywheel cover base, starter solenoid, and trim relay module, then install *EMM*. Refer to **EMM SERVICING** on p. 68.

Install fuel pump assemblies, fuel manifolds, and filter. Refer to **FUEL COMPONENT SERVICING** on p. 146.

Install the electric starter. Refer to **Starter Installation** on p. 123.



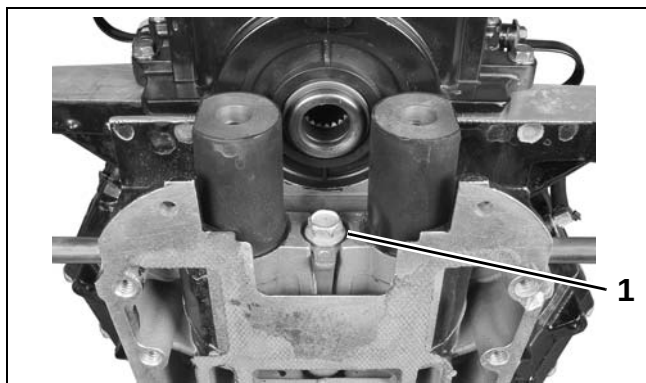
WARNING

To prevent fire and explosion hazard, make sure all electrical and ignition wiring is routed and clamped in original positions.

UPPER MOUNT SERVICING

Removal

Remove mount retainer screw.



1. Mount retainer screw

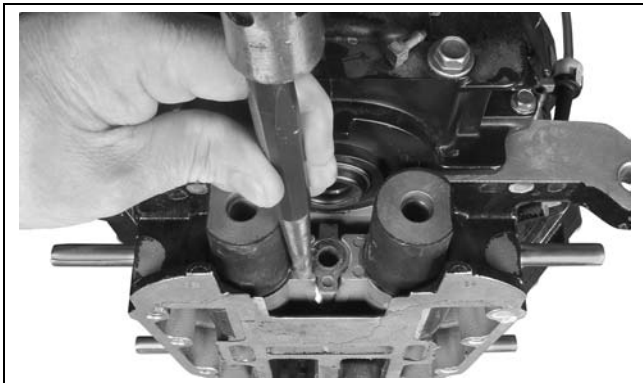
005309



WARNING

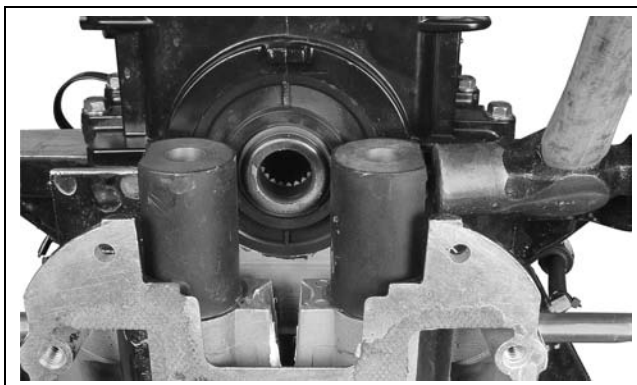
Wear safety glasses to avoid injury.

Tap the edge of one of the mount housings with a large, blunt punch to loosen the mount retainer.



005311

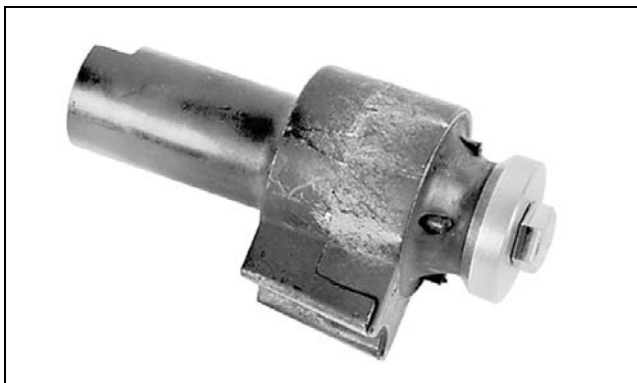
Dislodge mount assemblies and remove.



005312

Inspect mounts and replace if necessary.

IMPORTANT: The motor mount, washer, and screw are serviced as an assembly. Do not disassemble.

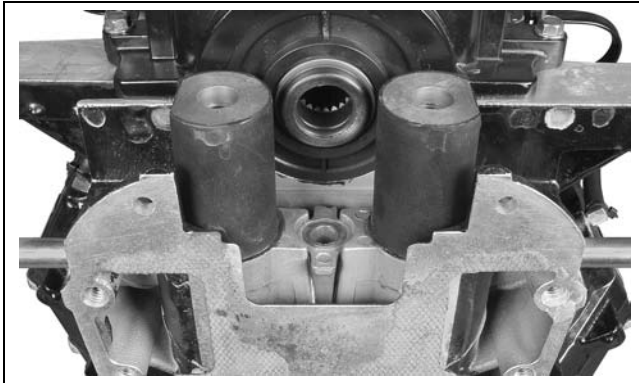


39820

Installation

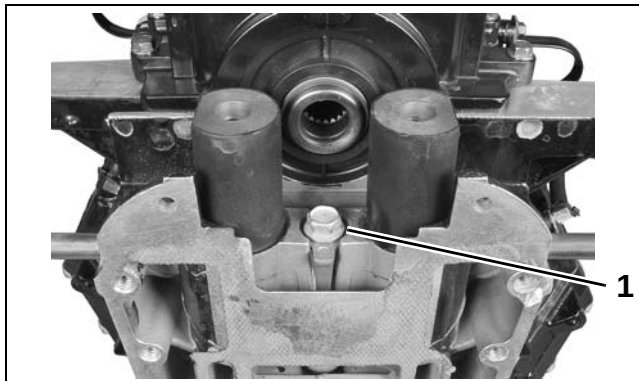
Place mount assemblies in position, with flats facing away from each other.

Apply *Moly Lube* to all sides of retainer and install between mounts.



005310

Install the retainer screw and tighten to a torque of 15 to 20 ft. lbs. (20 to 27 N·m).

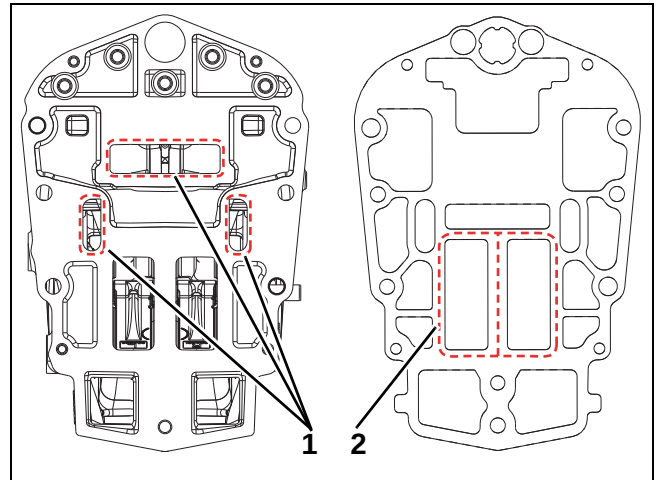


1. Mount retainer screw

005309

POWERHEAD INSTALLATION

Apply *Permatex No. 2* to both sides of a new base gasket as shown. Install gasket on adapter. To ensure proper sealing, mating surfaces must be clean and dry.



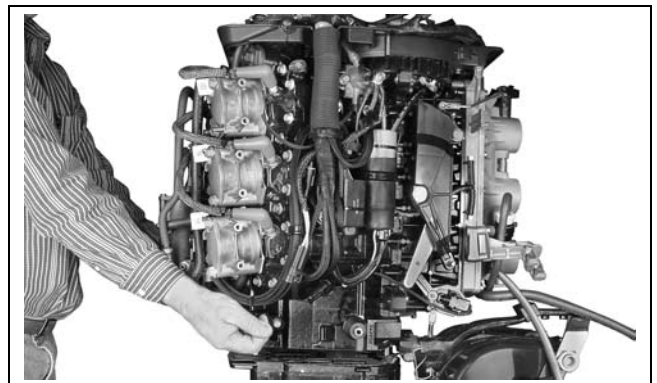
1. Apply sealant to exhaust housing (V4)
2. Apply sealant to both sides of gasket

007155

IMPORTANT: V4 and V6 base gaskets are NOT interchangeable. Be sure to use the correct part.

Coat the driveshaft splines with *Moly Lube*. Do not apply lubricant to end of driveshaft.

Use Lifting Fixture, P/N 342672, and hoist to slowly lower powerhead onto exhaust housing. If necessary, rotate flywheel in a clockwise direction to align crankshaft and driveshaft splines.

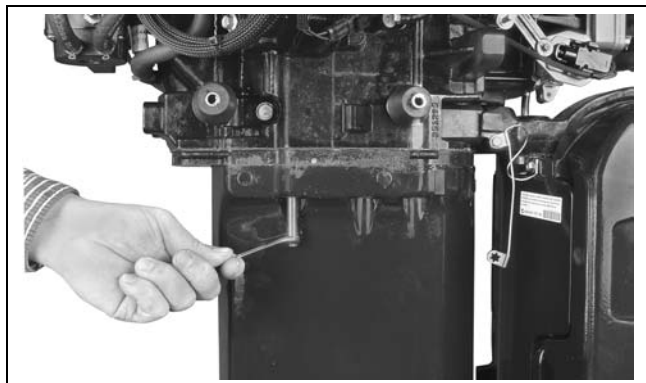


005276

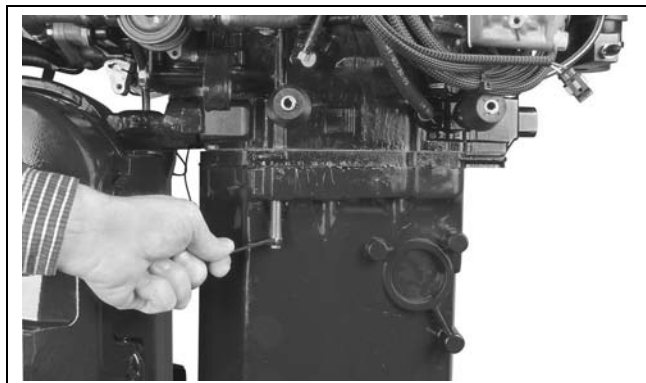
POWERHEAD

POWERHEAD INSTALLATION

Install pins from Alignment Pin Kit, P/N 5007167, as shown. Tighten pins until fully seated.



005274

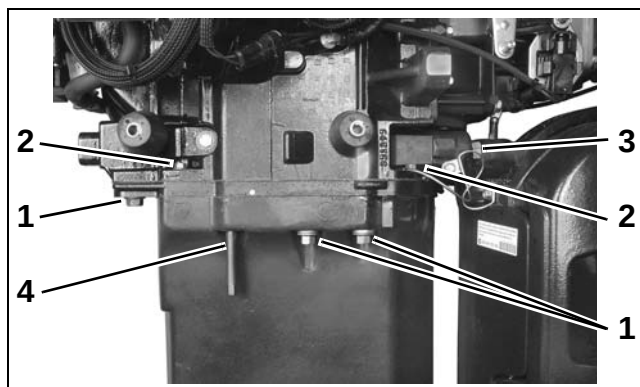


005275

Apply *Triple-Guard* grease to the threads, and *Gasket Sealing Compound* to the shank of the powerhead screws.

Apply *Triple-Guard* grease to upper mount screw threads.

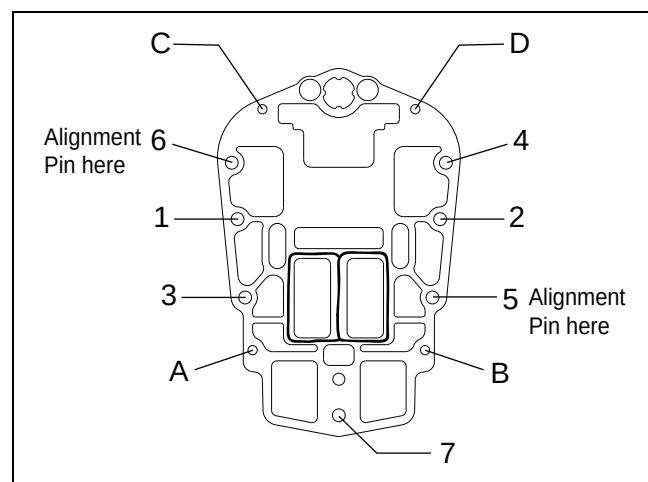
With alignment pins in place, loosely install remaining powerhead screws and upper mount screws.



005277

1. Large powerhead screws
2. Small powerhead screws
3. Upper mount screws
4. Alignment pin tool

- Tighten the large powerhead screws, 1 through 4, to a torque of 20 to 22 ft. lbs (27 to 30 N·m).
- Remove Alignment Pins and tighten screws 5 through 7 to a torque of 20 to 22 ft. lbs (27 to 30 N·m).
- Tighten the four small powerhead screws to a torque of 60 to 84 in. lbs. (7 to 9.5 N·m).
- Tighten the upper mount screws to a torque of 110 to 130 ft. lbs. (149 to 176 N·m). Make sure that screw heads are tight against steering arm.

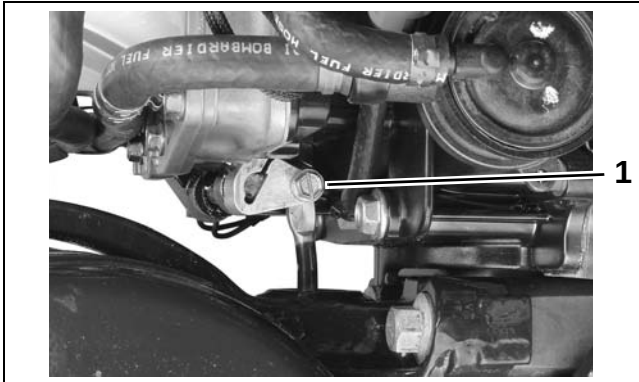


Large screw torque sequence, 1-7
Small screw torque sequence, A-D

005244

IMPORTANT: Retighten powerhead mounting screws after outboard has been run at full operating temperature and allowed to cool.

Place the shift rod in the shift rod lever. Install the retaining pin and washer. Tighten pin to a torque of 60 to 84 in. lbs. (7 to 9.5 N·m).



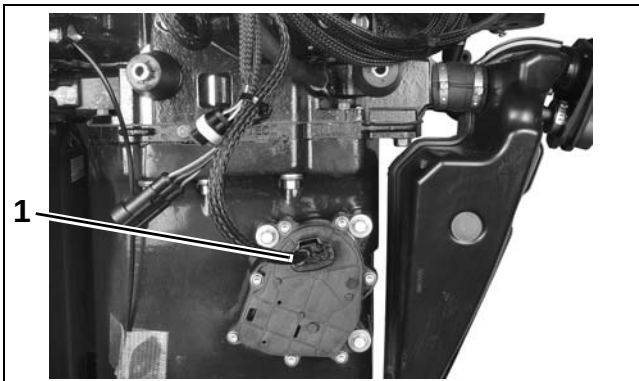
1. Shift rod screw

005253

IMPORTANT: Make sure the gearcase shifts solidly into both forward and reverse and that propeller shaft spins freely in neutral.

Fill exhaust valve actuator electrical connector with *Electrical Grease* and install on actuator (V4 models).

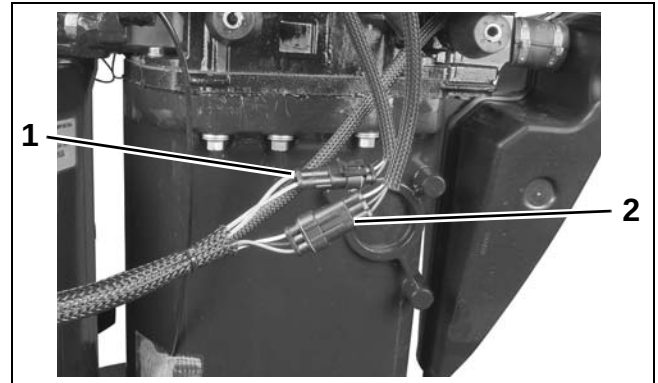
IMPORTANT: Leave enough slack in harness so that lower cover will not pull it away from actuator.



1. Actuator connector

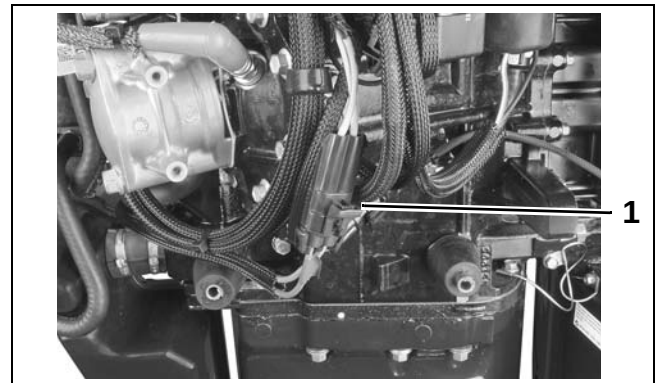
005247

Connect the power trim connectors.



1. Tilt limit switch connector
2. Sending unit connector

005254



1. Tilt relay connector

005255

Install air silencer and air temperature sensor.

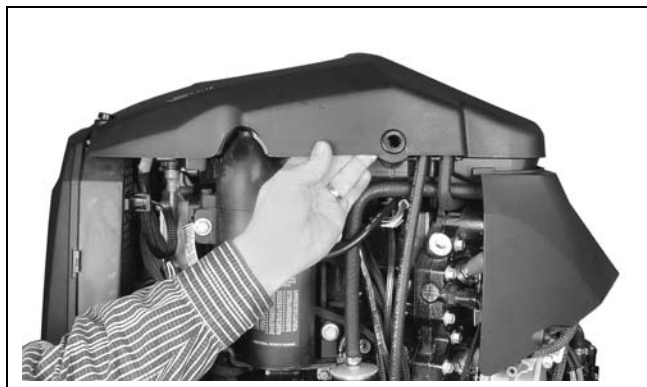


005272

POWERHEAD

POWERHEAD INSTALLATION

Install flywheel cover.



005248

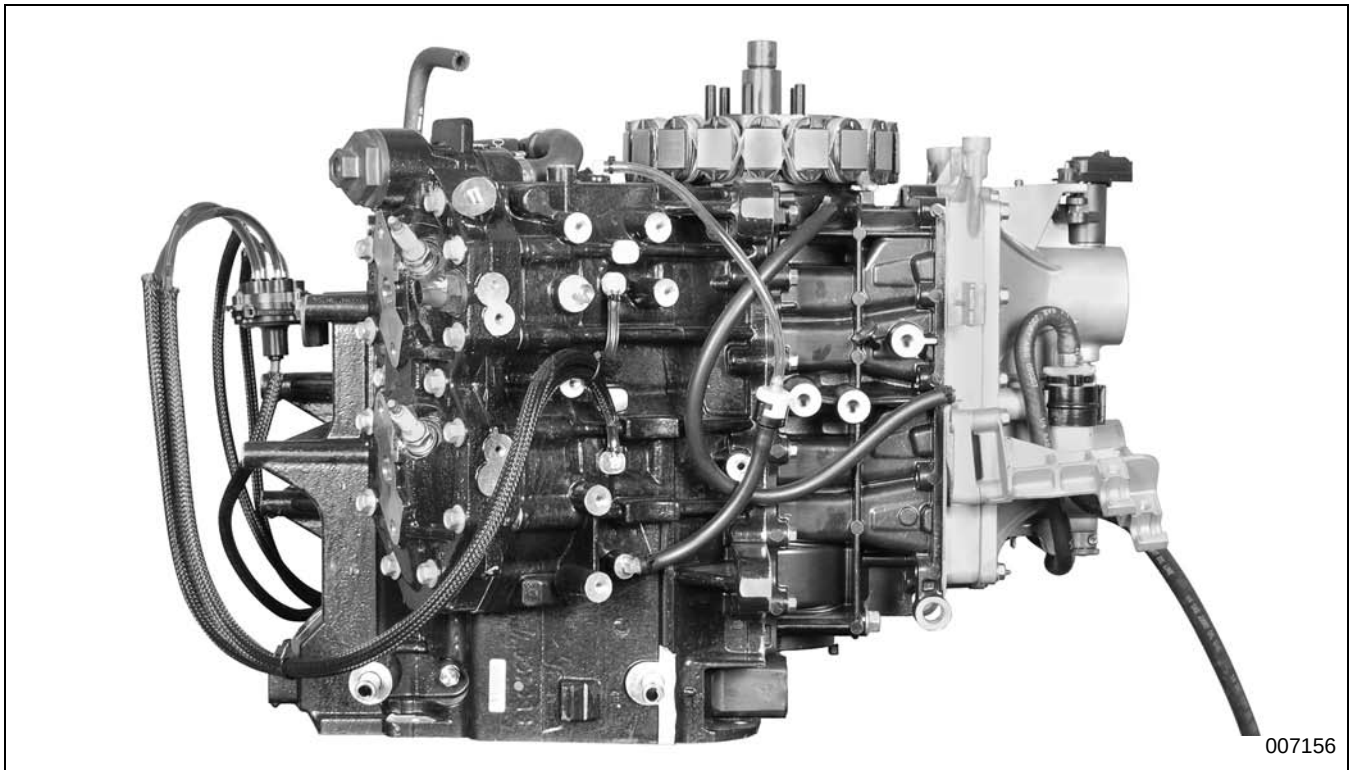
Install the lower engine covers. Refer to **LOWER COVER SERVICE** on p. 49.

Final Adjustments

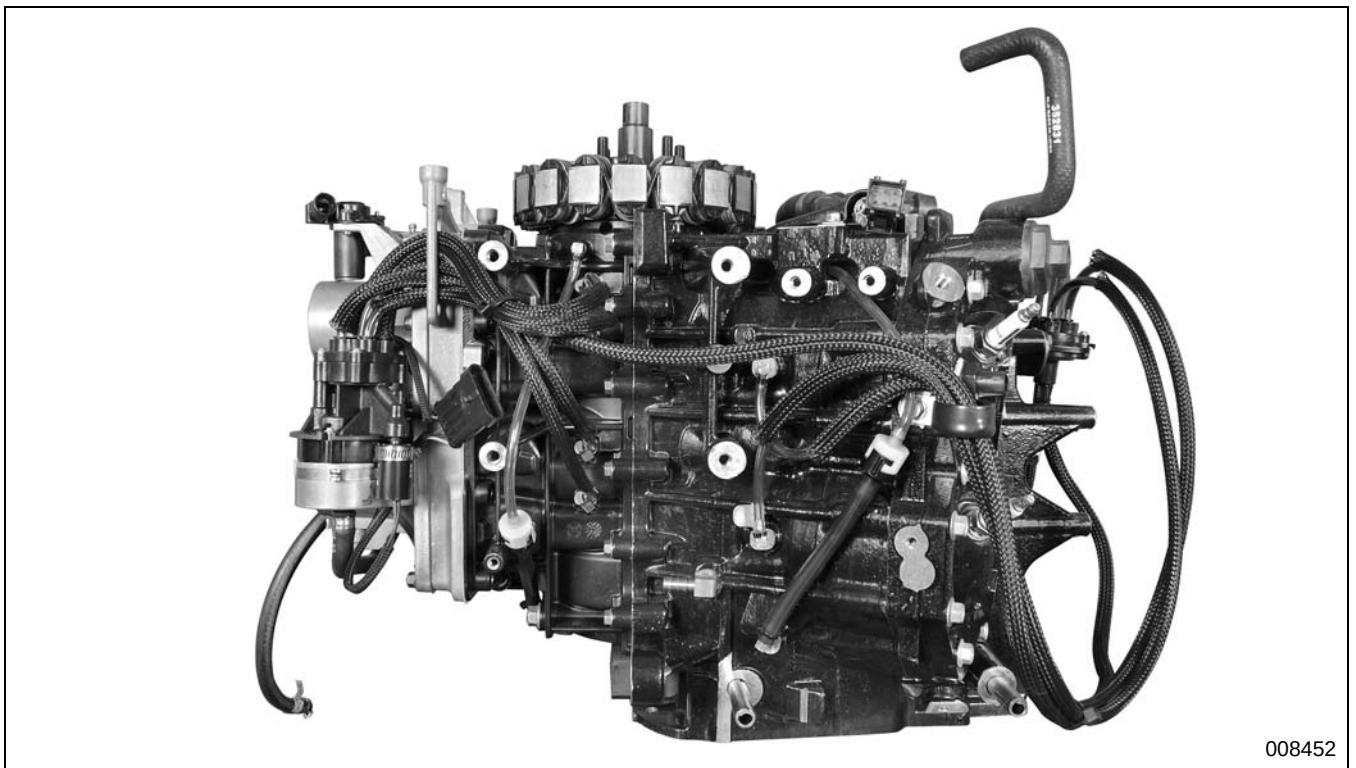
NOTICE After installing a new or rebuilt powerhead, perform the following procedures before returning outboard to service:

- Adjust timing pointer.
- Index all spark plugs. Refer to **Spark Plug Indexing** on p. 38.
- Use *Evinrude Diagnostics* software to start powerhead break-in oiling. Refer to **Powerhead Break-In** on p. 65.
- Use *Evinrude Diagnostics* software to set TPS calibration. Refer to **TPS Calibration** on p. 116.
- Use *Evinrude Diagnostics* software to make sure engine management software version and revision are current. Update as required.
- Prime fuel system.
- Prime oiling system. Refer to **Oil Supply Priming** on p. 173.
- Use *Evinrude Diagnostics* software to check engine timing. Refer to **TIMING ADJUSTMENTS** on p. 114.
- Run outboard and check for water, fuel, or oil leaks.
- Make sure engine reaches correct operating temperature and does not overheat.

V4 Starboard – Hose Routings

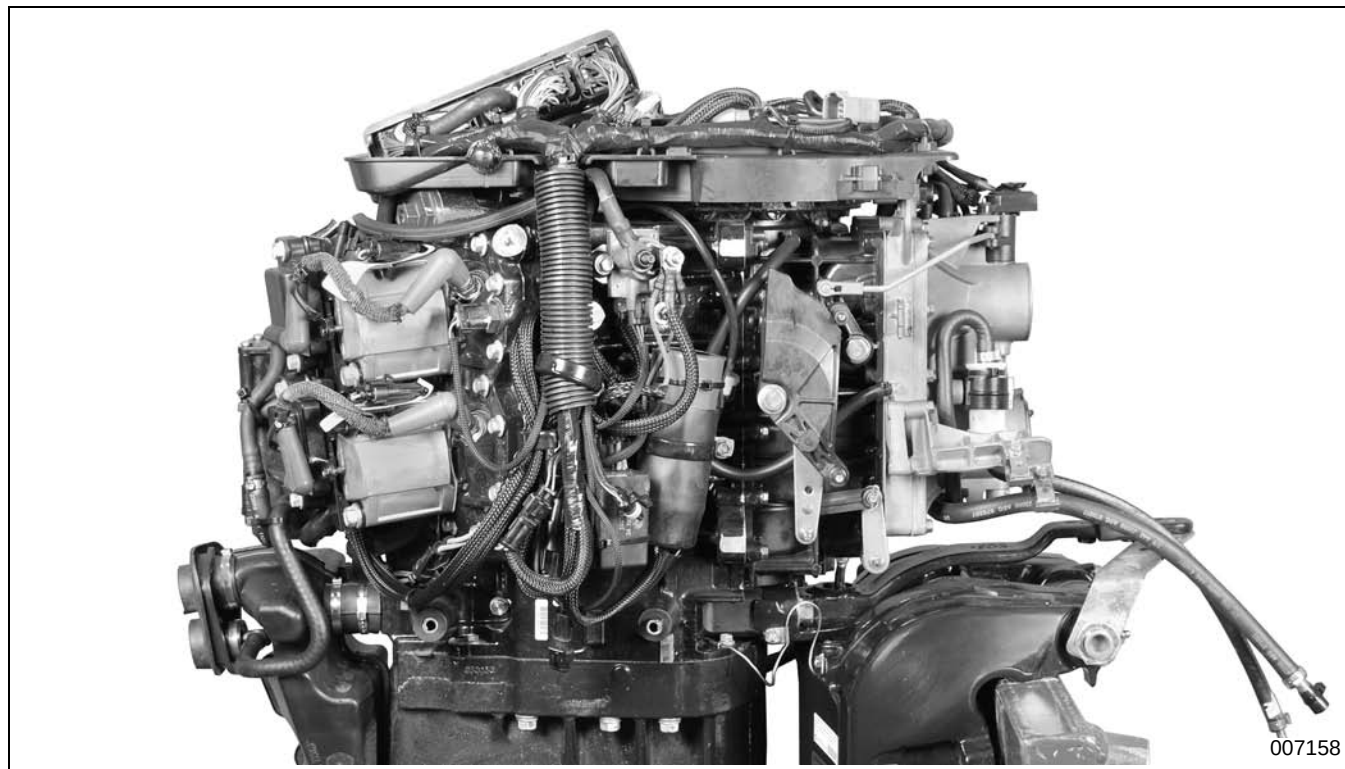


V4 Port – Hose Routings

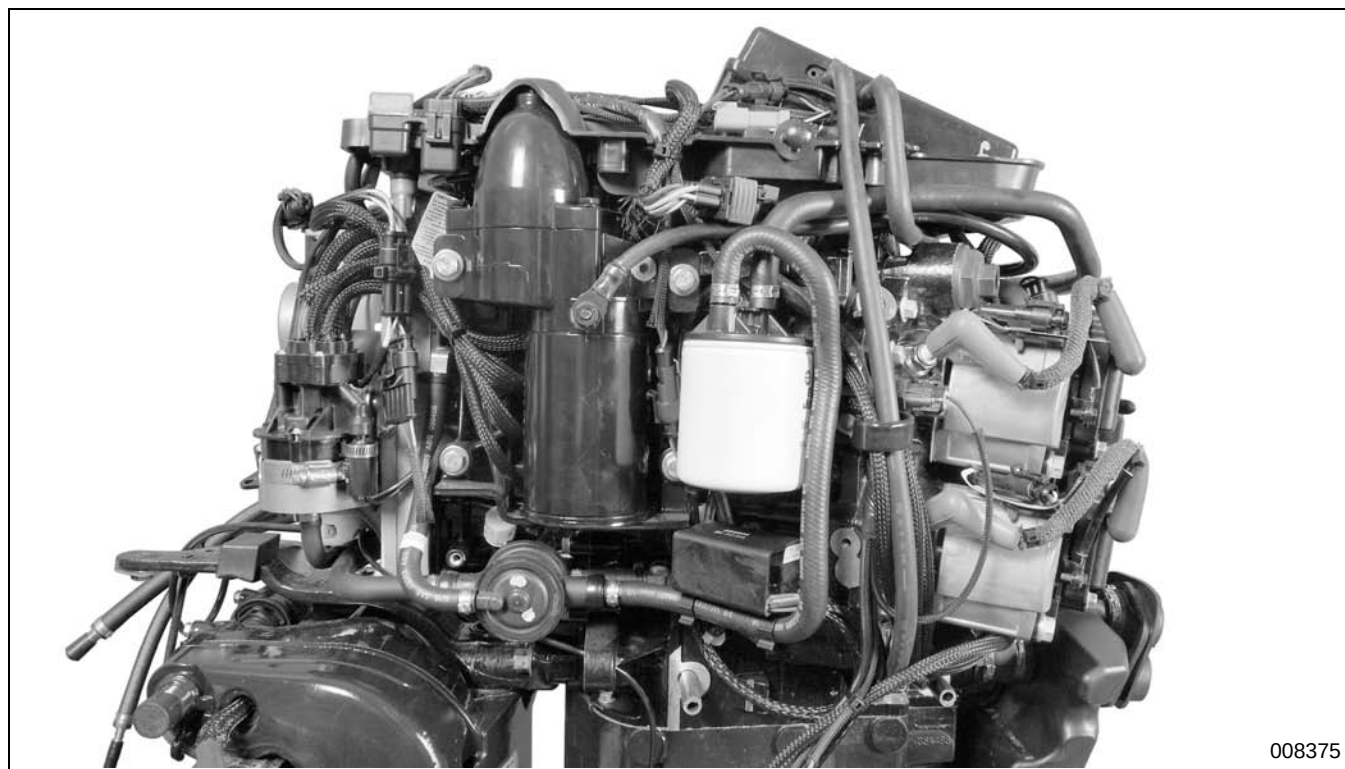


POWERHEAD
POWERHEAD VIEWS

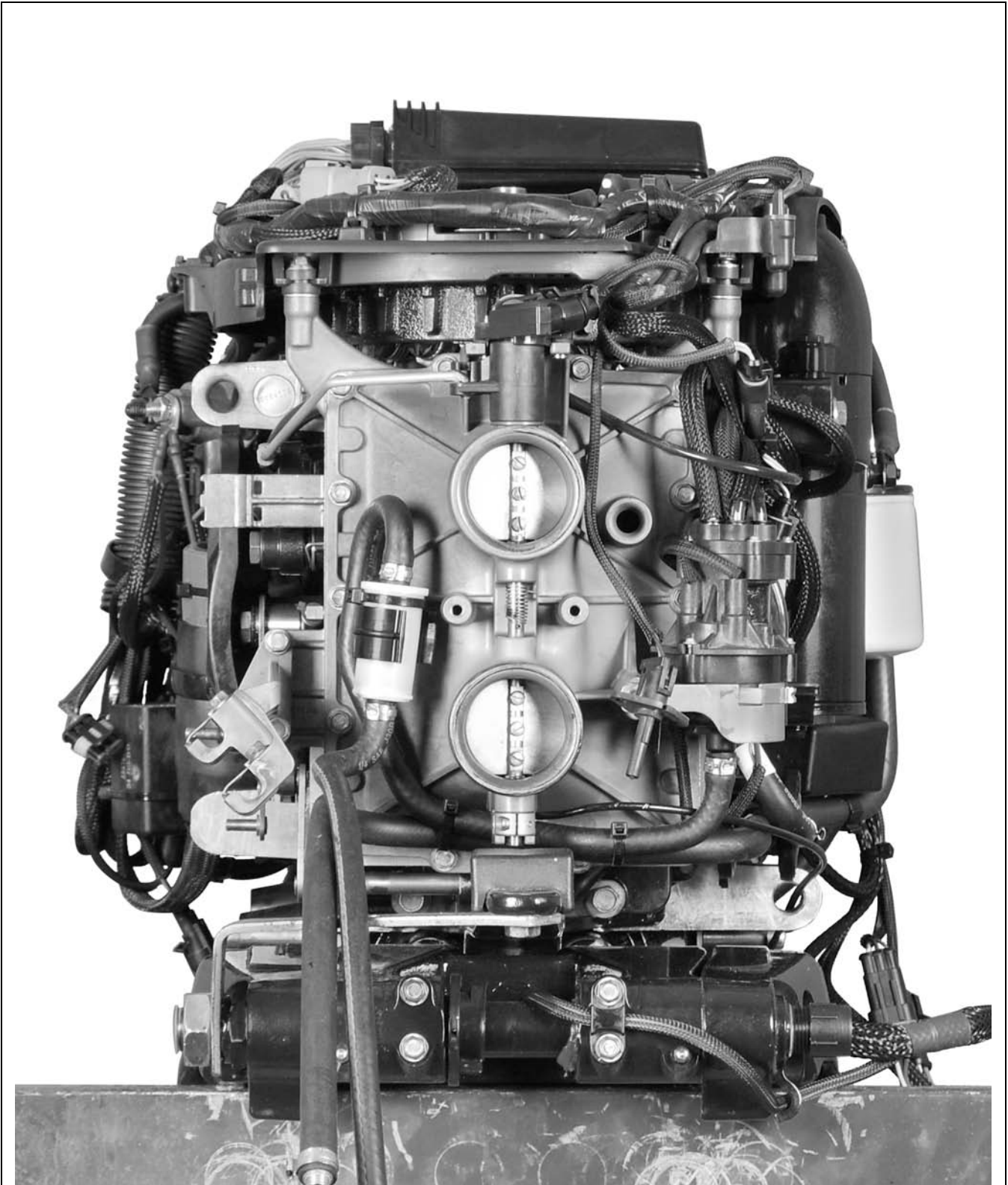
V4 Starboard



V4 Port



V4 Front



007160

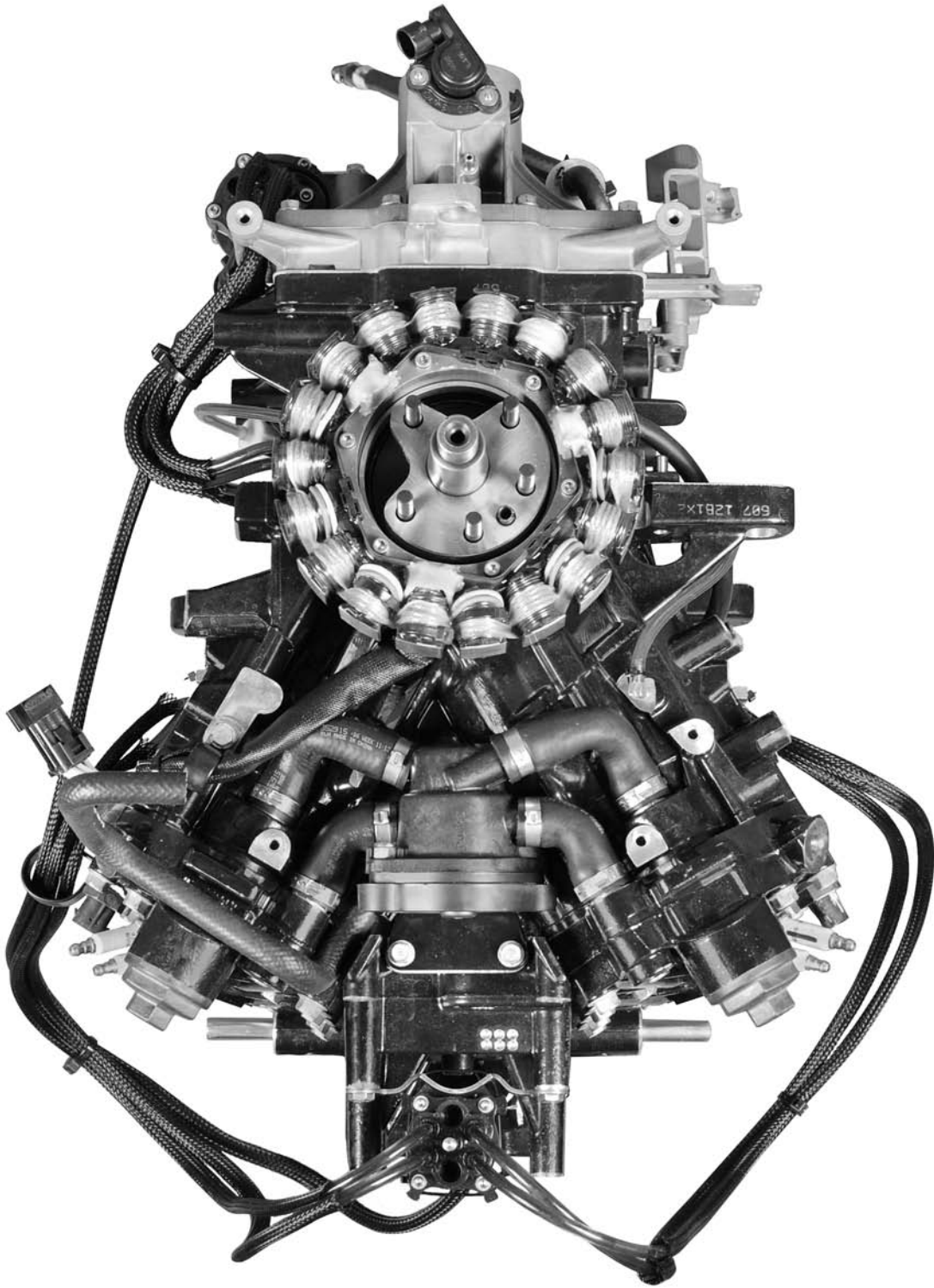
POWERHEAD
POWERHEAD VIEWS

V4 Rear



007161

V4 – V6 Top – Hose Routings



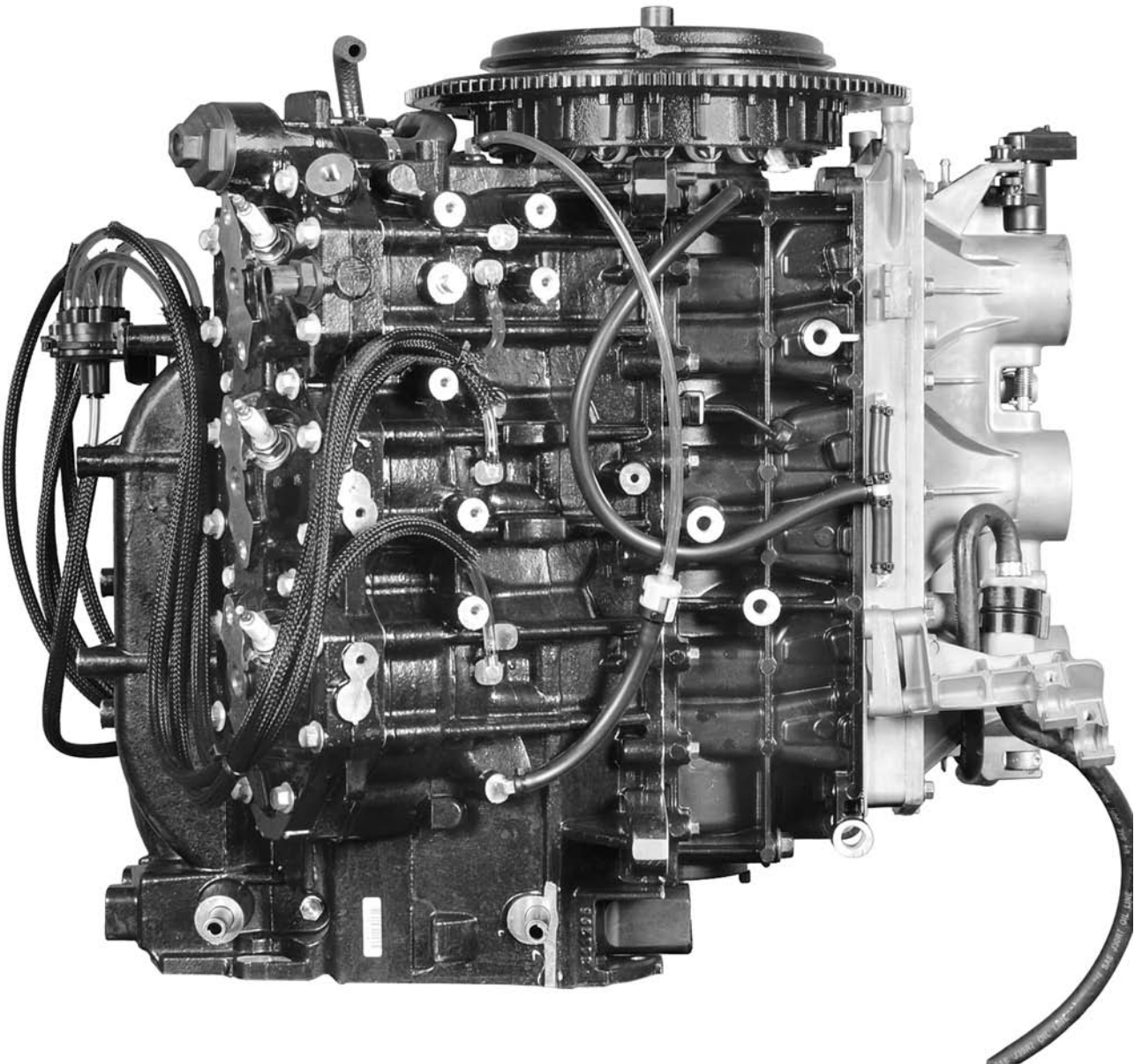
POWERHEAD
POWERHEAD VIEWS

V4 – V6 Top



007163

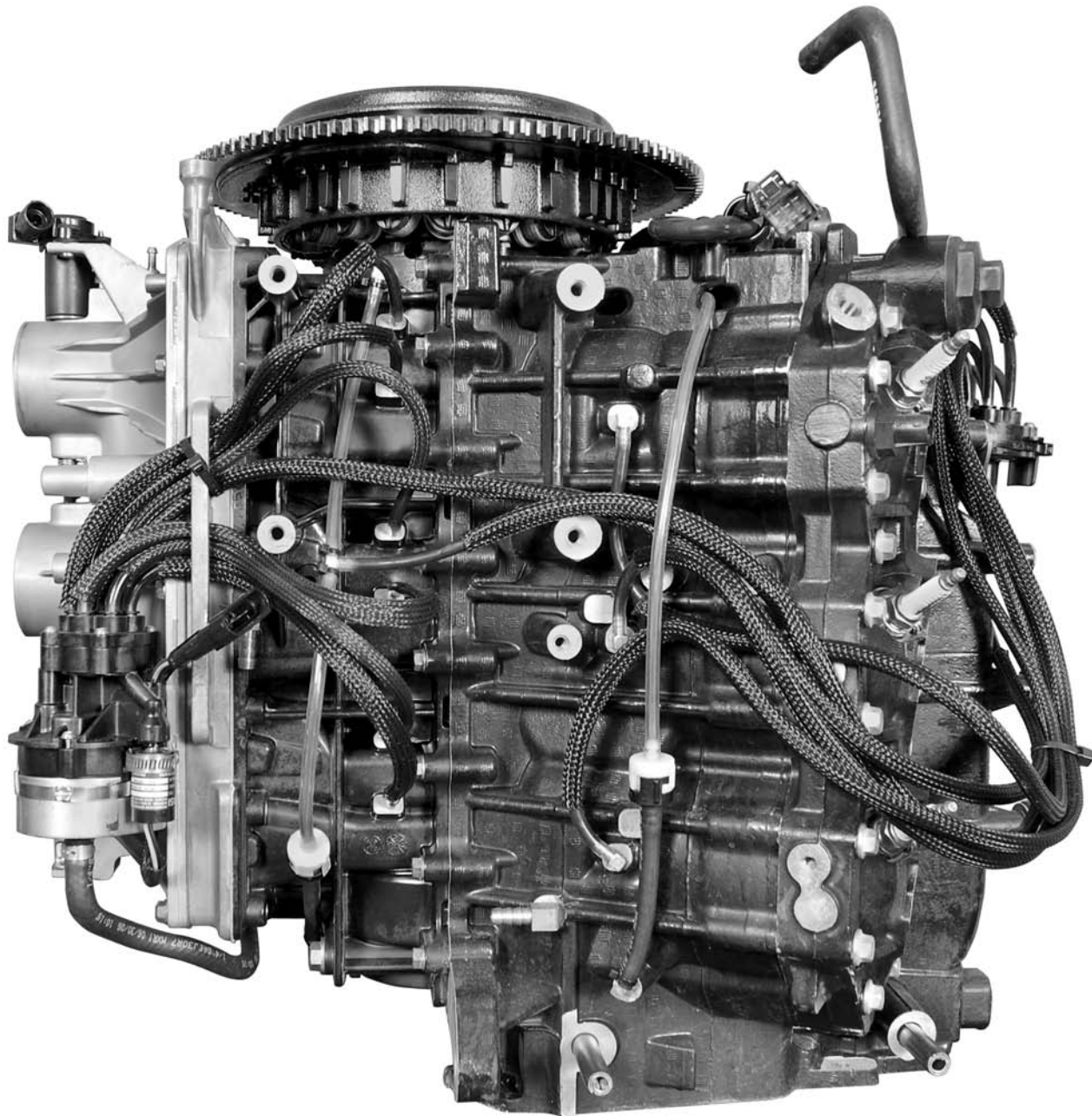
V6 Starboard – Hose Routings



10

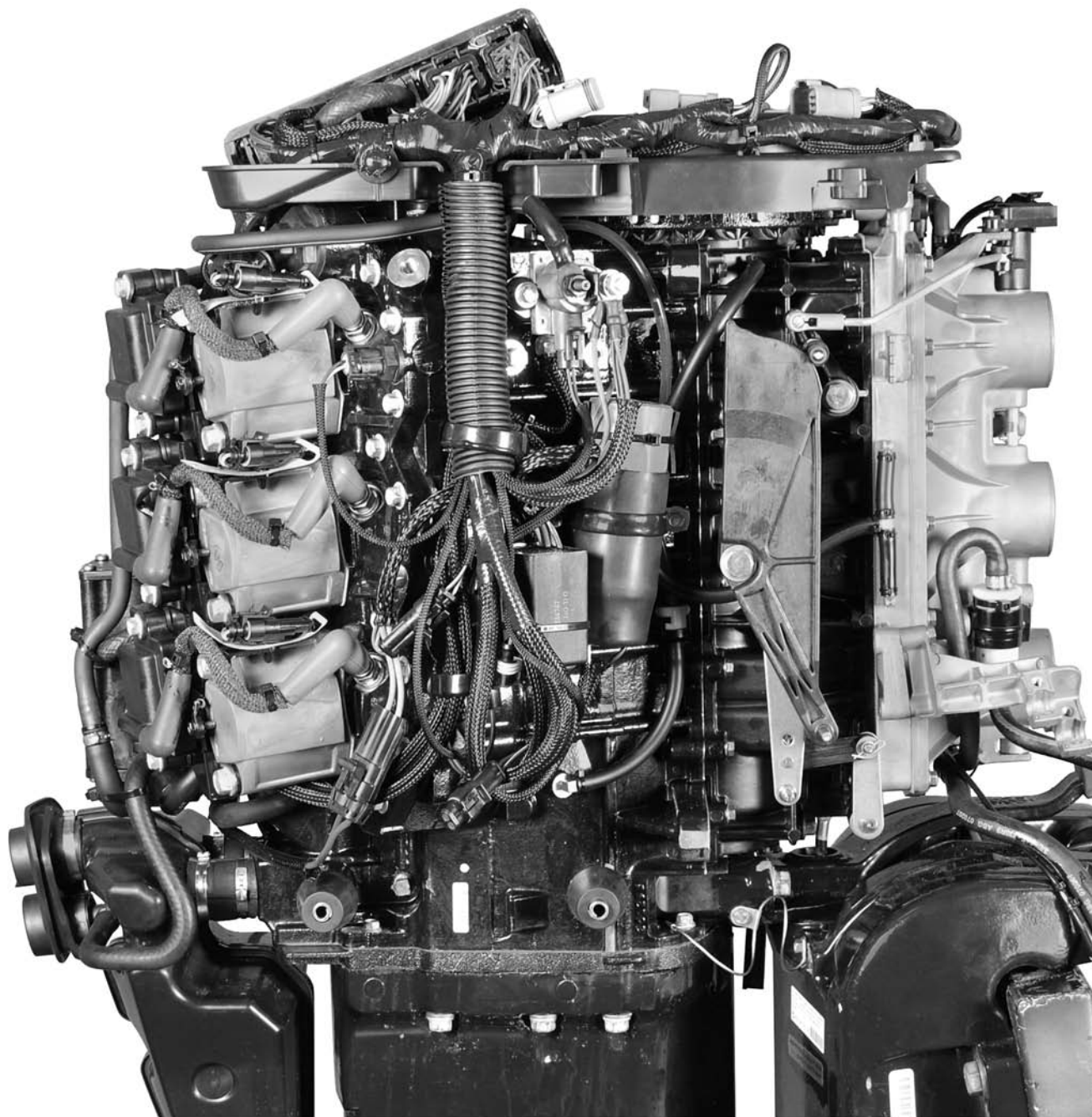
007164

V6 Port – Hose Routings



008453

V6 Starboard



10

007166

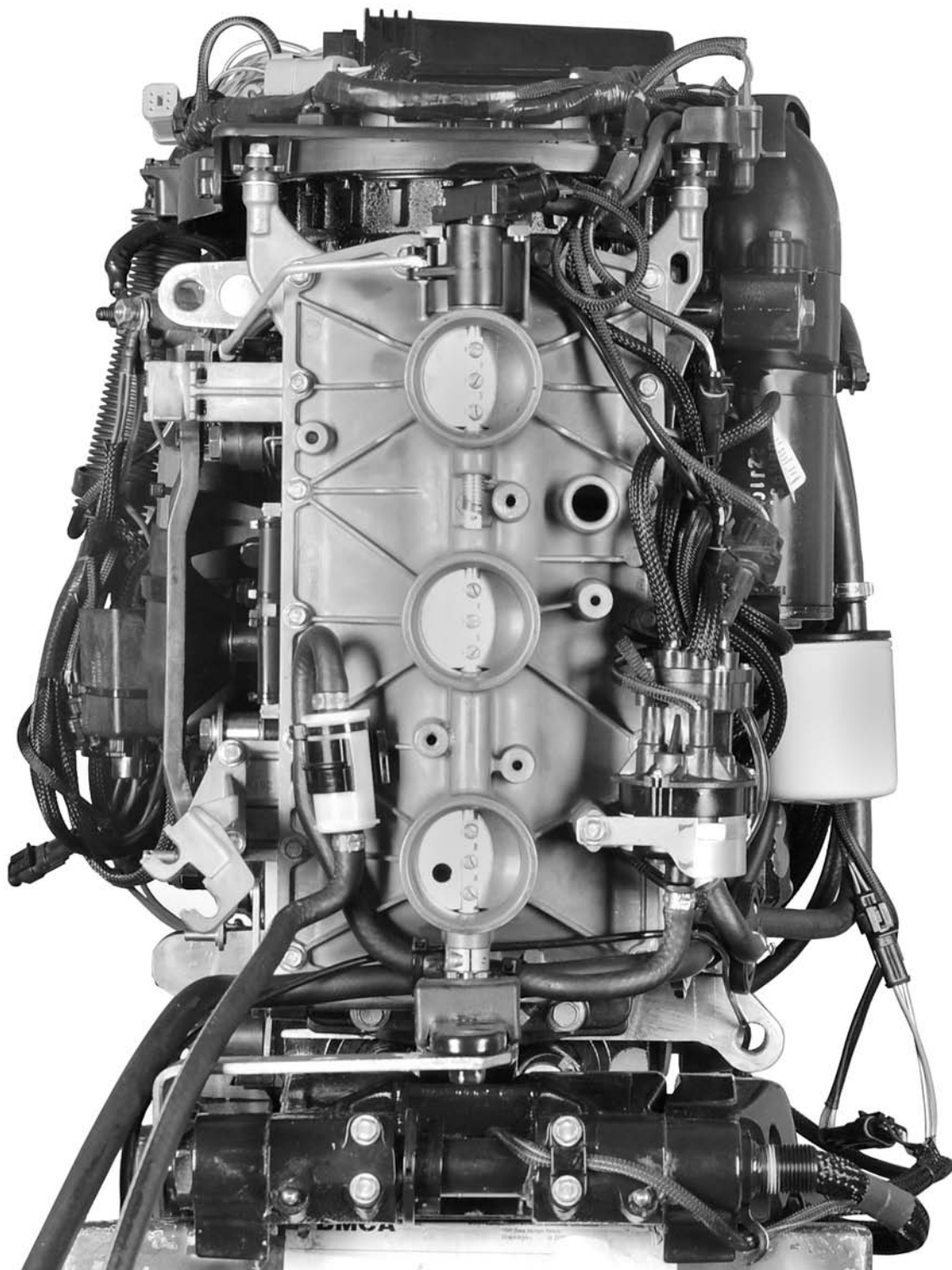
POWERHEAD
POWERHEAD VIEWS

V6 Port



007167

V6 Front



007168

POWERHEAD
POWERHEAD VIEWS

V6 Rear



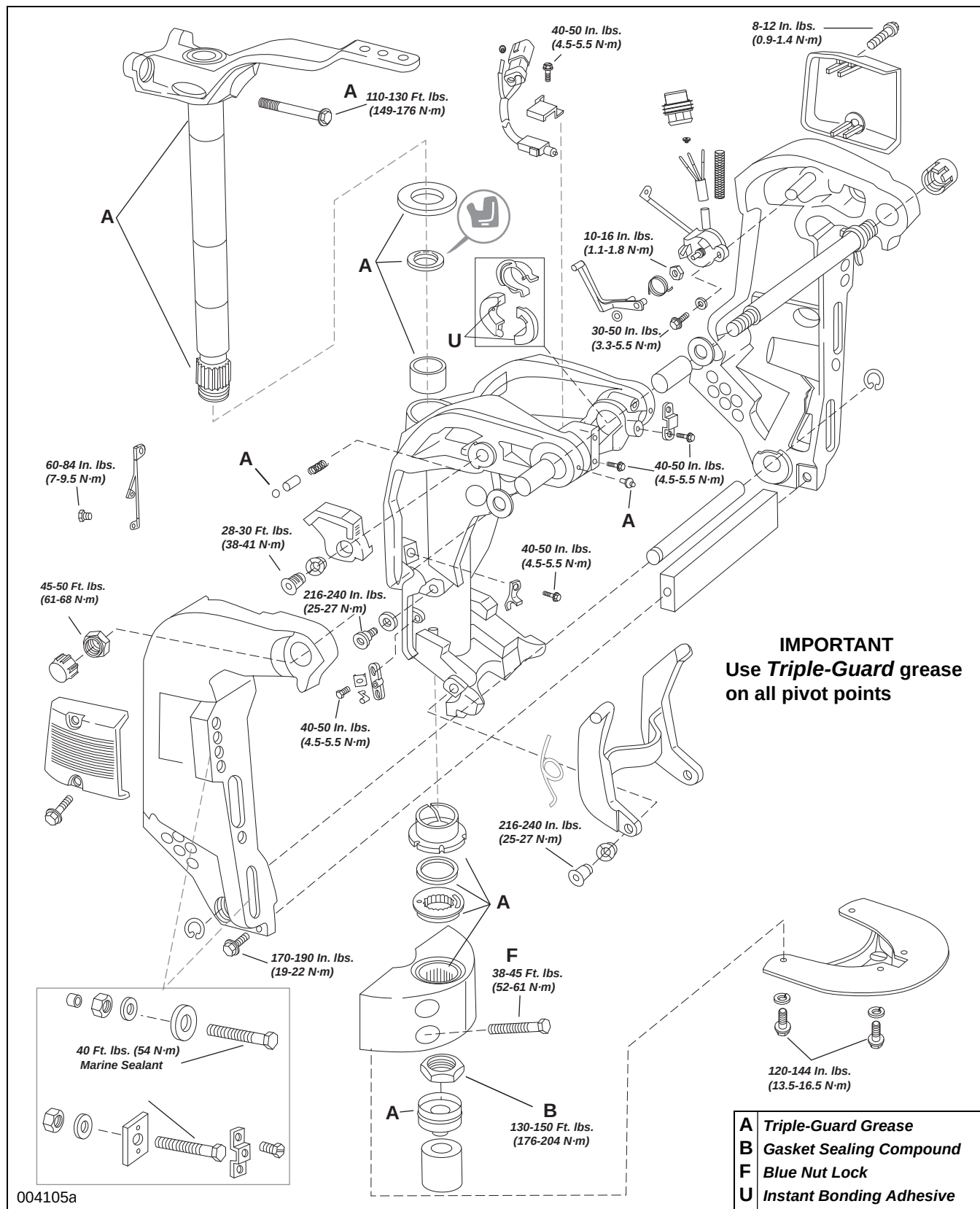
007169

MIDSECTION

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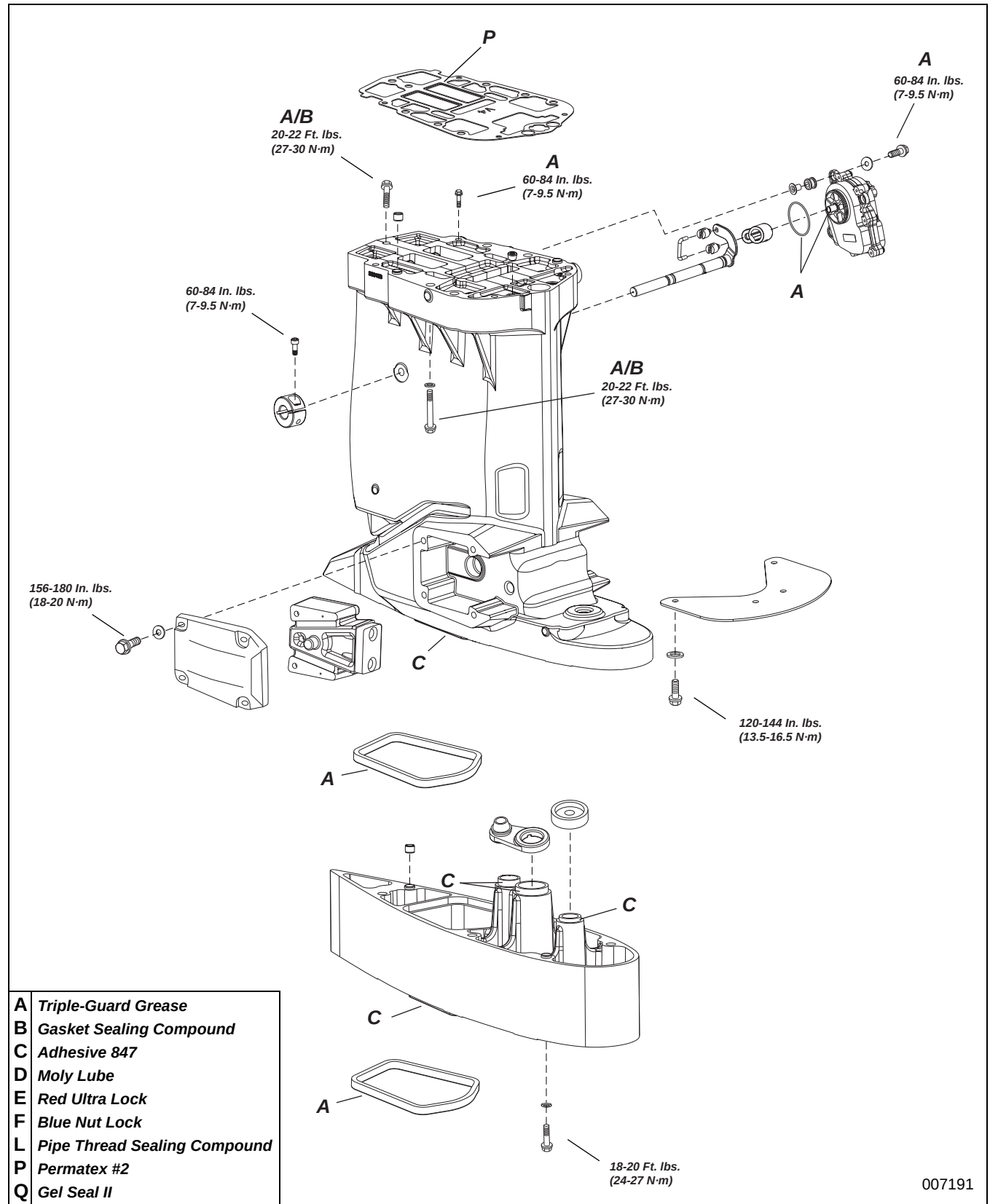
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SERVICE CHART



EXHAUST HOUSING

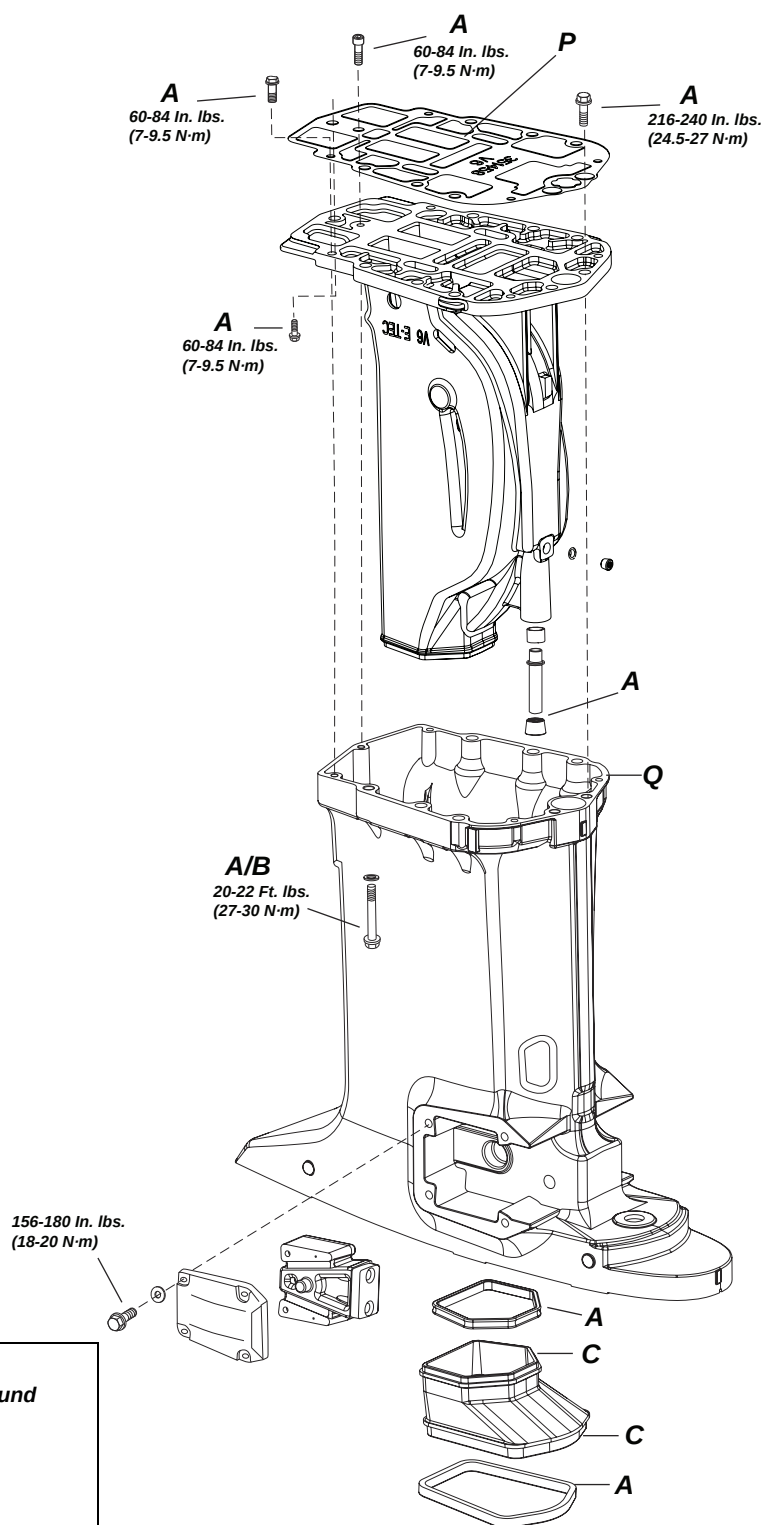
V4 MODELS



MIDSECTION SERVICE CHART

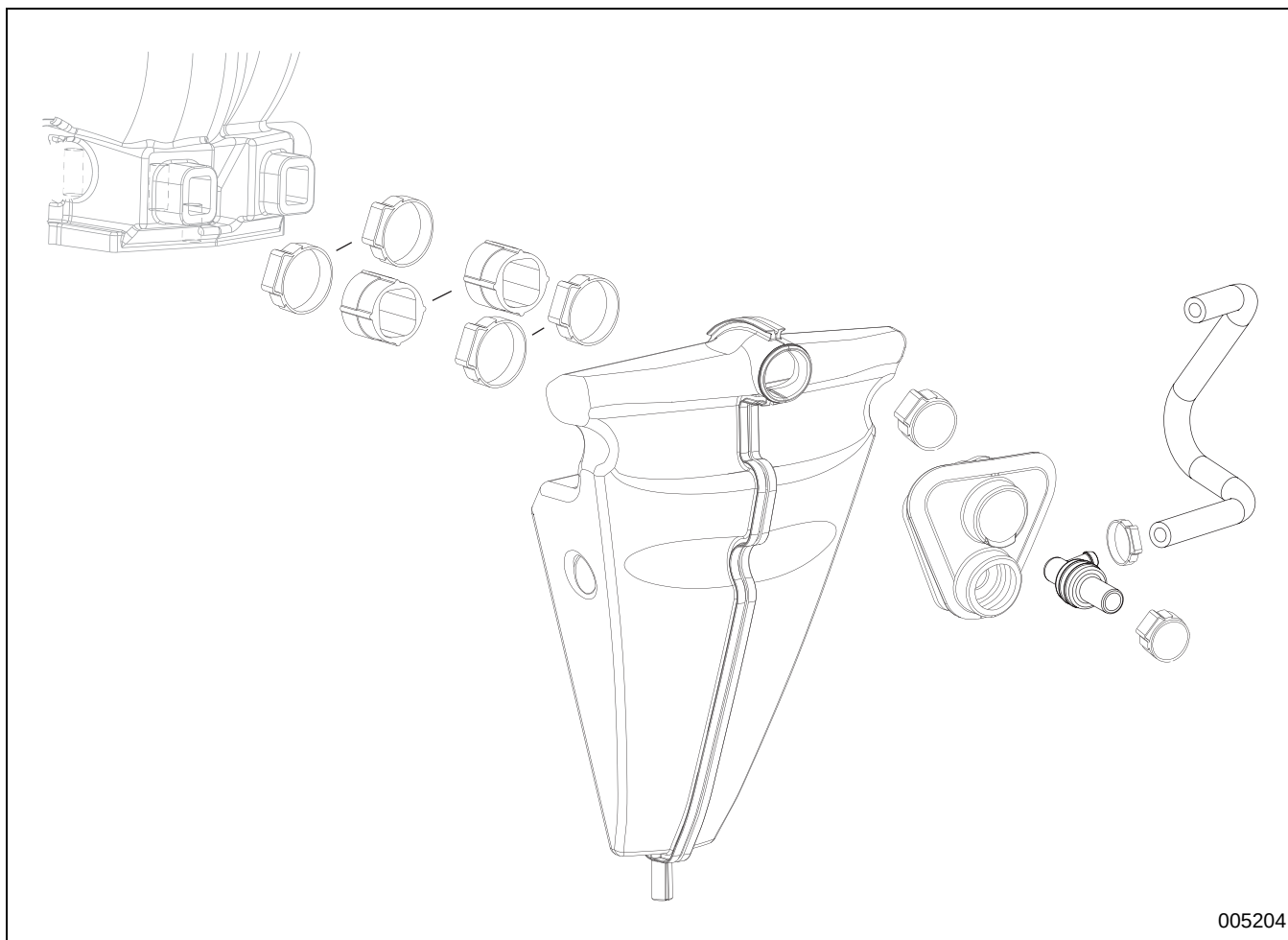
EXHAUST HOUSING

V6 MODELS



- A** Triple-Guard Grease
- B** Gasket Sealing Compound
- C** Adhesive 847
- D** Moly Lube
- E** Red Ultra Lock
- F** Blue Nut Lock
- L** Pipe Thread Sealing Compound
- P** Permatex #2
- Q** Gel Seal II

008377



MIDSECTION

TILT TUBE

TILT TUBE

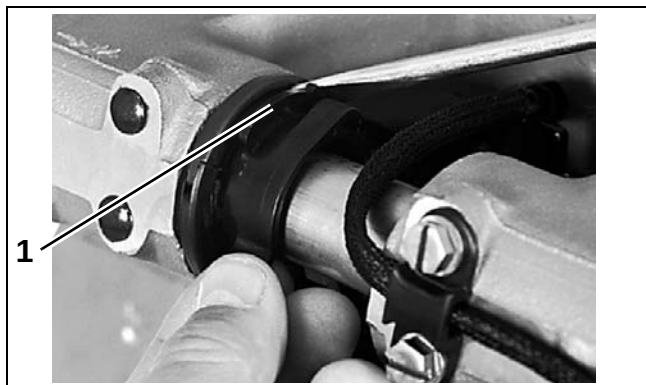
The tilt tube may be serviced without major disassembly of the outboard using Tilt Tube Service Kit, P/N 434523.

Removal

WARNING

Support the outboard with a suitable hoist.

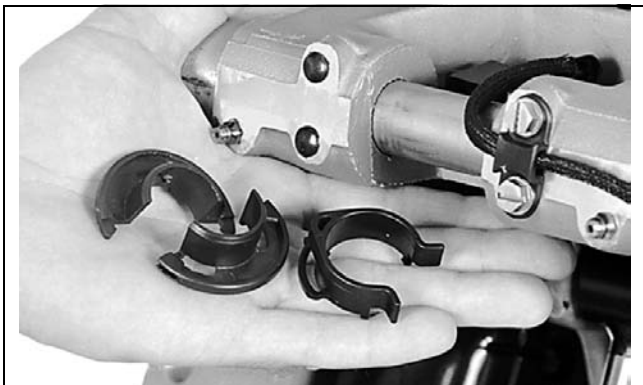
Pull the locking tabs on the tilt limit cam loose from the collar.



1. Locking tabs

30749

Remove the cam and collar from the tilt tube.



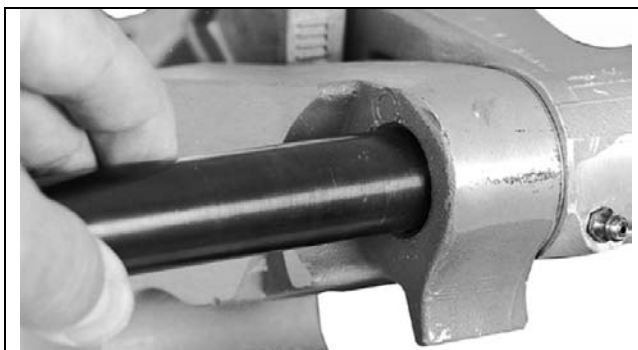
30748

Remove the nut from the starboard side.



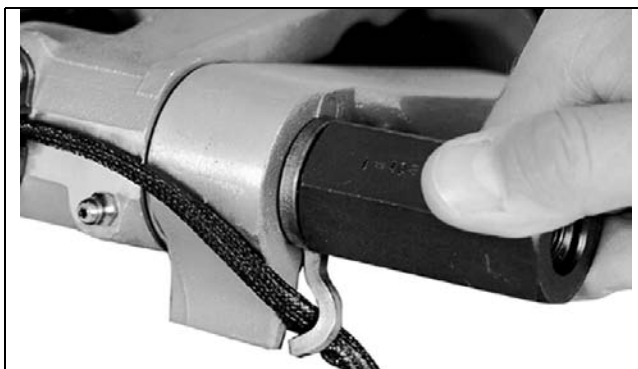
30747

Thread the spacer from Tilt Tube Service Kit, P/N 434523, onto the starboard end of the tilt tube.



30746

Remove steering cable wiper nut from tilt tube. Thread the adapter from Tilt Tube Service Kit, P/N 434523, onto the port end of the tilt tube.



30745

Thread Slide Hammer, P/N 432128, into the adapter until at least 2 in. (51 mm) of thread are engaged.



30744

Pull tilt tube from stern bracket with the slide hammer. When tilt tube clears the port stern bracket, remove tilt tube from the spacer.

Installation

Thread starboard end of tilt tube into the spacer.

Thread the adapter onto port end of tilt tube.

Use a wood or leather mallet to tap the tilt tube into position.



30743

Make sure the lock tab is in correct position.



1. Lock tab

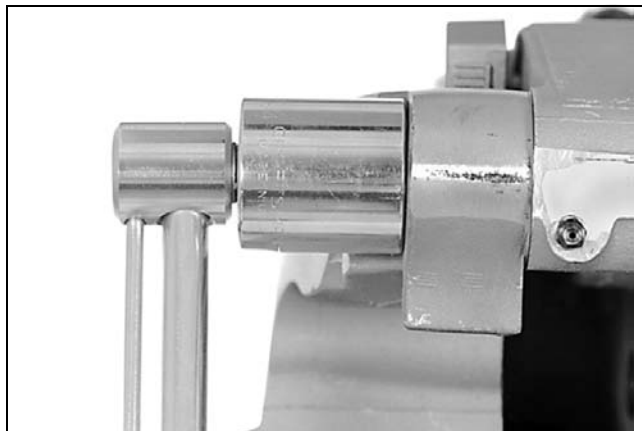
30742

Install the starboard locknut.

WARNING

Replace locknut if definite resistance is not felt.

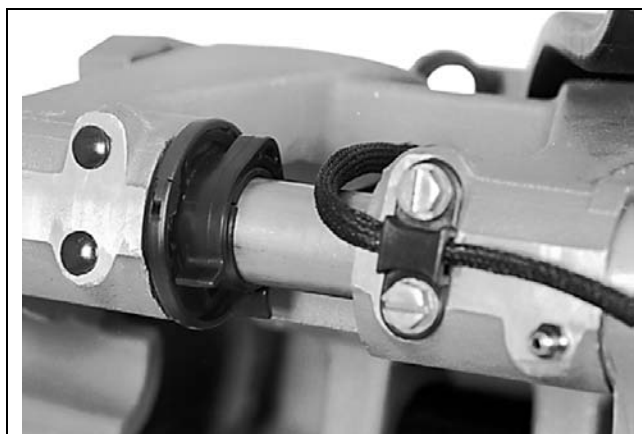
Tighten starboard tilt tube nut to a torque of 45 to 50 ft. lbs. (61 to 68 N·m).



30741

Replace steering cable wiper nut on port end of tilt tube.

Apply one drop of instant bonding adhesive in receiving channels of tilt limit switch collar and install collar and tilt cam on tilt tube. Be sure locating tab on collar fits in hole on tilt tube.



30750

EXHAUST HOUSING SERVICE

Exhaust Housing Removal

Before removing the exhaust housing:

- Remove the gearcase. Refer to Gearcase **GEARCASE REMOVAL AND INSTALLATION** on p. 268.
- Remove the powerhead. Refer to **POWER-HEAD REMOVAL** on p. 196.

Remove and discard four lower mount screws.



20" Models

23036



25" Models

32590

Remove the exhaust housing.

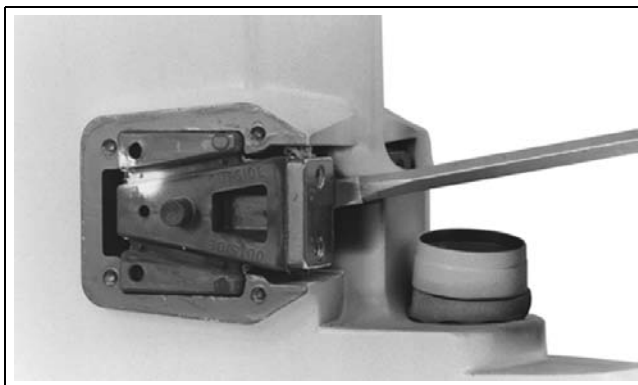


007178

Lower Mount Service

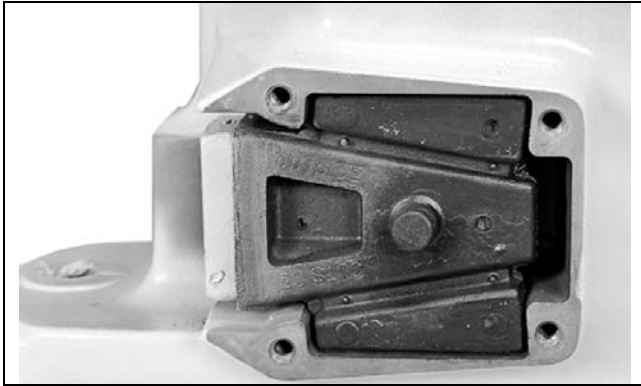
Remove lower mount covers and inspect the lower mounts.

If replacement is necessary, lubricate mount with soapy water and carefully pry at both ends to remove.



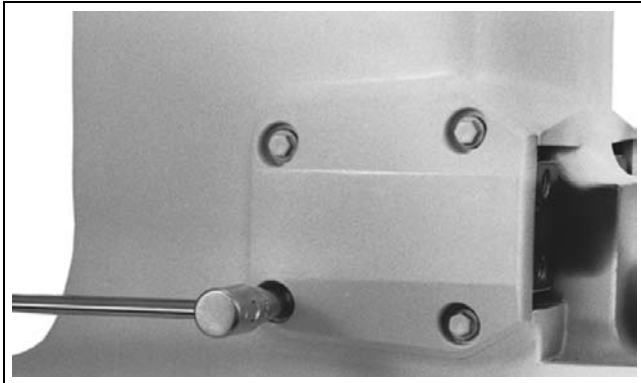
32578

If removed, coat the lower mounts with soapy water and press into the exhaust housing with the "OUTSIDE" mark facing outward.



23033

Install the mount covers. Apply *Nut Lock* to screws, install washers and screws, and tighten to a torque of 150 to 180 in. lbs. (17 to 20 N·m).



32579

Exhaust Housing Installation

Bring the exhaust housing into position with the stern bracket.

Install four **new** lower mount screws with lock-patch. Tighten screws to a torque of 38 to 45 ft. lbs. (51 to 61 N·m).



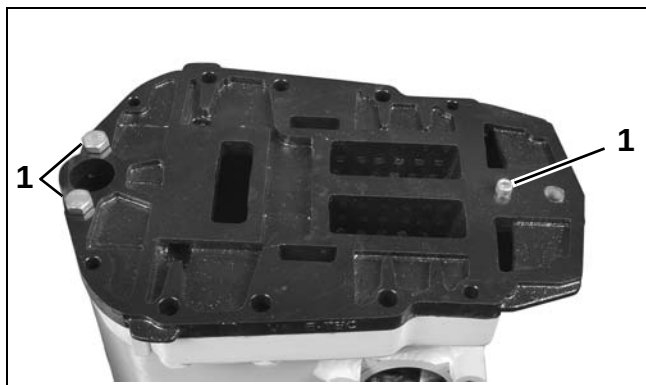
23036

Install powerhead. Refer to **POWERHEAD INSTALLATION** on p. 219.

Install gearcase. Refer to Gearcase **GEARCASE REMOVAL AND INSTALLATION** on p. 268.

Exhaust Housing Disassembly – V6 Models

Remove the front and rear screws retaining the adapter/inner exhaust housing to the exhaust housing.



1. Adapter retaining screws

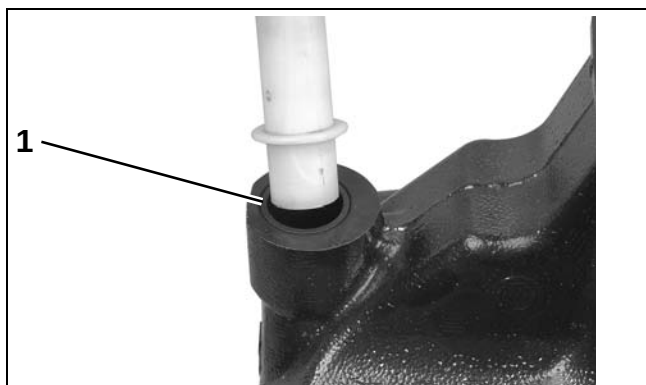
005205

Lift the adapter/inner exhaust housing out of the exhaust housing.



005207

Remove the water tube. Inspect water tube grommet and replace if necessary.

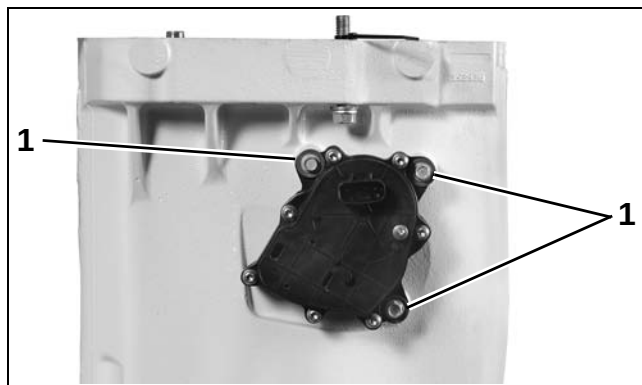


1. Water tube grommet

005210

Exhaust Housing Disassembly – V4 Models

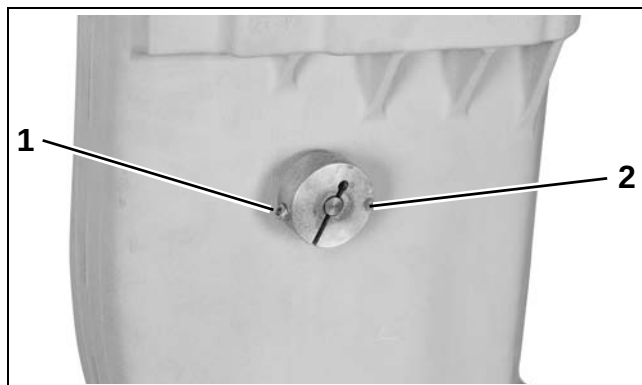
Remove three screws and exhaust valve actuator.



1. Actuator screws

007182

Remove collar only if replacing exhaust housing. Loosen collar screw. Remove collar.



1. Screw
2. Collar

007185

IMPORTANT: Do NOT remove exhaust valves they are not serviceable.

Cleaning and Inspection

WARNING

Wear safety glasses to avoid personal injury, and set compressed air to less than 25 psi (172 kPa).

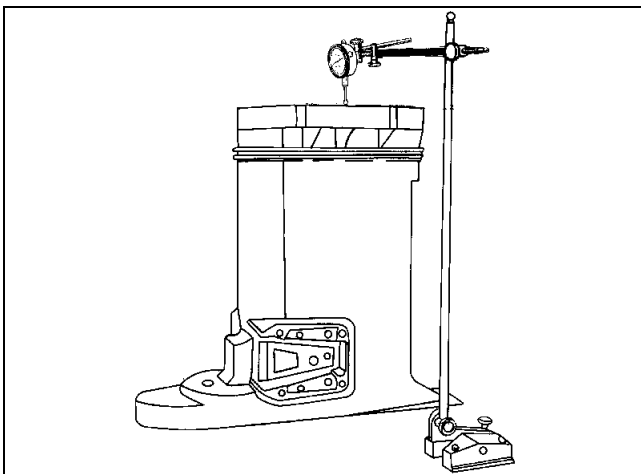
Clean all parts with parts cleaning solvent and dry with compressed air. All nut and screw threads coated with thread locking material must be thoroughly cleaned before assembly. When using a thread locking product, be sure to prime the threads with *Locquic Primer*.

Examine the upper and lower thrust mounts, and replace if deteriorated or damaged.

Before checking the exhaust housing for distortion, thoroughly clean the top and bottom mating surfaces and remove all sealer and corrosion.

Check the exhaust housing for distortion. Place the housing on a surface plate. Using a dial indicator, check flatness by measuring the run-out on the top edge of housing. The maximum allowable run-out is 0.009 in. (0.228 mm). If you do not have access to a dial indicator and surface plate, seek the services of a machine shop. DO NOT attempt to straighten a distorted housing. Replace it.

IMPORTANT: A distorted exhaust housing will cause the upper driveshaft splines to wear excessively and will damage the crankshaft splines.



DR2223

Inspect the water tube for obstructions or kinks, which may restrict water flow.

Exhaust Housing Assembly – V6 Models

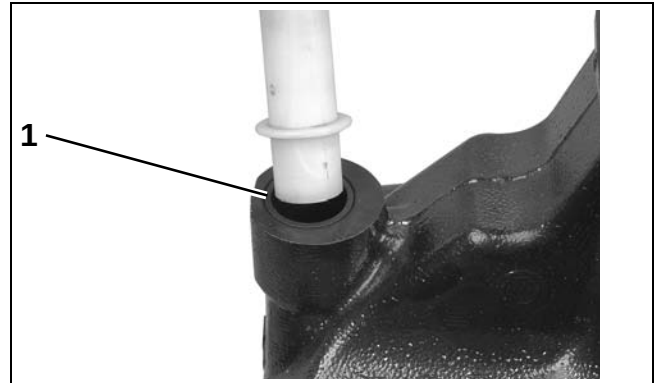
Apply *Adhesive 847* to the bottom flange of the inner exhaust housing. Install a new seal. Apply *Triple-Guard* grease to outer seal surface.



1. Adhesive 847
2. Triple-Guard grease

005217

Install the water tube.



1. Water tube grommet

005210

Clean and degrease the adapter housing and outer exhaust housing mating surfaces with

MIDSECTION

EXHAUST HOUSING SERVICE

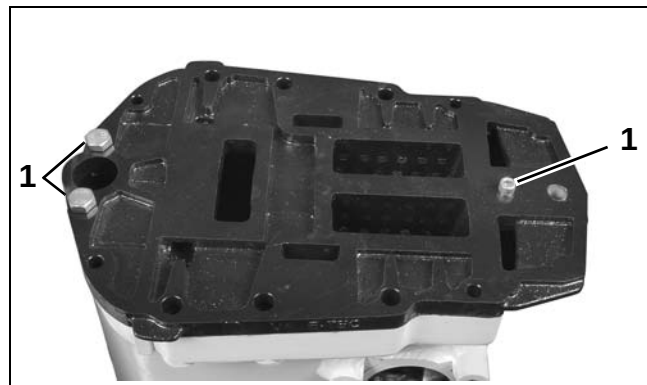
Cleaning Solvent. Apply *Gel-Seal II* sealant to the adapter flange of the exhaust housing.



13692

Place the adapter/inner exhaust housing into the exhaust housing. Guide the water tube through the hole in the outer housing.

Apply *Triple-Guard* grease to threads of adapter retaining screws. Tighten two forward screws to a torque of 216 to 240 in. lbs. (24.5 to 27 N·m) and rear screw to a torque of 60 to 84 in. lbs. (7 to 9.5 N·m).



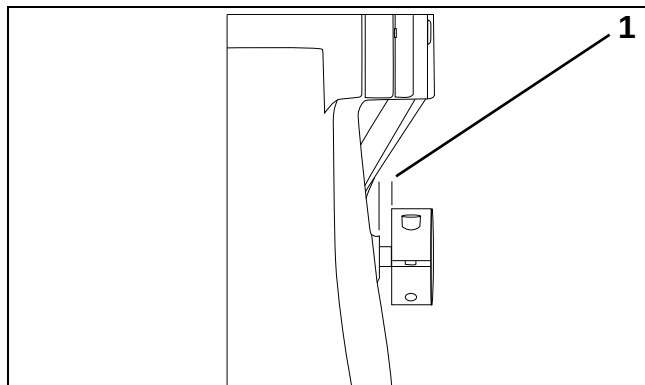
1. Adapter retaining screws

005205

Exhaust Housing Assembly – V4 Models

Install the collar on shaft.

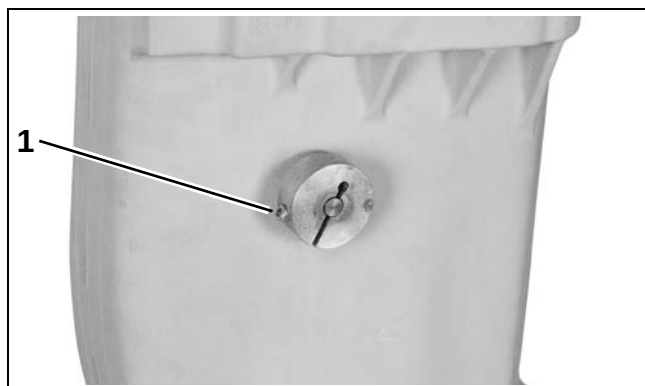
Use a 0.030 in. (0.762 mm) feeler gauge to set the gap between the collar and exhaust housing as shown.



1. Set gap to 0.030 in. (0.762 mm)

007192

Tighten screw to a torque of 60 to 84 in. lb. (18 to 20 N·m).

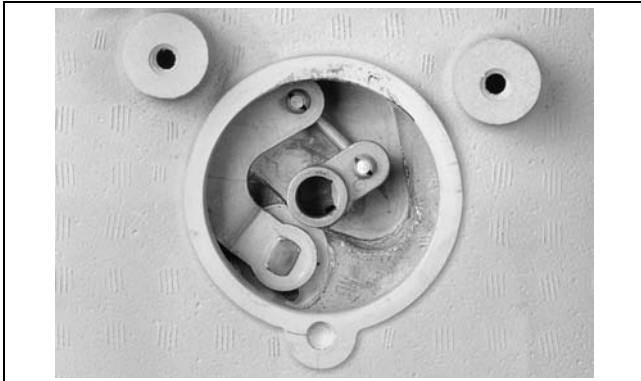


1. Screw

007185

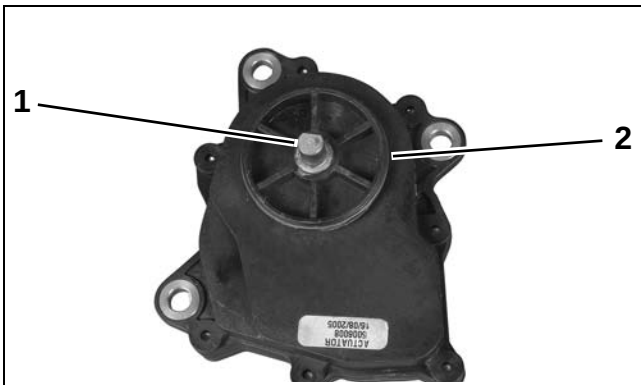
MIDSECTION EXHAUST HOUSING SERVICE

Check that exhaust valve linkage is oriented as shown.



007184

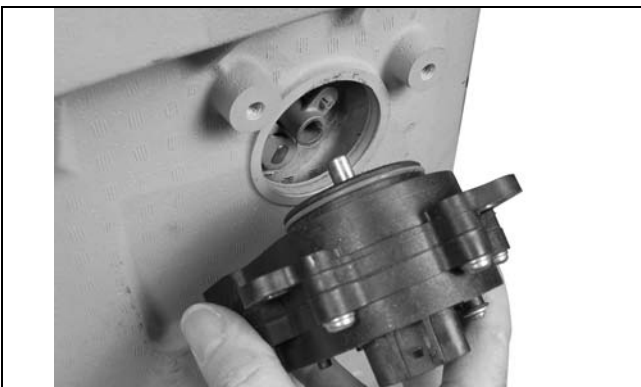
Apply a small amount of *Triple-Guard* grease to the actuator shaft and o-ring.



1. Shaft
2. O-ring

005209

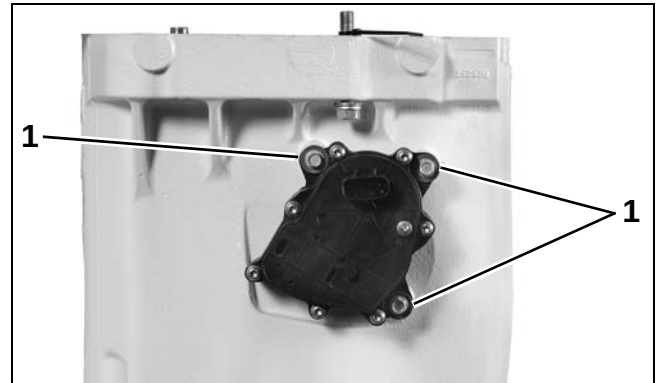
Carefully engage actuator shaft in linkage lever.



007183

Rotate and push actuator into position. Apply *Triple-Guard* grease to screw threads.

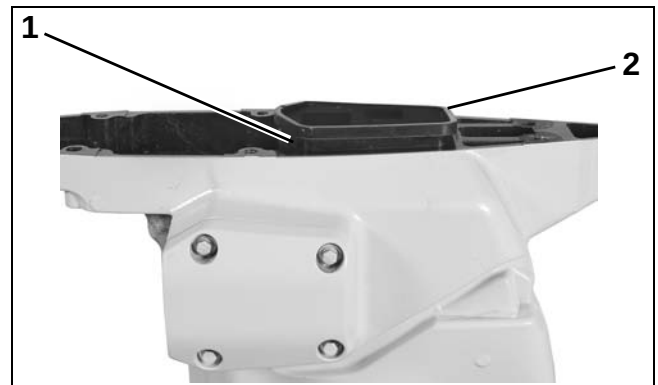
Install screws and washers. Tighten screws to 60 to 84 in. lbs. (7 to 9.5 N·m).



1. Actuator screws

007182

Apply *Adhesive 847* to the bottom flange of the exhaust housing. Install a new seal. Apply *Triple-Guard* grease to outer seal surface.



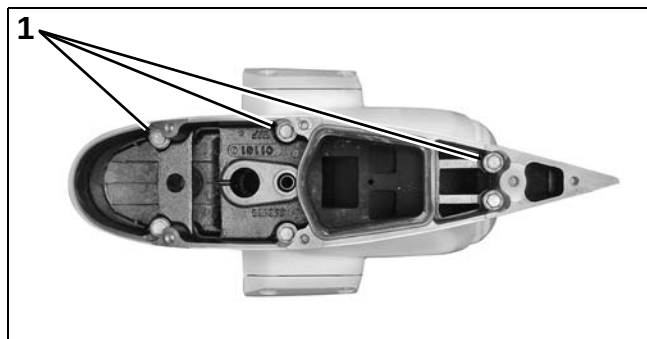
1. Adhesive 847
2. *Triple-Guard* grease

007181

EXTENSION SERVICE – V4 Models

Removal

Remove six screws retaining extension.



1. Screws

007180

Remove extension.

Remove grommets and seal.

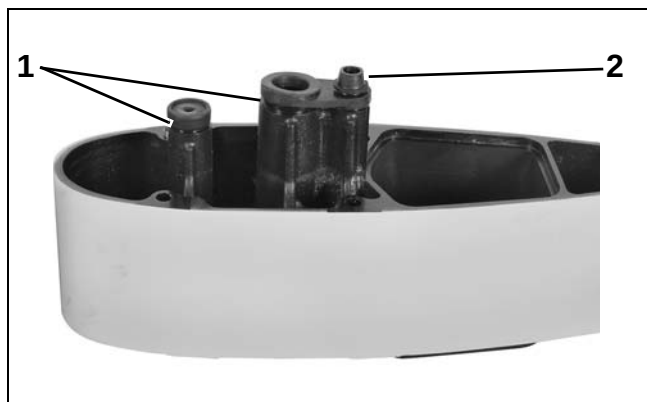
Installation

Apply *Adhesive 847* to the shift rod and water tube flange of the extension. Install new grommets.

Apply *Triple-Guard* grease to outer grommet surfaces.

Apply *Adhesive 847* to the bottom flange of the extension. Install a new seal.

Apply *Triple-Guard* grease to outer seal surface.



1. Adhesive 847
2. Triple-Guard grease

007179

Install extension with six screws and tighten to a torque of 18 to 20 ft lb. (24 to 27 N·m).

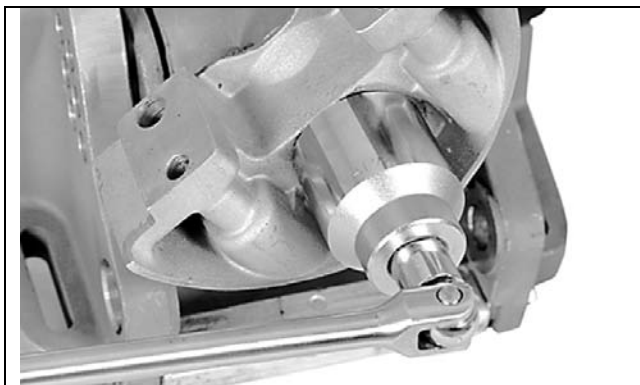
STERN BRACKET

Stern Bracket Disassembly

Before servicing the stern bracket:

- Remove gearcase. Refer to Gearcase **GEARCASE REMOVAL AND INSTALLATION** on p. 268.
- Remove powerhead. Refer to Powerhead **POWERHEAD REMOVAL** on p. 196.
- Remove exhaust housing. Refer to Exhaust Housing **Exhaust Housing Removal** on p. 242.
- Remove power trim/tilt unit. Refer to **TRIM AND TILT** section.

Remove and discard steering shaft locknut.



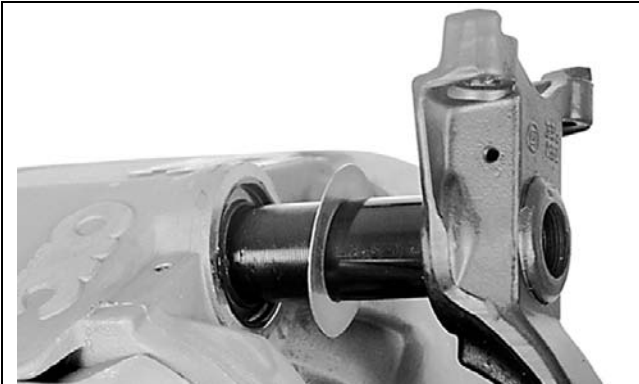
30738

Remove the lower mount bracket and keeper.



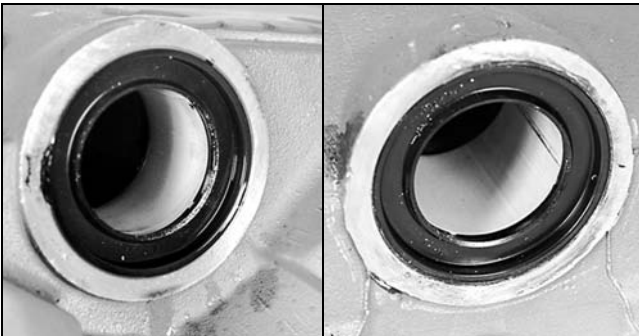
30736

Remove the steering shaft and thrust washer. It may be necessary to tap the steering shaft out using a wood dowel and mallet.



30735

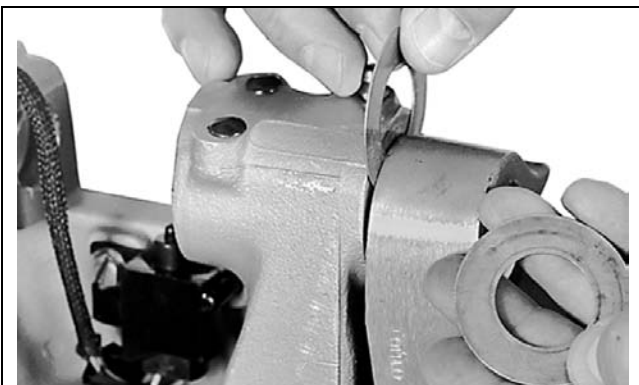
Pry out upper and lower steering shaft seals and discard. Remove the upper and lower steering shaft bushings.



30765 / 30764

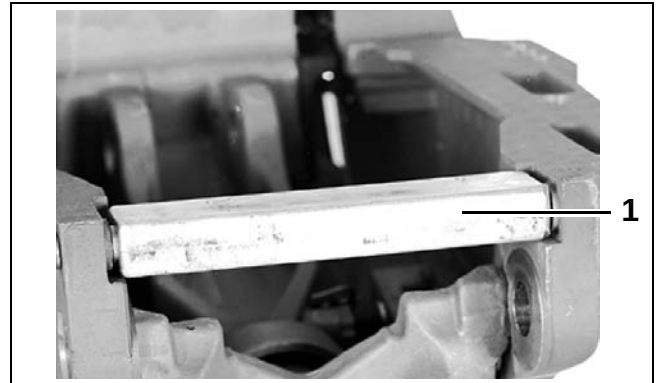
Remove the tilt tube. Refer to **TILT TUBE** on p. 240.

Remove the two tilt tube washers.



30763

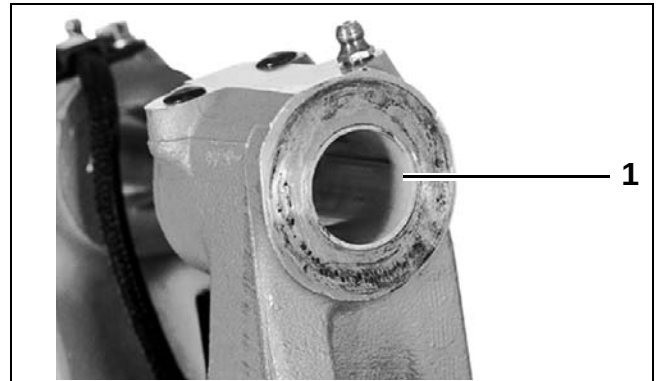
Remove the anode.



1. Anode

30762

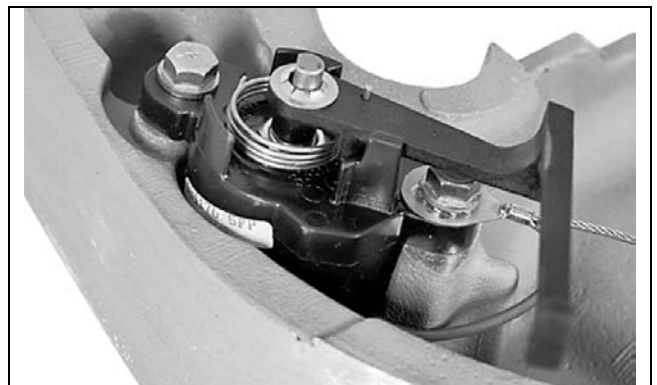
Remove the swivel bracket. Inspect and, if necessary, replace the tilt tube bushings.



1. Tilt tube bushing

30761

Remove the trim sender unit from the port stern bracket and pull its wires through the braided tube.

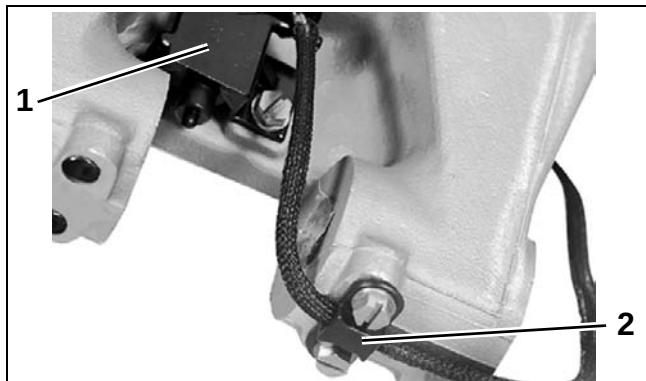


30760

MIDSECTION

STERN BRACKET

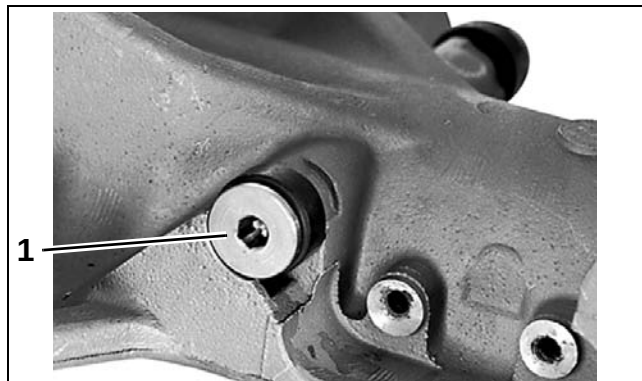
Remove the tilt limit switch and retainer from the swivel bracket.



1. Tilt limit switch
2. Retainer

30758

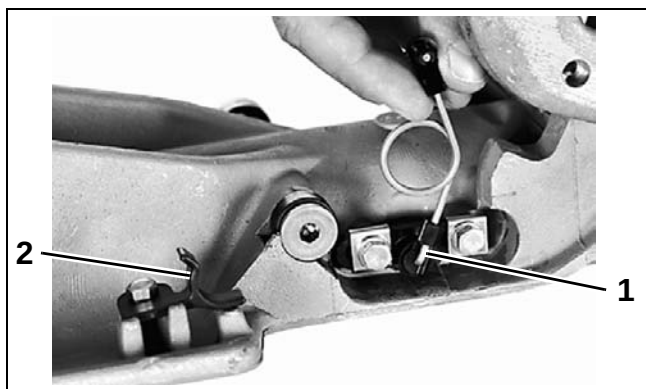
Remove the two trim rod rollers from the swivel bracket.



1. Trim rod roller

30754

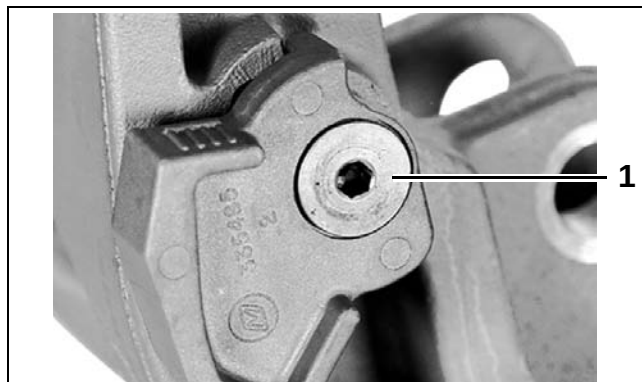
Disconnect the trail lock spring and remove it from the swivel bracket. Remove trail arm retainer.



1. Trail lock spring
2. Trail arm retainer

30756

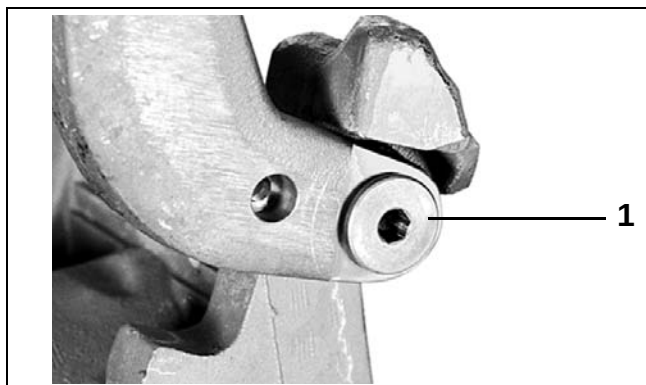
Remove the tilt support and bushing from the swivel bracket and inspect the detent roller and spring.



1. Tilt support bushing

30753

Remove the trail lock arm and bushings from the swivel bracket.



1. Trail lock bushing

30755

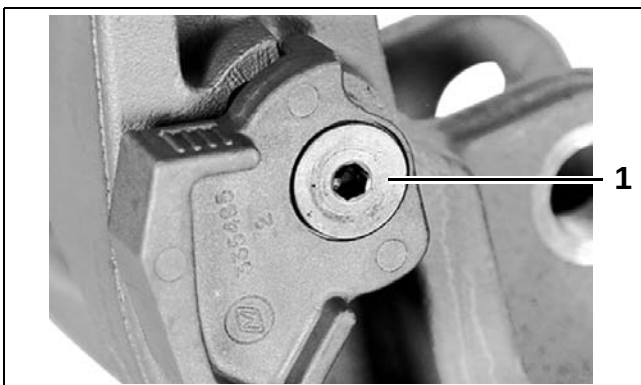
Stern Bracket Assembly

IMPORTANT: Before proceeding, make sure all components have been thoroughly cleaned. Replace any seals that have been removed. Inspect all thrust washers and bushings for evidence of deterioration.

Install the detent roller and spring and the tilt support with bushing in the swivel bracket. Tighten bushing to a torque of 28 to 30 ft. lbs. (38 to 41 N·m).



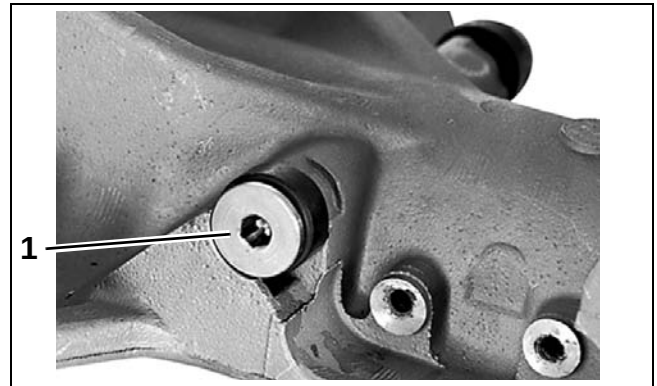
30752



1. Tilt support bushing

30753

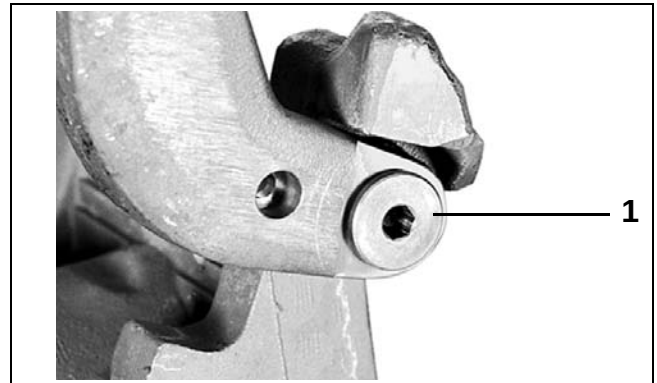
Install the two trim rod rollers on the swivel bracket. Tighten to a torque of 216 to 240 in. lbs. (25 to 27 N·m).



1. Trim rod roller

30754

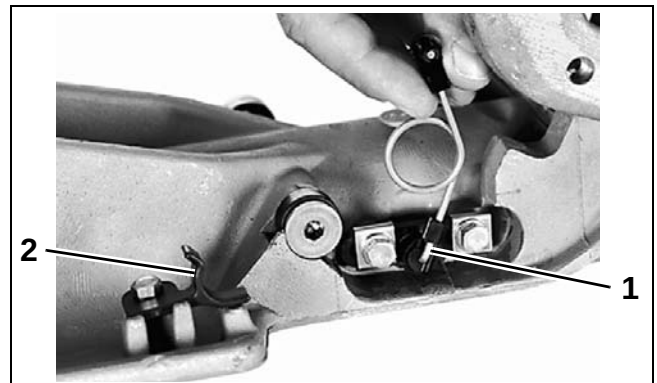
Install the trail lock and bushings in the swivel bracket. Tighten to a torque of 216 to 240 in. lbs. (25 to 27 N·m).



1. Trail lock bushing

30755

Install the trail lock spring in the swivel bracket and connect the spring to the trail lock.



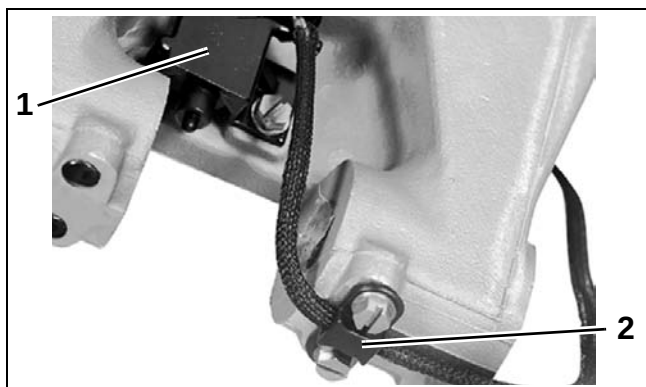
1. Trail lock spring
2. Trail arm retainer

30756

MIDSECTION

STERN BRACKET

Install the tilt limit switch and retainer on the swivel bracket. Tighten screws to a torque of 40 to 50 in. lbs. (4.5 to 5.5 N·m).



1. Tilt limit switch
2. Retainer

30758

Route the trim sender wires through the braided tube, and install the sender unit in the port stern bracket.

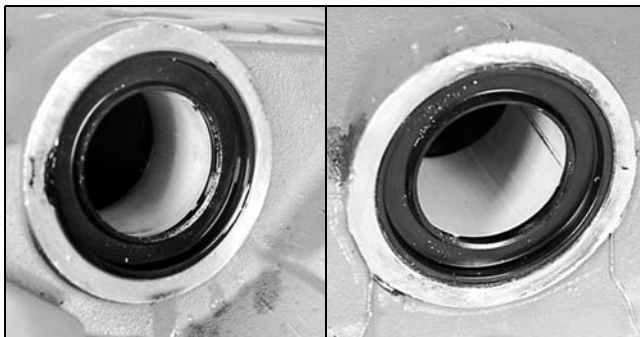


30760

Install the upper and lower steering shaft bushings and new seals in the swivel bracket. Both seal lips face out.

- Coat the outside surfaces of seals with *Gasket Sealing Compound*.

- Coat the bushings and seal lips with *Triple-Guard* grease.



30765 / 30764

Coat tilt tube bushings with *Triple-Guard* grease and, if removed, install them in the swivel bracket.

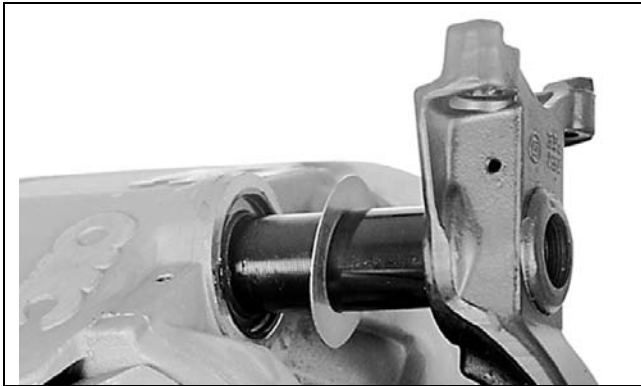


30761

Place the swivel bracket between the stern brackets and install the anode.

Install the tilt tube and tilt limit cam. Refer to **TILT TUBE** on p. 240.

Install the steering shaft and thrust washer.



30735

Install the steering shaft keeper. Apply *Locquic Primer* and *Nut Lock* to the splines of the steering shaft and lower mount bracket.



30736

Install the lower mount bracket and a new locking nut with its unstaked side facing the mount bracket. Align the bracket with the steering arm

and tighten the nut to a torque of 130 to 150 ft. lbs. (176 to 204 N·m).



30767

Fill the swivel bracket with *Triple-Guard* grease through the grease fitting on the bracket's port side. Lubricate the tilt tube, swivel bracket, and stern brackets through the two forward grease fittings.

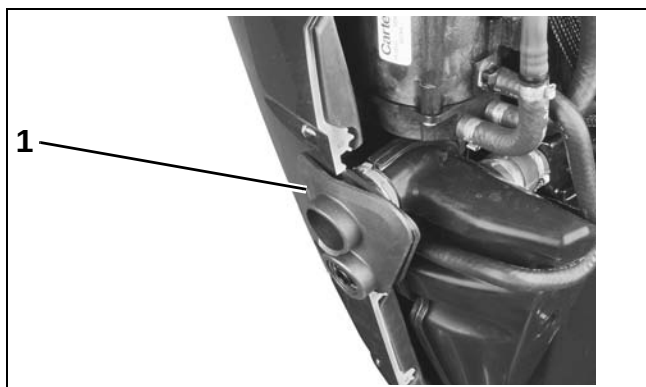
Install the exhaust housing. Refer to **Exhaust Housing Installation** on p. 243.

MIDSECTION

EXHAUST RELIEF MUFFLER ASSEMBLY

EXHAUST RELIEF MUFFLER ASSEMBLY

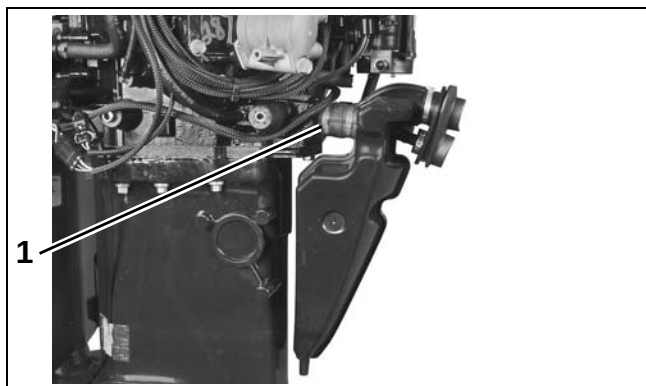
The exhaust relief muffler is located at the rear of the powerhead and concealed by the lower motor covers. The exhaust relief grommet connects directly to the muffler assembly.



1. Exhaust relief grommet

005220

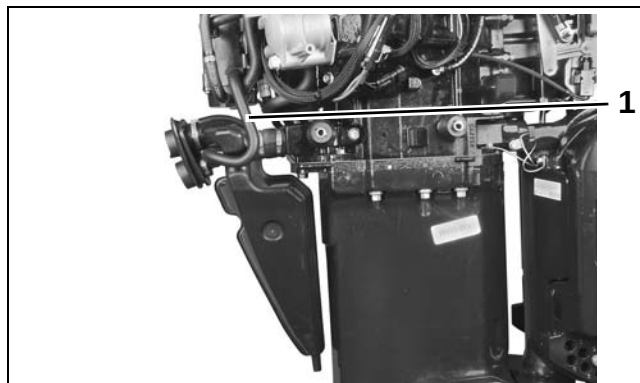
The muffler assembly connects to the exhaust relief hoses at the base of the powerhead.



1. Exhaust relief hoses

005221

The overboard indicator and flush port in the exhaust relief grommet connect to the vapor separator with a hose. This hose is not connected to the muffler assembly.



1. Overboard indicator hose

005222

Periodically inspect hoses and connections for condition. Replace muffler or hoses as needed.

GEARCASE

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GEARCASE

GEARCASE – COUNTER ROTATION

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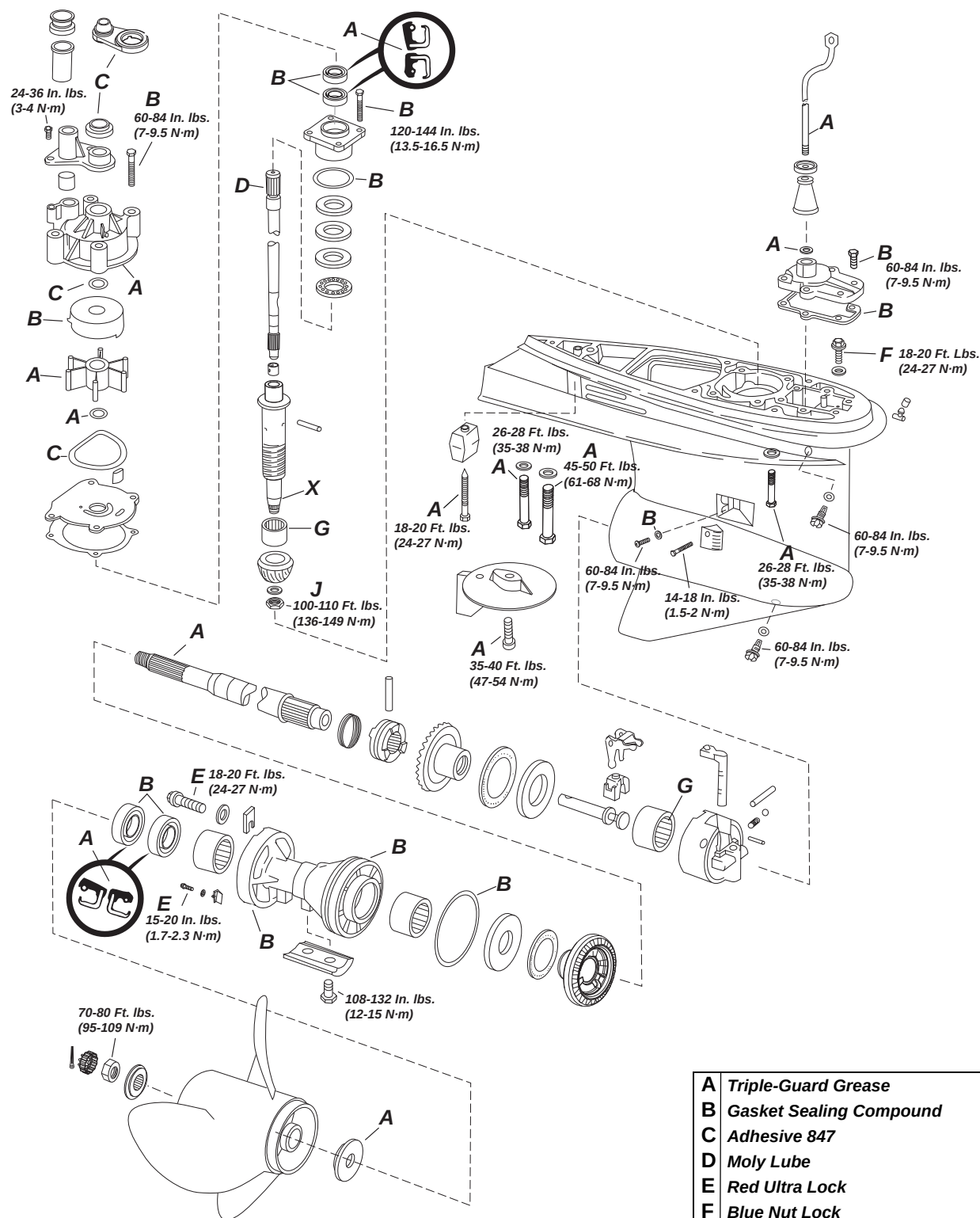
"S2"-TYPE GEARCASE



GEARCASE SERVICE CHARTS

V6 20 IN. AND V4 25 IN. STANDARD ROTATION

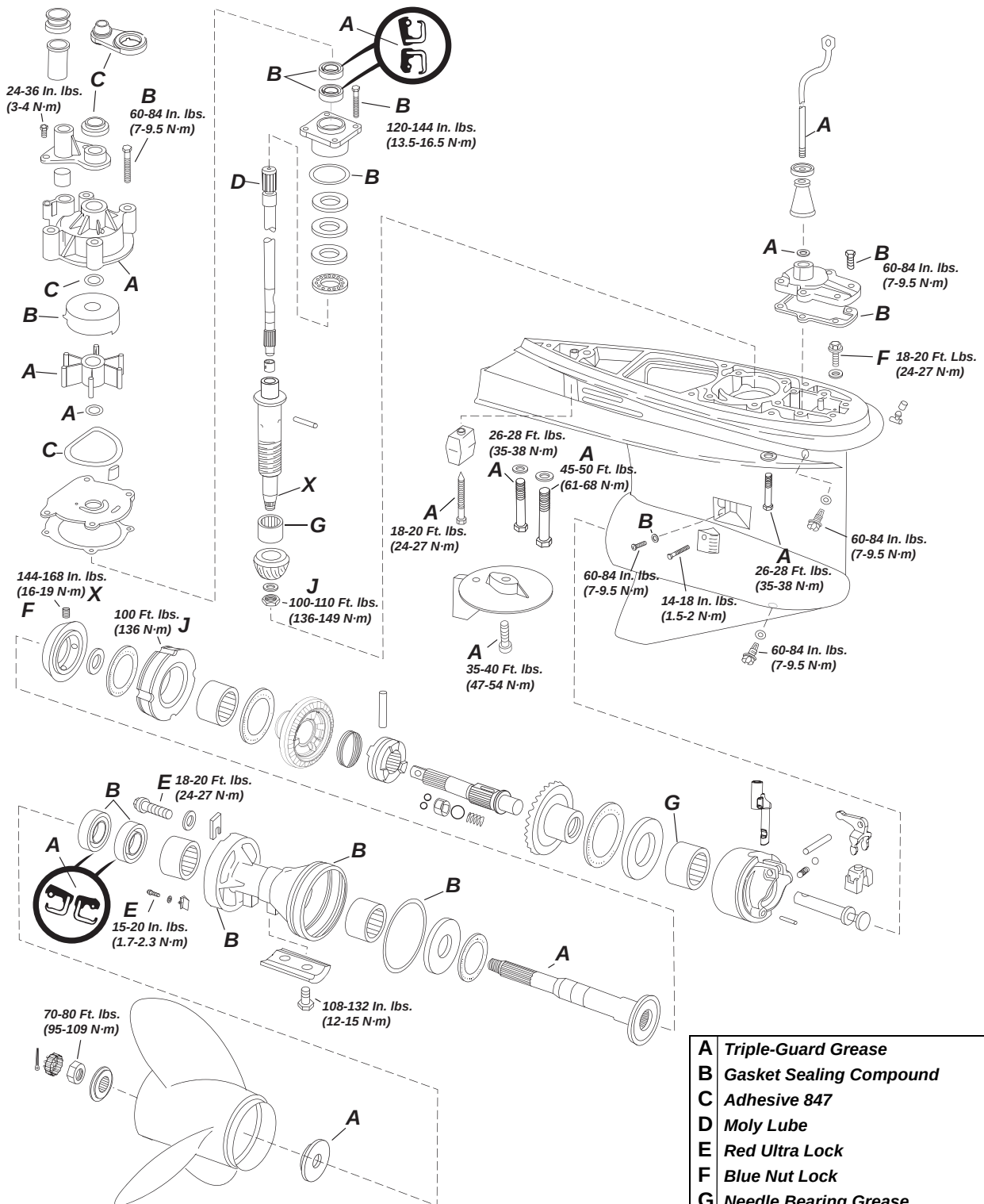
“O”-TYPE GEARCASE



006592

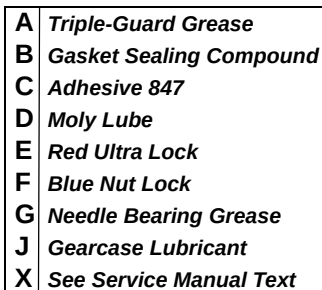
V4 25 IN. COUNTER ROTATION

"O"-TYPE GEARCASE



006593

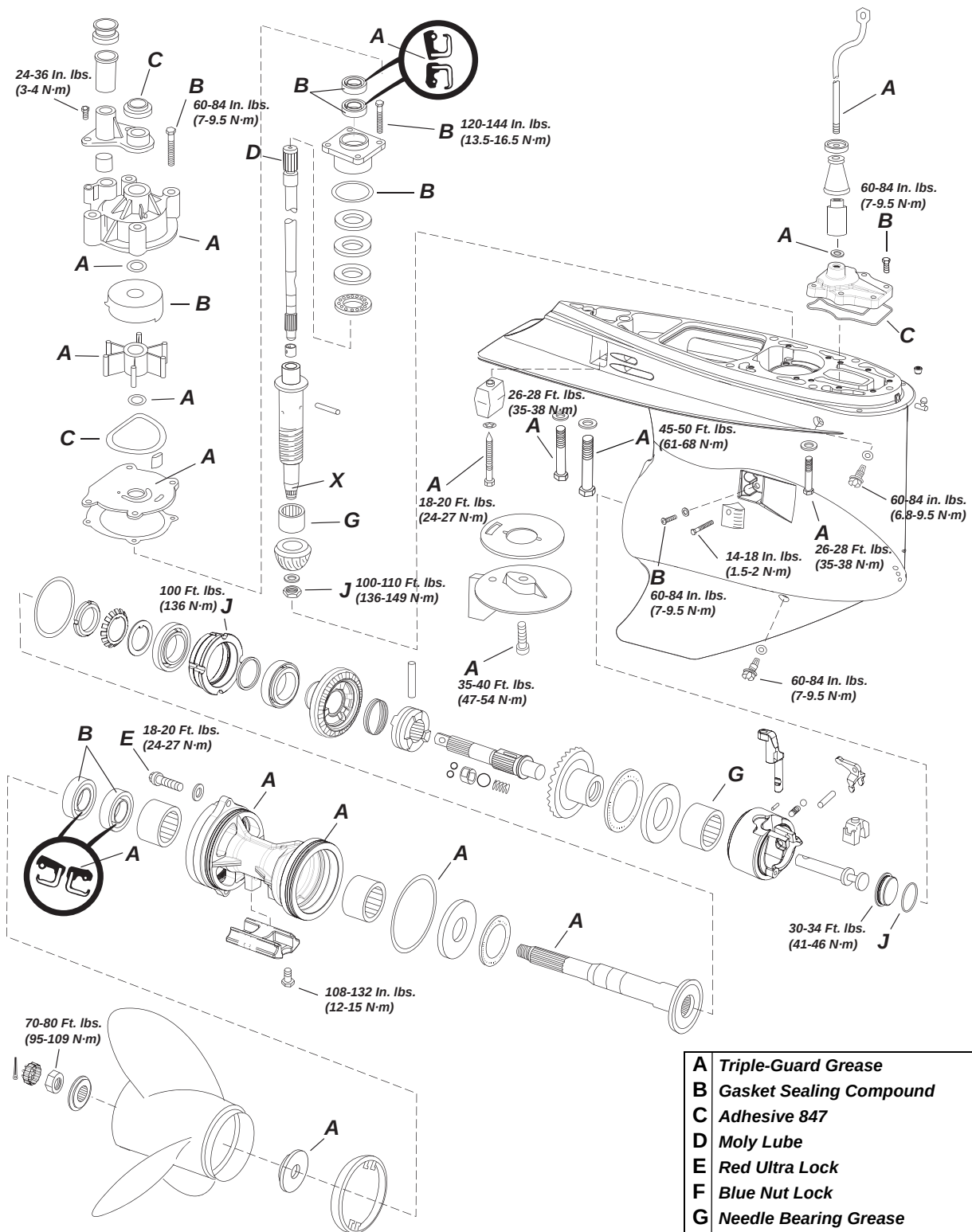
"M2"-TYPE GEARCASE



260

V6 COUNTER ROTATION

“M2”-TYPE GEARCASE

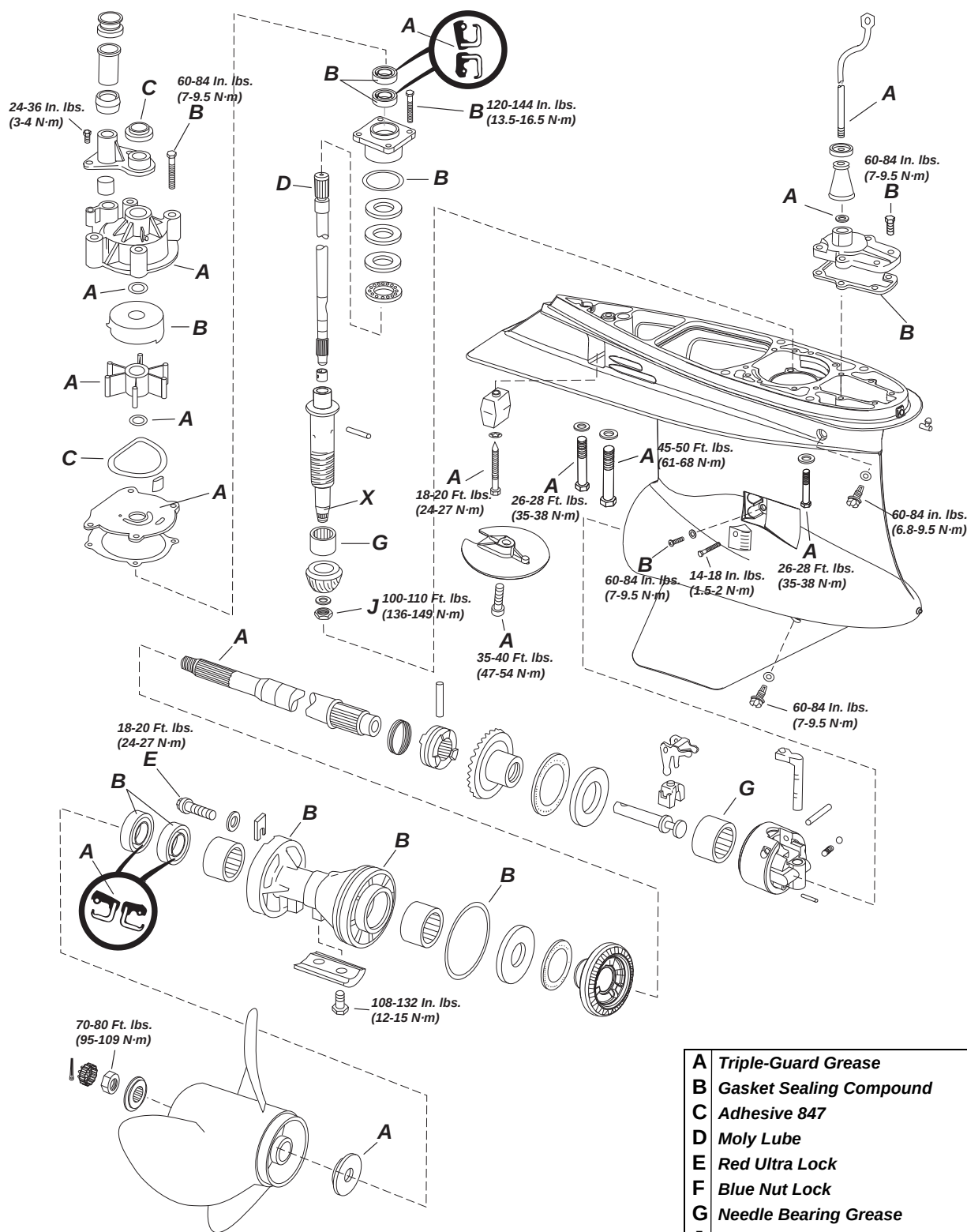


006831

GEARCASE SERVICE CHARTS

V6 PERFORMANCE MODELS

“L2”-TYPE GEARCASE



- | | |
|----------|-------------------------|
| A | Triple-Guard Grease |
| B | Gasket Sealing Compound |
| C | Adhesive 847 |
| D | Moly Lube |
| E | Red Ultra Lock |
| F | Blue Nut Lock |
| G | Needle Bearing Grease |
| J | Gearcase Lubricant |
| X | See Service Manual Text |

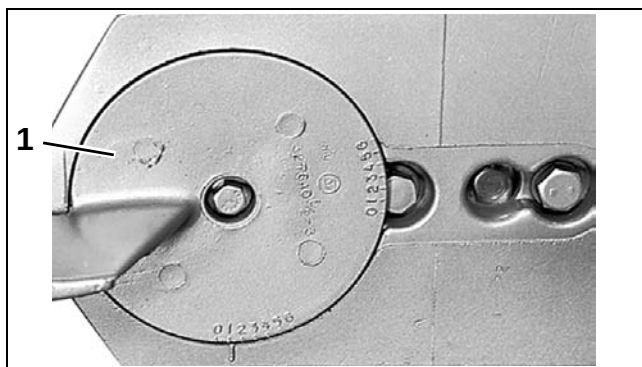
006829

GEARCASE TYPES

Outboard Model	Housing Type*	Description of Features	Gear Ratio
V4 20 in.	"S2"	unique driveshaft with bolted pinion, oversized gearset	13:26 (.500)
V4 25 in.	"O"	special gear ratio, uses V6 style prop	12:27 (.444)
V4 25 in. Counter Rotation		special gear ratio, uses V6 style prop	12:27 (.444)
60°V6 20 in.		standard gearset (V6)	14:26 (.538)
60°V6 20 in.	"L2"	high speed profile, external water screens, pressed in propeller bearing housing, performance gearset (V6).	14:26 (.538)
60°V6 25 in.	"M2"	front water inlets and straight leading edge, pressed in propeller shaft bearing housing with retaining flange, heavy duty standard gearset (V6)	13:24 (.542)
60°V6 25 in. Counter Rotation		front water inlets and straight leading edge, pressed in propeller shaft bearing housing with retaining flange "CR" shafts, bearings and heavy duty gearset (V6)	13:24 (.542)

Housing Identification

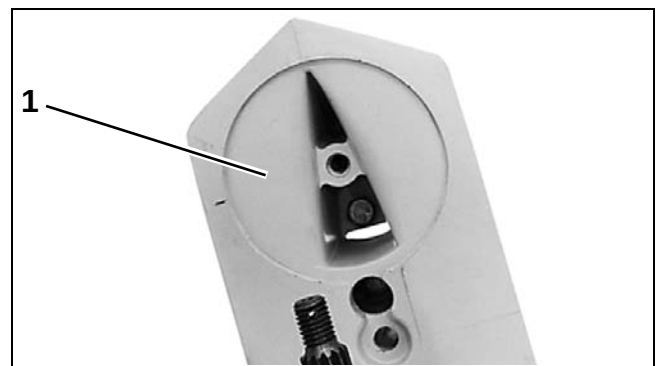
Remove the trim tab retaining screw, gasket and trim tab from the gearcase.



1. Trim tab

COA3663

Housing Profiles on p. 264.



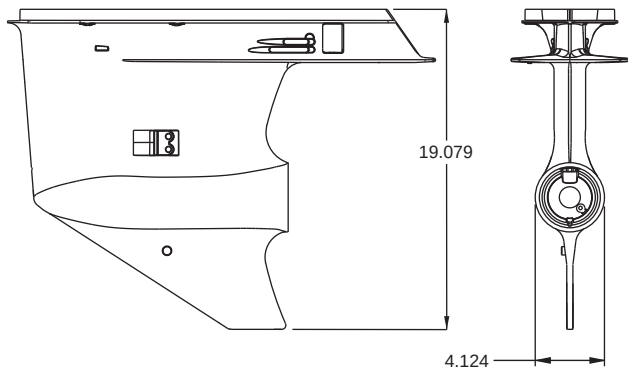
1. Identification markings

COA3139

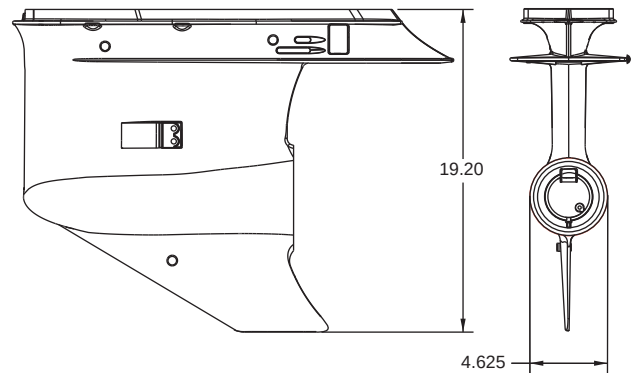
Make note of identification markings. Refer to

Housing Profiles

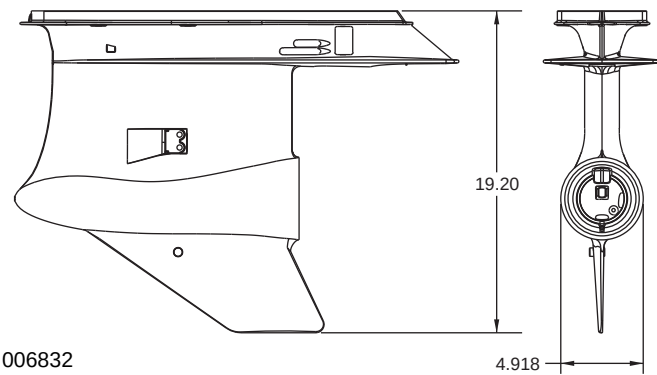
V4 “S2” Type



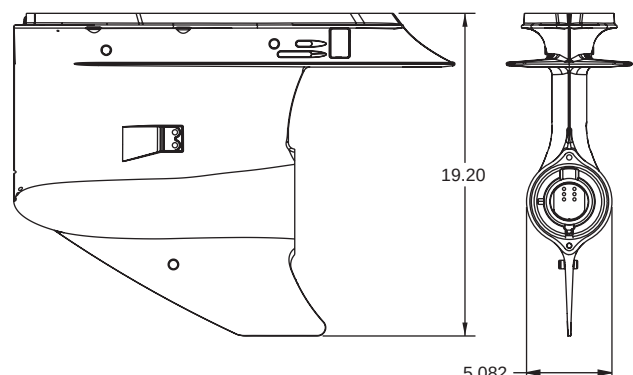
V4, V6 “O” Type



V6 “L2” Type



V6 “M2” Type



006832

PROPELLER SERVICE

Inspection

Carefully examine propeller and outboard for the following:

- Damaged blades and signs of propeller cavitation (burned paint, etc.)
- Spun or overheated inner hub
- Worn or twisted splines and inadequate lubricant
- Damaged or missing converging ring (if applicable)
- Damage to outer hub area
- Worn, missing, or incorrect thrust washer and spacer
- Correct size and style
- Check for bent or damaged propeller shaft and twisted splines.

Refer to **Propeller Hardware Installation** on p. 266.



WARNING

When servicing the propeller, always shift the outboard to **NEUTRAL**, turn the key switch **OFF**, and disconnect the battery positive (+) cable so the outboard cannot be started accidentally.

Propeller Selection

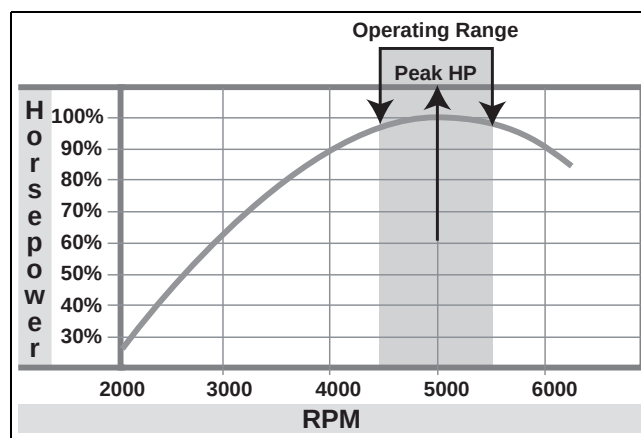


CAUTION

Selection of the wrong propeller could reduce engine service life, affect boat performance, or cause serious damage to the powerhead.

Water testing with various propeller designs and sizes is the best method of propeller selection.

The correct propeller, under normal load conditions, will allow the engine to run near the mid-point of the RPM operating range at full throttle. Refer to **SERVICE SPECIFICATIONS** on p. 10.



008329

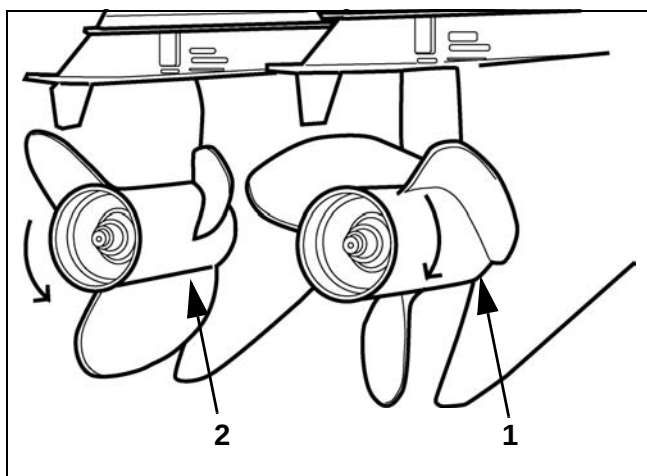
NOTICE If the propeller blades have too much pitch, the engine will operate below its normal range at full throttle. Power will be lost, and powerhead damage could occur. If the propeller blades have too little pitch, the engine will operate above its normal range and damage from overspeeding could occur.

GEARCASE

PROPELLER SERVICE

When selecting a propeller, consider the following:

- Use an accurate tachometer to determine the engine's full-throttle RPM.
- The outboard should be trimmed for top speed.
- Select a propeller that suits the customer's application and allows the engine to run near the midpoint of the full-throttle operating range when the boat has a normal load.
- Occasionally, one propeller will not cover a wide range of boat applications — water skiing to high speed performance boating. In such cases, it might be necessary to have a propeller for each situation.
- Refer to the *Evinrude/Johnson Genuine Parts and Accessories Catalog* for propeller styles and sizes.
- Right-hand propellers are considered standard rotation propellers. When propelling a boat forward, the propeller rotates in a right-hand (clockwise) direction as viewed from the rear.
- Left-hand propellers are considered counter-rotation propellers. When propelling a boat forward, the propeller rotates in a left-hand (counterclockwise) direction as viewed from the rear.



1. Right-hand rotation (clockwise)
2. Left-hand rotation (counterclockwise)

000033

WARNING

For dual-outboard installations, always check to be sure propellers are installed on the correct engines before aggressively operating the boat.

Propeller Hardware Installation

WARNING

To prevent accidental starting while servicing, twist and remove all spark plug leads.

IMPORTANT: Depending on propeller style, different thrust bushings, spacers, and cotter pin keepers are used. See the *Evinrude/Johnson Genuine Parts and Accessories Catalog* for correct propeller hardware.

Apply *Triple Guard* grease to the entire propeller shaft before installing the propeller.

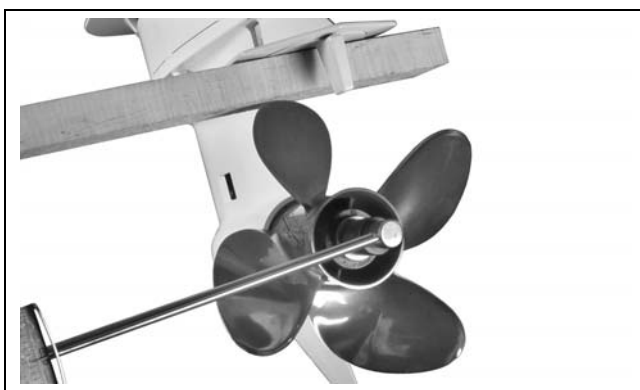
Install thrust bushing onto propeller shaft with taper of bushing matching taper of shaft.

If installing a propeller with an interchangeable hub, assemble the propeller following instructions provided with the propeller.

Align splines of propeller and shaft. Push propeller until seated on the thrust bushing.

Install the spacer over the propeller shaft splines.

Wedge a block of wood between propeller blade and the anti-ventilation plate.



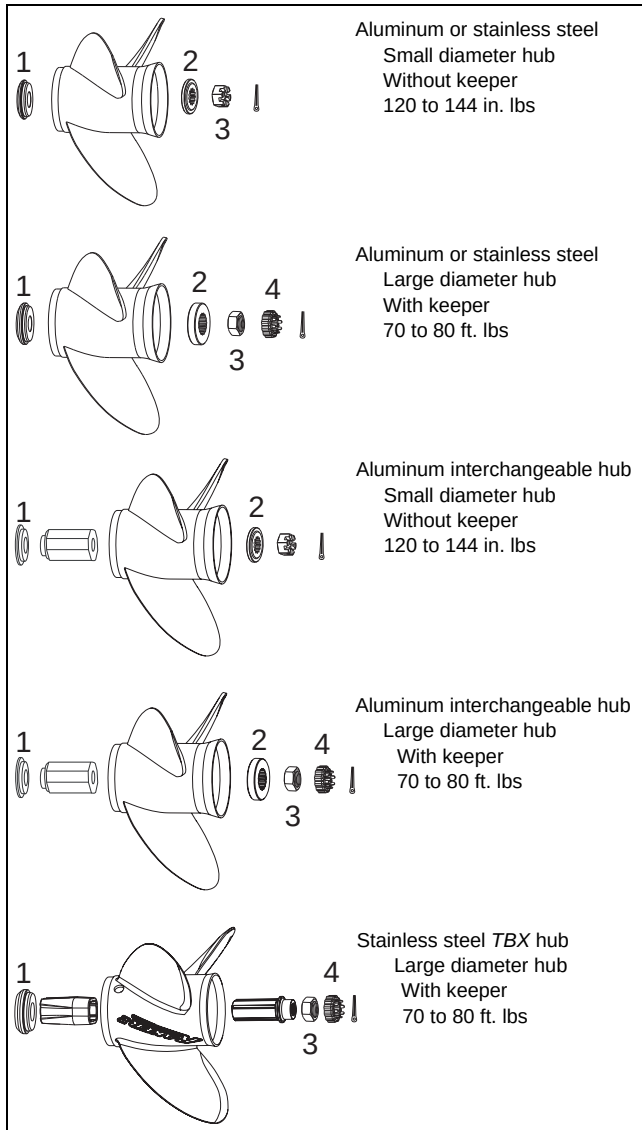
001992

Install the propeller nut and tighten to a torque of:

- With Keeper – 70 to 80 ft. lbs. (95 to 109 N·m)
- Without Keeper – 120 to 144 in. lbs. (13.6 to 16.3 N·m)

If cotter pin holes in the nut (without keeper) and shaft do not align, tighten further. Do not loosen.

Install keeper (if applicable). Install new cotter pin.



1. Thrust bushing
2. Spacer
3. Propeller nut
4. Keeper

008057

IMPORTANT: After installation, make sure outboard is in NEUTRAL and carefully spin propeller. Propeller must turn freely and should not spin off center. If propeller appears to wobble, check for possible bent propeller shaft.

GEARCASE LEAK TEST

Drain lubricant before testing.

Use Gearcase Pressure Tester, P/N 507977. Install lubricant drain/fill plug and seal, thread pressure test gauge fitting and seal in lubricant level hole.

Pressurize 3 to 6 psi (21 to 42 kPa).

If pressure gauge indicates leakage, submerge the gearcase in water to determine source of leak.

If the gauge does not indicate leakage, increase pressure to 16 to 18 psi (110 to 124 kPa). Check for leaks.

Make necessary repairs and repeat test.

Install Gearcase Vacuum Tester, P/N 507982. Apply 3 to 5 in. of vacuum (76 to 127 mm) Hg. with pump.

If vacuum gauge indicates leakage, apply oil around suspected seal. If leak stops or oil is drawn in, seal is defective.

Repeat test, gearcase must hold minimum of 15 in. vacuum (381 mm) Hg.



002388

GEARCASE REMOVAL AND INSTALLATION

Gearcase Removal

WARNING

To prevent accidental starting while servicing, twist and remove all spark plug leads.

During service, the outboard may drop unexpectedly. Avoid personal injury; always support the outboard's weight with a suitable hoist or the tilt support bracket during service.

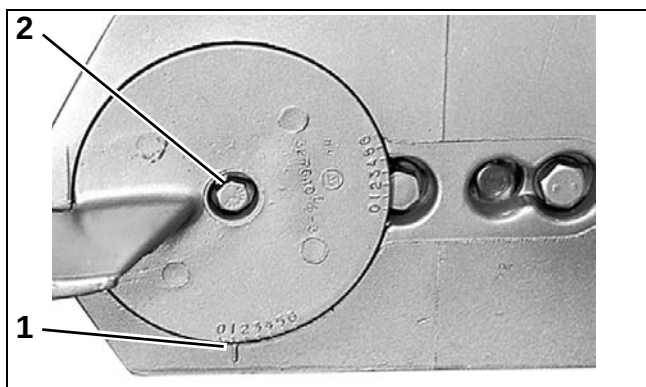
Remove pin and washer from shift rod lever to release the lower shift rod.



1. Shift rod screw

004241

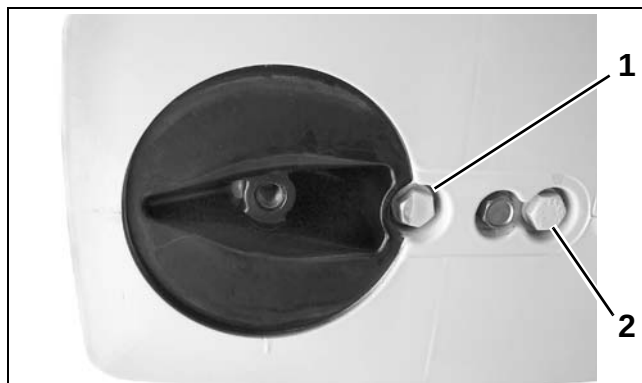
Note where the index mark on the gearcase aligns with the index number of the adjustable trim tab so the trim tab can be installed in the same position. Remove the trim tab retaining screw, gasket and trim tab from the gearcase.



1. Index mark
2. Trim tab retaining screw

COA3663

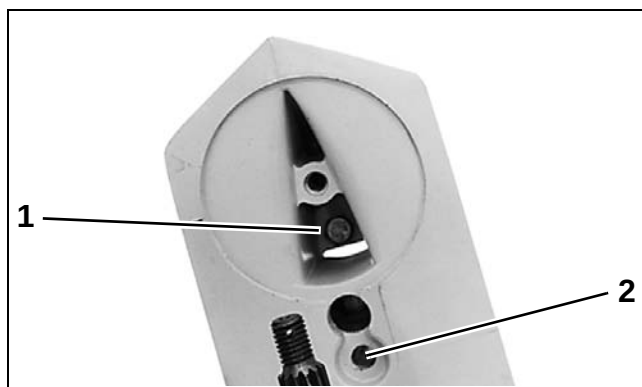
Remove the 3/8-16 in. screw and washer, and remove 7/16-14 x 3.5 in. screw and washer.



O, L, & M Type Gearcases

1. 3/8-16 x 3.5 in. screw
2. 7/16-14 x 3.5 in. screw

006869

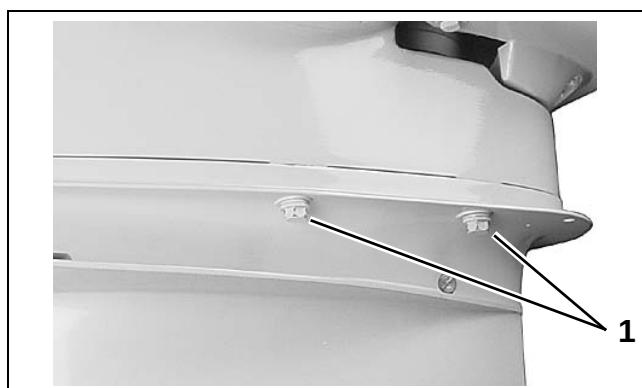


S Type Gearcases

1. 3/8-16 x 1.75 in. screw
2. 7/16-14 x 3.5 in. screw

COA3139

Remove the four 3/8-16 x 1.75 in. gearcase retaining screws and washers.



1. Gearcase retaining screws

001990

Remove the gearcase assembly from the exhaust housing, being careful not to bend the shift rod.

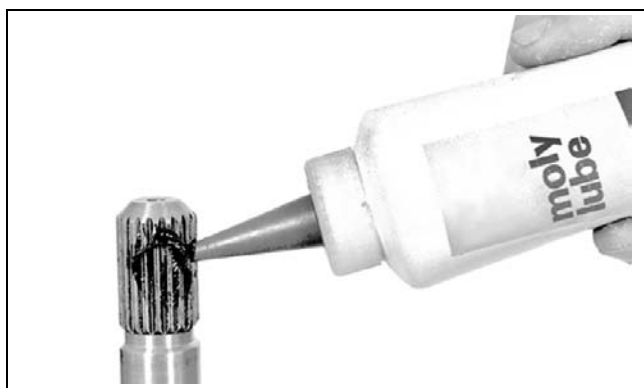
Gearcase Installation

WARNING

During service, the outboard may drop unexpectedly. Avoid personal injury; always support the outboard's weight with a suitable hoist or the tilt support bracket during service.

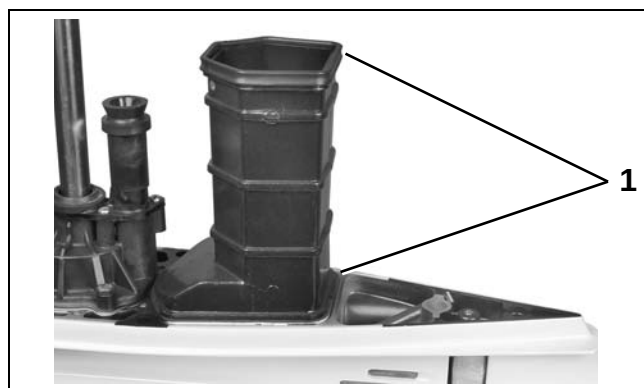
NOTICE Before installing gearcase, shift rod adjustment **MUST** be checked. Refer to **SHIFT ROD ADJUSTMENT** on p. 274.

Coat the driveshaft splines with *Moly Lube*. DO NOT coat top surface of the driveshaft because lubricant may prevent seating of the driveshaft in the crankshaft.



30385

Apply *Adhesive 847* to the lower exhaust housing seals' inner surfaces. Place two new seals on the housing. Apply *Triple-Guard* grease to the seals' outer surfaces and place the housing on the gearcase.



1. Lower exhaust seals

001985

Slide the gearcase into place, making sure:

- Driveshaft engages the crankshaft.
- Water tube enters the water pump.
- Lower inner exhaust housing installs correctly.
- Shift rod does not turn and is positioned properly in the shift rod lever below the crankcase.

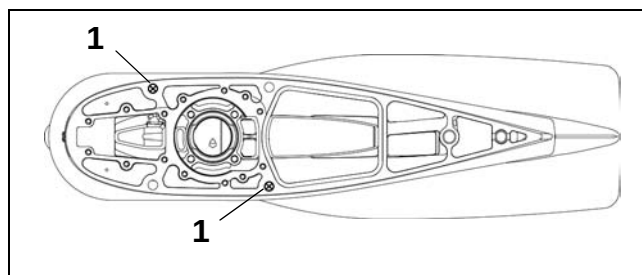
Some outboard models include hollow alignment pins between the exhaust housing and gearcase.

If outboard is not equipped with alignment pins, use Gearcase Alignment Kit, P/N 5007231, to accurately align gearcase housing to exhaust housing. Position alignment bolts (2) as indicated.



Alignment Bolt(s)

005401



1. Position of alignment bolts (2)

005402

IMPORTANT: Replace alignment bolts with mounting screws after all other gearcase mounting screws are installed.

WARNING

Failure to properly tighten gearcase screws with a torque wrench could lead to gearcase damage or loss, resulting in loss of control and possible personal injury.

Screw torque should be checked regularly, especially in high-speed applications, or any time propeller damage has occurred.

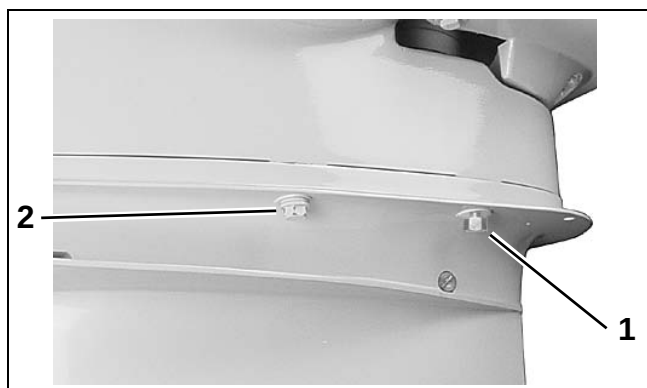
GEARCASE

GEARCASE REMOVAL AND INSTALLATION

IMPORTANT: New gearcase screws are treated with a thread-locking material. Apply *Triple-Guard* grease to threads to ensure that the correct clamping force is achieved when tightening—If a previously installed screw is re-used, use a wire brush to remove any old thread-locking material or corrosion and lubricate threads with *Triple-Guard* grease.

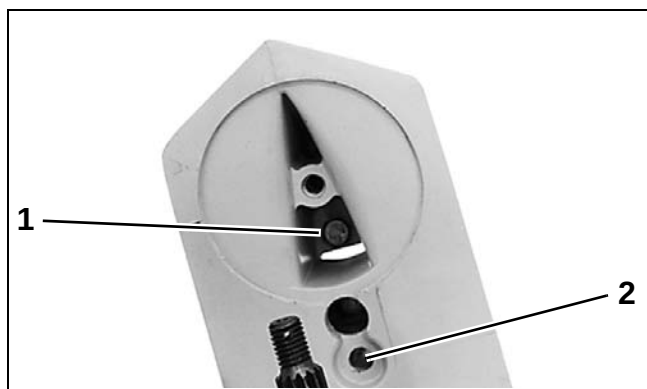
Install screws and washers and tighten to a torque of:

- **3/8 in.** screws – 26 to 28 ft. lbs. (35 to 38 N·m)
- **7/16 in.** screws – 45 to 50 ft. lbs. (61 to 68 N·m)



1. Alignment screw
2. 3/8-16 x 1.75 in. screw

005403

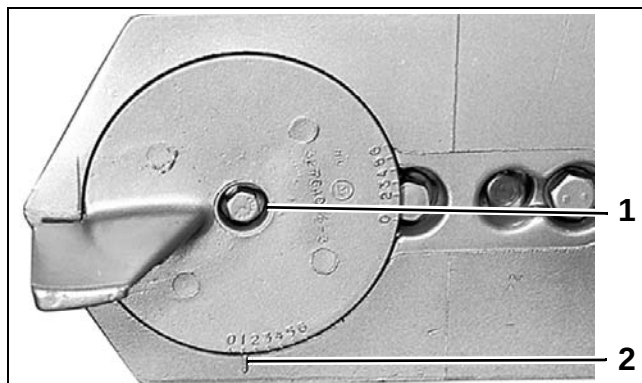


1. 3/8 in screw
2. 7/16 in. screw

COA3139

Apply *Triple-Guard* grease to threads of the trim tab screw. Install gasket on “M2”-type gearcases. Install and align the trim tab (cover on “L2”-type) with the index marks noted prior to disassembly. Tighten the trim tab screw to a torque of 35 to 40

ft. lbs. (47 to 54 N·m). For adjustment, refer to **Trim Tab Adjustment** on p. 29.

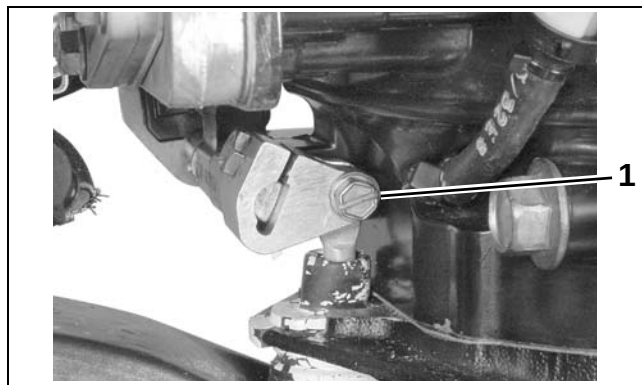


1. Trim tab screw
2. Index mark

COA3663

NOTICE Standard rotation and counter rotation trim tabs must not be interchanged. This would result in inadequate cooling water supply to the propeller hub.

Place the shift rod in the shift rod lever. Install the retaining pin and washer. Tighten pin to a torque of 60 to 84 in. lbs. (7 to 9.5 N·m).



1. Shift rod screw

004241



WARNING

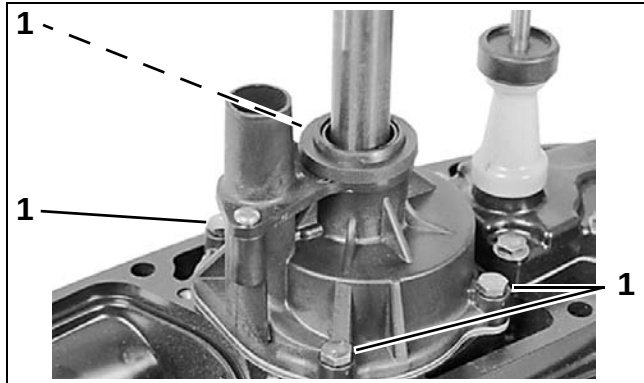
To prevent loss of operator control, check for proper shifting operation and adjust, if necessary.

IMPORTANT: During break-in period of a reassembled gearcase, change the gearcase lubricant between 10 to 20 hours of operation.

WATER PUMP SERVICE

Disassembly

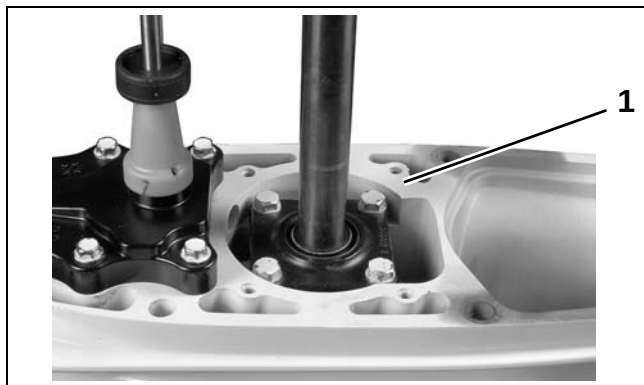
Rotate the driveshaft counterclockwise to unlock the impeller key. Remove the four impeller housing screws.



1. Screws

31998

Slide the water pump off the driveshaft. Remove the impeller key, O-ring, impeller plate, and gasket. Discard the gasket.



1. Gasket surface

006876

Remove all the parts from the housing.

Inspection

Check impeller for overheating, hub separation, and other wear or damage.

Check liner and wear plate for scoring, distortion, and impeller material transfer.

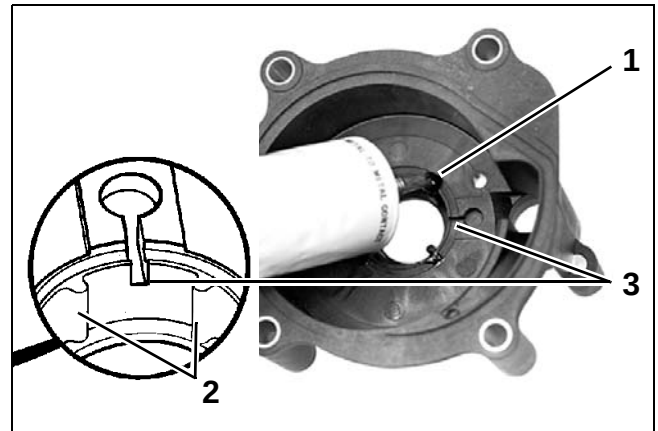
Inspect the housing for cracks or melting.

Make sure gasket surface is clean and smooth.

Assembly

Apply a drop of *Adhesive 847* in the seal ring groove at each of the four ribs.

IMPORTANT: Do not allow any sealer to get into the air bleed groove in the impeller housing. If this groove is blocked by adhesive, the pump will lose its prime and will not pump water.



1. Seal ring groove

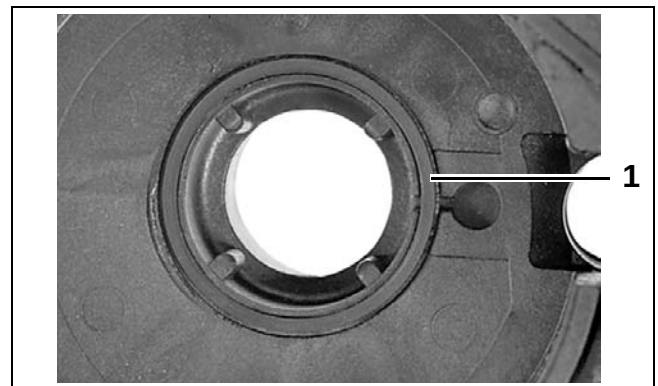
2. Ribs

3. Air bleed groove

2311

DR1185

Install the O-ring in groove in the impeller housing.



1. O-ring

34814

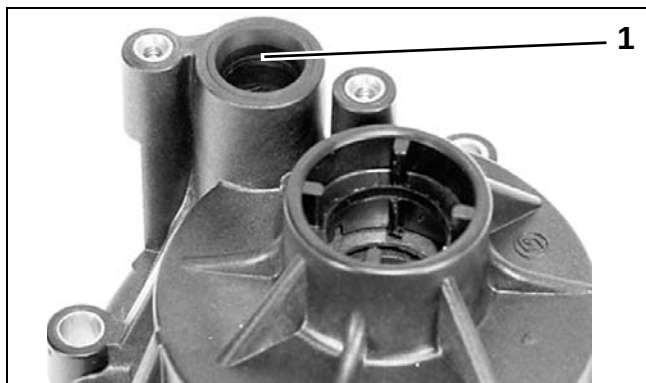
Lightly coat the exterior rim of the impeller cup with *Gasket Sealing Compound*. Install the cup in the impeller housing. The cup locks in place in the housing with a square index tab.

Make sure vent hole in impeller cup is open.

GEARCASE

WATER PUMP SERVICE

On V6 models, install the water tube grommet with the inside taper facing up.

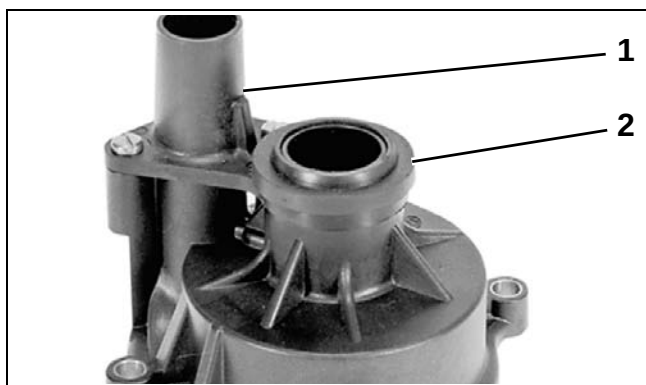


1. Water tube grommet

32000

On V6 models, apply *Triple-Guard* grease to screw threads and install the impeller housing cover. Tighten screws to a torque of 24 to 36 in. lbs. (3 to 4 N·m).

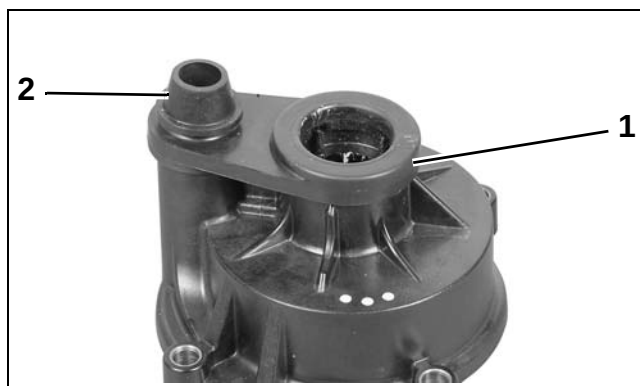
On all models, apply *Adhesive 847* to flat side of the impeller housing grommet. Install the grommet, flat side down. Apply *Triple-Guard* grease to the outer surface of the water tube grommet on V4 models.



V6 models

1. Impeller housing cover
2. Impeller housing grommet

32001



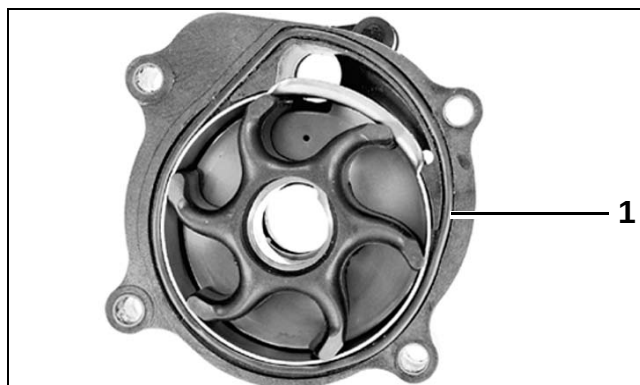
V4models

1. Impeller housing grommet
2. Triple-Guard grease

32001

Lightly coat the inside of the liner with *Triple-Guard* grease. With a counterclockwise rotation, install the impeller into the liner with the slot for the impeller key facing out.

Apply a thin bead of *Adhesive 847* in the seal groove, and install the special shaped O-ring seal.

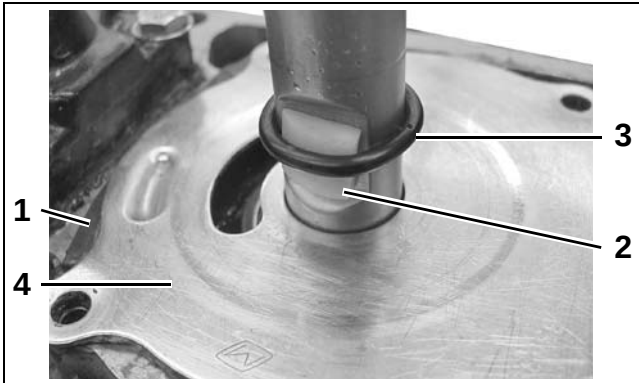


1. O-ring

34815

Apply *Gasket Sealing Compound* to both sides of a new impeller plate gasket. Install the gasket and impeller plate.

Apply *Triple-Guard* grease to a new impeller O-ring. Slide the O-ring down the driveshaft and half way over installed impeller key to temporarily hold key in place.

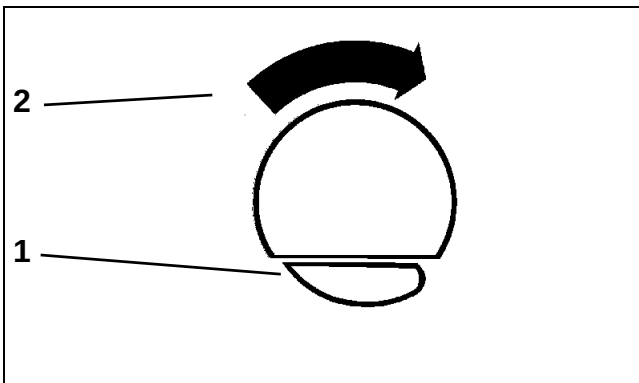


1. Impeller plate gasket
2. Impeller plate
3. O-ring
4. Drive key

DSC02326

The sharp edge of the key is the leading edge in clockwise rotation.

Slide the water pump down the driveshaft. Align impeller slot with the impeller key. Rotate the driveshaft to engage the key with the impeller, and slide water pump down over key. Be sure impeller key does not fall out of position.



1. Sharp edge of drive key
2. Direction of driveshaft rotation

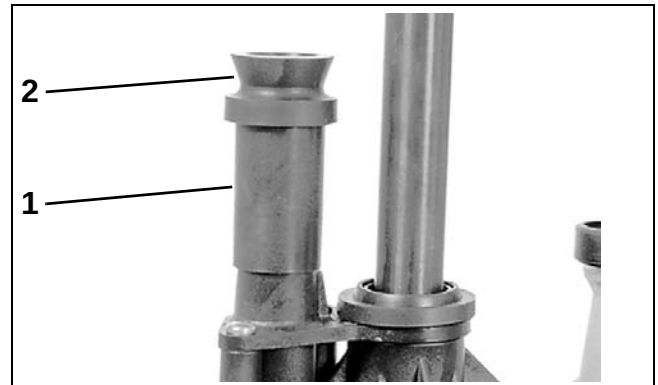
CO2995

NOTICE Make sure the impeller engages the impeller key. Serious powerhead damage will result if impeller key is not in place.

Align the impeller housing with the gearcase. Apply *Gasket Sealing Compound* to threads of the four impeller housing screws. Install the screws

and tighten to a torque of 60 to 84 in. lbs. (7 to 9.5 N·m).

On 25 in. and 30 in. V6 models, place the appropriate water tube spacer and grommet on the impeller housing cover.

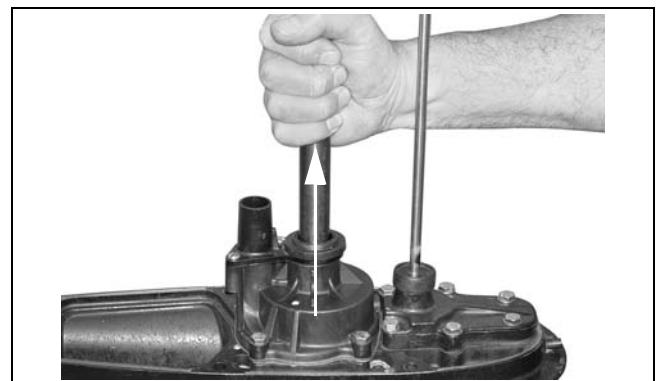


1. Spacer
2. Grommet

32728

After water pump is assembled completely, rotate driveshaft counter clockwise 1/4 turn to unlock and release impeller and key from driveshaft.

Next, pull up on driveshaft and turn clockwise to lock impeller to shaft. This process increases pump efficiency by locking the impeller lower on the driveshaft.



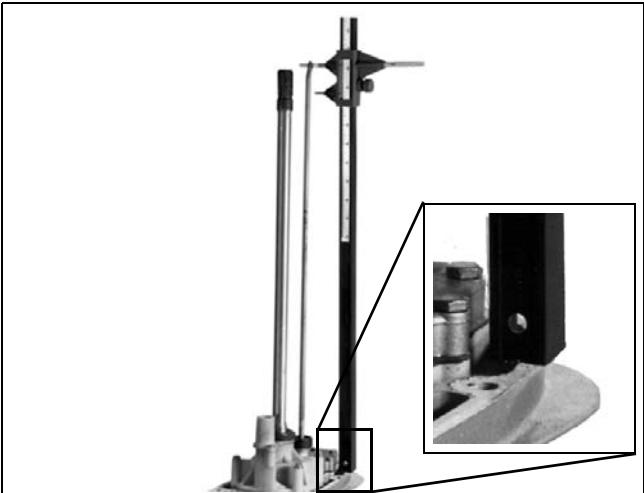
007078

NOTICE Before installing gearcase, shift rod adjustment **MUST** be checked. Refer to **SHIFT ROD ADJUSTMENT** on p. 274.

SHIFT ROD

ADJUSTMENT

Check the shift rod height from the shift rod hole to the surface of the gearcase using Universal Shift Rod Height Gauge, P/N 389997.



COA6166

With the gearcase in NEUTRAL, rotate the shift rod up or down as necessary for correct adjustment. Once correct height is achieved, rotate rod one half turn or less to direct offset forward.

IMPORTANT: The NEUTRAL detent is a two-step design. Make sure the NEUTRAL detent ball is in the center step before checking shift rod height.

Shift Rod Heights

Model	Type	Height
20 in. (L)	"S2"	20 15/16 in. (20.945 in./ 532 mm) ± 1/2 Half Turn
	"L2"	
	"O"	
25 in. (X)	"O"	25 15/16 in. (25.945 in./ 659 mm) ± 1/2 Turn
	"M2"	

GEARCASE DISASSEMBLY

Pre-Disassembly Inspection



WARNING

Wear safety glasses to avoid personal injury, and set compressed air pressure to less than 25 psi (172 kPa).

IMPORTANT: Clean and inspect all parts during disassembly. Replace any damaged parts, seals, O-rings, and gaskets.

Remove the propeller and mounting hardware.

Drain and inspect oil as described in **Gearcase Lubricant** on p. 36.

Remove gearcase as described in **GEARCASE REMOVAL AND INSTALLATION** on p. 268.

Remove water pump as described in **WATER PUMP SERVICE** on p. 271.

Before disassembling the gearcase, examine the following:

- **Gearcase Housing** — Check for visible damage to skag, strut, anti-ventilation plate, bullet, and mating surface. Check seal areas for visible signs of lubricant leakage.
- **Propeller Shaft** — Check for bent or damaged shaft. Check for twisted splines and damaged threads.
- **Shift Rod** — Check for misadjusted, bent, or binding rod. A misadjusted shift rod height can cause shift difficulty, loss of boat and outboard control, and gearcase damage.

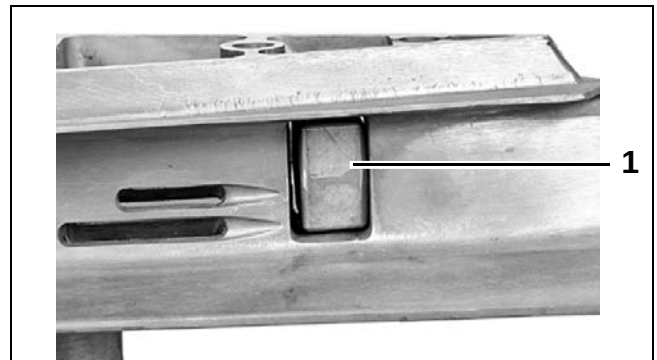
- **Hydrostatic Seal Grooves** — Must be in good condition to help prevent propeller ventilation.



1. Hydrostatic seal grooves

4557

- **Gearcase Anodes** — If anodes have eroded to two-thirds their original size, they must be replaced.



1. Gearcase anode

14161

- **Drive Shaft** — Check splines for visible damage, twisting and wear. Severe spline wear indicates the exhaust housing or gearcase has been distorted, possibly by impact damage.
- **Water Intake Screens** — Check for damage and blockage. If screens cannot be cleaned, they must be replaced. Different screens are available and should not be mixed. Refer to correct model parts manual for listing and description.

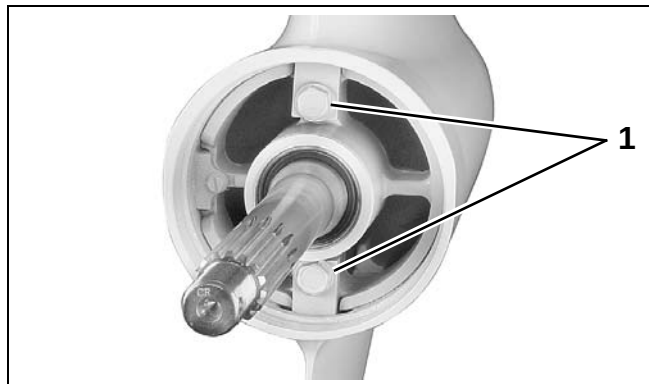
GEARCASE – STANDARD ROTATION

GEARCASE DISASSEMBLY

Propeller Shaft Bearing Housing Removal – “S2” and “O” Type

IMPORTANT: Identify gearcase type before disassembly. For counter rotation gearcases, refer to **GEARCASE DISASSEMBLY** on p. 307.

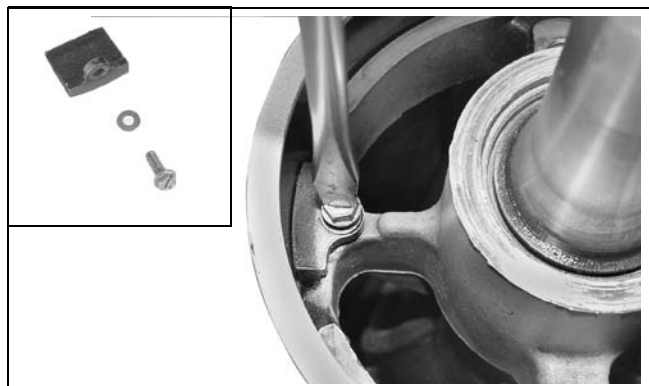
Remove the two screws, washers, and retainers holding the propeller shaft bearing housing.



1. Retainer tab screws

001989

Remove wedge, screw, and washer.

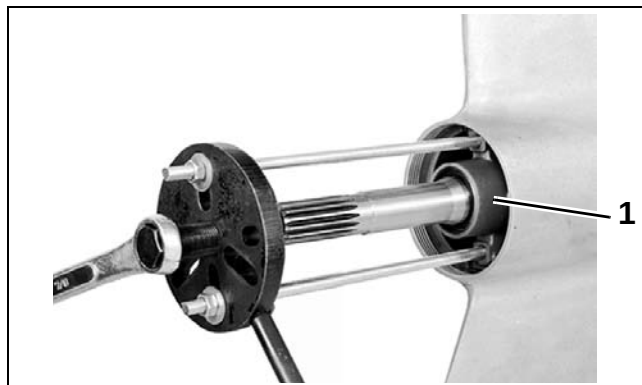


DSM02291
DSC02361

Remove the propeller shaft bearing housing from the gearcase using the following:

- Puller body, screw, and handle from Universal Puller Set, P/N 378103.
- Two 5/16-18 x 11 in. (279 mm) threaded rods, two large 5/16 in. I.D. flat washers, and two 5/16-18 nuts (obtain locally).

Assemble components and pull the bearing housing from the gearcase.



1. Bearing housing – slides in or out

22775

Remove the thrust washer, thrust bearing, and reverse gear from gearcase.

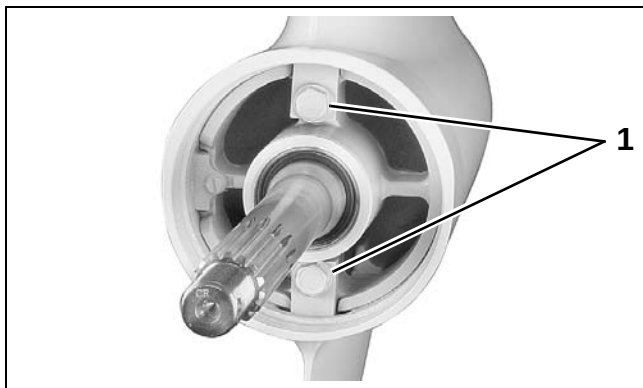
Propeller Shaft Bearing Housing Removal – “L2” and “M2” Type

IMPORTANT: Identify gearcase type before disassembly. For counter rotation gearcases, refer to **GEARCASE DISASSEMBLY** on p. 307.

The propeller shaft bearing housing on “L2” and “M2” models is **PRESSED** into gearcase housing.

“L2” TYPE GEARCASES

Remove the two screws, washers, and retainers holding the propeller shaft bearing housing.

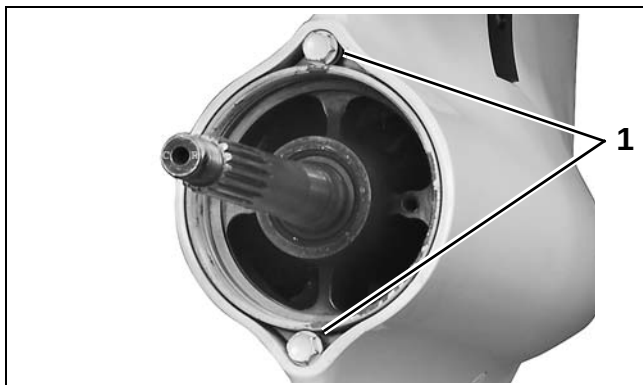


1. Retainer tab screws

001989

“M2” TYPE GEARCASES

Remove the two screws holding the propeller shaft bearing housing.



1. Retainer screws

006835

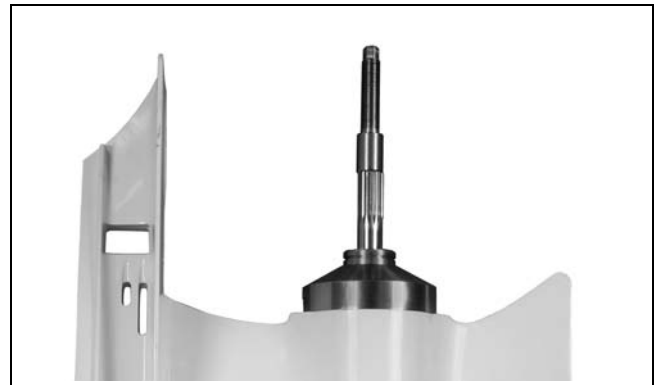
Remove the propeller shaft bearing housing from the gearcase using:

- Propeller Shaft Bearing Housing Puller Kit, P/N 354060.

DO NOT use tools designed to push on the propeller shaft. Pushing force against the propeller shaft could damage the forward gear thrust bearing or thrust washer.

IMPORTANT: The L2 type gearcase uses the adaptor ring included with puller kit.

Install the threaded adaptor from the puller kit on to the propeller shaft until seated.



006833

Assemble puller kit components. Hold adaptor with wrench and turn nut clockwise to pull bearing housing.



006834

GEARCASE – STANDARD ROTATION GEARCASE DISASSEMBLY

Pull propeller shaft and bearing housing far enough to loosen the **PRESSED** bearing housing from the gearcase housing.



“L2” Type Gearcase

006836



“M2” Type Gearcase

006837

Remove the bearing housing, thrust washer, thrust bearing, and reverse gear from gearcase.

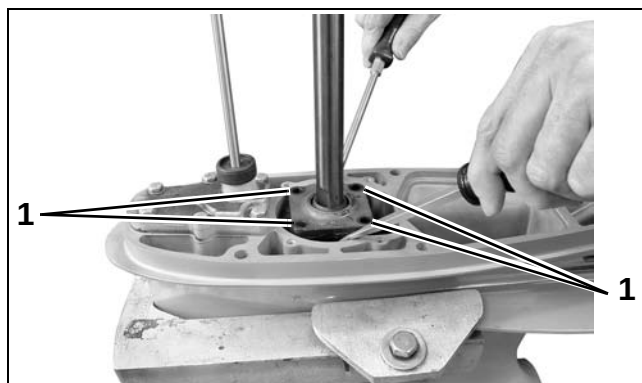


006838

Pinion Gear and Driveshaft Removal – “S2” Type

IMPORTANT: To separate the upper driveshaft from the lower driveshaft, the upper retainer **must** be removed and upper driveshaft must slide down into lower driveshaft.

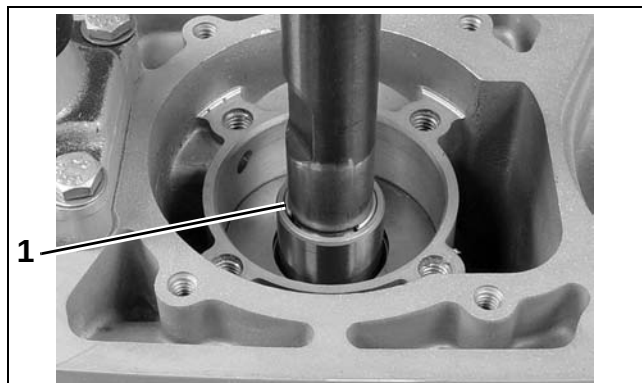
Remove the four driveshaft bearing housing screws and bearing housing.



1. Driveshaft bearing housing screws

005422

Remove upper retainer.

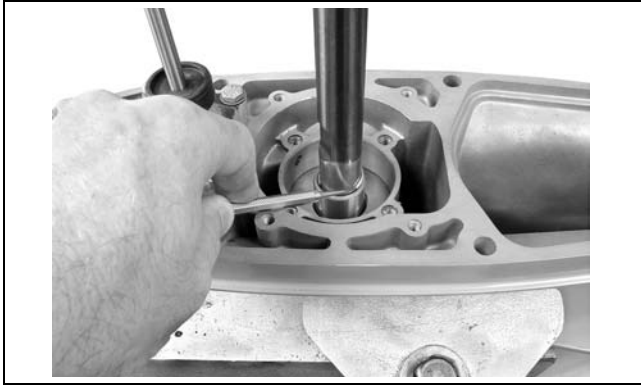


1. Retainer

005423

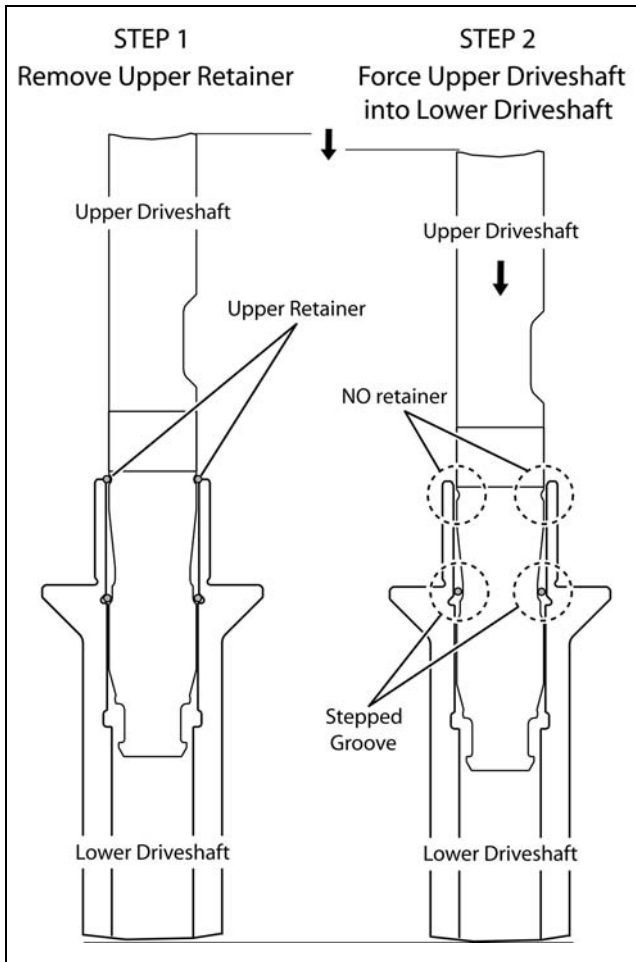
GEARCASE – STANDARD ROTATION

GEARCASE DISASSEMBLY



005424

Force upper driveshaft into lower driveshaft. This moves lower retainer on stepped groove of lower driveshaft. Refer to diagram below.



Upper Driveshaft Removal

005411

Lift and remove upper driveshaft from lower drive-shaft.

Refer to **Propeller Shaft Bearing Housing Removal – “S2” and “O” Type** on p. 276. Remove propeller shaft bearing housing and reverse gear, thrust bearing and thrust washer.

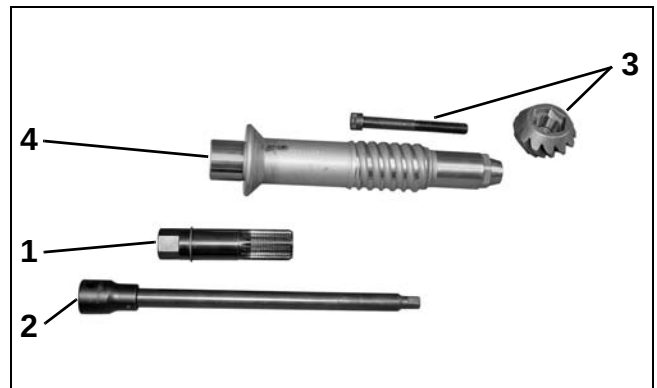
Push down on shift rod to move the clutch dog to reverse position. Pull propeller shaft aft to disengage from forward gear and shift housing. Allow shaft to drop against lower gearcase housing. This will assist in the removal of the pinion gear.



1. Propeller shaft

005405

Use the required tools to remove the pinion screw and gear from the lower driveshaft.



1. Lower Driveshaft Spline Tool, P/N 5007052

2. Lower driveshaft Wrench, P/N 352877

3. Pinion gear and screw

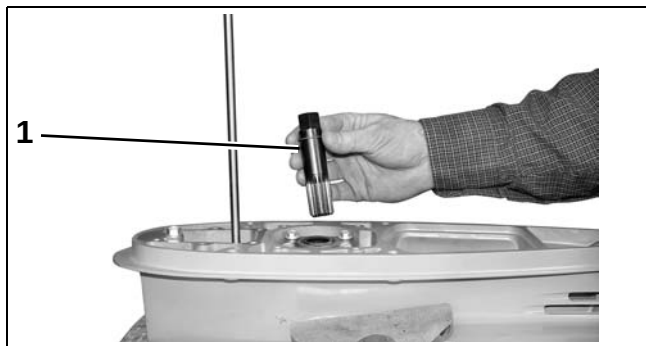
4. Lower driveshaft

005406

GEARCASE – STANDARD ROTATION

GEARCASE DISASSEMBLY

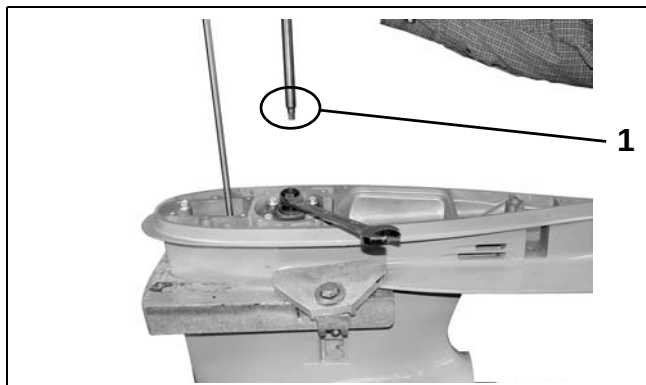
With driveshaft bearing housing and screws in place, insert Lower Driveshaft Spline Tool, P/N 5007052, into lower driveshaft.



1. Lower Driveshaft Spline Tool

005407

Insert Lower Driveshaft Wrench, P/N 352877, through Lower Driveshaft Spline Tool and lower driveshaft. Seat hex tip of wrench in head of pinion screw.



1. Wrench, hex tip

005408

IMPORTANT: Make sure Lower Driveshaft Wrench is fully seated in head of pinion screw.

Use a long 3/4 in. combination wrench to hold lower Driveshaft Spline Tool and a 1/2" drive wrench to turn the Lower Driveshaft Wrench in a

counterclockwise direction. Loosen screw completely



005409

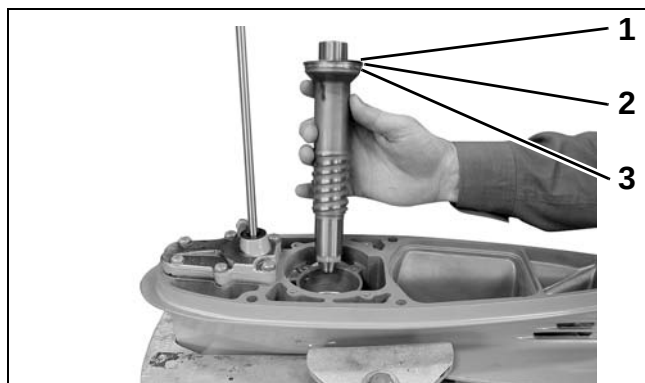
Remove the four driveshaft bearing housing screws and then the bearing housing.



1. Driveshaft bearing housing

005426

Remove shims, thrust washer, and thrust bearing with the lower driveshaft.



1. Shims
2. Thrust bearing
3. Thrust washer

005410

GEARCASE – STANDARD ROTATION GEARCASE DISASSEMBLY

Remove pinion gear from gearcase housing.



005420

Pinion Gear and Driveshaft Removal – “O”, “L2”, and “M2” Type

Adjust the shift rod to move the clutch dog as far forward as possible. This will help ease removal of the pinion nut.

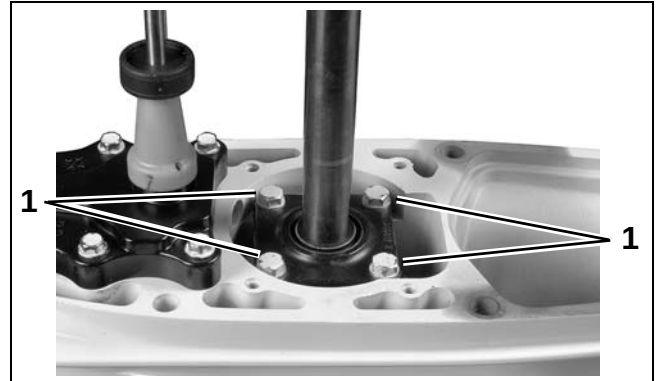
Use Driveshaft Holding Socket, P/N 311875, Pinion Nut Holder, P/N 334455, and Wrench Retainer, P/N 341438 to loosen and remove the pinion nut from the bottom of the driveshaft. Pad handle of holder to prevent damage to gearcase.



1. Holding socket
2. Pinion holder
3. Retainer

42229

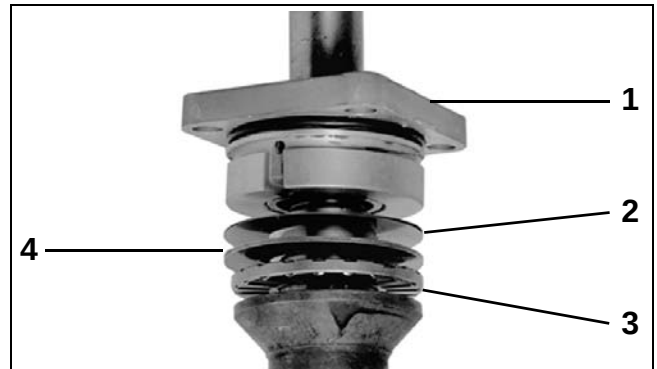
Remove the four driveshaft bearing housing screws.



1. Driveshaft bearing housing screws

006876

Remove the driveshaft from the gearcase. The bearing housing, shims, thrust bearing, and thrust washer will come out with the driveshaft.



1. Bearing housing
2. Shims
3. Thrust bearing
4. Thrust washer

COA3558

If driveshaft cannot be removed, refer to **Locked Driveshaft Removal** on p. 282.

Remove the pinion gear from the gearcase.



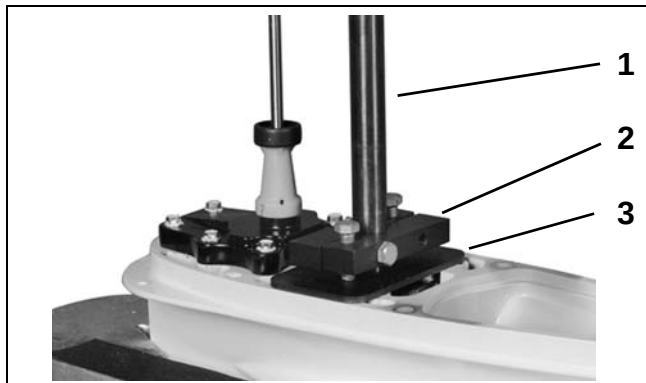
006878

GEARCASE – STANDARD ROTATION

GEARCASE DISASSEMBLY

Locked Driveshaft Removal

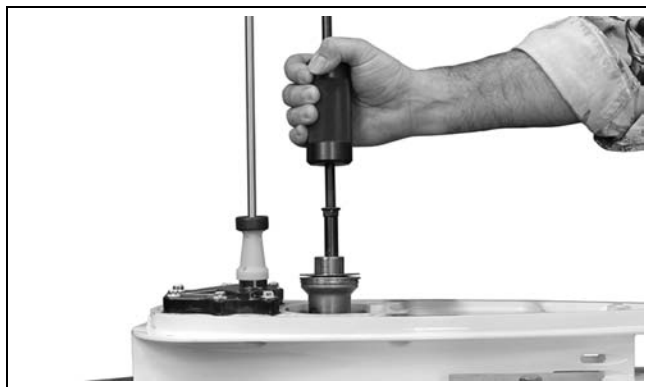
The driveshaft to pinion taper is a locking taper. If necessary, use Driveshaft Puller, P/N 390706, and Backing Plate, P/N 325867, to break the lock. Install the tools as shown by clamping them around the driveshaft. Alternately tighten the two vertical screws against the backing plate inserted between the puller and the gearcase until the driveshaft pops loose from the pinion.



1. Drive shaft
2. Puller
3. Backing plate

006879

If upper driveshaft becomes separated from lower driveshaft, use Lower Driveshaft Puller, P/N 342681, to remove. Install puller into lower driveshaft and turn 90° to position hook under pin in driveshaft. Thread Slide Hammer, P/N 391008, into puller and remove driveshaft.



006880

Driveshaft Service

To separate the upper driveshaft (if needed) from the lower driveshaft, remove the roll pin. Replace the damaged component.



29337

To assemble the driveshaft, install **new** driveshaft retainer into the groove of the upper driveshaft.



29338

Install the upper driveshaft into the lower driveshaft, aligning the holes in the driveshaft retainer and the lower driveshaft.

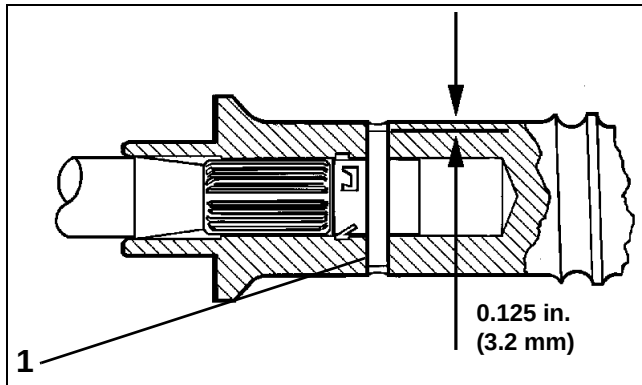


29330

GEARCASE – STANDARD ROTATION

GEARCASE DISASSEMBLY

Install the roll pin to the specified dimension.



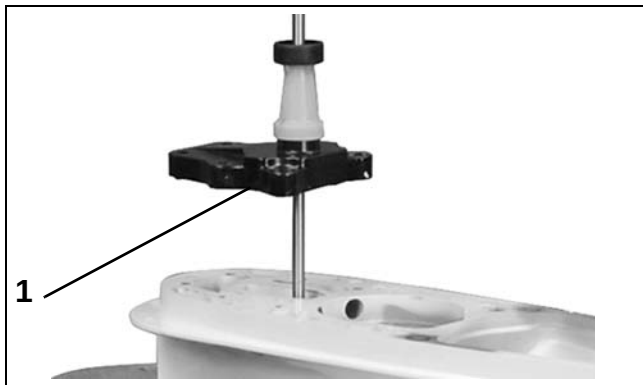
1. Roll pin

DR4610

Shift Housing, Gear and Propeller Shaft Removal

Push down on the shift rod. This will move the detent lever downward to clear the inside of the gearcase when the shaft assembly is pulled out. Unscrew the shift rod from the detent lever. Remove screws, cover, and shift rod from the gearcase.

Discard the cover gasket. Remove and discard the shift rod O-ring from inside of cover.



1. Cover gasket

006884

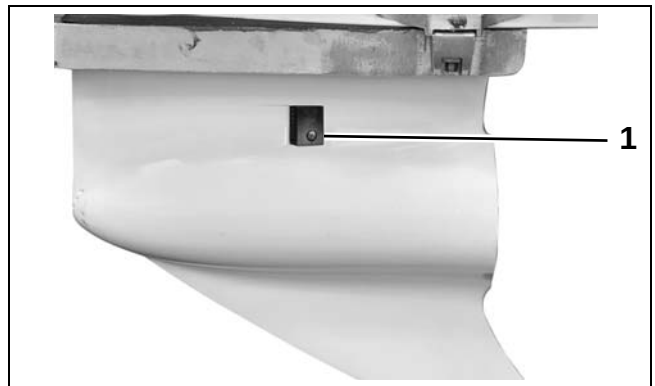
Remove propeller shaft assembly from gearcase.



006839

Water Intake Screens

Remove and clean water intake screens. Replace if damaged.



1. Water intake screen

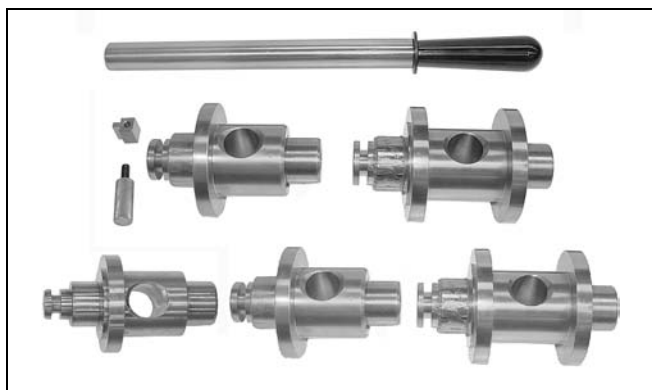
006886

GEARCASE HOUSING INSPECTION

Thoroughly clean gearcase housing to remove all dirt and debris prior to inspection. Inspect pinion bearing and forward thrust surface of gearcase housing.

Use Gearcase Alignment Gauge Kit, P/N 5006349 to check the condition of gearcase housing prior to reassembly. Refer to instructions provided with kit. Use additional Gauging Head as follows:

- P/N 352879, for “S2” Type gearcase housings
- P/N 5007750, for “L2” Type gearcase housings
- P/N 5007749, for “M2” Type gearcase housings



006787

NOTICE Use Alignment Gauge Puller, P/N 354718, to install and remove press fit propeller shaft bearing housing in L2 and M2 Type gearcase housings.

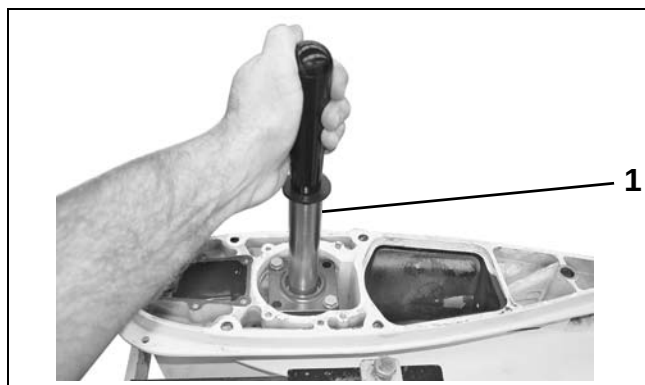
Failure to follow this procedure will result in inability to remove gauging head, forward thrust bearing and forward bearing housing from gearcase housing.



Alignment Gauge Puller, P/N 354718

354718

IMPORTANT: DO NOT force gauging shaft into alignment hole. Shaft **MUST** slide easily into hole of gauging head. If shaft does not slide into hole, gearcase housing is damaged and **must** be replaced.



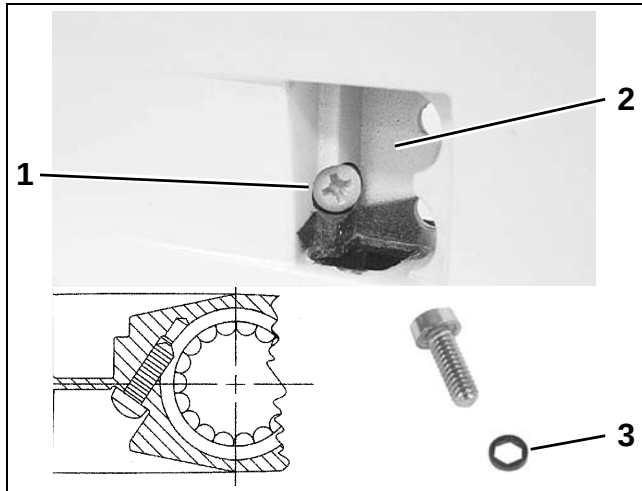
1. Gauging shaft

004347

SHIFTER, BEARING AND SEAL SERVICE

Pinion Bearing Removal

Remove pinion bearing retaining screw.



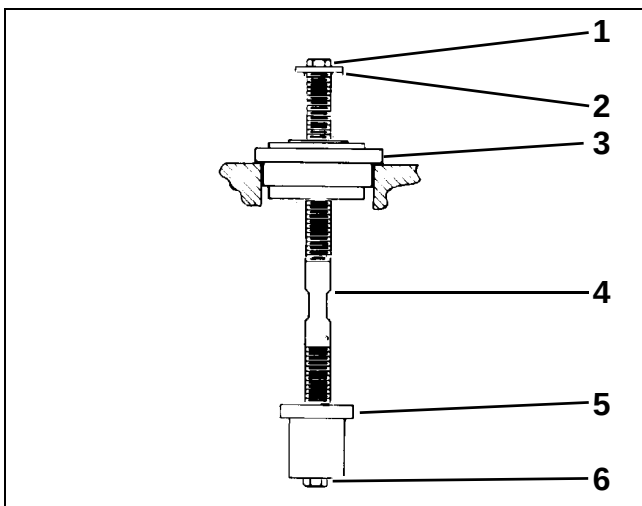
1. Pinion bearing retaining screw
2. Water screen pocket
3. Seal

DSC02370
DRC7416
DSC02313

Assemble Pinion Bearing Remover and Installer, P/N 5005927, in the gearcase as follows:

“S2” TYPE GEARCASE

Use a mallet to drive the bearing from the housing.

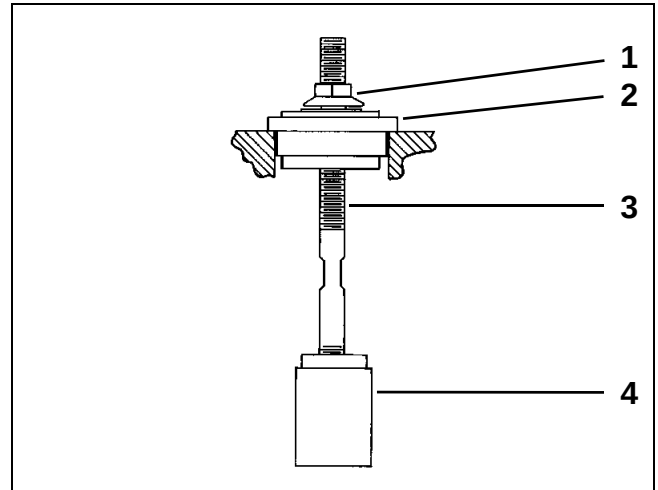


1. 1/4-20 x 1/2 in. Hex Head Screw
2. 1 in. O.D. Flat Washer
3. Plate, P/N 391260
4. Rod, P/N 326582
5. Installer/Remover, P/N 326574
6. 1/4-20 x 1 1/4 in. Hex Head Screw

824163

“O”, “L2”, AND “M2” TYPE GEARCASES

Use a 7/8 in. wrench to hold the remover in place.
Use a 3/4 in. wrench to turn flange nut clockwise.
Draw the bearing up from the housing.



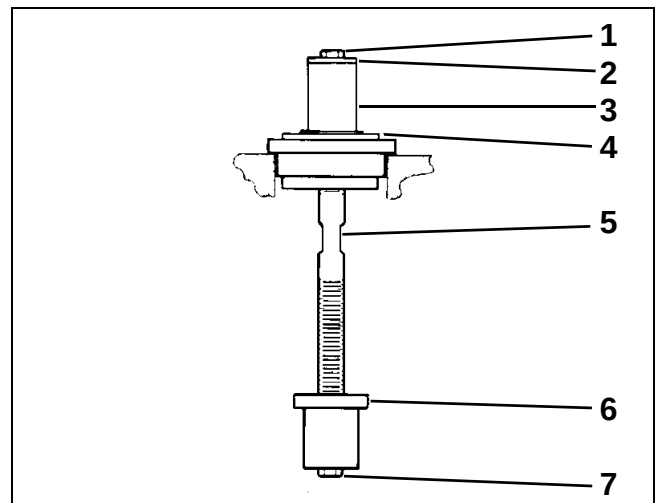
1. Flange nut, P/N 326586
2. Plate, P/N 391260
3. Rod, P/N 326582
4. Remover, P/N 326579

DR3419

Pinion Bearing Installation

Assemble the following components of Pinion Bearing Remover and Installer, P/N 5005927, as shown:

“S2” TYPE GEARCASE

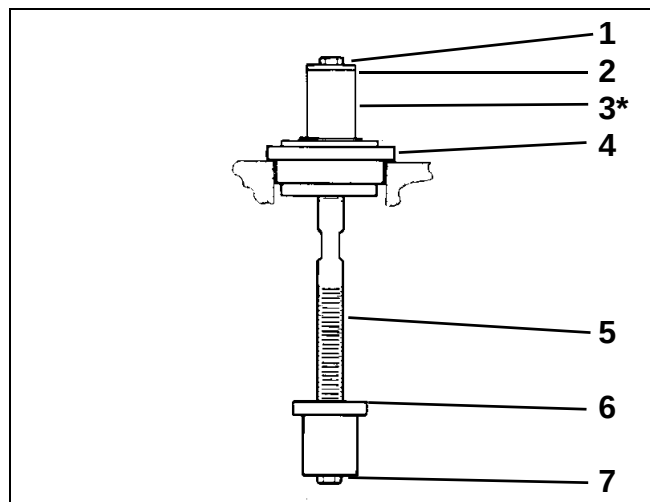


1. 1/4-20 X 1/2 in. Hex head screw
2. 1 in. O.D. Flat washer
3. Spacer, P/N 341437
4. Plate, P/N 391260
5. Rod, P/N 326582
6. Installer/Remover, P/N 326574
7. 1/4-20 X 1 1/4 in. Hex head screw

824182

GEARCASE – STANDARD ROTATION SHIFTER, BEARING AND SEAL SERVICE

“O”, “L2”, AND “M2” TYPE GEARCASES



1. 1/4-20 X 1/2 in. Hex head screw
2. 1 in. O.D. Flat washer
3. Spacer; P/N 350932 “M” and “M2”
P/N 326584 “L” and “L2”
4. Plate and Bearing P/N 391260
5. Rod P/N 326582
6. Installer/Remover, P/N 350958
7. 1/4-20 X 1 1/4 in. Hex head screw

824182

IMPORTANT: Spacers are different sizes and cannot be interchanged.

Apply *Needle Bearing* grease to the needle bearings and insert them into the bearing case. (Note: “S2” Type has caged roller bearing.)

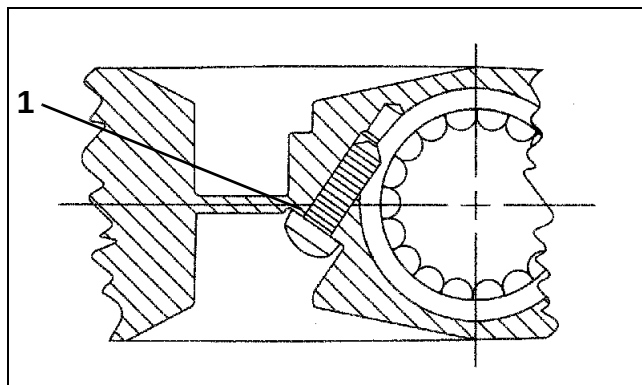
Place the bearing on the installer tool with the **lettered side of the bearing facing the top** of the gearcase. Use *Needle Bearing* grease to hold the bearing on the tool.

IMPORTANT: The pinion bearing is tapered so that, when installed correctly, its shape compensates for stresses in the gearcase and allows full bearing contact. Whenever a gearcase is disassembled, the pinion bearing should be checked to ensure that it has been installed with the lettering facing up.

Insert the tool with the bearing into the gearcase. Drive the bearing into the gearcase until the washer on the tool contacts the spacer.

Remove the tool.

Place a new O-ring on the pinion bearing retaining screw. Apply *Gasket Sealing Compound* to O-ring. Apply *Nut Lock* to screw threads. Install the screw and tighten to a torque of 60 to 84 in. lbs. (7 to 9.5 N·m).



1. O-ring

DRC7416

Shift Housing Disassembly

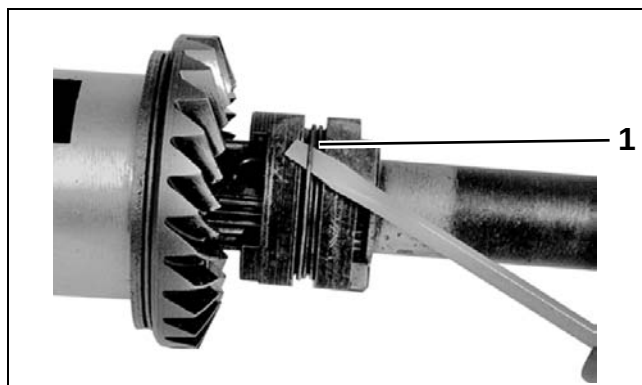


WARNING

Wear safety glasses to avoid injury.

IMPORTANT: The shift housing and bearing are serviced as an assembly. If either are worn or damaged, replace the complete assembly.

Insert a suitable tool under one end of the clutch dog spring and remove it from its groove by unwrapping it from around the clutch dog. **Discard the spring.**

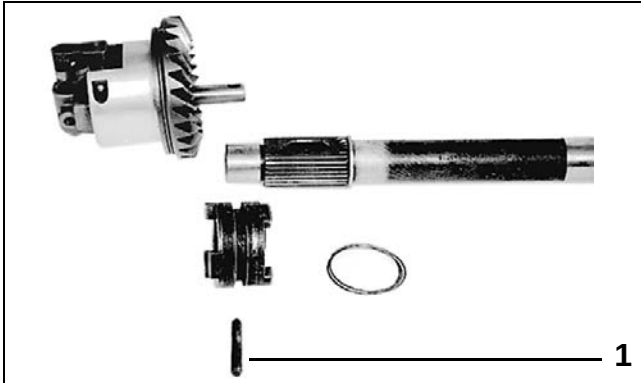


1. Clutch dog spring

COA3560

GEARCASE – STANDARD ROTATION SHIFTER, BEARING AND SEAL SERVICE

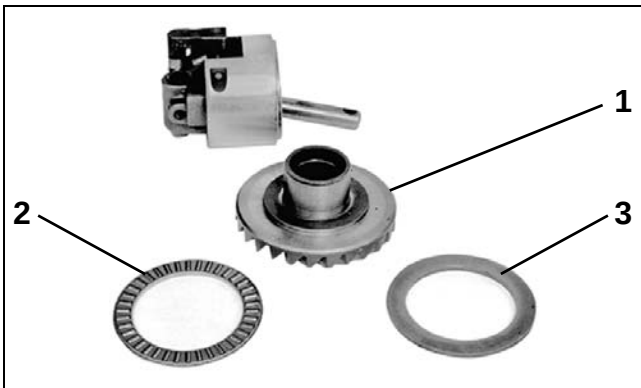
Push the pin out of the clutch dog. Remove all parts.



1. Pin

COA3561

Remove the gear, thrust bearing, and thrust washer from the shift housing.

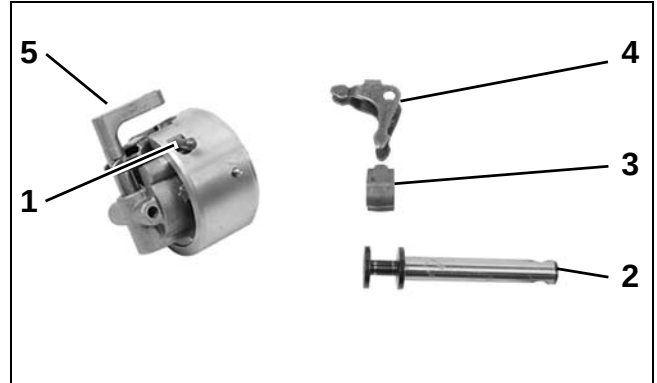


1. Gear
2. Thrust bearing
3. Thrust washer

COA3562

Remove the shift lever pin from the housing. Remove shift shaft, cradle and shift lever. Move

shifter detent as needed to help ease removal of parts.



1. Shift lever pin
2. Shift shaft
3. Cradle
4. Shift lever
5. Shifter detent

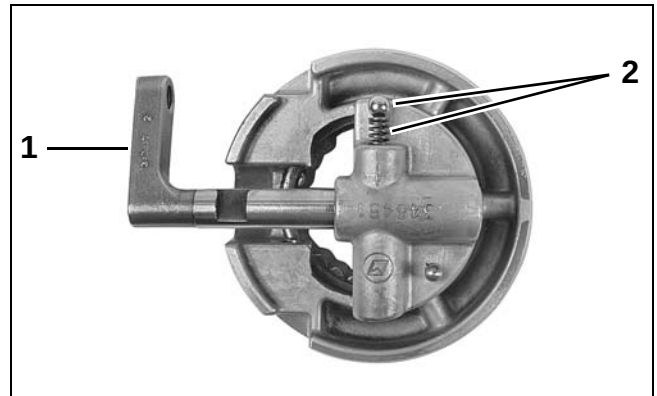
006890



WARNING

Wear safety glasses to avoid personal injury. The detent ball and spring and come out with great force.

Wrap the housing with a shop cloth to catch ball and spring. Rotate the shifter detent 90° in either direction, then pull the detent out of the housing.



1. Shifter detent
2. Ball and spring

DSC02518

Remove the detent ball and spring.

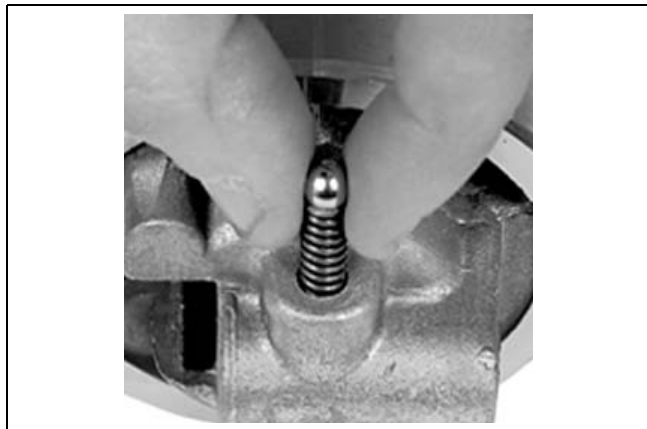
Remove needle bearings from bearing housing for cleaning and inspection (except "S2" Type).

GEARCASE – STANDARD ROTATION SHIFTER, BEARING AND SEAL SERVICE

Shift Housing Assembly

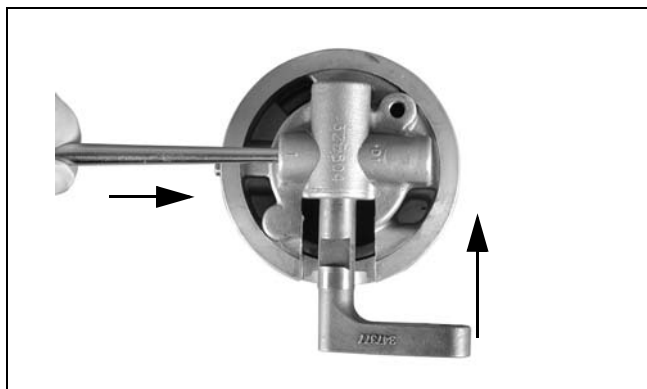
IMPORTANT: Clean and inspect all parts before beginning assembly procedures. Replace any damaged parts.

Lightly coat the detent ball and spring with *Needle Bearing* grease. Insert the spring in the housing, then the ball.



4518

Insert shifter detent at 90° angle into the housing as shown, while depressing the ball and spring with a suitable tool. Once the shifter detent is past the ball, remove the tool and position detent to engage NEUTRAL position.



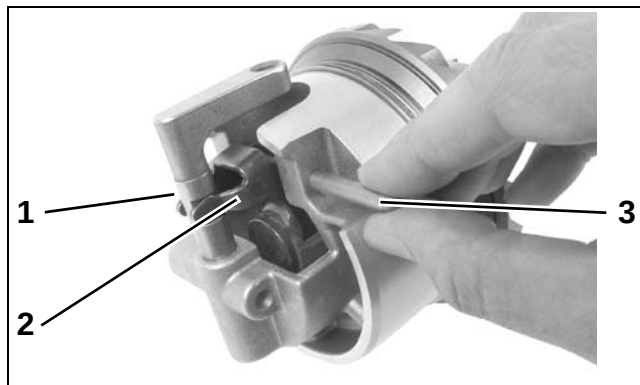
006900

Thoroughly grease 25 needle bearings with *Needle Bearing* grease and place in the bearing case. (Note: "S2" Type has caged roller bearing.)



4520

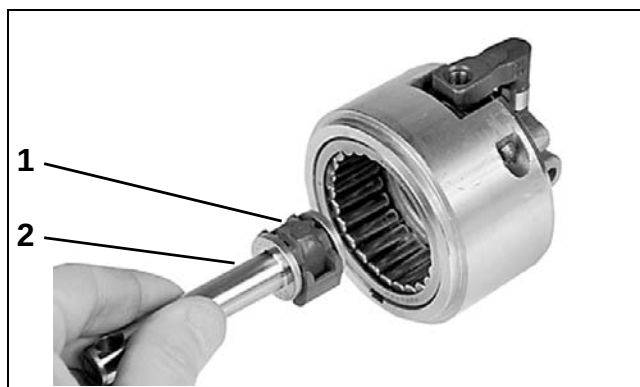
With shifter detent in NEUTRAL, install arms of shift lever into detent slots. Align the pivot holes and insert the retaining pin. Push shifter detent down.



1. Shifter detent
2. Shift lever
3. Pin, shift lever

DSC02449

Rest the cradle on the shift shaft.



1. Cradle
2. Shift shaft

4512

GEARCASE – STANDARD ROTATION SHIFTER, BEARING AND SEAL SERVICE

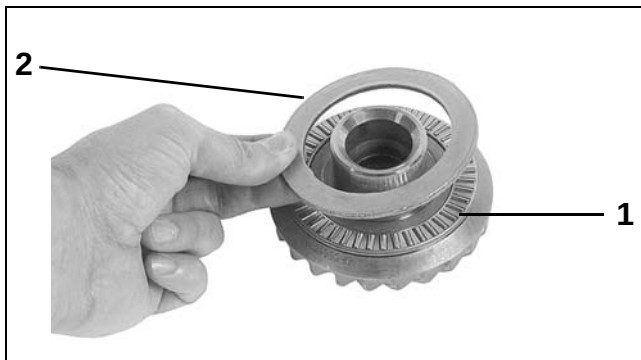
Place the shift lever arms into the recesses of the shift cradle. Pull shifter detent back up to NEUTRAL position to hold the cradle and shaft in place.



001219

Coat thrust bearing and thrust washer with *Needle Bearing* grease. Place the bearing on the back of the gear. Set the washer on top of the thrust bearing. Insert the gear, bearing, and washer into the bearing housing.

NOTICE Bearing and washer must be installed in the correct order.



- 1. Thrust bearing
- 2. Thrust washer

DSC02297

Align holes in the clutch dog with slot in the propeller shaft. Install the clutch dog on the shaft with "PROP END" facing rear of the shaft.

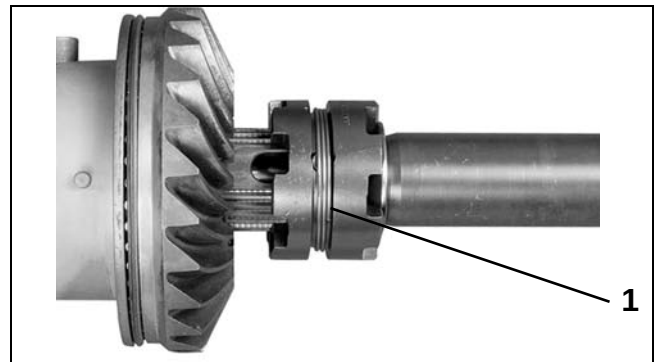
NOTICE The clutch dog is not symmetrical. If installed backward, it will not fully engage and will immediately damage itself and the gears.



- 1. "PROP END"

006906

Slide the propeller shaft onto the shift shaft, align the hole in the shaft with the hole in the clutch dog, install the pin and then, a **new** clutch dog retaining spring. Place three coils over each end of the pin, MAKING SURE NONE OF THE COILS OVERLAP OR ARE LOOSE.



- 1. Retaining spring

006907

Driveshaft Bearing Housing Service

The driveshaft bearing is not serviceable. Replace the bearing housing assembly if the bearing is worn or damaged. Also, inspect the driveshaft bearing surface if the bearing is damaged.

Seal Removal

Remove the driveshaft bearing housing seals using Puller Bridge, P/N 432127, and Large Puller Jaws, P/N 432129. Discard the seals.



14155

Remove and discard the O-ring from the bearing housing.

Clean the bearing housing in solvent to remove sealer from the seal bore and the O-ring groove.

Seal Installation

Lightly apply *Gasket Sealing Compound* to a new O-ring. Install the O-ring in top groove of the bearing housing. Do not allow sealant in oil passage.

NOTICE Do not install the O-ring in the bearing housing's bottom groove. The bottom

groove is an oil passage. Gearcase damage could result.

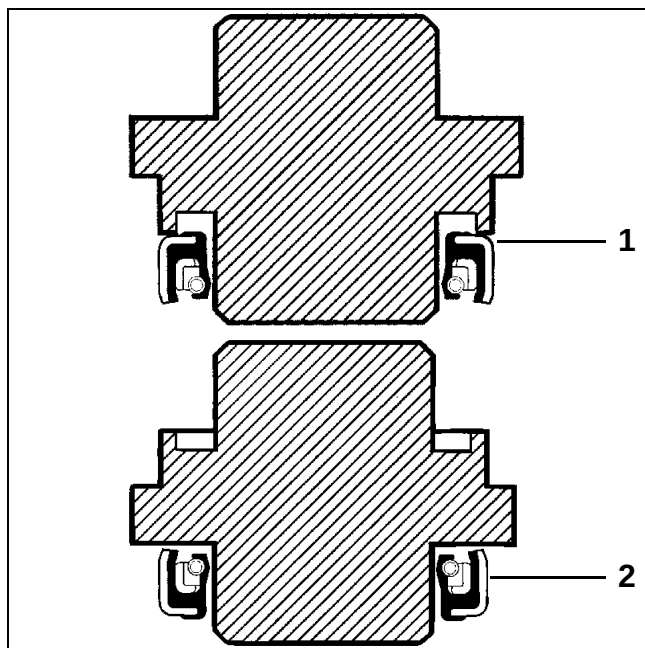


1. O-ring (top groove)
2. Oil passage

14156

Apply *Gasket Sealing Compound* to metal casings of new seals before installing.

Use Seal Installation Tool, P/N 330268 to install new seals back to back in bearing housing. Install inner seal with lip facing toward bearing housing, then the outer seal with lip facing away from bearing housing. Apply *Triple-Guard* grease to seal lips.



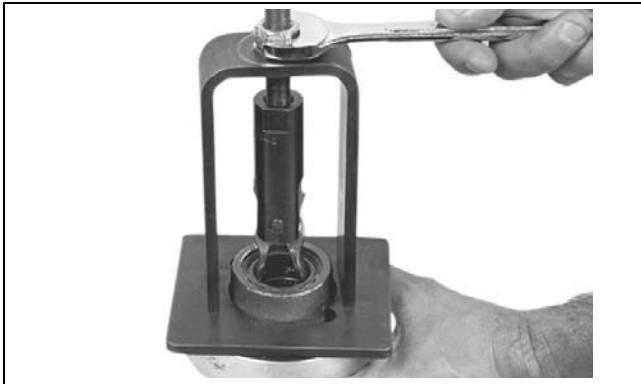
1. Inner seal
2. Outer seal

DR2061
DR2062

Propeller Shaft Bearing Housing Service

Rear Seal Removal

Remove seals using Puller Bridge, P/N 432127, and Small Puller Jaws, P/N 432131. Place the plate on top of the housing to support the bridge, and tighten jaws securely behind the inner seal.



13520

Bearing Removal

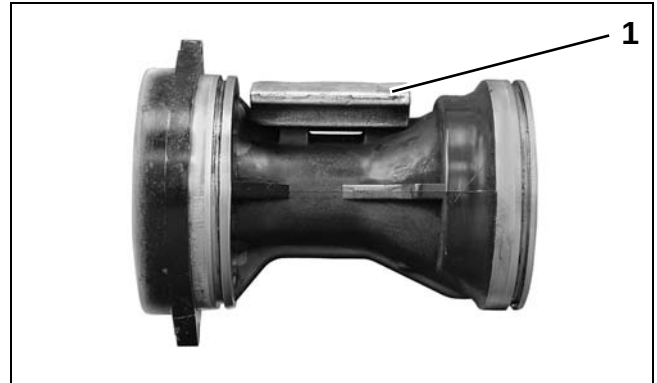
IMPORTANT: Inspect bearings in place. If a bearing is removed for any reason, it must be discarded.

Remove either bearing using Puller Bridge, P/N 432127, and Large Puller Jaws, P/N 432129. Place the puller plate on top of the housing to support the bridge, and tighten the jaws securely behind the bearing.



13522

Inspect the bearing housing anode. Replace anode if it is reduced to two-thirds of original size. Tighten screws to a torque of 108 to 132 in. lbs. (12 to 15 N·m).



1. Anode

006897

Discard the bearing housing O-ring. Clean the housing and bearings in solvent and dry thoroughly. If bearings were not replaced, rotate the needles to check for freedom of movement.

Inspect O-ring grooves. Sand off any sharp edges that might cut O-ring. Remove any nicks or burrs on front of bearing housing.



1. O-ring groove

006898

GEARCASE – STANDARD ROTATION SHIFTER, BEARING AND SEAL SERVICE

Bearing Installation

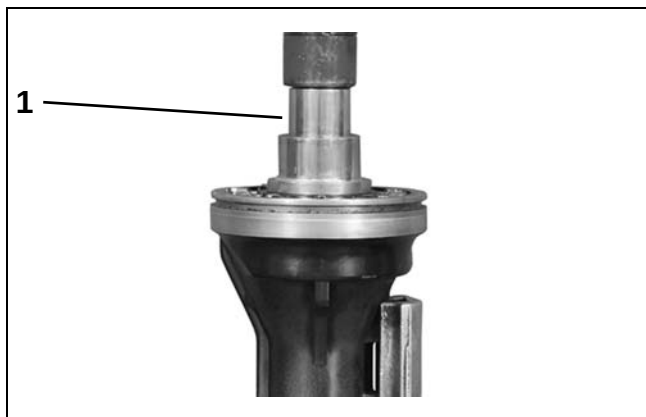
Oil, then install new bearings in bearing housing.

Place the **lettered end** of the bearing case on the bearing installer, then press the bearing into the housing until the tool seats. When installed, the lettered end of the bearing should be visible.

STANDARD ROTATION HOUSING

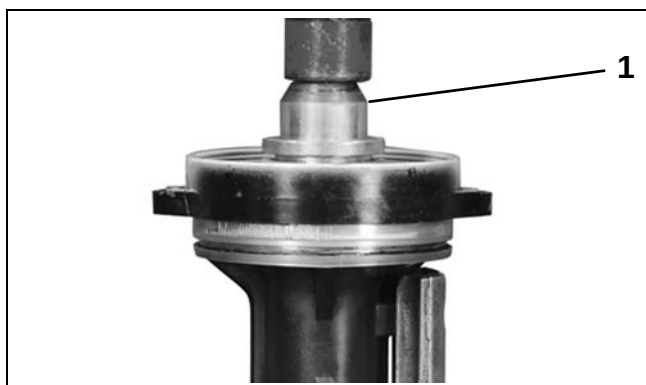
Bearing Installation Tool:

- P/N 326562 – front bearing “S2” type
- P/N 339750 – front bearing “O” type
- P/N 354139 – front bearing “L2” and “M2” type
- P/N 326562 – rear bearing “S2” type
- P/N 340820 – rear bearing “O” type
- P/N 354139 – rear bearing “L2” and “M2” type



Front Bearing
1. Bearing installation tool

006909



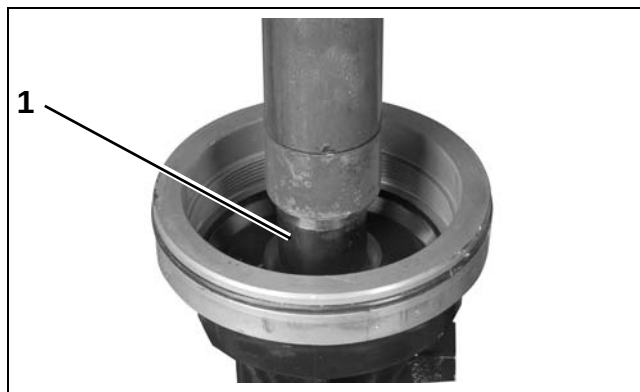
Rear Bearing
1. Bearing installation tool

006910

COUNTER ROTATION HOUSING

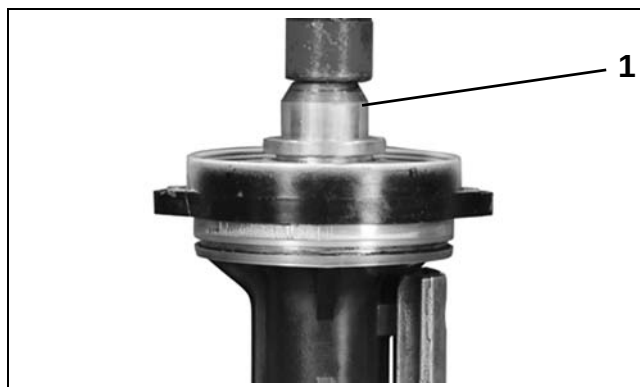
Bearing Installation Tool:

- P/N 432401 – front bearing “O” and “M2” type
- P/N 339750 – rear bearing “O” type
- P/N 354139 – rear bearing, “M2” type



Front Bearing
1. Bearing installation tool

006945



Rear Bearing
1. Bearing installation tool

006910

Rear Seal Installation

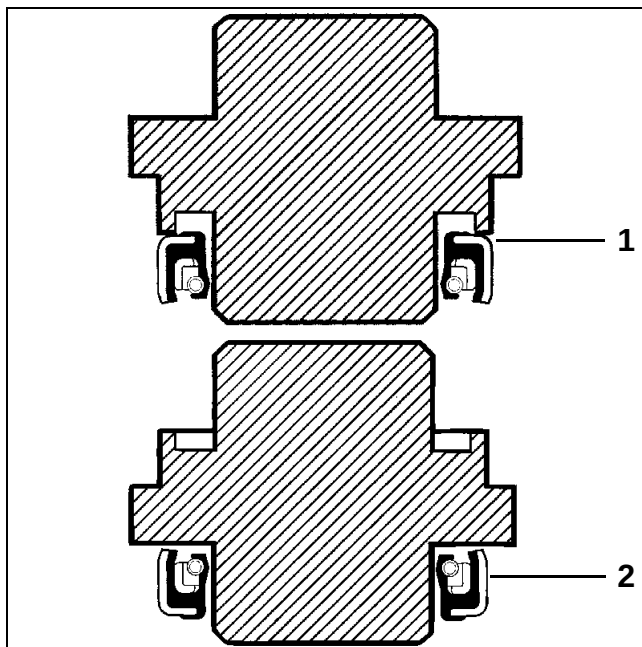
Apply *Gasket Sealing Compound* to metal casings of the seals before installing.

Use Seal Installation Tool to install new seals back to back in bearing housing.

Seal Installation Tool:

- P/N 326551 – “S2” type
- P/N 354056 – “O”, “L2”, and “M2” type

Install inner seal with lip facing toward the bearing housing, then outer seal with lip facing away from the bearing housing.



1. Inner seal
2. Outer seal

DR2061
DR2062

Apply *Triple-Guard* grease to seal lips.

DRIVESHAFT SHIMMING

NOTICE If a new pinion gear is needed, replace gear set before shimming.

Pinion gear backlash is achieved by using shims between the driveshaft bearing housing and the thrust washer. When installing a new thrust bearing or washer, bearing housing, pinion, or drive-shaft, it is necessary to properly shim the assembly to restore factory clearance.

Use Driveshaft Shimming Tool, P/N 5005925.

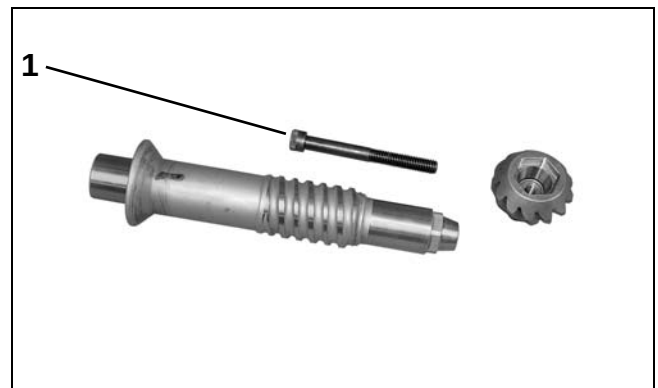
Shim gauge bars are precision made and should be handled carefully. The length of each bar is stamped near the part number. This dimension is 0.020 in. (0.508 mm) shorter than the actual shimmed length of the driveshaft.

“S2” TYPE GEARCASE

IMPORTANT: Clean pinion and driveshaft before assembly. Replace any damaged parts.

Assemble the driveshaft bearing housing, thrust washer, thrust bearing, and pinion onto the drive-shaft. Install shimming screw, P/N 352878 and tighten to a torque of 47 to 51 ft. lbs. (64 to 69 N·m).

IMPORTANT: The original pinion screw is **NOT** used for shimming, but is used in final assembly. Use Shimming Screw, P/N 352878 (service tool) for shimming procedure.



1. Shimming screw

005414

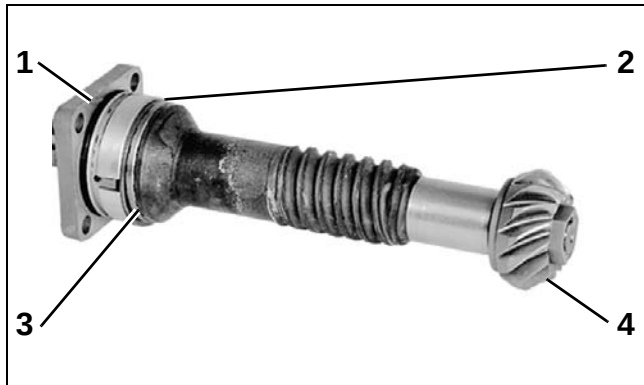
GEARCASE – STANDARD ROTATION DRIVESHAFT SHIMMING

“O”, “L2”, AND “M2” TYPE GEARCASES

IMPORTANT: Clean pinion and driveshaft before assembly. Replace any damaged parts.

Assemble the driveshaft bearing housing, thrust washer, thrust bearing, and pinion onto the driveshaft. Use Driveshaft Seal Protector, P/N 318674, when installing or removing the bearing housing.

Lightly coat the threads of the pinion nut with out-board lubricant and tighten to a torque of 100 to 110 ft. lbs. (136 to 149 N·m).



1. Driveshaft bearing housing COA3565
2. Thrust washer
3. Thrust bearing
4. Pinion

IMPORTANT: The original pinion nut may be used for shimming, but must **NOT** be used in final assembly.

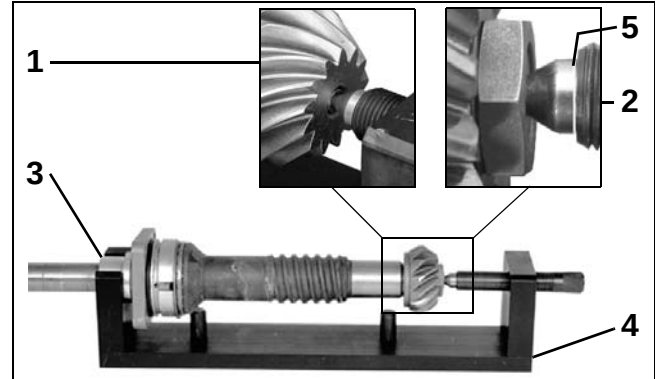
ALL GEARCASES

Select collar, P/N 341440, and the correct shim gauge bar:

- “M2”: Shim gauge bar, P/N 349957
- “L2”: Shim gauge bar, P/N 328367
- “O”: Shim gauge bar, P/N 328367
- “S2”: Shim gauge bar, P/N 328367

Slide the collar onto the driveshaft with large end in contact with the bearing housing.

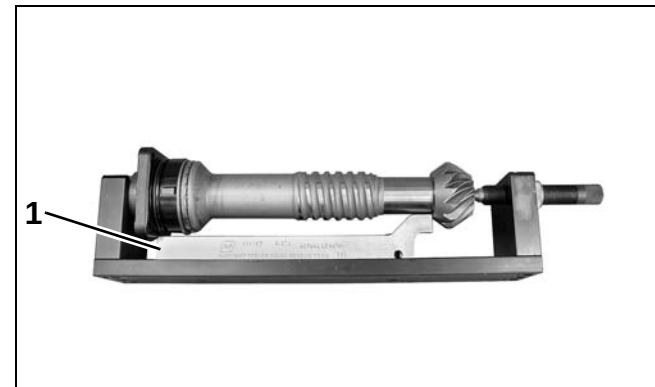
Insert the assembled driveshaft into the tool base and tighten preload screw against the driveshaft until groove on the spring-loaded plunger is flush with end of threads. Tighten locking ring on preload screw.



1. “S2” Type Gearcase - pinion shimming bolt COA3566
2. “O”, “L”, “L2”, “M” and “M2”, Type Gearcases - pinion nut DSC00326
3. Collar 005415
4. Tool base
5. Groove

Rotate the driveshaft several revolutions to seat bearings.

Lay the tool base on its side. Position the shim gauge bar against guide pins of the tool base.



1. Shim gauge bar 005416

Check squareness of the bearing housing mounting surface by holding the shim gauge bar against the pinion while rotating **just the bearing housing**. Use a feeler gauge to measure clearance between the gauge bar and the bearing housing between each pair of screw holes. Replace the bearing housing and repeat check if variance is greater than 0.004 in. (0.101 mm).

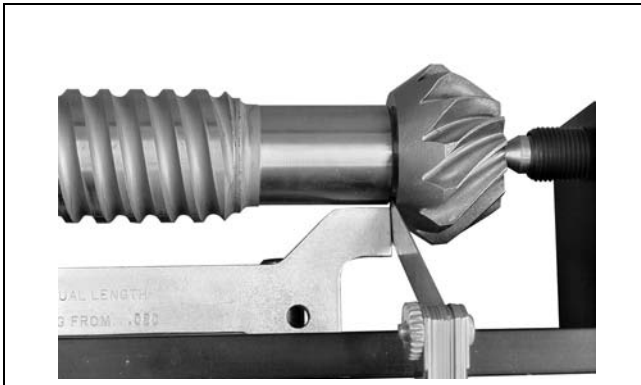
Check squareness of the pinion to the driveshaft. Hold the shim gauge bar against the bearing housing (between the screw holes) while rotating **just the driveshaft and pinion assembly**. Measure clearance between the gauge bar and the pinion at several locations. If variance is greater than 0.002 in. (0.050 mm) replace the pinion or driveshaft, as necessary, and repeat check.

Subtract the average clearance measurement from 0.020 in. (0.508 mm) to determine the correct shim thickness required. Select the fewest number of shims to achieve the correct thickness.

Remove the driveshaft from the tool and add the required shims between the bearing housing and the thrust washer.

IMPORTANT: Use extreme care when removing bearing housing to avoid damaging the seals. Use Driveshaft Seal Protector, P/N 318674.

Check clearance again. The measurement between the gauge bar and pinion should be 0.020 in. (0.508 mm).



005417

“S2” TYPE GEARCASE

Remove the shimming screw and pinion from the driveshaft.

IMPORTANT: Make sure shimming screw is not installed in assembled gearcase.

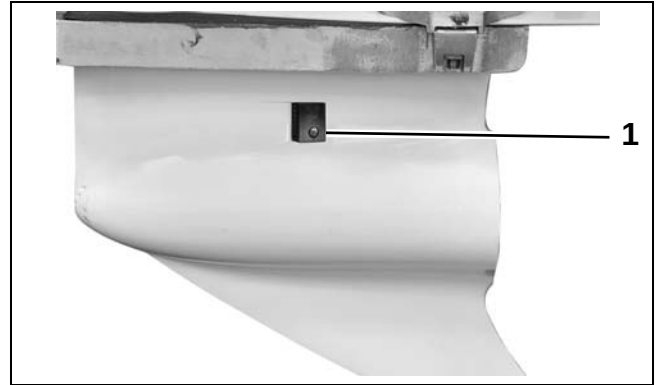
“O”, “L2”, AND “M2” TYPE GEARCASES

Remove the nut and pinion from the driveshaft. Discard the nut.

GEARCASE ASSEMBLY

Water Intake Screens

Install water intake screens. Tighten screws to a torque of 60 to 84 in. lbs. (7 to 9.5 N·m).



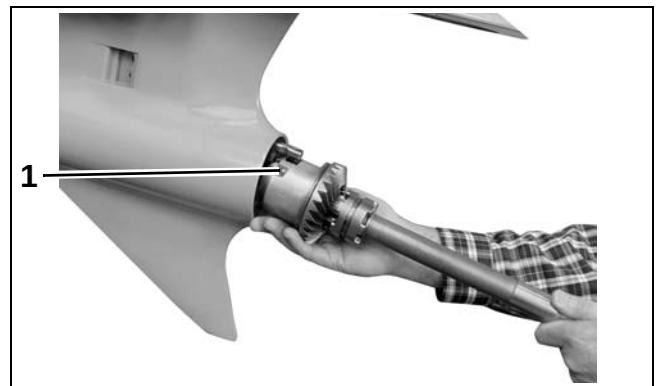
1. Water intake screen

006886

Shift Housing, Gear, and Propeller Shaft Installation

Push shifter detent into farthest downward position. Tip the rear of the gearcase slightly downward to assist in the installation of the shaft assembly.

Be sure the thrust bearing and the thrust washer are in the proper position. Insert the shaft assembly fully into the gearcase while aligning shift housing pin with hole in forward end of gearcase housing.



1. Pin

005427

GEARCASE – STANDARD ROTATION

GEARCASE ASSEMBLY

Shift Rod Housing Installation

Lubricate a new shift rod cover O-ring with *Triple-Guard* grease. Install the O-ring into the shift rod cover.

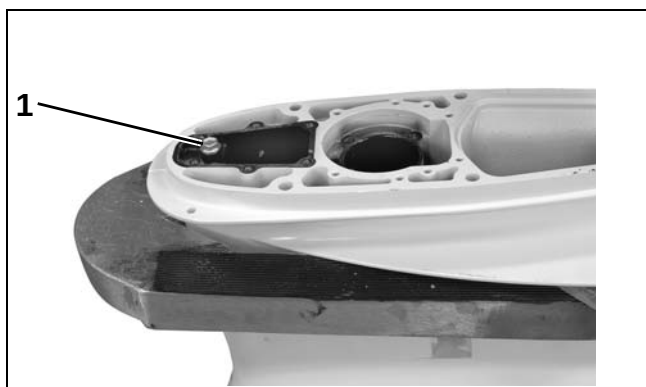
IMPORTANT: Make sure O-ring is fully seated in groove.



1. O-ring

006916

Install pitot tube screw and seal in housing. ("S2" and "O")

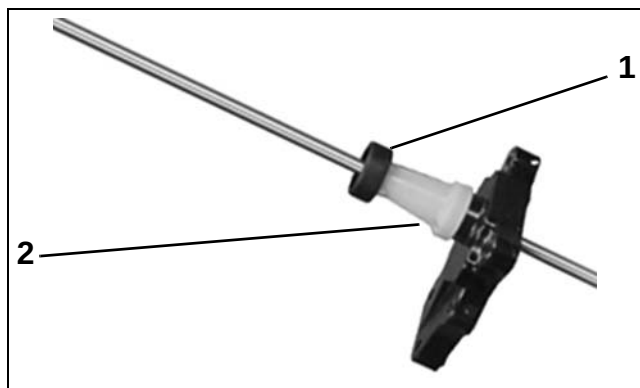


1. Screw and seal

006841

Install the shift rod spacer on the shift rod (25 in. models).

Place the shift rod grommet on the shift rod.



1. Grommet
2. Shift rod spacer

006917

Apply *Triple-Guard* grease to the threaded end of the shift rod and insert it through the cover. Turn the shift rod while pushing it through the cover to avoid damaging the O-ring.

"S2", "O", AND "L2" TYPE GEARCASES

Apply *Gasket Sealing Compound* to both sides of a new shift rod cover gasket. Place the gasket on the gearcase.



1. Cover gasket

COA3141

“M2” TYPE GEARCASES

Apply *Adhesive 847* to seal groove of shift rod cover. Place a new shift rod cover seal in groove.



1. Cover seal

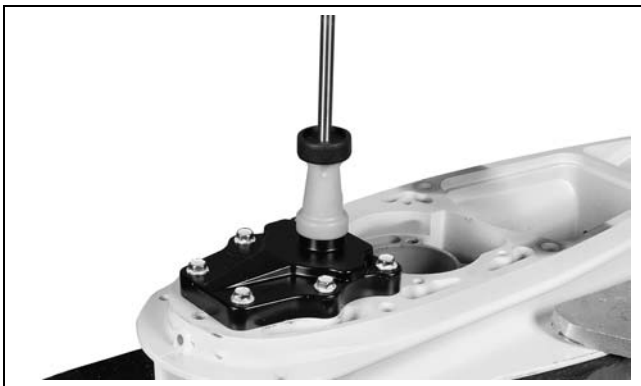
006842

ALL GEARCASES

Thread the shift rod into the shifter detent about four turns.

Move shift rod from side to side while pushing on the propeller shaft to ensure proper alignment of the bearing housing locator pin into the pin hole in the gearcase.

Apply *Gasket Sealing Compound* to the threads of the shift rod cover screws. Tighten the screws to a torque of 60 to 84 in. lbs. (7 to 9.5 N·m).



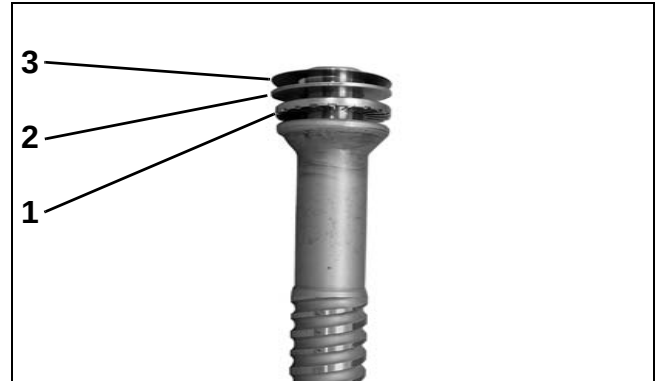
006919

Refer to **SHIFT ROD ADJUSTMENT** on p. 274.

Pinion Gear and Driveshaft Installation – “S2” Type

Refer to **DRIVESHAFT SHIMMING** on p. 293.

Place the driveshaft thrust bearing, thrust washer, and correct shim(s) on the driveshaft as shown.



1. Thrust bearing
2. Thrust washer
3. Shim(s)

005418

Push down on shift rod to move the clutch dog to reverse position. Pull propeller shaft aft to disengage from forward gear and shift housing. Allow shaft to drop against lower gearcase housing. This will allow the installation of the pinion gear.



1. Propeller shaft

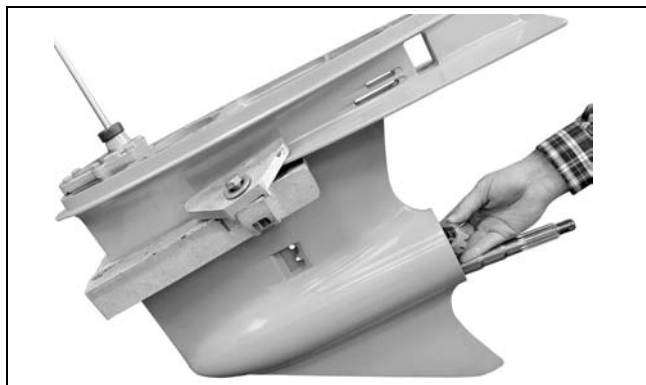
005405

IMPORTANT: Forward gear and thrust bearing and washer can become misaligned. Make sure forward thrust washer and thrust bearing and forward gear are properly aligned with shift housing before continuing gearcase assembly.

GEARCASE – STANDARD ROTATION

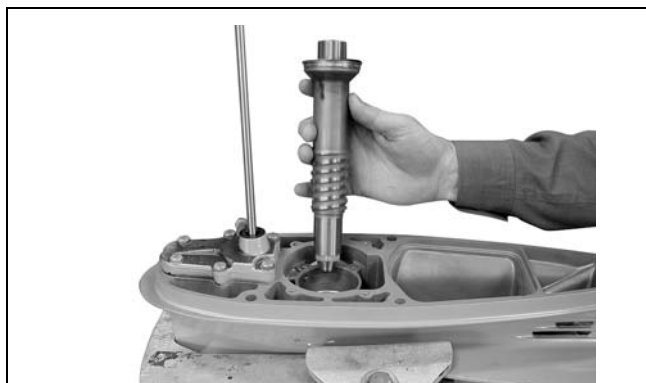
GEARCASE ASSEMBLY

Install pinion gear in gearcase housing



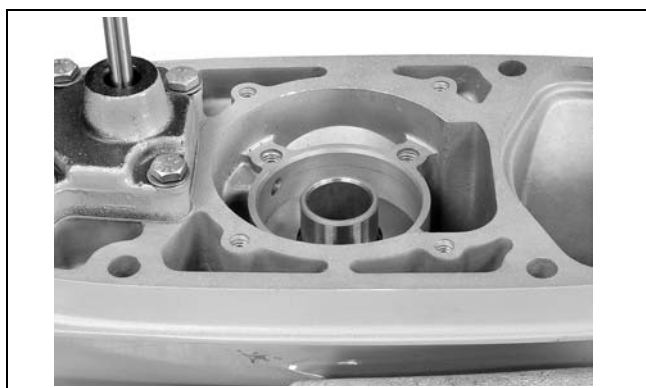
005420

Install driveshaft with thrust bearing, thrust washer, and correct shim(s) in gearcase housing. Position pinion on lower driveshaft.



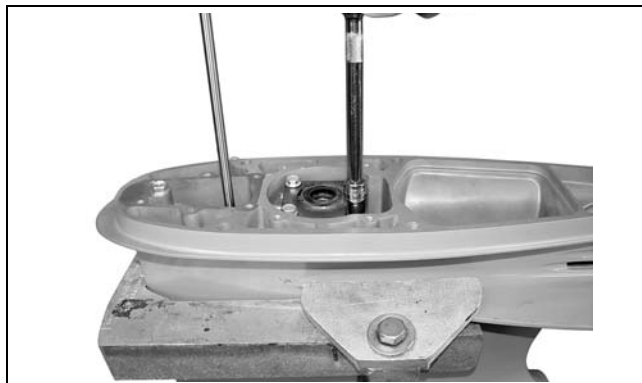
005410

Position pinion screw in lower driveshaft and thread into pinion.



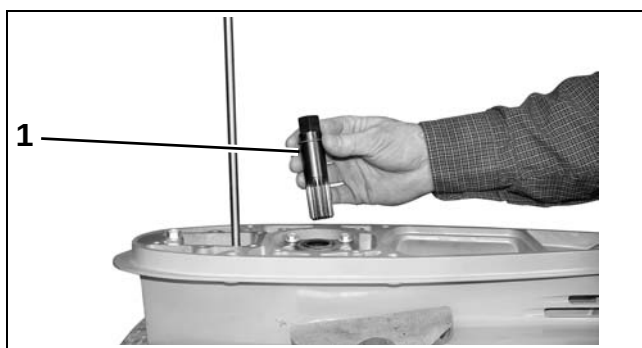
005421

IMPORTANT: Temporarily install bearing housing for support during pinion tightening procedure.



005426

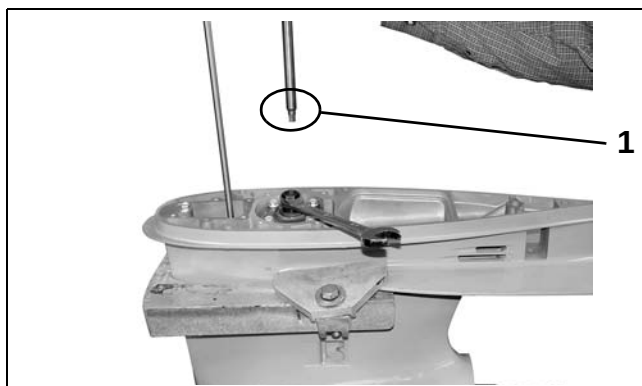
Insert Lower Driveshaft Spline Tool, P/N 5007052, into lower driveshaft.



1. Lower Driveshaft Spline Tool

005407

Insert Lower Driveshaft Wrench, P/N 352877, through Lower Driveshaft Spline Tool and lower driveshaft. Seat hex tip of wrench in head of pinion screw.



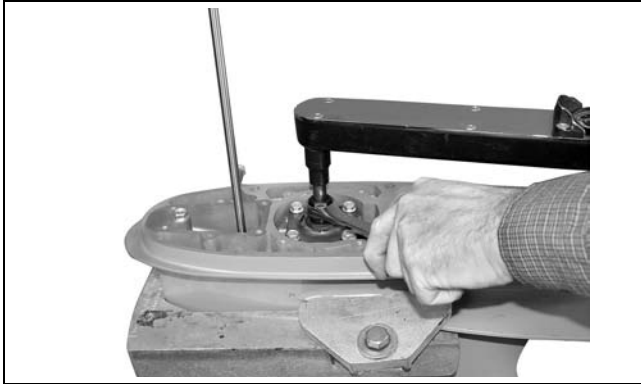
1. Wrench, hex tip

005408

GEARCASE – STANDARD ROTATION GEARCASE ASSEMBLY

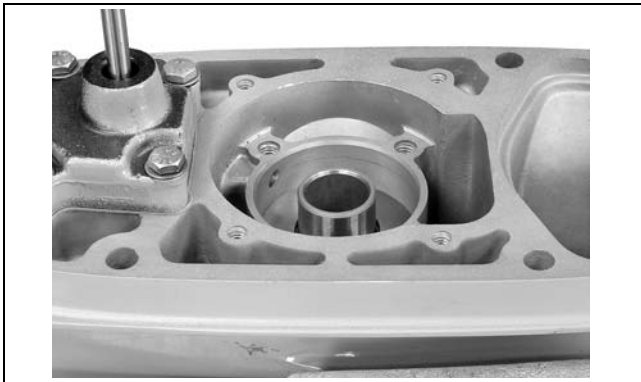
IMPORTANT: Make sure Lower Driveshaft Wrench is fully seated in head of pinion screw.

Use a long 3/4 in. combination wrench to hold Driveshaft Spline Tool and a 1/2" drive torque wrench to turn the Lower Driveshaft Wrench in a clockwise direction. Torque pinion screw to 47 to 51 ft. lbs. (64 to 69 N·m).



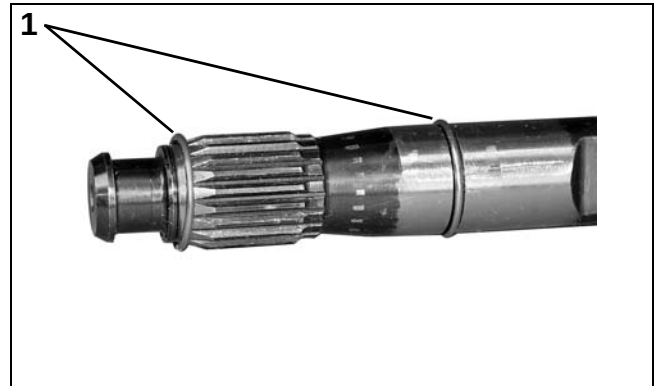
005409

Temporarily remove the four driveshaft bearing housing screws and bearing housing.



005421

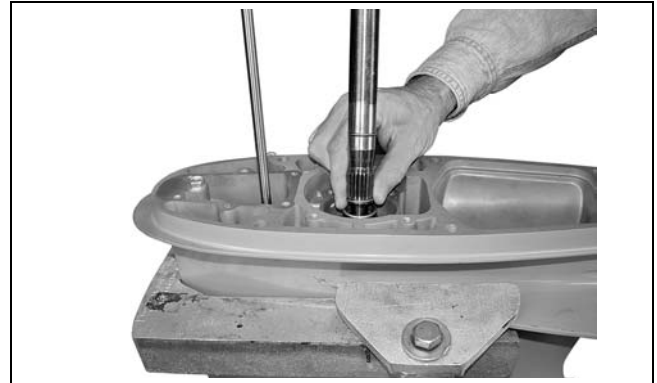
To install upper driveshaft into lower driveshaft, position **new** retainers (circlip type) on upper driveshaft as shown.



1. Retainer(s)

005412

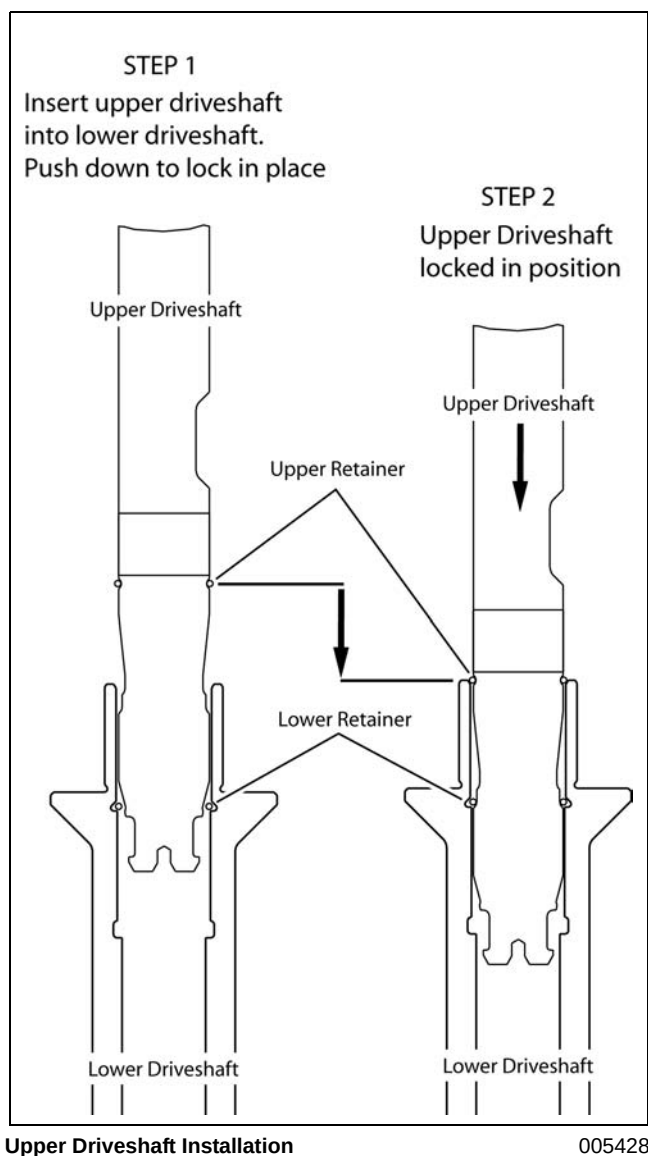
Hold lower retainer and align upper driveshaft with lower driveshaft. Force upper driveshaft down until seated. Driveshaft should lock in place.



005413

GEARCASE – STANDARD ROTATION

GEARCASE ASSEMBLY



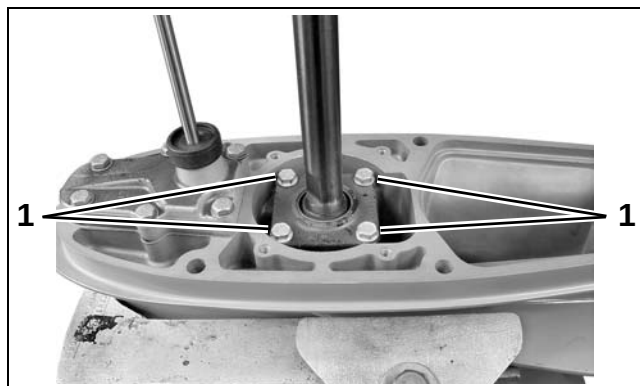
Install new seals in driveshaft bearing housing. Refer to **Driveshaft Bearing Housing Service** on p. 290. Using Driveshaft Seal Protector, P/N 318674, slide the driveshaft bearing housing onto the driveshaft.



1. Seal protector

COA3130

Apply *Gasket Sealing Compound* to the threads of the driveshaft bearing housing screws. Tighten screws **in stages** to a torque of 120 to 144 in. lbs. (13.5 to 16.5 N·m).



1. Driveshaft bearing housing screws

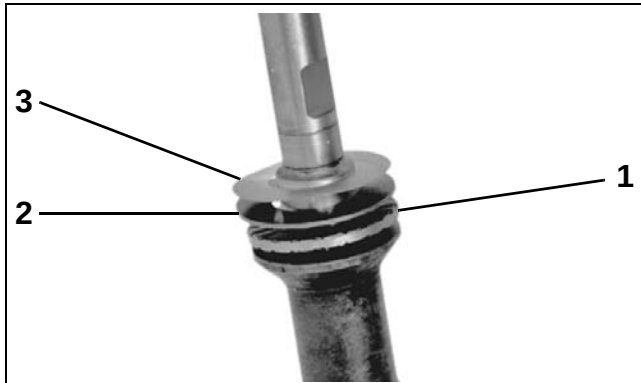
005425

Pinion Gear and Driveshaft Installation – “O”, “L2”, and “M2” Type

Refer to **DRIVESHAFT SHIMMING** on p. 293.

Install new seals in driveshaft bearing housing. Refer to **Driveshaft Bearing Housing Service** on p. 290.

Place the driveshaft thrust bearing, thrust washer, and correct shim(s) on the driveshaft as shown.



1. Thrust bearing
2. Thrust washer
3. Shim(s)

COA3168

Using Driveshaft Seal Protector, P/N 318674, slide the driveshaft bearing housing onto the driveshaft and into position in the gearcase.



1. Seal protector

COA3130

Adjust shift rod to move clutch dog as far forward as possible. Be sure excess grease is removed from the pinion bearing.

Washer must be snapped into recess of pinion gear.



1. Washer

006922

IMPORTANT: The inside taper of the pinion gear and the driveshaft taper **MUST** be completely free of grease. Clean the tapers with *Cleaning Solvent*. Use a shop towel free of grease and lint.

Place the pinion gear into the gearcase. Insert the driveshaft into the gearcase and through the pinion gear.

Lightly coat the threads of a **new** pinion nut with outboard lubricant. Use Pinion Nut Starting Tool, P/N 342216, to install nut on the driveshaft. Turn the driveshaft by hand to thread the nut on to shaft.

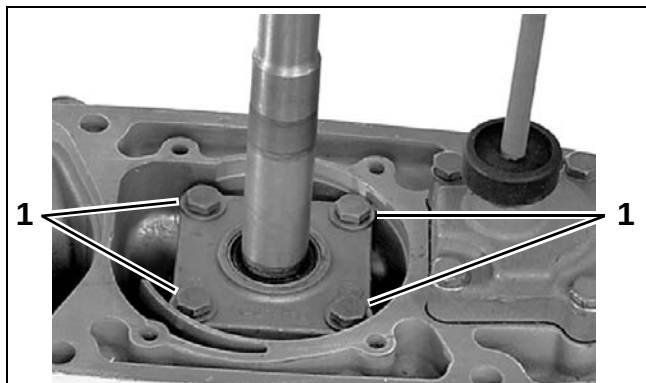


006923

GEARCASE – STANDARD ROTATION

GEARCASE ASSEMBLY

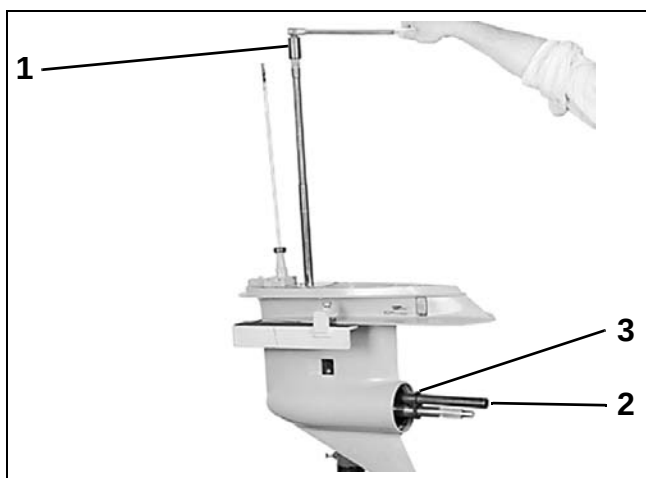
Apply *Gasket Sealing Compound* to the threads of the driveshaft bearing housing screws. Tighten screws **in stages** to a torque of 120 to 144 in. lbs. (13.5 to 16.5 N·m).



1. Driveshaft bearing housing screws

COA3153

Use Driveshaft Holding Socket, P/N 311875, Pinion Nut Holder, P/N 334455, and Wrench Retainer, P/N 341438, to tighten the pinion nut to a torque of 100 to 110 ft. lbs. (136 to 149 N·m). Pad handle of holder to prevent damage to gearcase.



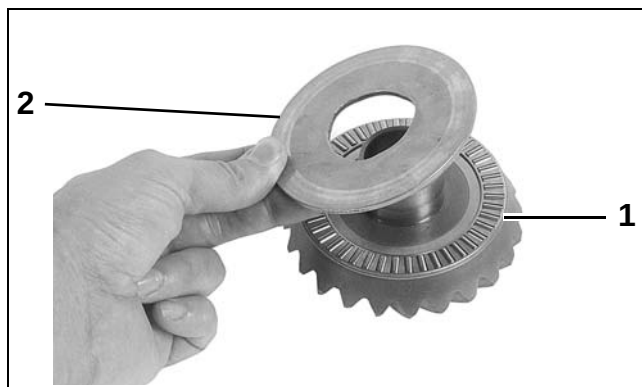
1. Holding socket
2. Pinion holder
3. Retainer

42229

Propeller Shaft Bearing Housing and Gear Installation – “S2” and “O” Type

The propeller shaft bearing housing on these models SLIDES in or out of gearcase housing.

Oil and install thrust bearing and thrust washer on hub of reverse gear. Slide the gear assembly onto the propeller shaft until it engages the pinion gear.



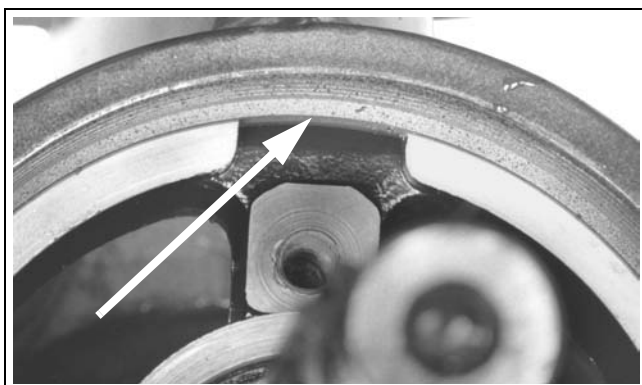
1. Thrust bearing
2. Thrust washer

DSC02295

Lightly apply *Gasket Sealing Compound* to a new bearing housing O-ring. Install O-ring in groove in the housing.

Install housing into gearcase. Align screw holes with retainer slots in gearcase.

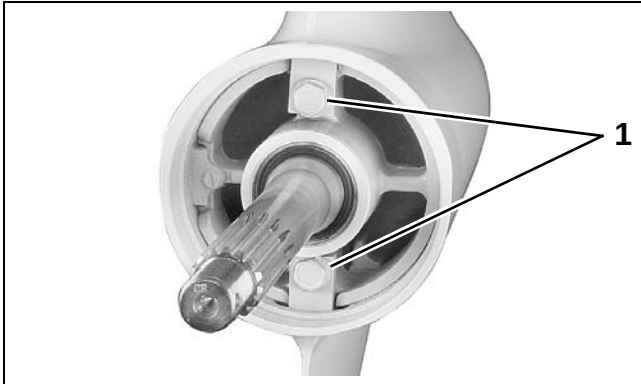
Housing must be completely seated to install retainer tabs.



Retainer Tab Slot

50106a

Install two retainers, washers and screws. Apply *Ultra Lock* to threads and tighten screws to a torque of 18 to 20 ft. lbs. (24 to 27 N·m).

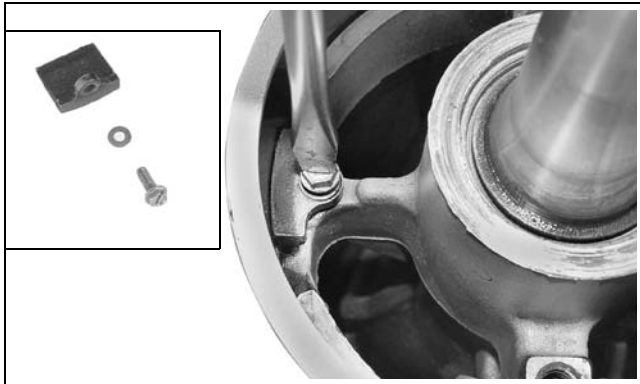


1. Retainer tab screws

001989

Loosen retainer screws 1/4 turn.

Install wedge, screw, and washer. Apply *Ultra Lock* to threads and tighten screw to a torque of 15 to 20 in. lbs. (1.7 to 2.3 N·m).



DSM02291
DSC02361

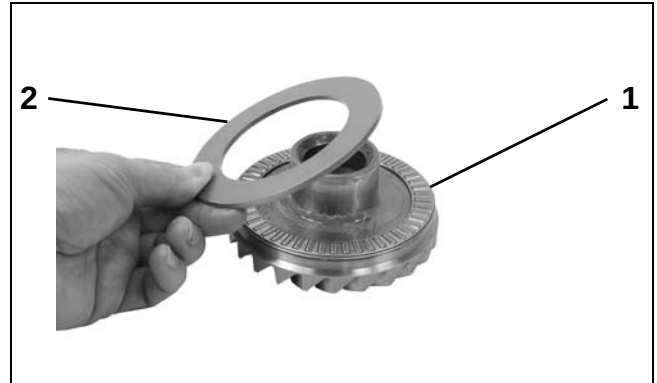
Re-tighten two retainer screws to 18 to 20 ft. lbs. (24 to 27 N·m).

Confirm that torque on the wedge screw is 15 to 20 in. lbs. (1.7 to 2.3 N·m).

Propeller Shaft Bearing Housing and Gear Installation – “L2” Type

IMPORTANT: The propeller shaft bearing housing on the “L2” type gearcases is **PRESSED** into the gearcase housing.

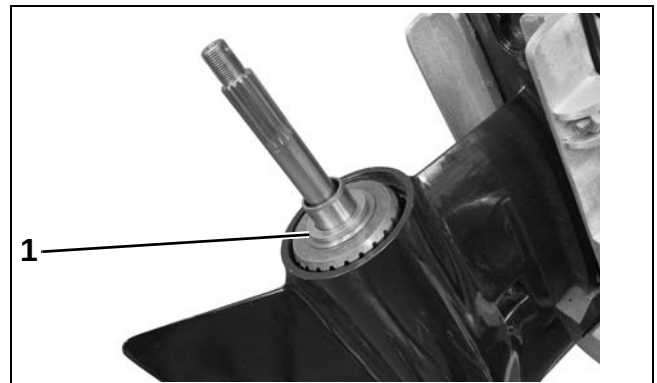
Oil and install thrust bearing and thrust washer on hub of reverse gear.



1. Thrust bearing
2. Thrust washer

006905

Slide the gear assembly onto the propeller shaft until it engages the pinion gear.



1. Thrust bearing and thrust washer

006843

Lightly apply *Triple Guard Grease* to a new bearing housing O-ring. Install O-ring in groove in the housing. Grease the machined side surfaces of bearing housing.

GEARCASE – STANDARD ROTATION

GEARCASE ASSEMBLY

Install housing into gearcase. Align screw holes with retainer slots in gearcase.



006836

Use Installer Handle, P/N 345822, Propeller Shaft Bearing Housing Installer, P/N 354058, Gearcase Fixture, P/N 354059 and an appropriate floor press (10 ton or greater) to install housing into gearcase. Align and level gearcase assembly in fixture as shown. Secure fixture to floor press.



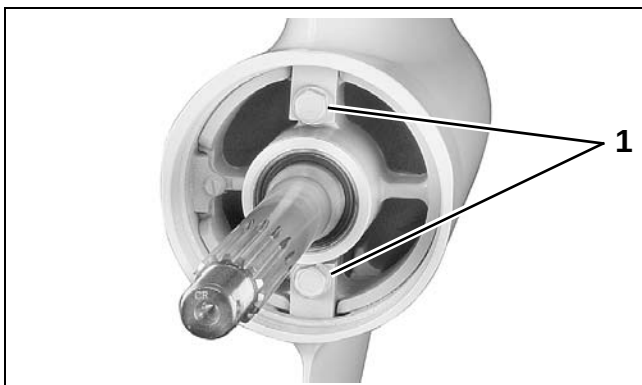
006844

Housing must be completely seated in gearcase to install retainer tabs. Depth to retainer tab surface on bearing housing is approximately 1 in. (25.4 mm).



006845

Install two retainers, washers and screws. Apply *Ultra Lock* to threads and tighten screws to a torque of 18 to 20 ft. lbs. (24 to 27 N·m).



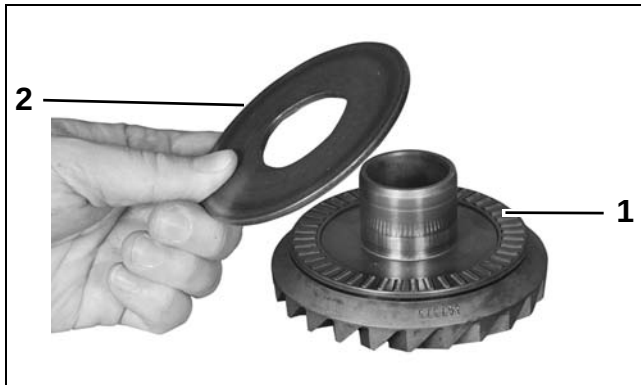
1. Retainer tab screws

001989

Propeller Shaft Bearing Housing and Gear Installation – “M2” Type

IMPORTANT: The propeller shaft bearing housing on the “M2” type gearcases is **PRESSED** into the gearcase housing.

Oil and install thrust bearing and thrust washer on hub of reverse gear. Slide the gear assembly onto the propeller shaft until it engages the pinion gear.

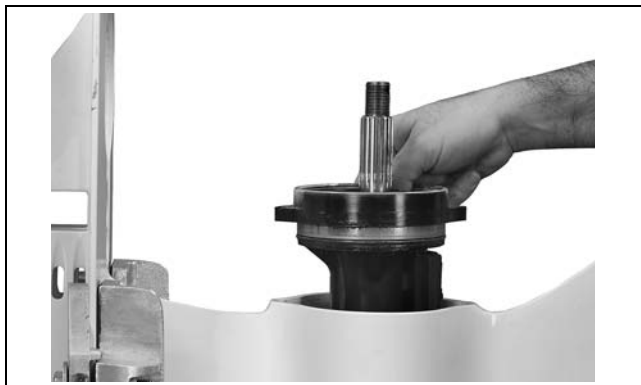


1. Thrust bearing
2. Thrust washer

006925

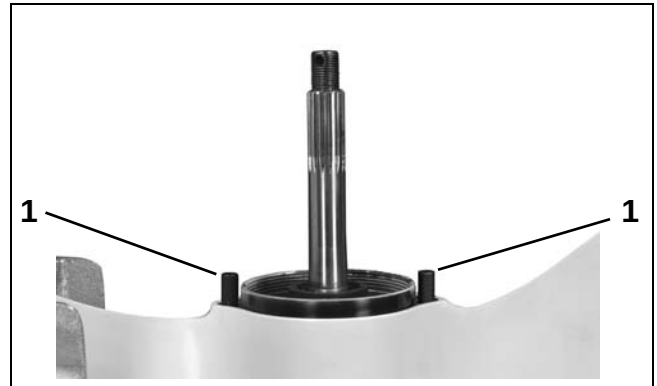
Lightly apply *Triple Guard Grease* to new bearing housing O-rings. Install O-rings in grooves in the housing. Grease the machined side surfaces of bearing housing.

Place bearing housing in gearcase.



006846

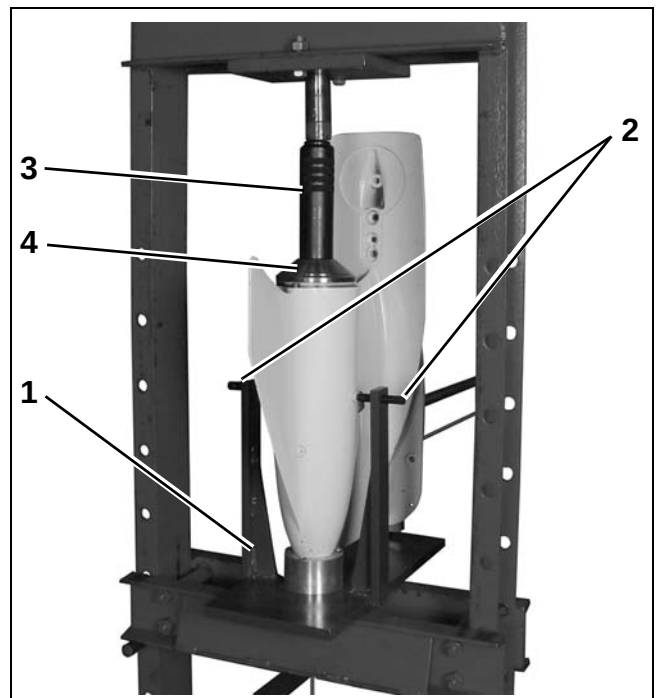
Align retaining holes in bearing housing with screw holes in gearcase. Thread Alignment Pins, P/N 354140, into gearcase.



1. Alignment pins

006926

Use Installer Handle, P/N 345822, Propeller Shaft Bearing Housing Installer, P/N 354057, Gearcase Fixture, P/N 354059 and an appropriate floor press (10 ton or greater) to install housing into gearcase. Align and level gearcase assembly in fixture as shown. Secure fixture to floor press.



1. Gearcase fixture, P/N 354059
2. Vertical alignment screws
3. Handle P/N 345822
4. Housing installer P/N 354057

006927

GEARCASE – STANDARD ROTATION

GEARCASE ASSEMBLY

Housing must be completely seated in gearcase to install retainer screws. Bearing housing is approximately level with gearcase.



006928

Apply *Ultra Lock* to threads and install two retaining screws. Tighten screws to a torque of 18 to 20 ft. lbs. (24 to 27 N·m).



1. Retainer screws

006835

Final Assembly and Adjustment

To complete gearcase assembly, refer to:

- **GEARCASE LEAK TEST** on p. 267
- **WATER PUMP SERVICE** on p. 271
- **SHIFT ROD ADJUSTMENT** on p. 274
- **GEARCASE REMOVAL AND INSTALLATION** on p. 268
- **Gearcase Lubricant** on p. 36
- **Propeller Hardware Installation** on p. 266
- **Trim Tab Adjustment** on p. 29

During break-in period of a reassembled gearcase, change the gearcase lubricant between 10 to 20 hours of operation.

GEARCASE DISASSEMBLY

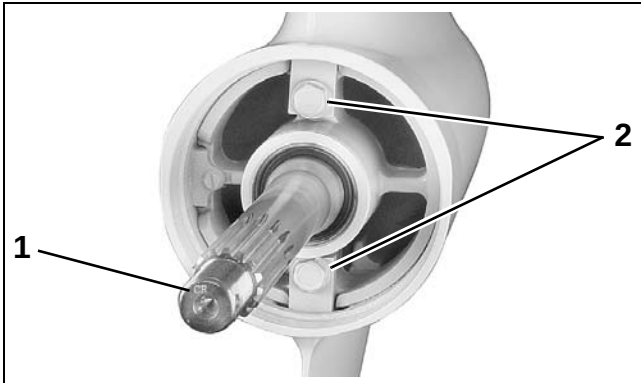
IMPORTANT: Counter rotation (CR) gearcases use unique components and require different service procedures. Use care when working on counter rotation gearcases. DO NOT interchange parts between standard and counter rotation models. Identify gearcase type before disassembly. Make sure the “CR” marking is on the end of the propeller shaft.

Pre-Disassembly Inspection

Refer to **Pre-Disassembly Inspection** on p. 275.

Propeller Shaft Bearing Housing Removal – “O” Type

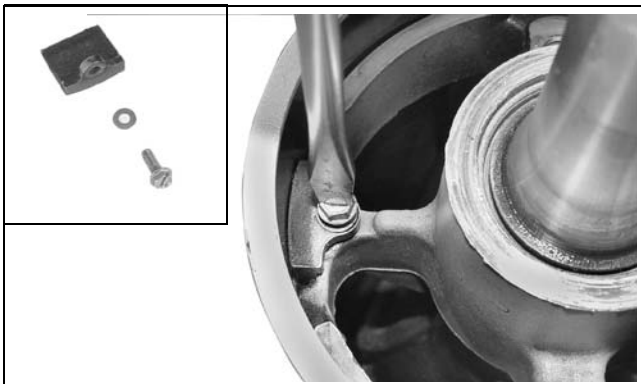
Remove the two screws, washers, and retainers holding the propeller shaft bearing housing.



1. “CR” marking
2. Retainer tab screws

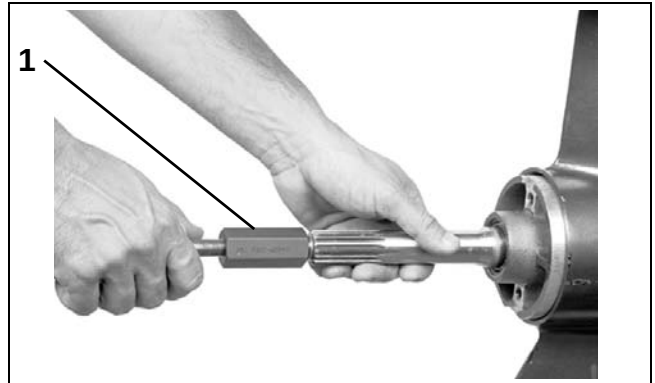
001989

Remove wedge, screw, and washer.



DSM02291
DSC02361

To remove the propeller shaft, bearing housing and forward gear from gearcase, thread Propeller Shaft Adapter, P/N 432398, onto Slide Hammer, P/N 432128, until it seats. Thread adapter completely onto propeller shaft and pull propeller shaft, bearing housing, and forward gear assembly out of gearcase.



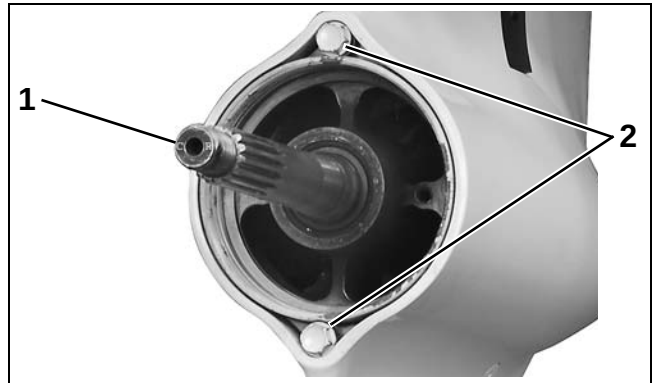
1. Adapter, P/N 432398

13501

Propeller Shaft Bearing Housing Removal – “M2” Type

IMPORTANT: The propeller shaft bearing housing on “M2” type gearcases is **PRESSED** into gearcase housing.

Remove the two retaining screws holding the propeller shaft bearing housing.



1. “CR” marking
2. Retainer screws

006835

Remove the propeller shaft bearing housing from the gearcase using:

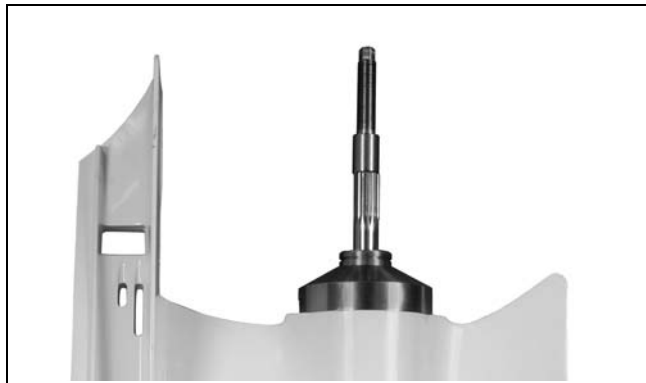
- Propeller Shaft Bearing Housing Puller Kit, P/N 354060.

GEARCASE – COUNTER ROTATION

GEARCASE DISASSEMBLY

DO NOT use tools designed to push on the propeller shaft. Pushing against the propeller shaft could damage the forward gear thrust bearing or thrust washer.

Install the threaded adaptor from the puller kit on to the propeller shaft until seated.



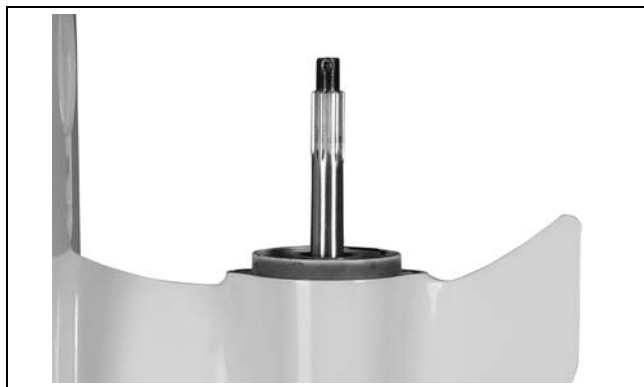
006833

Assemble puller kit components. Hold adaptor with wrench and turn nut clockwise to pull bearing housing.



006834

Pull propeller shaft and bearing housing far enough to loosen the **PRESSED** bearing housing from the gearcase housing.



“M2” Type Gearcase

006837

Remove propeller shaft, forward gear and bearing housing assembly from gearcase.



006850

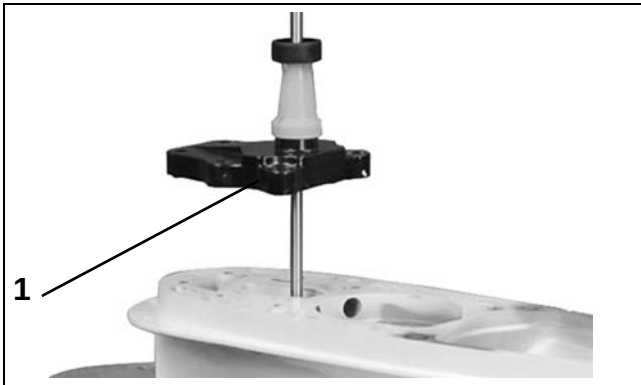
Pinion Gear Removal and Driveshaft Servicing

Refer to **Pinion Gear and Driveshaft Removal – “O”, “L2”, and “M2” Type** on p. 281.

Shift Housing, Gear and Propeller Shaft Removal

Push down on the shift rod. This will move the detent lever downward to clear the inside of the gearcase when the shaft assembly is pulled out. Unscrew the shift rod from the detent lever. Remove screws, cover, and shift rod from the gearcase.

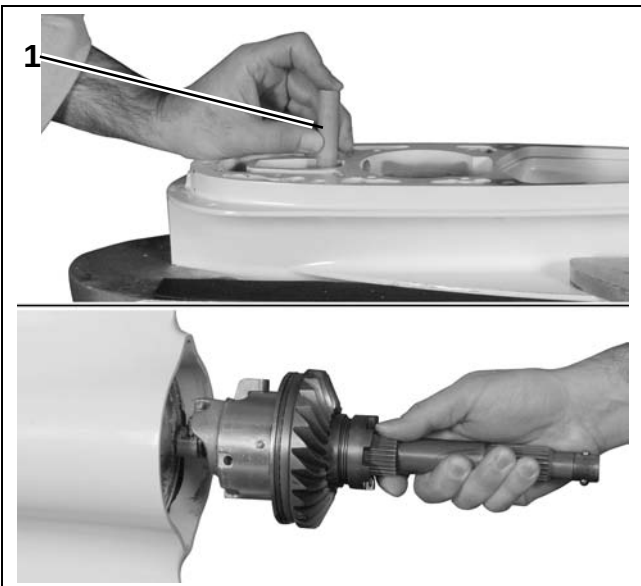
Discard the cover gasket. Remove the shift rod O-ring from inside of cover and discard.



1. Cover gasket

006884

Use an appropriate tool to apply downward pressure on the detent while pulling on the propeller shaft assembly. Remove propeller shaft assembly from the gearcase.



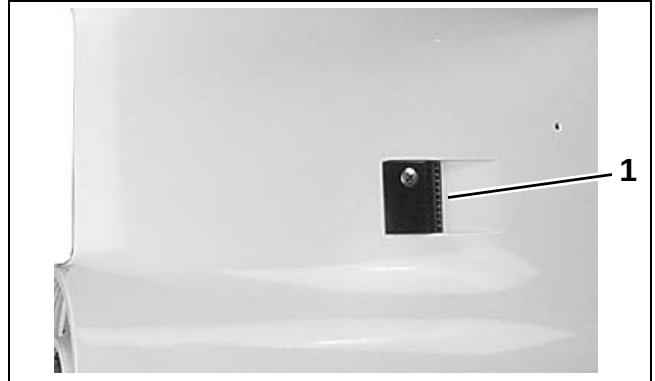
Counter Rotation Models

1. Tool

006929

Water Intake Screens

Remove and clean water intake screens. Replace if damaged.



1. Water intake screen

001991

GEARCASE HOUSING INSPECTION

Refer to **GEARCASE HOUSING INSPECTION** on p. 284.

SHIFTER, BEARING AND SEAL SERVICING

Shift Housing Disassembly

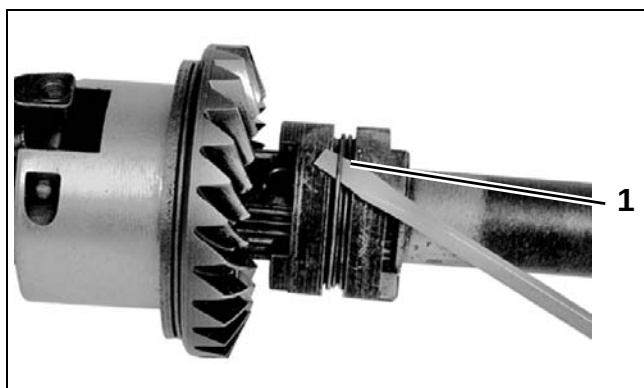


WARNING

Wear safety glasses to avoid injury.

IMPORTANT: The shift housing and bearing are serviced as an assembly. If either are worn or damaged, replace the complete assembly.

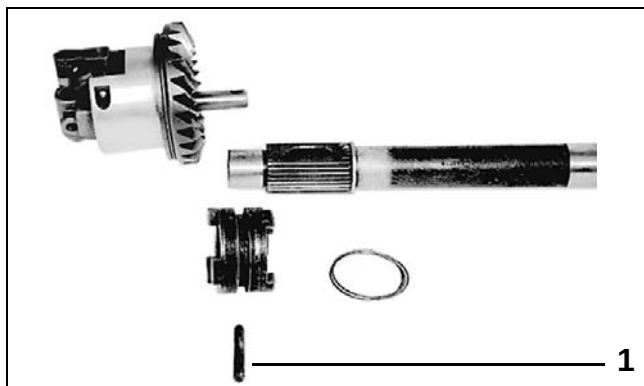
Insert a suitable tool under one end of the clutch dog spring and remove it from its groove by unwrapping it from around the clutch dog. **Discard the spring.**



1. Clutch dog spring

COA3560

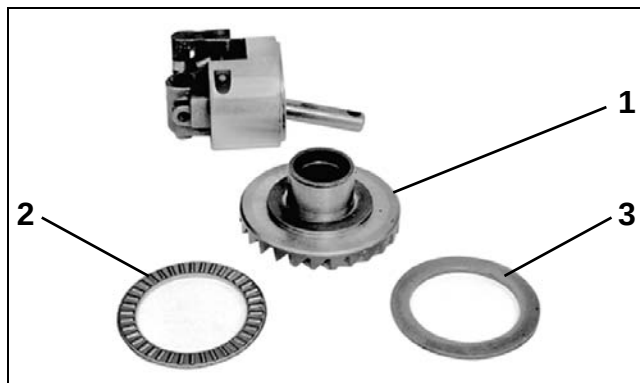
Push the pin out of the clutch dog. Remove all parts.



1. Pin

COA3561

Remove the gear, thrust bearing, and thrust washer from the shift housing.

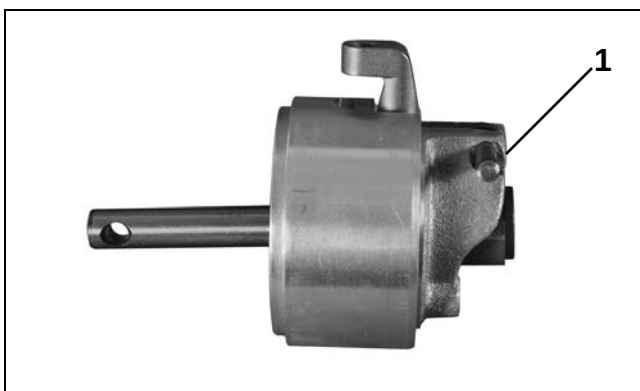


- 1. Gear
- 2. Thrust bearing
- 3. Thrust washer

COA3562

IMPORTANT: The shift housing supports the reverse gear on counter rotation gearcases.

Remove the shift lever pin from the housing. Remove shift shaft, cradle and shift lever. Move shifter detent as needed to help ease removal of parts.



1. Pin

006861

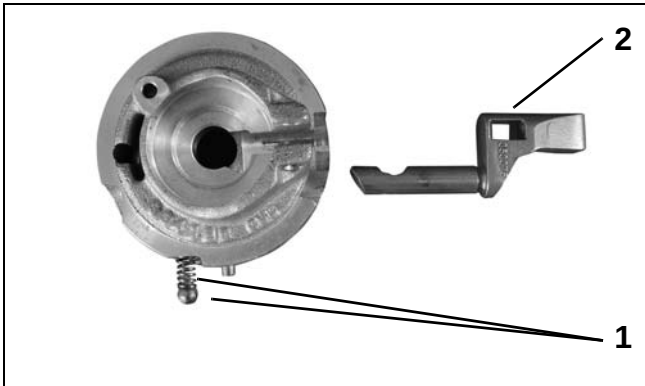


WARNING

Wear safety glasses to avoid personal injury. The detent ball and spring and come out with great force.

GEARCASE – COUNTER ROTATION SHIFTER, BEARING AND SEAL SERVICING

Wrap the housing with a shop cloth to catch ball and spring. Pull the shifter detent straight out of the housing.



- 1. Ball and spring
- 2. Shifter detent

006932

Remove the detent ball and spring.

Remove needle bearings from bearing housing for cleaning and inspection.

Shift Housing Assembly

IMPORTANT: Clean and inspect all parts before beginning assembly procedures. Replace any damaged parts.

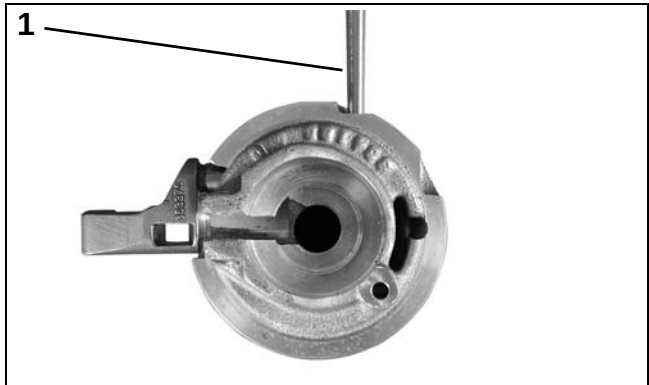
Lightly coat the detent ball and spring with *Needle Bearing* grease. Insert the spring in the housing, then the ball.



006933

Insert shifter detent into the housing as shown, while depressing the ball and spring with a suit-

able tool. Once the detent is past the ball, remove the tool and position detent to engage NEUTRAL.



- 1. Punch

006934

Thoroughly grease 25 needle bearings with *Needle Bearing* grease and place in the bearing case.



4520

Rest the cradle and shift lever on the shift shaft and insert through the front side of the shift housing.

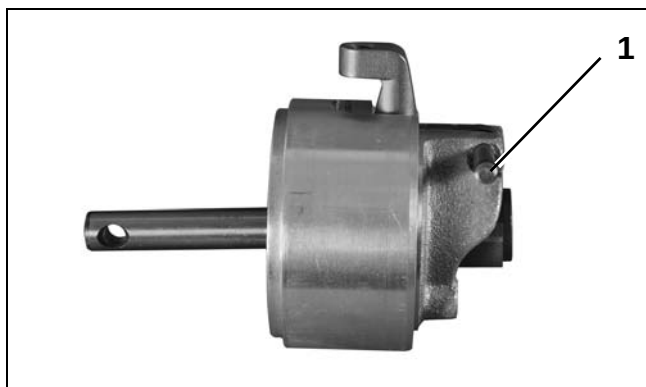


- 1. Cradle
- 2. Shift lever

006860

GEARCASE – COUNTER ROTATION SHIFTER, BEARING AND SEAL SERVICING

Install arms of shift lever into detent slots. Align the pivot holes and insert the retaining pin. Push shifter detent down.



1. Pin, shift lever

006861

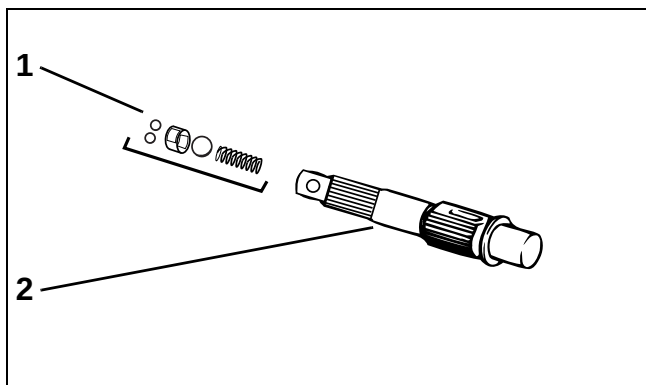
Inspect clutch shaft detent balls, retainer and spring. These parts should not require removal under normal servicing.



WARNING

Wear safety glasses to avoid injury.

If these parts are damaged or removed, a new service kit should be installed. Refer to parts catalog for kit part number.

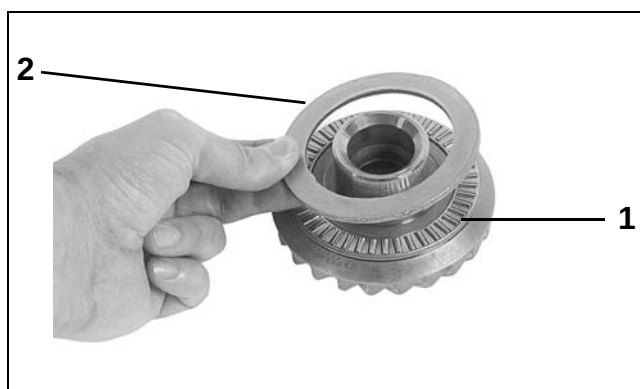


1. Clutch Shaft Retainer Kit
2. Clutch Shaft

0000

Coat thrust bearing and thrust washer with *Needle Bearing* grease. Place the bearing on the back of the gear. Set the washer on top of the thrust bearing. Insert the gear, bearing, and washer into the bearing housing.

NOTICE Bearing and washer must be installed in the correct order.



1. Thrust bearing
2. Thrust washer

DSC02297

Align holes in the clutch dog with slot in the propeller shaft. Install the clutch dog on the shaft with "PROP END" facing rear of the shaft.

NOTICE The clutch dog is not symmetrical. If installed backward, it will not fully engage and will immediately damage itself and the gears.



1. "PROP END"

006906

Slide the propeller shaft onto the shift shaft, align the hole in the shaft with the hole in the clutch dog, install the pin and then, a **new** clutch dog retaining spring. Place three coils over each end of the pin, MAKING SURE NONE OF THE COILS OVERLAP OR ARE LOOSE.



1. Retaining spring

COB3101

Pinion Bearing

Refer to **Pinion Bearing Installation** on p. 285.

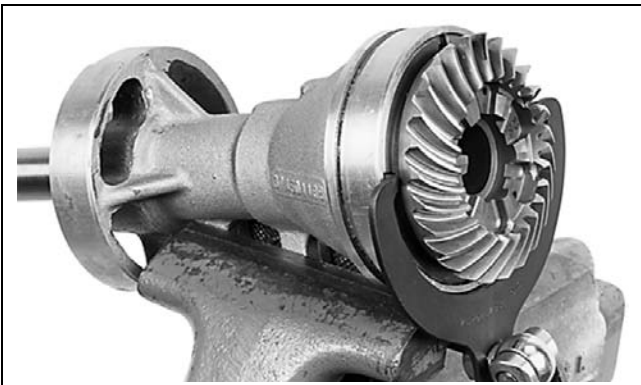
Propeller Shaft Bearing Housing and Forward Gear – “O” Type

Disassembly

Remove and discard the bearing housing O-ring.

Remove the anode and discard if more than two-thirds deteriorated.

Clamp the bearing housing by the anode bosses in a vise, as shown. Remove the forward gear assembly by unscrewing it with Spanner Wrench, P/N 432400.



13491

Remove gear housing retaining ring.



DSC02486

Remove the set screws and remove the flange.



31965

Remove the shim from either the flange or forward gear.



31964

GEARCASE – COUNTER ROTATION SHIFTER, BEARING AND SEAL SERVICING

Remove the thrust bearing.



31963

Remove the bearing housing from the forward gear.



31961

Remove the thrust bearing from the forward gear.

Inspect the forward gear for excessive wear or damage.



31960

Remove the forward gear bearing only if it needs to be replaced. If removal of the bearing is necessary, use Large Puller Jaws, P/N 432129, and Puller Bridge, P/N 432127, with an appropriate base. Leave the rollers in to allow for good contact with the puller jaws.



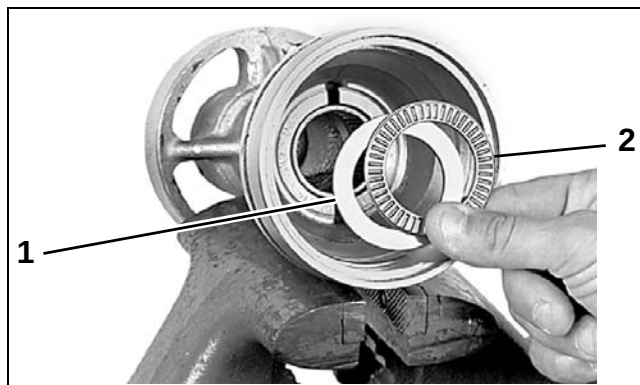
31958

Push propeller shaft out of the bearing housing.



13479

Remove the thrust washer and thrust bearing.



1. Thrust washer
2. Thrust bearing

13593

GEARCASE – COUNTER ROTATION SHIFTER, BEARING AND SEAL SERVICING

For seal and bearing service refer to **Propeller Shaft Bearing Housing Service** on p. 291.

Assembly

If removed, install a new forward gear bearing. Apply *Needle Bearing* grease to 25 new rollers. Install the rollers in the bearing.

Use Bearing Installation Tool, P/N 339778, to install the bearing, lettered side facing tool.



31956

Install the thrust bearing on the forward gear.



31960

Place the bearing housing on the forward gear.



31960

Install 0.030 in. (0.7 mm) of shims and the thrust bearing in the flange. Install the thrust bearing on the forward gear.



31955

Install set screws and tighten to a torque of 144 to 168 in. lbs. (16.5 to 19 N·m). Use no thread sealant.

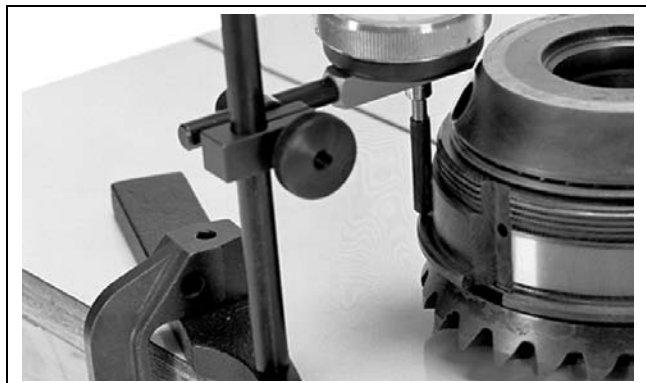


31967

Anchor a dial indicator gauge to a flat, level surface.

GEARCASE – COUNTER ROTATION SHIFTER, BEARING AND SEAL SERVICING

Place the gear assembly so the indicator needle makes contact with the flange on the housing. The indicator needle must be parallel with the side of the gear housing and perpendicular to the table surface. Zero the dial indicator.



31953

Grip the bearing housing 180° apart and pull up to get a reading on the indicator. To determine thickness of shims; use the following example:

- 0.030 in. of shims in the assembly
- 0.020 in. reading on the dial indicator
- = 010 in. difference
- + 0.001 in. necessary end play
- = 0.011 in. required shims



31968

Remove the 0.030 in. (0.7 mm) of shims from the assembly. Reassemble the gear assembly using a combination of shims to achieve the required thickness. Apply *Nut Lock* to the threads of the set screws and torque to 144 to 168 in. lbs. (16.3 to 19 N·m).

Apply *Needle Bearing* grease to the thrust bearing. Position bearing around shoulder on the propeller shaft.

Apply *Needle Bearing* grease to the thrust washer. Place washer in recess of bearing housing.



- 1. Thrust bearing
- 2. Thrust washer

14214

Coat bearing surfaces of propeller shaft with gear-case lubricant. Slide the propeller housing onto the propeller shaft. Thrust bearing must remain around shoulder on the propeller shaft.



14159

Apply gearcase lubricant to the threads of the forward gear bearing housing.

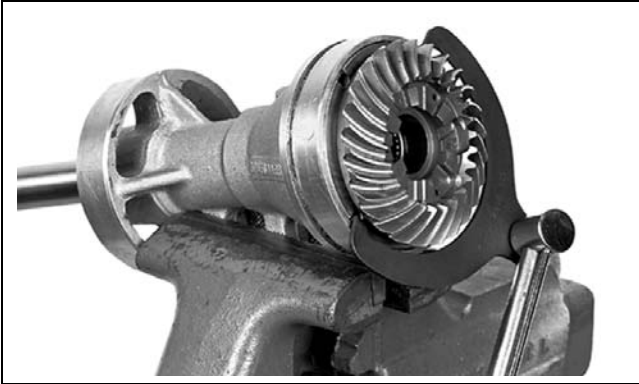


DSC02486

GEARCASE – COUNTER ROTATION SHIFTER, BEARING AND SEAL SERVICING

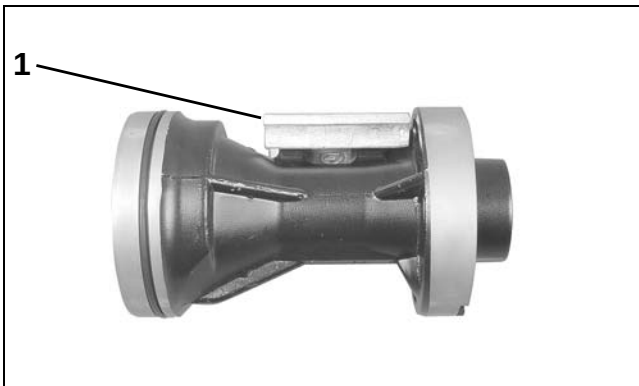
IMPORTANT: To prevent damage to threads, install forward gear bearing housing assembly by hand until fully seated against propeller shaft bearing housing.

Use Spanner Wrench, P/N 432400, to tighten the gear assembly to a torque of 100 ft. lbs. (136 N·m).



13529

Inspect the bearing housing anode. Replace anode if it is reduced to two-thirds of original size. Tighten screws to a torque of 108 to 132 in. lbs. (12 to 15 N·m).



1. Anode

001220

Propeller Shaft Bearing Housing and Forward Gear – “M2” Type

Disassembly

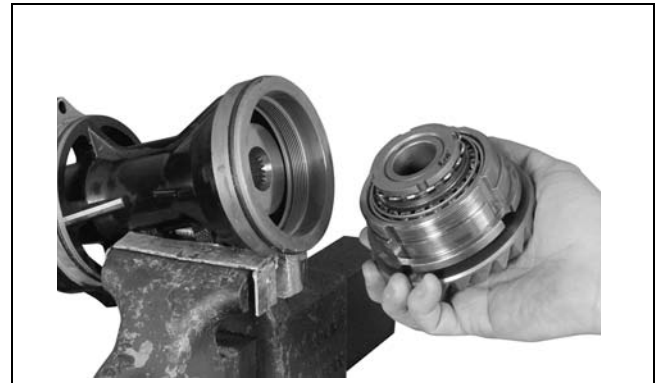
Remove and discard the bearing housing O-ring.

Remove the anode and discard if more than two-thirds deteriorated.

Clamp the propeller shaft bearing housing by the anode bosses in a vise, as shown. Remove the forward gear bearing housing assembly from propeller shaft bearing housing. Use Spanner Wrench, P/N 432400, to unscrew in a counter-clockwise direction.



006936



006937

Remove the shim(s).



006852

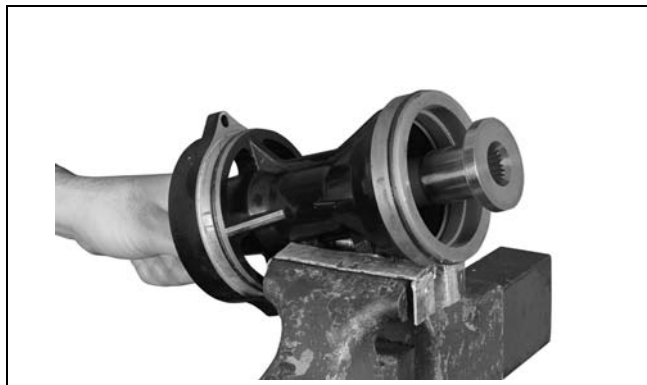
GEARCASE – COUNTER ROTATION SHIFTER, BEARING AND SEAL SERVICING

Inspect the forward gear and bearing housing assembly for excessive wear or damage.



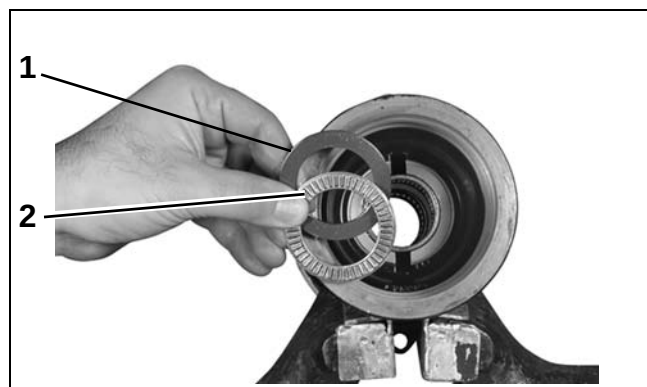
006853

Push propeller shaft out of the bearing housing.



006939

Remove the thrust washer and thrust bearing.



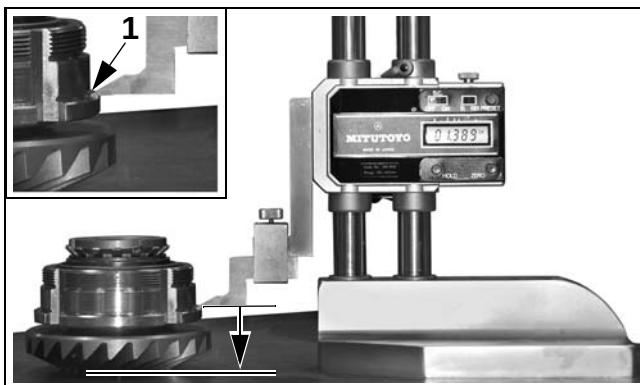
1. Thrust washer
2. Thrust bearing

006940

For seal and bearing service refer to **Propeller Shaft Bearing Housing Service** on p. 291.

Assembly

Position the forward gear bearing housing assembly on a flat, level surface. (Mirror or glass can be used.) Use depth gauge to measure distance from flange of housing to flat surface as shown.



1. Flange

006855

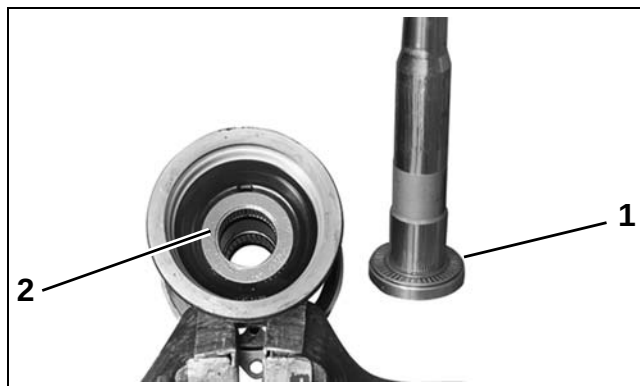
Add the appropriate shims to create a dimension of 0.140 in. (3.556 mm).

To determine thickness of shims; use the following example:

$$\begin{aligned} & \underline{1.389 \text{ in. reading on the gauge}} \\ & + \underline{0.011 \text{ in. shims required}} \\ & = \underline{1.400 \text{ in. required dimension}} \end{aligned}$$

Apply *Needle Bearing* grease to the thrust bearing. Position bearing around shoulder on the propeller shaft.

Apply *Needle Bearing* grease to the thrust washer. Place washer in recess of bearing housing.



1. Thrust bearing
2. Thrust washer

006941

GEARCASE – COUNTER ROTATION SHIFTER, BEARING AND SEAL SERVICING

Coat bearing surfaces of propeller shaft with gearcase lubricant. Slide the propeller housing onto the propeller shaft.

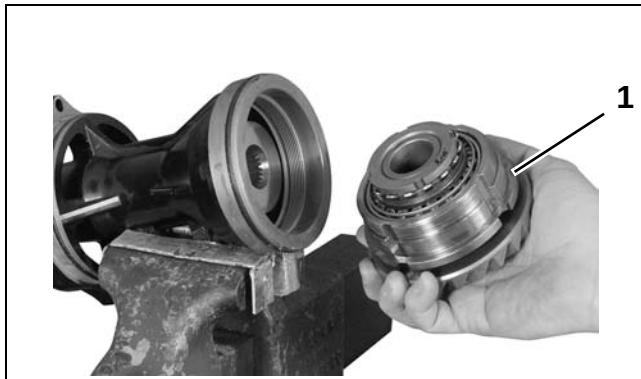


006942

IMPORTANT: Use caution when assembling the propeller shaft in the bearing housing. Thrust bearing must remain around shoulder on the propeller shaft.

Apply gearcase lubricant to the threads of the forward gear bearing housing.

Install forward gear assembly with correct shims in bearing housing.

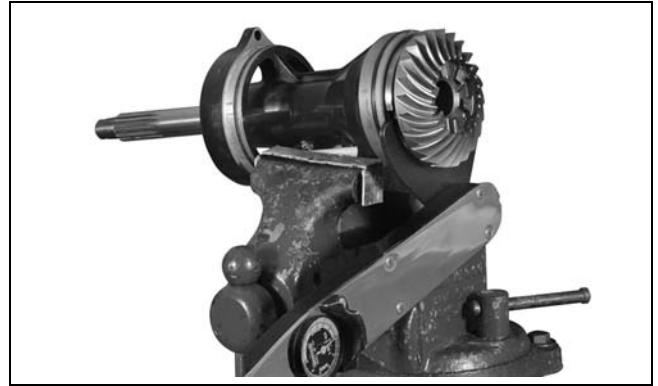


1. Shim(s)

006937

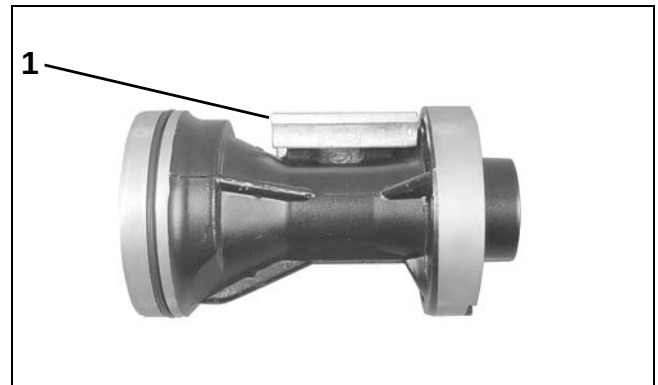
IMPORTANT: To prevent damage to threads, install forward gear bearing housing assembly by hand until fully seated against propeller shaft bearing housing.

Use Spanner Wrench, P/N 432400, to tighten the gear assembly to a torque of 100 ft. lbs. (136 N·m).



006943

Inspect the bearing housing anode. Replace anode if it is reduced to two-thirds of original size. Tighten screws to a torque of 108 to 132 in. lbs. (12 to 15 N·m).



1. Anode

001220

DRIVESHAFT SHIMMING

NOTICE If a new pinion gear is needed, replace gear set before shimming.

Pinion gear backlash is achieved by using shims between the driveshaft bearing housing and the thrust washer. When installing a new thrust bearing or washer, bearing housing, pinion, or driveshaft, it is necessary to properly shim the assembly to restore factory clearance.

Use Driveshaft Shimming Tool, P/N 5005925.

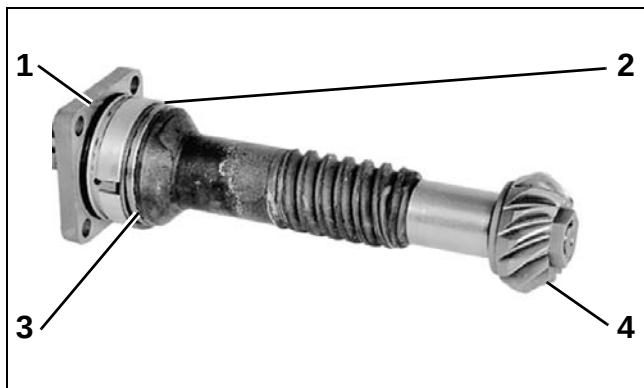
Shim gauge bars are precision made and should be handled carefully. The length of each bar is stamped near the part number. This dimension is 0.020 in. (0.508 mm) shorter than the actual shimmed length of the driveshaft.

IMPORTANT: Clean pinion and driveshaft before assembly. Replace any damaged parts.

Assemble the driveshaft bearing housing, thrust washer, thrust bearing, and pinion onto the driveshaft. Use Driveshaft Seal Protector, P/N 318674, when installing or removing the bearing housing.

Lightly coat the threads of the pinion nut with out-board lubricant and tighten to a torque of 100 to 110 ft. lbs. (136 to 149 N·m).

IMPORTANT: The original pinion nut may be used for shimming, but must **NOT** be used in final assembly.



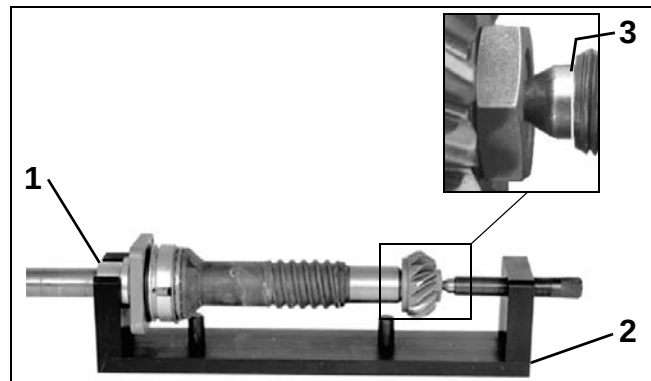
1. Driveshaft bearing housing COA3565
2. Thrust washer
3. Thrust bearing
4. Pinion

Select collar, P/N 341440, and shim gauge bar:

- “M2”: Shim gauge bar, P/N 349957
- “O”: Shim gauge bar, P/N 328367

Slide the collar onto the driveshaft with large end in contact with the bearing housing.

Insert the assembled driveshaft into the tool base and tighten preload screw against the driveshaft until groove on the spring-loaded plunger is flush with end of threads. Tighten locking ring on preload screw.

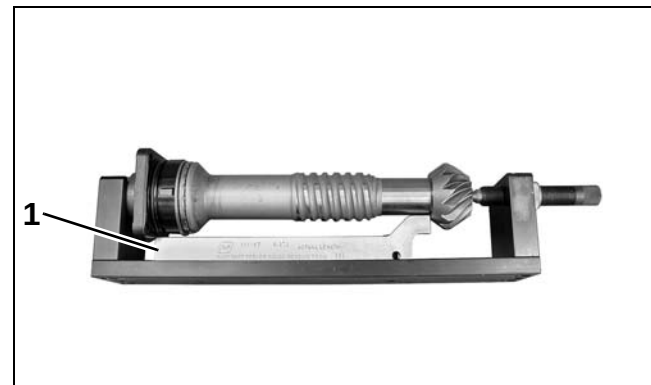


1. Collar
2. Tool base
3. Groove

COA3566
DSC00326
005415

Rotate the driveshaft several revolutions to seat bearings.

Lay the tool base on its side. Position the shim gauge bar against guide pins of the tool base.



1. Shim gauge bar

005416

Check squareness of the bearing housing mounting surface by holding the shim gauge bar against the pinion while rotating **just the bearing housing**. Use a feeler gauge to measure clearance between the gauge bar and the bearing housing between each pair of screw holes. Replace the bearing housing and repeat check if variance is greater than 0.004 in. (0.101 mm).

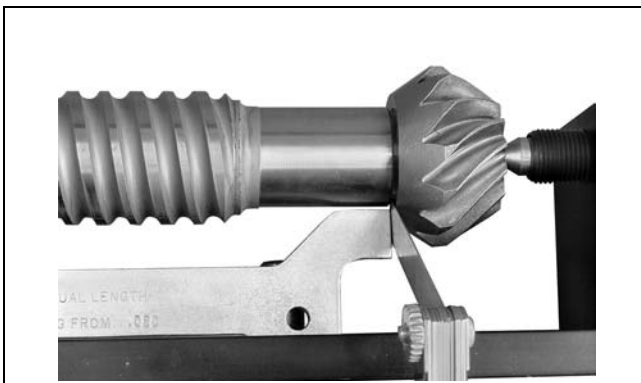
Check squareness of the pinion to the driveshaft. Hold the shim gauge bar against the bearing housing (between the screw holes) while rotating **just the driveshaft and pinion assembly**. Measure clearance between the gauge bar and the pinion at several locations. If variance is greater than 0.002 in. (0.050 mm) replace the pinion or driveshaft, as necessary, and repeat check.

Subtract the average clearance measurement from 0.020 in. (0.508 mm) to determine the correct shim thickness required. Select the fewest number of shims to achieve the correct thickness.

Remove the driveshaft from the tool and add the required shims between the bearing housing and the thrust washer.

IMPORTANT: Use extreme care when removing bearing housing to avoid damaging the seals. Use Driveshaft Seal Protector, P/N 318674.

Check clearance again. The measurement between the gauge bar and pinion should be 0.020 in. (0.508 mm).



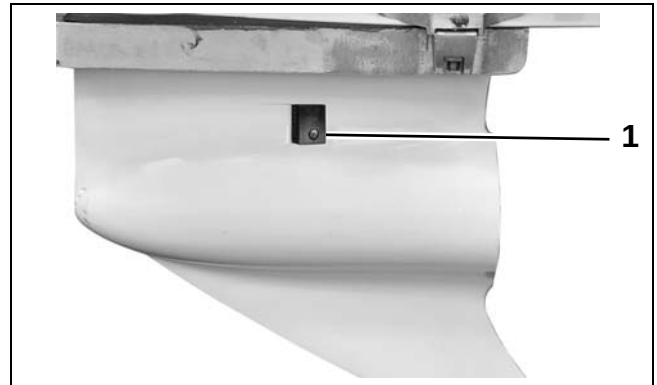
005417

Remove the nut and pinion from the driveshaft. Discard the nut.

GEARCASE ASSEMBLY

Water Intake Screens

Install water intake screens. Tighten screws to a torque of 60 to 84 in. lbs. (7 to 9.5 N·m).



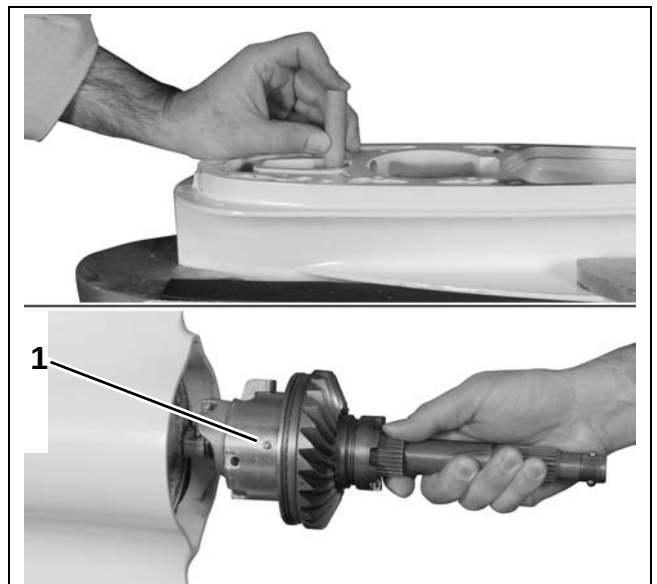
1. Water intake screen

006886

Shift Housing, Gear, and Propeller Shaft Installation

Push shifter detent into farthest downward position. Tip the rear of the gearcase slightly downward to assist in the installation of the shaft assembly.

Be sure the thrust bearing and the thrust washer are in the proper position. Insert the shaft assembly fully into the gearcase while aligning shift housing pin with hole in forward end of gearcase housing.



1. Pin

006929

GEARCASE – COUNTER ROTATION GEARCASE ASSEMBLY

Shift Rod Cover

Refer to **Shift Rod Housing Installation** on p. 296.

Pinion Gear and Driveshaft Installation

Refer to **Pinion Gear and Driveshaft Installation** – “O”, “L2”, and “M2” Type on p. 301.

Propeller Shaft Bearing Housing and Gear Installation – “O” Type

Lightly apply *Gasket Sealing Compound* to a new bearing housing O-ring. Install O-ring in groove in the housing.

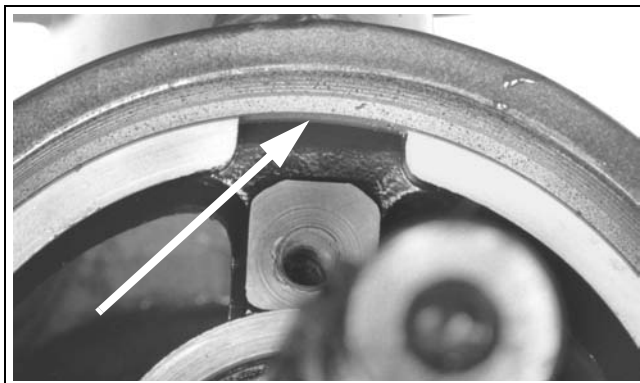
Install housing into gearcase. Align screw holes with retainer slots in gearcase.

IMPORTANT: The propeller shaft must engage the clutch shaft and the forward gear must fully engage the pinion gear.



13586

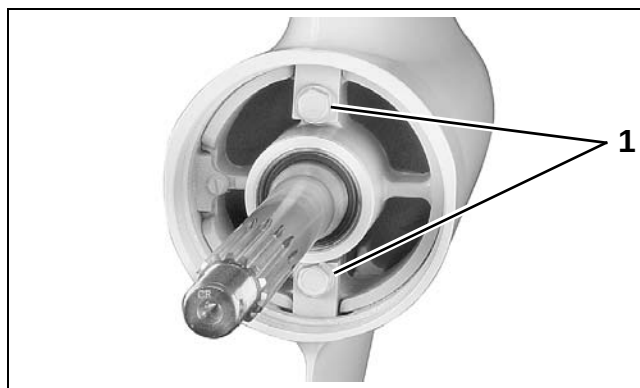
Housing must be completely seated to install retainer tabs.



Retainer Tab Notch

50106a

Install two retainers, washers and screws. Apply *Ultra Lock* to threads and tighten screws to a torque of 18 to 20 ft. lbs. (24 to 27 N·m).

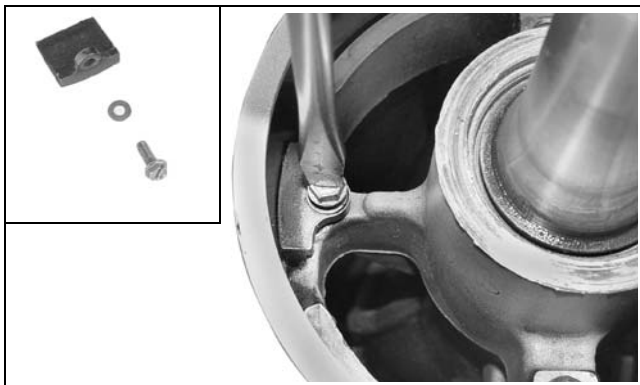


1. Retainer tab screws

001989

Loosen retainer screws 1/4 turn.

Install wedge, screw, and washer. Apply *Ultra Lock* to threads and tighten screw to a torque of 15 to 20 in. lbs. (1.7 to 2.3 N·m).



DSM02291
DSC02361

Re-tighten two retainer screws to 18 to 20 ft. lbs. (24 to 27 N·m).

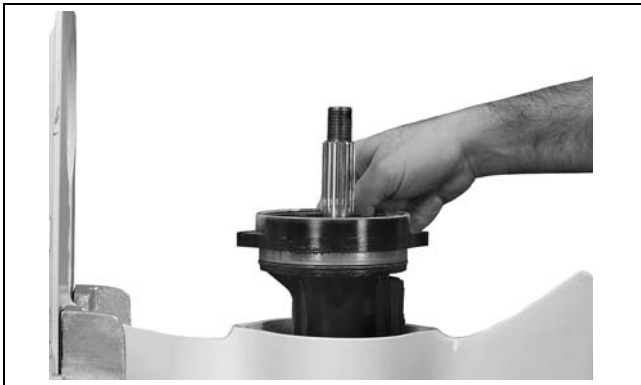
Confirm that torque on the wedge screw is 15 to 20 in. lbs. (1.7 to 2.3 N·m).

Propeller Shaft Bearing Housing and Gear Installation – “M2” Type

IMPORTANT: The propeller shaft bearing housing on “M2” type gearcases is **PRESSED** into the gearcase housing.

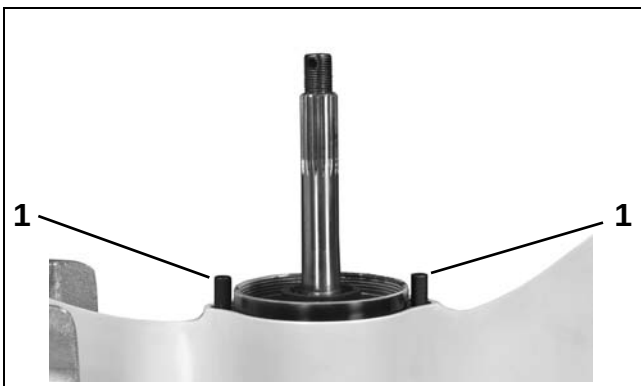
Lightly apply *Triple Guard Grease* to new bearing housing O-rings. Install O-rings in grooves in the housing. Grease the machined side surfaces of bearing housing.

Place bearing housing in gearcase.



006846

Align retaining holes in bearing housing with screw holes in gearcase. Thread Alignment Pins, P/N 354140, into gearcase.

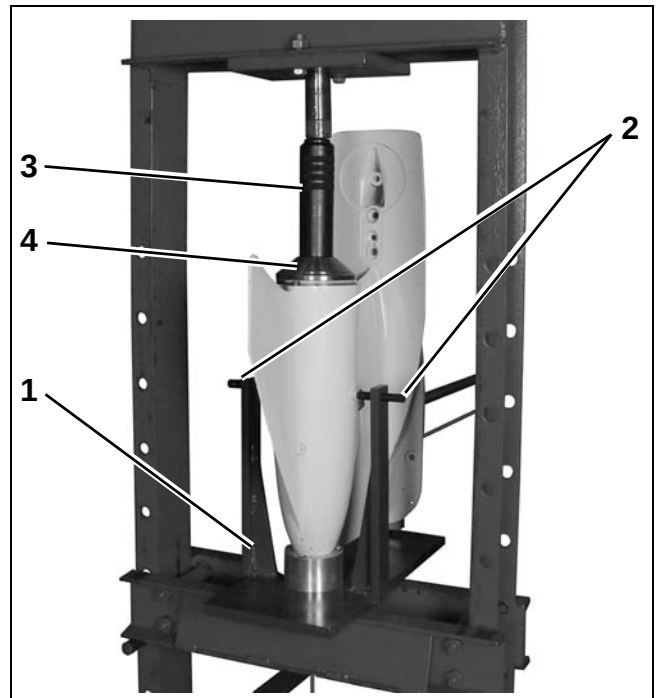


1. Alignment pins

006926

IMPORTANT: Pinion, clutch dog and forward gears must align properly for bearing housing to seat properly.

Use Installer Handle, P/N 345822, Propeller Shaft Bearing Housing Installer, P/N 354057, Gearcase Fixture, P/N 354059 and an appropriate floor press (10 ton or greater) to install housing into gearcase. Align and level gearcase assembly in fixture as shown. Secure fixture to floor press.



1. Gearcase fixture, P/N 354059
2. Vertical alignment screws
3. Handle P/N 345822
4. Housing installer P/N 354057

006927

Housing must be completely seated in gearcase to install retainer screws. Bearing housing is approximately level with gearcase.

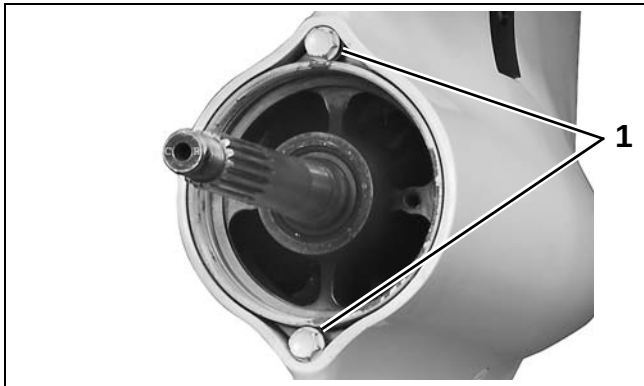


006928

GEARCASE – COUNTER ROTATION

GEARCASE ASSEMBLY

Apply *Ultra Lock* to threads and install two retaining screws. Tighten screws to a torque of 18 to 20 ft. lbs. (24 to 27 N·m).



1. Retainer screws

006835

Final Assembly and Adjustment

To complete gearcase assembly, refer to:

- **GEARCASE LEAK TEST** on p. 267
- **WATER PUMP SERVICE** on p. 271
- **SHIFT ROD ADJUSTMENT** on p. 274
- **GEARCASE REMOVAL AND INSTALLATION** on p. 268
- **Gearcase Lubricant** on p. 36
- **Propeller Hardware Installation** on p. 266
- **Trim Tab Adjustment** on p. 29

During break-in period of a reassembled gearcase, change the gearcase lubricant between 10 to 20 hours of operation.

TRIM AND TILT

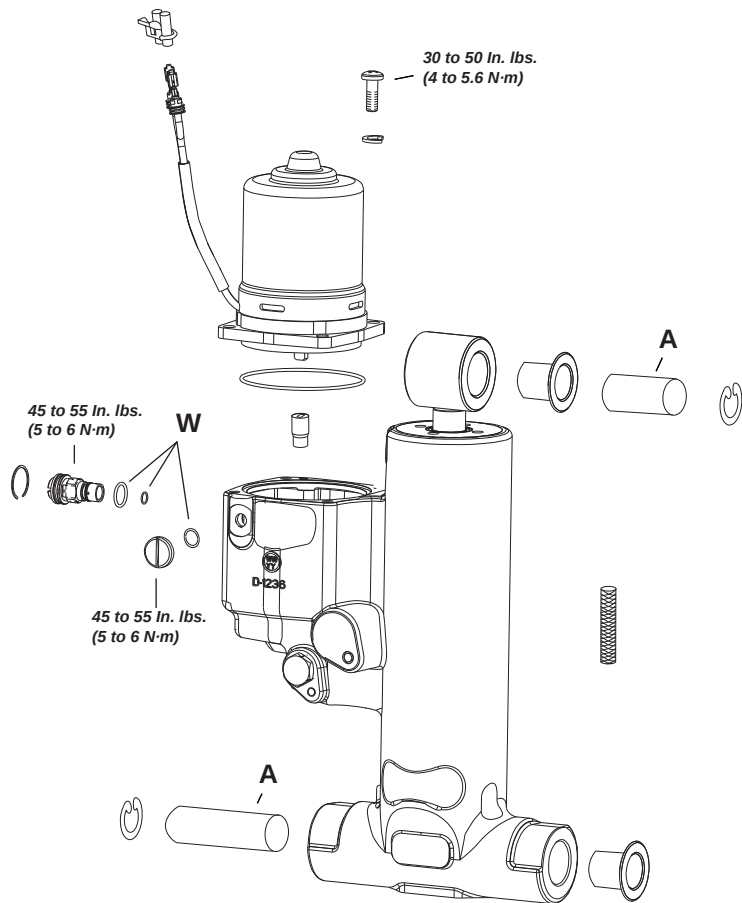
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SERVICE CHART

20" 115 HP MODELS

(SINGLE PISTON SYSTEM)

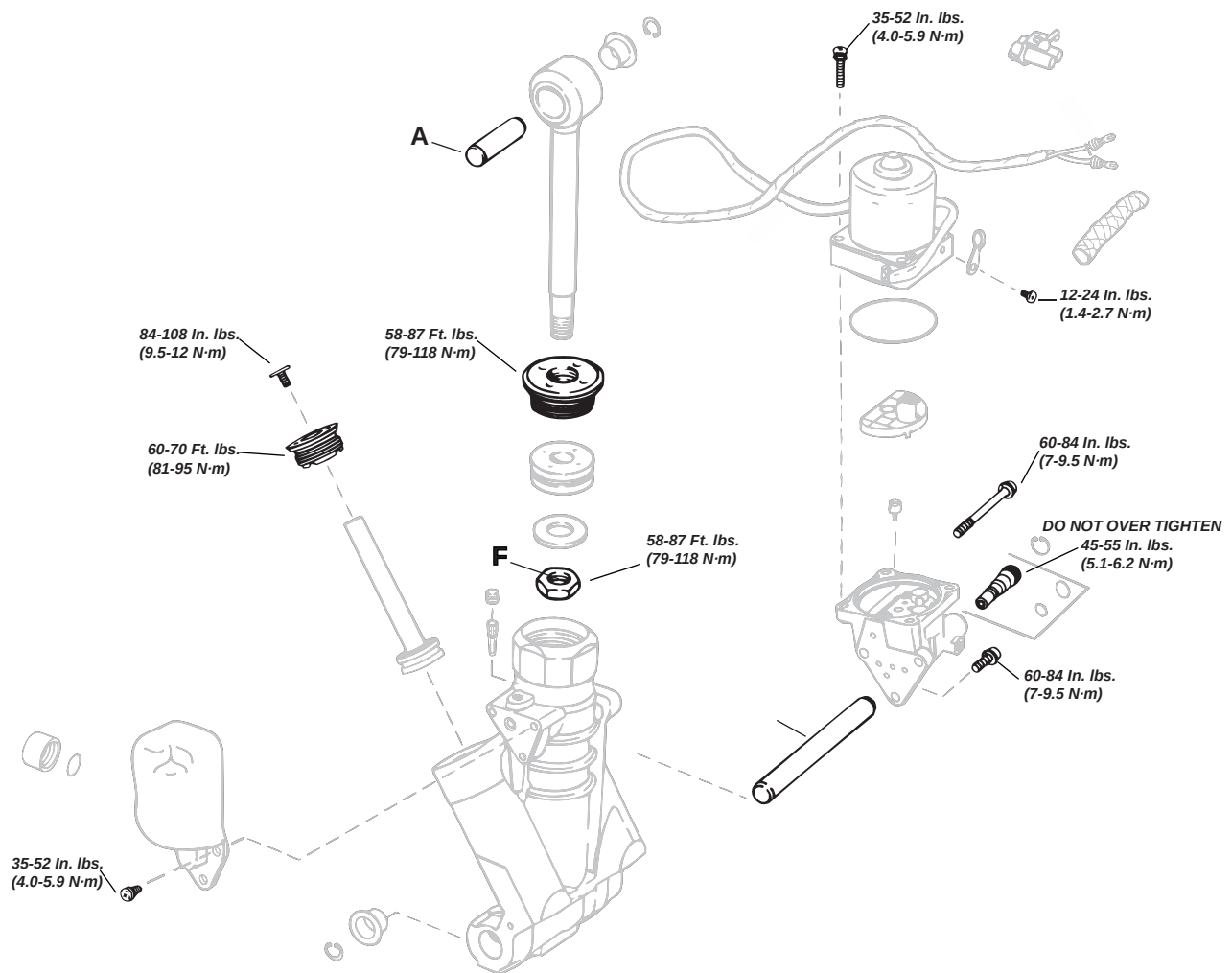


005002

A	Triple-Guard Grease
W	Biodegradable TNT Fluid

25" MODELS

(THREE PISTON SYSTEM)



DSS130

- | | |
|----------|-------------------------|
| A | Triple-Guard Grease |
| B | Gasket Sealing Compound |
| C | Adhesive 847 |
| D | Moly Lube |
| E | Red Ultra Lock |
| F | Blue Nut Lock |
| G | Needle Bearing Grease |

SYSTEM DESCRIPTION

The power trim/tilt hydraulic system is completely contained between the outboard's stern brackets.

The system consists of:

- Electric motor
- Oil reservoir
- Pump manifold assembly
- Cylinder body assembly

Optimal boat and outboard performance can be achieved by adjusting (trimming) the angle of outboard propeller thrust. The first 15° of outboard movement is considered trim range.

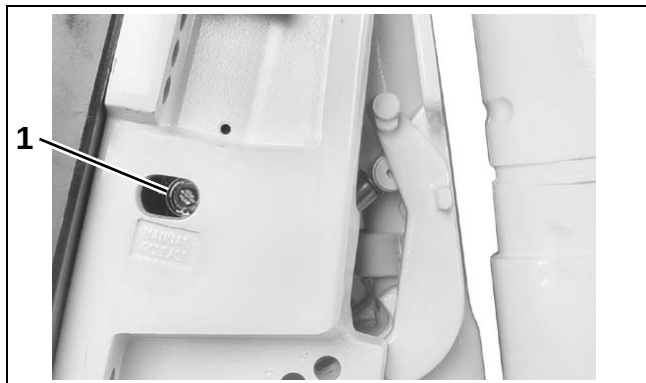
Outboard movement beyond the trim range is considered tilting. Tilting of the outboard may be desired for shallow water drive and for trailering/storage. The tilt cylinder moves the outboard through the tilt range (final 50°).

A tilt relief valve limits the propeller thrust load that will be supported by the unit in tilt range. As pressure increases, the outboard will tilt down to the top of the trim range.

IMPORTANT: When in tilt range, make sure water is available to gearcase water pickups.

Manual Adjustment

The outboard can be manually raised or lowered through the entire trim and tilt range by opening the manual release valve a minimum of three turns. The manual release valve must be closed and torqued 45 to 55 in. lbs. (5 to 6 N·m) to hold the outboard in position and before normal operation can be resumed.



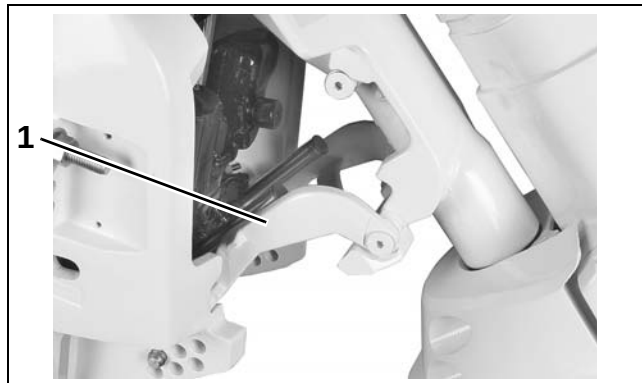
1. Manual release valve

001988

Trailering Bracket And Tilt Support

Use the trailering bracket to support the outboard when trailering in the tilted position. This bracket protects the hydraulic system from damage.

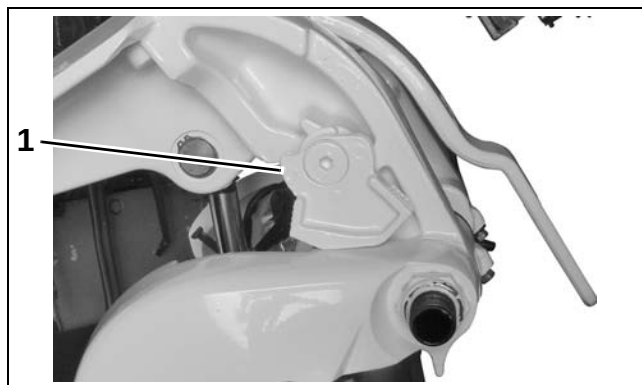
Tilt the outboard up fully, engage the bracket, then tilt the outboard down until the bracket is firmly in position.



1. Trailering Bracket

001987

For mooring or storing the boat with the outboard tilted, a tilt support is provided to support the outboard.



1. Tilt support

002279

IMPORTANT: The tilt support must not be used to support the outboard while trailering.

MODES OF OPERATION

(Three Piston System)

The trim/tilt hydraulic assembly achieves trim and tilt movement through the following modes of operation.

Trim-OUT / Tilt-UP Mode

When the UP switch is pressed, the trim/tilt motor rotates clockwise (as viewed from pump end) and turns the pump gears.

Fluid pressure passes through the UP shuttle valve to the DOWN shuttle valve, mechanically opening the DOWN check valve.

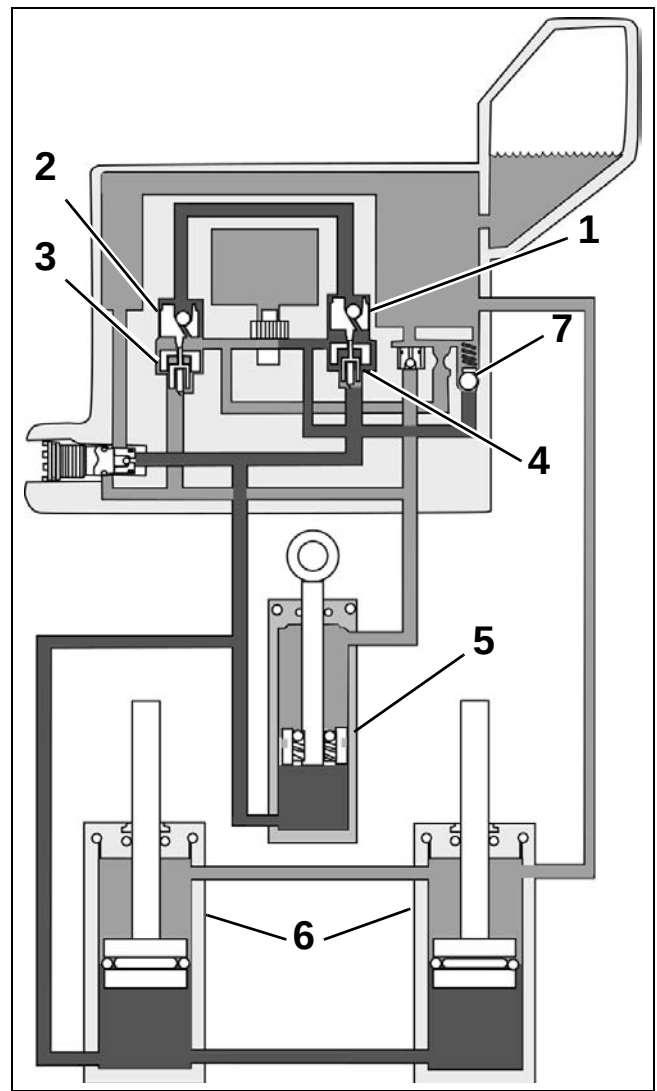
Fluid pressure pushes the UP check valve off its seat, and fluid passes through the valve to the bottom of all cylinders, pushing the pistons UP.

Fluid is pushed from the top of the tilt cylinder by the piston and returns to the pump through the open DOWN check valve.

In the trim range, fluid is pushed from the top of the trim cylinders by the pistons and returns to the reservoir.

Only fluid from the top of the tilt cylinder is returned to the pump. Because the cylinder rod displaces some fluid, that volume is less than the volume of the bottom of the tilt cylinder. So, additional fluid is drawn into the pump from the reservoir.

When all the cylinders are completely extended, the pressure increases until the UP relief valve opens at the tilt-up stall pressure (approximately 1500 psi (10342 kPa)).



1. Up shuttle valve
2. Down shuttle valve
3. Down check valve
4. Up check valve
5. Tilt cylinder
6. Trim cylinders
7. Up relief valve

DRC3462

TRIM AND TILT

MODES OF OPERATION (THREE PISTON SYSTEM)

Tilt-DOWN / Trim-IN Mode

When the DOWN switch is pressed, the trim/tilt motor rotates counterclockwise (as viewed from pump end) and turns the pump gears.

Fluid pressure passes through the DOWN shuttle valve to the UP shuttle valve, which mechanically opens the UP check valve.

Fluid pressure pushes the DOWN check valve off its seat and fluid passes through the valve to the top of the tilt cylinder, moving the tilt piston DOWN.

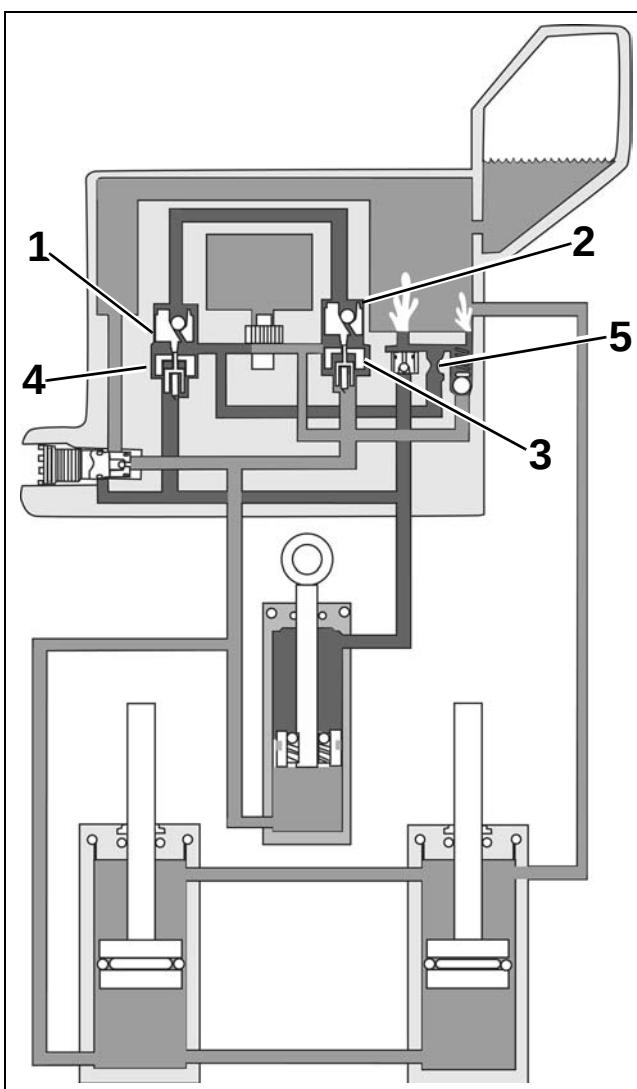
When the swivel bracket contacts the top of the trim rods, the mechanical force of the tilt cylinder pulling the outboard down also pushes the trim pistons down. Fluid is pulled from the reservoir to the top of the trim cylinders.

Fluid from the bottom of the cylinders returns through the open UP check valve to the pump.

In the tilt range, all of the fluid from the bottom of the tilt cylinder returns through the UP check valve to the pump. Since more fluid is returning to the pump than is required to fill the top of the cylinder, the excess fluid is vented through the DOWN relief orifice to the reservoir.

In the trim range, fluid from the bottom of all the cylinders is routed to the pump, which feeds only the top of the tilt cylinder. All of the excess fluid vents through the DOWN relief orifice to the reservoir.

When all cylinders are completely retracted, all of the pump output vents through the DOWN relief orifice to the reservoir at stall pressure (approximately 800 psi (5516 kPa)).



DRC3463

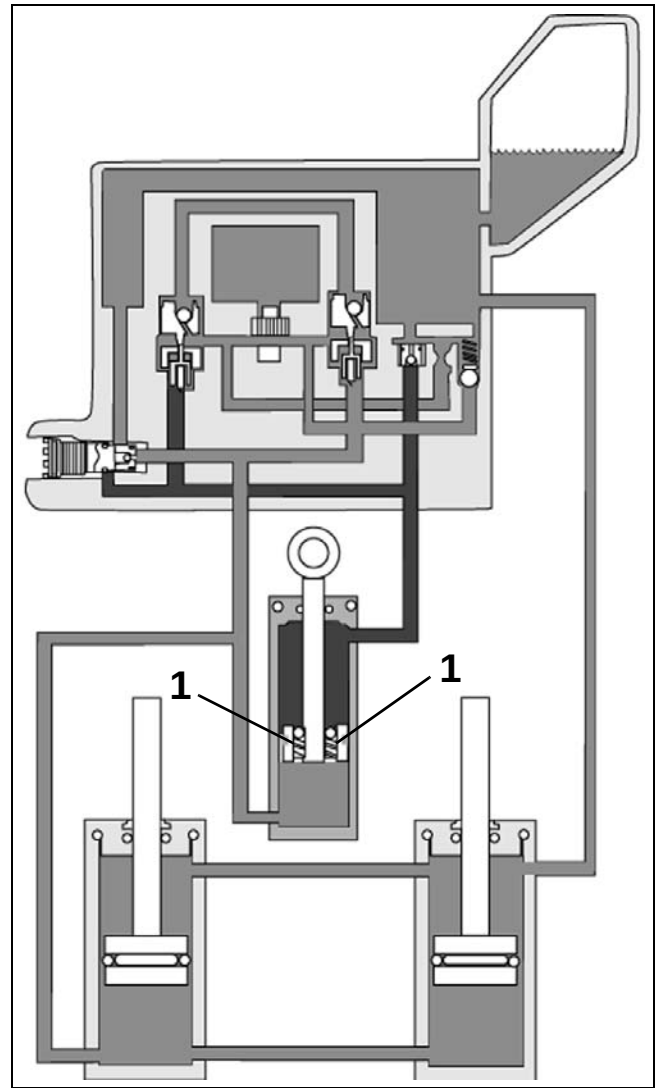
1. Down shuttle valve
2. Up shuttle valve
3. Up check valve
4. Down check valve
5. Down relief orifice

Impact Relief

Should the gearcase hit an underwater object and the outboard suddenly tilts up, the tilt cylinder extends. The fluid above the piston is compressed, producing high pressure.

This high pressure fluid passes through the impact relief valves in the tilt piston, dissipating much of the energy of the impact.

To return the outboard to its original position, the hydraulic unit must be operated in the DOWN direction.



1. Impact relief valves

DRC3467

TRIM AND TILT

MODES OF OPERATION (THREE PISTON SYSTEM)

Shallow Water Drive Tilt Relief

If the outboard exceeds idle RPM while operating in shallow water drive mode (tilted up beyond the trim range), increased pressure beneath the tilt piston forces fluid through the tilt relief valve built into the manual release valve.

Fluid flows from below the tilt piston, through the tilt relief valve, and to the reservoir.

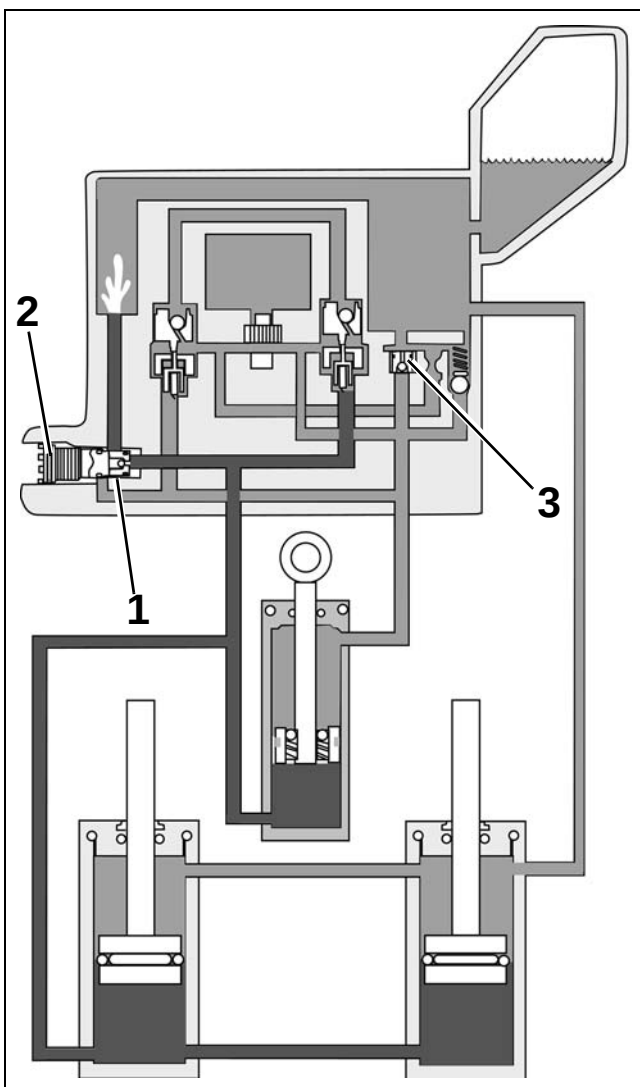
As the tilt piston moves down, the filter valve opens and allows fluid to flow from the reservoir to the top of the tilt cylinder.

The outboard will tilt down to the top of the trim range.

Thermal Expansion Relief

Ambient air temperature increase can cause fluid expansion within the hydraulic assembly. If the fluid expands when stored in the tilt range, the fluid under all of the pistons (and above the tilt piston) cannot expand, so its pressure increases.

If the pressure gets high enough to push the ball of the tilt relief valve off its seat, the excess pressure is vented to the reservoir.



1. Tilt relief valve
2. Manual release valve
3. Filter valve

DRC3465

Manual Release – UP

The outboard can be positioned manually by first opening (loosening) the manual release valve.

Open the manual release valve (turn it slowly counterclockwise) with a screwdriver, about 3 1/2 turns, until it lightly contacts its retaining ring.



1. Manual release valve

001988

When the manual release valve is opened and the outboard is manually raised, fluid flows from the top of the tilt cylinder to the manual release valve. The fluid may pass through the manual release valve to the bottom of the tilt cylinder, or return to the reservoir. Additional fluid may be drawn from the bottom of the trim cylinders, which retract and draw additional fluid from the reservoir to the tops of the cylinders.

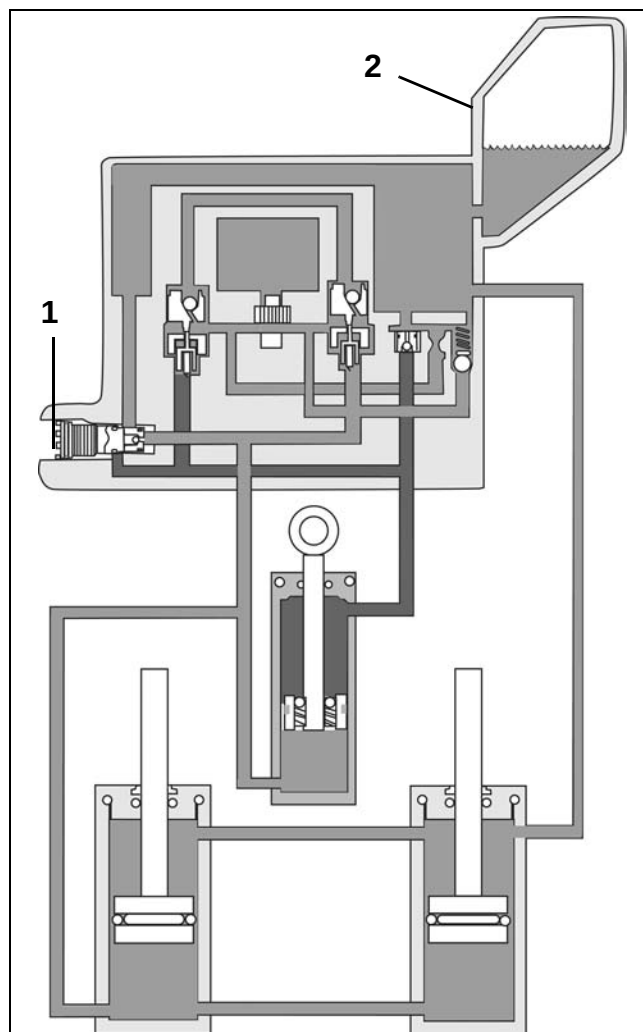
Trimming Outboard OUT

Pull gearcase out farther than the desired final position (up into the tilt range, if necessary).

Close the manual release valve.

Manually, push the gearcase in (or down) until it is supported by the trim system.

Open the manual release valve only enough to let the outboard trim in to desired position.



1. Manual release valve
2. Reservoir

DRC3464

Tilting Outboard UP

Tilt outboard up and hold it with a suitable hoist or engage either its tilt support or trailering bracket.



WARNING

Do not attempt to hold the outboard up by closing the manual release valve. The outboard must be held manually, and lowered to the trim range manually, after it has been tilted up manually. The outboard can drop to the trim range if the support is removed.

Close the manual release valve firmly. The manual release valve must be closed to enable the trim/tilt unit to function.

TRIM AND TILT

MODES OF OPERATION (THREE PISTON SYSTEM)

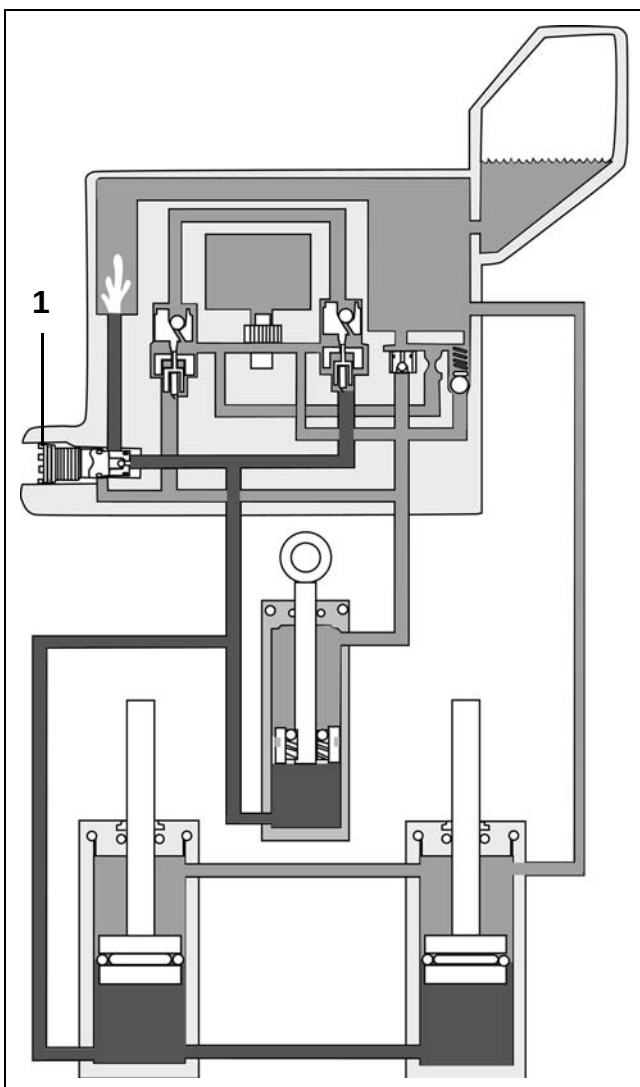
Manual Release – DOWN

When the manual release valve is opened and the outboard is manually tilted down or trimmed in, fluid flows from the bottom of the tilt cylinder (in the tilt range), or from the bottom of all of the cylinders (in the trim range), and past the manual release valve.

Fluid flows from the bottom of the tilt cylinder (in the tilt range) to the top of the tilt cylinder. The excess fluid, equal to the volume of the piston rod, is vented to the reservoir.

In the trim range, the fluid from the bottom of all three cylinders is vented to the reservoir, except for the amount required to fill the top of the tilt cylinder.

After opening the manual release valve, close it firmly. The manual release valve must be closed to enable the trim/tilt unit to function.



1. Manual release valve

DRC3465

ROUTINE INSPECTIONS

General

Check for external signs of fluid leakage. Correct causes as necessary.

Check the battery to be sure it is in good operating condition.

Reservoir Fluid

Check reservoir fluid level every three years or every 300 operating hours. System capacity is approximately 21 fl. oz. (620 ml).

Refer to **Trim and Tilt** on p. 37 for filling procedure.

Manual Release Valve

Check the manual release valve with a torque wrench.

IMPORTANT: Tighten valve to a torque of 45 to 55 in. lbs. (5 to 6 N·m).

Stern Brackets

Inspect the stern brackets for binding.

Tighten starboard tilt tube nut to a torque of 45 to 50 ft. lbs. (61 to 68 N·m).

TROUBLESHOOTING

Single Piston System

Use the following guidelines to check a single piston trim/tilt unit that is not working correctly.

Cylinder Leakdown:

- Manual release valve seals
- External leaks

No reverse lock:

- External leaks

No operation, motor runs:

- Manual release valve open
- Fluid level low
- Pump coupler
- Hydraulic pump

No tilt down:

- Manual release valve
- Fluid level

Slow performance:

- Manual release valve
- Fluid level low
- Mechanical binding
- Electric motor
- Hydraulic pump

Unit locked in tilt up:

- Mechanical binding
- Hydraulic pump

Three Piston System

If the power trim/tilt system has malfunctioned and the cause has not been determined, the **Symptoms Chart** on p. 336 should help locate the problem.

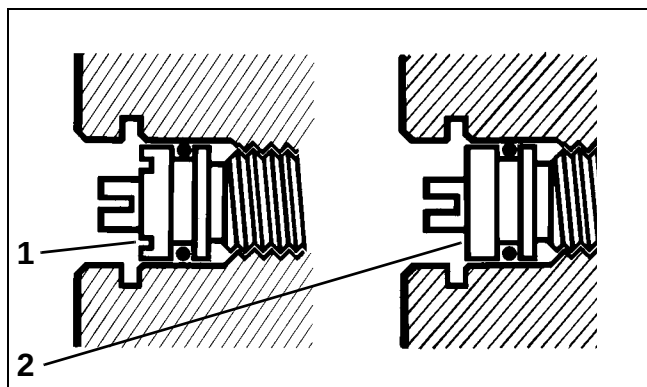
Keep a manual release valve and a valve body in stock for troubleshooting. Use these parts when the **Service Procedures** on p. 336 call for the substitution of known good parts.

If the trim/tilt does not work, and its motor neither runs nor hums, troubleshoot the problem by referring to **TILT/TRIM RELAY TEST** on p. 104.

If the outboard tilts part way up but not smoothly, or with a constant sound, there is probably air in the system due to low fluid. Fill reservoir and bleed (purge air from) the system.

To test for mechanical binding, open the manual release valve and manually tilt the motor up and down. If parts are binding, refer to **MIDSECTION** section.

If a V4 model will not lower from shallow water drive position at any throttle setting, or if a V6 model will not stay in shallow water drive and drops down at fast idle, the wrong manual release valve may be installed. Check for the identification groove in the face of the valve.



1. Grooves (V4 Models)
2. No grooves (V6 Models)

30959

If the outboard does not tilt as high as it should, and the tilt motor **TURNS OFF** at maximum tilt (does not sound like it is stalled at the maximum tilt position), adjust the tilt limit switch higher and retest. Refer to **Tilt Limit Switch Adjustment** on p. 27.

Symptoms Chart

If any of these symptoms describe the unit, follow the indicated Service Procedures, in the order listed, to locate and correct the problem.

Symptom	Service Procedures
Unit will not move in either direction.	1, 2, 3, 4, 6
Unit runs slowly in one direction, normal speed in other direction.	1, 2, 6
Unit runs slowly. (if low hours) (if high hours)	1, 2, 7 1, 2, 5, 7
Unit leaks DOWN and/or will not hold trim position against thrust in forward.	1, 2, 6
Unit leaks both UP and DOWN – Leaks down in tilt range and/or will not hold trim position against thrust in forward or reverse.	1, 2, 7
Unit will not trim/tilt one way, but works the other way. Unit will not run DOWN, but runs UP; or it runs DOWN, but will not run UP.	2, 3, 6

Service Procedures

STEP 1

Be sure the manual release valve is closed. If NOT, torque to 45 to 55 in. lbs. (5 to 6 N·m).

STEP 2

Temporarily install a known good manual release valve and retest. If symptoms remain, original valve is not the problem. Reinstall original valve.

If symptoms disappear, the original valve was faulty. Remove temporary valve and replace with correct new valve.

STEP 3

Go to **TILT/TRIM RELAY TEST** on p. 104 to determine if problem is power supply.

STEP 4

Remove trim motor and check condition of drive coupling. If coupling is damaged, replace it.

STEP 5

Temporarily install a known good pump manifold assembly and retest. If symptoms remain, original assembly is not the problem. Reinstall original assembly.

If symptoms disappear, the original pump manifold assembly was faulty. Remove temporary assembly and replace it with correct one.

STEP 6

Install replacement pump manifold assembly and retest. If all symptoms are not corrected, reconsider the problem using the new symptoms.

STEP 7

Install O-ring kit. Look for any cylinder damage. Look for chips in fluid or impact valves. Look for other abnormal conditions. If all symptoms are not corrected, reconsider the problem using the new symptoms.

Pressure Leakdown Test

Before servicing a hydraulic unit, it should be pressure tested to determine the unit's malfunction. This test must be performed with the hydraulic unit removed from the outboard and mounted in a vise or holding fixture.

Power Trim/Tilt Service Kit, P/N 434524, allows testing of trim/tilt operation and component condition.

- The "A" adapter, P/N 336658, checks operation of the UP circuit.

- The "B" adapter, P/N 336659, checks operation of the DOWN circuit.



1. A Adapter
2. B Adapter

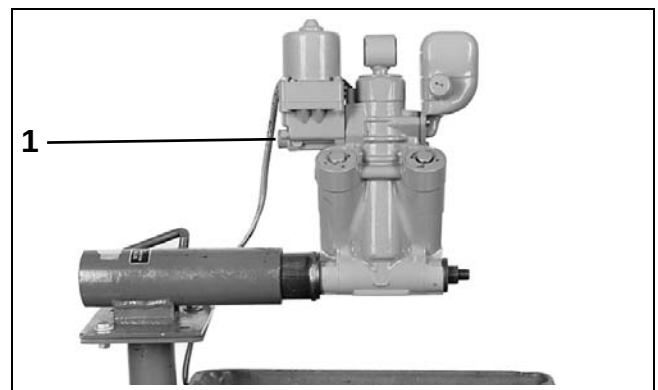
27340

This kit does not include a gauge and collar assembly. Gauge and collar assembly shipped with Power Trim/Tilt Service Kit, P/N 390010, will work. Gauge and Collar Assembly, P/N 983975, is also available.

Be sure to use a fully charged battery.

STEP 1

Screw the manual release valve in the hydraulic unit until it is seated. Place a large drain pan under the unit to catch hydraulic fluid.



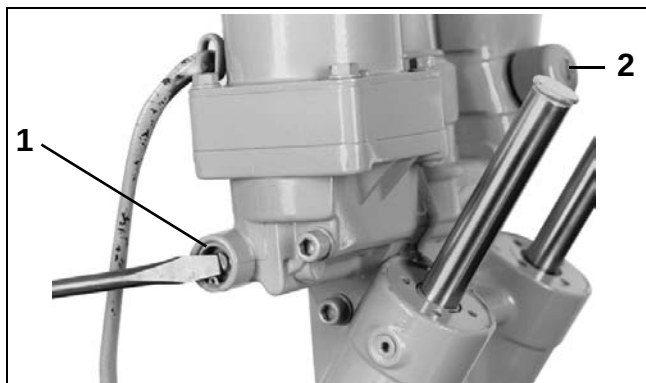
1. Manual release valve

41736

Operate the unit to the full UP position, then run the unit down momentarily to reduce pressure. Loosen the reservoir cap one full turn. Loosen the manual release valve three turns. Some fluid will

TRIM AND TILT TROUBLESHOOTING

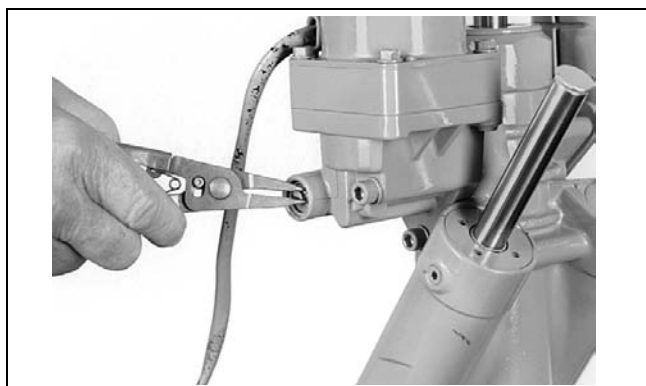
bypass the reservoir cap. These steps will relieve the pressure in the unit.



1. Manual release valve
2. Reservoir cap

41739

Remove the manual release valve retaining ring using retaining ring pliers.



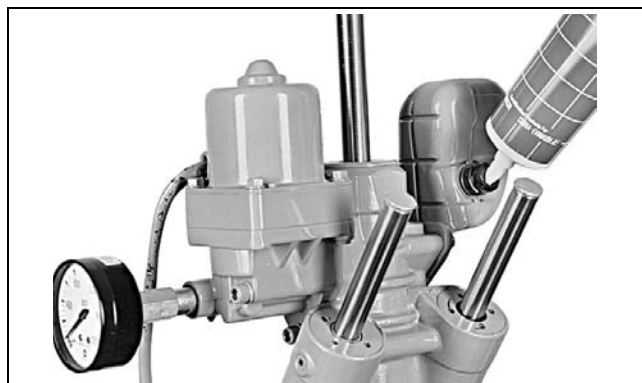
41754

Remove the manual release valve. Install pressure gauge and adapter "A" to check problems in the UP circuit.

IMPORTANT: Torque gauge and adapter lightly to 5 to 10 in. lbs. (0.6 to 1.2 N·m). Excessive torque might damage adapter or O-rings.

Cycle the unit down and up several times to purge air. With all rods fully extended, run the unit down momentarily to reduce pressure. Check fluid level again, and add fluid if necessary. Remember that

all rods must be completely extended to check fluid level.



41757

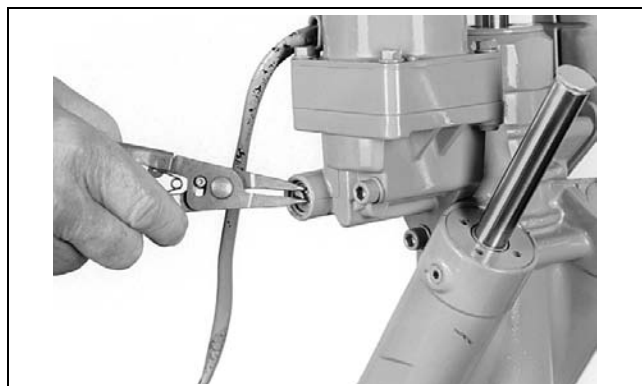
Starting with the tilt cylinder fully retracted, run the unit UP.

- The gauge should show 0 to 200 psi (0 to 1379 kPa) as the tilt cylinder is extending.
- The gauge should show 1400 to 1600 psi (9653 to 11032 kPa) as the unit stalls.
- Release the switch and watch for a pressure drop. The stall pressure reading must not drop more than 200 psi (1379 kPa) after motor stops.

If results vary from the above limits, there is a problem in the UP circuit. Refer to **MODES OF OPERATION (Three Piston System)** on p. 329 for circuit description.

STEP 2

Remove the manual release valve retaining ring using retaining ring pliers.



41754

Remove the manual release valve. Install pressure gauge and adapter "B" to check problems in the DOWN circuit. Cycle the unit down and up several times to purge air. With all rods fully extended, run the unit down momentarily to reduce pressure. Check fluid level again, and add fluid if necessary. Remember that all rods must be completely extended to check fluid level.

Starting with the tilt cylinder fully extended, run the unit DOWN.

- The gauge should show 0 to 200 psi (0 to 1379 kPa) as the tilt cylinder is retracting.
- The gauge should show approximately 800 psi (5516 kPa) as the unit stalls.
- Release the switch and watch for a pressure drop. The stall pressure reading must not drop more than 200 psi (1379 kPa) after motor stops.

If results vary from the above limits, there is a problem in the DOWN circuit. Refer to **MODES OF OPERATION (Three Piston System)** on p. 329 for circuit description.



CAUTION

After tests are complete, run the unit up, then down momentarily. Cycle the unit down and up several times to purge air. With all rods fully extended, run the unit down momentarily to reduce pressure.

Check fluid level again and add fluid, if necessary.

ELECTRICAL CIRCUIT TESTS

Relay Testing

When the trim-UP button is pressed, the UP relay is energized and connects the blue trim motor wire to the battery positive (+) terminal. The green trim motor wire remains grounded. When the button is released, the blue trim motor wire returns to a grounded position.

When the trim-DOWN button is pressed, the DOWN relay is energized and connects the green trim motor wire to the battery positive (+) terminal. The blue motor wire remains grounded. When the button is released, the green trim motor wire returns to a grounded position.

Refer to **TILT/TRIM RELAY TEST** on p. 104 for relay testing procedure.

Trim and Tilt Motor Current Draw Tests

Careful analysis of the electric motor's current draw and trim/tilt unit operating speed aids evaluation of the electric motor and certain mechanical components.

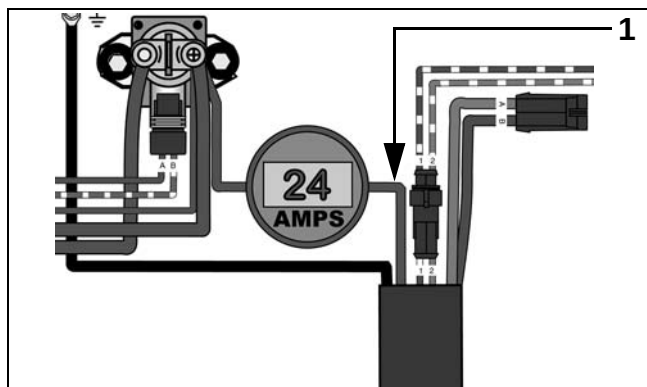
Use a battery rated at 360 CCA (50 Ah) or higher that is in good condition and fully charged to perform this test.

IMPORTANT: Specifications are for static hydraulic tests. DO NOT attempt to perform the following tests while the boat is moving.

TRIM AND TILT

ELECTRICAL CIRCUIT TESTS

Connect a 0 to 100 A DC ammeter in series between the battery side of the starter solenoid and the red lead to the trim/tilt relay module.



1. Red lead

005441

Observe ammeter and a stopwatch while running hydraulic unit through several complete cycles.

Compare test results to the values listed:

Three piston system

Mode	Normal Current Draw	Time in Seconds
Trim-OUT (Trim range)	22 A	14
Tilt-UP Stall	80 A	N/A
Trim-IN (Trim range)	16 A	7
Trim-IN Stall	35 to 45 A	N/A

Single piston system

Mode	Normal Current Draw	Time in Seconds
Full Range UP	<30 A	12-18
Full Range DOWN	<30 A	<18
Stall	<40 A	—

Test results include three basic possibilities:

A. Low current draw – Check for:

- Valves leaking
- Pump damaged
- O-rings leaking
- Manual release valve damaged
- Relief valve springs weak
- Check valves fouled or damaged

B. High current draw – Check for:

- Pump binding
- Motor binding
- Cylinder binding
- Valves sticking

C. Normal current draw, slow operating speed – Check for:

- Manual release valve damaged
- Impact valves damaged
- Check valve or shuttle valve malfunctioning

Trim and Tilt Motor No Load Test

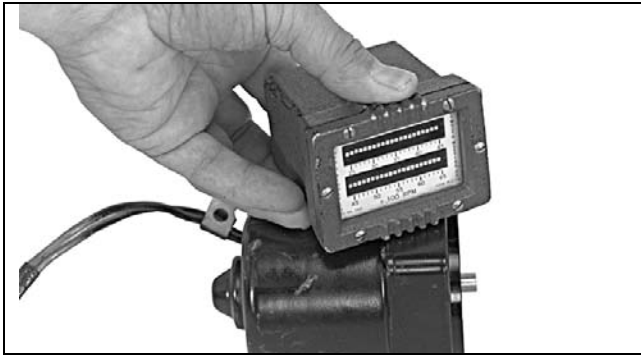
IMPORTANT: Securely fasten motor in a suitable fixture before proceeding with this test.

Use a battery rated at 360 CCA (50 Ah) or higher that is in good condition and fully charged to perform this test.

Connect a 0 to 50 A ammeter in series with the battery positive (+) terminal, ammeter red lead toward battery.

Attach or hold a vibration or mechanical tachometer to the motor while performing this test.

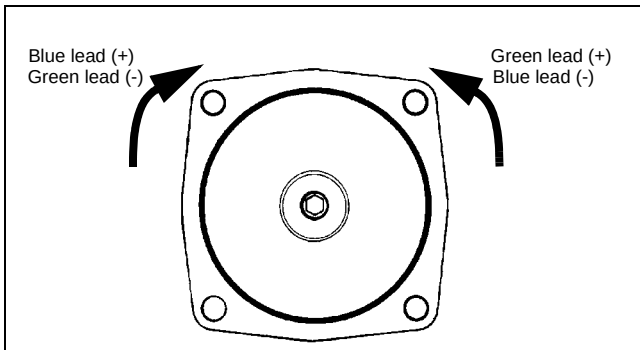
Monitor motor RPM and current draw.



30957

The motor shaft must rotate clockwise, as viewed from the pump end, when positive (+) is applied to the blue lead, and negative (–) is connected to green lead.

The motor shaft must rotate counterclockwise, as viewed from the pump end, when positive (+) is applied to the green lead, and negative (–) is applied to the blue lead.



DR4238r

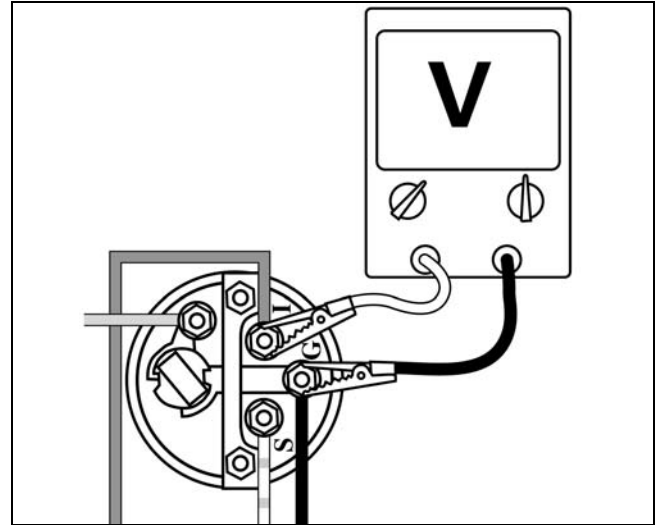
If test results vary, replace the motor.

Trim Gauge Test

STEP 1

Turn key switch ON. Using a voltmeter, check for voltage between the trim gauge "I" and "G" terminals.

- If no voltage, check condition of instrument harness, key switch, and engine 20 A fuse.
- If voltage, go to **STEP 2**.

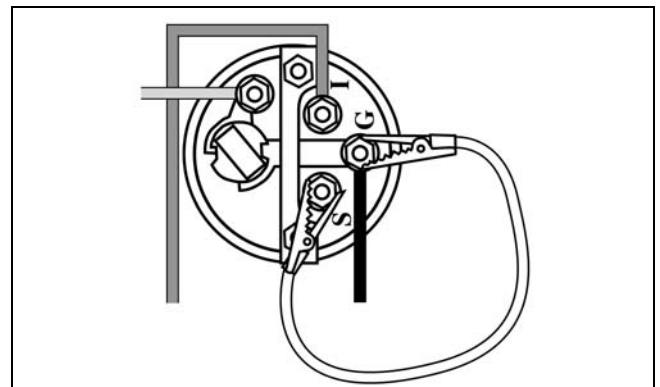


DRC6245

STEP 2

Remove the white/tan lead from the trim gauge "S" terminal. With key switch ON, gauge should indicate full-trim DOWN position. Now connect a jumper wire between terminals "S" and "G." Gauge should indicate full-trim UP position.

- If results are different, replace the trim gauge.
- If results agree, refer to **Trim Sender Test** on p. 342.



DRC6246A

TRIM AND TILT

TRIM AND TILT REPLACEMENT

Trim Sender Test

IMPORTANT: To avoid immediate meter damage, never apply a multimeter to an electrical circuit where voltage is present.

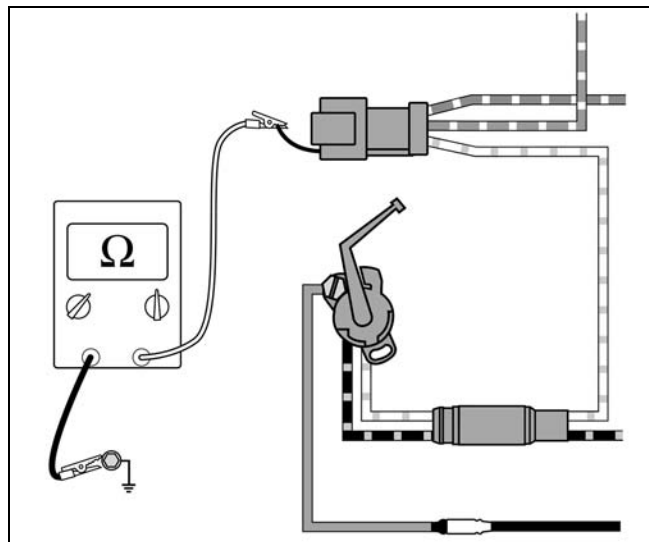
Disconnect the 3-pin connector between the instrument harness and engine trim harness.

Connect an ohmmeter between the white/tan wire, terminal "C," of the engine harness and a clean engine ground.

With the outboard fully DOWN, meter must show a reading above 80 W.

With the outboard fully UP, meter must show a reading below 10 W.

- If results agree, refer to **Trim Gauge Test** on p. 341.
- If results are different, replace trim sender.



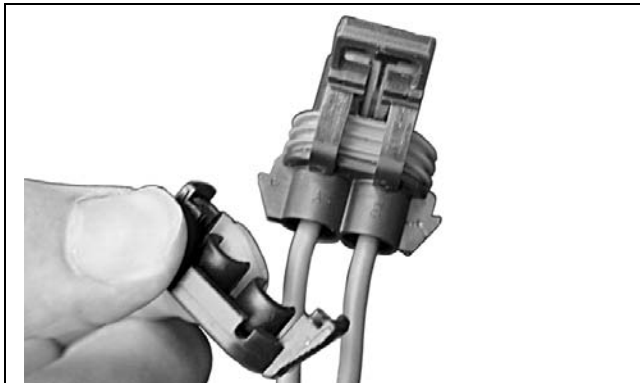
DRC6247

TRIM AND TILT REPLACEMENT

Removal

Raise the outboard and engage the tilt support.

Remove the rubber grommet from the blue/green trim/tilt cable connector.



000686

Remove the terminals from the connector by using a suitable tool to depress the tab. While the tab is depressed, pull on the wire from the rear of the connector to release it from the connector.



000687

TRIM AND TILT

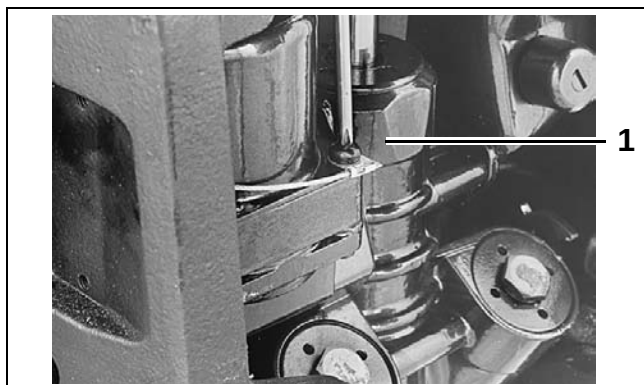
TRIM AND TILT REPLACEMENT

Separate the trim/tilt unit wires in the braided tube to permit removal through the hole in the stern bracket.



25078

Remove the ground wire from the trim/tilt unit.



1. Ground wire

25057

Remove the external snap rings from the upper pin.



25064

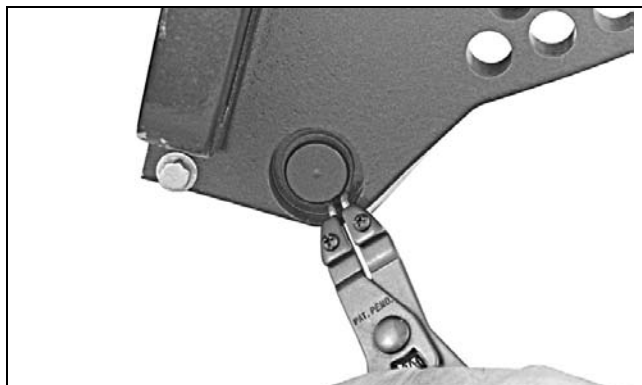
Use a punch to remove the upper pin.



25065

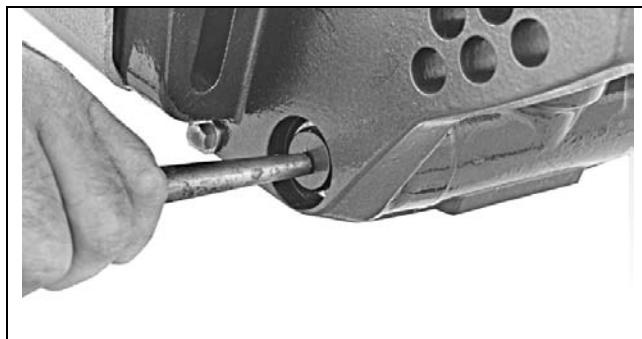
Retract the tilt cylinder rod.

Remove the external snap rings from the lower pin.



25077

Use a punch to remove the lower pin and remove the trim/tilt unit from the stern brackets.



25076

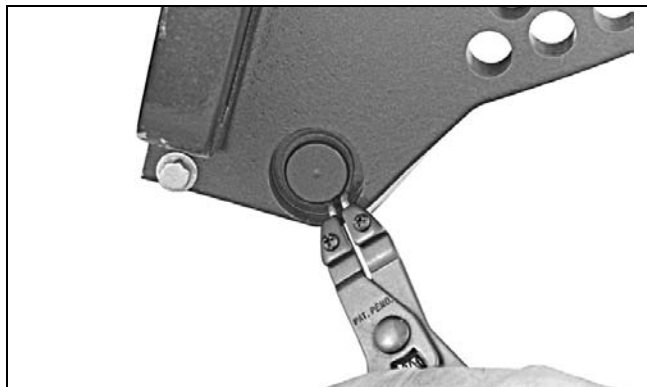
TRIM AND TILT

TRIM AND TILT REPLACEMENT

Installation

Place trim/tilt unit into position. Apply *Triple-Guard* grease to the lower pin and install the pin.

Install external snap rings on lower pin with sharp edge of ring facing out.

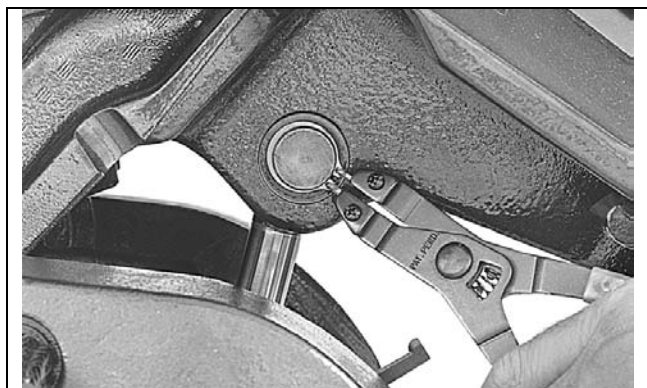


25077

Loosen the manual release valve if necessary and extend tilt cylinder rod to match with holes in swivel bracket.

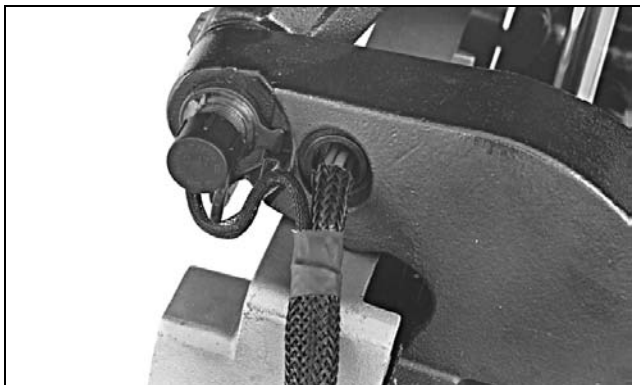
Apply *Triple-Guard* grease to upper pin and install the pin.

Install external snap rings onto upper pin with sharp edge facing out.



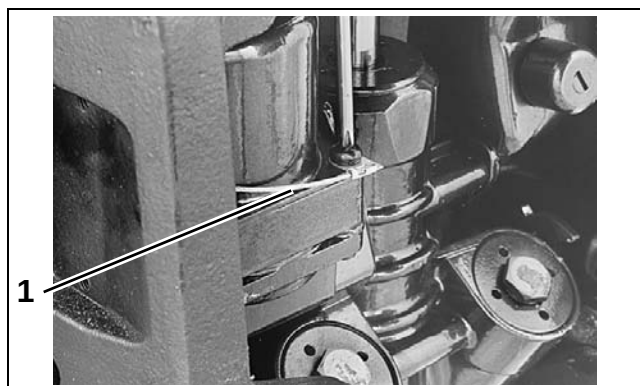
25064

Place trim/tilt wires in braided tube and install through hole in the stern bracket.



25079

Attach the ground wire to the trim/tilt unit.

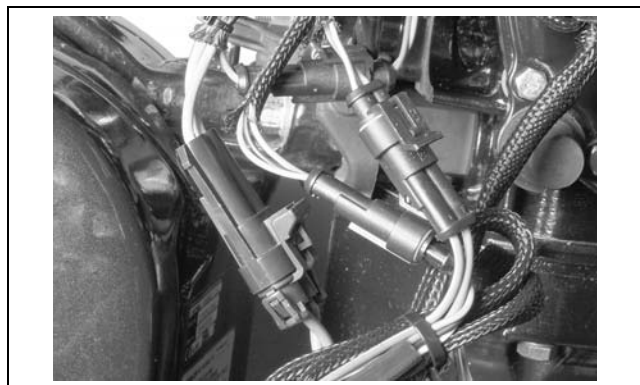


1. Ground wire

25057

Release the tilt support and lower the outboard. Tighten the manual release valve to a torque of 45 to 55 in. lbs. (5 to 6 N·m).

Install connector on trim/tilt cable and reconnect trim connectors to engine wire harness.



002152

SERVICING—SINGLE PISTON SYSTEM

Disassembly

Thoroughly clean the unit before disassembling. Scrub all outside surfaces with a stiff brush and hot, soapy water to prevent surface dirt from contaminating internal parts.

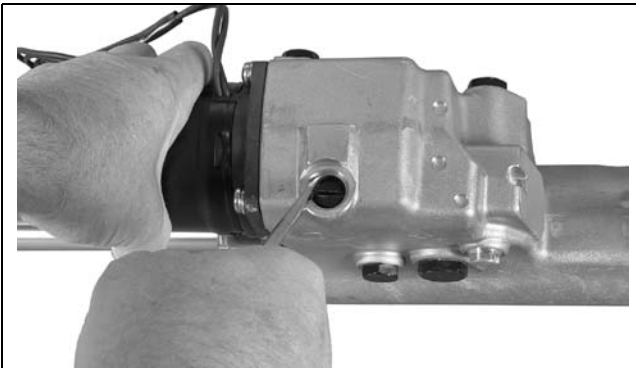
Always use a lint free shop cloth when handling power trim/tilt components.

If painting the unit is required, paint it after it is completely assembled. Painting of individual components may cause flakes of paint to enter the hydraulic passages during assembly. Tape the trim/tilt piston rods before painting.

WARNING

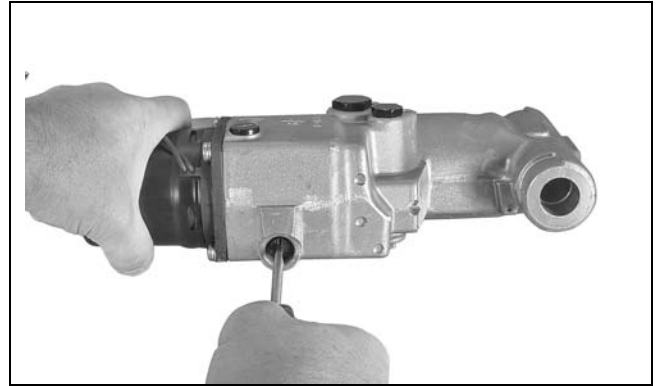
There may be high pressure behind some power trim valves. To avoid injury when removing manual release valve, be sure to cover valve with a shop cloth until the pressure is released. Wear safety glasses.

IMPORTANT: Before removing manual release valve, relieve pressure by fully extending cylinder. Screw the manual release valve in. Remove the retaining ring using a small pick or screwdriver. Discard the retaining ring.



004279

Slowly remove the manual release valve. There may be pressure behind the valve—wear safety glasses.



004285

Inspect the manual release valve. Discard the O-rings on the housing.



007108

Remove the four large motor flange retaining screws. Remove the motor and discard O-ring, screws, and washers.



004282

TRIM AND TILT

SERVICING—SINGLE PISTON SYSTEM

Remove drive coupler from either the motor or the pump assembly.



004281

Position the motor on the manifold and install four **new** screws and lock washers. Tighten the screws 35 to 50 in. lbs. (4 to 5.6 N·m).



004282

Assembly

IMPORTANT: Use only *Evinrude/Johnson* Bio-degradable TNT Fluid to fill the hydraulic system.

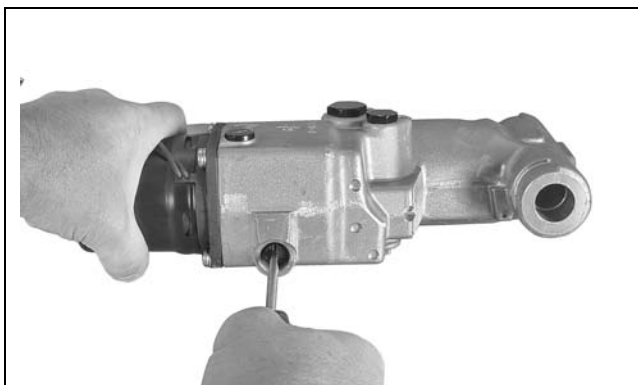
Install drive coupler in pump assembly.

Install a new motor O-ring.



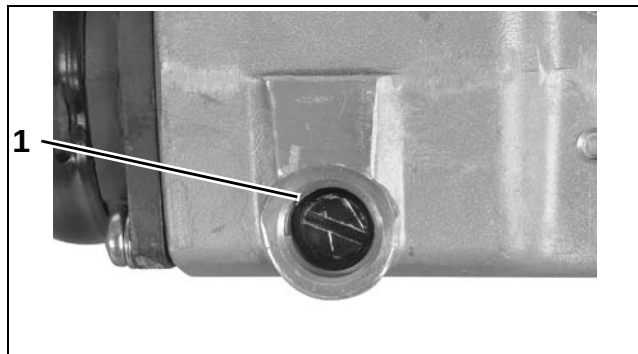
004280

Oil O-rings and install them on the manual release valve. Tighten the valve to a torque of 45 to 55 in. lbs. (5.1 to 6.2 N·m).



004285

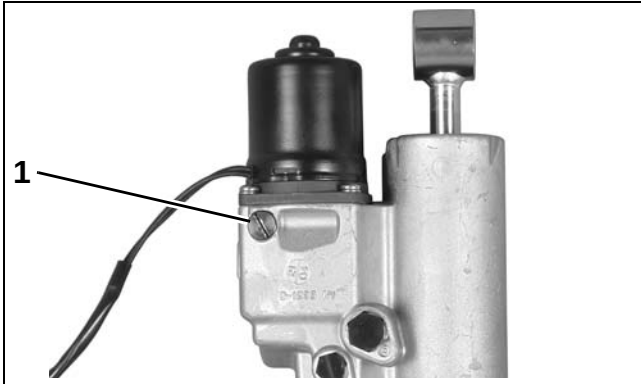
Install **new** retaining ring in groove.



1. Retaining ring

004283

Fill the oil reservoir up to the fill plug with *Evinrude/Johnson* Biodegradable TNT Fluid. Install the fill plug.



1. Reservoir cap

004278

Run the motor, then recheck oil level. Cycle the unit several times and check the oil level when the cylinder is fully extended. Oil should be level with bottom of fill port. Install and tighten the fill plug to a torque of 45 to 55 in. lbs. (5 to 6 N·m).

SERVICING – THREE PISTON SYSTEM

Disassembly

WARNING

Before removing the manual release valve, operate the unit to the full UP position, then run the unit down momentarily and loosen the reservoir cap one full turn.

To avoid personal injury, always wear eye protection when servicing the hydraulic unit. Since there might be significant residual pressure behind some components, cover each component with a shop cloth as you remove it.

Thoroughly clean the unit before disassembling. Scrub all outside surfaces with a stiff brush and hot, soapy water to prevent surface dirt from contaminating internal parts.

CAUTION

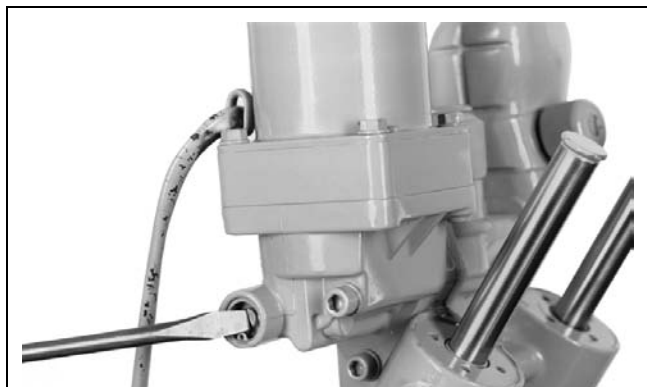
Do not apply heat to the cylinder body or cylinders. Excessive heat can cause high pressure leaks or failure of parts.

Always use a lint free shop cloth when handling power trim/tilt components.

If painting the unit is required, paint it after it is completely assembled. Painting of individual components may cause flakes of paint to enter the hydraulic passages during assembly. Tape the trim/tilt piston rods before painting.

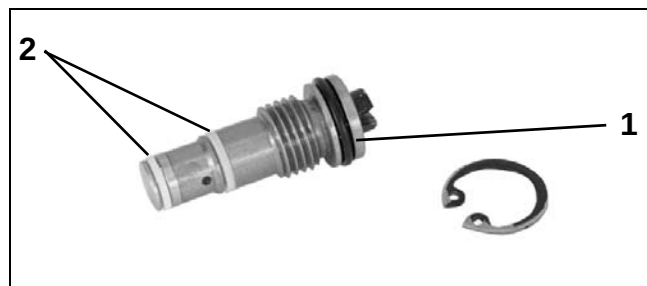
TRIM AND TILT SERVICING – THREE PISTON SYSTEM

Screw the manual release valve in. Remove the retaining ring using retaining ring pliers. Remove the manual release valve.



41739

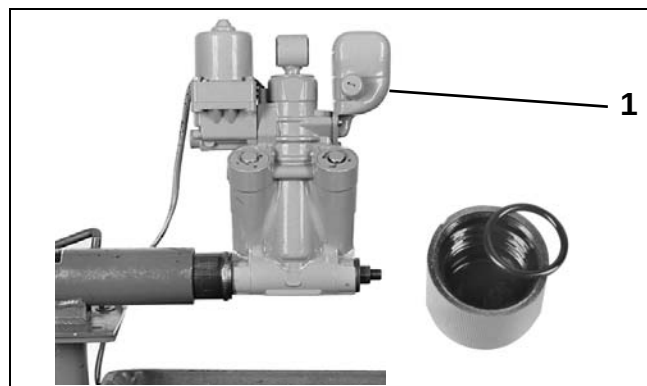
Inspect O-ring and two plastic split rings on the manual release valve for nicks and cuts. Inspect tip of valve for damage. The two plastic split rings are not available separately. If rings are damaged, replace the manual release valve.



- 1. O-ring
- 2. Plastic split rings

22863

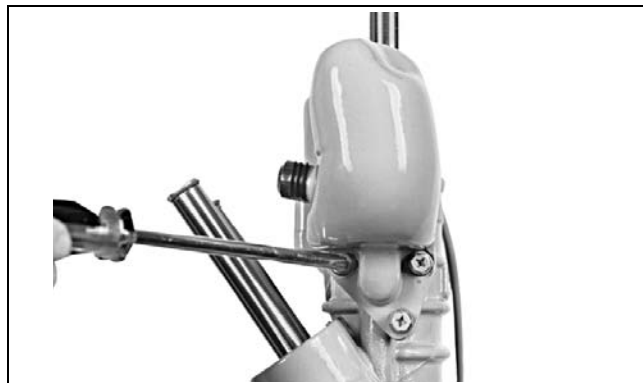
Remove reservoir cap and drain the fluid into a container. Inspect the O-ring in the cap.



- 1. Reservoir cap

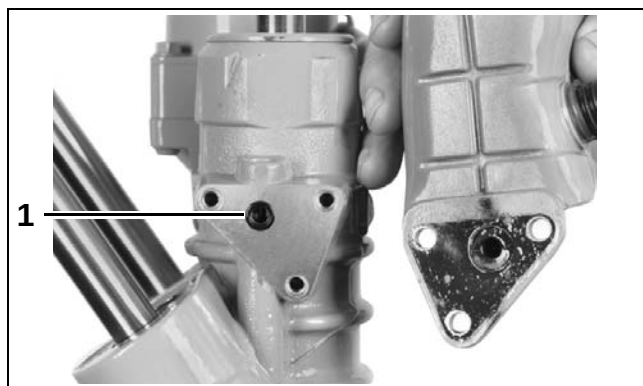
41736
41751

Remove the three *Pozidriv* screws securing the reservoir to cylinder body. Remove reservoir.



41753

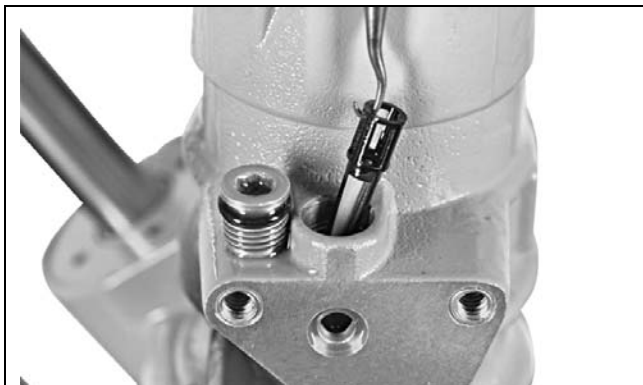
Remove the reservoir O-ring from the cylinder body. Check machined surfaces for nicks and scratches.



- 1. O-ring

41759

Use a 6 mm hex wrench to remove the plug from the cylinder body. Inspect the O-ring and the filter. Replace, if necessary.



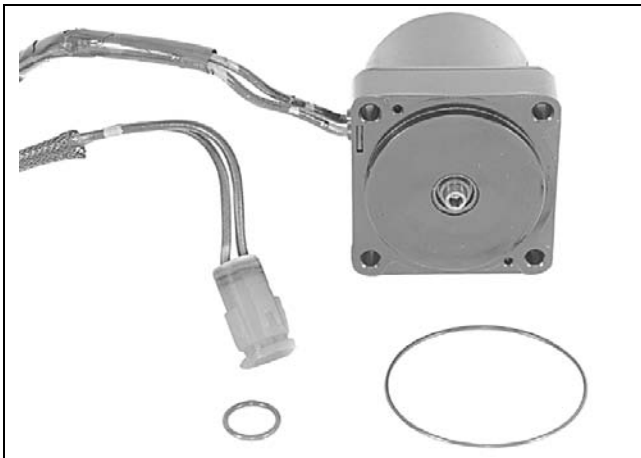
41787

Remove the four screws securing motor to pump manifold assembly.



41760

Remove the wire shield from the pump manifold. Remove the motor and inspect the motor O-ring and the O-ring on the cable connector.



22878

Remove and inspect the coupler. Remove the filter screen from the pump manifold. Check the machined surfaces on the manifold for nicks and scratches. The pump manifold is not serviceable. Do not remove the pump or any control valves from the manifold. Clean the screen with a mild

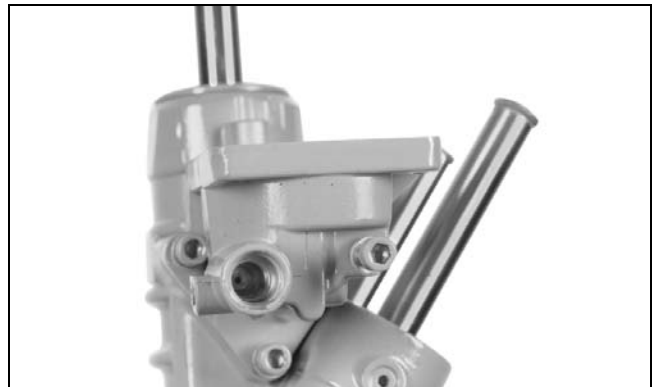
solvent and inspect it for tears, clogging, or other damage.



1. Coupler
2. Filter screen

41763

Remove the three Allen head screws securing the pump manifold assembly to cylinder body.



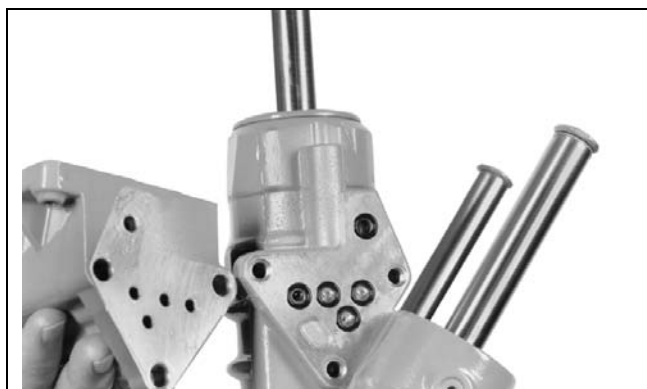
41798

IMPORTANT: Individual parts in the pump manifold assembly are not available separately. Do not remove pump or any control valves from the body.

TRIM AND TILT

SERVICING – THREE PISTON SYSTEM

Remove the manifold. Remove five O-rings from cylinder body. Check machined surfaces for nicks and scratches.



41799

Slowly pull the piston out with a rag wrapped around the rod and the top of the cylinder. Drain the remaining fluid from the cylinder.



41765

Tilt Piston Removal

Use Tilt Cylinder End Cap Remover/Installer, P/N 326485, or Universal Spanner Wrench, P/N 912084, and a breaker bar, to unscrew the tilt rod end cap.



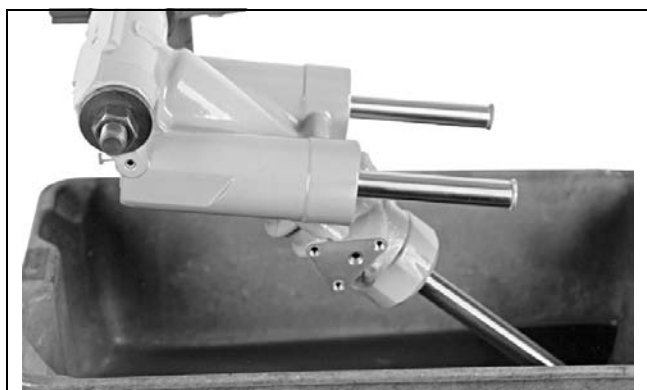
41788

Inspect the bore of the tilt cylinder for excessive scoring. If the bore of the tilt cylinder is scored or damaged, the hydraulic assembly must be replaced.



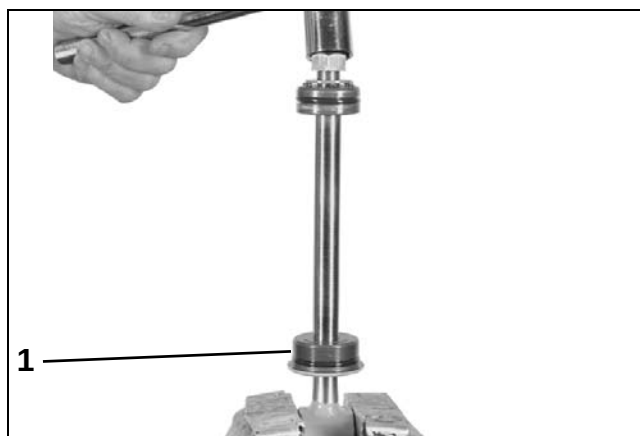
41767

Drain the fluid from above the piston.



41789

Clamp the rod eye tightly in a soft jaw vise. Remove the nut from the piston end of the rod.



1. End cap

41781

Remove the washer. Slide the tilt piston off the rod. Be careful not to lose the springs, plungers, or small check valves in the piston assembly.



41784

Remove and discard the small inner O-ring and large outer O-ring.



1. Small inner O-ring
2. Large outer O-ring

41819

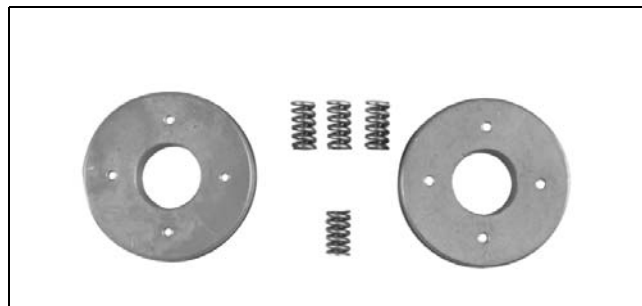
Tilt Piston Identification



WARNING

Different tilt pistons are used on hydraulic units for various outboard models. All plungers and check balls are identical. The tilt piston assemblies contain valving specific to certain models. To provide impact protection, it is important the correct piston assembly be installed.

Three of the four springs are one length, and the fourth spring is shorter. On assembly, the shorter spring can be positioned in any hole in the piston.

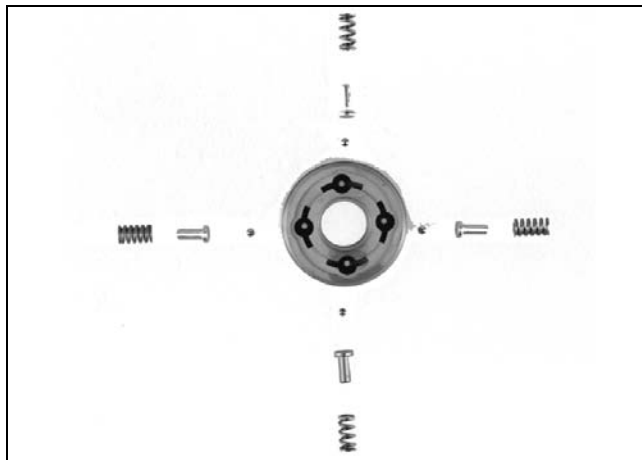


41882

Tilt Piston Assembly

Piston check balls and plungers are identical. Lubricate and install a new outer O-ring on the tilt piston. Place one ball, one plunger, and one spring in each hole in the piston as indicated.

Three of the four springs are one length, and the fourth spring is shorter. On assembly, the shorter spring can be positioned in any hole in the piston. Set piston aside.



41818

TRIM AND TILT SERVICING – THREE PISTON SYSTEM

Use a screwdriver to carefully pry the scraper out of the end cap. Discard the scraper. Remove and discard the large outer O-ring.



41791

Use a wire brush to clean all thread-locking material from the threads on the tilt rod.



41821

Remove and discard inner O-ring of the end cap.



41792

Lubricate the inside surface of the end cap. Lubricate and install Tilt Cylinder Seal Protector, P/N 326005. Use a deep-well socket and a plastic mallet to drive the end cap onto the rod, then remove the seal protector. Slide the end cap down the tilt rod.

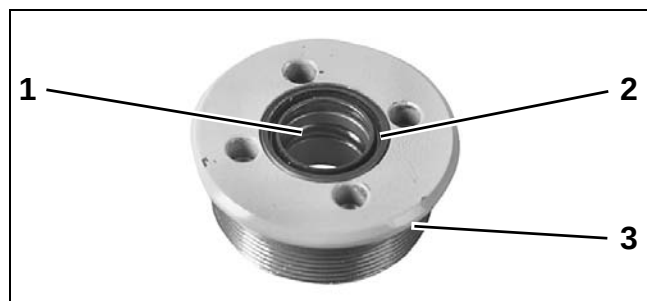


1. Tilt Cylinder Seal Protector

41824

Tilt Rod Assembly

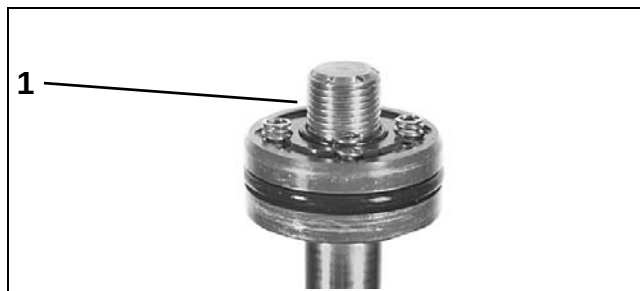
Clean the end cap thoroughly, then lubricate and install a new O-ring in the end cap. Lubricate and install a new scraper. The scraper is installed with the lip facing out. Lubricate and install a new O-ring on the outside of the end cap.



1. Inner O-ring
2. Lip
3. Outer O-ring

41795

Remove any lubricant from the threads on the tilt rod, prime with *Locquic Primer*, and let dry. Slide the piston assembly onto the tilt rod. Place a new rod O-ring over the threads.



1. O-ring

41816

Clean any thread-locking material from the threads on the inside of the nut. Spray threads of with *Locquic Primer* and let dry. Apply a small amount of *Nut Lock* to the threads. Slide the washer over the threads and install the nut. Torque to 58 to 87 ft. lbs. (79 to 118 N·m).



41783

To ensure that the tilt piston has been properly assembled and the impact relief balls are properly seated, apply *Power Trim/Tilt & Steering Fluid* on top of the tilt piston. Fluid should not leak past the impact relief balls while seated. If fluid does leak, disassemble the piston assembly and inspect the relief ball seats. Set the tilt rod assembly aside.



41828

Trim Rod Removal

Unscrew trim cylinder end caps using Trim Cylinder End Cap Remover/Installer, P/N 436710, or Universal Spanner Wrench, P/N 912084, and a breaker bar. Small pins must be used in the spanner wrench.



41829

Slide the caps to the end of the rods. Drain the fluid from the top of the pistons.



41837

Slowly pull each piston out with a rag wrapped around the rod and the top of the cylinder.

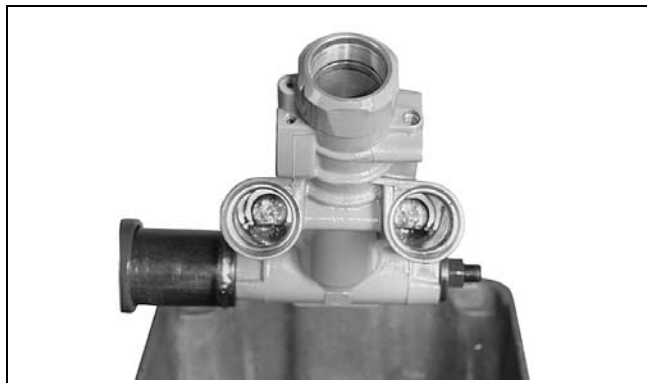


41838

TRIM AND TILT

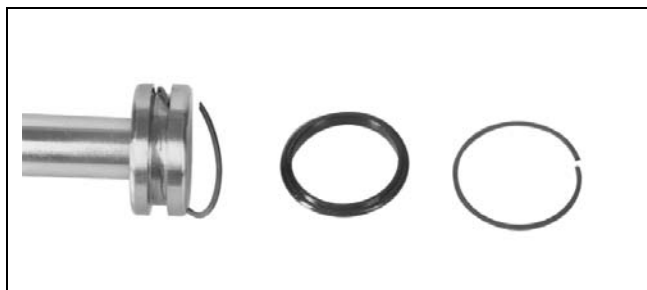
SERVICING – THREE PISTON SYSTEM

Drain the remaining fluid from the cylinders. Inspect both bores of the trim cylinders for excessive scoring. If one or both trim bores are scored or damaged, the hydraulic assembly must be replaced.



41840

Remove and discard both back-up rings and the O-ring from each trim rod piston.



41841

Using Hydraulic Cylinder Rod Holder, P/N 983213, clamp the rod tightly in a vise. Remove the thrust pad from the trim rod, then remove the end cap.



41842

Remove the rod from the vise. Use a small screwdriver to carefully pry the scraper out of the end cap. Discard the scraper.



41843

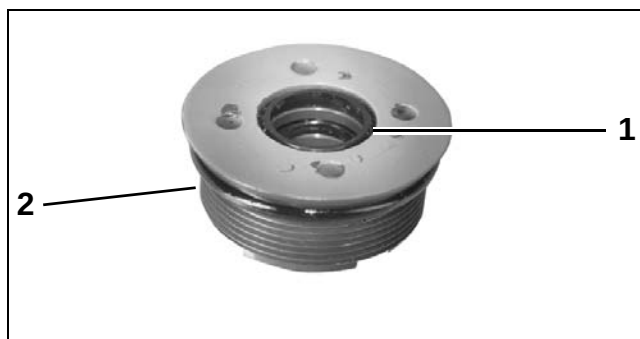
Use a suitable tool to remove the inner quad-ring and the outer O-ring. Discard the quad-ring and O-ring.



41844

Trim Rod Assembly

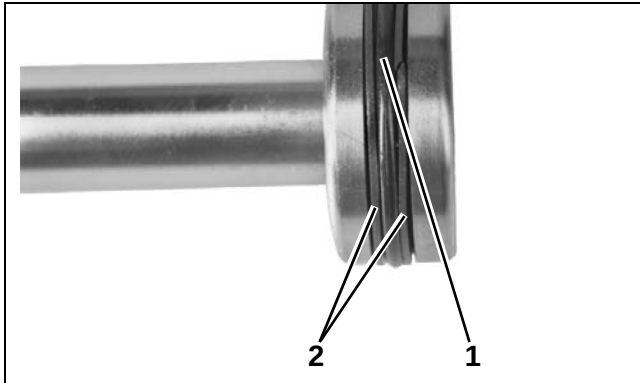
Lubricate and install a new quad-ring and scraper in the end cap. Install the scraper with the bevel facing out. Lubricate and install a new O-ring on the outside of the end cap.



- 1. Bevel
- 2. O-ring

41845

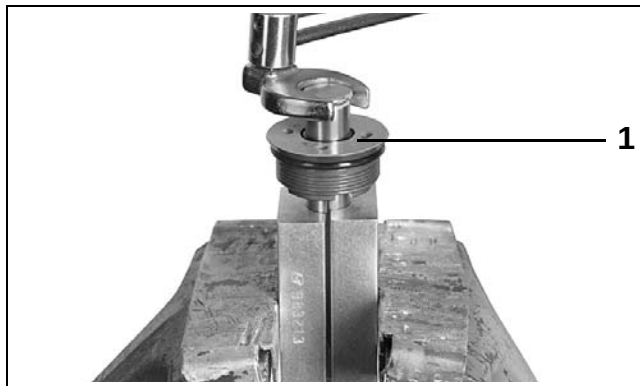
Lubricate and install a new O-ring and two new back-up rings on the trim rod piston. Place one back-up ring on each side of the O-ring. Position the open end of the back-up rings 180° apart.



1. O-ring
2. Back-up rings

41847

Using Hydraulic Cylinder Rod Holder, P/N 983213, clamp the rod tightly in a vise and lubricate the cap and rod. Slide the end cap onto the rod and install thrust pad. Torque thrust pad 84 to 108 in. lbs. (9.5 to 12 N·m).



1. Thrust pad

41848

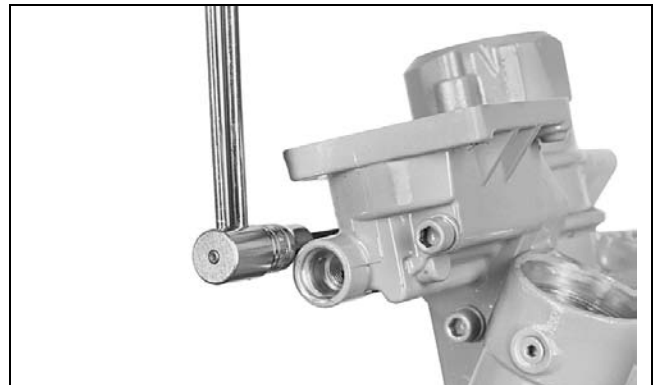
Manifold and Reservoir Installation

Lubricate five new manifold body O-rings. Place them in the cylinder body.



41849

Attach the valve pump assembly to the cylinder body with three *Pozidriv* screws. Torque screws to 60 to 84 in. lbs. (7 to 9.5 N·m).



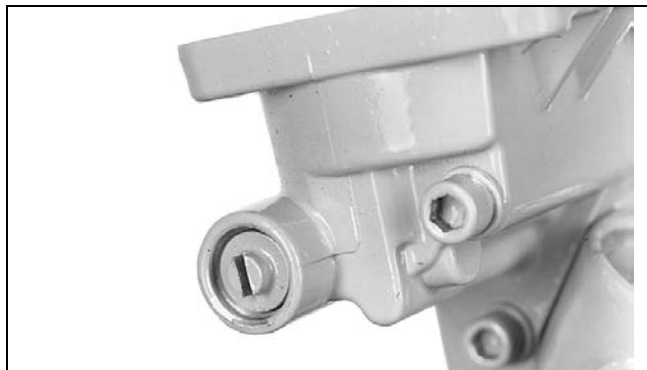
41850

Oil and install the manual release valve. Thread the valve just past the snap ring groove. Do not install the snap ring at this time. The valve will be

TRIM AND TILT

SERVICING – THREE PISTON SYSTEM

removed later for the **Pressure Leakdown Test** on p. 337.



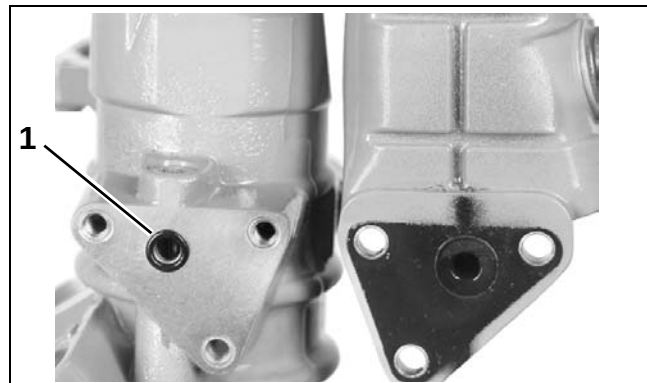
41851

Install the reservoir filter screen in the cylinder body. Make sure that the screen is seated. Use a 6 mm Allen wrench to install the plug. Tighten the plug securely.



41863

Lubricate and place a new reservoir O-ring in the cylinder body.



1. O-ring

41865

Attach the reservoir to the cylinder body with three *Pozidriv* screws. Torque the screws to 35 to 52 in. lbs. (4.0 to 5.9 N·m).



41866

Trim Rod Installation

Lubricate the trim rod pistons. Place the rod assemblies into the body. Push them in until the end caps just clear the tops of the cylinders. Fill the cylinders with *Power Trim/Tilt & Steering Fluid*. Failure to fill the cylinders could cause difficulty in purging air from the unit.



41867

Screw the trim rod end caps into the cylinder body. Use Trim Cylinder End Cap Remover/Installer, P/N 436710, or Universal Spanner Wrench,

P/N 912084. Tighten caps to a torque of 60 to 70 ft. lbs. (81 to 95 N·m).



41868

P/N 912084. Torque cap to 58 to 87 ft. lbs. (79 to 118 N·m).



41870

Tilt Rod Installation

Lubricate the tilt rod piston. Slide the end cap all the way up on the rod assembly. Place the piston end of the rod assembly into the cylinder body. Push it in until the end cap just clears the cylinder top. Leave enough room to pour fluid into the cylinder. Fill the cylinder with *Power Trim/Tilt & Steering Fluid*. Failure to fill the cylinder could cause difficulty purging air from the unit.

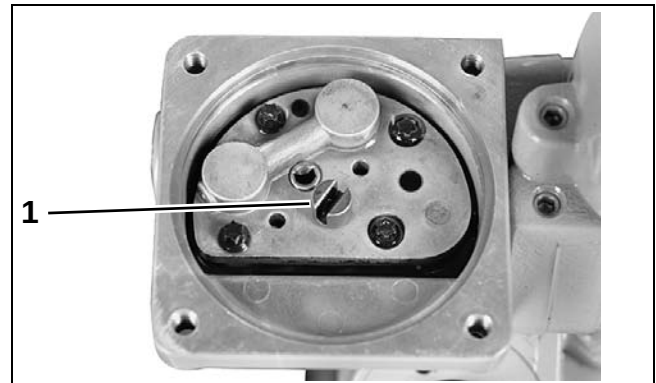


41869

Screw tilt cylinder end cap into cylinder body. Use Tilt Cylinder End Cap Remover/Installer, P/N 326485, or Universal Spanner Wrench,

Motor Installation

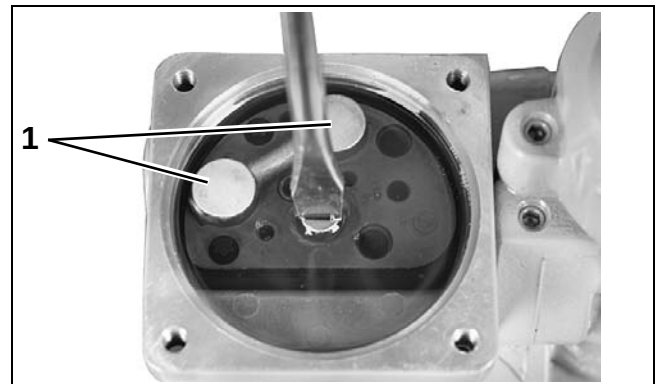
Position the pump manifold so the pump mounting surface is level. Install the coupler into the pump.



1. Coupler

41852

Fill the pump cavity with *Power Trim/Tilt & Steering Fluid* up to the top of the two bosses. Rotate the coupler clockwise and then counterclockwise until no more air bubbles come out of the pump.



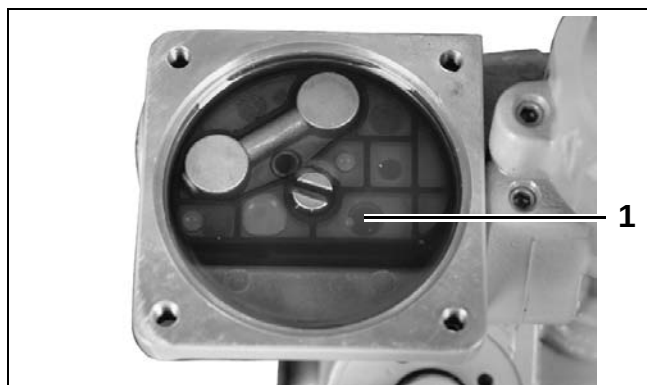
1. Bosses

41854

TRIM AND TILT

SERVICING – THREE PISTON SYSTEM

Install the filter screen.



1. Filter screen

41856

Lubricate and place a new O-ring on the motor. Make sure the cable is on the transom side of the unit; align the coupler slot with the motor shaft. Place the motor on the pump manifold assembly.



1. O-ring
2. Cable

41857

Install the four motor screws. Tighten the screws to a torque of 35 to 52 in. lbs. (4.0 to 5.9 N·m).



41858

Fill the reservoir to the bottom of the fill hole with *Power Trim/Tilt & Steering Fluid*. Install and tighten the reservoir cap. Turn the manual release valve in until it seats. Cycle the unit up and down several times to purge air.



41859

Operate the unit to the full UP position, then run down momentarily to release pressure. Check the fluid level again and add fluid, if necessary. Remember that all rods must be completely up to check the fluid level. Test the unit by performing the **Pressure Leakdown Test** on p. 337.



41885

Check the tilt rod bushings. Replace them if they are worn excessively.



41888

Check the bushings on the bottom of the manifold body. Replace them if they are worn excessively.



41878

Check system operation in both trim and tilt range.

NOTES

Technician's Notes

[illegible]

Related Documents

[illegible]

SAFETY

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MARINE PRODUCTS AND THE SAFETY OF PEOPLE WHO USE THEM



WARNING

This Safety section contains information relevant to the safety of boaters and people that service boats. Please read this section carefully and share it with all shop technicians. Always follow common shop safety practices. If you have not had training related to common shop safety practices, you should do so not only to protect yourself, but also to protect the people around you.

It is impossible for this manual to cover every potentially hazardous situation you may encounter. However, your understanding and adherence to the recommendations contained in this manual and use of good judgment when servicing outboards will help promote safety. Always be alert and careful: a good foundation for safety.

Enjoyable boating is the goal of people who design and build marine products. To reach this goal, manufacturers are careful to make sure:

- Product user is informed; and
- Products are safe and reliable.

It is up to you, the people who...

- Rig boats;
- Fix machinery; and
- Maintain equipment

...to keep the products safe **and** reliable.

This section talks about safe boating and how you can help make it safe. Some of these safety issues you will know, others you may not.

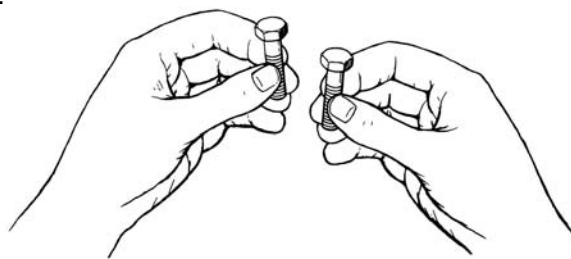
First!

A word about parts... Plain parts; special parts; all parts!

DO NOT SUBSTITUTE PARTS

"They look the same, but are they the same?"

- Same size?
- Same strength?
- Same material?
- Same type?

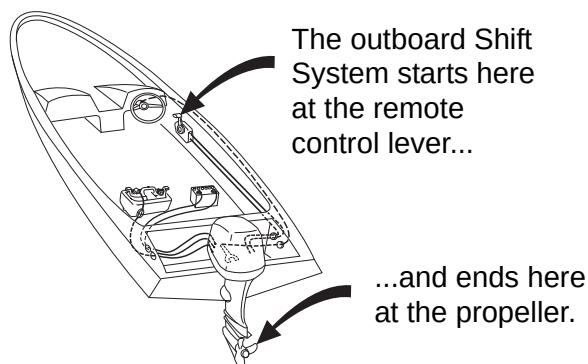


Don't substitute unless **you know** they are the **same** in **all** characteristics.

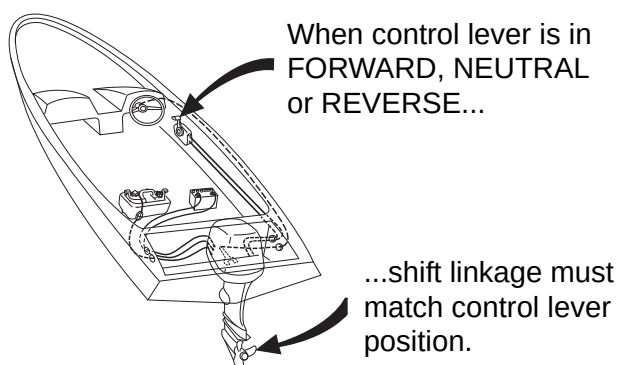
Second!

- Special locking bolts and nuts are often used to hold steering, shift, and throttle remote control cables to the outboard.
- When you take any outboard off a boat, keep track of special nuts and bolts. Do not mix with other parts. Store them on the outboard, then they are there when you need them.
- When the outboard is returned to the boat, use only the special nuts and bolts to hold remote steering, shift, and throttle cables to the outboard.

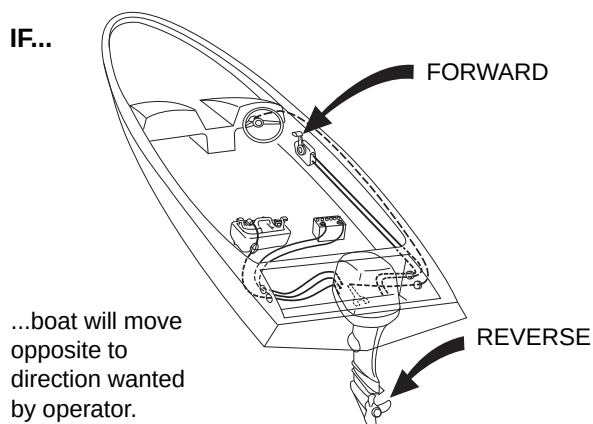
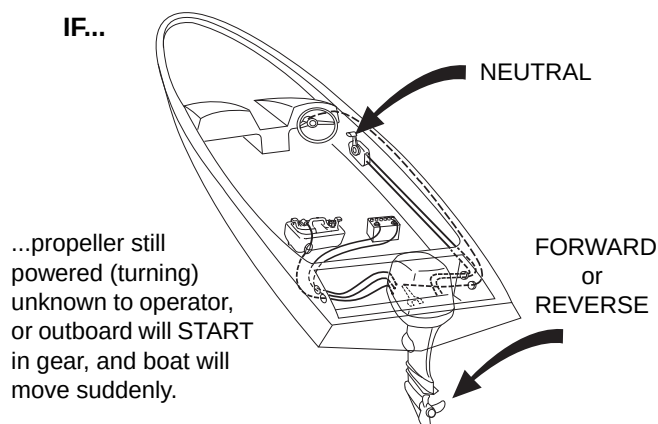
Outboard Shift Systems and Safety



What is most important?



What could happen?



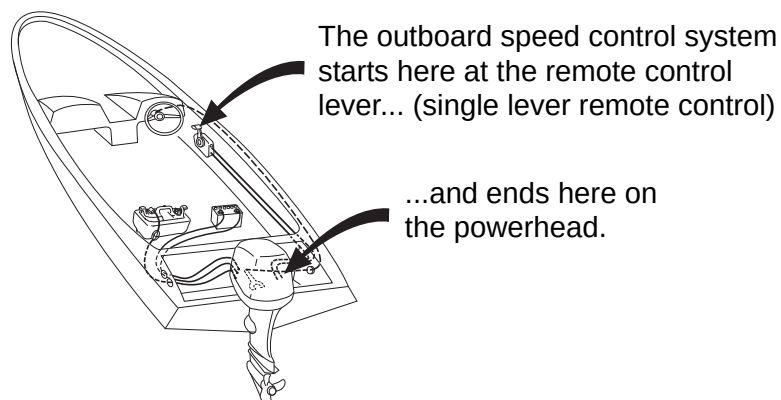
How can loss of shift control be minimized?

When rigging or after servicing

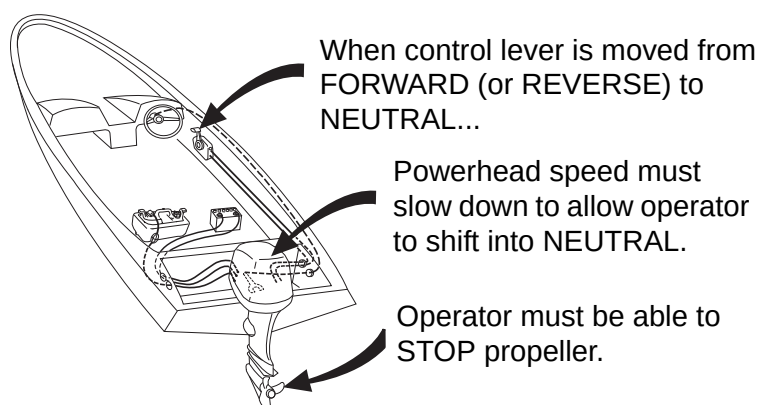
Read, understand, and follow manufacturer's instructions

- Follow warnings marked "⚠" closely.
- Assemble parts carefully.
- Make adjustments carefully.
- Test your work. Do not guess. Make sure propeller does just what the operator wants and nothing else.
- Do not shift gears on a stopped outboard. Adjustments can be lost and parts weakened.

Outboard Speed Control System and Safety



What is most important?



What could happen?

If Operator cannot slow down the outboard or shift into NEUTRAL gear (stop propeller), Operator could panic and lose control of boat.

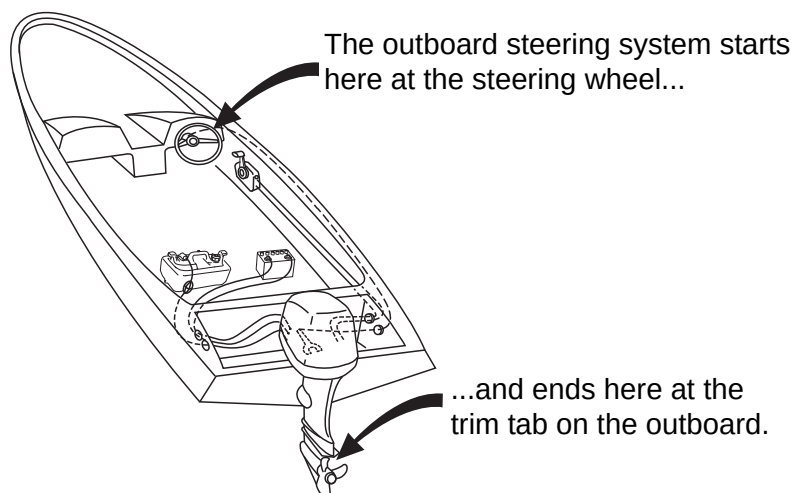
How can loss of speed control be minimized?

When rigging or after servicing

Read, understand, and follow manufacturer's instructions

- Follow warnings marked "⚠" closely.
- Assemble parts carefully.
- Make adjustments carefully.
- Test your work. Do not guess. Make sure speed control system does just what the operator wants and nothing else.
- Make sure full throttle can be obtained so Operator will not overload parts.

Outboard Steering Control System and Safety



What is most important?

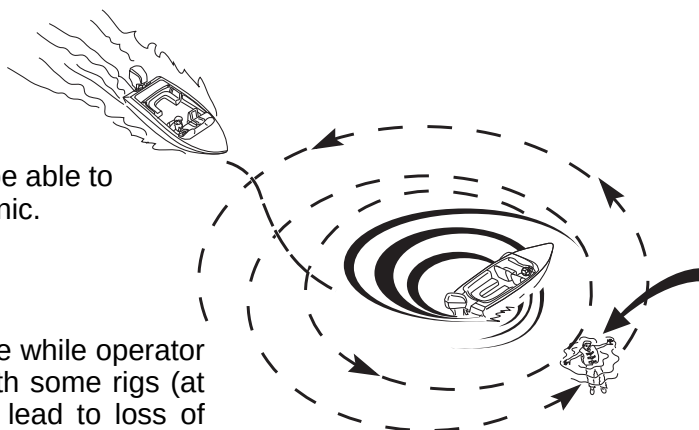
The steering system:

- Must not come apart;
- Must not jam; and
- Must not be sloppy or loose.

What could happen?

- If steering system comes apart, boat might turn suddenly and circle. Persons thrown into the water could be hit.

- If steering jams, operator may not be able to avoid obstacles. Operator could panic.
- If steering is loose, boat may weave while operator tries to steer a straight course. With some rigs (at high speed), loose steering could lead to loss of boat control.



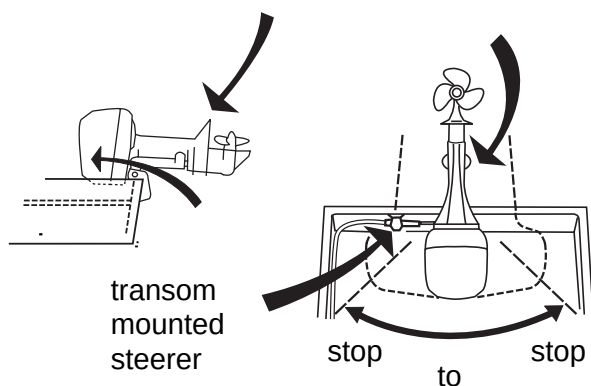
How can loss of steering control be minimized?

When rigging or after servicing

- Use a steering system recommended by the outboard manufacturer which meets Marine Industry Safety Standards (ABYC).
- **Read, understand, and follow** manufacturer's **instructions**
- Follow warnings marked "⚠" closely.
- Assemble parts carefully.
- Make adjustments carefully.
- Keep parts moving freely. Lubricate parts as shown in manual.
- Use the bolts, nuts and washers supplied with steering attachment kits—they are a special locking type that will not loosen, rust, or weaken.

Transom Mounted Steering Systems – Check to Uncover Possible Trouble!

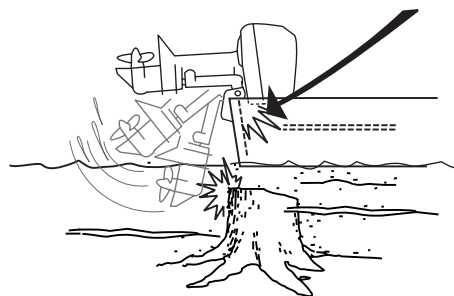
Tilt outboard into boat, then turn it.



During this procedure, steering parts:

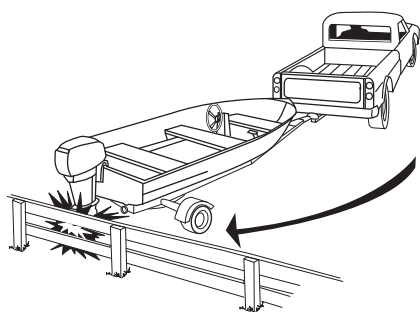
- Must not bind; and
- Must not touch other boat, outboard, or accessory parts in transom area.

Why? A hard blow to the outboard's gearcase can result in damage to steering parts.



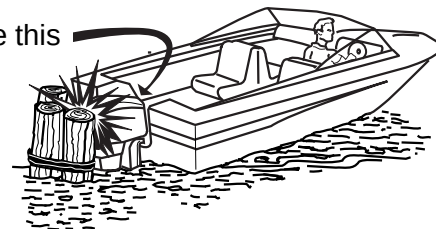
Be aware that raising or lowering outboard on transom can change a set-up which was OK earlier. If moved up or down even one-half inch, run test again to make sure steering parts are free and clear.

Check for damaged parts. Blows to the outboard like this



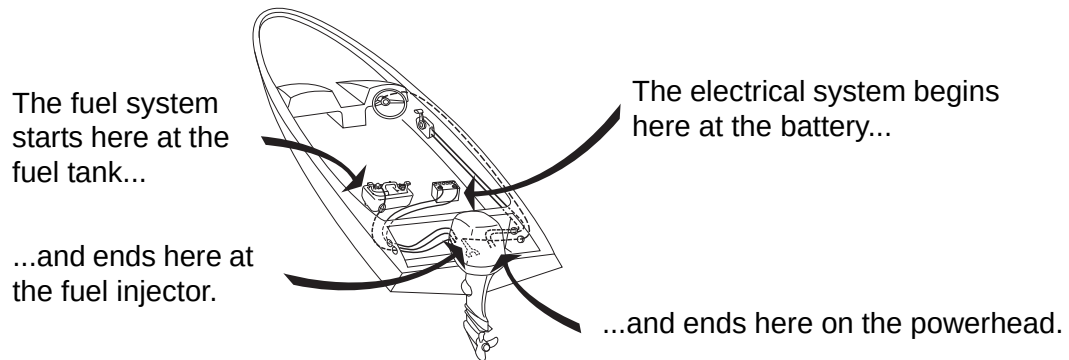
or this can put heavy loads on steering parts. Look for:

- Cracked parts, including steering parts, swivel brackets, and transom brackets;
- Bent parts; and
- Loose nuts and bolts.



Replace damaged parts. If weakened, parts could fail later on the water when least expected.

Outboard Fuel, Electrical System, and Safety



What is most important?

- Fuel leakage must be eliminated.
- Stray electric sparks must be avoided.

What could happen?

- **When not boating**, fuel leaking in car trunk or van, or place where portable tank is stored (basement or cottage), could be ignited by any open flame or spark (furnace pilot light, etc.).
- **When boating**, fuel leaking under the engine cover could be ignited by a damaged or deteriorated electrical part or loose wire connection making stray sparks.

How Can Fire and Explosion Be Minimized?

- **Read, understand, and follow** manufacturer's instructions
- Follow warnings marked "⚠" closely.
- **Do not** substitute fuel or electrical systems parts with other parts which may look the same. Some electrical parts, like starter motors, are of special design to prevent stray sparks outside their cases.
- Replace wires, sleeves, and boots which are cracked or torn or look in poor condition.

When mixing and refueling, always mix gas and oil outside...



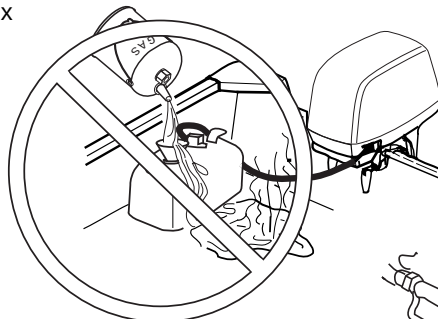
Remember:



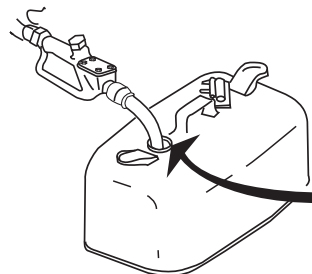
Do not use electrical devices such as cellular phones in the vicinity of a fuel leak or while fueling.

If you use a funnel, it has to be metal to ground the spout to the tank.

Always fill the tank outside the boat



Fumes are hard to control. They collect and hide in the bottom of the boat.



To avoid those static electric sparks, ground (touch) the spout against the tank.

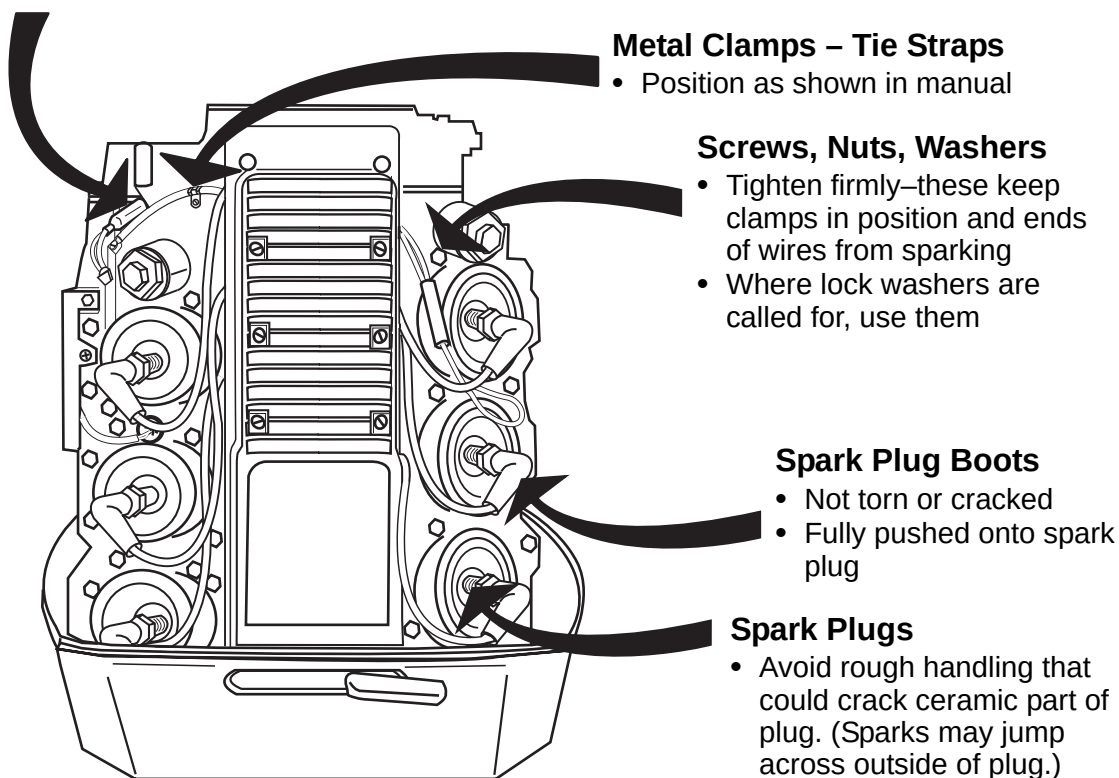
If electrical parts are replaced or even removed from the outboard, check the following:

Wire and high voltage lead routing

- As shown in service manual
- Away from moving parts which could cut wires or wire insulation
- Away from engine cover latches which can catch and cut insulation from high voltage spark plug leads

Sleeves, boots, shields

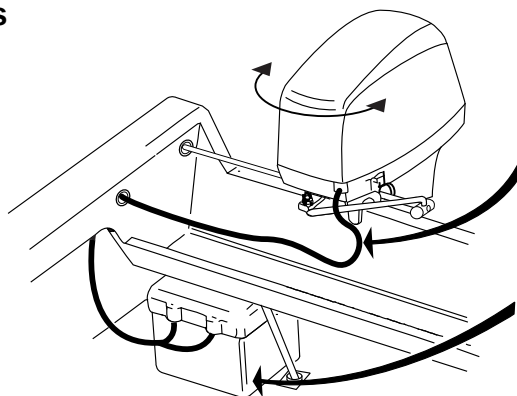
- In position (to avoid shock hazard)
- Not torn or cracked



In transom area:

All Connections

- Clean
 - Tight
- (Prevents sparks)



Electric Cable

- Not rubbing on sharp objects
- Enough slack to allow full turning without pull loads on cable (prevents sparks)

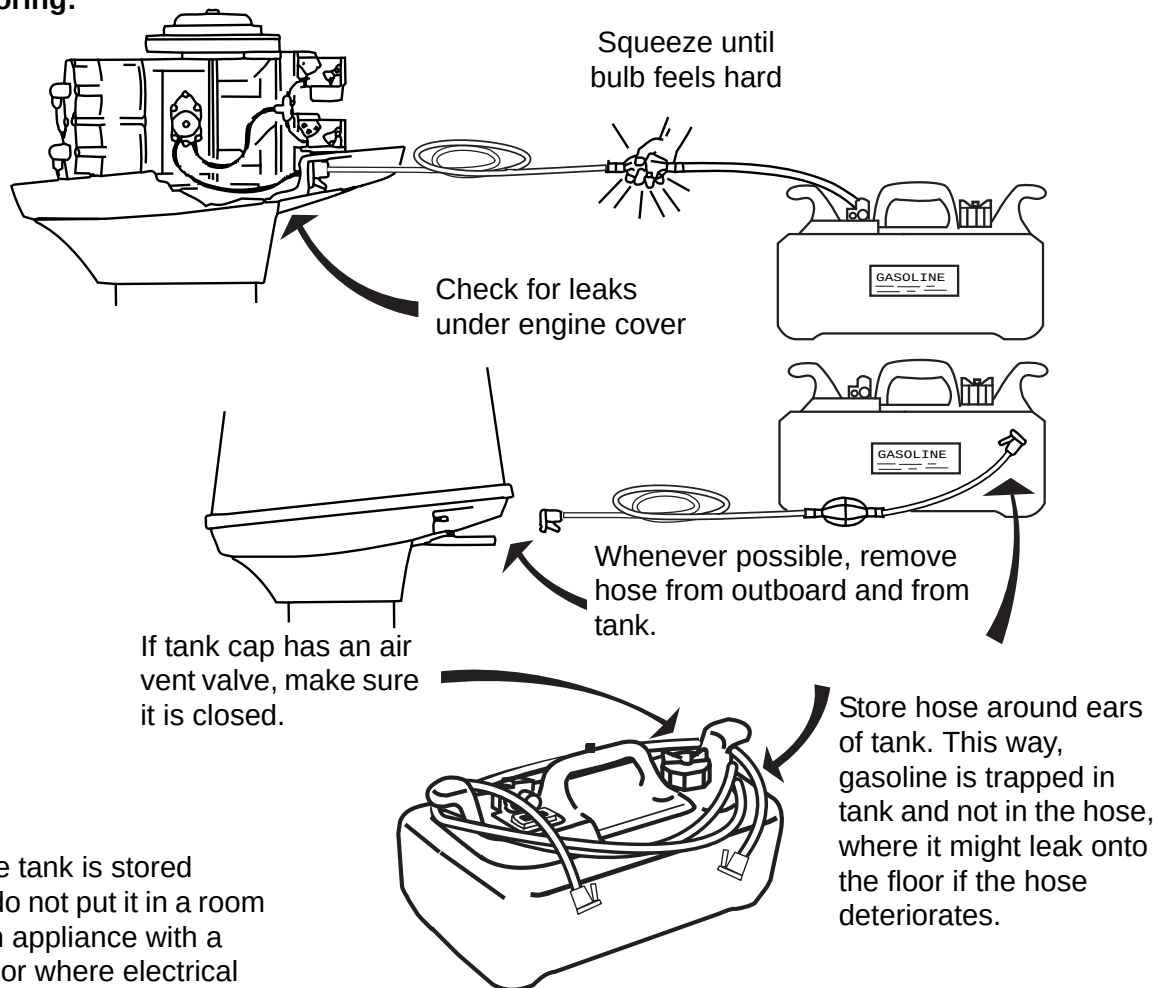
Batteries

- Secure in approved battery box or battery tray
- Battery terminals insulated
- No strain on cables

SAFETY

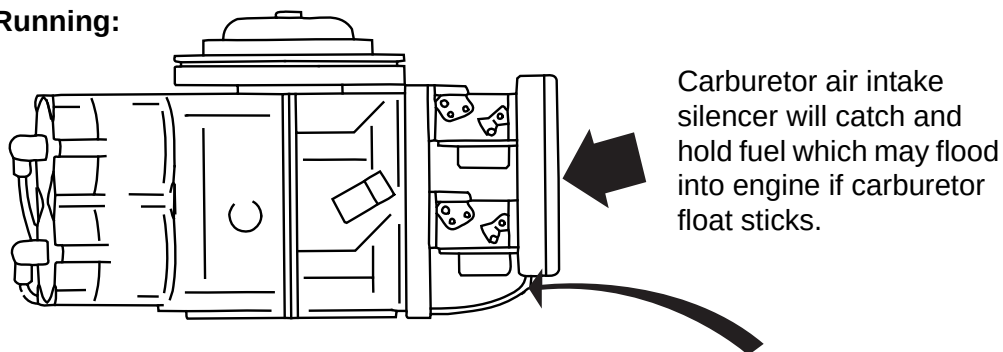
After repair on any part of the fuel system, pressure test engine portion of fuel system as shown:

When Storing:



If gasoline tank is stored indoors, do not put it in a room having an appliance with a pilot light or where electrical appliances or switches (which may spark) will be used.

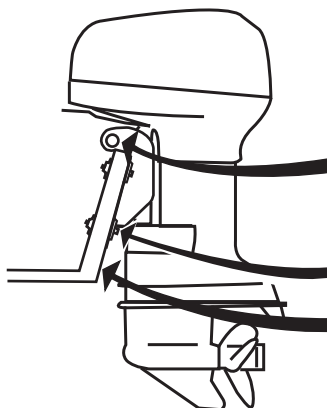
When Running:



- Make sure silencer and its gaskets are on engine and drain hose is in place.
- Air silencer mounting screws are special lock screws. Use only the special screws.

Outboard Mounting System and Safety

The mounting system includes:

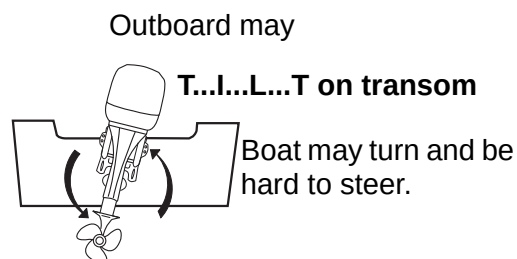
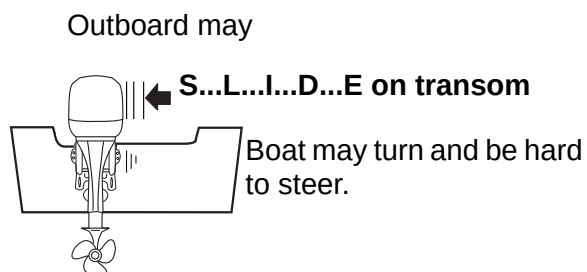


- outboard parts
- bolts, nuts, and washers
- boat's transom

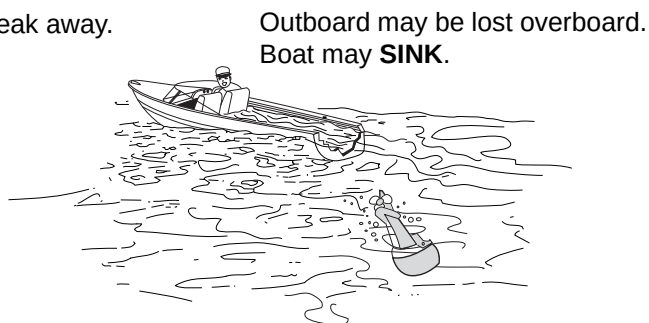
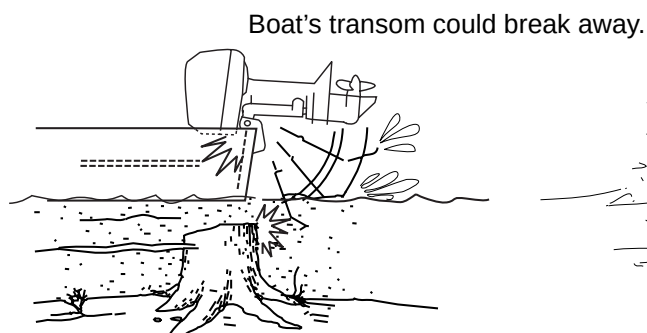
What is most important?

- Outboard must **stay** in position on boat's transom.

What could happen?



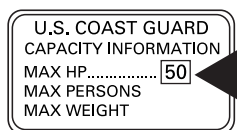
- If outboard hits something solid and does not stay on the transom, boat occupants may be injured from the outboard or its parts entering the boat.



How Can Loss of Mounting Be Minimized?

- **Read, understand, and follow** manufacturer's **instructions**.
- Follow warnings marked "⚠" closely.

If weakened, parts could fail later on the water, when not expected

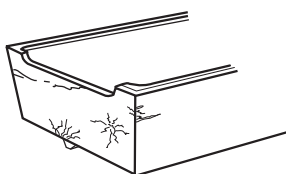


If boat plate shows...

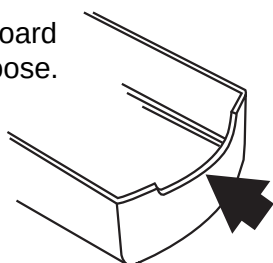
Use only
or smaller



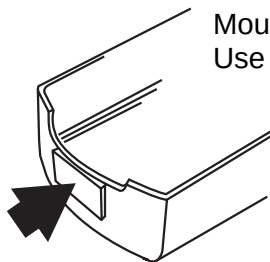
When rigging or fixing any boat, if transom looks weak, tell the owner.



If transom is curved, outboard may come loose.



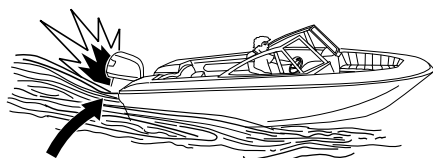
Mount on flat surface only.
Use shims to make surface flat.



Use bolts, nuts, and washers supplied with outboard. They are usually special, and will not rust or weaken.

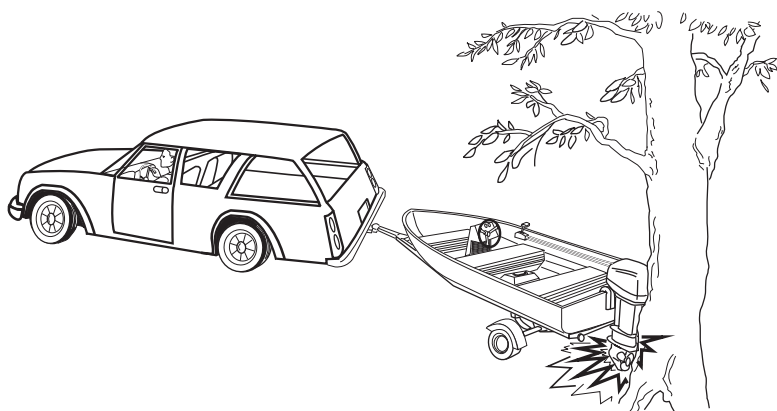


If owner tells you "I hit something really hard..."



Check for a high speed blow to the lower unit.

OR...



"I was backing up and I think the outboard may have hit a tree or something."

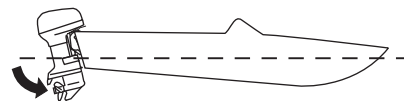
Check for a slow, heavy squash to the outboard.

- Look for damaged parts and loosened nuts and bolts in both the steering and mounting systems. Replace damaged parts.

Outboard Hydraulic Tilt/Trim Shock Absorption System and Safety

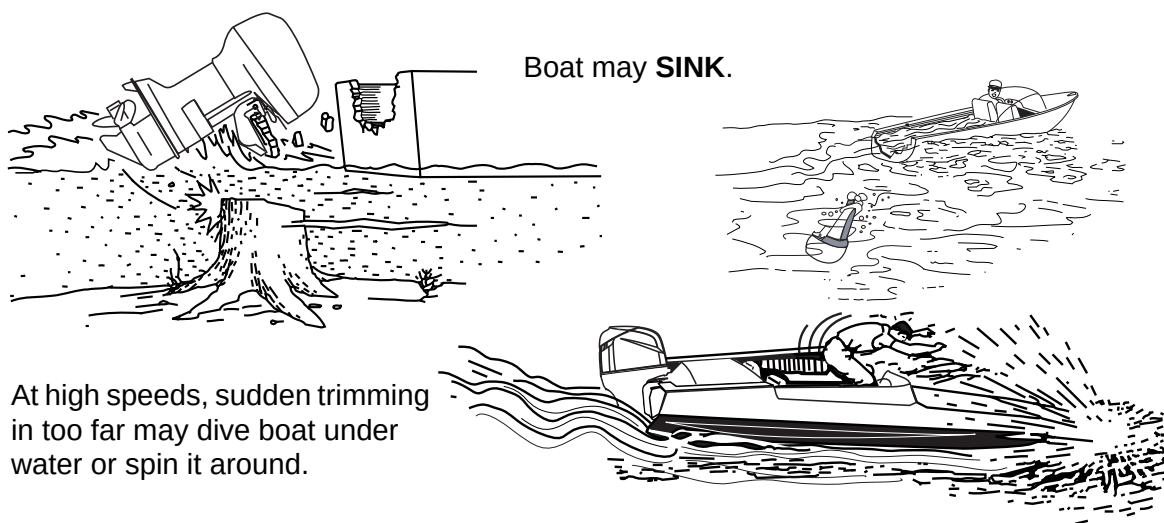
What is most important?

- Shock absorption system must always be ready to absorb some blows to the lower parts of the outboard.
- Outboard must not trim in too far suddenly.



What can happen?

Without shock protection, a blow like this could cause serious damage to the outboard and injury to boat occupants from the outboard or its parts entering the boat. Transom could break away and outboard may be lost overboard.

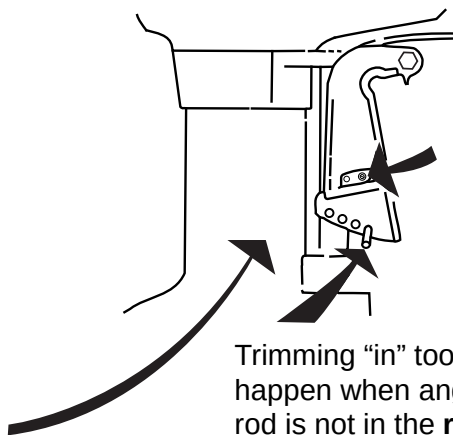


Boat may **SINK**.

At high speeds, sudden trimming in too far may dive boat under water or spin it around.

How can possible conditions be minimized?

- **Read, understand, and follow** manufacturer's **instructions**.
- Follow warnings marked "⚠" closely.
- Test your work whenever possible.
- If oil leaks are seen in service areas, determine source. Keep reservoir filled.
- If outboard is hydraulic tilt/trim model, always return rod to hole position determined by boat operator and make sure angle adjusting rod retain is in locked position.

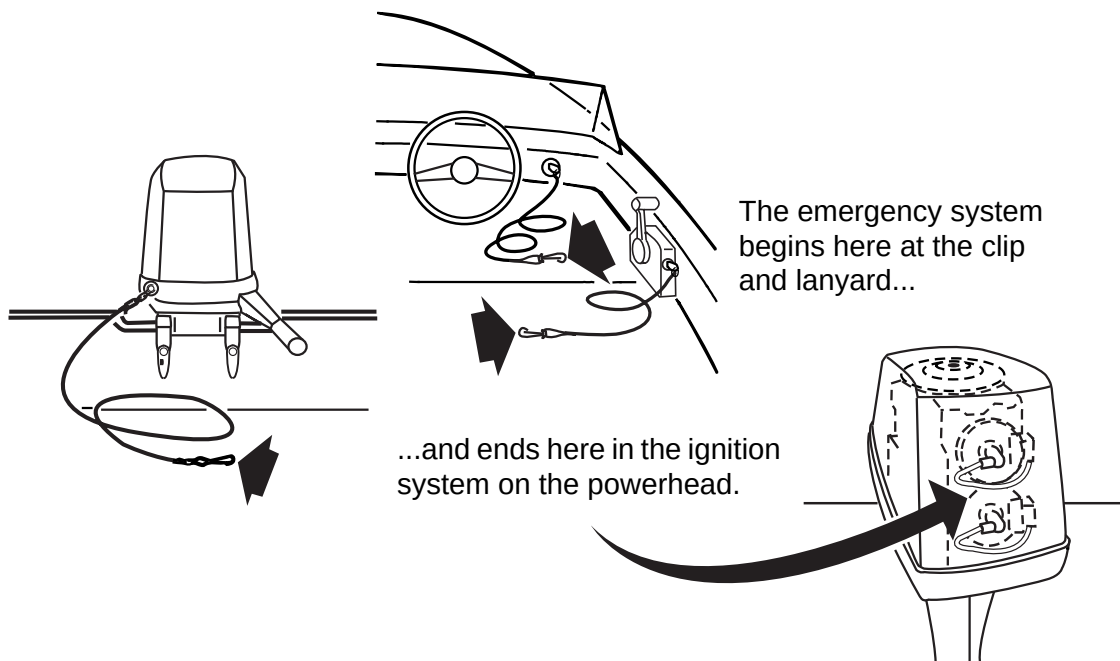


Make sure manual release valve is closed tight. Torque to 45 to 55 in. lbs. (5.1 to 6.2 N·m).

If left open, outboard has no shock protection.

Trimming "in" too far can happen when angle adjusting rod is not in the **right** hole or is not in **any** hole (lost).

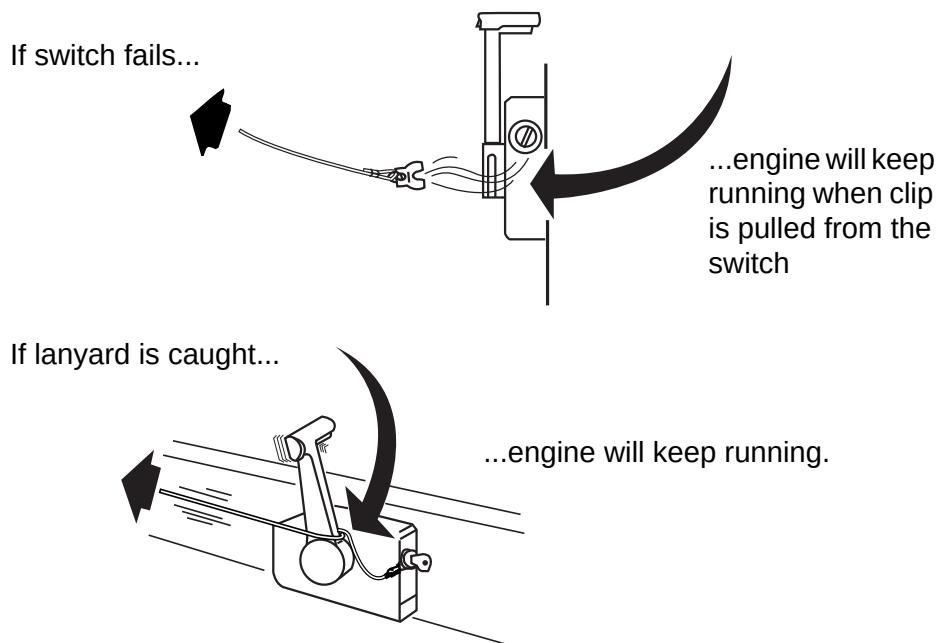
Outboard Emergency Stop System and Safety



What is most important?

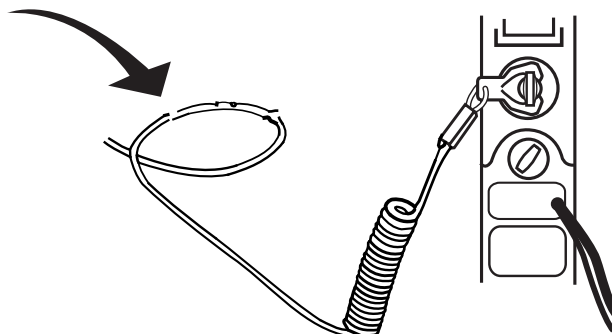
- The emergency stop system must **STOP** the engine when the clip is removed or the lanyard pulled from the emergency stop / key switch.

What could happen?

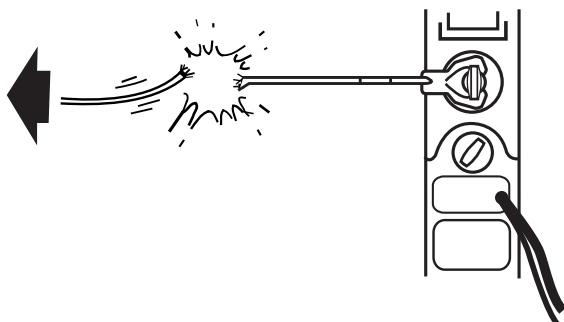


What could happen?

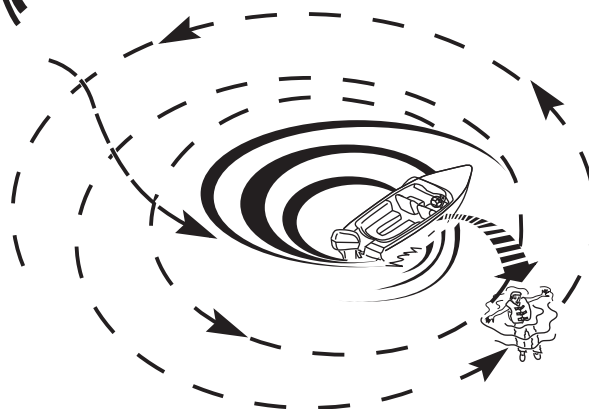
If lanyard is cut or frayed...



...lanyard or clip may break when pulled...



If engine does **NOT** stop when lanyard is pulled, an operator thrown from the boat could be hit as boat circles area. Or, boat may not turn but leave area as a runaway. Operator may drown and boat **WILL** run into something.



How can failure of the emergency stop system be minimized?

**When
rigging
or after
servicing**

- **Read, understand, and follow** manufacturer's instructions
- Follow warnings marked "⚠" closely.
- Assemble parts carefully.
- Inspect lanyard for cuts or fraying; clip for wear. Replace with original parts. Do not substitute.
- Locate control box and other items in area to keep lanyard from being caught.
- **ALWAYS TEST EMERGENCY STOP SYSTEM. PULL LANYARD. ENGINE MUST STOP. IF IT DOES NOT, REPAIR BEFORE NEXT USE.**

Summing up

Now you know some things that can take the joy out of boating.

No doubt about it—proper safety takes time!

- Reading and understanding instructions
- Re-reading warnings marked “⚠”
- Putting parts together correctly
- Making correct adjustments
- Testing your work

And making sure

- Worn or damaged parts are replaced
- Replaced parts are like originals in every way
- Customer is told of things which need attention

But, do you really want the alternative?

MARINE PRODUCTS AND THE SAFETY OF PEOPLE WHO FIX THEM

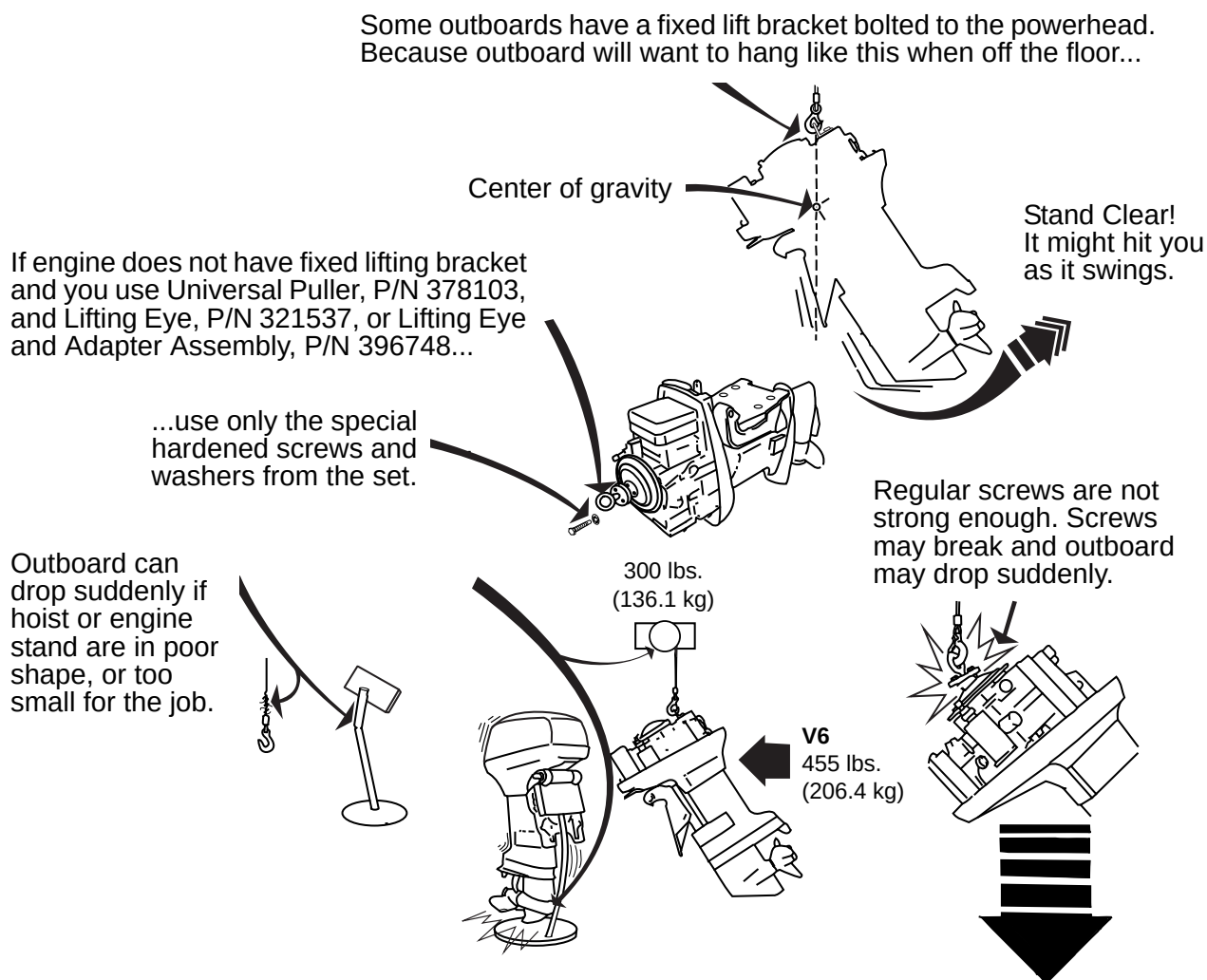
The first part of this Safety section talked about safe boating and how you, the technician, can help keep it safe for the boater. But what about you? Technicians can be hurt while:

- Rigging boats
- Troubleshooting problems
- Fixing components
- Testing their work

Some of these safety issues you will know, others you may not.

Handling Outboards

When lifting outboards

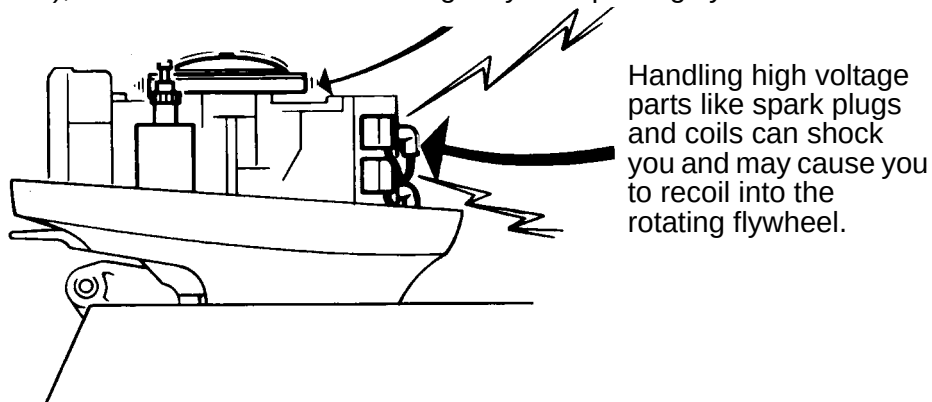


- Make sure shop aids have extra capacity, and keep them in good repair.

SAFETY

Running outboard with engine cover removed

Engine cover is a guard. When you remove cover/guard to work on the outboard, remember: loose clothing (open shirt sleeves, neckties), hair, jewelry (rings, watches, bracelets), hands and arms can be caught by the spinning flywheel.



- Two people working together on a live outboard must look out for each other. Never, ever, use the key to start the outboard before signaling your partner. He may be leaning over the outboard with hands on the flywheel, handling a “hot” electrical part, or near the propeller.

Outboard starting at the wrong time

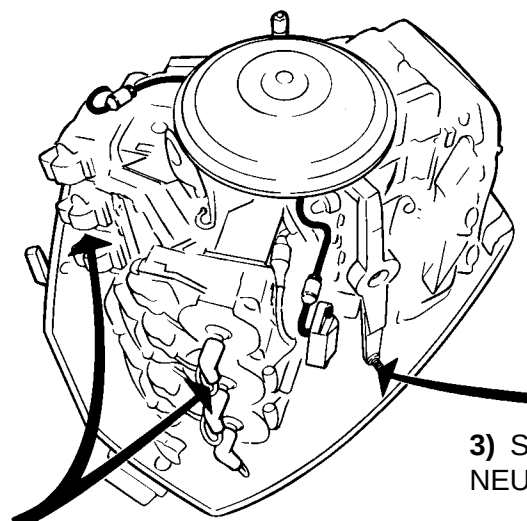
When you do things that turn the flywheel like:

- Off-season storage fogging (oiling) of outboard;
- Removing propeller with a powered tool;
- Electrical system checks;
- Servicing the flywheel; or
- Any other actions **ALWAYS...**

1) Turn key switch OFF

2) Twist and remove ALL spark plug leads

3) Shift to NEUTRAL



Check prop shaft. Is outboard really in NEUTRAL?

NO SPARK



NO START



NO SURPRISES

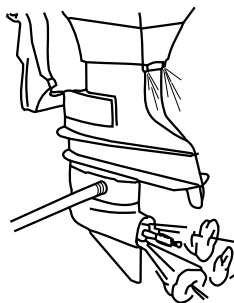
Running outboard too fast (Overspeeding)

- “Too fast” means running faster than outboard normally runs on boat.

Running too fast can happen when:

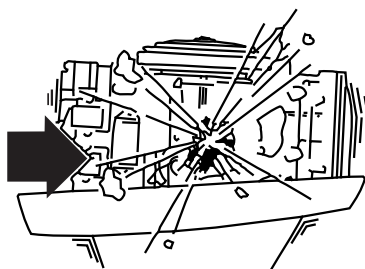
1) Using a flushing device...

Turn on water before starting outboard.
Keep engine speed below 2000 RPM.
With no load, outboard will run too fast very easily. Wear eye protectors.



2) Running with the wrong test wheel...

This may happen if outboard runs too fast.



Use the right test wheel.

Running outboards: Exhaust fumes

DANGER

DO NOT run the engine indoors or without adequate ventilation or permit exhaust fumes to accumulate in confined areas. Engine exhaust contains carbon monoxide which, if inhaled, can cause serious brain damage or death.

- Whenever running the engine, assure there is proper ventilation to avoid the accumulation of carbon monoxide (CO), which is odorless, colorless, and tasteless, and can lead to unconsciousness, brain damage, or death if inhaled in sufficient concentrations. CO accumulation can occur while docked, anchored, or underway, and in many confined areas such as the boat cabin, cockpit, swim platform, and heads. It can be worsened or caused by weather, mooring and operating conditions, and other boats. Avoid exhaust fumes from the engine or other boats, provide proper ventilation, shut off the engine when not needed, and be aware of the risk of backdrafting and conditions that create CO accumulation. In high concentrations, CO can be fatal within minutes. Lower concentrations are just as lethal over long periods of time.

SAFETY

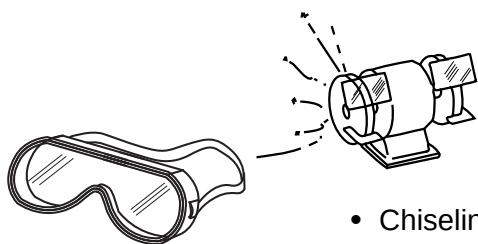
Running outboards: Propellers

DANGER

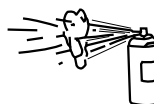
Contact with a rotating propeller is likely to result in serious injury or death. Assure the engine and prop area is clear of people and objects before starting engine or operating boat. Do not allow anyone near a propeller, even when the engine is off. Blades can be sharp and the propeller can continue to turn even after the engine is off. Always shut off the engine when near people in the water.

Eye protection

Eyes need protection when:



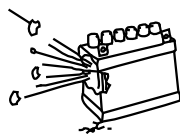
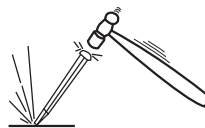
- Grinding



- Spraying cleaners and paints

- Chiseling

Tip: When steel on steel, use plastic- or brass-type hammers. They don't chip off as easily as steel hammers.



Protect eyes from:

- Acid

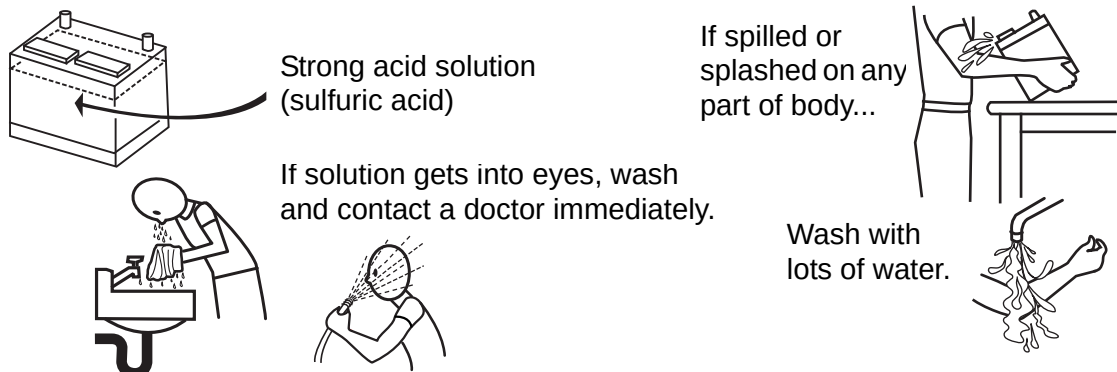


- Ends of cables

**Wear
Safety
Glasses**

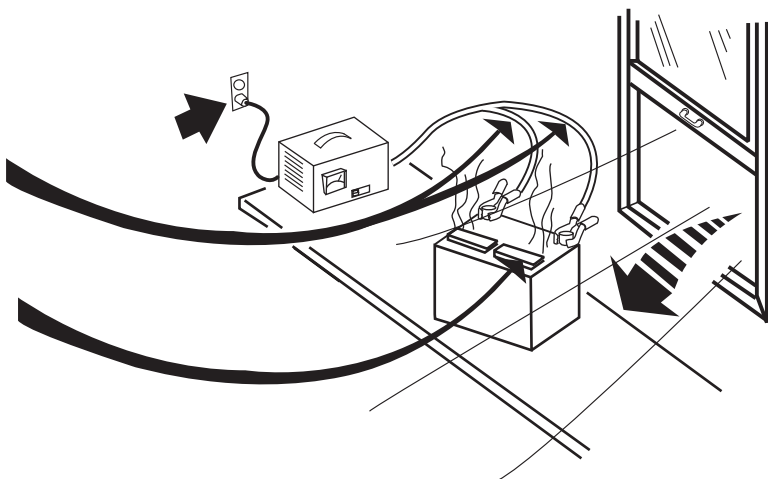


Handling Lead/Acid Batteries



Charging lead acid batteries

- 1) Attach and remove these cables with charger **UNPLUGGED** from 110 V wall socket. (This prevents shocks if charger is defective.)
- 2) Observe correct polarity when connecting these larger leads.
- 3) Always charge in a well ventilated area. Charging causes acid solution to give off hydrogen gas through the vents in the caps. **Make sure vents are open.** If clogged, pressure inside may build. Battery may **EXPLODE**.



Battery gas is explosive!

While charging or discharging, remember:

- No smoking
- No flames
- No sparks



Never remove charger cables from battery posts. It is a sure way to make a lot of sparks in an area surrounded by battery gas.

DO NOT check battery charge by placing metal objects across posts. You will make sparks and serious burns are possible.



After charging:

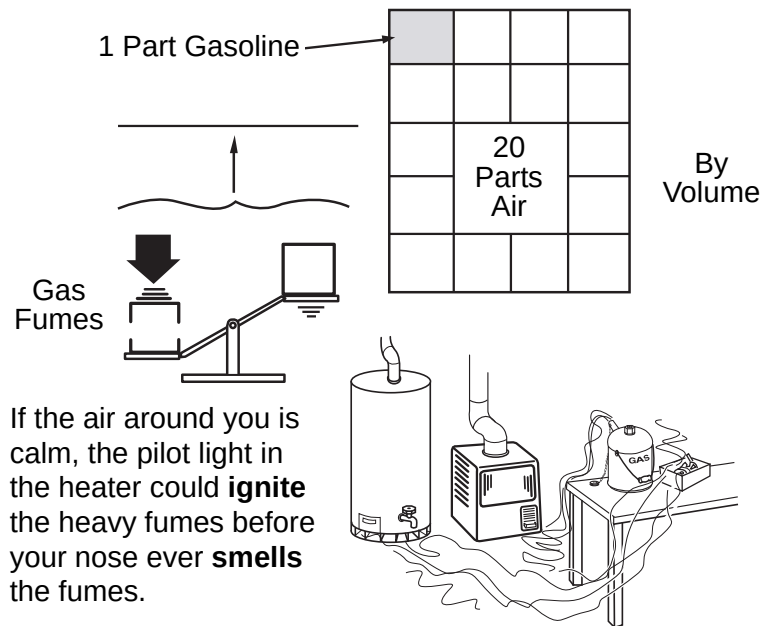
- Shut off charger
- Pull charger plug out of 110 V outlet
- Take charger cables off battery posts

Gasoline – Handle With Care!

Gasoline vapor and air mixtures explode easily and violently when mixed as shown...

When you smell ANY odor of gasoline, explosion is possible.

Gasoline fumes are heavy and will sink to the lowest point in the boat or room and will STAY there, WAITING...



What can you do?



Store gasoline in sturdy, approved, sealed gas can and keep outside.

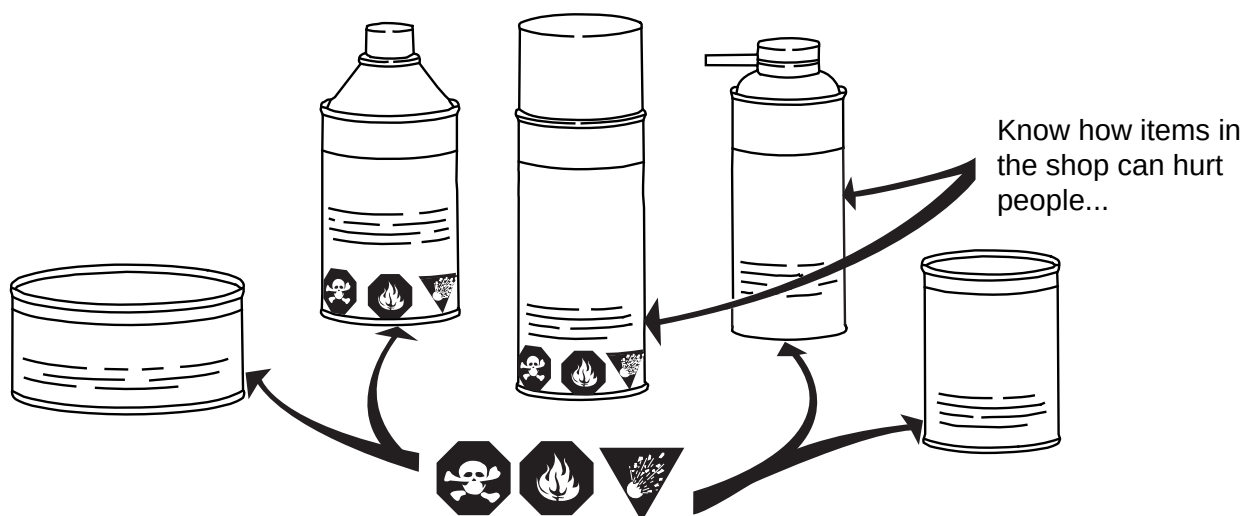
- Always store gasoline outside in a safe can (flame arrester and pressure relief valve in pour spout).
- Fill portable tanks outside of boat. Spillage will collect in bottom of boat.
- Use fuel as fuel **ONLY**, **not** for a cleaner or degreaser.
- If fumes are smelled in shop, basement, or garage, **immediately**:
 - Put out open flames, cigarettes, sparking devices;
 - Wipe up spill or leak;
 - Get towels and rags outside fast;
 - Open doors and windows; and
 - Check **lowest** area for fumes.

Be aware of items in and around repair area which can ignite fumes. Control them if fumes are smelled.

- Matches, cigarettes, blow torches, welders
- Electric motors (with unsealed cases)
- Electric generators (with unsealed cases)
- Light switches
- Appliance pilot lights or electric ignitors (furnace, dryer, water heaters)
- Loose wires on running outboards
- Other variables which may ignite fumes

How many of these are in your repair area?

Hazardous Products

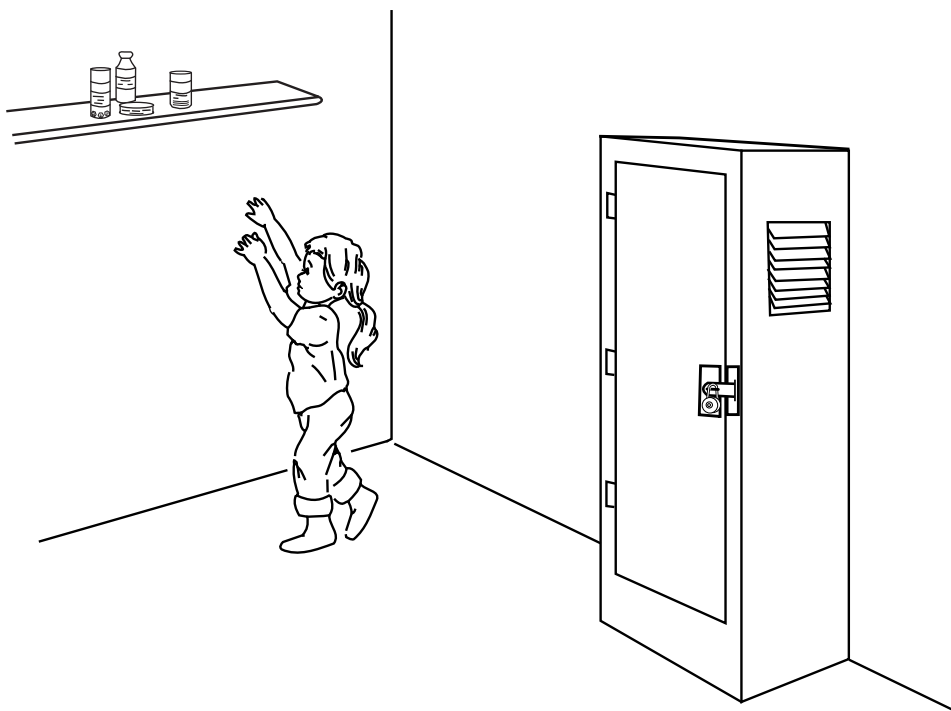


READ

- "How and where to use"
- "How to give First Aid." Have recommended First Aid materials on hand should an emergency arise
- "How to dispose of can"

It's all on the **back of the can or bottle label**.

And remember: Little children are very curious and will try to taste everything so **keep containers away from children!**



Safety Awareness Test

The Technician's Safety Awareness Test....

- 1)** Did you read this Safety section from page S–1 to page S–24?
- 2)** Are you ready to take responsibility for the safe maintenance practices and procedures of your repair shop, co-workers, and technicians?
- 3)** Do you understand all the safety precautions and instructions contained in this entire service manual?
- 4)** Will you follow all safety warnings, precautions, instructions and recommendations outlined in this service manual?
- 5)** Do you understand that the service manual as a whole and this Safety section, in particular, contain essential information to help prevent personal injury and damage to equipment and your customers?
- 6)** Have you received training related to common shop safety practices to protect yourself and others around you?
- 7)** When replacement parts are required, will you use *Evinrude®/Johnson® Genuine Parts* or parts with equivalent characteristics, including type, strength and material?
- 8)** Are you ready to follow the recommendations in this service manual before you service any boat or outboard?
- 9)** Do you understand that safety-related accidents can be caused by carelessness, fatigue, overload, preoccupation, unfamiliarity of operator with the product, drugs and alcohol, just to name a few?

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Related Documents

[illegible]

TROUBLE CHECK CHART

OUTBOARD WILL NOT START

OBSERVATION	POSSIBLE CAUSE	PROCEDURE
Outboard does not turn over	Battery switch not ON	Check battery switch operation
	Discharged battery	Check battery, recharge or replace
	Battery cables and connections	Clean and tighten connections. Check for voltage drop in starter circuit.
	Faulty connection or ground, damaged electrical harness	Check all grounds, connections and wiring
	Fuse (10 A)	Check wiring, then replace faulty fuse
	Wiring harness	Check for 12 V at terminal "B" of key switch
	Key switch	Check key switch operation
	Starter solenoid	Check wiring and test solenoid
	Starter or bendix/drive gears	Check starter, inspect bendix/drive gears
	Seized powerhead or gearcase	Check and repair as needed
Outboard turns slowly	Discharged battery	Check battery, recharge or replace
	Battery cables and connections	Clean and tighten connections. Check voltage drop in starter circuit.
	Powerhead hydro-locked	Check cylinders for water
	Partially seized powerhead or gearcase	Check and repair as needed
	Starter or bendix/drive gears	Check starter, inspect bendix/drive gears

TROUBLE CHECK CHART
OUTBOARD WILL NOT START

OUTBOARD WILL NOT START

OBSERVATION	POSSIBLE CAUSE	PROCEDURE
Outboard turns over	Stop circuit grounded	Check wiring and emergency stop switch. Check the safety lanyard is installed and stop circuit is not grounded.
	In gear—Tiller models	Make sure outboard is in neutral
	No Fuel	Check for fuel in fuel tank
	Water in fuel	Check fuel filter, sample fuel from fuel return manifold.
	Contaminated or poor fuel quality	Check or replace fuel supply
	Fuel supply restricted	Check primer, anti-siphon valve, and fuel pick-up. Use primer to fill vapor separator with fuel.
	Air in fuel system	Check for air in fuel supply manifold, refer to FUEL SYSTEM (vapor separator venting and fuel supply)
	Low or no fuel pressure to injectors	Check fuel manifold pressure, refer to FUEL SYSTEM
	Incorrect, fouled, or worn spark plugs	Replace spark plugs
	Fuel injectors not working	Check voltage at injectors
	Excessive fuel or oil, engine flooded	Check for leaking injectors, leaking fuel or oil lift pump, or leaking vapor separator vent, refer to FUEL SYSTEM
	Low or no 55 V alternator output	Check voltage on 55 V circuit (SAC), refer to SYSTEM ANALYSIS and ELECTRICAL AND IGNITION
	Capacitor or 55 V circuit wiring	Check capacitor and 55 V circuits, refer to SYSTEM ANALYSIS and ELECTRICAL AND IGNITION
	Ignition	Check ignition, refer to SYSTEM ANALYSIS and ELECTRICAL AND IGNITION
	CPS input to <i>EMM</i> , no sync	Check RPM reading while cranking
	No ignition system primary voltage output from <i>EMM</i> to ignition coils	Check cranking RPM (300 minimum), refer to SYSTEM ANALYSIS
	Low or no compression	Check compression
	Water in engine	Check condition of spark plugs and cylinders
	Internal powerhead damage	Check and repair as needed
	Leaking cylinder/crankcase, intake manifold, or reed valves	Check and repair as needed
	<i>EMM</i> program, timing, or operation	Check <i>EMM</i> program and timing; check injector information (by location and serial number)
	Neutral switch, tiller models	Check neutral switch operation

OUTBOARD HARD TO START

OBSERVATION	POSSIBLE CAUSE	PROCEDURE
Outboard eventually starts, may or may not run properly once started	Weak battery	Check battery, recharge or replace
	Battery cables and connections	Clean and tighten connections, check voltage drop on high amperage circuit
	Starter or bendix/drive gears	Check starter, inspect bendix/drive gears
	Water in fuel system	Check water separator/fuel filter, sample fuel from fuel return manifold test port
	Contaminated or poor fuel quality	Check or replace fuel supply
	Air in fuel system	Check for air in fuel supply manifold, refer to FUEL SYSTEM (vapor separator venting and fuel supply)
	Incorrect, fouled, or worn spark plugs	Replace spark plugs
	Low fuel pressure	Check pressure, refer to FUEL SYSTEM
	Fuel supply restricted	Check primer bulb, anti-siphon valve, and fuel pick-up, check for fuel system air leaks
	Low or no alternator output (55 V)	Check voltage on 55 V circuit, refer to SYSTEM ANALYSIS and ELECTRICAL AND IGNITION
	Capacitor or 55 V circuit wiring	Check capacitor and 55 V circuit (white/red), refer to SYSTEM ANALYSIS and ELECTRICAL AND IGNITION
	Restricted or leaking fuel injector(s)	Check injectors, refer to FUEL SYSTEM
	Weak or erratic ignition operation	Check ignition, refer to SYSTEM ANALYSIS and ELECTRICAL AND IGNITION
	Crankshaft Position Sensor (CPS)	Check CPS air gap and <i>EMM</i> LED indicators
	Excessive fuel or oil, engine flooding	Check for leaking injectors, leaking fuel or oil lift pump, or leaking vapor separator vent. Refer to SYSTEM ANALYSIS .
	<i>EMM</i> program, timing, or operation	Check <i>EMM</i> program and timing; check injector coefficients; and monitor injector circuits and ignition primary outputs
	Internal powerhead damage	Check and repair as needed
	Leaking cylinder/crankcase, intake manifold, or reed valves	Check and repair as needed

TROUBLE CHECK CHART
OUTBOARD WILL NOT SHUT OFF

OUTBOARD WILL NOT SHUT OFF

OBSERVATION	POSSIBLE CAUSE	PROCEDURE
Outboard starts and runs, normal performance while running	Key switch or wire harness ground	Check key switch and ground to key switch, refer to SYSTEM ANALYSIS and ELECTRICAL AND IGNITION
	Stop circuit wiring	Check <i>EMM</i> LED indicators. Check wire harness (black/yellow) and key/stop switch(s).
	<i>EMM</i> failure	Check <i>EMM</i> LED indicators and eliminate stop circuit as possible cause. Stop wire (black/yellow) has 4.0 VDC from <i>EMM</i> with key on or outboard running.

OUTBOARD STARTS AND STALLS

OBSERVATION	POSSIBLE CAUSE	PROCEDURE
Outboard may not run for more than a few seconds	Faulty wiring, connections, or grounds	Check all grounds, connections, and wiring
	Incorrect, fouled, or worn spark plugs	Replace spark plugs
	Low or no alternator output (55 V)	Check voltage on 55 V circuits, refer to SYSTEM ANALYSIS and ELECTRICAL AND IGNITION
	Capacitor or 55 V circuit wiring	Check capacitor and 55 V circuit, refer to SYSTEM ANALYSIS and ELECTRICAL AND IGNITION
	Contaminated or poor fuel quality	Check or replace fuel supply
	Low fuel pressure	Check pressure, refer to FUEL SYSTEM
	Air in fuel system	Check for air in fuel supply manifold, refer to FUEL SYSTEM (vapor separator venting and fuel supply)
	Fuel supply restricted	Check primer bulb, anti-siphon valve, and fuel pick-up, check for fuel system air leaks
	Injector electrical circuit or control function	Check voltage at injectors, refer to SYSTEM ANALYSIS
	Restricted or leaking fuel injector(s)	Check injectors, refer to FUEL SYSTEM
	<i>EMM</i> program, timing, or operation	Check <i>EMM</i> program and timing; check injector coefficients; and monitor injector control wires and ignition primary outputs
	Weak or erratic ignition output	Check ignition, refer to SYSTEM ANALYSIS and ELECTRICAL AND IGNITION
	Internal powerhead damage	Check and repair as needed

OUTBOARD STARTS, LOW MAXIMUM RPM

OBSERVATION	POSSIBLE CAUSE	PROCEDURE
SystemCheck light	Outboard is in S.A.F.E.	Access <i>EMM</i> service codes and check System-Check warning
Setup or rigging change	Incorrect propeller	Refer to specifications, check recommended WOT RPM; water test and install correct pitch propeller
	Incorrect outboard mounting height	Refer to installation guidelines
Performance of outboard at lower speeds appears normal	Throttle plate opening	Check throttle plate and WOT opening
	Incorrect, fouled, or worn spark plugs	Replace spark plugs
	Contaminated or poor quality fuel	Check or replace fuel supply
	Fuel supply restricted	Check primer bulb, anti-siphon valve, and fuel pick-up, check for fuel system air leaks
	Low alternator output (55 V)	Check voltage on 55 V circuits, refer to SYSTEM ANALYSIS and ELECTRICAL AND IGNITION
	Weak or erratic ignition operation	Check ignition, refer to SYSTEM ANALYSIS and ELECTRICAL AND IGNITION
	Fuel injector electrical circuit or control function	Check voltage at injectors, refer to SYSTEM ANALYSIS
	Restricted or leaking fuel injectors	Check injectors, refer to FUEL SYSTEM
	Low fuel pressure	Check circulation pump operation, refer to FUEL SYSTEM
	<i>EMM</i> programming, timing, or operation	Check <i>EMM</i> program and timing; check injector coefficients; and monitor injector circuits and ignition primary outputs
	Restricted engine exhaust	Check and repair as needed

EXCESSIVE SMOKING

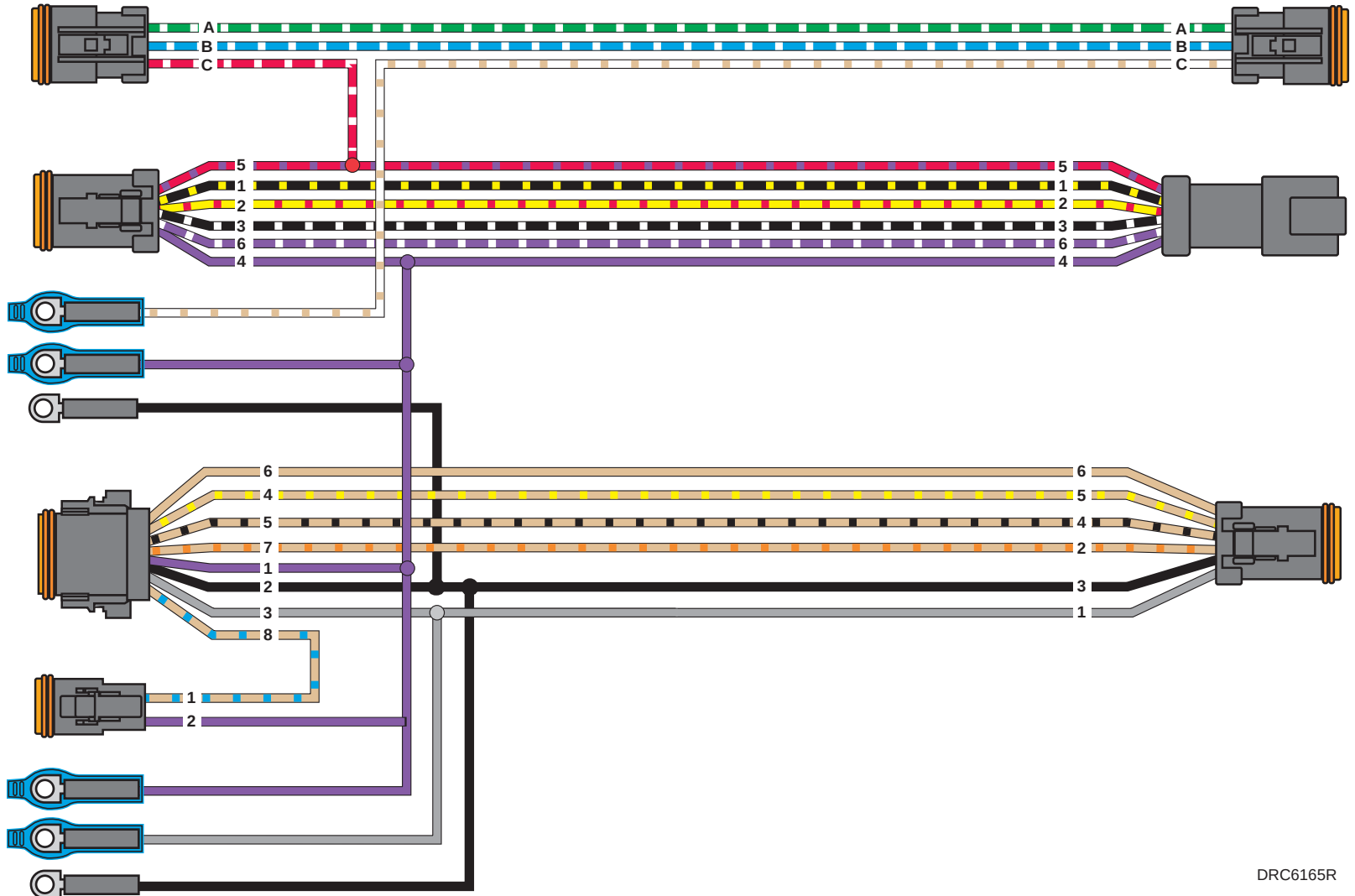
OBSERVATION	POSSIBLE CAUSE	PROCEDURE
May coincide with increased oil consumption (normal if occurs after winterization)	Contaminated or poor fuel	Check or replace fuel supply
	Excessive fuel or oil consumption	Check fuel system for fuel supply air leaks or leaking fuel injectors
	Outboard in break-in mode	Use diagnostic program to confirm
	Outboard mounted too low	Check installation height of outboard
	Vapor separator vent	Check vapor separator assembly for proper venting/float valve operation
	Faulty/leaking fuel injector(s)	Check injectors, refer to FUEL SYSTEM
	Damaged fuel lift pump	Check for internal leaks

TROUBLE CHECK CHART
OUTBOARD SURGES, RUNS ROUGH

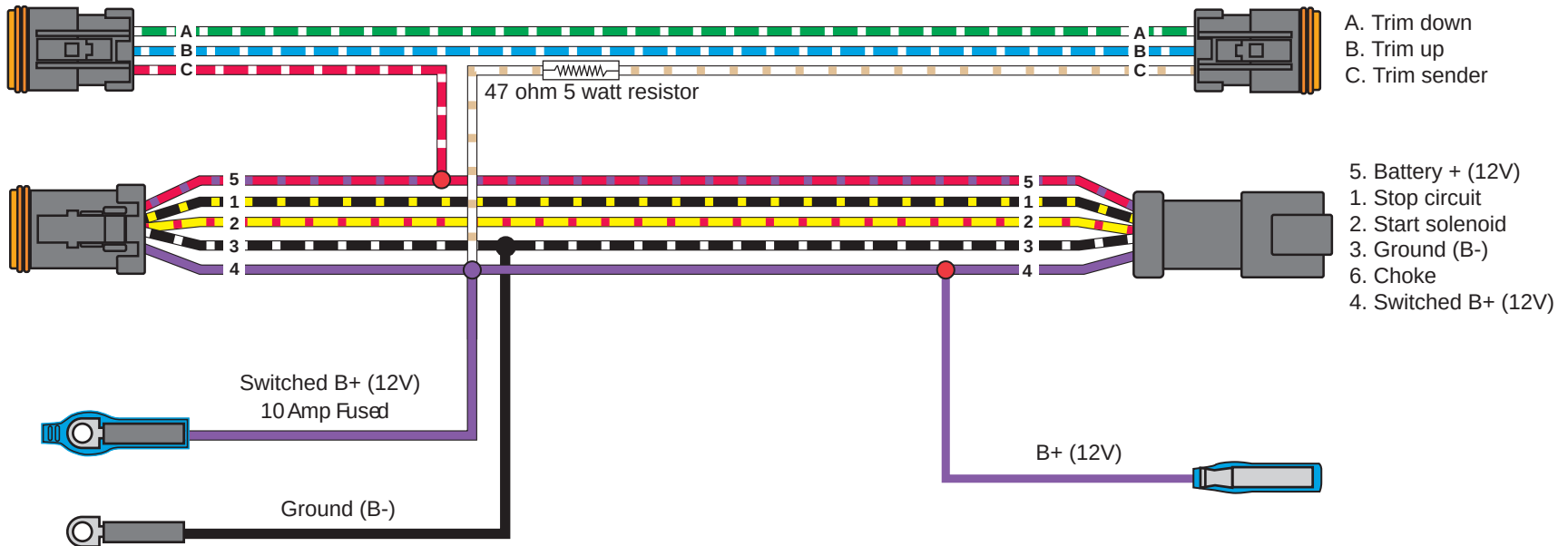
OUTBOARD SURGES, RUNS ROUGH

OBSERVATION	POSSIBLE CAUSE	PROCEDURE
1200 RPM and above	<i>S.A.F.E.</i>	Access <i>EMM</i> fault codes
May be erratic or inconsistent	Incorrect, fouled, or worn spark plugs	Replace spark plugs
	Water in fuel system	Check water separator/fuel filter, sample fuel from fuel return manifold test port
	Contaminated or poor fuel quality	Check and replace fuel supply
	Low or erratic fuel pressure	Check pressure, refer to FUEL SYSTEM
	Air in fuel system	Check for air in fuel supply manifold, refer to FUEL SYSTEM (vapor separator venting and fuel supply)
	Fuel supply restricted	Check primer bulb, anti-siphon valve, and fuel pick-up, check for fuel system air leaks
	Restricted or leaking fuel injector(s)	Check injectors, refer to FUEL SYSTEM
	Faulty wiring, connections, grounds, or CPS air gap	Check all grounds, connections, and wiring. Check CPS air gap.
	Low alternator output (55 V)	Check voltage on 55 V circuit, refer to SYSTEM ANALYSIS and ELECTRICAL AND IGNITION
	<i>EMM</i> program, timing, or operation	Check <i>EMM</i> program and timing; check injector coefficients; and monitor injector circuits and ignition primary outputs
	Weak or erratic ignition operation	Check ignition, refer to SYSTEM ANALYSIS and ELECTRICAL AND IGNITION
	Capacitor or 55 V circuit wiring	Check capacitor and 55 V circuit (white/red), refer to SYSTEM ANALYSIS and ELECTRICAL AND IGNITION
	Restricted engine exhaust	Check and repair as needed
Audible noise	Propping	Change propeller type or size as needed
	Internal powerhead damage	Check and repair as needed
	Damaged gearcase	Inspect gearcase and lubricate

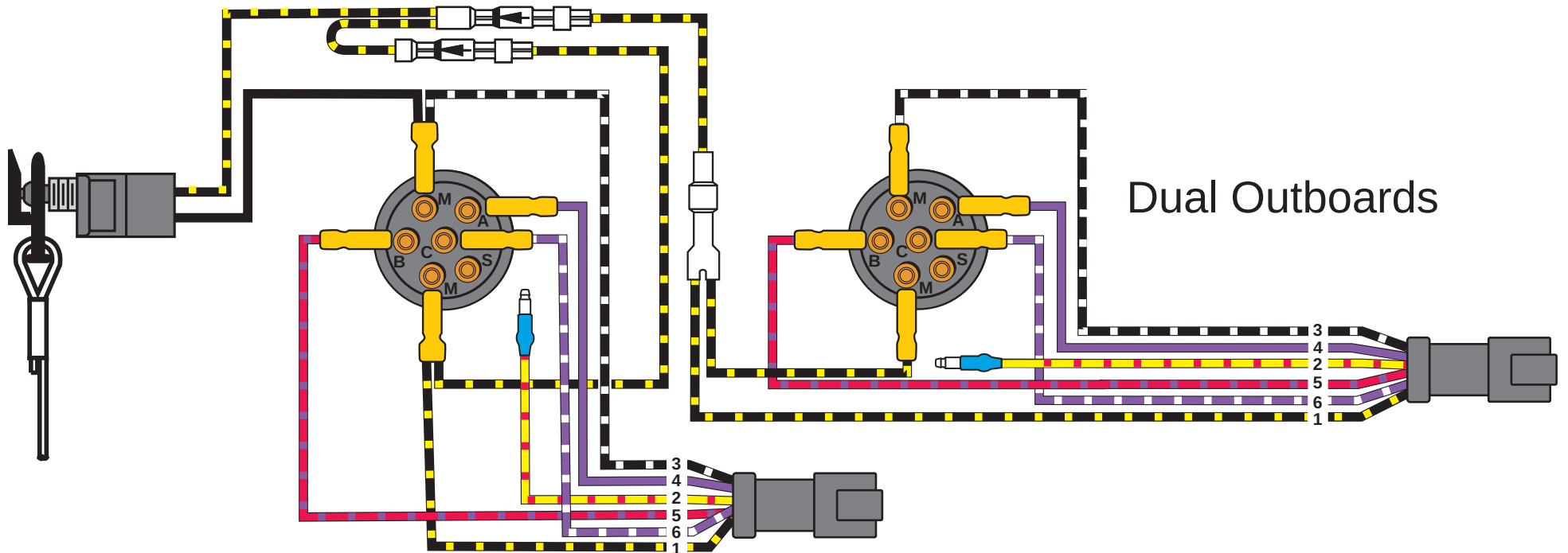
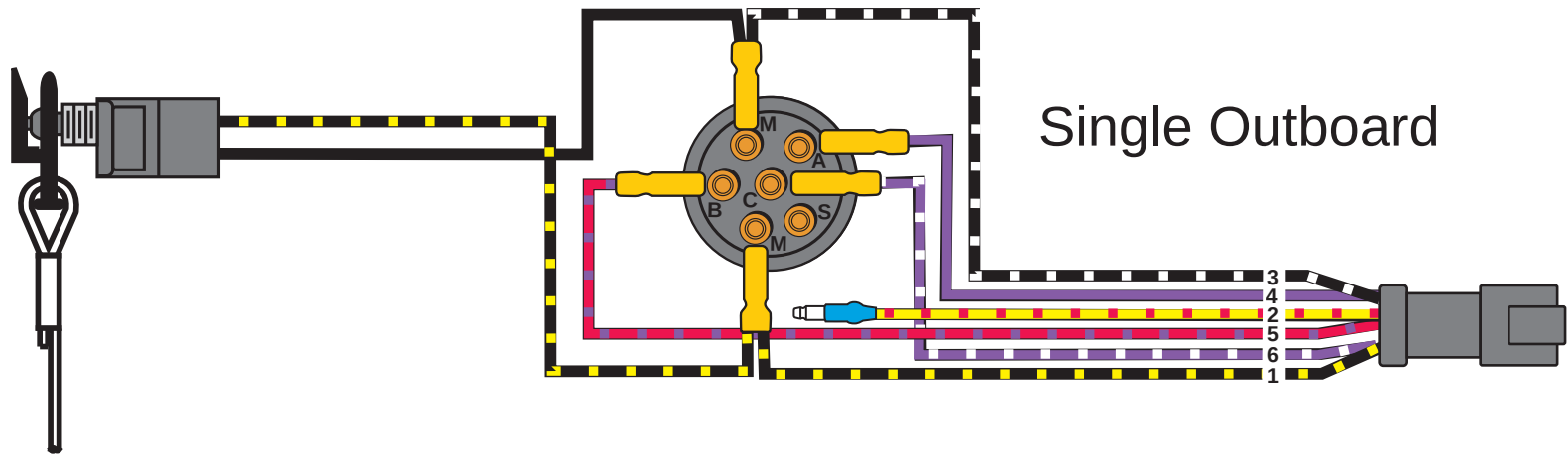
MWS Instrument Wiring Harness



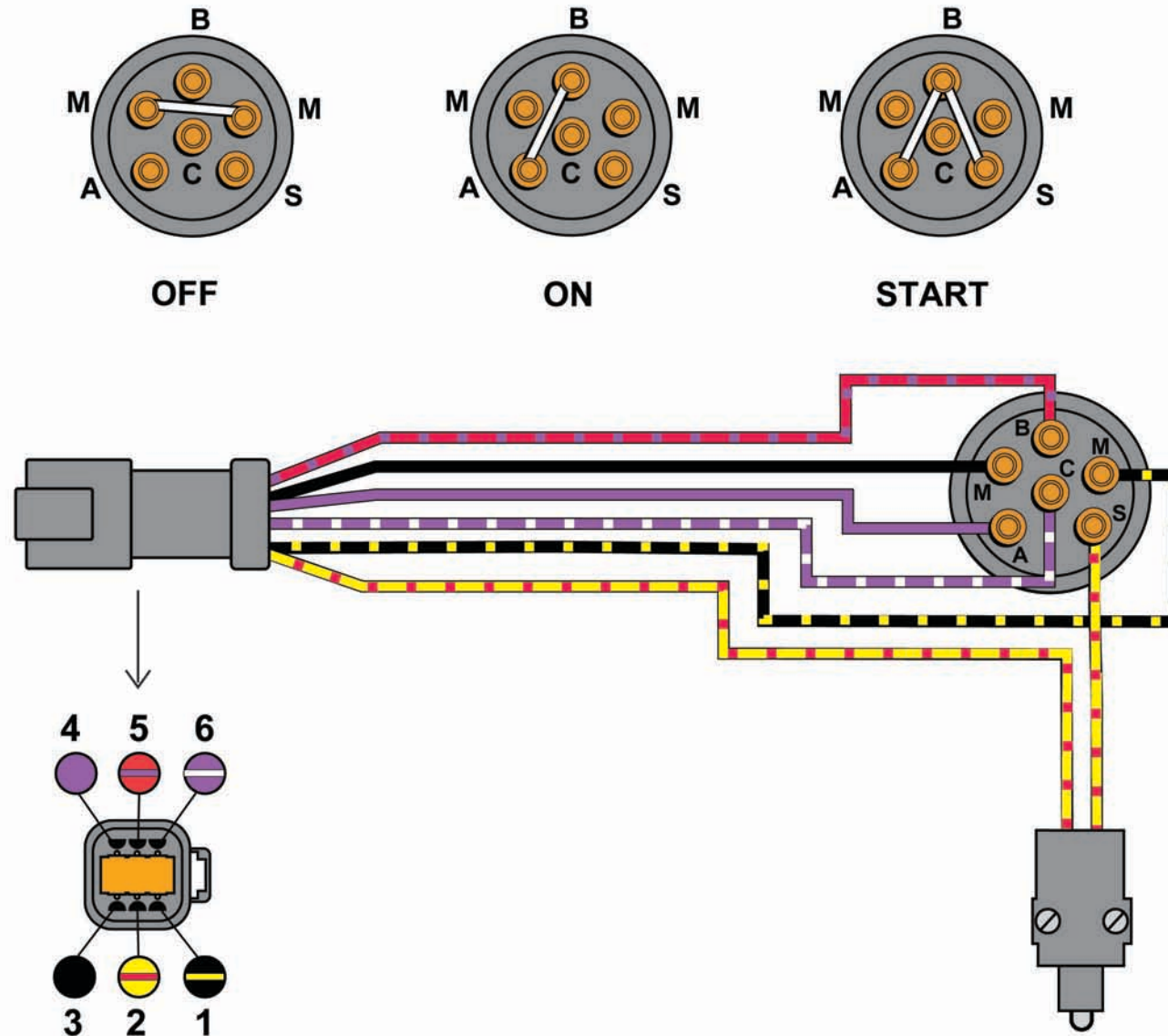
I-Command Keyswitch/TNT Wiring Harness



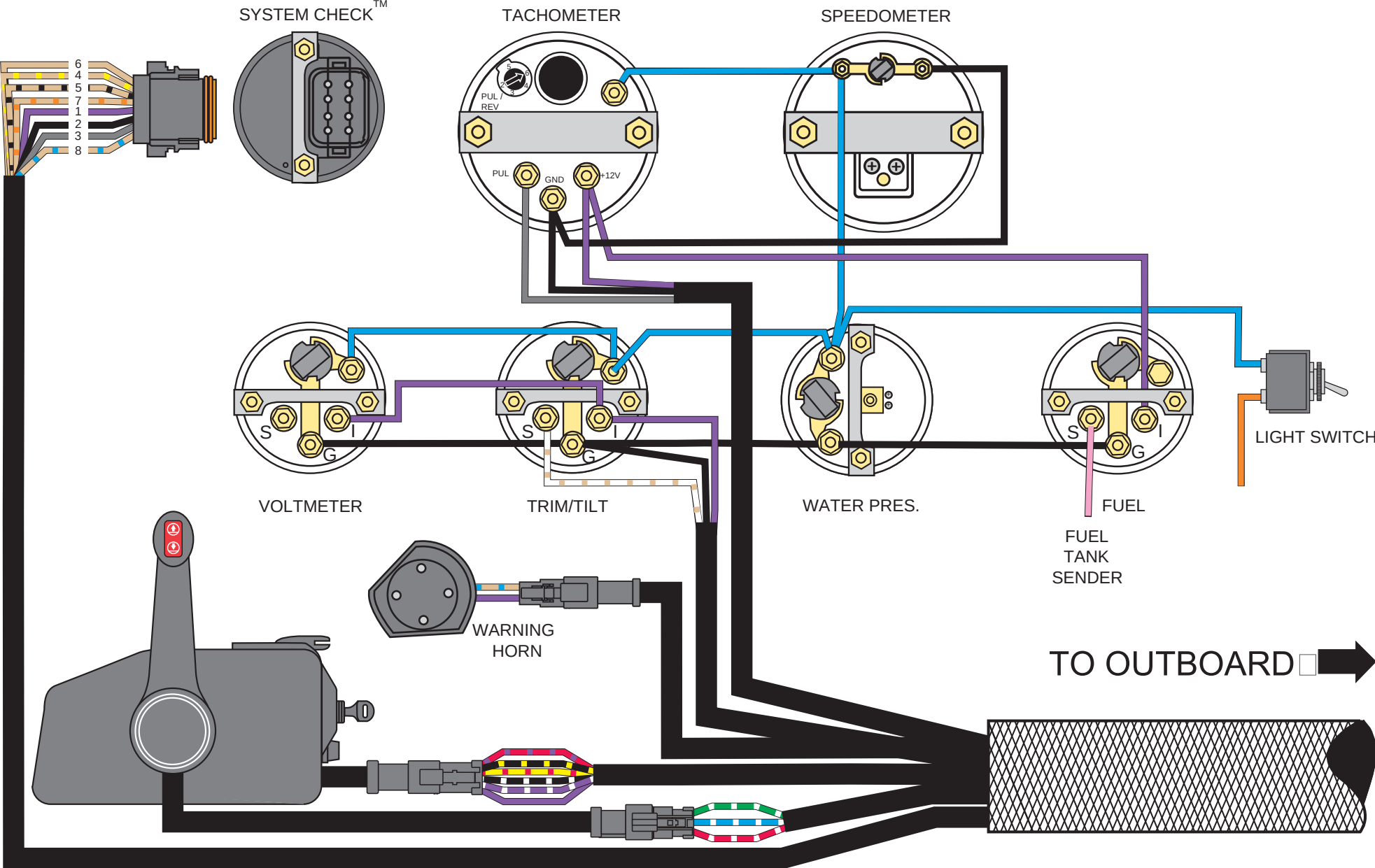
Lanyard Switch / Emergency Stop Circuits



MWS Key Switch and Neutral Safety Switch



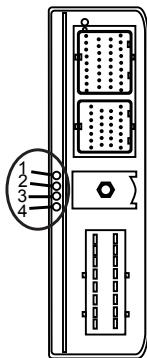
MWS DASHBOARD



Evinrude E-TEC

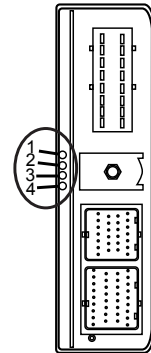
EMM LED Diagnostic Indicators

In-line Models



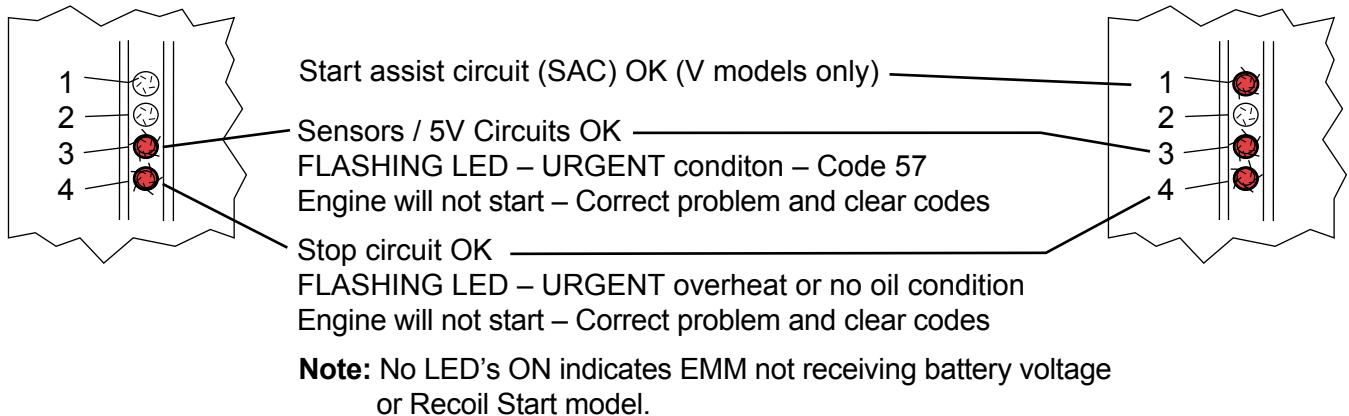
- | | | | | | | |
|---|---|---|---|-----------------------------------|---|---|
| 1 | — | ⦿ | — | Charging / 55V Circuit | ⦿ | 1 |
| 2 | — | ⦿ | — | CPS OK - Injection/Ignition/Fault | ⦿ | 2 |
| 3 | — | ⦿ | — | Sensors / 5V Circuits | ⦿ | 3 |
| 4 | — | ⦿ | — | Stop Circuit - No Oil/Overheat | ⦿ | 4 |

V Models

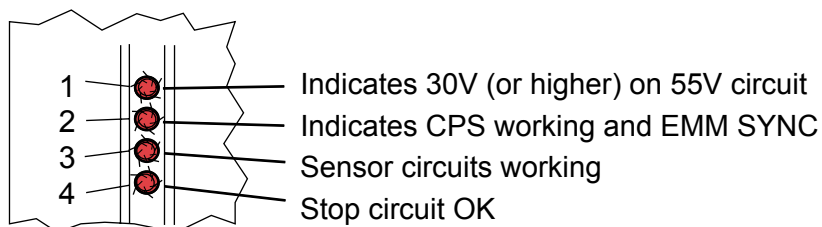


For more information, refer to **SYSTEM ANALYSIS** in the Service Manual.

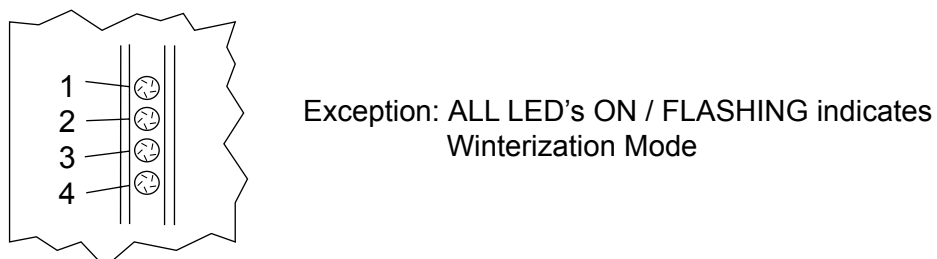
KEY ON : LED's illuminate to indicate circuit function

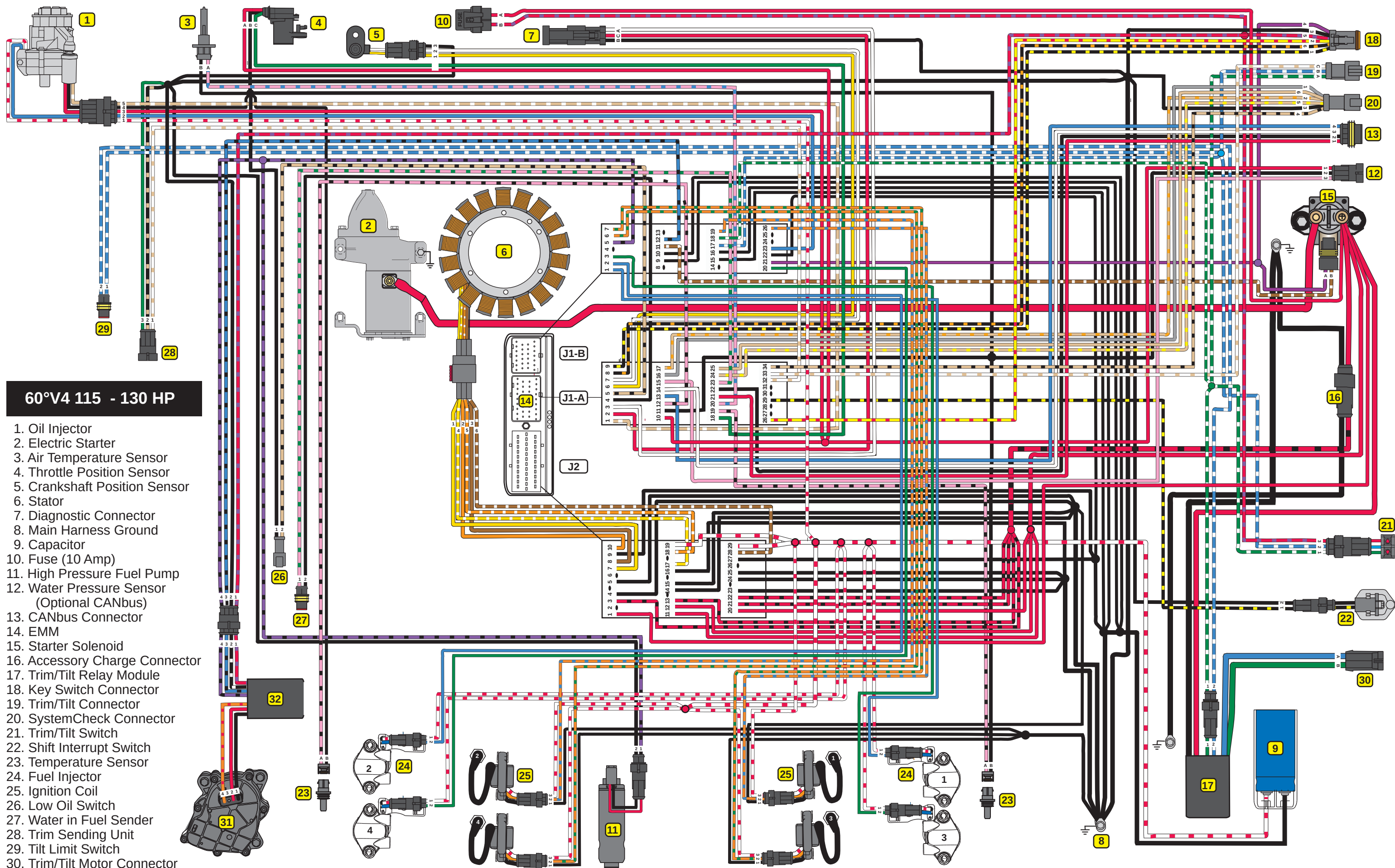


STARTING : LED's illuminate to indicate circuit function



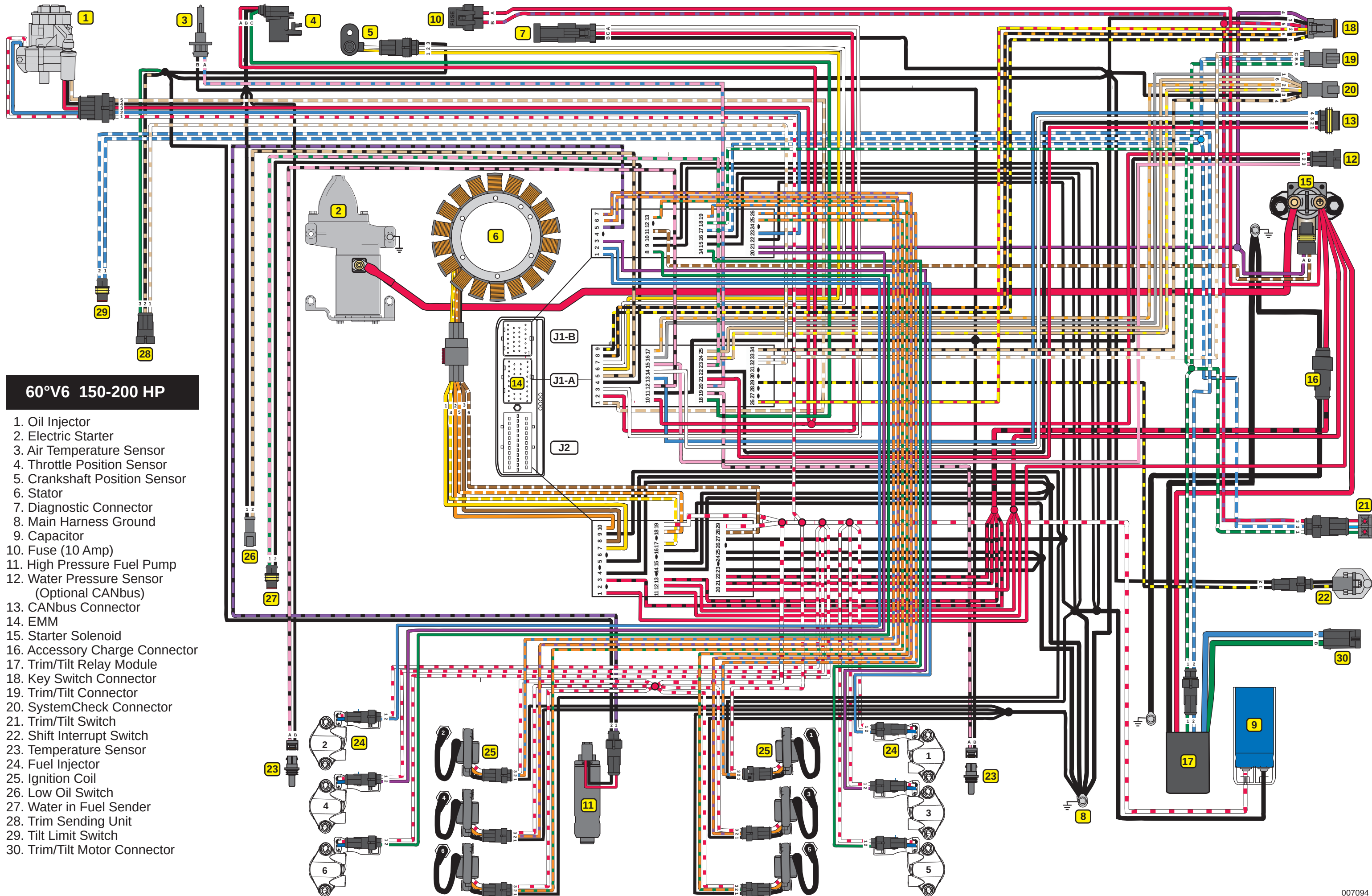
RUNNING : LED's illuminate to indicate circuit fault





60°V4 115 - 130 HP

1. Oil Injector
2. Electric Starter
3. Air Temperature Sensor
4. Throttle Position Sensor
5. Crankshaft Position Sensor
6. Stator
7. Diagnostic Connector
8. Main Harness Ground
9. Capacitor
10. Fuse (10 Amp)
11. High Pressure Fuel Pump
12. Water Pressure Sensor (Optional CANbus)
13. CANbus Connector
14. EMM
15. Starter Solenoid
16. Accessory Charge Connector
17. Trim/Tilt Relay Module
18. Key Switch Connector
19. Trim/Tilt Connector
20. SystemCheck Connector
21. Trim/Tilt Switch
22. Shift Interrupt Switch
23. Temperature Sensor
24. Fuel Injector
25. Ignition Coil
26. Low Oil Switch
27. Water in Fuel Sender
28. Trim Sending Unit
29. Tilt Limit Switch
30. Trim/Tilt Motor Connector
31. Exhaust Valve Actuator
32. Exhaust Valve Relay Module



EVINRUDE 115 – 300 HP EMM SERVICE CODE CHART

CODE	EMM CIRCUIT/SENSOR	INTERNAL SENSOR	S.A.F.E	SHUT DOWN	EMM LED DISPLAY	DASHBOARD GAUGE WARNING DISPLAY	TIME TO ACTIVATE	SENSOR: CIRCUIT VOLTAGE / RESISTANCE (Ω) / INFORMATION
1-6	Excessive knock detected		✓		-	CHECK ENGINE	Immediate	Code number indicates affected cylinder. 20 knock events in 100 combustion cycles with maximum correction applied. Make sure sensor is securely fastened to the cylinder head. Check timing adjustments. Test fuel and cooling systems. Check fuel quality.
7-8	Knock Sensor circuit OPEN – Port/Stbd				LED 3: OFF (Cranking) / ON (Running)	CHECK ENGINE	5 seconds	Sensor output < 0.15 V and RPM > 3000. Check sensor connection.
11	Throttle Position Sensor (TPS) out of idle range				-	-	2 seconds	TPS Voltage > 0.65 V with key ON (or cranking). Becomes stored fault when outboard starts. When both hard and stored faults are present, check for improperly adjusted throttle cable. If voltage is > .78 V, engine speed is limited to idle.
12	Throttle Position Sensor (TPS) circuit fault				LED 3: OFF (Cranking) / ON (Running)	CHECK ENGINE	2 seconds	TPS Voltage: < 0.14 V, or > 4.92 V. Engine limited to idle speed. Check sensor resistance—3000 Ω (between pins A and B) & 4000 Ω (between pins A and C)
13	TPS below range				LED 3: OFF (Cranking) / ON (Running)	CHECK ENGINE	10 seconds	TPS Voltage < 0.2 V. Check linkage and IDLE stop.
14	TPS above range				LED 3: OFF (Cranking) / ON (Running)	CHECK ENGINE	10 seconds	TPS Voltage > 4.85 V. Check linkage and WOT stop.
15	ROM (EMM program)	✓			-	-	15 seconds	ROM “CHECKSUM” failure. Check software program number in <i>EMM</i> . Reload or replace with proper program.
16	Crankshaft Position Sensor (CPS) Intermittent loss of SYNC				LED 2: OFF (Cranking) LED 3: ON (Running)	-	5 losses, rpm<2000 1 loss, rpm >2000	<i>EMM</i> counts losses of synchronization with crankshaft sensor. Check CPS mounting and resistance. Air gap range: 00.036 to 0.110 in. (1 to 2.8 mm), nominal 0.073 in. (1.85 mm) Resistance: 560 Ω ± 10% @ 77°F (25°C)
17	55 V circuit BELOW range	✓	✓		LED 1: ON (Running)	CHECK ENGINE	1 min: V4–3.3L V6 10 sec: 3.4L V6	55 V alternator output < 45 V at 500 to 1000 RPM, or < 52 V above 1000 RPM. Engine limited to 1200 RPM. Perform stator/charging tests.
18	55 V circuit ABOVE range	✓	✓		LED 1: ON (Running)	CHECK ENGINE	1 minute	System Voltage > 57 V. Engine limited to 1200 RPM. Perform stator/charging tests. Check for loose connections in 55 V circuit. Check capacitor.
19	Start-in-gear				LED 3: OFF (Cranking)	CHECK ENGINE	-	Attempted engine start while in gear (<i>EMM</i> in tiller mode). Engine will not start.
21	Winterization activated				All LEDs FLASHING	All LEDs FLASHING	-	Engine is speed limited, and stops after 360 oil pulses. Refer to Maintenance or Operator's Guide.
23	<i>EMM</i> Temperature Sensor circuit fault	✓			LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	<i>EMM</i> Temperature < -67° F (-55° C), or > 311° F (155° C).
24	<i>EMM</i> Temperature BELOW range	✓			LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	<i>EMM</i> Temperature < -22 ° F (-30° C).
25	<i>EMM</i> Temperature ABOVE range	✓	✓		LED 4: ON (Running)	WATER TEMP/HOT	10 seconds	<i>EMM</i> Temperature > 176°F (80°C). Engine limited to 1200 RPM. See Code 29.
26	12 V circuit BELOW range	✓			LED 1: ON (Running)	LOW BATTERY	5 minutes	Battery voltage <12 V below 2000 RPM or < 12.5 V above 2000 RPM. Perform stator/charging tests.
27	12 V circuit ABOVE range	✓			LED 1: ON (Running)	LOW BATTERY	5 minutes	Battery voltage > 15.5 V. Check battery connections and wiring.
28	Shift switch malfunction				LED 3: ON (Running)	-	10 seconds	Check shift switch linkage and switch activation. Check continuity of switch: normally open / continuity depressed. 90°V6 models only.
29	<i>EMM</i> Temperature OVER range	✓		✓	LED 4: FLASHING	WATER TEMP/HOT (FLASHING)	5 seconds	<i>EMM</i> Temperature > 212° F (100° C). Engine SHUTDOWN. Will NOT restart until <i>EMM</i> temperature returns to operating range. Check outboard and <i>EMM</i> cooling systems.
31	Engine temperature OVER range			✓	LED 4: FLASHING	WATER TEMP/HOT (FLASHING)	3 seconds	Engine Temperature > 248° F (120° C). Engine SHUTDOWN. Check cooling system. Check temperature sensor resistance—9000 to 11000 Ω @ 77°F (25°C).
33	Critical NO OIL detected	✓		✓	LED 4: FLASHING	NO OIL (FLASHING)	5 hours	Outboard has run five hours with code 34 or 38. Engine SHUTDOWN. Will restart and run for 1 minute intervals.
34	Oil injection pump circuit OPEN		✓		LED 4: ON (Running)	NO OIL	4 seconds	Engine limited to 1200 RPM. Check oil injection pump circuit resistance—2-3 Ω.
36	Rear Oil injection pump circuit OPEN (3.4 L)		✓		LED 4: ON (Running)	NO OIL	4 seconds	Engine limited to 1200 RPM. Check oil injection pump circuit resistance—5-6 Ω.
37	Water in fuel				LED 3: OFF (Cranking) / ON (Running)	CHECK ENGINE	10 seconds	Check fuel supply, 5 V circuit, and ground (NEG). Resistance between probes should be infinite (no continuity).
38	Oil pressure feedback NOT detected		✓		LED 4: ON (Running)	NO OIL	60° V4 100 oiler cycles 60° V6 150 oiler cycles 90° V6 (3.3L) 150 oiler cycles 90° V6 (3.4L) 75 oiler cycles	Loss of oil manifold pressure. Engine limited to 1200 RPM. Check oil supply. Test injection pump. Monitor oil flow to distribution hoses.
40	Engine Temperature ABOVE range (port)– low speed		✓		LED 4: ON (Running)	WATER TEMP/HOT	3 seconds	60° V4 & V6 Models: Engine Temperature > 230° F (110° C) below 3000 RPM 90° V6 Models: Engine Temperature > 230° F (110° C) below 2000 RPM
41	Engine Temperature Sensor circuit fault (port)				LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	Engine Temperature < -13° F (-25° C), or > 329° F (165° C). Check 5 V circuit and ground (NEG), and sensor resistance—9000 to 11000 Ω @ 77°F (25°C).
42	Engine Temperature BELOW range (port)				LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	Engine Temperature < -4° F (-20° C). Check engine temperature and sensor resistance.
43	Engine Temperature ABOVE range (port)		✓		LED 4: ON (Running)	WATER TEMP/HOT	3 seconds	60° V4 & V6 Models: Engine Temperature > 194°F (90°C) above 3000 RPM activates S.A.F.E. 90° V6 Models: Engine Temperature > 185° F (85° C) above 2000 RPM for 60 seconds activates warning light and horn; 90° V6 Models: Engine Temperature > 194°F (90°C) above 2000 RPM for 3 seconds activates S.A.F.E. Engine limited to 1200 RPM. Check cooling system.
44	Barometric Pressure (BP) Sensor circuit fault	✓			-	-	10 seconds	Pressure < 3.8 in. Hg (13 kPa), or > 35.1 in. Hg (119.0 kPa). Make sure <i>EMM</i> BP sensor tube is NOT plugged. Check atmospheric condition for comparison. Clear code and retest.
45	BP Sensor BELOW range	✓			-	-	10 seconds	Pressure < 20.7 in. Hg (70 kPa).
46	BP Sensor ABOVE range	✓			-	-	10 seconds	Pressure > 31 in. Hg (105 kPa).
47	Air Temperature (AT) circuit fault				LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	Air temperature < -67° F (-55° C), or > 212° F (100° C). Check 5 V circuit and ground (NEG), and sensor resistance—9000 to 11000 Ω @ 77°F (25°C).
48	Air Temperature BELOW range				LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	Air temperature below -22°F (-30°C)
49	Air Temperature ABOVE range				LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	Air temperature above 158°F (70°C)

CODE	EMM CIRCUIT/SENSOR	INTERNAL SENSOR	S.A.F.E	SHUT DOWN	EMM LED DISPLAY	DASHBOARD GAUGE WARNING DISPLAY	TIME TO ACTIVATE	SENSOR: CIRCUIT VOLTAGE / RESISTANCE (Ω) / INFORMATION
51-6	Fuel injector circuit OPEN				LED 2: ON (Running)	-	10 seconds	Last digit indicates affected cylinder. Check injector/circuit resistance—2 to 3 Ω @ 72°F (22°C).
57	High RPM with low TPS setting	✓		✓	LED 3: FLASHING	CHECK ENGINE (FLASHING)	10 seconds	TPS < 5% and RPM > 3000. Engine SHUTDOWN. Will NOT restart until code has been cleared. The problem could be caused by uncontrolled fuel entering the engine. DO NOT attempt to start the outboard until the problem has been found and repaired.
58	Operating temperature not reached (port)				LED 3: OFF (Cranking) / ON (Running)	-	10 minutes	Engine temperature < 122°F (50°C) with engine speed < 1000 RPM. Check thermostat and pressure relief valve.
59	Operating temperature not reached (stbd)				LED 3: OFF (Cranking) / ON (Running)	-	10 minutes	Engine temperature < 122°F (50°C) with engine speed < 1000 RPM. Check thermostat and pressure relief valve.
61-6	Fuel injector circuit SHORTED				LED 2: ON (Running)	-	10 seconds	Last digit indicates affected cylinder. Check injector/circuit resistance—2 to 3 Ω @ 72°F (22°C).
67	Engine Temperature Sensor circuit fault (stbd)				LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	Engine Temperature < -13° F (-25° C), or > 329° F (165° C). Check 5 V circuit and ground (NEG), and sensor resistance—9000 to 11000 Ω @ 77°F (25°C).
68	Engine Temperature BELOW range (stbd)				LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	Engine Temperature < -4° F (-20° C). Check engine temperature and sensor resistance.
69	Engine Temperature ABOVE range (stbd)		✓		LED 4: ON (Running)	WATER TEMP/HOT	3 seconds	60° V4 & V6 Models: Engine Temperature > 194°F (90°C) above 3000 RPM activates S.A.F.E. 90° V6 Models: Engine Temperature > 185° F (85° C) above 2000 RPM for 60 seconds activates warning light and horn; 90° V6 Models: Engine Temperature > 194°F (90°C) above 2000 RPM for 3 seconds activates S.A.F.E. Engine limited to 1200 RPM. Check cooling system.
70	Engine Temperature ABOVE range (stbd)—low speed		✓		LED 4: ON (Running)	WATER TEMP/HOT	3 seconds	60° V4 & V6 Models: Engine Temperature > 230° F (110° C) below 3000 RPM 90° V6 Models: Engine Temperature > 212° F (100° C) below 2000 RPM
71	Oil pressure sensor circuit fault detected				LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	< 0.15 V , > 4.85 V
72	Oil pressure BELOW expected range				LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	< 0.4 V
73	Oil pressure ABOVE expected range				LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	> 4.6 V
74	Water pressure sensor circuit fault detected				LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	< 0.15 V , > 4.85 V. <i>EMM</i> water pressure option (<i>I-Command</i>) active
75	Water pressure BELOW expected range				LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	< 0.4 V. <i>EMM</i> water pressure option (<i>I-Command</i>) active
76	Water pressure ABOVE expected range				LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	> 4.6 V. <i>EMM</i> water pressure option (<i>I-Command</i>) active
77	S.A.C. overcurrent fault	✓			LED 1: OFF (Key On) / ON (Running)	-	10 instances	SAC current > 2 amps and/or < 20 V. Check for shorted 55 V wiring (injector circuits). Check for pinched or chafed wiring.
78	Sensor supply voltage fault	✓			LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	Sensor voltage < 4.75 V. Check sensors and related wiring. Check for pinched or chafed wiring.
79	Starter solenoid circuit OPEN				LED 3: OFF (Key On)	CHECK ENGINE	10 seconds	Check starter solenoid circuit for continuity (key switch OFF) and for 12 V with key switch ON.
81-6	Ignition timing circuit OPEN				LED 2: ON (Running)	-	16 instances	Last digit indicates affected cylinder. <i>EMM</i> counts failed ignition events (crankshaft revolutions). Check circuit resistance.
87	Exhaust pressure circuit fault	✓			LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	< -85 in. water or > 85 in. water. Check for plugged or pinched hose or exhaust fitting.
88	Exhaust pressure BELOW expected range	✓			LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	<-40 in. water
89	Exhaust pressure ABOVE expected range	✓			LED 3: OFF (Cranking) / ON (Running)	-	10 seconds	> 80 in. water
91	Fuel pump circuit OPEN				LED 2: ON (Running)	-	10 seconds	Check pump/circuit resistance—2 to 3 Ω @ 77°F (25°C).
92	Exhaust valve solenoid OPEN (V4)				LED 2: ON (Running)	-	10 seconds	Refer to exhaust valve relay tests.
94	Fuel pump circuit SHORTED				LED 2: ON (Running)	-	2 seconds	Check pump/circuit resistance—2 to 3 Ω @ 77°F (25°C).
97	Intermittent switched B+ detected				LED 3: ON (Running)	-	10 seconds	Switched battery voltage < 7 V. Check connections and wiring
101-6	Ignition timing circuit SHORTED				LED 2: ON (Running)	-	9 events at low RPM, 3 events at high RPM	Last digit indicates affected cylinder. <i>EMM</i> counts failed ignition events. Check wiring. Test with known good ignition coil.
107	ICON control communication error		✓		-	CHECK ENGINE	Immediate	Cycle master power switch off and back on. Check <i>ICON</i> 10 Amp fuse, buss cables, and ESM to <i>EMM</i> connections.
108	ICON system fail-safe mode		✓		-	CHECK ENGINE	2 seconds	<i>ICON</i> control head commands <i>EMM</i> to activate S.A.F.E. Check other <i>ICON</i> codes.
109	ICON control head failure		✓		-	CHECK ENGINE	2 seconds	Cycle master power switch off and back on. See <i>Evinrude ICON</i> Installation Guide.
110	ICON trim switch communication error				-	-	2 seconds	Cycle master power switch off and back on. Check harness between panel and control.
111	ICON ESM communication error		✓		-	CHECK ENGINE	2 seconds	Cycle master power switch off and back on. Check <i>ICON</i> buss cable connections. See <i>Evinrude ICON</i> Installation Guide.
149	ICON throttle actuator sensor fault		✓		-	CHECK ENGINE	2 seconds	Check actuator harness and connections. Check for RFI from excessive spark plug gap. See <i>Evinrude ICON</i> Installation Guide.
150	ICON throttle actuator motion fault		✓		-	CHECK ENGINE	2 seconds	Cycle master power switch off and back on. Check for throttle linkage for obstructions. Check harnesses.
151	ICON shift actuator sensor fault		✓		-	CHECK ENGINE	2 seconds	Check actuator harness and connections. Check for RFI from excessive spark plug gap. See <i>Evinrude ICON</i> Installation Guide.
152	ICON shift actuator motion fault				-	CHECK ENGINE	2 seconds	Cycle master power switch off and back on. Check actuator calibration. Check harnesses.
NOTE: Always note service codes before clearing codes. Clear stored codes using diagnostic software. Clearing some codes requires turning EMM “OFF” and then “ON” again.								

