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Important Information

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Notice to Users of This Manual

Throughout this publication, Dangers, Warnings and Cautions (accompanied by the International HAZARD Symbol ) are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. **OBSERVE THEM CAREFULLY!**

These safety alerts alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus common sense operation, are major accident prevention measures.

DANGER

DANGER - indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury.

WARNING

WARNING - indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION

CAUTION - indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury or property damage. It may also be used to alert against unsafe practices.

This service manual has been written and published by the Service Department of Mercury Marine to aid our dealers' mechanics and company service personnel when servicing the products described herein. We reserve the right to make changes to this manual without prior notification.

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It is assumed that these personnel are familiar with marine product servicing procedures. Furthermore, it is assumed that they have been trained in the recommended service procedures of Mercury Marine Power Products, including the use of mechanics' common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the marine trade of all conceivable procedures and of the possible hazards and/or results of each method. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the products safety will be endangered.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. As required, revisions to this manual will be sent to all dealers contracted by us to sell and/or service these products.

Refer to dealer service bulletins, operation maintenance and warranty manuals and installation manuals for other pertinent information concerning the products described in this manual.

Precautions

It should be kept in mind, while working on the product, that the electrical and ignition systems are capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note, during any maintenance procedure replacement fasteners must have the same measurements and strength as those removed. Numbers on the heads of the metric bolts and on the surfaces of metric nuts indicate their strength. American bolts use radial lines for this purpose, while most American nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possibly personal injury. Therefore, fasteners removed should be saved for reuse in the same locations whenever possible. Where the fasteners are not satisfactory for reuse, care should be taken to select a replacement that matches the original.

Replacement Parts

Use of parts other than the recommended service replacement parts, will void the warranty on those parts that are damaged as a result.

WARNING

Electrical, ignition and fuel system components on Mercury Marine Power Products are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Cleanliness and Care of Product

A Mercury Marine Power Product is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in the ten thousands of an inch/mm. When any product component is serviced, care and cleanliness are important. Throughout this manual, it should be understood that proper cleaning and protection of machined surfaces and friction areas is a part of the repair procedure. This is considered standard shop practice even if not specifically stated.

Whenever components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.

Personnel should not work on or under an engine that is suspended. Engines should be attached to work stands, or lowered to ground as soon as possible.

Important Information

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Section 1A - Master Specifications

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200/225/250/275 Verado Master Specifications

General Specifications

Model Specifications	
Kilowatts (Horsepower)	149 kw (200 HP) 168 kw (225 HP) 186 kw (250 HP) 205 kw (275 HP)
Weight	
50.8 cm (20 in.)	293 kg (645 lbs.)
63.5 cm (25 in.)	299 kg (659 lbs.)
76.2 cm (30 in.)	307 kg (677 lbs.)
Displacement (All Hp)	2.6L (158.5 cu. in.)
RPM	
Idle	550 ± 50 RPM
WOT	5800 - 6400 RPM
Induction System	SmartCraft DTS® electronic throttle, intercooled supercharged aspiration with electronic boost pressure control
Fuel System	Computer controlled sequential multi-port Electronic Fuel Injection
Ignition System	SmartCraft Propulsion Control Module (PCM) 03 digital inductive
Charging System	Regulated belt driven 70 amp alternator
Exhaust System	Through prop
Cooling System	Water cooled - thermostat with pressure control
Lubrication System	
Integrated dry sump	7 Liters (7.4 qts.)
Engine Control System	SmartCraft PCM 03 Digital Throttle and Shift (DTS)
Trim System	SmartCraft programmable
Maximum Tilt Range	73° (-6° to 67°)
Maximum Trim Range	20° (-6° to 14°)
Steering System	Electric - Hydraulic Power Steering with integral hydraulic cylinder

Fuel System Specifications

Fuel System Specifications	
Type of fuel	
149 kw (200 hp), 168 kw (225 hp), 186 kw (250 hp)	Automotive unleaded with a minimum pump posted octane rating of 87 (90 RON)
205 kw (275 hp)	Automotive unleaded with a minimum pump posted octane rating of 91 (96 RON)
Approximate fuel pressure @ idle	279 - 289 kPa (40 - 42 psi)
Fuel filtration	
Fuel inlet water separator	2 Microns
High pressure	20 Microns

Ignition Specifications

Ignition Specifications	
Full Throttle RPM (All Models)	5800 - 6400
Idle RPM (All Models)	550
Ignition Type	Digital Inductive
Spark Plug Type	NGK ILFR6G
Spark Plug Gap	0.8 mm (0.031 in.)
Spark Plug Hex Size	16 mm
Spark Plug Torque	27.5 Nm (19 lb. ft.)
Spark Plug Hole Size	14 mm
Firing Order	1-3-5-6-4-2
Ignition Timing @ Idle	Not Adjustable; Controlled by PCM
Ignition Timing @ WOT	Not Adjustable; Controlled by PCM
PCM Over Speed Limiter	Activates @ 6500 RPM

Charging and Starting Specifications

Charging and Starting Specifications	
Alternator Output (Regulated)	
Output @ Battery (@ 1000 RPM)	37 - 44 Amperes
Output @ Battery (@ 3000 RPM)	53 - 69 Amperes
Output @ Alternator (@ 1000 RPM)	48 - 54 Amperes
Output @ Alternator (@ 3000 RPM)	65 - 72 Amperes
Voltage Set Point	14.5 +/- 0.25 Volts
Regulator Current Draw ¹ .	
Ignition Switch "OFF" (maximum)	1.0 mA
Ignition Switch "ON"	350 mA
Starter Draw (Under Load)	160 Amperes
Starter Draw (No Load)	60 Amperes
Minimum Brush Length	65.4 mm (0.25 in.)
Battery Rating	
Marine Cranking Amperes (minimum)	1000
Cold Cranking Amperes (minimum)	800
Ampere Hour (Ah) (minimum)	180

1. All model alternator specifications require an amperage draw of less than 1.0 mA with the ignition key in the "OFF" position and an amperage draw of not more than 350.0 mA with key in the "ON" position.

Cylinder Head Specifications

Cylinder Head Specifications	
Maximum deck warp	0.075 mm (0.003)
Number of valves	24
Number of valves per cylinder	4
Number of cams	2
Cam bearing journal (intake and exhaust)	28.95 mm (1.1398 in.)
Camshaft bearing cap ID	29.000 - 29.021 mm (1.1417 - 1.1425 in.)
Cam lobe	
Intake	42.50 mm (1.6732 in.)
Exhaust	43.55 mm 1.7145 in.)
Valve lash	
Intake	0.150 - 0.230 mm (0.0059 - 0.009)
Exhaust	0.350 - 0.430 mm (0.0137 - 0.0169 in.)
Valve seat angles	30°, 45°, 60°
Valve spring free length	48.77 mm (1.920 in.)
Valve outside diameter	
Intake	32.0 ± 0.15 mm (1.259 ± 0.0059 in.)
Exhaust	27.2 mm ± 0.190 (1.0708 ± 0.0059 in.)
Valve face width (intake and exhaust)	2.25 mm (0.0886 in.)
Valve margin	
Intake	0.75 mm (0.0295 in.)
Exhaust	0.65 mm (0.0256 in.)
Valve guide bore ID (intake and exhaust)	6.00 - 6.016mm (0.2362 - 0.2368 in.)
Valve stem diameter	
Intake	5.97 mm (0.235 in.)
Exhaust	5.96 mm (0.2346 in.)
Valve stem run-out (maximum)	0.038 mm (0.0015 in.)
Valve stem to valve guide clearance	
Intake	0.03 - 0.046 mm (0.0011 - 0.0018 in.)
Exhaust	0.04 - 0.056 mm (0.0015 - 0.0022 in.)
Valve seat contact width (intake and exhaust)	2.25 mm (0.0886 in.)

Cylinder Block/Crankcase Specifications

Cylinder Block/Crankcase Specifications	
Number of cylinders	6
Displacement	2.6 Liters (158.6 CID)
Compression ratio	8.25:1
Standard bore	82.00 mm (3.228 in.)
Stroke	82.0 mm (3.228 in.)
Cylinder bore maximum taper (service)	0.0762 mm (0.003 in.)
Cylinder bore maximum out of round (service)	0.0762 mm (0.003 in.)
Cylinder block main bearing	65.997 - 66.013 mm (2.5982 - 2.5989 in.)
Crankshaft main bearing journal	59.985 - 60.001 mm (2.3616 - 2.3622 in.)
Crankshaft pin journal	49.982 - 50.0 mm (1.9678 - 1.968 in.)
Crankshaft end play	0.08 - 0.19 mm (0.003 - 0.007 in.)
Crankshaft run out	0.05 mm (0.002 in.)
Crankshaft main bearing oil clearance (without expansion)	0.014 - 0.042 mm (0.0005 - 0.0016 in.)
Crankshaft pin bearing oil clearance (without expansion)	0.020 - 0.050 mm (0.0008 - 0.0019 in.)
Connecting rod wrist pin bore diameter	22.005 - 22.014 mm (0.8663 - 0.8666 in.)
Connecting rod crankshaft pin diameter	53.000 - 53.018 mm (2.0866 - 2.0873 in.)
Piston skirt standard diameter	81.975 mm (3.2273 in.)
Piston wrist pin bore diameter	22.004 - 22.011 mm (0.8662 - 0.8665 in.)
Wrist pin diameter	21.997 - 22.000 mm (0.8660 - 0.8661 in.)
Top ring groove width	1.25 mm (0.049 in.)
Second ring groove width	1.25 mm (0.049 in.)
Third ring groove width	2.05 mm (0.081 in.)
Top ring thickness	1.19 mm (0.047 in.)
Second ring thickness	1.19 mm (0.047 in.)
Third ring thickness	1.98 mm (0.078 in.)
Top ring side clearance	0.04 - 0.08 mm (0.001 - 0.003 in.)
Second ring side clearance	0.04 - 0.08 mm (0.001 - 0.003 in.)
Third ring side clearance	0.05 - 0.17 mm (0.002 - 0.006 in.)
Top ring end gap	0.27 - 0.42 mm (0.010 - 0.016 in.)
Second ring end gap	0.42 - 0.62 mm (0.016 - 0.024 in.)
Oil ring end gap	0.2 - 0.7 mm (0.007 - 0.027 in.)

Power Trim Specifications

Power Trim Specifications	
Trim up circuit pressure, maximum	18,270 - 28,960 kPa (2650 - 4200 psi)
Trim down circuit pressure	1255 - 2765 kPa (182 - 401 psi)
System fluid	Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) (Type Dexron III)

Oil System Specifications

Oil System Specifications	
Engine Capacity Wet	7 liters (7.4 qts.)
Engine Capacity Dry	8 liters (8.4 qts.)
Oil Filter Part Number	35-883701K01
Oil Pressure (Minimum) @ 550 RPM	70 kPa (10 psi)
Oil Pressure (Minimum) @ 6000 RPM	220 kPa (32 psi)
IOM thermostat opening temperature	105 °C (221 °F)

Gear Housing Specifications (Standard Rotation)

Gear Housing Specifications (Standard Rotation)	
Gear Ratio	1.85:1 (13/24 Teeth)
Gearcase Capacity	970 ml (32.8 fl.oz.)
Gear Lubricant Type	Premium Gear Lubricant
Pinion Height	0.635 mm (0.025 in.)
Forward Gear Backlash	0.482 - 0.660 mm (0.019 - 0.026 in.)
Reverse Gear Backlash	1.27 - 1.47 mm (0.050 - 0.058 in.)
Water Pressure @ RPM	55 - 68.9 kPa (8 - 10 psi)
Gear Housing Pressure (without gear lubricant, 5 minutes without leakage)	103.4 kPa (15 psi)

Gear Housing Specifications (Counter Rotation)

Gear Housing Specifications (Counter Rotation)	
Gear Ratio	1.85:1 (13/24 Teeth)
Gearcase Capacity	970 ml (32.8 fl.oz.)
Gear Lubricant Type	Premium Gear Lubricant
Pinion Height	0.635 mm (0.025 in.)
Forward Gear Backlash	0.482 - 0.660 mm (0.019 - 0.026 in.)
Reverse Gear Backlash	1.27 - 1.47 mm (0.050 - 0.058 in.)
Water Pressure @ RPM	55 - 68.9 kPa (8 - 10 psi)
Gear Housing Pressure (without gear lubricant, 5 minutes without leakage)	103.4 kPa (15 psi)

Power Steering Specifications

Power Steering Specifications	
Fluid Type	SAE 0W-30 synthetic power steering fluid
Capacity	Typical 1 - 2 liters (1 - 2 quarts)
Current Draw	Shall not exceed 75 Amps
Steering Ratio (40 cc helm and single steering cylinder, lock to lock)	4.1 turns
Steering Ratio (50 cc helm with dual steering cylinders, lock to lock)	6.5 turns

Propeller Chart

Mercury/Mariner 200 (6 Cyl., 4 Stroke)

- Wide Open Throttle RPM: 5800 - 6400
- Recommended Transom Height: 50.8 cm (20 in.), 63.5 cm (25 in.), 76.2 cm (30 in.)
- Gear Reduction: 1.85:1
- Right Hand Rotation (RH), Left Hand Rotation (LH)

Diameter	Pitch	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
13.75	27	4	Trophy Plus	Up to 952.54 Kg (2100 lbs.)	Up to 6.4 m (21 ft.)	120.70 - 136.8 km (75 - 85 MPH)	48-825946A47
14.62	27	3	Tempest Plus	Up to 952.54 Kg (2100 lbs.)	Up to 6.4 m (21 ft.)	120.70 - 136.8 km (75 - 85 MPH)	48-825868A47
15.25	26	4	Bravo 1	861.83 - 997.7 Kg (1900-2200 lbs.)	6.4 - 7.0 m (21 - 23 ft.)	115.87 - 130.4 km (72 - 81 MPH)	48-831914A45 (RH) 48-831913A45 (LH)
13.75	26	4	Trophy Plus	861.83 - 997.7 Kg (1900-2200 lbs.)	6.4 - 7.0 m (21 - 23 ft.)	115.87 - 130.4 km (72 - 81 MPH)	48-825944A47
14.62	26	3	Tempest Plus	861.83 - 997.7 Kg (1900-2200 lbs.)	6.4 - 7.0 m (21 - 23 ft.)	115.87 - 130.4 km (72 - 81 MPH)	48-825874A47
14.50	25	3	Mirage Plus	907.18 - 1043.26 Kg (2000-2300 lbs.)	6.4 - 7.0 m (21 - 23 ft.)	111.04 - 125.53 km (69 - 78 MPH)	48-13706A46 (RH) 48-13707A46 (LH)
13.75	25	4	Trophy Plus	907.18 - 1043.26 Kg (2000-2300 lbs.)	6.4 - 7.0 m (21 - 23 ft.)	111.04 - 125.53 km (69 - 78 MPH)	48-825942A47
14.62	25	3	Tempest Plus	907.18 - 1043.26 Kg (2000-2300 lbs.)	6.4 - 7.0 m (21 - 23 ft.)	111.04 - 125.53 km (69 - 78 MPH)	48-825866A47
15.25	24	4	Bravo I	952.54 - 1088.62 Kg (2100-2400 lbs.)	6.7 - 7.3 m (22 - 24 ft.)	106.22 - 119.09 km (66 - 74 MPH)	48-831912A45 (RH) 48-831911A45 (LH)
13.75	24	4	Trophy Plus	952.54 - 1088.62 Kg (2100-2400 lbs.)	6.7 - 7.3 m (22 - 24 ft.)	106.22 - 119.09 km (66 - 74 MPH)	48-825940A47
14.62	24	3	Tempest Plus	952.54 - 1088.62 Kg (2100-2400 lbs.)	6.7 - 7.3 m (22 - 24 ft.)	106.22 - 119.09 km (66 - 74 MPH)	48-825872A47
14.62	23	4	Revolution 4	997.90 - 1133.98 Kg (2200-2500 lbs.)	6.7 - 7.3 m (22 - 24 ft.)	101.39 - 114.26 km (63 - 71 MPH)	48-857030A46 (RH) 48-857031A46 (LH)
13.75	23	4	Trophy Plus	997.90 - 1133.98 Kg (2200-2500 lbs.)	6.7 - 7.3 m (22 - 24 ft.)	101.39 - 114.26 km (63 - 71 MPH)	48-825938A47
14.62	23	3	Tempest Plus	997.90 - 1133.98 Kg (2200-2500 lbs.)	6.7 - 7.3 m (22 - 24 ft.)	101.39 - 114.26 km (63 - 71 MPH)	48-825864A47
14.63	23	3	Mirage Plus	997.90 - 1133.98 Kg (2200-2500 lbs.)	6.7 - 7.3 m (22 - 24 ft.)	101.39 - 114.26 km (63 - 71 MPH)	48-13704A46 (RH) 48-13705A46 (LH)
13.25	23	5	High Five	997.90 - 1133.98 Kg (2200-2500 lbs.)	6.7 - 7.3 m (22 - 24 ft.)	101.39 - 114.26 km (63 - 71 MPH)	48-815762A46

Master Specifications

Diameter	Pitch	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14.00	23	4	VenSura	997.90 - 1133.98 Kg (2200-2500 lbs.)	6.7 - 7.3 m (22 - 24 ft.)	101.39 - 114.26 km (63 - 71 MPH)	48-825906A48 (RH) 48-825907A48 (LH)
13.75	21	4	Trophy Plus	1133.98 - 1270.06 Kg (2500-2800 lbs.)	6.7 - 7.3 m (22 - 24 ft.)	91.73 - 103.0 km (57 - 64 MPH)	48-825934A47
14.62	21	3	Tempest Plus	1133.98 - 1270.06 Kg (2500-2800 lbs.)	6.7 - 7.3 m (22 - 24 ft.)	91.73 - 103.0 km (57 - 64 MPH)	48-825862A47
14.75	21	3	Mirage Plus	1133.98 - 1270.06 Kg (2500-2800 lbs.)	6.7 - 7.3 m (22 - 24 ft.)	91.73 - 103.0 km (57 - 64 MPH)	48-13702A46 (RH) 48-13703A46 (LH)
13.25	21	5	High Five	1133.98 - 1270.06 Kg (2500-2800 lbs.)	6.7 - 7.3 m (22 - 24 ft.)	91.73 - 103.0 km (57 - 64 MPH)	48-815760A46
14.00	21	4	VenSura	1133.98 - 1270.06 Kg (2500-2800 lbs.)	6.7 - 7.3 m (22 - 24 ft.)	91.73 - 103.0 km (57 - 64 MPH)	48-825902A48 (RH) 48-825903A48 (LH)
14.62	19	3	Tempest Plus	1270.06 - 1451.50 Kg (2800-3200 lbs.)	6.7 - 7.6 m (22 - 25 ft.)	82.08 - 93.34 km (51 - 58 MPH)	48-825860A47
15.25	19	3	Mirage Plus	1270.06 - 1451.50 Kg (2800-3200 lbs.)	6.7 - 7.6 m (22 - 25 ft.)	82.08 - 93.34 km (51 - 58 MPH)	48-13700A46 (RH) 48-13701A46 (LH)
13.25	19	5	High Five	1270.06 - 1451.50 Kg (2800-3200 lbs.)	6.7 - 7.6 m (22 - 25 ft.)	82.08 - 93.34 km (51 - 58 MPH)	48-815758A46
14.00	19	4	VenSura	1270.06 - 1451.50 Kg (2800-3200 lbs.)	6.7 - 7.6 m (22 - 25 ft.)	82.08 - 93.34 km (51 - 58 MPH)	48-825900A48 (RH) 48-825901A48 (LH)
15.5	17	3	Mirage Plus	1406.14 - 1678.29 Kg (3100-3700 lbs.)	6.7 - 7.9 m (22 - 26 ft.)	72.42 - 83.69 km (45 - 52 MPH)	48-18278A46 (RH) 48-90159A46 (LH)
13.5	17	5	High Five	1406.14 - 1678.29 Kg (3100-3700 lbs.)	6.7 - 7.9 m (22 - 26 ft.)	72.42 - 83.69 km (45 - 52 MPH)	48-821154A46
14.25	17	4	VenSura	1406.14 - 1678.29 Kg (3100-3700 lbs.)	6.7 - 7.9 m (22 - 26 ft.)	72.42 - 83.69 km (45 - 52 MPH)	48-825898A48 (RH) 48-825899A48 (LH)
15.75	15	3	Mirage Plus	1632.93- 1995.81 Kg (3600-4400 lbs.)	6.7 - 7.9 m (22 - 26 ft.)	61.16 - 75.64 km (38 - 47 MPH)	48-19838A46 (RH) 48-19841A46 (LH)
16	13	3	Mirage Plus	1859.73- 2630.84 Kg (4100-5800 lbs.)	6.7 - 7.9 m (22 - 26 ft.)	49.89 - 64.37 km (31 - 40 MPH)	48-826072A46
16	12	3	Aluminum	2222.60- 3084.43 Kg (4900-6800 lbs.)	7.0 - 8.2 m (23 - 27 ft.)	41.84 - 56.33 km (26 - 35 MPH)	48-16436A45
16	11	3	Aluminum	2721.55+ Kg (6000+ lbs.)	Workboat	1.61 - 46.67 km (1 - 29 MPH)	48-78112A45 (RH) 48-78117A40 (LH)

Mercury/Mariner 225 (6 Cyl., 4 Stroke)

- Wide Open Throttle RPM: 5800 - 6400
- Recommended Transom Height: 50.8 cm (20 in.), 63.5 cm (25 in.), 76.2 cm (30 in.)
- Gear Reduction: 1.85:1

- Right Hand Rotation (RH), Left Hand Rotation (LH)

Diameter	Pitch	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
15.25	28	4	Bravo I	Up to 997.90 Kg (2200 lbs.)	Up to 6.7 m (22 ft.)	125.53-141.62 km (78-88 MPH)	48-831916A55 (RH) 48-831915A55 (LH)
13.75	28	4	Trophy Plus	Up to 997.90 Kg (2200 lbs.)	Up to 6.7 m (22 ft.)	125.53-141.62 km (78-88 MPH)	48-825948A47
13.75	27	4	Trophy Plus	907.18-1043.26 Kg (2000-2300 lbs.)	Up to 6.7 m (22 ft.)	120.70-136.8 km (75-85 MPH)	48-825946A47
14.62	27	3	Tempest Plus	907.18-1043.26 Kg (2000-2300 lbs.)	Up to 6.7 m (22 ft.)	120.70-136.8 km (75-85 MPH)	48-825868A47
15.25	26	4	Bravo I	952.54-1088.62 Kg (2100-2400 lbs.)	6.4-7.0 m (21-23 ft.)	115.87-130.4 km (72-81 MPH)	48-831914A45 (RH) 48-831913A45 (LH)
13.75	26	4	Trophy Plus	952.54-1088.62 Kg (2100-2400 lbs.)	6.4-7.0 m (21-23 ft.)	115.87-130.4 km (72-81 MPH)	48-825944A47
14.62	26	3	Tempest Plus	952.54-1088.62 Kg (2100-2400 lbs.)	6.4-7.0 m (21-23 ft.)	115.87-130.4 km (72-81 MPH)	48-825874A47
14.50	25	3	Mirage Plus	997.90-1133.98 Kg (2200-2500 lbs.)	6.4-7.0 m (21-23 ft.)	111.04-125.53 km (69-78 MPH)	48-13706A46 (RH) 48-13707A46 (LH)
13.75	25	4	Trophy Plus	997.90-1133.98 Kg (2200-2500 lbs.)	6.4-7.0 m (21-23 ft.)	111.04-125.53 km (69-78 MPH)	48-825942A47
14.62	25	3	Tempest Plus	997.90-1133.98 Kg (2200-2500 lbs.)	6.4-7.0 m (21-23 ft.)	111.04-125.53 km (69-78 MPH)	48-825866A47
15.25	24	4	Bravo I	1088.62-1224.70 Kg (2400-2700 lbs.)	6.7-7.3 m (22-24 ft.)	106.22-119.09 km (66-74 MPH)	48-831912A45 (RH) 48-831911A45 (LH)
13.75	24	4	Trophy Plus	1088.62-1224.70 Kg (2400-2700 lbs.)	6.7-7.3 m (22-24 ft.)	106.22-119.09 km (66-74 MPH)	48-825940A47
14.62	24	3	Tempest Plus	1088.62-1224.70 Kg (2400-2700 lbs.)	6.7-7.3 m (22-24 ft.)	106.22-119.09 km (66-74 MPH)	48-825872A47
14.62	23	4	Revolution 4	1133.98-1270.06 Kg (2500-2800 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-857030A46 (RH) 48-857031A46 (LH)
13.75	23	4	Trophy Plus	1133.98-1270.06 Kg (2500-2800 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-825938A47
14.62	23	3	Tempest Plus	1133.98-1270.06 Kg (2500-2800 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-825864A47
14.63	23	3	Mirage Plus	1133.98-1270.06 Kg (2500-2800 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-13704A46 (RH) 48-13705A46 (LH)
13.25	23	5	HighFive	1133.98-1270.06 Kg (2500-2800 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-815762A46
14.00	23	4	VenSura	1133.98-1270.06 Kg (2500-2800 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-825906A48 (RH) 48-825907A48 (LH)
13.75	21	4	Trophy Plus	1270.06-1451.50 Kg (2800-3200 lbs.)	6.7-7.3 m (22-24 ft.)	91.73-103.0 km (57-64 MPH)	48-825934A47

Master Specifications

Diameter	Pitch	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14.62	21	3	Tempest Plus	1270.06-1451.50 Kg (2800-3200 lbs.)	6.7-7.3 m (22-24 ft.)	91.73-103.0 km (57-64 MPH)	48-825862A47
14.75	21	3	Mirage Plus	1270.06-1451.50 Kg (2800-3200 lbs.)	6.7-7.3 m (22-24 ft.)	91.73-103.0 km (57-64 MPH)	48-13702A46 (RH) 48-13703A46 (LH)
13.25	21	5	HighFive	1270.06-1451.50 Kg (2800-3200 lbs.)	6.4-7.3 m (21-24 ft.)	91.73-103.0 km (57-64 MPH)	48-815760A46
14.00	21	4	VenSura	1270.06-1451.50 Kg (2800-3200 lbs.)	6.4-7.3 m (21-24 ft.)	91.73-103.0 km (57-64 MPH)	48-825902A48 (RH) 48-825903A48 (LH)
14.62	19	3	Tempest Plus	1406.14-1632.93 Kg (3100-3600 lbs.)	6.7-7.6 m (22-25 ft.)	82.08-93.34 km (51-58 MPH)	48-825860A47
15.25	19	3	Mirage Plus	1406.14-1632.93 Kg (3100-3600 lbs.)	6.7-7.6 m (22-25 ft.)	82.08-93.34 km (51-58 MPH)	48-13700A46 (RH) 48-13701A46 (LH)
13.25	19	5	HighFive	1406.14-1632.93 Kg (3100-3600 lbs.)	6.7-7.6 m (22-25 ft.)	82.08-93.34 km (51-58 MPH)	48-815758A46
14.00	19	4	VenSura	1406.14-1632.93 Kg (3100-3600 lbs.)	6.7-7.6 m (22-25 ft.)	82.08-93.34 km (51-58 MPH)	48-825900A48 (RH) 48-825901A48 (LH)
15.5	17	3	Mirage Plus	1587.57-1859.73 Kg (3500-4100 lbs.)	6.7-7.9 m (22-26 ft.)	72.42-83.69 km (45-52 MPH)	48-18278A46 (RH) 48-90159A46 (LH)
13.5	17	5	HighFive	1587.57-1859.73 Kg (3500-4100 lbs.)	6.7-7.9 m (22-26 ft.)	72.42-83.69 km (45-52 MPH)	48-821154A46
14.25	17	4	VenSura	1587.57-1859.73 Kg (3500-4100 lbs.)	6.7-7.9 m (22-26 ft.)	72.42-83.69 km (45-52 MPH)	48-825898A48 (RH) 48-825899A48 (LH)
15.75	15	3	Mirage Plus	1859.73-2494.76 Kg (4100-5500 lbs.)	7.0-8.2 m (23-27 ft.)	56.33-72.42 km (35-45 MPH)	48-19838A46 (RH) 48-19841A46 (LH)
16	13	3	Mirage Plus	2267.96 + Kg (5000 + lbs.)	7.6-9.1 m (25-30 ft.)	40.23-61.16 km (25-38 MPH)	48-825072A46

Mercury/Mariner 250 (6 Cyl., 4 Stroke)

- Wide Open Throttle RPM: 5800 - 6400
- Recommended Transom Height: 50.8 cm (20 in.), 63.5 cm (25 in.), 76.2 cm (30 in.)
- Gear Reduction: 1.85:1
- Right Hand Rotation (RH), Left Hand Rotation (LH)

Diameter	Pitch	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
15.25	28	4	Bravo I	Up to 1133.98 Kg (2500 lbs.)	Up to 6.7 m (22 ft.)	125.53-141.62 km (78-88 MPH)	48-831916A55 (RH) 48-831915A55 (LH)
13.75	28	4	Trophy Plus	Up to 1133.98 Kg (2500 lbs.)	Up to 6.7 m (22 ft.)	125.53-141.62 km (78-88 MPH)	48-825948A47
13.75	27	4	Trophy Plus	997.90-1179.34 Kg (2200-2600 lbs.)	Up to 6.7 m (22 ft.)	120.70-136.8 km (75-85 MPH)	48-825946A47
14.62	27	3	Tempest Plus	997.90-1179.34 (2200-2600 lbs.)	Up to 6.7 m (22 ft.)	120.70-136.8 km (75-85 MPH)	48-825868A47

Diameter	Pitch	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
15.25	26	4	Bravo I	1088.62-1224.70 Kg (2400-2700 lbs.)	6.4-7.0 m (21-23 ft.)	115.87-130.4 km (72-81 MPH)	48-831914A45 (RH) 48-831913A45 (LH)
13.75	26	4	Trophy Plus	1088.62-1224.70 Kg (2400-2700 lbs.)	6.4-7.0 m (21-23 ft.)	115.87-130.4 km (72-81 MPH)	48-825944A47
14.62	26	3	Tempest Plus	1088.62-1224.70 Kg (2400-2700 lbs.)	6.4-7.0 m (21-23 ft.)	115.87-130.4 km (72-81 MPH)	48-825874A47
14.50	25	3	Mirage Plus	1133.98-1270.06 Kg (2500-2800 lbs.)	6.4-7.0 m (21-23 ft.)	111.04-125.53 km (69-78 MPH)	48-13706A46 (RH) 48-13707A46 (LH)
13.75	25	4	Trophy Plus	1133.98-1270.06 Kg (2500-2800 lbs.)	6.4-7.0 m (21-23 ft.)	111.04-125.53 km (69-78 MPH)	48-825942A47
14.62	25	3	Tempest Plus	1133.98-1270.06 Kg (2500-2800 lbs.)	6.4-7.0 m (21-23 ft.)	111.04-125.53 km (69-78 MPH)	48-825866A47
15.25	24	4	Bravo I	1179.34-1360.78 Kg (2600-3000 lbs.)	6.7-7.3 m (22-24 ft.)	106.22-119.09 km (66-74 MPH)	48-831912A45 (RH) 48-831911A45 (LH)
13.75	24	4	Trophy Plus	1179.34-1360.78 Kg (2600-3000 lbs.)	6.7-7.3 m (22-24 ft.)	106.22-119.09 km (66-74 MPH)	48-825940A47
14.62	24	3	Tempest Plus	1179.34-1360.78 Kg (2600-3000 lbs.)	6.7-7.3 m (22-24 ft.)	106.22-119.09 km (66-74 MPH)	48-825872A47
14.62	23	4	Revolution 4	1224.70-1406.14 Kg (2700-3100 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-857030A46 (RH) 48-857031A46 (LH)
13.75	23	4	Trophy Plus	1224.70-1406.14 Kg (2700-3100 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-825938A47
14.62	23	3	Tempest Plus	1224.70-1406.14 Kg (2700-3100 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-825864A47
14.63	23	3	Mirage Plus	1224.70-1406.14 Kg (2700-3100 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-13704A46 (RH) 48-13705A46 (LH)
13.25	23	5	HighFive	1224.70-1406.14 Kg (2700-3100 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-815762A46
14.00	23	4	VenSura	1224.70-1406.14 Kg (2700-3100 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-825906A48 (RH) 48-825907A48 (LH)
13.75	21	4	Trophy Plus	1406.14-1587.57 Kg (3100-3500 lbs.)	6.7-7.3 m (22-24 ft.)	91.73-103.0 km (57-64 MPH)	48-825934A47
14.62	21	3	Tempest Plus	1406.14-1587.57 Kg (3100-3500 lbs.)	6.7-7.3 m (22-24 ft.)	91.73-103.0 km (57-64 MPH)	48-825862A47
14.75	21	3	Mirage Plus	1406.14-1587.57 Kg (3100-3500 lbs.)	6.7-7.3 m (22-24 ft.)	91.73-103.0 km (57-64 MPH)	48-13702A46 (RH) 48-13703A46 (LH)
13.25	21	5	HighFive	1406.14-1587.57 Kg (3100-3500 lbs.)	6.4-7.3 m (21-24 ft.)	91.73-103.0 km (57-64 MPH)	48-815760A46
14.00	21	4	VenSura	1406.14-1587.57 Kg (3100-3500 lbs.)	6.4-7.3 m (21-24 ft.)	91.73-103.0 km (57-64 MPH)	48-825902A48 (RH) 48-825903A48 (LH)
14.62	19	3	Tempest Plus	1542.21-1814.37 Kg (3400-4000 lbs.)	6.7-7.6 m (22-25 ft.)	82.08-93.34 km (51-58 MPH)	48-825860A47

Master Specifications

Diameter	Pitch	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
15.25	19	3	Mirage Plus	1542.21-1814.37 Kg (3400-4000 lbs.)	6.7-7.6 m (22-25 ft.)	82.08-93.34 km (51-58 MPH)	48-13700A46 (RH) 48-13701A46 (LH)
13.25	19	5	HighFive	1542.21-1814.37 Kg (3400-4000 lbs.)	6.7-7.6 m (22-25 ft.)	82.08-93.34 km (51-58 MPH)	48-815758A46
14.00	19	4	VenSura	1542.21-1814.37 Kg (3400-4000 lbs.)	6.7-7.6 m (22-25 ft.)	82.08-93.34 km (51-58 MPH)	48-825900A48 (RH) 48-825901A48 (LH)
15.5	17	3	Mirage Plus	1769.01-2267.96 Kg (3900-5000 lbs.)	6.7-7.9 m (22-26 ft.)	62.76-78.86 km (39-49 MPH)	48-18278A46 (RH) 48-90159A46 (LH)
13.5	17	5	HighFive	1769.01-2267.96 Kg (3900-5000 lbs.)	6.7-7.9 m (22-26 ft.)	62.76-78.86 km (39-49 MPH)	48-851154A46
14.25	17	4	VenSura	1950.45-2267.96 Kg (4300-5000 lbs.)	6.7-7.9 m (22-26 ft.)	62.76-78.86 km (39-49 MPH)	48-825898A48 (RH) 48-825899A48 (LH)
15.75	15	3	Mirage Plus	2086.53-2721.55 Kg (4600-6000 lbs.)	7.0-8.2 m (23-27 ft.)	56.33-72.42 km (35-45 MPH)	48-19838A46 (RH) 48-19841A46 (LH)
16	13	3	Mirage Plus	2494.76 + Kg (5500 + lbs.)	7.6-9.1 m (25-30 ft.)	40.23-61.16 km (25-38 MPH)	48-826072A46

Mercury/Mariner 275 (6 Cyl., 4 Stroke)

- Wide Open Throttle RPM: 5800 - 6400
- Recommended Transom Height: 50.8 cm (20 in.), 63.5 cm (25 in.), 76.2 cm (30 in.)
- Gear Reduction: 1.85:1
- Right Hand Rotation (RH), Left Hand Rotation (LH)

Diameter	Pitch	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
15.25	28	4	Bravo I	Up to 1224.70 Kg (2700 lbs.)	Up to 6.7 m (22 ft.)	125.53-141.62 km (78-88 MPH)	48-831916A55 (RH) 48-831915A55 (LH)
13.75	28	4	Trophy Plus	Up to 1224.70 Kg (2700 lbs.)	Up to 6.7 m (22 ft.)	125.53-141.62 km (78-88 MPH)	48-825948A47
13.75	27	4	Trophy Plus	1133.98-1270.06 Kg (2500-2800 lbs.)	Up to 6.7 m (22 ft.)	120.70-136.8 km (75-85 MPH)	48-825946A47
14.62	27	3	Tempest Plus	1133.98-1270.06 Kg (2500-2800 lbs.)	Up to 6.7 m (22 ft.)	120.70-136.8 km (75-85 MPH)	48-825868A47
15.25	26	4	Bravo I	1179-34-1360.78 Kg (2600-3000 lbs.)	6.4-7.0 m (21-23 ft.)	115.87-130.4 km (72-81 MPH)	48-831914A45 (RH) 48-831913A45 (LH)
13.75	26	4	Trophy Plus	1179-34-1360.78 Kg (2600-3000 lbs.)	6.4-7.0 m (21-23 ft.)	115.87-130.4 km (72-81 MPH)	48-825944A47
14.62	26	3	Tempest Plus	1179-34-1360.78 Kg (2600-3000 lbs.)	6.4-7.0 m (21-23 ft.)	115.87-130.4 km (72-81 MPH)	48-825874A47
14.50	25	3	Mirage Plus	1224.70-1406.14 Kg (2700-3100 lbs.)	6.4-7.0 m (21-23 ft.)	111.04-125.53 km (69-78 MPH)	48-13706A46 (RH) 48-13707A46 (LH)
13.75	25	4	Trophy Plus	1224.70-1406.14 Kg (2700-3100 lbs.)	6.4-7.0 m (21-23 ft.)	111.04-125.53 km (69-78 MPH)	48-825942A47

Diameter	Pitch	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14.62	25	3	Tempest Plus	1224.70-1406.14 Kg (2700-3100 lbs.)	6.4-7.0 m (21-23 ft.)	111.04-125.53 km (69-78 MPH)	48-825866A47
15.25	24	4	Bravo I	1315.42-1496.86 Kg (2900-3300 lbs.)	6.7-7.3 m (22-24 ft.)	106.22-119.09 km (66-74 MPH)	48-831912A45 (RH) 48-831911A45 (LH)
13.75	24	4	Trophy Plus	1315.42-1496.86 Kg (2900-3300 lbs.)	6.7-7.3 m (22-24 ft.)	106.22-119.09 km (66-74 MPH)	48-825940A47
14.62	24	3	Tempest Plus	1315.42-1496.86 Kg (2900-3300 lbs.)	6.7-7.3 m (22-24 ft.)	106.22-119.09 km (66-74 MPH)	48-825872A47
14.62	23	4	Revolution 4	1360.78-1542.21 Kg (3000-3400 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-857030A46 (RH) 48-857031A46 (LH)
13.75	23	4	Trophy Plus	1360.78-1542.21 Kg (3000-3400 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-825938A47
14.62	23	3	Tempest Plus	1360.78-1542.21 Kg (3000-3400 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-825864A47
14.63	23	3	Mirage Plus	1360.78-1542.21 Kg (3000-3400 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-13704A46 (RH) 48-13705A46 (LH)
13.25	23	5	HighFive	1360.78-1542.21 Kg (3000-3400 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-815762A46
14.00	23	4	VenSura	1360.78-1542.21 Kg (3000-3400 lbs.)	6.7-7.3 m (22-24 ft.)	101.39-114.26 km (63-71 MPH)	48-825906A48 (RH) 48-825907A48 (LH)
13.75	21	4	Trophy Plus	1542.21-1769.01 Kg (3400-3900 lbs.)	6.7-7.3 m (22-24 ft.)	91.73-103.0 km (57-64 MPH)	48-825934A47
14.62	21	3	Tempest Plus	1542.21-1769.01 Kg (3400-3900 lbs.)	6.7-7.3 m (22-24 ft.)	91.73-103.0 km (57-64 MPH)	48-825862A47
14.75	21	3	Mirage Plus	1542.21-1769.01 Kg (3400-3900 lbs.)	6.7-7.3 m (22-24 ft.)	91.73-103.0 km (57-64 MPH)	48-13702A46 (RH) 48-13703A46 (LH)
13.25	21	5	HighFive	1542.21-1769.01 Kg (3400-3900 lbs.)	6.4-7.3 m (21-24 ft.)	91.73-103.0 km (57-64 MPH)	48-815760A46
14.00	21	4	VenSura	1542.21-1769.01 Kg (3400-3900 lbs.)	6.4-7.3 m (21-24 ft.)	91.73-103.0 km (57-64 MPH)	48-825902A48 (RH) 48-825903A48 (LH)
14.62	19	3	Tempest Plus	1723.65-1995.81 Kg (3800-4400 lbs.)	6.7-7.6 m (22-25 ft.)	82.08-93.34 km (51-58 MPH)	48-825860A47
15.25	19	3	Mirage Plus	1723.65-1995.81 Kg (3800-4400 lbs.)	6.7-7.6 m (22-25 ft.)	82.08-93.34 km (51-58 MPH)	48-13700A46 (RH) 48-13701A46 (LH)
13.25	19	5	HighFive	1723.65-1995.81 Kg (3800-4400 lbs.)	6.7-7.6 m (22-25 ft.)	82.08-93.34 km (51-58 MPH)	48-815758A46
14.00	19	4	VenSura	1723.65-1995.81 Kg (3800-4400 lbs.)	6.7-7.6 m (22-25 ft.)	82.08-93.34 km (51-58 MPH)	48-825900A48 (RH) 48-825901A48 (LH)
15.5	17	3	Mirage Plus	1950.45-2494.76 Kg (4300-5500 lbs.)	6.7-7.9 m (22-26 ft.)	62.76-78.86 km (39-49 MPH)	48-18278A46 (RH) 48-90159A46 (LH)
13.5	17	5	HighFive	1950.45-2494.76 Kg (4300-5500 lbs.)	6.7-7.9 m (22-26 ft.)	62.76-78.86 km (39-49 MPH)	48-821154A46

Master Specifications

Diameter	Pitch	No. of Blades	Model	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14.25	17	4	VenSura	1950.45-2494.76 Kg (4300-5500 lbs.)	6.7-7.9 m (22-26 ft.)	62.76-78.86 km (39-49 MPH)	48-825898A48 (RH) 48-825899A48 (LH)
15.75	15	3	Mirage Plus	2267.96-2948-35 Kg (5000-6500 lbs.)	7.0-8.2 m (23-27 ft.)	56.33-72.42 km (35-45 MPH)	48-19838A46 (RH) 48-19841A46 (LH)
16	13	3	Mirage Plus	2721.55 + Kg (6000 + lbs.)	7.6-9.1 m (25-30 ft.)	40.23-61.16 km (25-38 MPH)	48-826072A46

Important Information

Section 1B - Maintenance

1 B

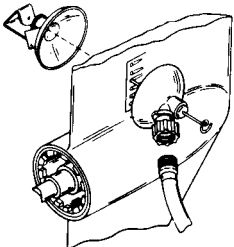
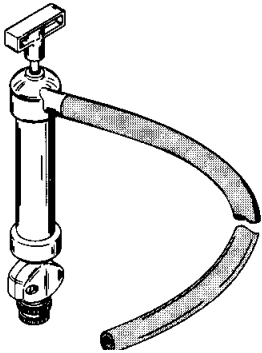
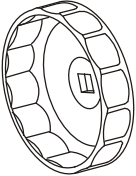
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Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 94	Anti-Corrosion Grease	Propeller shaft splines	92-802867A1
 95	2-4-C Marine Lubricant with Teflon	Propeller shaft splines	92-802859A1

Special Tools - Maintenance

Oil Drain Funnel	91-892866A01
 4993	Diverts draining engine oil from contacting the anti-splash and anti-cavitation plates.
Flushing Attachment	44357T2
 5218	Attaches to gearcase water intake, to provide a fresh water connection when flushing the cooling system or operating the engine out of water
Crankcase Oil Pump	91-90265A5
 5221	Alternate tool for draining engine oil sump.
Oil Filter Wrench	91-895277001
 5221	Assists in removing oil filter.

Dual Water Pick-up Flushing Seal Kit	91-881150Q1
 5235	Blocks off the front water inlet holes on the dual water inlet gearcase.

Outboard Care

To keep your outboard in the best operating condition, it is important that your outboard receive the periodic inspections and maintenance listed in the Inspection and Maintenance Schedule. We urge you to keep it maintained properly to ensure the safety of you and your passengers, and retain its dependability.

⚠ WARNING

Neglected inspection and maintenance service of your outboard or attempting to perform maintenance or repair on your outboard if you are not familiar with the correct service and safety procedures could cause personal injury, death, or product failure.

Record maintenance performed in Maintenance Log at the back of this book. Save all maintenance work orders and receipts.

Selecting Replacement Parts For Your Outboard

We recommend using original Mercury Precision or Quicksilver replacement parts and Genuine Lubricants.

⚠ WARNING

Using a replacement part that is inferior to the original part could result in personal injury, death, or product failure.

EPA Regulations

All new outboards manufactured by Mercury Marine are certified to the United States Environmental Protection Agency, as conforming to the requirements of the regulations for the control of air pollution from new outboard motors. 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, wherever practicable, returned to the original intent of the design. **Maintenance, replacement, or repair of the emission control devices and systems may be performed by any marine spark ignition (SI) engine repair establishment or individual.**

EPA Emissions

Emission Certification Label

An emission certification label, showing emission levels and engine specifications directly related to emissions, is placed on the engine at time of manufacture.

MERCURY		EMISSION CONTROL INFORMATION	
THIS ENGINE CONFORMS TO ☐ CALIFORNIA AND U.S. EPA EMISSION REGULATIONS FOR SPARK IGNITION MARINE ENGINES			
REFER TO OWNERS MANUAL FOR REQUIRED MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS			
a	IDLE SPEED (in gear) :		f
b	hp	cc	g
c	TIMING (IN DEGREES):		h
d		SPARK PLUG :	i
e	COLD VALVE CLEARANCE (mm)	INTAKE :	
		EXHAUST :	

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- | | |
|--|--|
| a - Idle speed | f - Family number |
| b - Engine horsepower | g - Maximum emission output for the engine family |
| c - Piston displacement | h - Timing specification |
| d - Date of manufacture | i - Recommended spark plug and gap |
| e - Valve clearance (if applicable) | |

Owner Responsibility

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

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

Inspection And Maintenance Schedule

Before Each Use

- Check engine oil level.
- Check that lanyard stop switch stops the engine.
- Visually inspect the fuel system for deterioration or leaks.
- Check outboard for tightness on transom.
- Check steering system for binding or loose components.
- Visually check power steering fittings and hoses for leaks or signs of damage. Check tie bar fasteners (multiple outboard rigs) for proper tightness.
- Check propeller blades for damage.

After Each Use

- Flush out the outboard cooling system if operating in salt or polluted water. .
- Wash off all salt deposits and flush out the exhaust outlet of the propeller and gearcase with fresh water if operating in salt water.

Every 100 Hours Of Use Or Once Yearly, Whichever Occurs First

- Change engine oil and replace the oil filter. The oil should be changed more often when the engine is operated under adverse conditions such as extended trolling.

- Inspect thermostat visually for corrosion and broken spring. Make sure thermostat closes completely at room temperature.
- Check engine fuel filter for contaminants.
- Check corrosion control anodes. Check more frequently when used in salt water.
- Drain and replace gearcase lubricant.
- Check power steering fluid.
- Inspect battery.
- Saltwater usage. Remove and inspect spark plugs for corrosion and replace spark plugs as necessary. Apply a thin coating of Anti-Seize Compound only on threads of spark plug prior to installation.
- Check wiring and connectors
- Check tightness of bolts, nuts, and other fasteners.

Every 300 Hours Of Use Or Three Years

IMPORTANT: Engine oil must be drained before removing gearcase to avoid oil spillage. Perform scheduled water pump replacement in combination with an engine oil change.

- Replace water pump impeller (more often if overheating occurs or reduced water pressure is noted).
- Check power trim fluid.
- Replace spark plugs at first 300 hours or three years. After that, inspect spark plugs every 300 hours or three years. Replace spark plugs as needed.
- Replace accessory drive belt.

Before Periods Of Storage

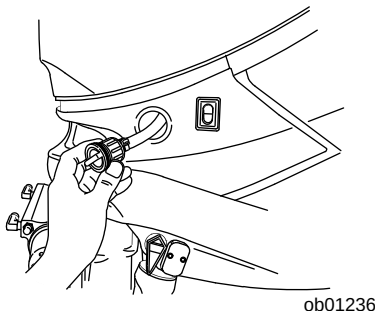
- Refer to Storage procedure.

Flushing The Cooling System

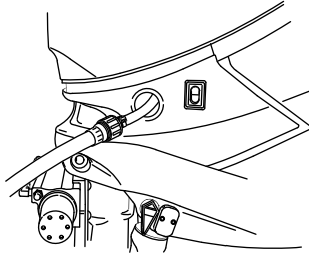
Flush the internal water passages of the outboard with fresh water after each use in salt, polluted, or muddy water. This will help prevent a buildup of deposits from clogging the internal water passages.

NOTE: The outboard can be tilted or in the vertical operating position during flushing.

1. With the engine turned off, place the outboard in either the operating position (vertical) or in a tilted position.
2. Disconnect the flush connector from fitting on the bottom cowl.



3. Thread a water hose into the flush fitting.



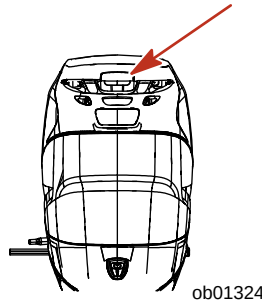
4. Turn on the water tap (1/2 maximum) and let the water flush through the cooling system for about 15 minutes.
5. When flushing is complete, turn off water and disconnect the water hose.
6. Reinstall the flushing connector to the fitting on the bottom cowl. Tighten the connector securely.

Cowl Removal and Installation

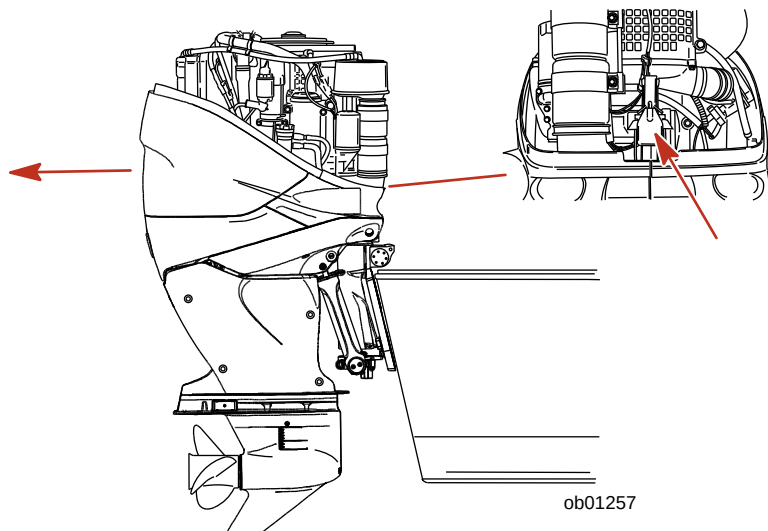
Cowl Removal

IMPORTANT: Most maintenance points are accessible by removing the top cowl only.

1. Pull up on the top cowl lock latch.

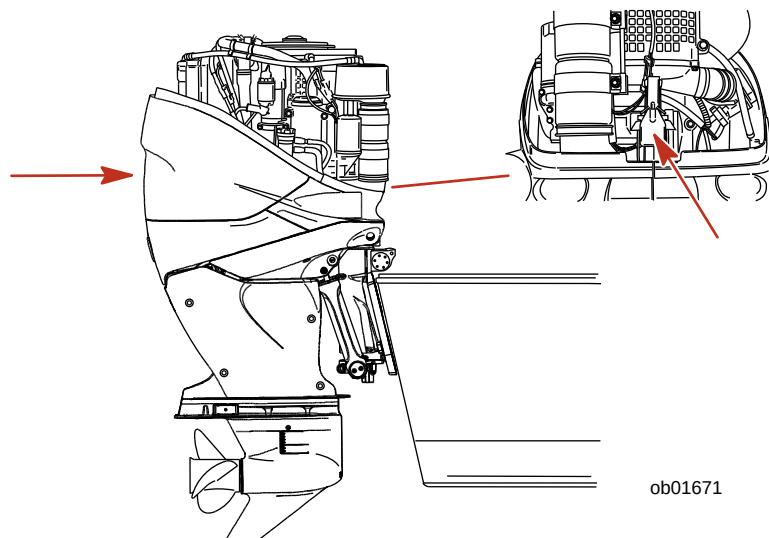


2. Pull top cowl forward and lift off.
3. Pull lower cowl release latch up.
4. Remove rear cowl towards aft of outboard.



Cowl Installation

1. Position lower cowl from aft side of outboard. Make sure it fits properly in the rubber seal.
2. Lock cowl in place by pulling lower cowl latch down.



3. Place top cowl into position over engine, front first. Ensure cowl fits properly into the rubber seal.
4. The top cowl will lock into place when downward pressure is applied to the back side of cowl. Ensure cowl is securely fastened by pulling up on back of cowl.

Exterior Care

The outboard is protected with a durable baked enamel finish. Clean and wax often using marine cleaners and waxes. Do not wax textured areas of cowl.

Battery Inspection

The battery should be inspected at periodic intervals to ensure proper engine starting capability.

IMPORTANT: Read the safety and maintenance instructions which accompany your battery.

1. Turn off the engine before servicing the battery.
2. Add water as necessary to keep the battery full.
3. Make sure the battery is secure against movement.
4. Battery cable terminals should be clean, tight, and correctly installed. Positive to positive and negative to negative.
5. Make sure the battery is equipped with a nonconductive shield to prevent accidental shorting of battery terminals.

DTS Battery Specifications

IMPORTANT: Do not use deep cycle batteries for the main engine starting battery.

IMPORTANT: Boating industry standards (BIA, ABYC, etc.), federal standards and Coast Guard regulations must be adhered to when installing the battery. Ensure that battery cable installation meets the pull test requirements and that positive battery terminal is properly insulated in accordance with regulations.

IMPORTANT: It is recommended (required in some states) that the battery be installed in an enclosed case. Refer to regulations for your area.

Minimum SAE Starting Battery Requirements - BCI GRP 24	
MCA	1000
CCA	800
Ah	180 (International Rating)

NOTE: Due to the wide variety of battery manufactures throughout the world, ratings and physical battery sizes will vary. Check with the manufacturer for a starting battery with a MCA, CCA, or Ah specification that will be equal to or greater than the SAE Standard J537 specified above.

IMPORTANT: For DTS products, each engine must be equipped with its own starting battery. If your boat application requires additional battery loads for boat accessories or marine electronics, it is recommended that an auxiliary battery or batteries be installed.

⚠ CAUTION

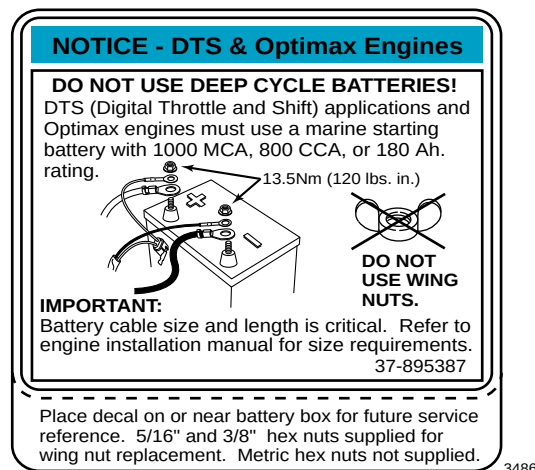
Hex nuts must be used to secure battery leads to battery posts to avoid loss of electrical power.

When connecting engine battery, hex nuts must be used to secure battery leads to battery posts. Torque nuts to specifications.

Description	Nm	lb. in.	lb. ft.
Hex nuts	13.5	120	

IMPORTANT: Battery cable size and length is critical. Refer to Battery Cable Size tables or engine installation manual for size requirements.

Decal needs to be placed on or near battery box for future service reference. One 5/16 in. and one 3/8 in. hex nut are supplied per battery for wing nut replacement. Metric hex nuts are not supplied.



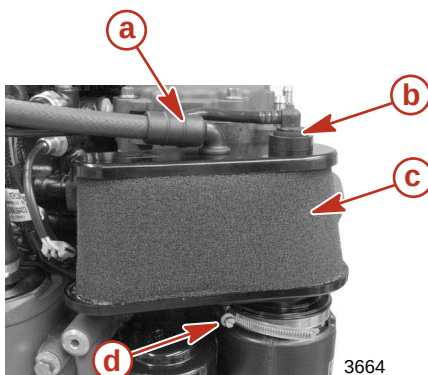
Air Filter

The air filter assembly is a serviceable item and can be cleaned with warm soap water if required.

Air Filter Removal and Cleaning

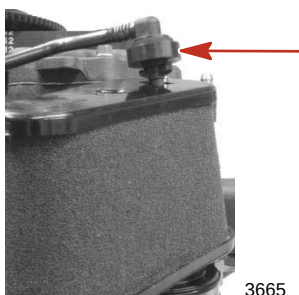
1. Loosen air filter clamp screw.

2. Remove crankcase ventilation hose.



- a** - Crankcase ventilation hose **c** - Filter assembly
b - Fuel System Module (FSM) purge valve hose **d** - Clamp screw

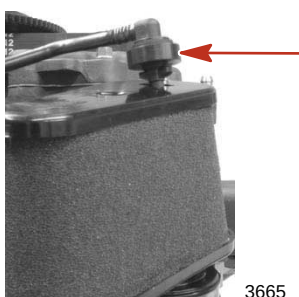
3. Remove air filter assembly and disconnect Fuel System Module (FSM) purge valve hose by rotating the air filter assembly and pulling on hose.



4. Wash air filter assembly in warm soap water.
5. Dry filter assembly with compressed air.
6. Apply 4-Cycle Outboard Oil on rag or towel and lightly pad air filter element. Wipe off excess oil. Air filter element should be moist to the touch.

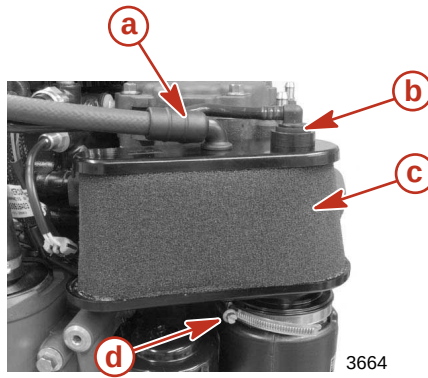
Air Filter Installation

1. Install Fuel System Module (FSM) purge valve hose to air filter assembly.



2. Install crankcase ventilation hose.

3. Install air filter assembly and tighten clamp screw securely.



- a** - Crankcase ventilation hose **c** - Filter assembly
b - Fuel System Module (FSM) purge valve hose **d** - Clamp screw

Fuel System

⚠ WARNING

Avoid serious injury or death from gasoline fire or explosion. Carefully follow all fuel system service instructions. Always stop the engine and do not smoke or allow open flames or sparks in the area while servicing any part of the fuel system.

IMPORTANT: Use an approved container to collect and store fuel. Wipe up spilled fuel immediately. Material used to contain spilled fuel must be disposed of in an approved receptacle.

Before servicing any part of the fuel system:

1. Stop engine and disconnect the battery.
2. Perform fuel system service in a well ventilated area.
3. Inspect any completed service work for sign of fuel leakage.

Fuel Line Inspection

Visually inspect the fuel line for cracks, swelling, leaks, hardness, or other signs of deterioration or damage. If any of these conditions are found, the fuel line must be replaced.

Water Separating Fuel Filter

NOTE: The warning system will turn on when water in the fuel filter reaches the full level.

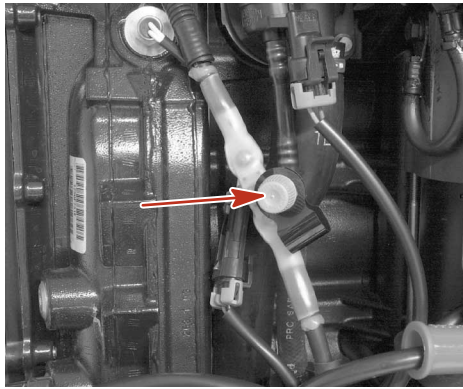
This filter removes moisture and debris from the fuel. If the filter holder becomes filled with water, the water can be removed. If the filter becomes plugged with debris, replace the filter.

Refer to the **Inspection and Maintenance Schedule** for the proper maintenance interval.

FILTER REMOVAL

1. Turn ignition key switch to "OFF" position.

2. Remove fuel vapor purge relief valve cap (green cap located aft of starter motor).

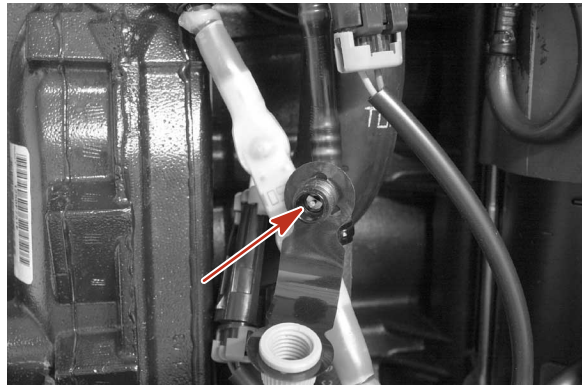


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⚠ CAUTION

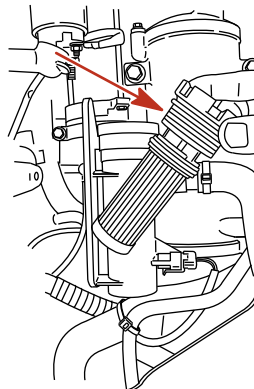
Fuel vapor vent system is under pressure. Cover valve assembly with a rag or towel to prevent fuel or fuel vapor spray. Relieve pressure slowly.

3. Place rag or towel around valve, release pressure by pushing core of valve end in.



3472

4. Unscrew the filter in a counterclockwise direction to remove.



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FILTER DRAINING

1. Slide filter holder up to release from bracket. Hoses and wire harness can remain attached to filter holder.

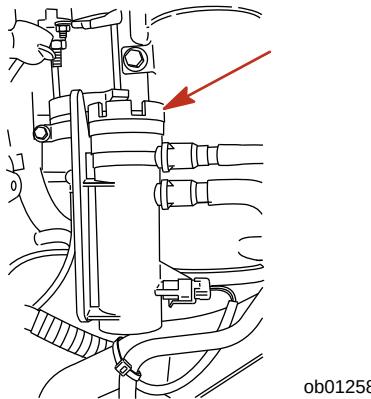
2. Tip the filter holder to drain any fluid into an approved container.



FILTER INSTALLATION

1. Position filter holder onto bracket and secure filter holder in place.
2. Lubricate the sealing ring on the filter with oil.
3. Install the filter and tighten securely by hand.

IMPORTANT: Visually inspect for fuel leakage from the filter while turning the ignition key to the run position, forcing fuel into the filter.

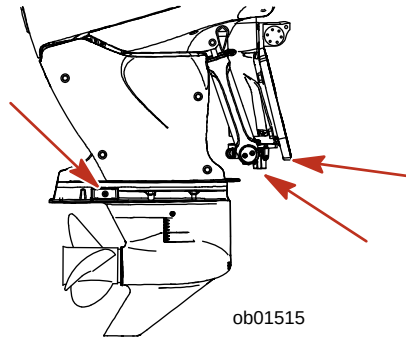


Corrosion Control Anode

The outboard has corrosion control anodes at different locations. An anode helps protect the outboard against galvanic corrosion by sacrificing its metal to be slowly eroded instead of the outboard metals.

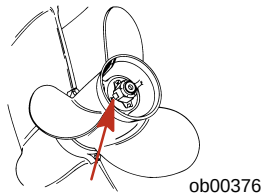
Each anode requires periodic inspection, especially in salt water which will accelerate the erosion. To maintain this corrosion protection, always replace the anode before it is completely eroded. Never paint or apply a protective coating on the anode as this will reduce effectiveness of the anode.

Two anodes are located on each side of the gearcase. Another anode is installed on the bottom of the pedestal. Two more anodes are located on the bottom of each power trim ram.

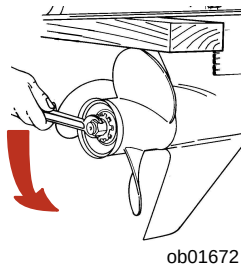


Propeller Replacement

1. Shift outboard to neutral position.
2. Straighten the bent tabs on the propeller nut retainer.



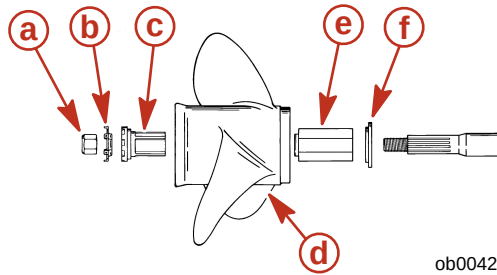
3. Place a block of wood between gearcase and propeller to hold propeller and remove propeller nut.



4. Pull propeller straight off shaft. If propeller is seized to the shaft and cannot be removed, have the propeller removed by an authorized dealer.
5. To aid in future removal of the propeller, liberally coat the propeller shaft splines with one of the following Mercury/Quicksilver products:

Tube Ref No.	Description	Where Used	Part No.
94	Anti-Corrosion Grease	Propeller shaft splines	92-802867A1
95	2-4-C Marine Lubricant with Teflon	Propeller shaft splines	92-802859A1

6. **Flo-Torq II Drive Hub Propellers** - Install forward thrust hub, replaceable drive sleeve, propeller, thrust hub, propeller nut retainer and propeller nut onto the shaft.



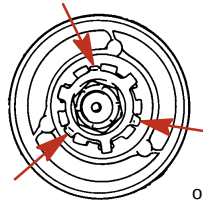
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- a** - Propeller nut
b - Propeller nut retainer
c - Thrust hub
d - Propeller
e - Replaceable drive sleeve
f - Forward thrust hub

7. Place a block of wood between gearcase and propeller and torque to specifications.

Description	Nm	lb. in.	lb. ft.
Propeller nut	75		55

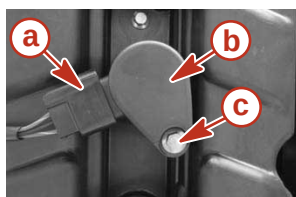
8. Secure propeller nut by bending three of the tabs into the thrust hub grooves.



ob00422

Spark Plug Inspection and Replacement

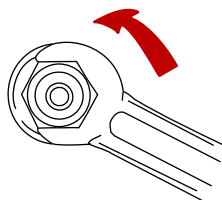
1. Remove top and rear cowlings. Refer to **Cowl Removal and Installation**.
2. Disconnect the six wiring harness connectors from pencil coil connections.
3. Remove mounting bolts, using a twisting motion, and pull pencil coils from spark plugs.



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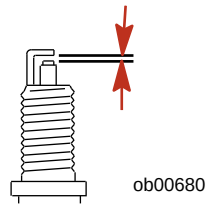
- a** - Wiring harness connector
b - Pencil coil
c - Bolt

4. Remove the spark plugs to inspect. Replace spark plug if electrode is worn, threads of seal area are corroded, or the insulator is rough, cracked, broken, blistered or fouled.



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5. Set the spark plug gap to specifications.



Spark Plug	
Spark Plug Gap	0.8 mm (0.0315 in.)

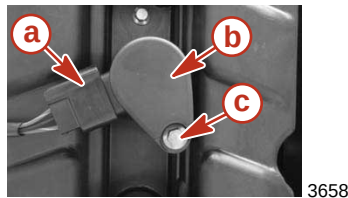
6. Saltwater use - Apply a thin coating of Anti-Seize Compound only on threads of spark plugs.
7. Clean area of spark plug seat.
8. Before installing spark plugs, clean off any dirt on the spark plug seats. Install plugs finger tight, and then tighten 1/4 turn or torque to specifications.

Description	Nm	lb. in.	lb. ft.
Spark plug	27		20

9. Push pencil coils into place over the spark plugs using a twisting motion.
10. Secure coils with retained bolts. Torque to specifications.

Description	Nm	lb. in.	lb. ft.
Bolts	8	71	

11. Connect the six wiring harness connectors to pencil coil connections.



a - Wiring harness connector

c - Bolt

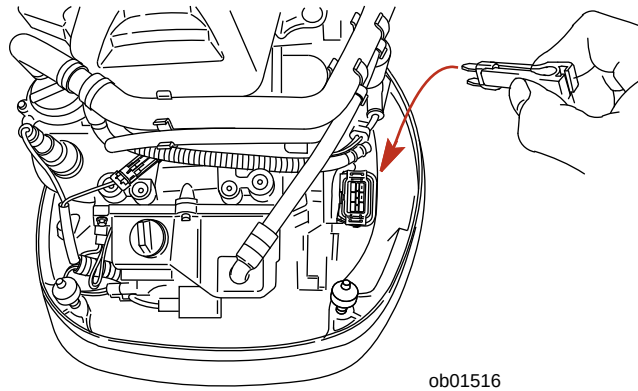
b - Pencil coil

12. Reinstall rear and top cowls.

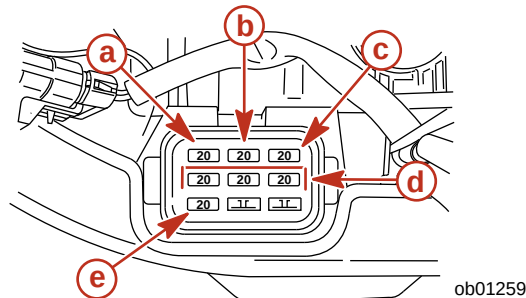
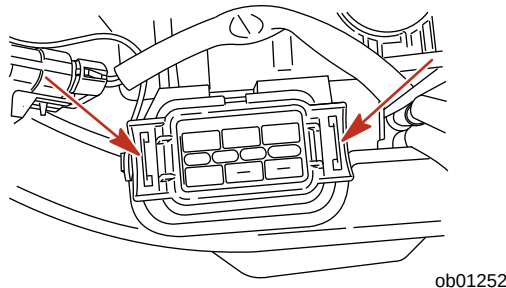
Fuses

The electrical wiring circuits on the outboard are protected from overload by fuses in the wiring. If a fuse is blown, try to locate and correct the cause of the overload. If the cause is not found, the fuse may blow again.

1. Remove top cowl. Locate fuse holder on starboard side of engine.



2. Remove the plastic cover from the fuse holder.
3. Remove fuse puller from fuse holder.
4. Remove suspected blown fuse to determine if the silver colored band is broken.
5. Replace fuse with a new fuse of the same amperage rating.



- a** - Electronic Control Module and purge valve "ECM" - 20 amp fuse
- b** - Ignition coils "IGN. COILS" - 20 amp fuse
- c** - Fuel delivery "FUEL" - 20 amp fuse
- d** - Spare fuses - 20 amp fuse
- e** - Injector power and boost valve "INJ. PWR." - 20 amp fuse

DTS Wiring System

⚠ WARNING

To avoid the possibility of serious injury or death from loss of boat control, do not splice or probe into any wire insulation of the DTS system. Splicing or probing will damage the wire insulation allowing water to enter the wiring. Water intrusion may lead to wiring failure and loss of throttle and shift control.

- Verify the harnesses are not routed near sharp edges, hot surfaces or moving parts.

- Verify that all unused connectors and receptacles are covered with a weather cap.
- Verify that the harnesses are fastened along the routing path.

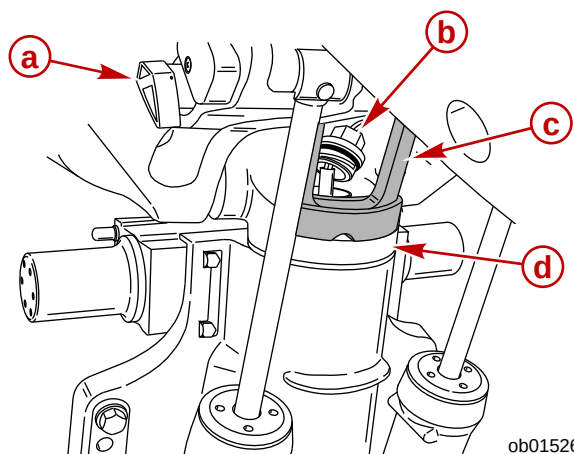
Accessory Drive Belt Inspection

Inspect the accessory drive belt and have it replaced by an authorized dealer if any of the following conditions are found.

- Cracks in the back of the belt or in the base of V grooves.
- Excessive wear at the roots of the grooves.
- Rubber portion swollen by oil.
- Belt surfaces roughened.
- Signs of wear on edges or outer surfaces of belt.

Checking Power Trim Fluid

1. Tilt outboard to the full up position.
2. Rotate the tilt support bracket down.
3. Lower outboard until tilt support bracket rests on pedestal.
4. Remove the power trim fill cap. The fill cap only requires 1/4 turn to remove.



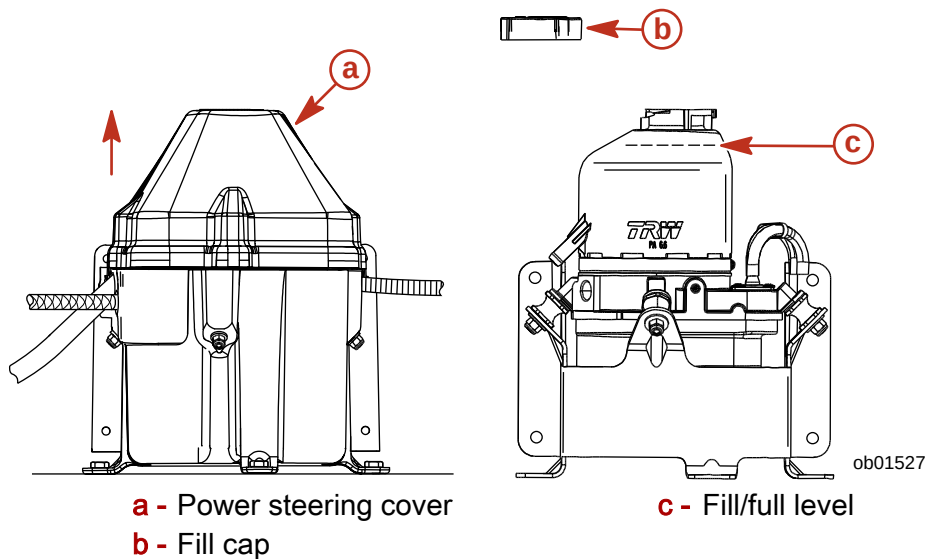
a - Tilt support lever
b - Power trim fill cap

c - Tilt support bracket
d - Pedestal

5. The fluid level should be approximately 25 mm (1 in.) from the top of the fill neck. Add Quicksilver or Mercury Precision Lubricants Power Trim & Steering Fluid. If not available, use automotive automatic transmission fluid (ATF).
6. Reinstall the power trim fill cap. Tighten fill cap 1/4 turn. Cap will snap in place. Do not tighten beyond this point.

Checking Power Steering Fluid

Remove power steering cover and fill cap to check fluid level. The fluid level should be slightly below the bottom of the fill hole. Use SAE 0W-30 synthetic power steering fluid, if needed.



Changing Engine Oil

Engine Oil Capacity

Engine oil capacity is approximately 7.0 liters (7.4 quarts)

Pump Method

IMPORTANT: Tilt outboard out/up past vertical for approximately one minute to allow trapped oil to drain back to the oil sump.

IMPORTANT: To reduce or prevent oil spillage when removing the oil filter, make sure that the outboard is upright (not tilted) and the engine is cold or has not run for at least one hour.

IMPORTANT: The pump method is preferred to remove engine oil from XXL models. If the drain method is used, an oil drain deflector tool must be used to divert oil from the lower splash plate and into the container.

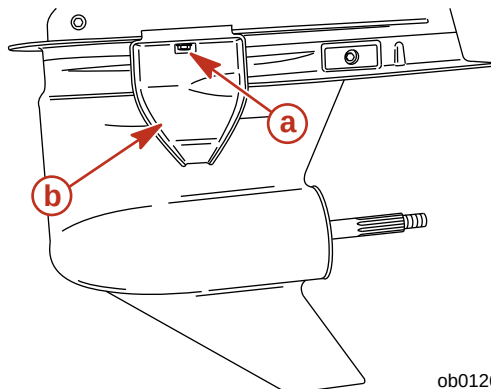
1. Tilt outboard out/up past vertical for approximately one minute to allow trapped oil to drain back to the oil sump.
2. Place the outboard in a vertical position.
3. Remove dipstick and slide adaptor tube of crankcase oil pump through oil dipstick hole, to bottom of engine oil sump.
4. Pump out the engine oil into an appropriate container.

Crankcase Oil Pump	91-90265A5
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Drain Method

1. Tilt outboard out/up past vertical for approximately one minute to allow trapped oil to drain back to the oil sump.
2. Place the outboard in a vertical position.
3. Place appropriate container under engine oil sump plug. Drain plug/seal washer is located beneath the splash plate (port side of outboard).

- Loosen drain plug/seal washer and install optional oil drain funnel over drain plug/seal washer and slide tool onto splash plate.



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a - Drain plug/seal washer**b** - Oil drain funnel

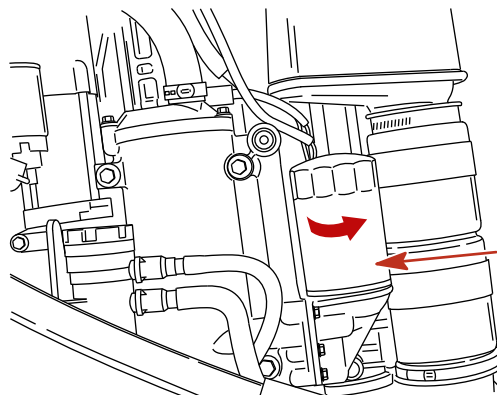
Oil Drain Funnel	91-892866A01
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- Remove drain plug/seal washer and drain engine oil into container.
- Reinstall drain plug/seal washer.

Changing Oil Filter

IMPORTANT: To reduce or prevent oil spillage when removing the oil filter ensure that the outboard is upright (not tilted) and the engine is cold or has not run for at least one hour.

- Remove the top cowl.
- Place a rag or towel below the oil filter to absorb any spilled oil.
- Unscrew old filter by using oil filter wrench tool and turning the filter counterclockwise.



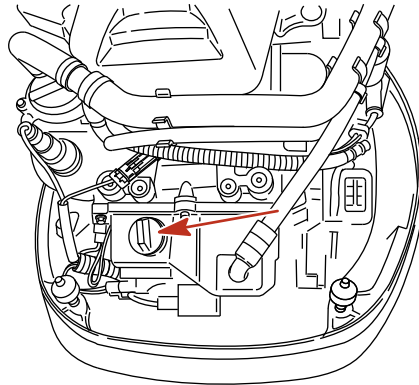
ob01251

Oil Filter Wrench	91-895277001
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- Clean the oil filter mounting base.
- Apply film of clean oil to filter gasket. Do not use grease.
- Screw new filter on until gasket contacts base, then tighten $\frac{3}{4}$ to 1 turn.

Oil Filling

1. Remove the oil fill cap and add recommended oil to the mid point of the operating range (mid point of cross hatched region). Adding approximately 7 liters (7.4 quarts) will bring oil level to mid point of cross hatched region.



ob01250

2. Reinstall oil fill cap.
3. With outboard in water or cooling water flush hose connected, idle engine for five minutes to check for leaks at the oil filter.
4. Stop engine and check oil level.

Storage Preparation

The major consideration in preparing your outboard for storage is to protect it from rust, corrosion, and damage caused by freezing of trapped water.

The following storage procedures should be followed to prepare your outboard for out of season storage or prolonged storage (two months or longer).

⚠ CAUTION

Never start or operate your outboard (even momentarily) without water circulating through all the cooling water intake holes in the gearcase to prevent damage to the water pump (running dry) or overheating of the engine.

Fuel System

IMPORTANT: Gasoline containing alcohol (ethanol or methanol) can cause a formation of acid during storage and can damage the fuel system. If the gasoline being used contains alcohol, it is advisable to drain as much of the remaining gasoline as possible from the fuel tank, remote fuel line, and engine fuel system.

IMPORTANT: This outboard is equipped with a closed fuel system when the engine is not running. With this closed system, fuel within the engine's fuel system, other than the fuel tank, will remain stable during normal storage periods without the addition of fuel treatment stabilizers.

Fill the fuel tank and engine fuel system with treated (stabilized) fuel to help prevent formation of varnish and gum. Proceed with following instructions.

- **Portable Fuel Tank** - Pour the required amount of gasoline stabilizer (follow instructions on container) into fuel tank. Tip fuel tank back and forth to mix stabilizer with the fuel.
- **Permanently Installed Fuel Tank** - Pour the required amount of gasoline stabilizer (follow instructions on container) into a separate container and mix with approximately one quart (one liter) of gasoline. Pour this mixture into fuel tank.

Protecting External Outboard Components

- Touch up any paint nicks. See your dealer for touch-up paint.
- Spray Quicksilver or Mercury Precision Lubricants Corrosion Guard on external metal surfaces (except corrosion control anodes).

Protecting Internal Engine Components

IMPORTANT: Refer to Maintenance - Spark Plug Inspection and Replacement for correct procedure for removing spark plugs.

- Remove pencil coils and spark plugs.
- Spray approximately 30 ml (1 fl. oz.) of Storage Seal Rust Inhibitor into each spark plug hole.
- Actuate key/push button start switch to crank the engine through one start cycle, which will distribute the storage seal throughout the cylinders.
- Reinstall spark plugs and pencil coils.

Gearcase

- Drain and refill the gearcase lubricant (refer to Maintenance - Gearcase Lubrication).

Positioning Outboard For Storage

Store outboard in an upright (vertical) position to allow water to drain out of outboard.

CAUTION

If outboard is stored tilted up in freezing temperature, trapped cooling water or rain water that may have entered the propeller exhaust outlet in the gearcase could freeze and cause damage to the outboard.

Battery Storage

- Follow the battery manufacturer's instructions for storage and recharging.
- Remove the battery from the boat and check water level. Recharge if necessary.
- Store the battery in a cool, dry place.
- Periodically check the water level and recharge the battery during storage.

Gearcase Lubrication

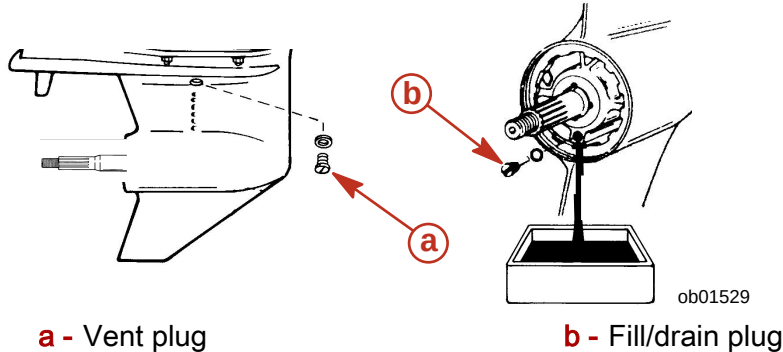
When adding or changing gearcase lubricant, visually check for the presence of water in the lubricant. If water is present, it may have settled to the bottom and will drain out prior to the lubricant, or it may be mixed with the lubricant, giving it a milky colored appearance. If water is noticed, have the gearcase checked by your dealer. Water in the lubricant may result in premature bearing failure or, in freezing temperatures, will turn to ice and damage the gearcase.

Examine the drained gearcase lubricant for metal particles. A small amount of metal particles indicates normal gear wear. An excessive amount of metal filings or larger particles (chips) may indicate abnormal gear wear and should be checked by an authorized dealer.

Draining Gearcase

1. Place outboard in a vertical operating position.

2. Remove propeller. Refer to **Propeller Replacement**.
3. Place drain pan below outboard.
4. Remove vent plug and fill/drain plug and drain lubricant.



Gearcase Lubricant Capacity

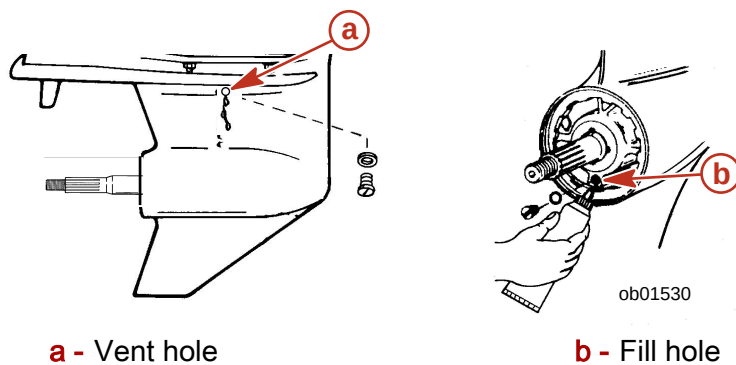
Gearcase lubricant capacity is approximately 970 ml (32.8 fl. oz.).

Gearcase Lubricant Recommendation

Mercury or Quicksilver Premium or High Performance Gear Lubricant.

Checking Lubricant Level and Refilling Gearcase

1. Place outboard in a vertical operating position.
2. Remove vent plug/sealing washer.
3. Remove fill/drain plug. Place lubricant tube into the fill hole and add lubricant until it appears at the vent hole.



IMPORTANT: Replace sealing washers if damaged.

4. Stop adding lubricant. Install the vent plug and sealing washer before removing the lubricant tube.
5. Remove lubricant tube and reinstall cleaned fill/drain plug and sealing washer.

Submerged Outboard

A submerged outboard will require service within a few hours by an authorized dealer once the outboard is recovered from the water. This immediate attention by a servicing dealer is necessary once the engine is exposed to the atmosphere to minimize internal corrosion damage to the engine.

Important Information

1
C

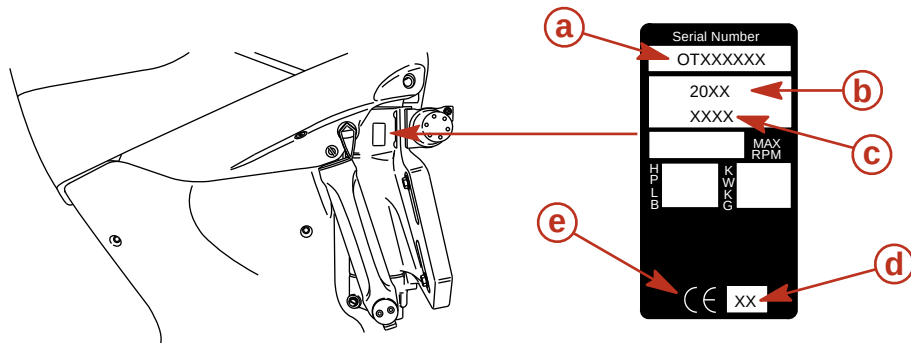
Section 1C - General Information

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Serial Number Location

The serial number of the engine is located on the starboard side of the pedestal.

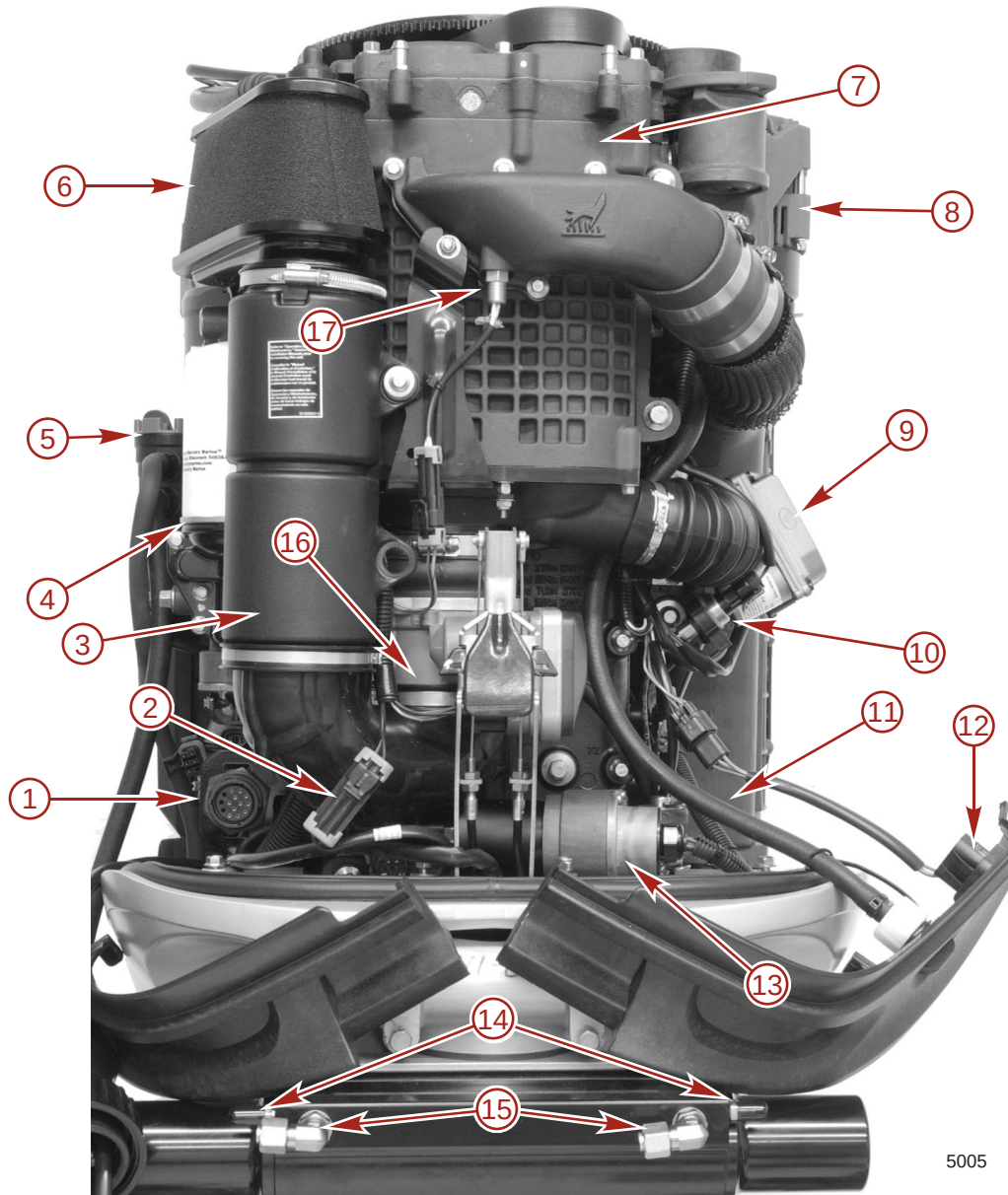


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- a** - Serial number
- b** - Model year
- c** - Model designation

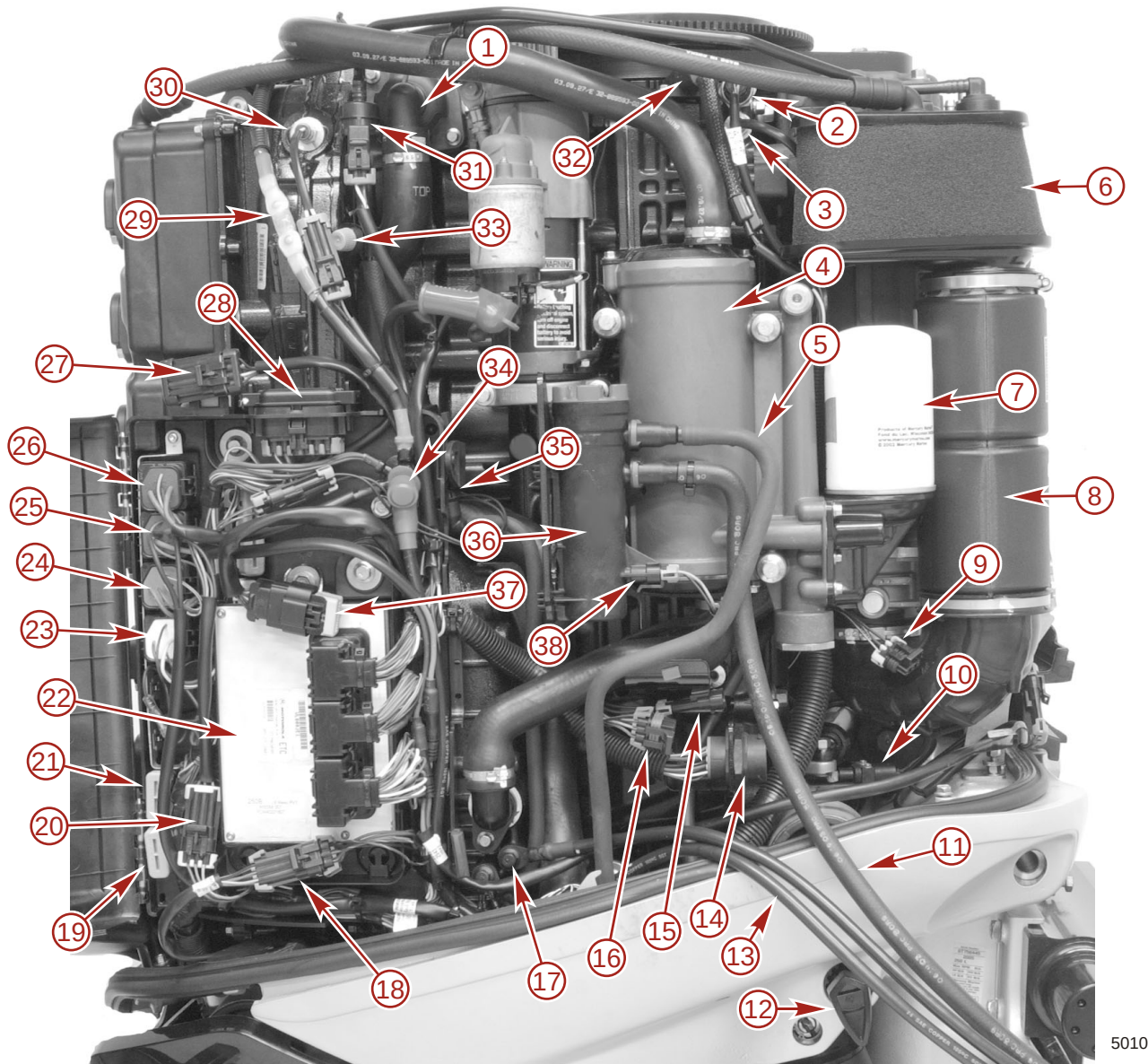
- d** - Year manufactured
- e** - Certified Europe Insignia (as applicable)

Model Year 2005 Verado Powerhead Front View



- | | |
|--|--|
| 1 - 14 pin engine harness connector | 10 - Speedometer sensor |
| 2 - Shift position indicator harness | 11 - Fresh water flush hose |
| 3 - Resonator | 12 - Cowl mounted tilt switch |
| 4 - Oil filter | 13 - Electronic Shift Control (ESC) Assembly |
| 5 - Fuel filter | 14 - Steering cylinder bleed port |
| 6 - Air filter | 15 - Steering cylinder hydraulic fittings |
| 7 - Supercharger | 16 - Electronic Throttle Control (ETC) Assembly |
| 8 - Alternator | 17 - Supercharger boost air temperature sensor |
| 9 - Electronic Boost Control (EBC) Assembly | |

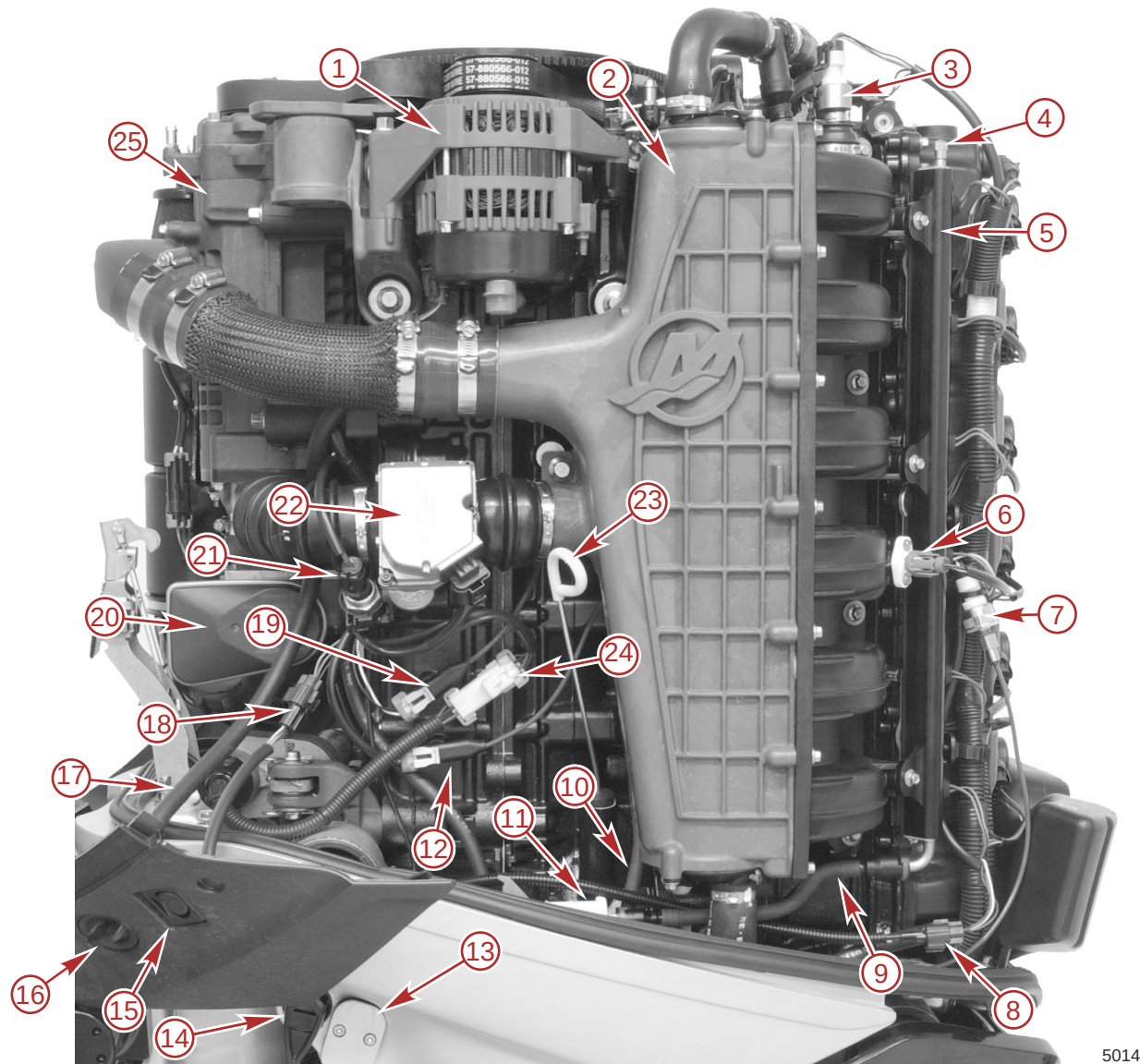
MODEL YEAR 2005 VERADO POWERHEAD STARBOARD VIEW



5010

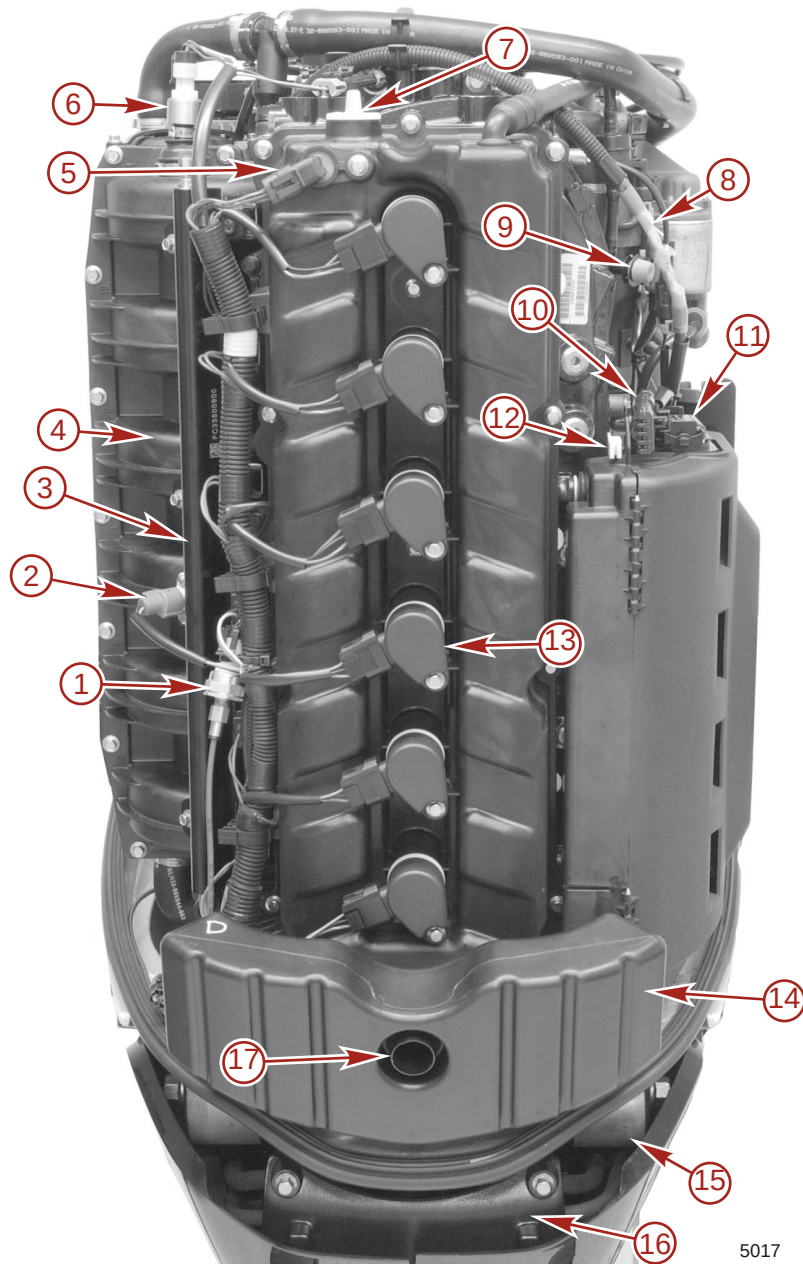
- 1 - Thermostat housing
- 2 - Oil pressure sensor
- 3 - Oil temperature sensor
- 4 - Integrated Oil Module (IOM)
- 5 - Fuel line to Fuel System Module
- 6 - Air filter
- 7 - Oil filter
- 8 - Resonator
- 9 - Power steering signal harness connector
- 10 - Shift indicator switch
- 11 - Fuel line (Fuel in)
- 12 - Tilt lock lever
- 13 - Battery cable (Positive)
- 14 - 14 pin engine harness connector
- 15 - DTS power harness
- 16 - Boat sensor harness
- 17 - Battery cable (Ground)
- 18 - Fuel System Module (FSM) harness connector
- 19 - Splicesaver (red / yellow)
- 20 - Trim wire harness connector
- 21 - Splicesaver (red / orange)
- 22 - PCM
- 23 - Relay, starter
- 24 - Relay, Main power
- 25 - Relay, Trim down
- 26 - Relay, Trim up
- 27 - Diagnostic port (4 pin)
- 28 - Fuses
- 29 - Fuseable link, 150 Amp
- 30 - Cylinder head temperature sensor
- 31 - Vent Canister Purge Valve (VCPV)
- 32 - Crank Position Sensor (CPS)
- 33 - FSM purge valve
- 34 - Hot stud (battery positive)
- 35 - Vent Canister Float Switch (VCFS)
- 36 - Fuel filter (2 micron)
- 37 - CAN terminating resistor
- 38 - Water separating sensor

MODEL YEAR 2005 VERADO POWERHEAD PORT VIEW



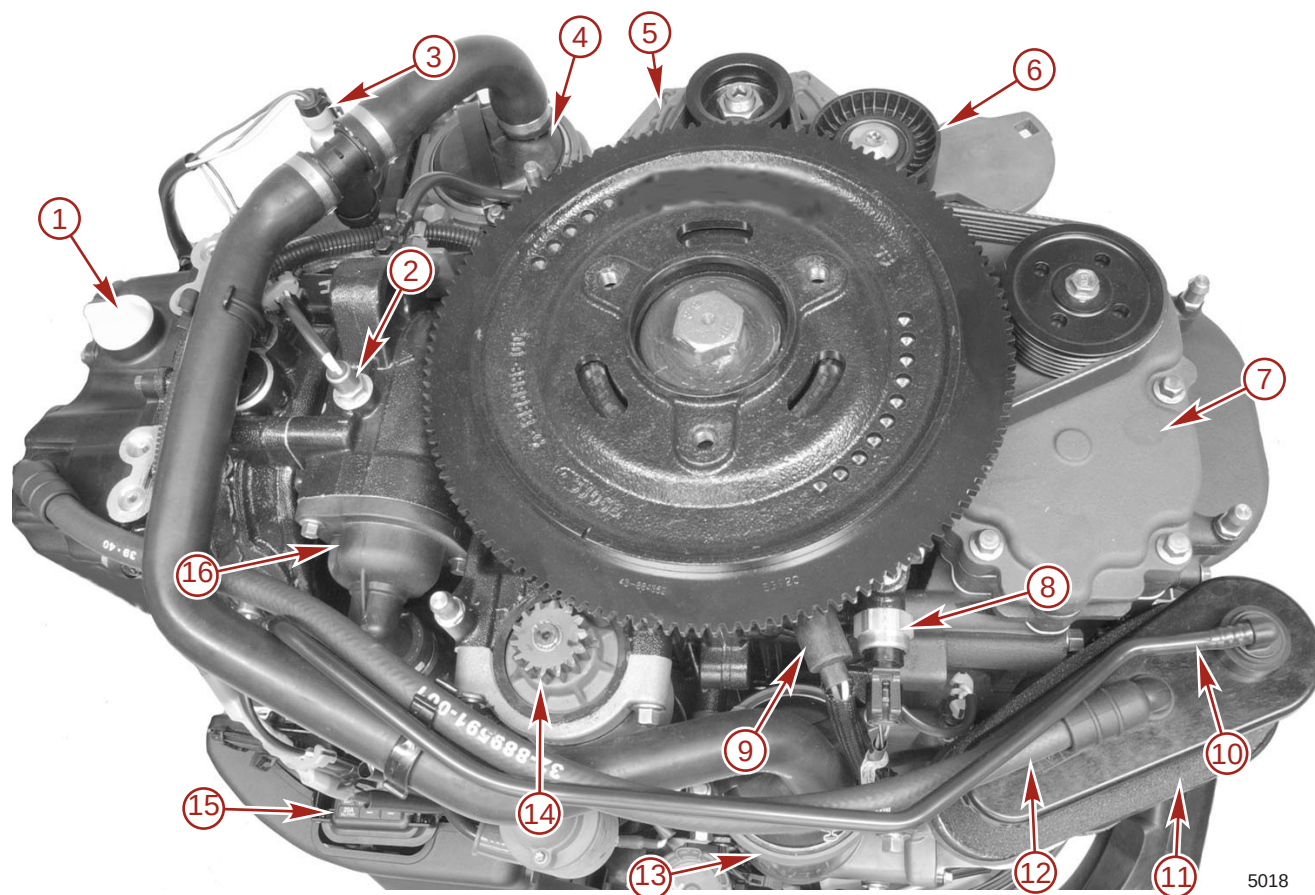
- 1 - Alternator
- 2 - Charge Air Cooler (CAC)
- 3 - Manifold Absolute Pressure (MAP) sensor
- 4 - Fuel pressure port
- 5 - Fuel rail
- 6 - Manifold Air Temperature (MAT) sensor
- 7 - Cylinder block water pressure sensor
- 8 - Trim position sensor harness connector
- 9 - Fuel inlet line to fuel rail
- 10 - MAP reference line to FSM
- 11 - Fuel filter (20 micron)
- 12 - Lower knock sensor harness connector (with black sleeve)
- 13 - Trim position sensor
- 14 - Tilt lock lever
- 15 - Tilt switch
- 16 - Fresh water flush inlet
- 17 - Fresh water flush hose
- 18 - Tilt switch harness connector
- 19 - Upper knock sensor harness connector
- 20 - Electronic Throttle Control (ETC) Assembly
- 21 - Speedometer sensor
- 22 - Electronic Boost Control (EBC)
- 23 - Oil dipstick
- 24 - Electronic Shift Control (ESC) harness connector
- 25 - Supercharger

Model Year 2005 Verado Powerhead Aft View



- | | |
|---|------------------------------|
| 1 - Block water pressure sensor | 10 - Diagnostic port (4 pin) |
| 2 - Manifold Air Temperature (MAT) sensor | 11 - Fuse holder |
| 3 - Fuel rail | 12 - Fuse puller |
| 4 - Intake manifold | 13 - Pencil coil |
| 5 - Cam position sensor | 14 - Plenum |
| 6 - Manifold Absolute Pressure (MAP) sensor | 15 - Motor mount, rear |
| 7 - Oil fill plug | 16 - FSM protection cover |
| 8 - Fuseable link, 150 amp | 17 - Exhaust relief |
| 9 - FSM purge valve | |

Model Year 2005 Verado Powerhead Top View



5018

- | | |
|--|-------------------------------------|
| 1 - Oil fill plug | 9 - Crank Position Sensor (CPS) |
| 2 - Cylinder block water temperature sensor | 10 - Vent canister purge valve hose |
| 3 - Manifold Absolute Temperature (MAP) sensor | 11 - Air filter |
| 4 - Charge Air Cooler | 12 - Breather hose |
| 5 - Alternator | 13 - Integrated Oil Module (IOM) |
| 6 - Belt Tensioner | 14 - Starter |
| 7 - Supercharger | 15 - Fuse holder |
| 8 - Oil pressure sensor | 16 - Thermostat housing |

Conditions Affecting Performance

Weather

It is a known fact that weather conditions exert a profound effect on the power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated RPM under a specific combination of weather conditions.

Corporations internationally have settled on adoption of I.S.O. (International Standards Organization) engine test standards, as set forth in I.S.O. 3046 standardizing the computation of horsepower from data obtained on the dynamometer. All values are corrected to the power that the engine will produce at sea level, at 30% relative humidity, at 25° C (77° F) temperature and a barometric pressure of 29.61 inches of mercury.

Summer conditions of high temperature, low barometric pressure and high humidity all combine to reduce the engine power. This in turn is reflected in decreased boat speeds as much as 3 to 5 km/h (2 to 3 MPH) in some cases. Nothing will regain this speed for the boater but cooler, dry weather.

Pointing out the consequences of weather effects, an engine running on a hot humid day may encounter a loss of as much as 14% of the horsepower it would produce on a dry, brisk day. The horsepower that any internal combustion engine produces, depends upon the density of the air that it consumes. The density of air is dependent upon the ambient air temperature, the barometric pressure and the humidity (water vapor) content.

Accompanying the effects of weather inspired loss of power is a second but more subtle loss. Consider a boat rigged during cooler, less humid weather with a propeller that allowed the engine to turn within its recommended RPM range at full throttle. Higher temperatures with high humidity weather will consequently decrease the available horsepower. The propeller in effect is too large for the atmospheric conditions. Consequently the engine operates at less than its recommended RPM.

The engine rated horsepower is a direct relation to the engines' RPM. An engine with too large a propeller will have a further loss of horsepower and subsequent decrease in boat speed. This secondary loss of RPM and boat speed can be regained by switching to a smaller pitch propeller that allows the engine to run at recommended RPM.

For boaters to realize optimum engine performance under changing weather conditions, it is essential that the engine have the proper propeller to allow it to operate at or near the top end of the recommended maximum RPM range at wide-open-throttle with a normal boat load. Not only does this allow the engine to develop full power, but equally important, is the engine will be operating in an RPM range that discourages damaging detonation. This of course enhances overall reliability and durability of the engine.

Weight Distribution (Passengers and Gear) Inside the Boat

Shifting weight to rear (stern):

- Generally increases speed and engine RPM
- Causes bow to bounce in choppy water
- Increases danger of following wave splashing into the boat when coming off plane
- At extremes, can cause the boat to porpoise

Shifting weight to front (bow):

- Improves ease of planing
- Improves rough water ride
- At extremes, can cause the boat to veer back and forth (bow steer)

Bottom of Boat

For maximum speed, a boat bottom should be nearly a flat plane where it contacts the water and particularly straight and smooth in fore and aft direction.

- **Hook:** Exists when bottom is concave in fore and aft direction when viewed from the side. When boat is planing, hook causes more lift on bottom near transom and allows bow to drop, thus greatly increasing wetted surface and reducing boat speed. Hook frequently is caused by supporting boat too far ahead of transom while hauling on a trailer or during storage.
- **Rocker:** The reverse of hook and much less common. Rocker exists if bottom is convex in fore and aft direction when viewed from the side, and boat has strong tendency to porpoise.
- **Surface Roughness:** Moss, barnacles, etc., on boat or corrosion of outboards gear housing increase skin friction and cause speed loss. Clean surfaces when necessary.

Water Absorption

It is imperative that all through hull fasteners be coated with a quality marine sealer at time of installation. Water intrusion into the transom core and/or inner hull will result in additional boat weight (reduced boat performance), hull decay and eventual structural failure.

Cavitation

Cavitation occurs when water flow cannot follow the contour of a fast-moving underwater object, such as a gear housing or a propeller. Cavitation permits the propeller to speed up, but the boat speed to reduce. Cavitation can seriously erode the surface of the gear housing or the propeller. Common causes of cavitation are:

- Weeds or other debris snagged on the propeller
- Bent propeller blade
- Raised burrs or sharp edges on the propeller

Ventilation

Ventilation is caused by surface air or exhaust gases that are introduced around the propeller resulting in propeller speed-up and a reduction in boat speed. Air bubbles strike the propeller blade and cause erosion of the blade surface. If allowed to continue, eventual blade failure (breakage) will occur. Excessive ventilation is usually caused by:

- Drive unit trimmed out too far.
- A missing propeller diffuser ring.
- A damaged propeller or gear housing, which allows exhaust gases to escape between propeller and gear housing.
- Drive unit installed too high on transom.

Detonation

Detonation in a 4-cycle engine resembles the pinging heard in an automobile engine. It can be otherwise described as a tin-like rattling or plinking sound.

Detonation is the explosion of the unburned fuel/air charge after the spark plug has fired. Detonation creates severe shock waves in the engine. These shock waves often find or create a weakness: the dome of a piston, cylinder head or gasket, piston rings or piston ring lands, piston pin and roller bearings.

A few of the most common causes of detonation in a marine 4-cycle application are as follows:

- Over-advanced ignition timing.
- Use of low octane gasoline.
- Propeller pitch too high: engine RPM below recommended maximum range.
- Lean fuel mixture at or near wide open throttle.
- Spark plugs: heat range too hot, incorrect reach, cross-firing.
- Deteriorated or inadequate engine cooling system.
- Combustion chamber deposits: result in higher compression ratio.

Detonation usually can be prevented if:

- The engine is correctly set up.
- Regular maintenance is scheduled.

Following Complete Engine Submersion

Engine Submerged While Running (Special Instructions)

When an engine is submerged while running, the possibility of internal engine damage is greatly increased. After the engine is recovered, remove the spark plugs. If the engine fails to turn over freely when turning the flywheel, the possibility of internal damage (bent connecting rod and/or bent crankshaft) exists. The powerhead must be disassembled for inspection.

Fresh Water Submersion (Special Instructions)

1. Recover the engine as quickly as possible.
2. Place engine at full trim in.
3. Remove cowling.
4. Flush exterior of outboard with fresh water to remove mud, weeds, etc. Do not attempt to start engine if sand has entered powerhead. Disassemble powerhead if necessary to clean components.
5. Remove spark plugs and get as much water as possible out of powerhead. Most of the water inside the combustion chambers, can be eliminated by rotating the flywheel while the engine is tilted in.
6. Remove the rubber boot from the ETC assembly. Drain water from the rubber boot.
7. Remove spark plugs and pour approximately one teaspoon of engine oil into each spark plug opening. Rotate flywheel to distribute oil in cylinders.
8. Change the engine oil. Run the outboard for short time and check for the presence of water in the oil. If water is present, the oil will appear milky. Drain and replace the oil.
9. Dry all wiring and electrical components using compressed air.
10. Disassemble the engine starter motor and dry all the internal parts with compressed air. Be careful not to loose the brush springs.
11. Reinstall spark plugs.
12. Attempt to start engine, using a fresh fuel source. If engine starts, it should be run for at least one hour to eliminate any water in engine. Run the outboard for short time and check for the presence of water in the oil. If water is present, the oil will appear milky. Drain and replace the oil as previously mentioned.

NOTE: *The fuel system is closed to the ambient air at all times when the engine is not running.*

13. If engine fails to start, determine if the cause is fuel, electrical or mechanical. The engine should be run within 2 hours after recovery from the water, or serious internal damage will occur. If unable to start engine within 2 hours of recovery, disassemble the engine and clean all parts. Apply oil as soon as possible.

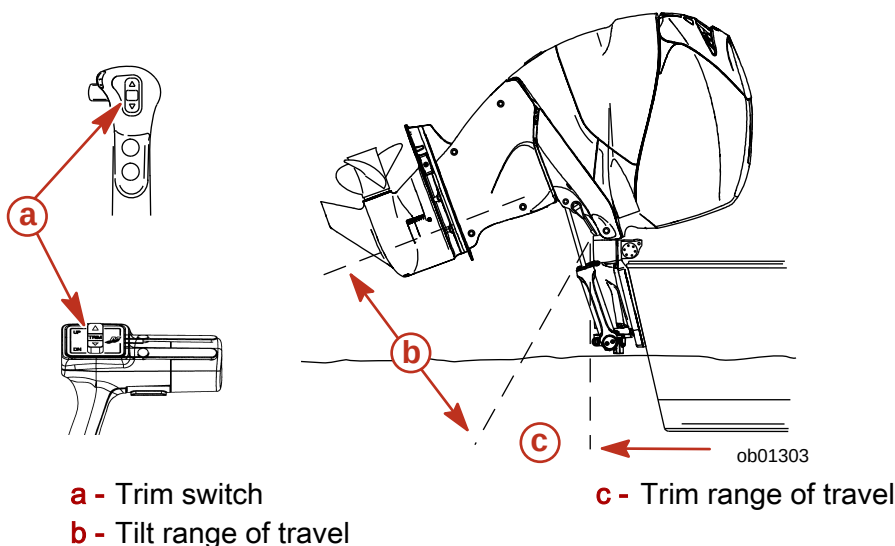
Salt Water Submersion (Special Instructions)

Due to the corrosive effect of salt water on internal engine components, complete disassembly of the engine is necessary before any attempt is made to start the engine.

Power Trim System

Power Trim and Tilt

The outboard has a trim/tilt control called power trim. This enables the operator to easily adjust the position of the outboard by pressing the trim switch. Moving the outboard in closer to the boat transom is called trimming in or trimming down. Moving the outboard further away from the boat transom is called trimming out or trimming up. The term trim generally refers to the adjustment of the outboard within the first 20° range of travel. This is the range used while operating the boat on plane. The term tilt is generally used when referring to adjusting the outboard further up out of the water. With the engine not running and the key switch in the "ON" position, the outboard can be tilted out of the water. At low idle speed (2000 RPM and below), the outboard can also be tilted up past the trim range to permit shallow water operation.



Power Trim Operation

With most boats, operating around the middle of the trim range will give satisfactory results. However, to take full advantage of the trimming capability there may be times when you choose to trim the outboard all the way in or out. Along with an improvement in some performance aspects comes a greater responsibility for the operator, this being an awareness of some potential control hazards.

Consider the following lists carefully:

1. Trimming In or Down Can:

- Lower the bow.
- Result in quicker planing off, especially with a heavy load or a stern heavy boat.
- Generally improve the ride in choppy water.
- In excess can lower the bow of some boats to a point where they begin to plow with their bow in the water while on plane. This can result in an unexpected turn in either direction (called bow steering or over-steering) if any turn is attempted, or if a significant wave is encountered.

⚠ WARNING

Avoid possible serious injury or death. Adjust outboard to an intermediate trim position as soon as boat is on plane to avoid possible ejection due to boat spin out. Do not attempt to turn boat when on plane if outboard is trimmed extremely in or down and there is a pull on the steering wheel.

2. Trimming Out or Up can:

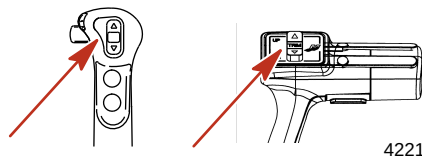
- Lift the bow higher out of the water.
- Generally increase top speed.
- Increase clearance over submerged objects or a shallow bottom.
- In excess can cause boat porpoising (bouncing) or propeller ventilation.
- Cause engine overheating if any cooling water intake holes are above the water line.

Tilting To Full Up Position

TILT AT HELM

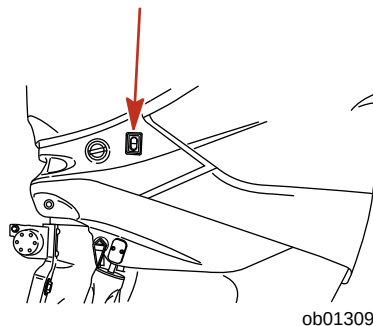
IMPORTANT: Turning key to the "START" position while the engine is running will result in engine shut down, while leaving the DTS system active. This will allow the use of the power trim/tilt from the remote control handle.

1. Shut off engine by:
 - a. Turning the key to the "START" position, then releasing it to the "ON" position.
 - b. Turning the key to "OFF" position and returning it to the "ON" position.
2. Press the trim/tilt switch to the up position. The outboard will tilt up until the switch is released or it reaches its maximum tilt position.



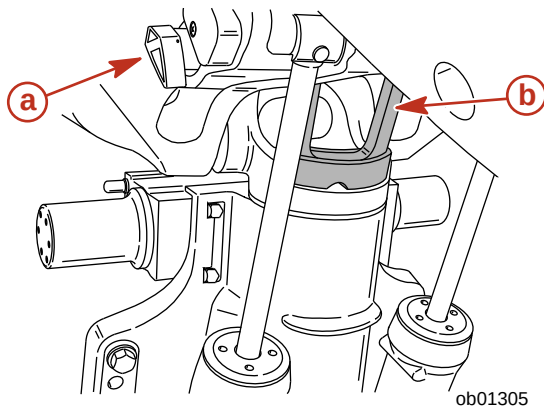
TILT AT ENGINE

The cowl mounted auxiliary tilt switch can be used to tilt the outboard with the key switch in the "OFF" position.



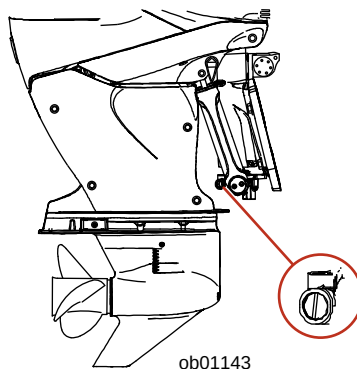
1. Rotate the tilt support lever down.
2. Lower outboard until tilt support bracket rests on the pedestal.

3. Disengage the tilt support bracket, by raising the outboard up and rotating the tilt support lever up. Lower the outboard.

**a - Tilt support lever****b - Tilt support bracket**

Manual Tilting

If the outboard cannot be tilted using the power trim/tilt switch, the outboard can be manually tilted.

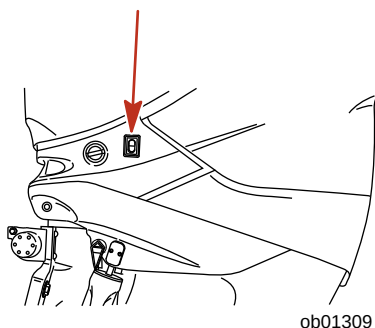


NOTE: The manual tilt release valve must be tightened before operating the outboard to prevent the outboard from tilting up during reverse operation.

1. Turn out the manual tilt release valve 3 turns counterclockwise. This allows manual tilting of the outboard. Tilt the outboard to the desired position and tighten the manual tilt release valve.

Auxiliary Tilt Switch

The auxiliary tilt switch can be used to tilt the outboard up or down using the power trim system.



Shallow Water Operation

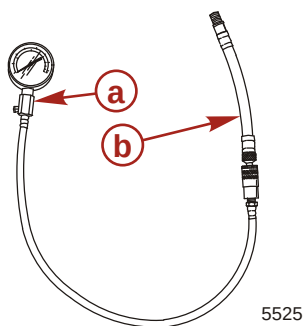
When operating your boat in shallow water, you can tilt the outboard beyond the maximum trim range to prevent hitting bottom.

1. Reduce engine speed below 2000 RPM.
2. Tilt outboard up. Make sure all the water intake holes stay submerged at all times.
3. Operate the engine at slow speed only. With the outboard tilted past 20° trim limit, the warning horn will sound and engine speed will be automatically limited to approximately 2000 RPM. The outboard must be tilted (trimmed) down below the maximum trim range to allow operation above 2000 RPM.

Compression Check

Engine compression should be checked with the engine block at operating temperatures, all spark plugs removed and using a fully charged battery.

1. Remove spark plugs.
2. Install compression gauge in spark plug hole.



a - Compression gauge (Snap-On EEEPV303A)

b - 14 mm Adaptor (Snap-On MT26J-200)

3. Crank the engine over until the compression reading peaks on the gauge. Record the reading.
4. Check and record compression of each cylinder. The highest and lowest reading recorded should not differ by more than 15%. A reading below 827.4 kPa (120 psi) may indicate a total engine wear problem. **The following example chart below, is not a representation of compression values specific to the engine that is actually tested. It is only an example.**

Compression Test Differences		
Condition	Maximum Reading	Minimum Reading
Good	1241 kPa (180 psi)	1062 kPa (154 psi)
Bad	1172 kPa (170 psi)	972.2 kPa (141 psi)

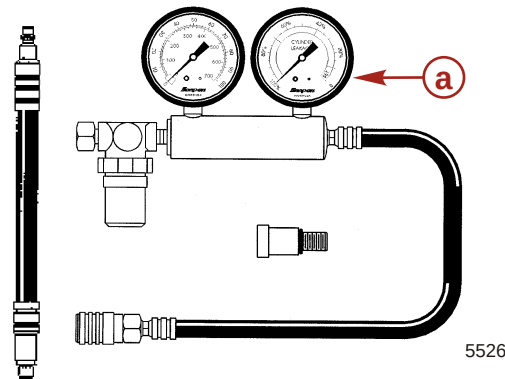
5. To find the maximum allowable minimum compression reading difference, use this formula; highest compression reading x 0.85 = the lowest allowable difference.
 $1241 \text{ kPa} \times 0.85 = 1054.85 \text{ kPa}$ ($180 \times 0.85 = 153 \text{ psi}$).
6. Compression check is important because an engine with low or uneven compression can not be tuned successfully to give peak performance. It is essential therefore, that improper compression be corrected before proceeding with an engine tune-up.
7. A variance of more than 103.4 kPa (15 psi) indicates the need for a powerhead inspection/disassembly.

Cylinder Leakage Testing

Engine Firing Order	
Cylinder sequence	1 - 3 - 5 - 6 - 4 - 2

NOTE: Cylinder leakage testing, along with compression testing, can help the mechanic pinpoint the source of a mechanical failure by gauging the amount of leakage in an engine cylinder. Refer to the manufacturer tester instructions for proper testing procedures.

NOTE: Spark plug hole is a 14 mm diameter. Use Snap-On Tool MT26J-200 adapter (or equivalent) with valve core removed.



a - Cylinder leakage tester (Snap-On EEPV309A)

1. Remove the spark plugs from cylinders 2, 3, 4, 5 and 6.
2. Rotate the engine clockwise until resistance is felt.
3. Continue to rotate flywheel so the timing marks on the flywheel and cylinder block are in alignment. This will be the compression stroke for cylinder #1.
4. Remove the spark plug from #1 cylinder.
5. Complete the cylinder leak down test on the #1 spark plug hole. Refer to the manufactures tester instructions for proper testing procedures.
6. After testing cylinder #1, install a dial indicator on the next firing order sequence cylinder.
7. Rotate the flywheel so the piston is at TDC.
8. Complete the cylinder leak down test.
9. Proceed with the succeeding firing order cylinder TDC and complete the cylinder leak down test.
10. Complete the procedure in sequence on the remain cylinders.

Analysis

Due to standard engine tolerances and engine wear, no cylinder will maintain a 0% of leakage. It is important only that cylinders have somewhat consistent reading between them. Differences of 15 to 30% indicate excessive leakage. Larger engines tend to have a larger percentage of cylinder leakage than smaller engines.

If excessive leakage is present, first check that the piston is at top dead center of its compression stroke. Leakage will naturally occur if the exhaust or intake valve is open.

To determine the cause of high percentage leaks, you must locate where the air is escaping from. Listen for air escaping through the intake, adjacent spark plug holes, exhaust pipe, and crankcase oil fill plug. Use the following table to aid in locating the source of cylinder leakage.

Air Escaping From	Possible Location
Air induction	Intake valve
Exhaust system	Exhaust valve
Oil fill plug	Piston/rings
Adjacent cylinder	Head gasket

Painting Procedures

WARNING

Avoid serious injuries from airborne particles. Avoid continuous breathing of vapors and spray mist. Use proper ventilation with approved eye and breathing protection.

Propellers

1. Sand the entire area to be painted with 3M 120 Regalite Polycut or coarse Scotch-Brite, disc or belts.
2. Feather edges of all broken paint edges. Try not to sand through the primer.
3. Clean the surface to be painted using PPG Industries DX330 Wax and Grease Remover or equivalent (Xylene or M.E.K.).
4. If bare metal has been exposed, use Mercury/Quicksilver Light Gray Primer.
5. Allow a minimum of 1 hour dry time and no more than 1 week before applying the finish coat.
6. Apply the finish coat using Mercury/Quicksilver EDP Propeller Black.

Gear Housing

The following procedures should be used in refinishing gear housings. This procedure will provide the most durable paint system available in the field. The materials recommended are of high quality and approximate marine requirements. The following procedure will provide a repaint job that compares with a properly applied factory paint finish. It is recommended that the listed materials be purchased from a local Ditzler Automotive Finish Supply Outlet. The minimum package quantity of each material shown following is sufficient to refinish several gear housings.

1. Wash the gear housing with a muriatic acid base cleaner to remove any type of marine growth, and rinse with water.
2. Wash the gear housing with soap and water. Rinse with clean water.
3. Sand blistered area with 3M 180 grit sandpaper or P180 Gold Film Disc to remove paint blisters only. Feather edge all broken paint edges.
4. Clean gear housing thoroughly with DX-330 Wax and Grease Remover.
5. Spot repair surfaces where bare metal is exposed with DX-503 Alodine Treatment.

IMPORTANT: Do not use aerosol spray paints as the paint will not properly adhere to the surface nor will the coating be sufficiently thick to resist future paint blistering.

6. Mix Epoxy Chromate Primer DP-90LF with equal part catalyst DP-402LF per the manufacturers instructions. Allow proper induction period for permeation of the epoxy primer and catalyst.
7. Allow a minimum of one hour drying time and no more than one week before the top coat application.
8. Use Ditzler Urethane DU9300 for Mercury Black, DU34334 for Mariner Grey, DU35466 for Force Charcoal, DU33414M for Sea Ray White, and DFHS 37372H for Verado Silver. Catalyze all five colors with Ditzler DU5 catalyst mixed 1:1 ratio. Reduce with solvents per Ditzler label.

⚠ CAUTION

Be sure to comply with the paint manufacturers label instructions for proper respiration protection and recommended ventilation.

NOTE: Apply one half to one mil even film thickness with a spray gun. Allow the paint to flash off for five minutes before applying the second even coat of one half to one mil film thickness. Urethane paint will dry to the touch in a matter of hours, but will remain sensitive to scratches and abrasions for a few days.

9. The type of spray gun used will determine the proper reduction ratio of the paint.

IMPORTANT: Do not paint sacrificial anode.

10. Cut out a cardboard plug for trim tab pocket to keep paint off of mating surface to maintain good continuity circuitry between trim tab and gear housing.

Decal Removal

1. Mark decal location before removal to assure proper alignment of new decal.
2. Carefully soften decal and decal adhesive with a heat gun or heat blower while removing old decal.
3. Clean decal contact area with a 1:1 mixture of isopropyl alcohol and water.
4. Thoroughly dry decal contact area and check for a completely cleaned surface.

Decal Application

1. Mix 16 ml (1/2 oz.) of dish washing liquid in 4 liter (1 gal.) of cool water to use as wetting solution.

NOTE: Leave protective masking on the face of decal until final steps of decal installation. This will ensure the vinyl decal keeps its shape during installation.

2. Place the decal face down on a clean work surface and remove the paper backing from adhesive side of decal.
3. Using a spray bottle, flood the entire adhesive side of the decal with the pre-mixed wetting solution.
4. Flood area where the decal will be positioned with wetting solution.
5. Position pre-wetted decal on wetted surface and slide into position.
6. Starting at the center of the decal, lightly squeegee out the air bubbles and wetting solution with overlapping strokes to the outer edge of the decal. Continue going over the decal surface until all wrinkles are gone and adhesive bonds to the cowl surface.
7. Wipe decal surface with soft paper towel or cloth.
8. Wait 10 - 15 minutes.
9. Starting at one corner, carefully and slowly pull the masking off the decal surface at a 180 angle.

NOTE: To remove any remaining bubbles, pierce the decal at one end of the bubble with stick pin and press out the entrapped air or wetting solution with your thumb, moving toward the puncture.

Important Information

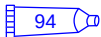
1 D

Section 1D - Outboard Motor Installation

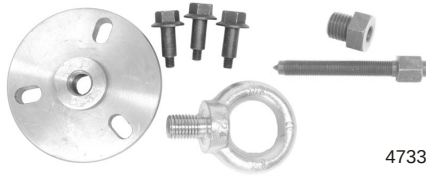
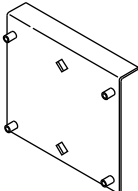
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Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 94	Anti-Corrosion Grease	Propeller shaft splines	92-802867A1
 95	2-4-C Marine Lubricant with Teflon	Propeller shaft splines	92-802859A1

Special Tools - Outboard Motor Installation

Flywheel Puller/Lifting Ring  4733	91-895343A01 Removes flywheel from engine. Used for lifting powerhead/engine.
Transom Drilling Fixture  5489	91-98234A2 Aids in engine installation by acting as a template for engine mounting holes.
Data Cable Puller  5548	91-888462A1 Attaches to end of DTS data harness to aid in pulling harness through boat. Prevents damage to DTS data harness.

Avoiding Loss of Throttle and Shift Control

⚠ WARNING
To avoid the possibility of serious injury or death from loss of boat control, do not splice or probe into any wire insulation of the DTS system. Splicing or probing will damage the wire insulation allowing water to enter the wiring. Water intrusion may lead to wiring failure and loss of throttle and shift control.

Accessory Electric Fuel Pump/Fuel Line Primer Bulb

IMPORTANT: Do not install either an accessory electric fuel pump or a fuel line primer bulb into the fuel system of this engine.

Avoiding Fuel Flow Restriction

IMPORTANT: Adding components to the fuel supply system (filters, valves, fittings, etc.) may restrict the fuel flow. This may cause engine stalling at low speed, and/or a lean fuel condition at high RPM that could cause engine damage.

Boat Horsepower Capacity

⚠ WARNING

Using an outboard that exceeds the maximum horsepower limit of a boat can: 1) cause loss of boat control 2) place too much weight at the transom altering the designed flotation characteristics of the boat or 3) cause the boat to break apart particularly around the transom area. Overpowering a boat can result in serious injury, death or boat damage.

Do not overpower or overload your boat. Most boats will carry a required capacity plate indicating the maximum acceptable power and load as determined by the manufacturer following certain federal guidelines. If in doubt, contact your dealer or the boat manufacturer.

U.S. COAST GUARD CAPACITY	
MAXIMUM HORSEPOWER	XXX
MAXIMUM PERSON CAPACITY (POUNDS)	XXX
MAXIMUM WEIGHT CAPACITY	XXX

ob00306

Selecting Accessories For Your Outboard

Genuine Mercury Precision or Quicksilver Accessories have been specifically designed and tested for this outboard

Some accessories not manufactured or sold by Mercury Marine are not designed to be safely used with this outboard or outboard operating system. Acquire and read the installation, operation, and maintenance manuals for all selected accessories.

Fuel Tanks

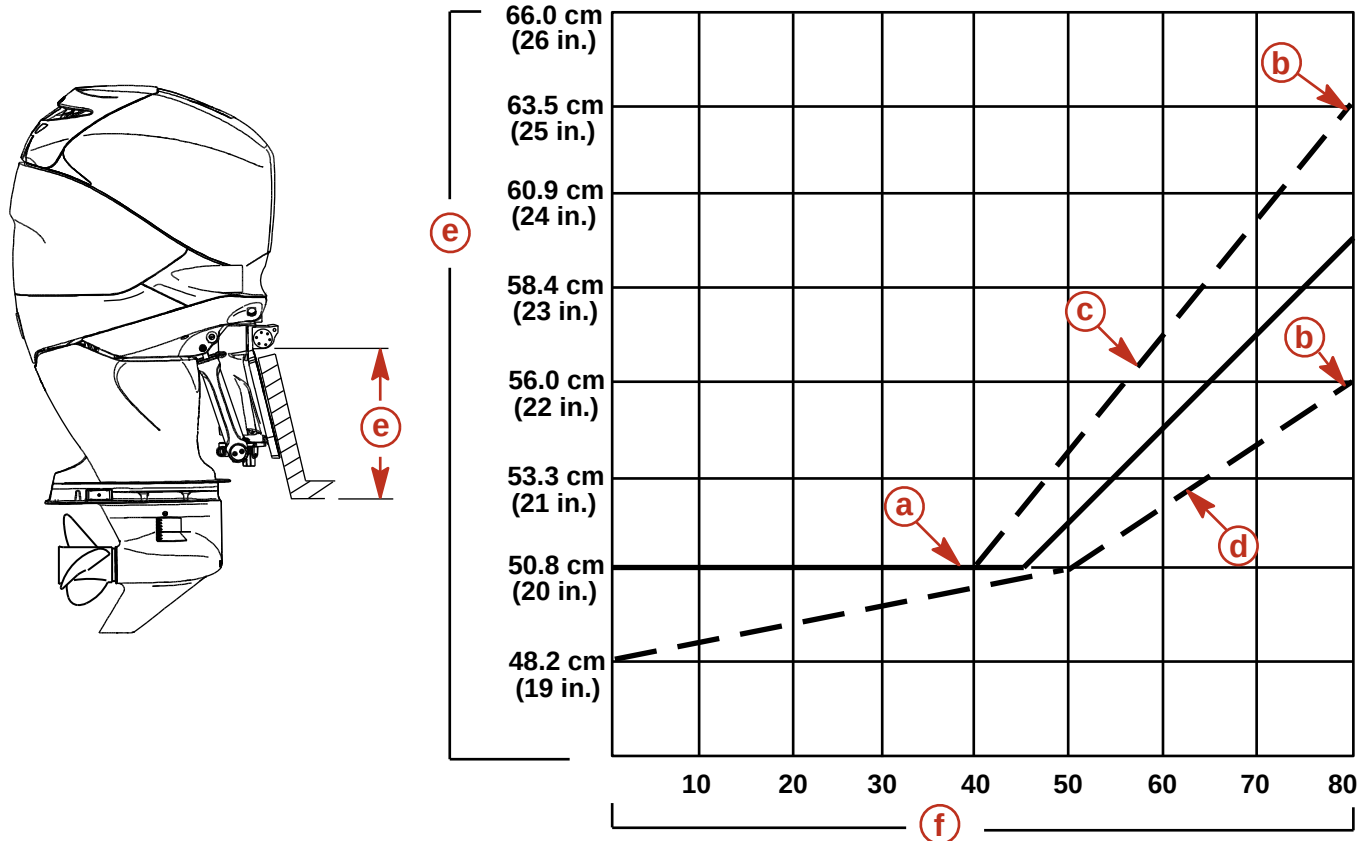
Portable Fuel Tank

Select a suitable location in the boat within the engine fuel line length limitations and secure the tank in place.

Permanent Fuel Tank

Permanent fuel tanks should be installed in accordance with industry and federal safety standards, which include recommendations applicable to grounding, anti-siphon protection, ventilation, etc.

Determining Recommended Outboard Mounting Height



ob01470

- a** - The solid line is recommended to determine the outboard mounting height.
- b** - The broken lines represent the extremes of known successful outboard mounting height dimensions.
- c** - The line may be preferred to determine outboard mounting height dimension, if maximum speed is the only objective.
- d** - The line may be preferred to determine outboard mounting height dimension for dual outboard installation.
- e** - Outboard mounting height (height from a point on the pedestal 48 mm [1-7/8 in.] above center of top mounting hole to the bottom of the boat transom). For heights over 56.0 cm (22 in.), a propeller designed for surfacing operation is usually preferred.
- f** - Maximum boat speed (m.p.h.) anticipated.

NOTICE	
- The static waterline, with boat at rest, must be below the "MAX STATIC WATERLINE" mark on the idle relief grommet (located at the rear of the outboard), when the outboard is fully tilted in/down. If waterline is above "MAX STATIC WATERLINE" mark, adjust boat load forward or increase (raise) outboard mounting height to correctly place mark above waterline. - Add 12.7 cm (5 in.) for XL models and 25.4 cm (10 in.) for XXL models to listed outboard mounting height. - The mounting height of the outboard must not exceed 63.5 cm (25 in.) for XL models and 76.2 cm (30 in.) for XXL models. Mounting the outboard higher may cause damage to the gearcase components.	

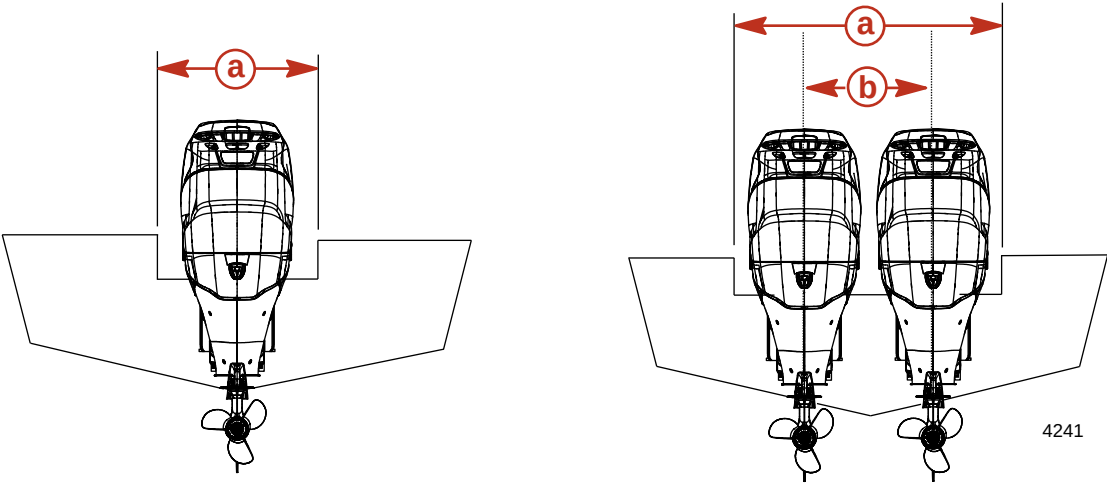
Increasing the mounting height will usually:

- Increase top speed

- Increase boat stability
- Cause propeller to break loose during planing or turning

Installing Outboard

Installation Specifications

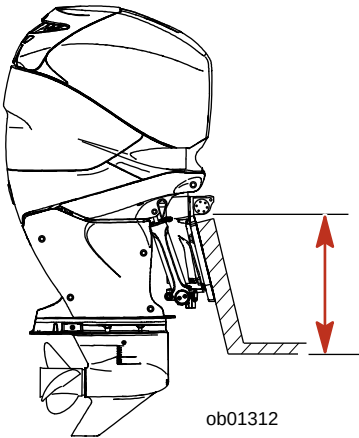


- a** - Minimum transom opening
- b** - Engine center line for dual engine - 66.0 cm (26 in.)

Minimum Transom Opening	
Single engine	99.0 cm (39 in.)
Dual engine	165.0 cm (65 in.)

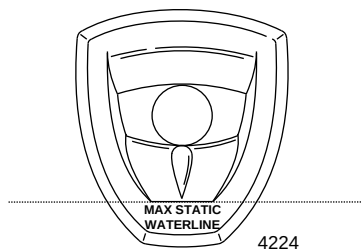
Maximum Outboard Mounting Height

The mounting height of the outboard must not exceed 63.5 cm (25 in.) for L models, 76.2 cm (30 in.) for XL models and 88.9 cm (35 in.) for XXL models. Mounting the outboard higher may cause damage to the gearcase components.



MAXIMUM STATIC WATERLINE

The static waterline, with boat at rest, must be below the "MAX STATIC WATERLINE" mark on the idle relief grommet (located at the rear of the outboard) when the outboard is fully tilted in/down. If waterline is above "MAX STATIC WATERLINE" mark, adjust boat load forward or increase (raise) outboard mounting height to correctly place mark above waterline.



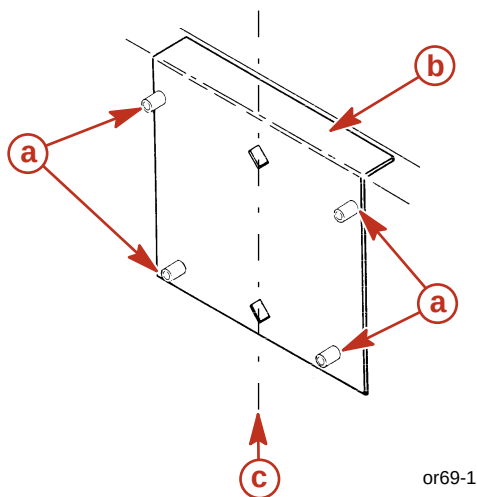
Drilling Outboard Mounting Holes

IMPORTANT: Before drilling any mounting holes, carefully read Determining Recommended Outboard Mounting Height. There is a 19 mm (0.75 in.) difference between the outboard mounting holes in the transom brackets.

⚠ WARNING

Avoid possible serious injury or death. Do not, under any circumstances, allow the upper outboard mounting bolts to be closer than 25.4 mm (1 in.) from the top of the boat transom. Never install the upper mounting bolts through shims.

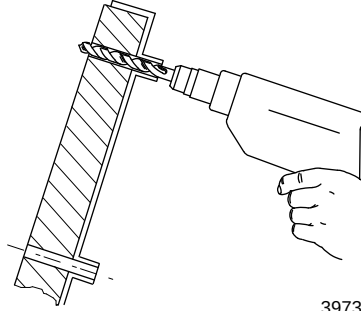
1. Mark four mounting holes on the transom using the transom drilling fixture.



- a** - Drill guide holes
- b** - Transom drilling fixture - not included
- c** - Transom centerline

Transom Drilling fixture	91-98234A2
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2. Place masking tape directly onto the boat where the mounting holes will be drilled to help keep the fiberglass from chipping.

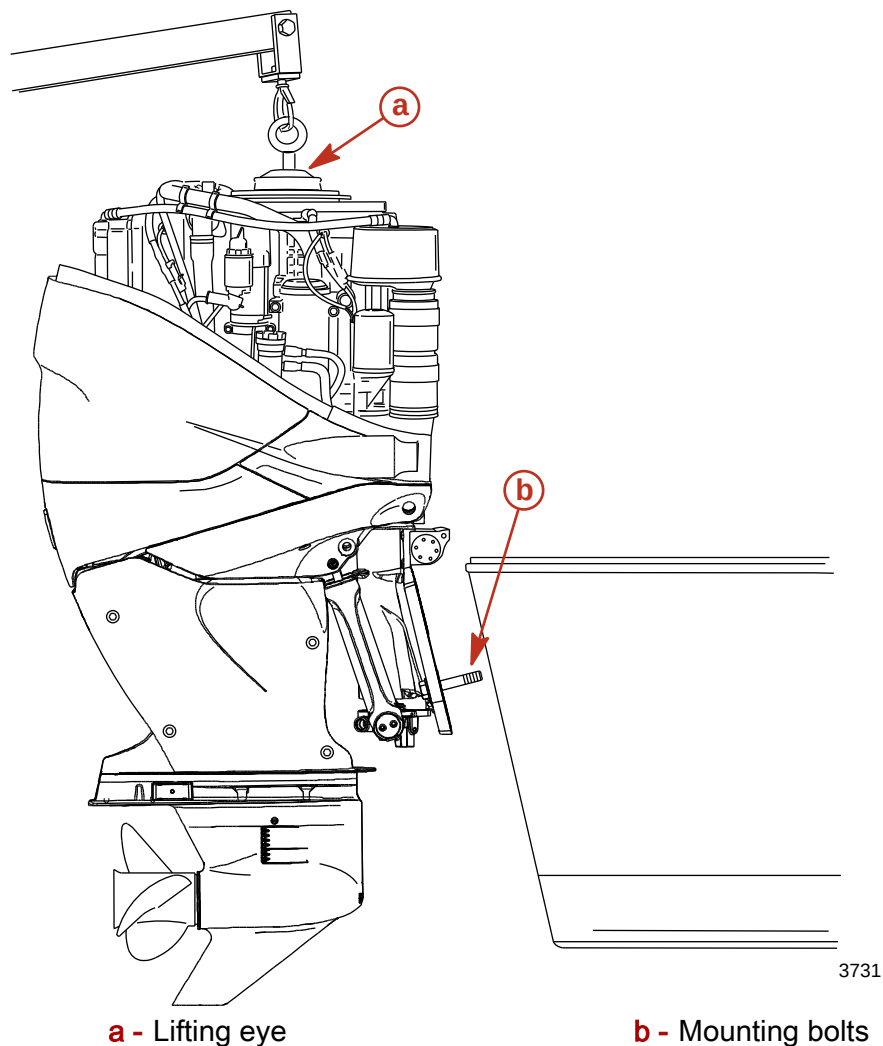


3. Using the drill guide holes on the transom drilling fixture, drill four 13 mm (17/32 in.) holes perpendicular to and through the transom.

Lifting Outboard

1. Remove top cowl and engine flywheel cover.
2. Install lifting ring/flywheel puller to flywheel. Tighten bolts securely.
3. Lift engine using engine lift with a minimum capacity of 450kg (1000 lb.).
4. Avoid interference by placing the lower mounting bolts into the lower mounting slots before placing outboard against the transom.

5. Refer to **Determining Recommended Outboard Mounting Height**, and install outboard to the nearest recommended mounting height.



Lifting Eye	91-895343T01
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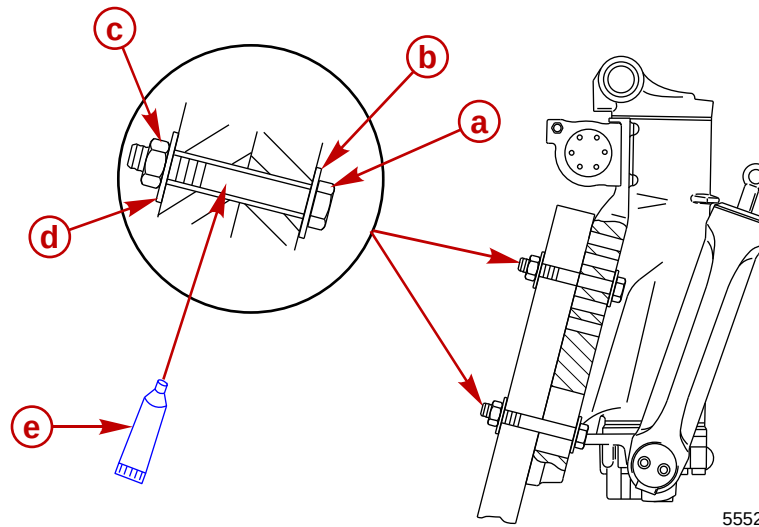
6. Fasten outboard with mounting hardware provided. Refer to **Fastening Outboard**.

Fastening Outboard

1. Place lower mounting bolts into mounting slots before placing outboard on transom.
2. Refer to **Determining Recommended Outboard Mounting Height**, and install outboard to the nearest recommended mounting height.
3. Fasten outboard with the stainless steel bolts, nylon insert locknuts and flat washers as shown.

⚠ CAUTION

To avoid loss of outboard, ensure that a minimum of two full threads of bolt extend beyond locknut after tightening locknut. Ensure mounting nut is tightened against transom, not the shank of the mounting bolt.



a - Transom bolts (1/2 x 20) (4)

b - Flat washers - outer (4)

c - Nylon insert locknuts (4)

d - Flat washers - inner (4)

e - Marine sealer - apply to shank of bolts, not threads

Outboard Transom Mounting Hardware - Supplied with Outboard

Part Number	Part Name	Description
10-67755003	Transom bolt	1/2 x 20 x 5.50 in. long (3.25 in. thread)
11-826711-17	Nylon insert locknut	1/2 x 20
12-28421	Washer - inner	0.516 in. ID x 1.50 in. OD
12-895062	Washer - outer	0.551 in. ID x 1.06 in. OD

Available Transom Mounting Bolts

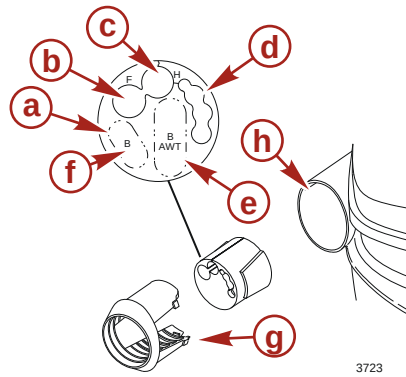
Part Number	Part Name	Description
10-814259	Transom bolt	1/2 x 20 x 4.00 in. long (2.25 in. thread)
10-67755-1	Transom bolt	1/2 x 20 x 4.50 in. long (2.25 in. thread)
10-67755-2	Transom bolt	1/2 x 20 x 6.50 in. long (2.75 in. thread)

Routing Connections Through the Cowl

IMPORTANT: Ensure that sufficient excess exists in the wiring harness and battery cables routed between the cowl fitting and the engine attachment point to relieve stress and prevent hoses from being kinked or pinched. Ensure that excess exists in all hoses and cables in full left and right turns and full tilt position.

NOTE: Mercury Marine suggests routing the wiring, cables and fuel hose through a rigging hose or flexible sleeve from the engine to the boat's gunnel or motor well. Follow the installation instructions included with the Rigging Hose or Flexible Sleeve Kit.

1. Pull out the grommet fitting from the front cowl opening. Route the wiring harnesses, battery cables, and fuel hose through the correct openings in the rubber grommet as shown.



- a** - Rubber grommet
- b** - Fuel hose
- c** - 14 pin data harness
- d** - DTS power harness, vessel sensor harness, power steering pump harness
- e** - Large diameter battery cables
- f** - Small diameter battery cables
- g** - Grommet fitting
- h** - Front cowl opening

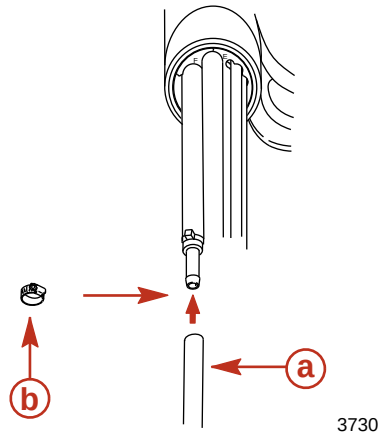
2. Insert rubber grommet into fitting and secure fitting in front cowl opening.

Fuel Hose Connection

FUEL HOSE SIZE

IMPORTANT: Fuel line inside diameter (I.D.) must be 10 mm (3/8 in.) with separate fuel line/fuel tank pickup for each engine.

Fasten remote fuel hose to fitting with hose clamp.



a - Remote fuel hose

b - Hose clamp

Wiring And Installation

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

Installation Guidelines for DTS System Components

⚠ WARNING

To avoid the possibility of serious injury or death from loss of boat control, do not splice or probe into any wire insulation of the DTS system. Splicing or probing will damage the wire insulation allowing water to enter the wiring. Water intrusion may lead to wiring failure and loss of throttle and shift control.

DATA HARNESS

⚠ WARNING

To avoid the possibility of serious injury or death from loss on boat control, do not pull on cable connectors when pulling cable into boat. Observe correct pulling procedure. Pulling on connectors can loosen terminals resulting in open or poor electrical connections. Open or poor electrical connections may result in loss of throttle and shift control.

CONNECTORS

IMPORTANT: Connectors should never have to be forced into the receptacle. Ensure that connectors are free of any lubricant or dielectric grease before installation. When the connector is properly aligned, it will only take a small amount of pressure to insert it into the receptacle. Rotate the locking collar to secure the electrical connection.

NOTE: Connect only one data harness of the required length between the engine and helm. If a data harness is too short, do not connect multiple harnesses together to make up the required length. For installations requiring a data harness length longer than 12.2 m (40 ft.), contact Mercury Marine for more information.

Data Harness Pulling Procedure

IMPORTANT: Do not route data harness near engine ignition components (coils, spark plug leads, and spark plugs), high power VHF coax or radios. An electrical field generated from these components could cause interference with data transmission.

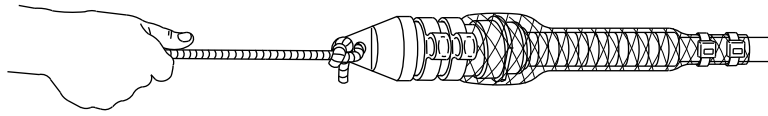
IMPORTANT: Do not route data harness near sharp edges, hot surfaces or moving parts. Fasten cables away from any sharp edges, fasteners or objects that could wear into the harness.

IMPORTANT: Avoid sharp bends in the data harness. Minimum bend radius should be 7.6 cm (3 in.) for the final wiring installation.

1. Inspect the routing path to make sure surfaces are free of any sharp edges or burrs that could cut the harness.

2. Install cable pulling tool to data harness.
3. Secure pulling tool with 2 cable ties.

IMPORTANT: The cables ties must be tight to prevent any slipping during installation.



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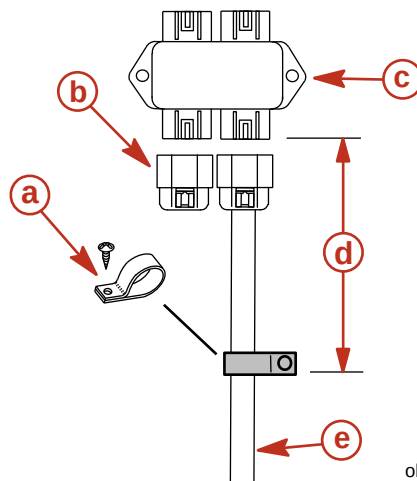
Data Cable Puller	91-888462A1
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IMPORTANT: Carefully inspect data harness pins to ensure all pins are securely fastened to data harness connector end following installation.

NOTE: Data harness should be secured with mounting clips or cable ties along the routing path.

Junction Box (If Equipped)

- Although the junction box connections are watertight, it is recommended that the junction box be mounted in an area that stays relatively dry.
- Mount in an area where the wiring connection will not get stepped on or disturbed.
- Mount in an area that is accessible for troubleshooting and servicing the system.
- Ensure the DTS command module harness will reach all the connection points.
- Fasten all junction box connections within 25.4 cm (10 in.) of the junction box.
- Seal all unused connections with weather caps.



ob01481

a - Clamp

b - Weather cap (859318T 2)

c - Junction box

d - 25.4 cm (10 in.)

e - DTS Command Module harness

Non-Mercury Marine Provided Ignition Switch

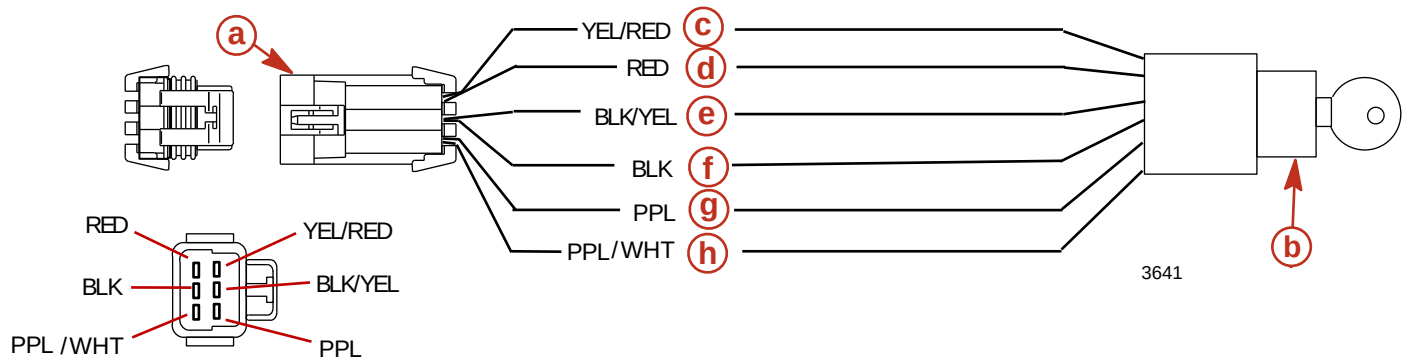
⚠ CAUTION

Prevent unexpected engine start-up. Non-Mercury Marine ignition switches may allow sufficient current leakage to cause engine to start unexpectedly.

IMPORTANT: Correct ignition key switch must be used. If a non-Mercury Marine ignition key switch is being used, make sure that the ignition switch being used meets the requirement listed.

IMPORTANT: Current leakage exceeding 5 mA at 12 volts could cause engine to start unexpectedly.

- Ignition key switch must pass ingress protection testing per IEC IP66 specification minimum. Switches that do not pass this specification could leak current.
- Switches must contain an emergency stop circuit.



4 Position Key Switch

- | | |
|---|--|
| a - Connector - Packard Metripack 150 Series Sealed™ (6 pin) | e - Lanyard stop |
| b - Ignition switch | f - Ground |
| c - Crank | g - Run |
| d - + 12V | h - Accessory - 4 position key switch |

Wiring Accessories

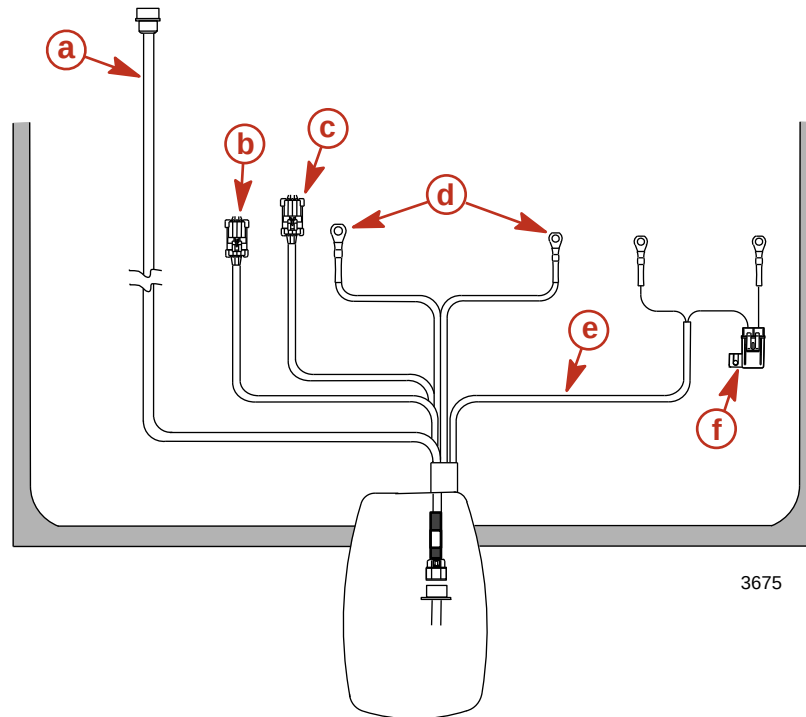
NOTE: Refer to *Mercury Precision Parts Accessories Guide*.

System Wiring Reference Points

FEATURES

- **DTS power harness** - Provides 12V power to the DTS system. Requires connection to the starting battery. If starting battery is located at the helm, DTS power harness accessory kit is required to minimize voltage drop. Use cable ties to secure power harness leads to battery cables, beginning within 15 cm (6 in.) of battery posts and continuing along the entire length of the harness.
- **Battery cables** - Connect to the starting battery.
- **Vessel sensor harness** - This harness connects to the main fuel tank sensor, auxiliary fuel tank and the paddle wheel speed/temperature sensor, if equipped.

- **14 pin data harness** - Connects between the command module harness and engine.

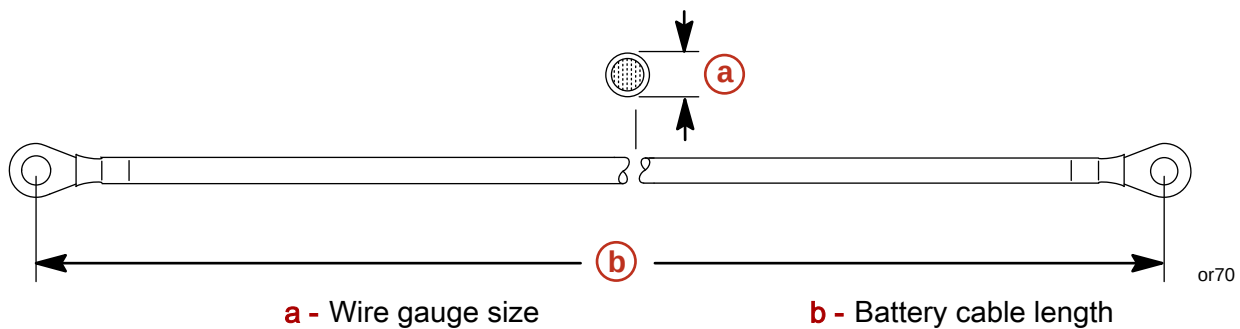


- a** - 14 pin data harness
- b** - Power steering pump harness
- c** - Vessel sensor harness
- d** - Battery cables
- e** - DTS power harness
- f** - 5 Amp fuse

Battery Cable Size For Outboard Models

IMPORTANT: Only use copper battery cables. Do not use aluminum cables for any outboard marine installations.

- If longer battery cables are required, the wire gauge size must increase. See chart following for correct wire gauge size.
- DTS L models are equipped with 3.7 m (12 ft.) cables. DTS XL and XXL models are not shipped with battery cables.



a - Wire gauge size

b - Battery cable length

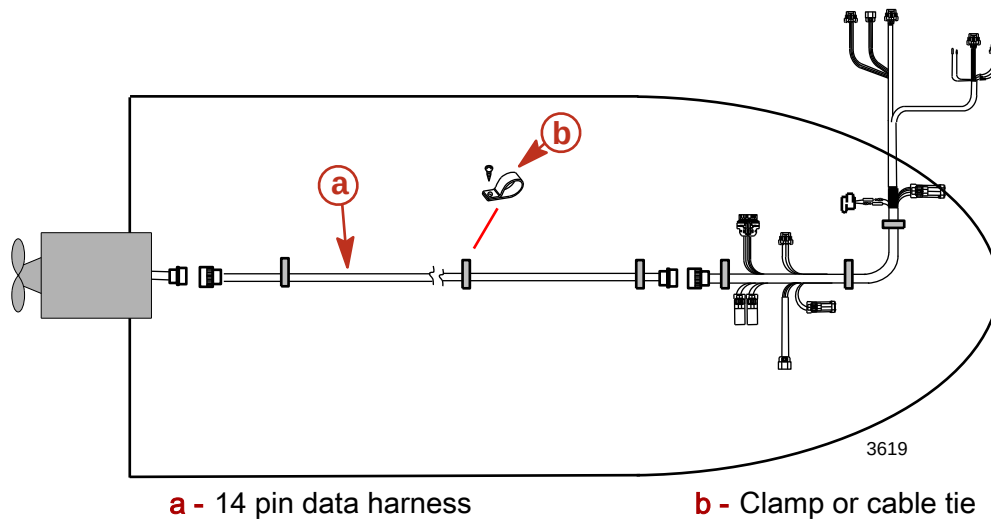
Copper Battery Cable Wire Gauge Size					
Wire Gauge Size Number SAE					
Models		6-25 hp	30-115 hp (except OptiMax)	125-250 hp (except OptiMax)	OptiMax/Verado
Cable Length	2.4 m (8 ft.)	8 ¹ .	6 ¹ .	-	-
	2.7 m (9 ft.)	6	4	-	-
	3.0 m (10 ft.)	6	4	6 ¹ .	-
	3.4 m (11 ft.)	6	4	4	-
	3.7 m (12 ft.)	6	4	4	4 ¹ .
	4.0 m (13 ft.)	6	2	4	2
	4.3 m (14 ft.)	4	2	4	2
	4.6 m (15 ft.)	4	2	4	2
	4.9 m (16 ft.)	4	2	2	2
	5.2 m (17 ft.)	4	2	2	2
	5.5 m (18 ft.)	4	2	2	2
	5.8 m (19 ft.)	4	2	2	2
	6.1 m (20 ft.)	4	2	2	2
	6.4 m (21 ft.)	2	1	2	1
	6.7 m (22 ft.)	2	1	2	1
	7.0 m (23 ft.)	2	1	2	1
	7.3 m (24 ft.)	2	1	2	1
	7.6 m (25 ft.)	2	1	2	1
	7.9 m (26 ft.)	2	1/0	1	1/0
	8.2 m (27 ft.)	2	1/0	1	1/0
	8.5 m (28 ft.)	2	1/0	1	1/0
	8.8 m (29 ft.)	2	1/0	1	1/0
	9.1 m (30 ft.)	2	1/0	1	1/0
	9.4 m (31 ft.)	2	1/0	1	1/0
	9.8 m (32 ft.)	2	1/0	1	1/0
	10.1 m (33 ft.)	2	2/0	1/0	2/0
	10.4 m (34 ft.)	2	2/0	1/0	2/0
	10.7 m (35 ft.)	1	2/0	1/0	2/0
	11.0 m (36 ft.)	1	2/0	1/0	2/0
	11.3 m (37 ft.)	1	2/0	1/0	2/0
	11.6 m (38 ft.)	1	2/0	1/0	2/0
	11.9 m (39 ft.)	1	2/0	1/0	2/0
	12.2 m (40 ft.)	1	2/0	1/0	2/0

1. Standard (original) cable length and wire gauge size.

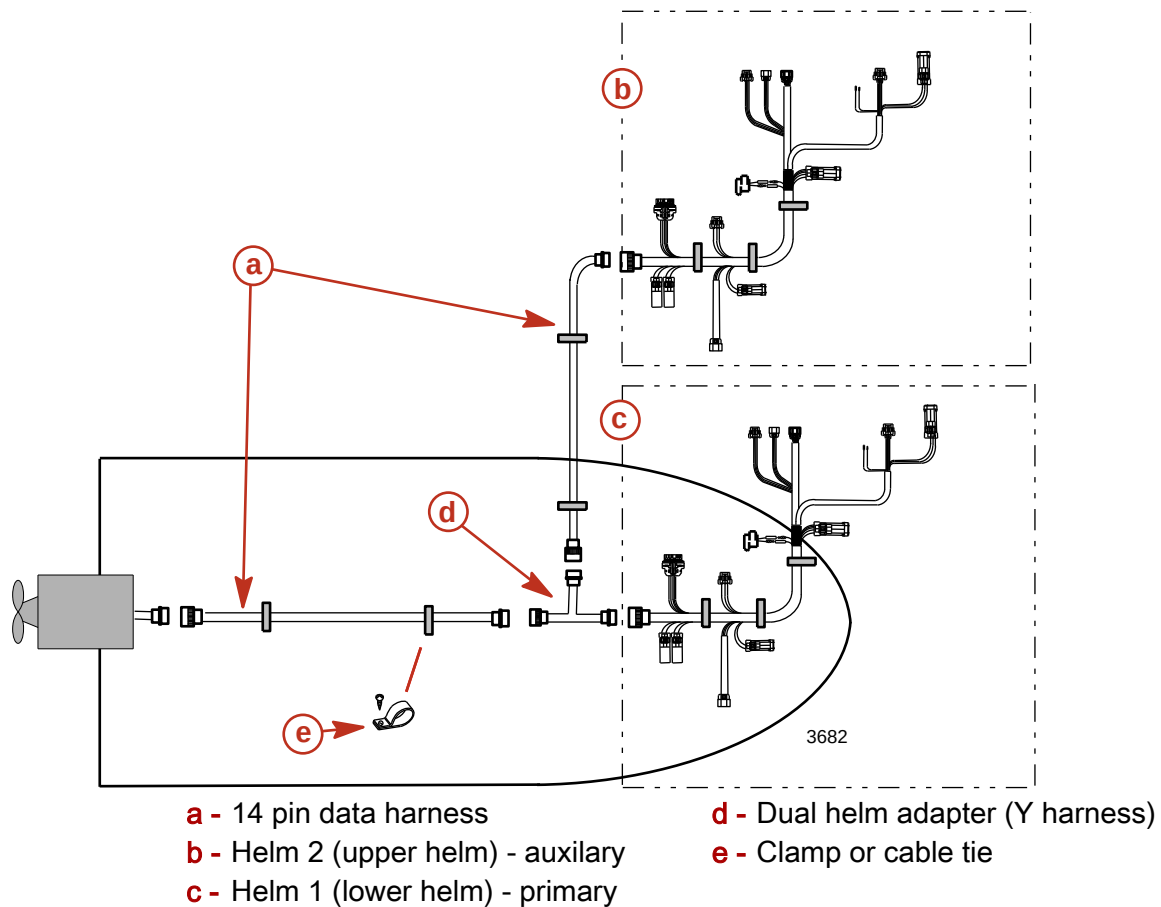
Connecting 14 Pin Data Harness - Single Engine

SINGLE HELM

IMPORTANT: Avoid sharp bends in the harness. Minimum bend radius should be 7.6 cm (3 in.).



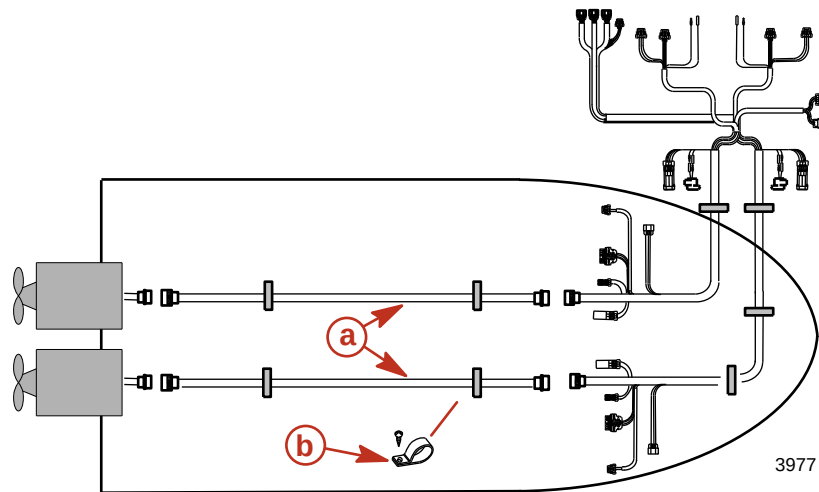
DUAL HELM



Connecting 14 Pin Data Harness - Dual Engine

SINGLE HELM

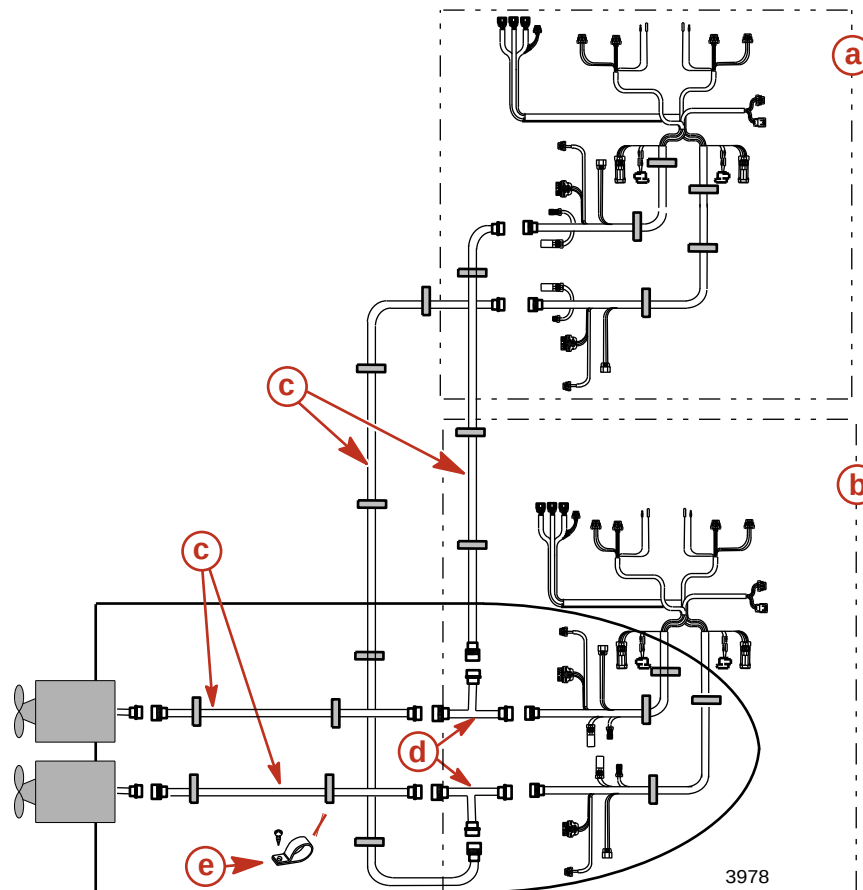
IMPORTANT: Avoid sharp bends in the harness. Minimum bend radius should be 7.6 cm (3 in.).



a - 14 pin data harness

b - Clamp or cable tie

DUAL HELM



a - Helm 2 (upper helm)

b - Helm 1 (lower helm)

c - 14 pin data harness

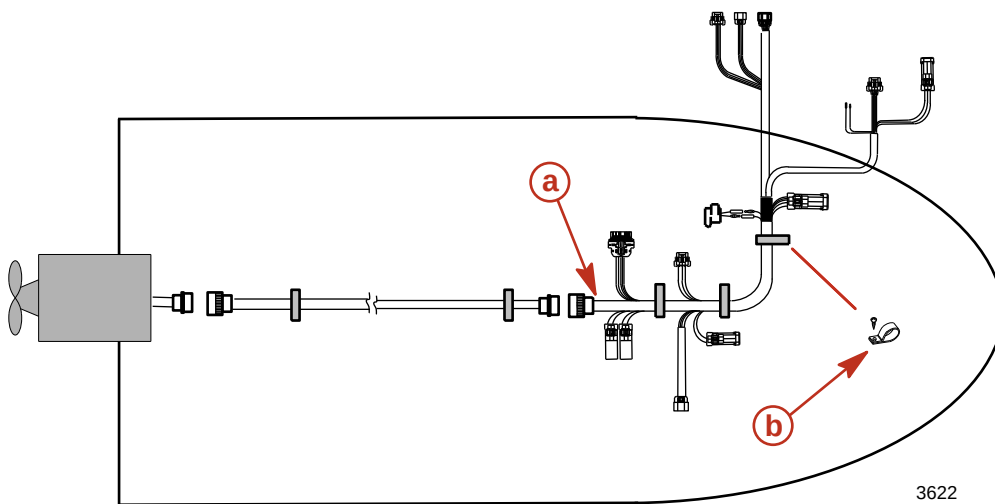
d - Dual helm adapter (Y harness)

e - Clamp or cable tie

Installing DTS Command Module and Harness - Single Engine

HARNESS INSTALLATION

- Locate a routing path for the harness connections so they reach their installation points.
- Inspect the routing path to make sure surfaces are free of any sharp edges or burrs that could cut the harness.
- Fasten and support the harness with clamps or cable ties along the routing path.
- Make sure all connections are tight and seal all unused connectors with weather caps.

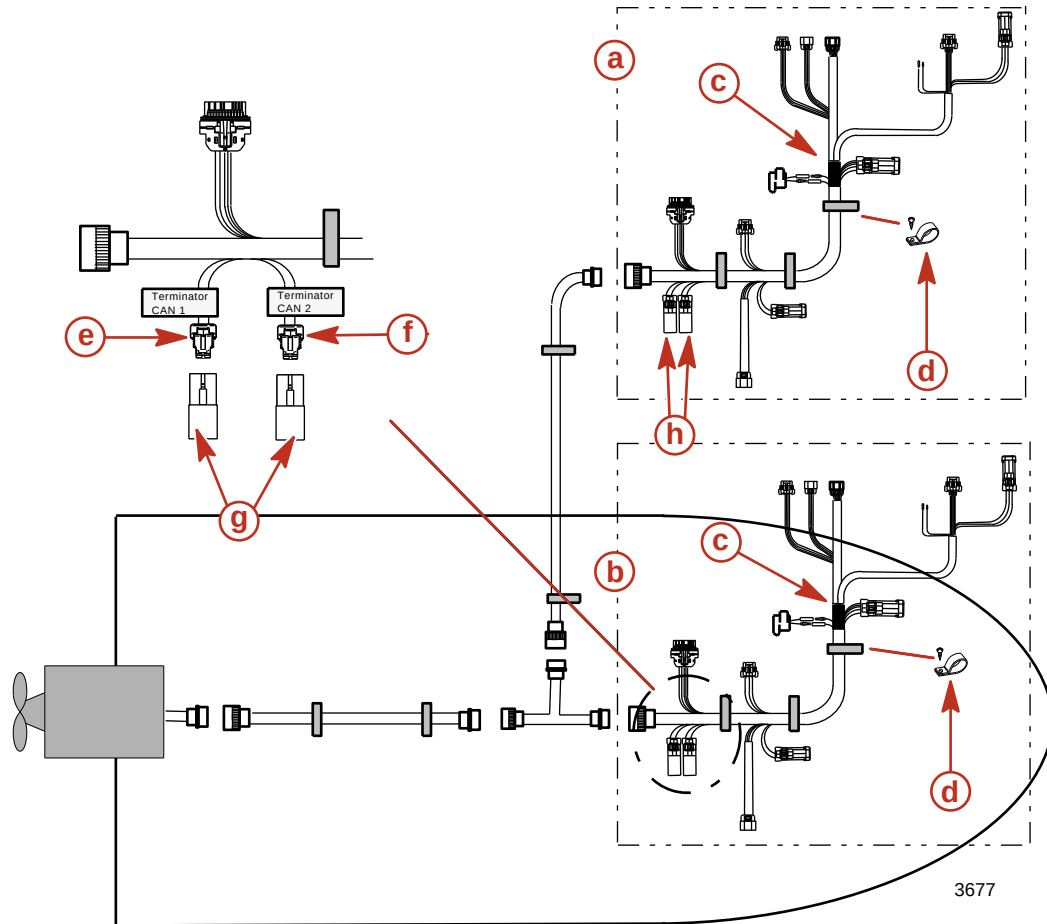


Single Helm Application

a - DTS command module harness

b - Clamp or cable tie

NOTE: For dual helm application - Remove CAN 1 and CAN 2 terminator resistors from helm 1 (helm closest to the engine), and seal connectors with weather caps.



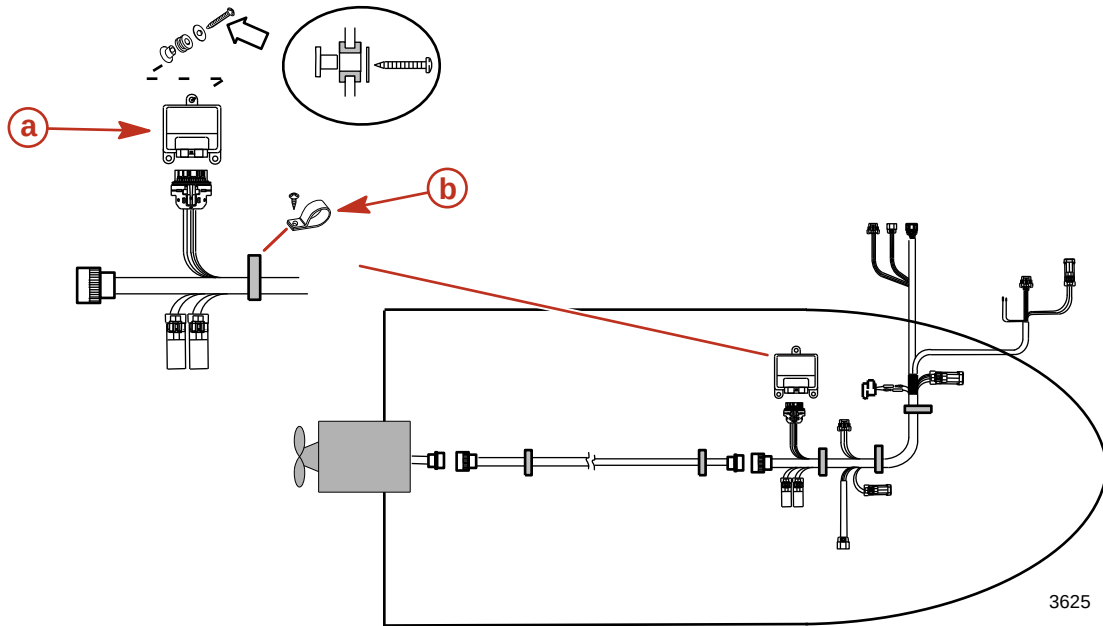
Dual Helm Application

- | | |
|---------------------------------------|---|
| a - Helm 2 (upper helm) | e - CAN 1 connector |
| b - Helm 1 (lower helm) | f - CAN 2 connector |
| c - DTS command module harness | g - Weather caps |
| d - Clamp or cable tie | h - Terminator resistors, blue (CAN1 & CAN2) |

MODULE INSTALLATION

- Although the Command Module connection is watertight, it is recommended that it be mounted in an area that stays relatively dry.
- Mount in an area where the wiring connection will not get stepped on or disturbed.
- Mount in an area that is accessible for troubleshooting and servicing the system.

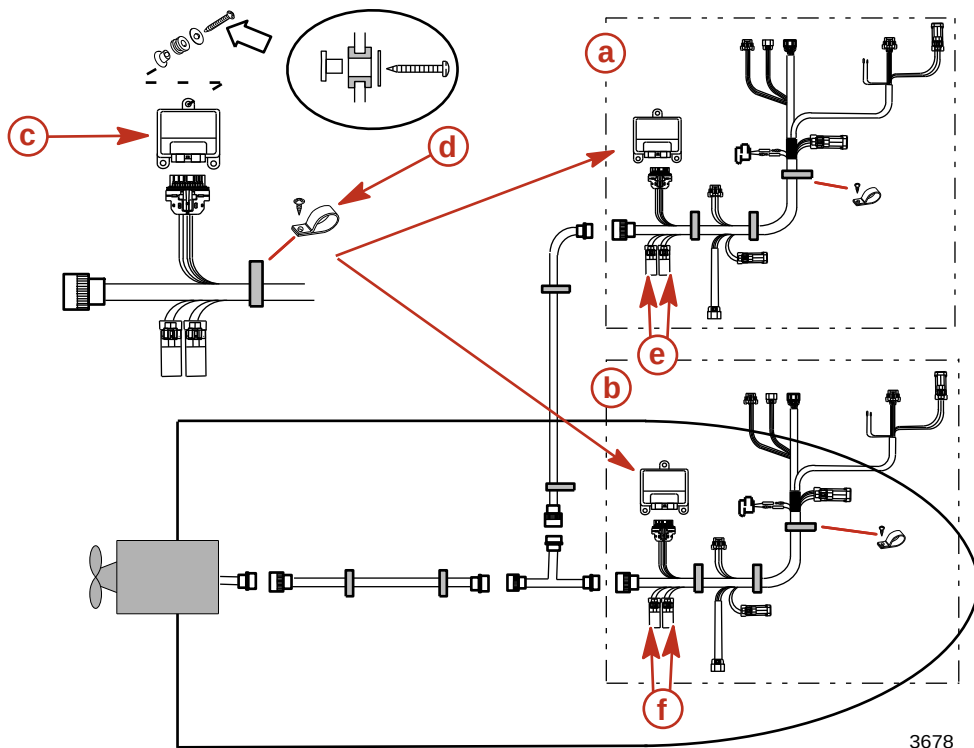
- Ensure the wiring harness connected to the command module will reach all the connection points.



Single Helm Application

a - DTS command module

b - Clamp or cable tie



Dual Helm Application

a - Helm 2

b - Helm 1

c - DTS command module

d - Clamp or cable tie

e - Terminator resistors, blue (CAN1 & CAN2)

f - Weather caps

-

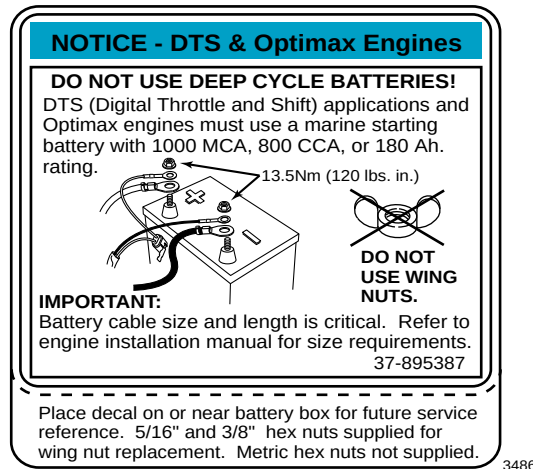
c - CAN link harness

⚠ CAUTION
Hex nuts must be used to secure battery leads to battery posts to avoid loss of electrical power.

- | Description | Nm | lb. in. | lb. ft. |
|-------------|------|---------|---------|
| Hex nuts | 13.5 | 120 | |

90-896580100 JULY 2004

Decal needs to be placed on or near battery box for future service reference. One 5/16 in. and one 3/8 in. hex nut are supplied per battery for wing nut replacement. Metric hex nuts are not supplied.

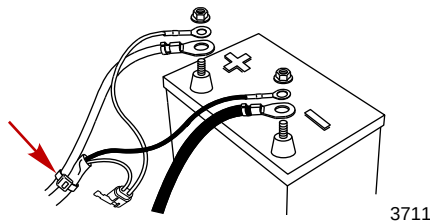


Connecting Battery Cables and DTS Power Harness

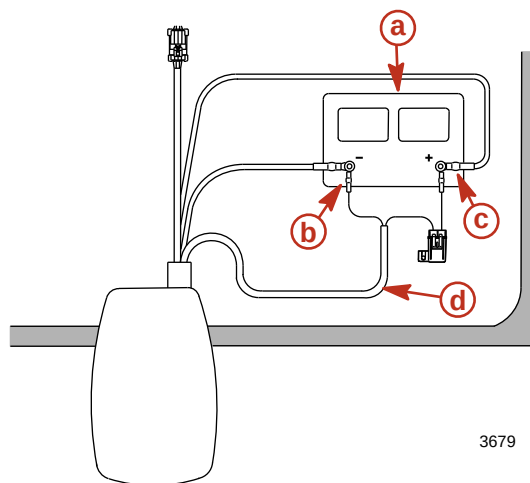
⚠ CAUTION

To avoid the possibility of loss of electrical power due to the DTS power harness connection being pulled off battery, fasten the DTS power harness to one of the battery cables near the battery with cable tie.

- Install DTS power harness directly to the starting battery only.
- Do not extend lead length of harness.
- See accessory manual for optional lead connection kit.



SINGLE ENGINE - BATTERY AT STERN



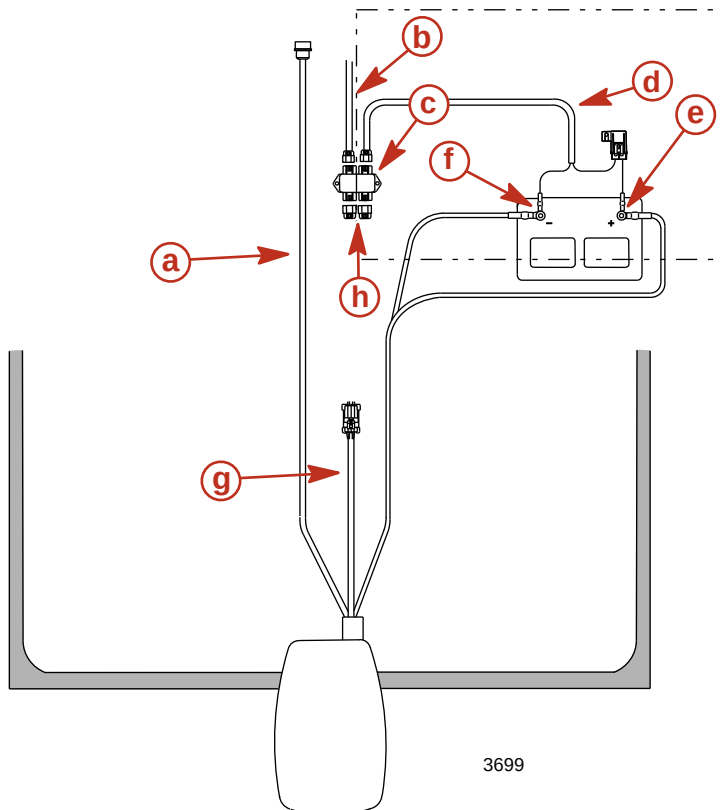
a - Battery

b - Black sleeve (negative)

c - Red sleeve (positive)

d - DTS power harness (provided)

SINGLE ENGINE - BATTERY AT HELM



a - 14 pin data harness

b - DTS command module harness

c - Junction box

d - DTS power harness (optional)

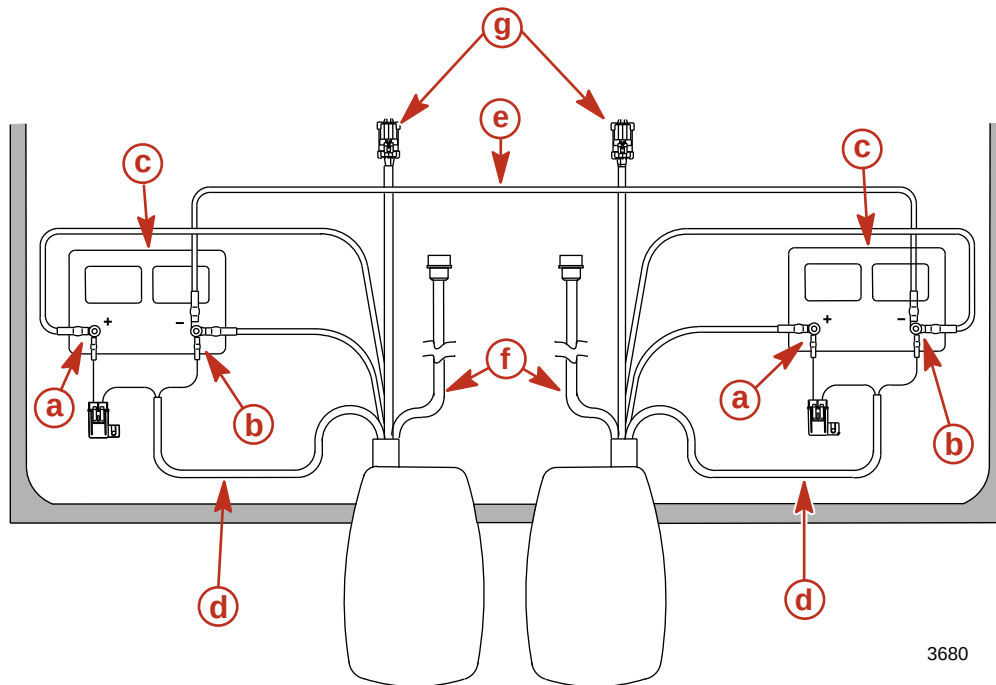
e - Red sleeve (Positive)

f - Black sleeve (Negative)

g - Vessel sensor harness

h - Weather caps

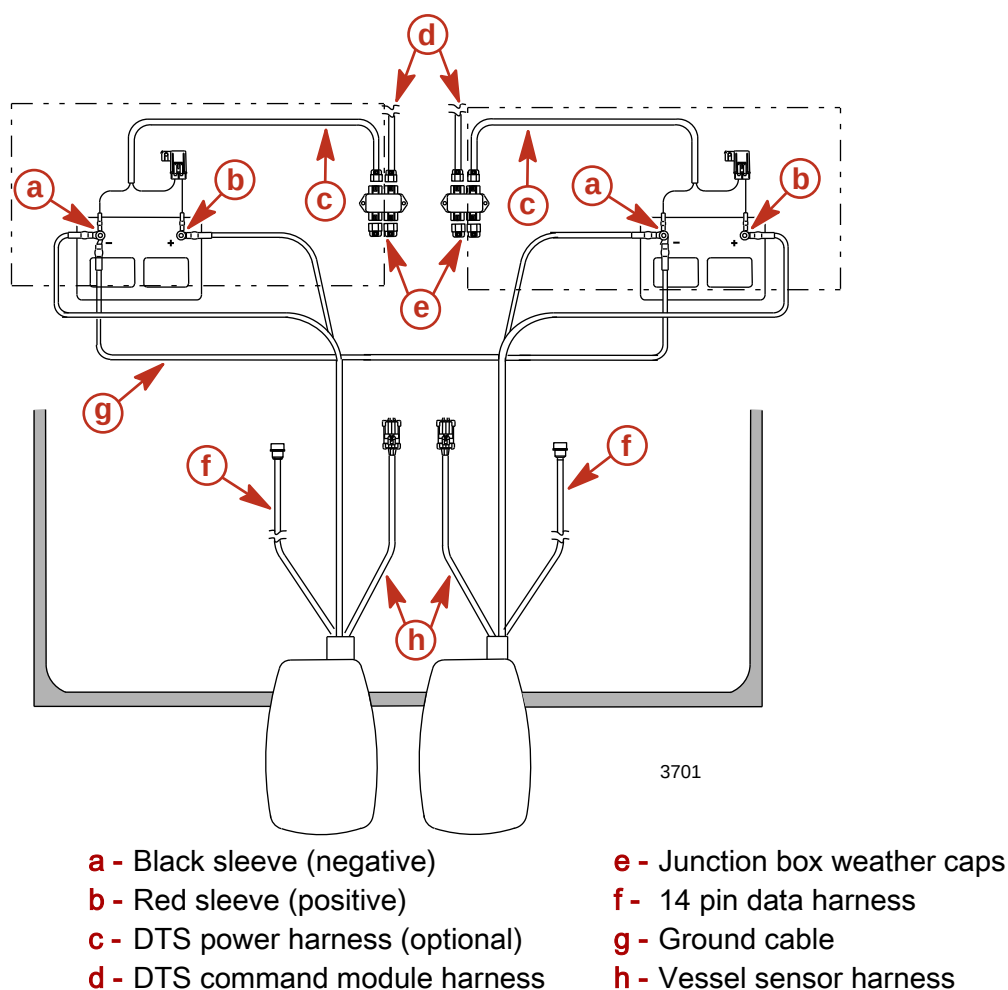
DUAL ENGINE - BATTERY AT STERN



3680

- a** - Red sleeve (positive)
- b** - Black sleeve (negative)
- c** - Battery
- d** - DTS power harness (provided)
- e** - Ground cable
- f** - Data cable
- g** - Vessel sensor harness

DUAL ENGINE - BATTERY AT HELM

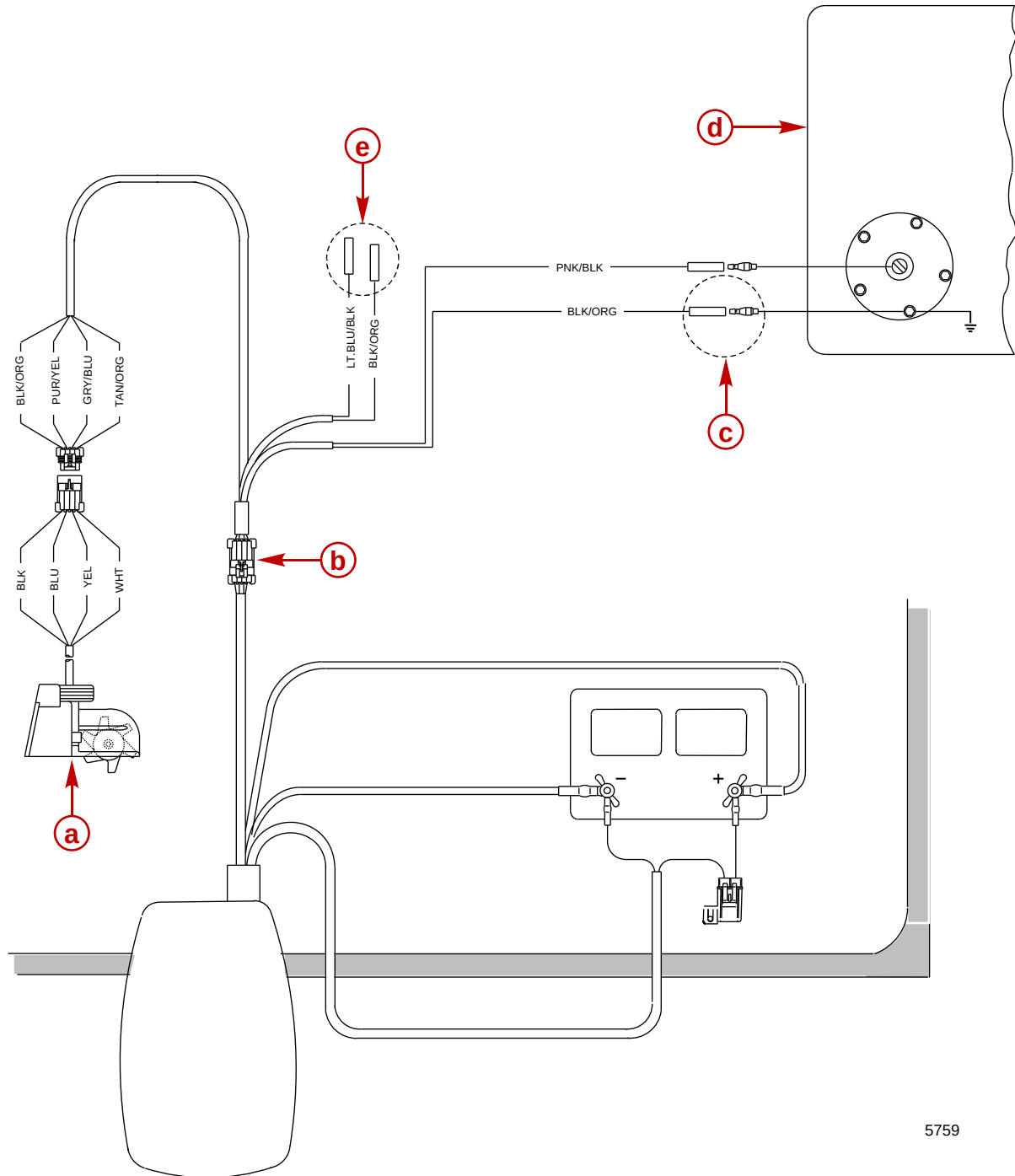


Connecting Fuel Tank And Speed Sensor

IMPORTANT: Do not connect the blk/orn wire (if equipped) to the fuel tank sensor when there is an engine battery ground strap connected to the fuel tank or sender assembly. If not used, plug the unused open bullet connector with rubber plug.

IMPORTANT: If fuel tank is plastic and fuel sensor mounting plate is not connected to battery ground, connect blk/orn wire (if equipped) to fuel sender mounting plate.

IMPORTANT: Metal fuel tanks must be grounded to hull or battery ground in accordance to coast guard regulations.

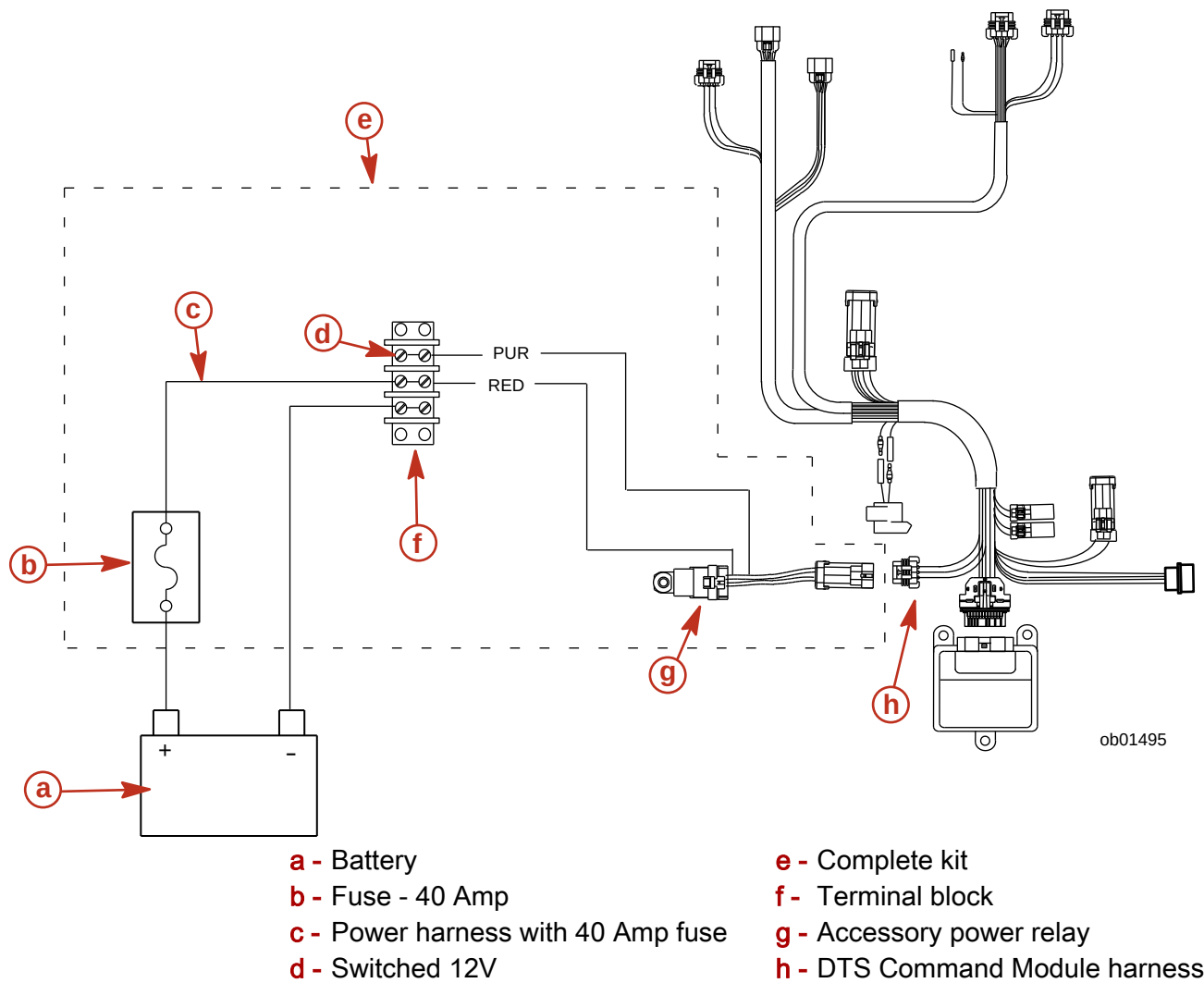


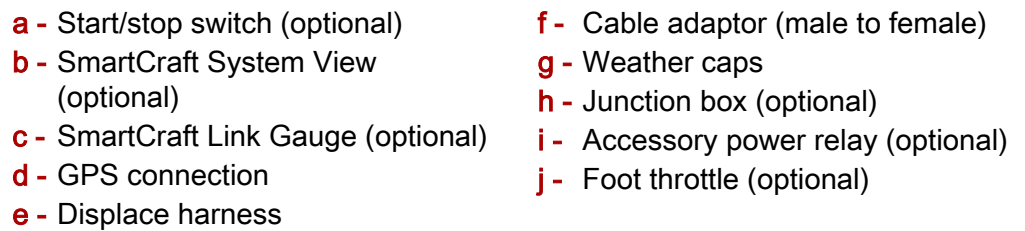
- a** - Paddle wheel kit
- b** - Vessel harness
- c** - Black/orange wire connection, if equipped

- d** - Fuel tank
- e** - To second fuel tank

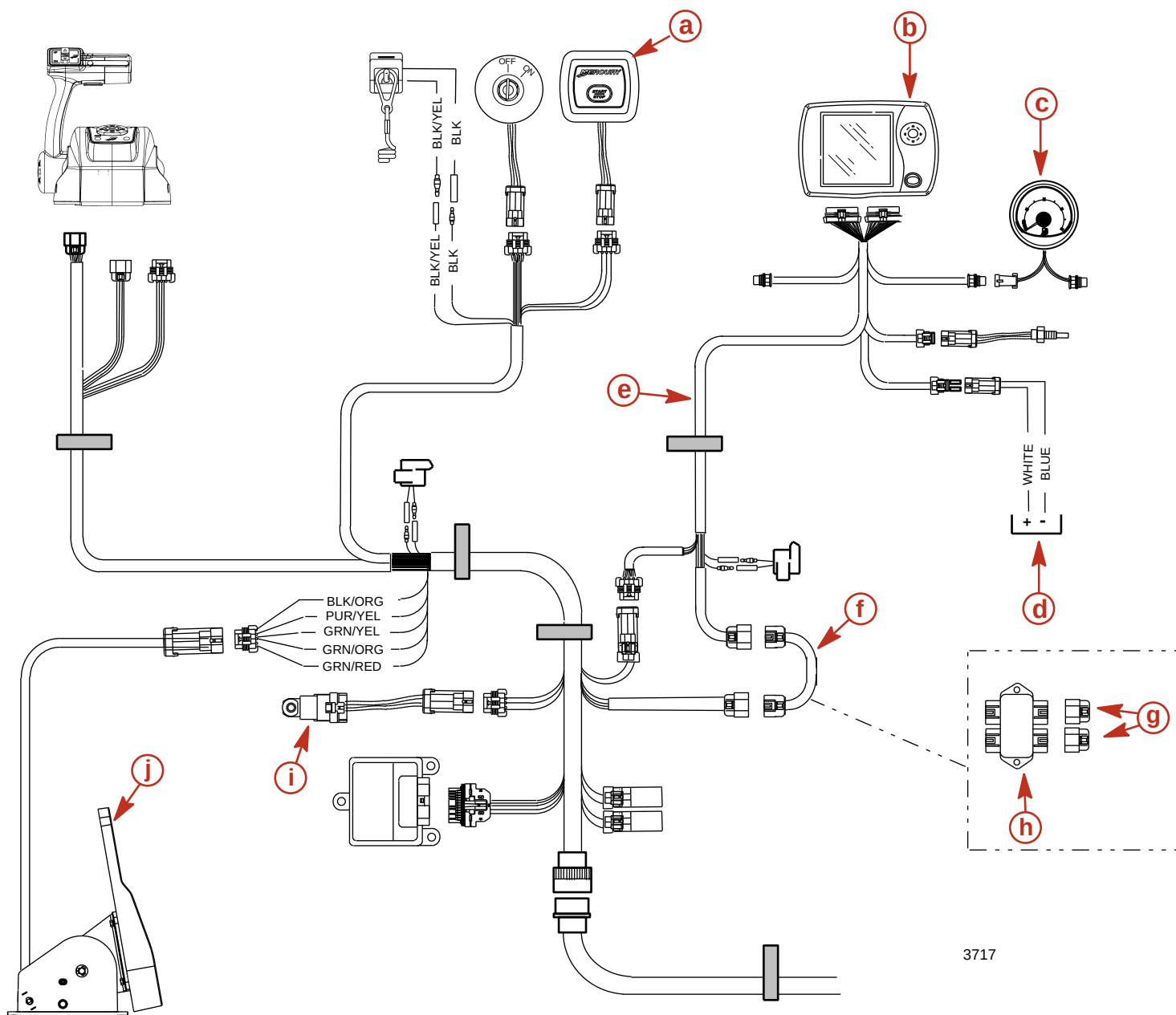
5759

Switched 12V Accessory Connection





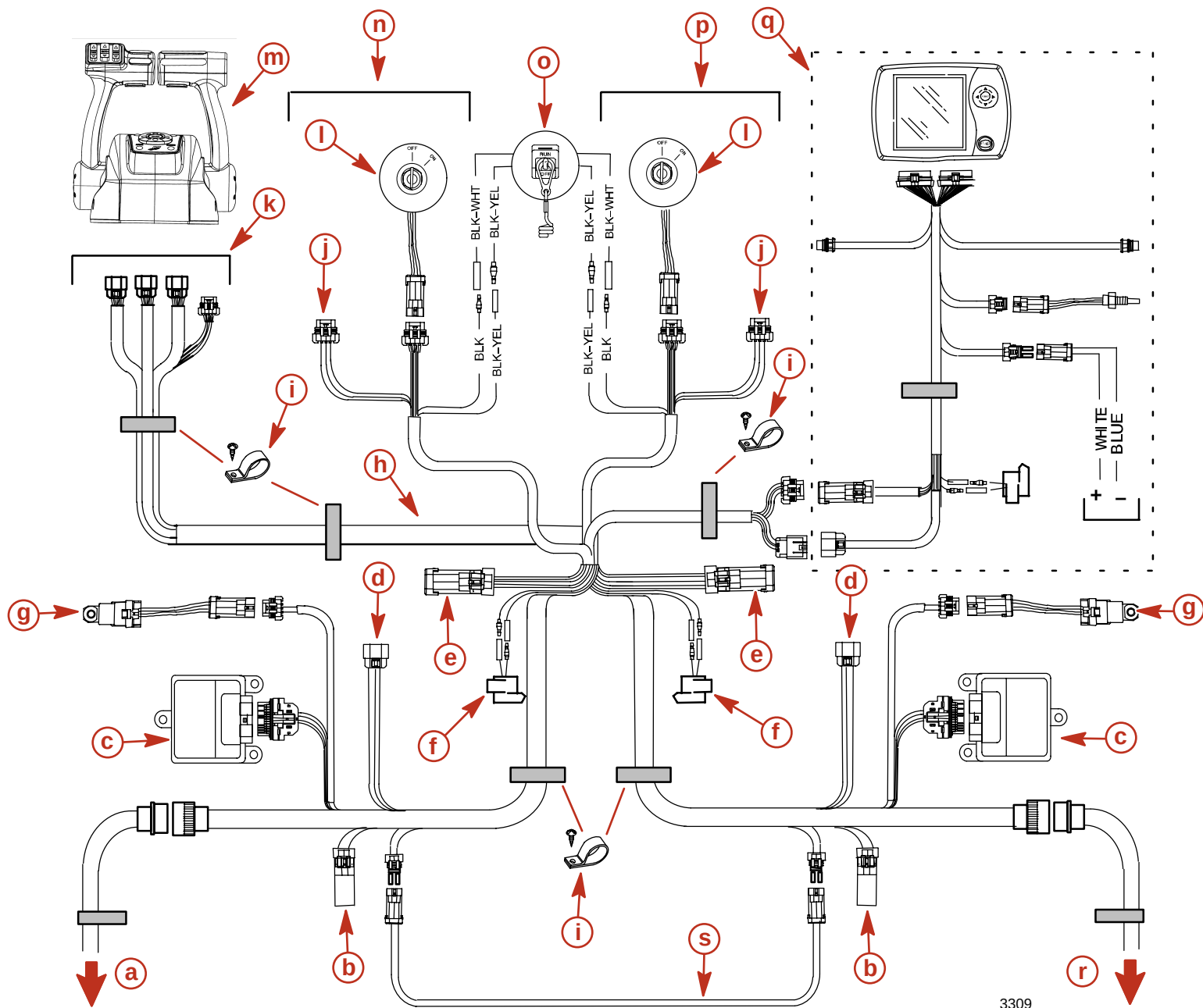
CONSOLE CONTROL



3717

- a** - Start/stop switch (optional)
- b** - SmartCraft System View (optional)
- c** - SmartCraft Link Gauge (optional)
- d** - GPS connection
- e** - Display harness
- f** - Cable adaptor (male to female)
- g** - Weather caps
- h** - Junction box
- i** - Accessory power relay (optional)
- j** - Foot throttle (optional)

DTS Wiring - Dual Engine CONSOLE CONTROL



3309

- | | |
|---|---------------------------------------|
| a - To port engine | k - Remote control connections |
| b - Terminator resistor | l - Key switch |
| c - DTS Command Module | m - Remote control |
| d - Junction box connection (optional) | n - To port engine |
| e - Connector - Zero Effort controls | o - Lanyard stop switch |
| f - Horn | p - To starboard engine |
| g - Accessory power relay (optional) | q - System View (optional) |
| h - DTS Command Module harness | r - To starboard engine |
| i - Clamp | s - CAN link harness |
| j - Connector - stop/start switch (optional) | |

System Wiring Installation Checklist

DATA CABLE

- ☐ Verify the data harness is not routed near sharp edges, hot surfaces or moving parts.
- ☐ Verify data harness is not routed near ignition components (coils, spark plug leads, and spark plugs), high power VHF coax or radios.

JUNCTION BOX (IF EQUIPPED)

- ☐ Verify the data harness is not routed near sharp edges, hot surfaces or moving parts.
- ☐ Ensure the harness connections are fastened within 25.4 cm (10 in.) of the junction box.
- ☐ Verify that all unused receptacles are covered with a weather cap.

NON-MERCURY MARINE SUPPLIED IGNITION KEY SWITCH

- ☐ If a non-Mercury Marine ignition key is used, verify that it passes the ingress protection testing per IEC IP66 specification minimum. Ignition switches must pass this specification.

ELECTRONIC REMOTE CONTROL

- ☐ Ensure Electronic Remote Control (ERC) connections are completed following ERC installation instructions prior to engine operation.

DTS COMMAND MODULE HARNESS

- ☐ Verify that all connectors are properly inserted and locked in their receptacle (remote control, key switch, command module, lanyard stop switch and junction box, if equipped).
- ☐ Verify that while moving the remote control handle (full forward and full reverse) the harness has unobstructed movement (moves freely).
- ☐ Verify that the lanyard stop switch is wired into the system correctly.
- ☐ Verify that the harness is fastened along the routing path.
- ☐ Verify that all unused connectors have weather caps to prevent corrosion.

BATTERY

- ☐ Verify that wing nuts have been replaced with hex nuts, provided.
- ☐ Verify that all engine battery cables are connected to the correct terminals.
- ☐ Verify that the DTS power harness leads are connected to the starting battery and secured with locknuts.
- ☐ Ensure the 5 Amp fuse for the DTS power harness is accessible.

LANYARD STOP SWITCH

- ☐ Verify that the switch is installed.
- ☐ Verify that the switch is connected to the DTS command module harness.

Propeller Installation

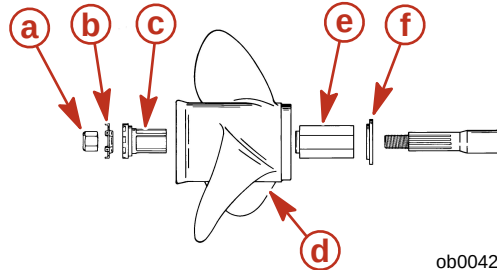
WARNING

When installing or removing propeller, ensure the remote control is in neutral position and the key switch is "OFF". Place a block of wood between the anti-cavitation plate and propeller to prevent accidental starting and to protect hands from propeller blades while removing or installing nut.

1. To aid in future removal of the propeller, liberally coat the propeller shaft splines with one of the following Mercury/Quicksilver products:

Tube Ref No.	Description	Where Used	Part No.
 94	Anti-Corrosion Grease	Propeller shaft splines	92-802867A1
 95	2-4-C Marine Lubricant with Teflon	Propeller shaft splines	92-802859A1

2. **Flo-Torq II Drive Propellers** - Install forward thrust hub, replaceable drive sleeve, propeller, thrust hub, propeller nut retainer, and propeller nut onto the shaft.

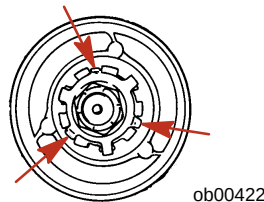


- a** - Propeller nut
b - Propeller nut retainer
c - Thrust hub
d - Propeller
e - Replaceable drive sleeve
f - Forward thrust hub

3. Place a block of wood between gearcase and propeller and torque nut to specification.

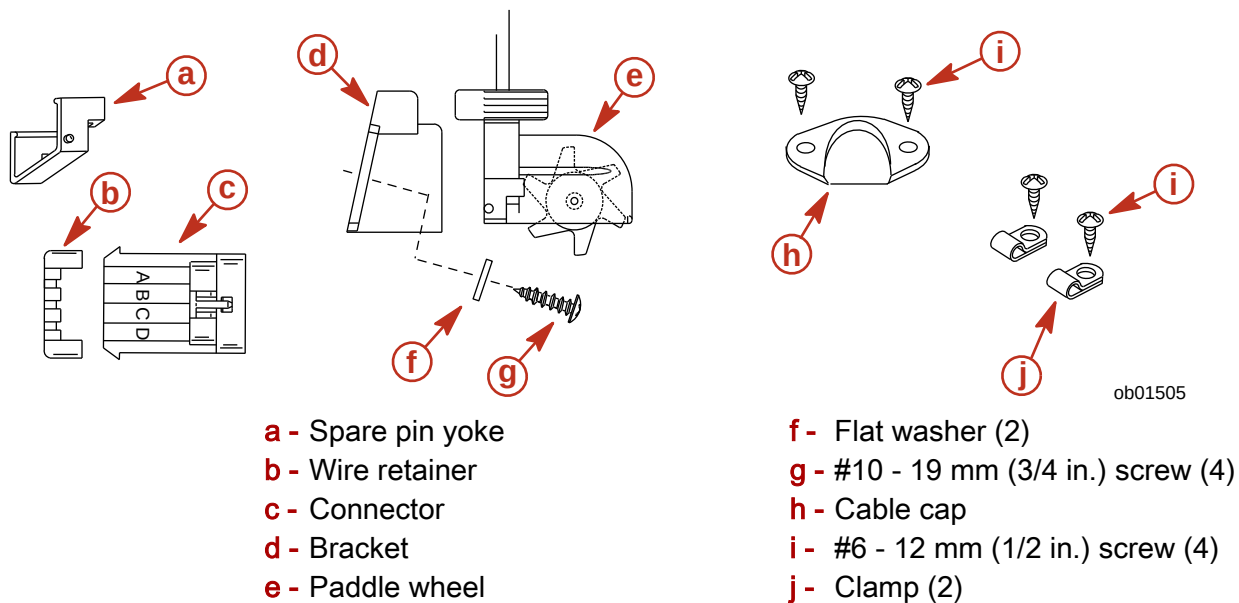
Description	Nm	lb. in.	lb. ft.
Nut	75		55

4. Secure propeller nut by bending three of the tabs into the thrust hub grooves.



Paddle Wheel Speed Sensor Installation (If Equipped)

Parts Provided

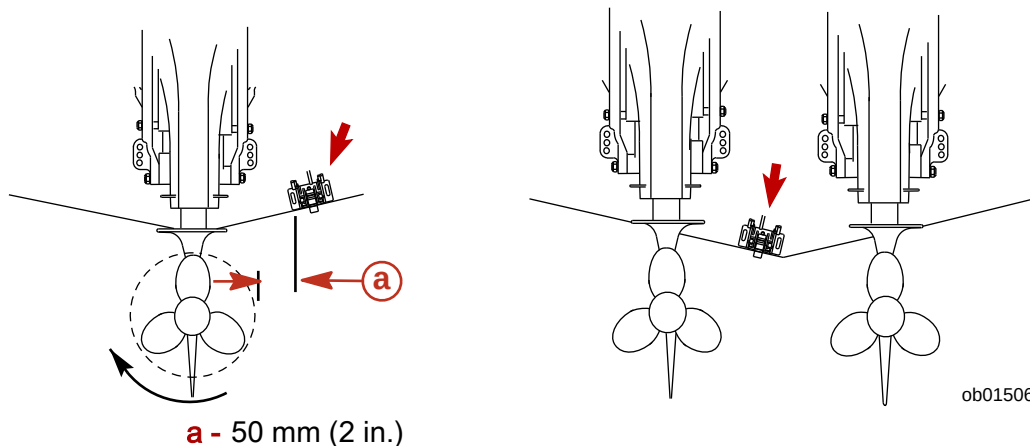


Selecting Location

Single engine installation - Mount paddle wheel on the transom where the propeller blade is rotating downward. Usually the right (starboard) side to minimize cavitation. If feasible, mount at least 50 mm (2 in.) beyond the swing radius of the propeller.

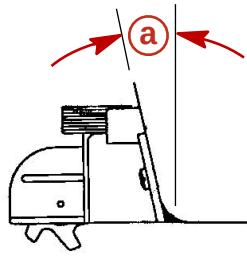
Dual engine installation - Mount the paddle wheel between the engines as close to the center line (keel) of the boat as possible. On slower, heavier displacement boats, however, positioning it farther from the keel is acceptable.

NOTE: Do not mount the paddle wheel directly behind any stakes, ribs, intakes or outlets for live wells or any protrusion that may cause turbulence or cavitation.

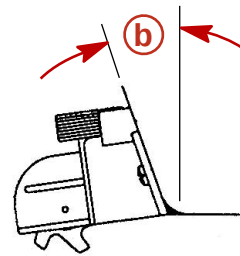


Transom Angle Requirements

Standard 13° to 20° transoms - No special adjustment required.



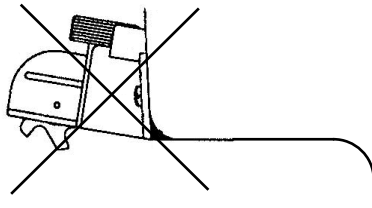
a - 13° transom angle



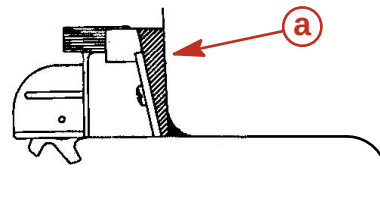
ob01507

b - 20° transom angle

Stepped or undercut transom with 3 angles - A small shim of tapered plastic, metal or wood must be fabricated and installed as shown. Mount the paddle wheel on the step for best performance.



a - Shim



ob01508

Installing Bracket

1. Cut out the template. At the location selected, tape the template to the transom. Make sure the black dotted line on the template is aligned with the transom bottom edge, as shown.

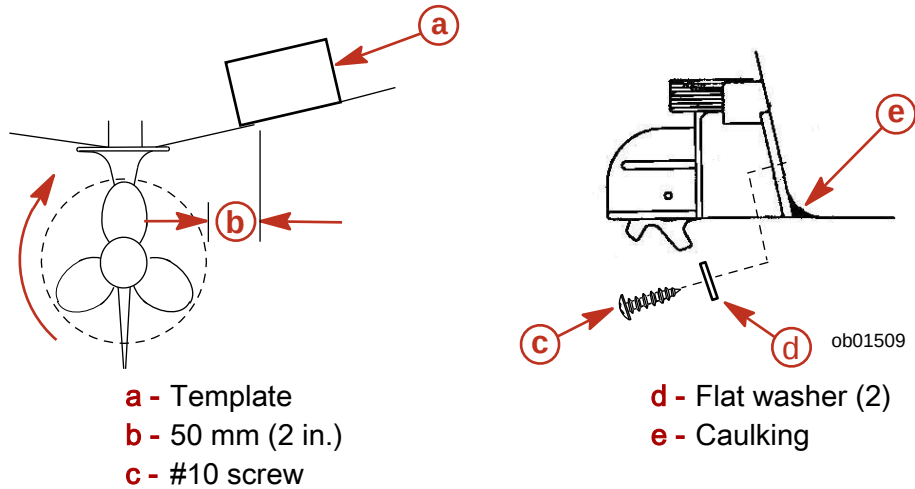
NOTE: The mounting template provided is located on the last page of this instruction sheet.

2. Using a #28 or 9/64 in. bit, drill two 22 mm (7/8 in.) deep holes where indicated on the template. To prevent drilling too deeply, wrap masking tape around the drill bit 22 mm (7/8 in.) from the point end of drill bit.

NOTE: In fiberglass hulls, first chamfer the gelcoat using a 6 mm (1/4 in.) drill; drilling about 15 mm (1/16 in.) deep to prevent surface cracks.

3. To prevent water seepage into the transom, apply a marine sealer (such as RTV) to the two #10 screws provided. Using the washer provided, attach and tighten the bracket to the hull making sure the bracket is flush with the underside of the hull.

4. Fill any gap between the housing and the transom with a caulking material, as shown. Using a putty knife, smooth the surface to ensure proper water flow.



Routing the Cable

DRILLING HOLE THROUGH TRANSOM (OPTIONAL)

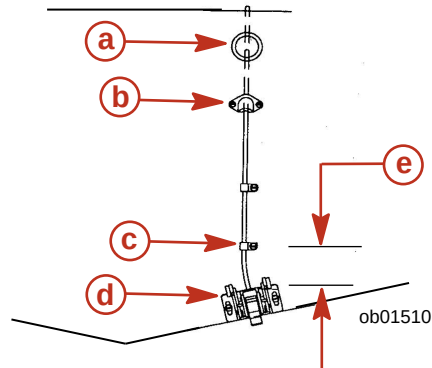
1. Select a transom location for the hole above the water line that does not interfere with other cables and controls.
2. Drill a 15 mm (5/8 in.) diameter hole.
3. Route the cable through the drilled hole. Seal the transom hole with silicone (RTV) or a comparable marine sealer after the cable has been routed through.

NOTE: The hole for the first clamp should be 25 mm (1 in.) above the paddle wheel. The hole for the second clamp should be positioned halfway between the first clamp and the cap covering the transom hole drilled for the cable.

4. Using a 2.8 mm (7/64 in.) bit, drill holes for the clamps and cap approximately 13 mm (1/2 in.) deep.
5. Apply silicone sealer (RTV) or a comparable marine sealer to the screw threads, install the cable clamps and feed the cable through cable cap.

WITHOUT DRILLING HOLE THROUGH TRANSOM (OPTIONAL)

Route the cable over the transom or through a drain hole that is above the water line.

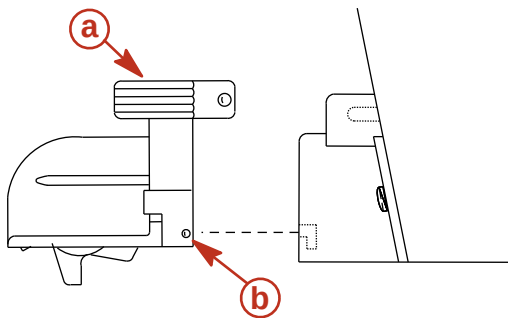


- a** - Splash well drain hole
- b** - Cable cap
- c** - Cable clamp
- d** - Paddle wheel assembly
- e** - Distance between first cable clamp and top of paddle wheel - 25.4 mm (1.0 in.)

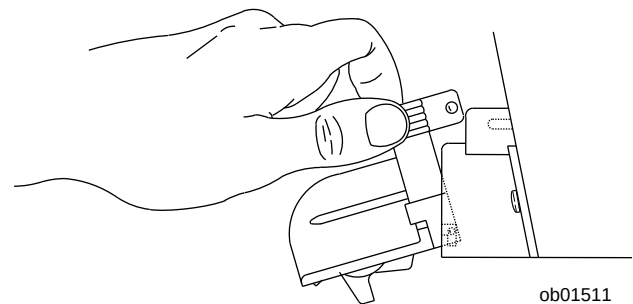
Installing and Removing the Paddle Wheel

Installation - Slide the pins into the slots in the bracket and snap the tabs into place.

Removal - squeeze open (unlock) the tabs and pull on the paddle wheel.



a - Tabs

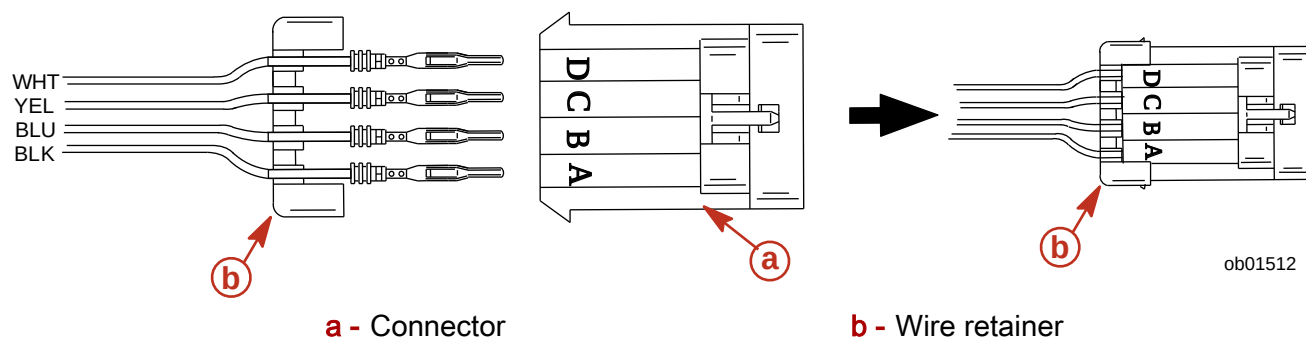


b - Pins

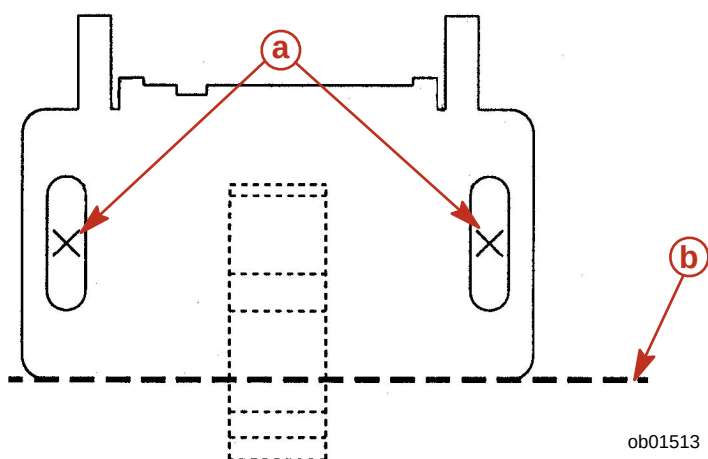
Wiring Connections

IMPORTANT: Before making wire connections, make sure wires are routed through the transom.

NOTE: Wires can only be pushed into the connector one way. Align the wire terminal with the tabs inside the connector. Have the wiring routed through the transom. Push each wire terminal into its respective location in the connector. Push wire in until they snap into place. Secure wires into connector with the wire retainer.



Template - Paddle Wheel Speed Sensor



Electrical

Section 2A - Ignition

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**2
A**

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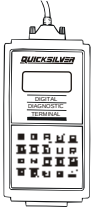
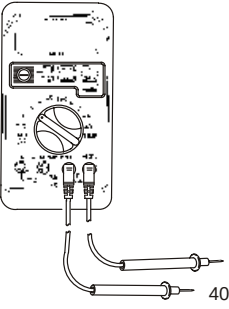
Ignition Specifications

Ignition Specifications	
Full Throttle RPM (All Models)	5800 - 6400
Idle RPM (All Models)	550
Ignition Type	Digital Inductive
Spark Plug Type	NGK ILFR6G
Spark Plug Gap	0.8 mm (0.031 in.)
Spark Plug Hex Size	16 mm
Spark Plug Torque	27.5 Nm (19 lb. ft.)
Spark Plug Hole Size	14 mm
Firing Order	1-3-5-6-4-2
Ignition Timing @ Idle	Not Adjustable; Controlled by PCM
Ignition Timing @ WOT	Not Adjustable; Controlled by PCM
PCM Over Speed Limiter	Activates @ 6500 RPM

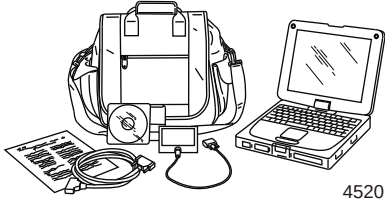
Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 136	Lubriplate SPO 255	Camshaft position sensor O-ring	Obtain Locally

Special Tools - Ignition System

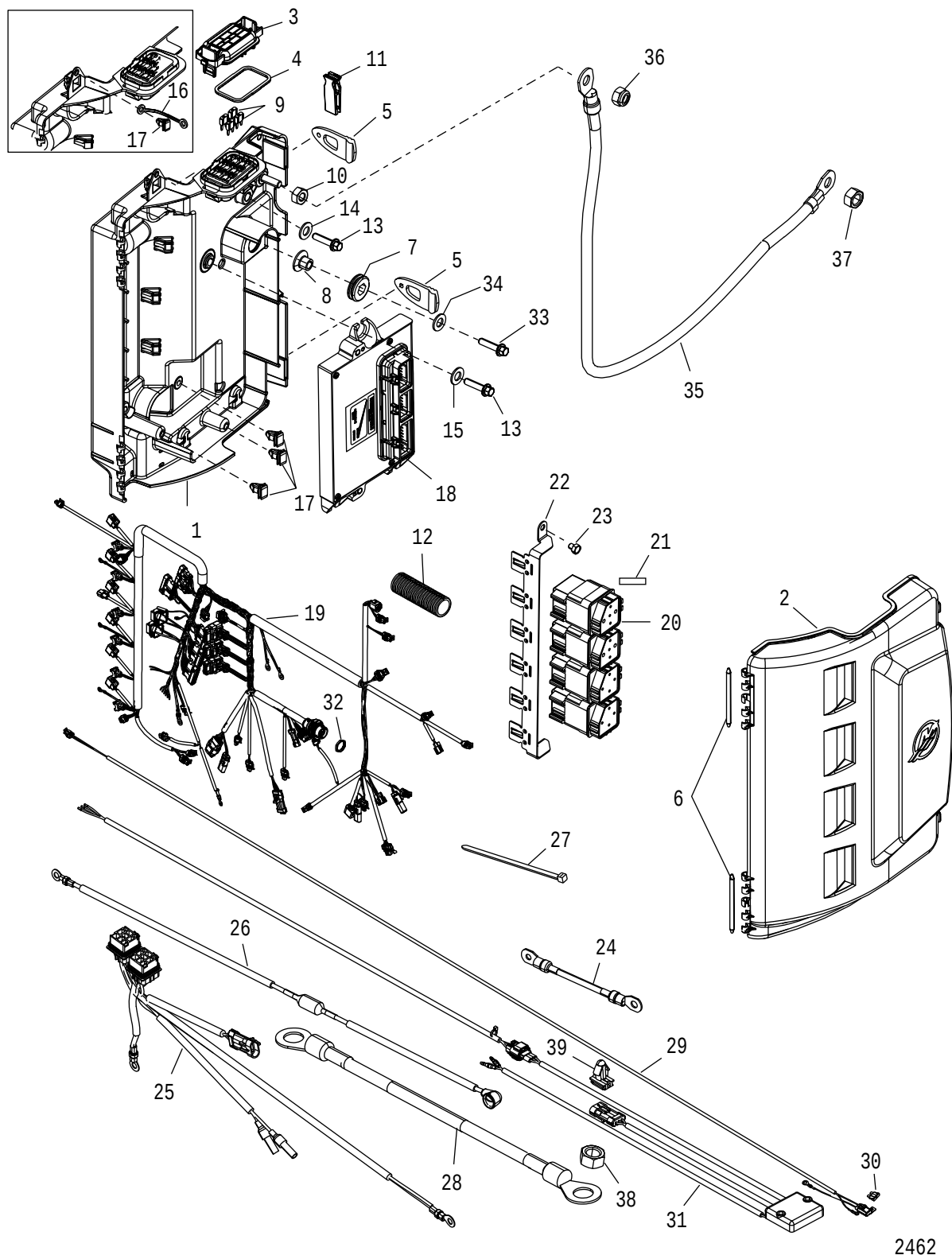
Digital Diagnostic Terminal (DDT)  4011	91-823686A2 Displays and stores real time sensor outputs. Performs self-test procedures on select engine electrical systems
DMT 2004 Digital Tachometer Multi-meter  4014	91-892647A01 Measures RPM, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.
Software Cartridge  4013	91-880118A20 Used with Digital Diagnostic Terminal 91-823686A2

Digital Diagnostic Terminal Reference Manual	90-881204003
 6160	Lists procedures, specifications and sensor outputs that can be monitored by using the Digital Diagnostic Terminal
Adaptor Harness	84-822560A13
 5826	Data link harness between engine and Computer Diagnostic System (CDS) or Digital Diagnostic Terminal (DDT)
Extension Cable 3.05 mm (10 ft.)	84-825003A1
 4012	Data link extension harness between adaptor harness and Digital Diagnostic Terminal
Flywheel Puller/Lifting Ring	91-895343T01
 4733	Removes flywheel and used to install outboard on boat
Flywheel Holding Tool	91-52344
 4738	Holds and/or turns the flywheel while making engine repairs, also used to torque the flywheel or the engine coupler.

Computer Diagnostic System	Order through SPX
 4520	Monitors all electrical systems for proper function and diagnostic purposes. NOTE: For additional information, pricing or to order the Computer Diagnostic System contact: SPX Corporation 28635 Mound Rd. Warren, MI 48092 or call: USA - 1-800-345-2233 Canada - 800-345-2233 Europe - 49 6182 959 149 Australia - (03) 9544-6222

Notes:

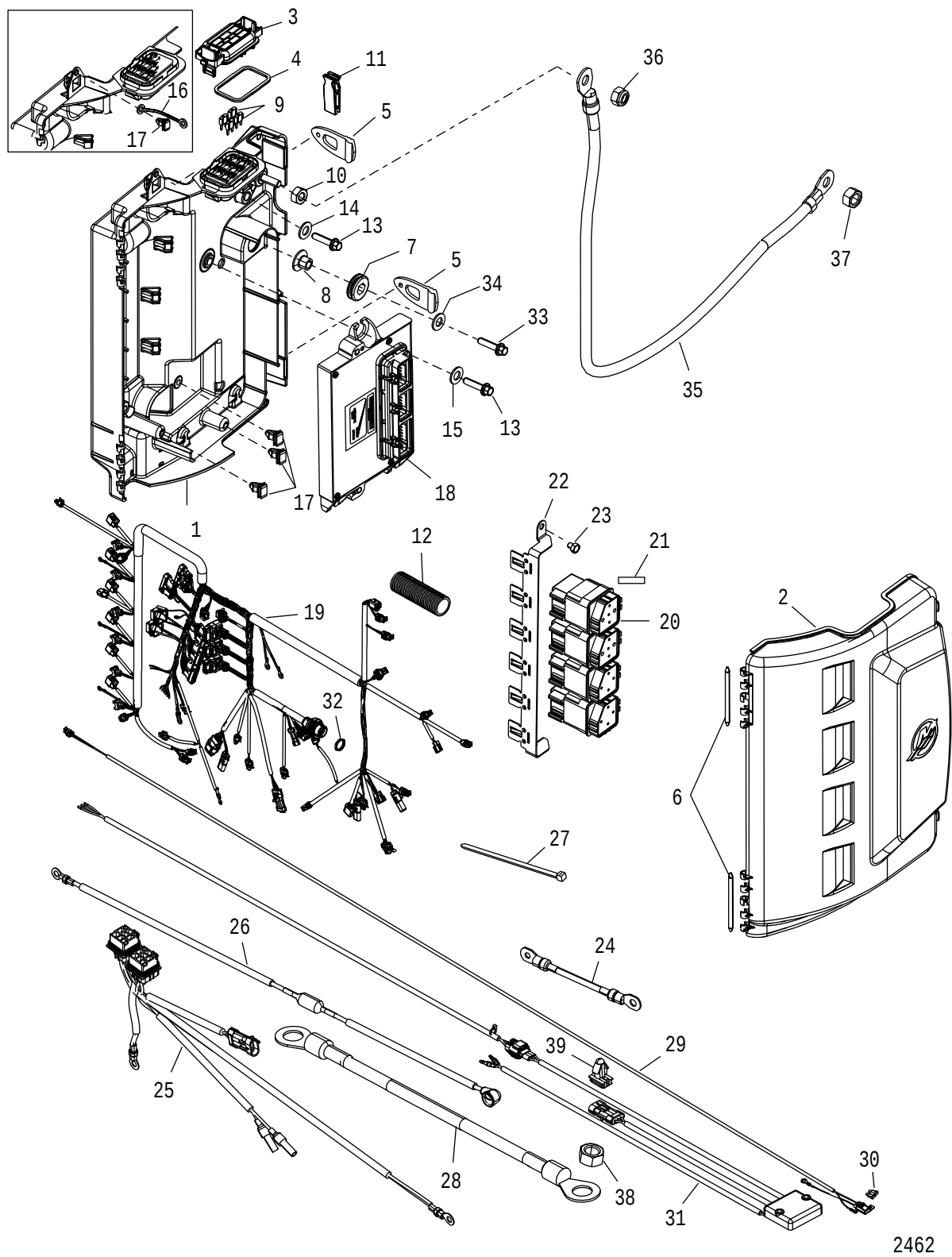
Electrical Components (200 through 275 HP In-line 4-Stroke)



Electrical Components (200 through 275 HP In-line 4-Stroke)

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Base, Electrical box			
2	1	Cover, Fuse box			
3	1	Fuse cover			
4	1	Seal			
5	2	Strap			
6	2	Hinge pin			
7	1	Grommet			
8	1	Bushing			
9	7	Fuse, Mini (20 amp)			
10	1	Nut, M8	17	150	
11	1	Extractor, Fuse			
12	1	Conduit			
13	2	Screw, M8 x 13	9	80	
14	1	Washer			
15	1	Washer			
16	1	Strap, Cover			
17	5	Clip			
18	1	PCM			
19	1	Harness, Engine			
20	4	Trim relay			
21	4	Decal			
22	1	Bracket			
23	2	Screw, M5 x 6	4.5	40	
24	1	Starter cable, 8-1/2 in.			
25	1	Trim harness			
26	1	Fuse harness			
27	6	Cable tie, 8-1/2 in.			
	4	Cable tie, 8 in.			
28	1	Battery cable, Negative (long)			
29	1	CHI power harness			
30	1	Fuse, 5 ampere			
31	1	Harness, DBW boat adaptor			
32	1	Nut	7.5	67	
33	1	Screw, M8 x 35	24		17.5
34	1	Washer			
35	1	Battery cable, Positive (long)			
36	5	Nut, M8	17	150	12.5
37	1	Nut, 3/8-16, Battery cable - positive	13.5	120	
38	1	Nut, 5/16-18, Battery cable - negative	13.5	120	
39	1	Clip			

Electrical Components (200 through 275 HP In-line 4-Stroke)



Troubleshooting without Digital Diagnostic Terminal or Computer Diagnostic System

Troubleshooting without the DDT or Computer Diagnostic System (CDS) is limited to checking resistance on some of the sensors.

Typical failures usually do not involve the PCM. Connectors, set-up and mechanical wear are most likely at fault.

- Verify ignition coils are securely installed (pushed in) into the spark plugs.
- The engine may not run or may not run above idle with the wrong spark plugs installed.
- Swap ignition coils to see if the problem follows the coil or stays with the particular cylinder.

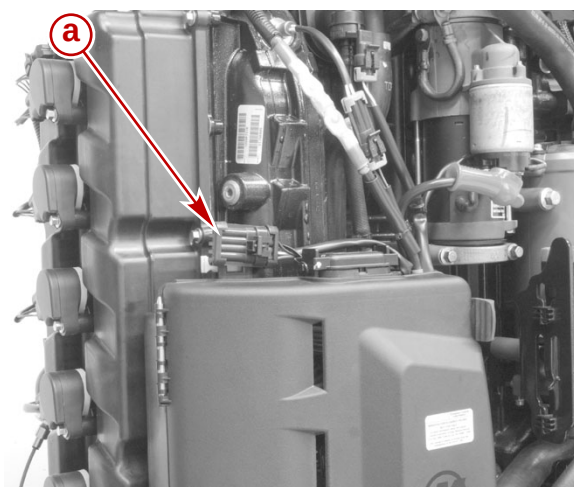
IMPORTANT: Disconnecting a sensor while the engine is running may result in a fault recording in the PCM Fault History. Use the DDT or CDS to view and clear the PCM fault history when troubleshooting/repair is completed.

- If all cylinders exhibit similar symptoms, the problem is with a sensor or harness input to the PCM.
- If problem is speed related or intermittent, it is probably connector or contact related. Inspect connectors for corrosion, loose wires or pins pushed back into connector. Verify connectors are properly seated.
- Inspect harness for damage: pinched or cut wires and chaffing.
- Secure grounds and all connections involving ring terminals (coat with Liquid Neoprene).
- Inspect fuel pump harness connector for corrosion, loose wires or pins pushed back into connector.
- Check fuel pump pressure.

Troubleshooting with the Computer Diagnostic Terminal (CDS) and Digital Diagnostic Terminal (DDT)

The Computer Diagnostic Terminal (CDS) and Digital Diagnostic Terminal (DDT) are designed to help technicians diagnose and repair Mercury Marine 2 and 4 cycle engines.

Attach the diagnostic cable to the PCM diagnostic connector and plug in the software cartridge. This will enable the technician to monitor sensors and PCM data values including status switches.



5483

a - Diagnostic terminal connector (for CDS and DDT)

The PCM program can help diagnose intermittent engine problems. It will record the state of the engine sensors and switches for a period of time and then can be played back to review the recorded information.

Refer to the Computer Diagnostic System or Digital Diagnostic Terminal reference manual for complete diagnostic procedures.

Computer Diagnostic System (CDS)	Order through SPX
Digital Diagnostic Terminal (DDT)	91-823686A2

Troubleshooting Guide

1. Engine Cranks But Will Not Start	
Cause	Action
1.0 Weak battery or bad starter motor, battery voltage drops below 11 volts while cranking (PCM cuts out below 8 volts) (Fuel pump requires 9 volts)	Replace/recharge battery Inspect condition of starter motor Check condition of battery terminals and cables
1.1 No fuel	Key-on engine to verify that fuel pump runs for 5 seconds and then turns off. If no fuel is available, fuel pump will run for as long as 180 seconds before shutting off NOTE: Running fuel pump for up to 180 seconds due to lack of fuel will damage fuel pump.
1.2 Low fuel pressure	Measure fuel pressure (valve on top of fuel rail) Fuel pressure should be 281 - 345 kPa (41 - 50 psi)
1.3 Flywheel key sheared or flywheel key not installed	Remove flywheel and inspect
1.4 Blown fuse	Inspect 20 ampere fuse in fuse holder and replace if blown
1.5 Main power relay not functioning	Listen for relay to click when the key switch is turned on. If relay does not click, inspect harness and connector pins for damage
1.6 Spark plugs ¹ .	Remove fuel pump fuse (FUEL) fuse holder. Remove spark plugs from each cylinder Install Spark Gap Tester 91-63988A1 to each ignition coil. Crank engine or use DDT or CDS output load test for each ignition coil and observe spark. If no spark is present, replace appropriate ignition coil. If spark is present, replace spark plugs
1.7 PCM not functioning	Fuel injection system; Listen for injector ticking when cranking or connect spare injector to each respective harness Ignition system: Install spark gap tool between ignition coil and engine ground. Check for purple/white colored spark while cranking engine Check for battery voltage (red/yellow lead) at ignition coils Check for blown 20 ampere fuse Check for battery voltage to fuse from main power relay (purple lead) Check for shorted stop wire (black/yellow lead). Power supply: Inspect and clean remote control male and female harness connector Defective PCM.
1.8 Crank position sensor not functioning	Check that magnet is not missing from end of sensor Perform ohm resistance check of sensor - (300 to 350 ohms between red and white leads) Defective crank position sensor.
2. Engine Will Not Crank	
Cause	Action
2.0 Defective PCM	Use Computer Diagnostic System (CDS) to determine proper functioning of ETC
2.1 Defective main power relay	Use Computer Diagnostic System (CDS) to determine proper functioning of main power relay
2.2 Main power relay fuse blown	Check for blown 20 ampere fuse
2.3 Lanyard stop switch in wrong position	Reset lanyard stop switch

1. Spark jumping the gap from all 6 cylinders at the same time in the spark gap tool may cause interference in the PCM. The interference may cause the absence of spark on some cylinders and a false diagnosis of a no spark condition. Crank the engine over with only one spark plug wire connected to spark gap tool at a time or use the DDT or CDS to fire one cylinder at a time

3. Engine Cranks, Starts and Stalls	
Cause	Action
3.0 Low fuel pressure in fuel rail	See 1.3
3.1 Abnormally high friction in engine	Check for scuffed piston or other sources of high friction
3.2 Air in fuel system/lines	See 1.3 Crank and start engine several times to purge
3.3 Defective electronic throttle control	Use Computer Diagnostic System (CDS) to determine proper functioning of ETC Replace electronic throttle control
3.4 Remote control to engine harness connection is poor	Clean and inspect male and female connections
3.5 Flywheel misaligned during installation	Flywheel key sheared or missing

4. Engine Idle is Rough	
Cause	Action
4.1 Fouled spark	Replace spark plug: If carbon bridges electrode gap or if it is completely black If it is not firing and is wet with fuel NOTE: If spark plug is gray or completely black with aluminum specs, this indicates a scuffed piston
4.2 Failed fuel injector	Refer to specifications for ohm test
4.3 Bad ignition coil/weak spark	Refer to specifications for ohm test
4.4 Flywheel misaligned during installation	Flywheel key sheared or missing
4.5 Engine not running all cylinders	Inspect for mechanical damage

5. Engine Idles Fast (RPM Above 700) or Surges	
Cause	Action
5.1 Defective electronic throttle control	Use Computer Diagnostic System (CDS) to determine proper functioning of ETC Replace electronic throttle control

6. Engine Runs Rough Below 3000 RPM	
Cause	Action
6.1 Fouled spark plug	Replace spark plug: If carbon bridges electrode gap or if it is completely black If it is not firing and is wet with fuel NOTE: If spark plug is gray or completely black with aluminum specs, this indicates a scuffed piston
6.2 Low fuel pressure in fuel rail	Measure fuel pressure (valve on top of fuel rail). Fuel pressure should be 281 - 345 kPa (41 - 50 psi)
6.3 Defective electronic throttle control	Use Computer Diagnostic System (CDS) to determine proper functioning of ETC. Replace electronic throttle control
6.4 Bad ignition coil/weak spark	Refer to specifications for ohm test
6.5 Fuel system module float fails in conjunction with failure of vent canister switch	Excess fuel will enter air intake. Use CDS system to determine proper function of vent canister switch
6.6 Engine not running on all cylinders	Inspect for mechanical damage

7. Engine Runs Rough Above 3000 RPM.	
Cause	Action
7.1 Fouled spark plug	Replace spark plug: If carbon bridges electrode gap or if it is completely black If it is not firing and is wet with fuel
7.2 Defective electronic throttle control	Use Computer Diagnostic System (CDS) to determine proper functioning of ETC Replace electronic throttle control
7.3 Low fuel pressure in fuel rail	Measure fuel pressure (valve on top of fuel rail). Fuel pressure should be 281 - 345 kPa (41 - 50 psi)
7.4 Speed reduction	Refer to Smartcraft gauges for low oil, engine overheat or sensor/actuator out of range. DDT or CDS will help identify proper functioning of sensors/actuator
7.5 Defective crank position sensor	Refer DDT or CDS for fault identification

8. Speed Reduction (RPM Reduced to Idle)	
Cause	Action
8.1 Engine communication/remote control failure	Refer CDS for fault identification
8.2 Sensor/actuator is out of range	Refer DDT or CDS for fault identification
8.3 Low oil pressure	Check oil dipstick for proper oil level
8.4 Engine overheat	Check engine cooling system for proper functioning

9. Speed Reduction (RPM Reduced to 75%)	
Cause	Action
9.1 Sensor/actuator is out of range	Refer DDT or CDS for fault identification
9.2 Low oil pressure	Check oil dipstick for proper oil level
9.3 Engine overheat	Check engine cooling system for proper functioning

Wire Color Code Abbreviations

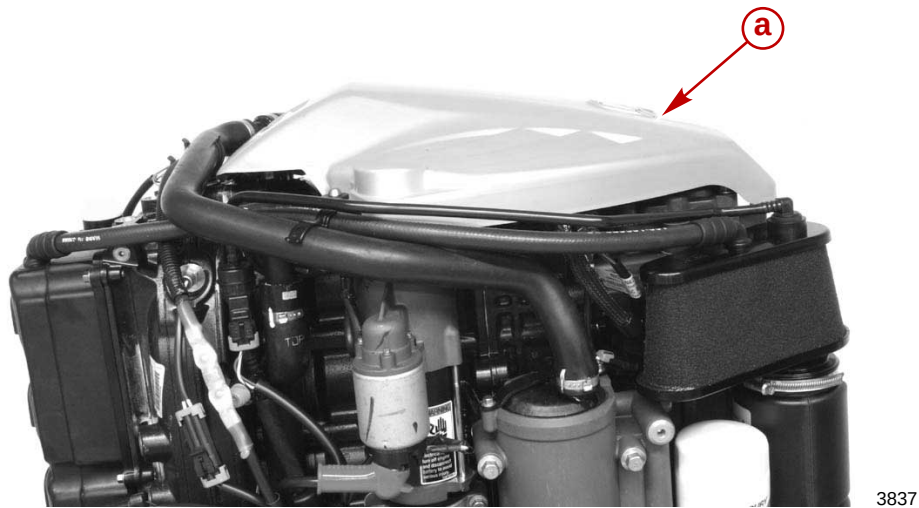
Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

Ignition Components

Flywheel Cover

The purpose of the flywheel cover is to provide basic protection against accidental contact with the flywheel, starter motor pinion gear and alternator/supercharger drive belt while the engine is running.

Removal of the flywheel cover provides access to the flywheel, alternator/supercharger drive belt, starter motor pinion gear, cylinder block water temperature sensor, cylinder block water pressure sensor, crankshaft position sensor, oil temperature sensor and oil pressure sensor.



a - Flywheel cover

The flywheel cover is secured to the engine by four rubber grommets pressed over four locating pins on the cylinder block. To remove cover, lift cover off of locating pins. To reinstall cover, align flywheel cover grommets with locating pins and push down until cover seats against locating pins.

Flywheel

The flywheel is weighted and balanced to improve engine running characteristics. The flywheel is secured to the crankshaft by a bolt (M20 x 68) (30 mm socket) and washer. The flywheel has two ring gears. The top ring gear is used with the starter motor to start the engine. The lower ring gear has 54 teeth with 6 teeth missing at specific locations. As the lower ring gear passes the crankshaft position sensor, an electrical pulse is generated and sent to the propulsion control module (PCM). The frequency of these pulses in conjunction with the missing tooth locations on the ring gear provides crankshaft location information to the PCM. The PCM will use this information to regulate ignition and fuel injector timing.

FLYWHEEL REMOVAL

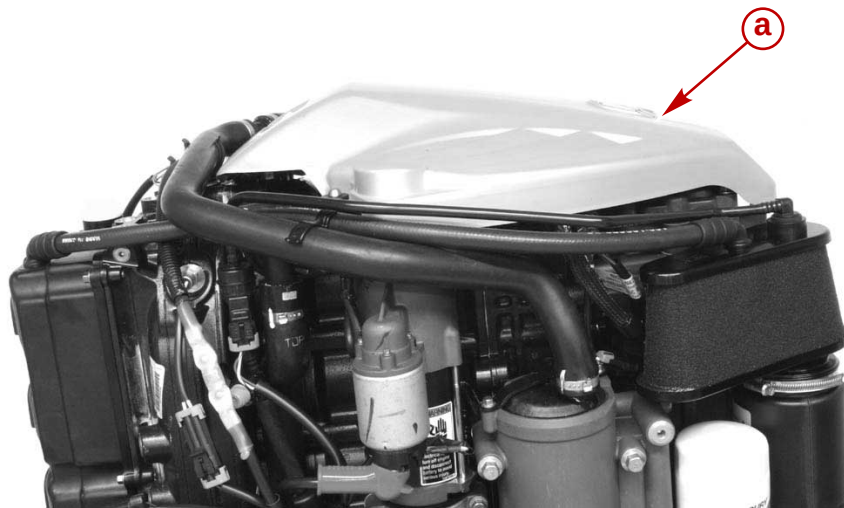
The flywheel has three threaded holes which are used with Flywheel Puller/Lifting Ring to remove the flywheel. These three holes can also be used with the Flywheel Puller/Lifting Ring to remove or install the complete outboard on a boat.

Flywheel Puller/Lifting Ring	91-895343A01
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⚠ CAUTION

Do not use heat or strike the flywheel to aid in the flywheel removal process as the flywheel may be damaged.

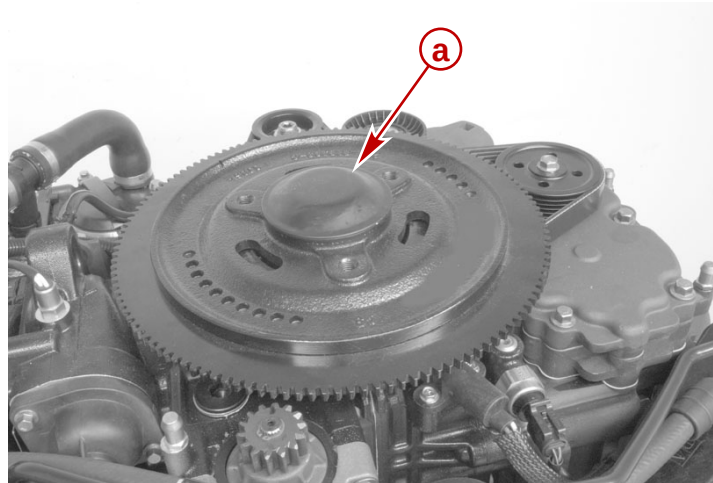
1. Remove flywheel cover.



3837

a - Flywheel cover

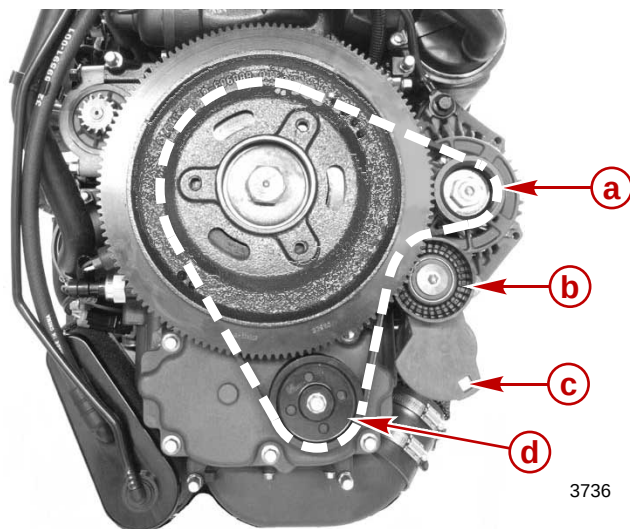
2. Remove flywheel bolt cap from flywheel.



5407

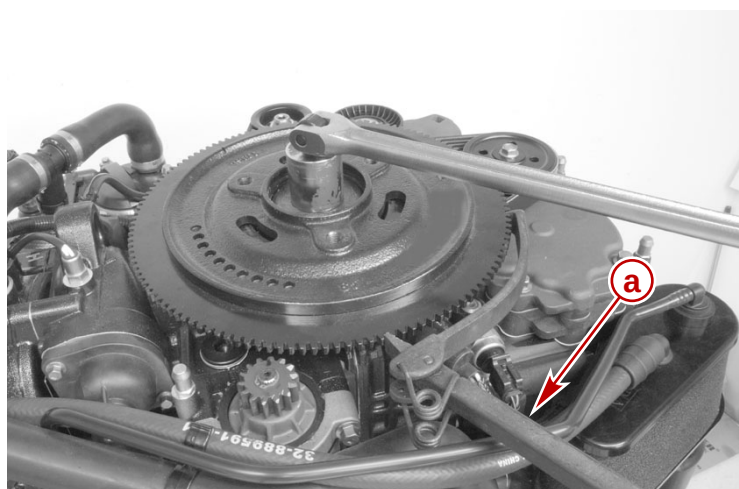
a - Cap

3. Use a breaker bar to release alternator/supercharger belt tension and remove belt from flywheel.



- a** - Alternator
b - Tensioner pulley
c - Tensioner release slot
d - Supercharger

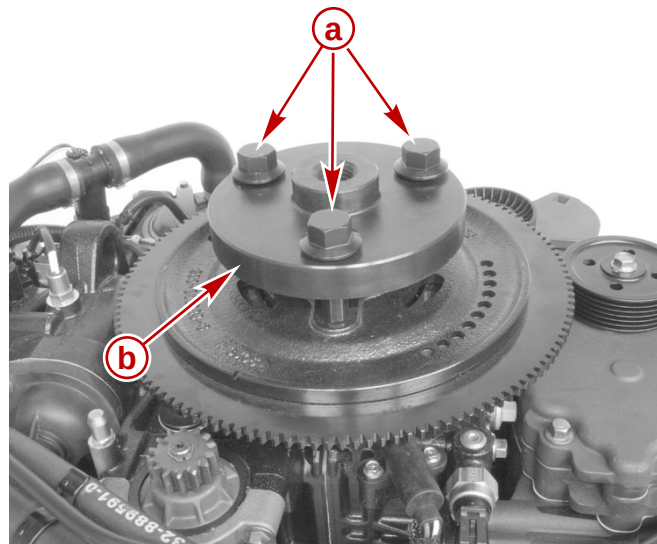
4. Hold the flywheel with Flywheel Holding Tool. Loosen the flywheel bolt four turns out from a light seat.



- a** - Flywheel Holding Tool

Flywheel Holding Tool	91-52344
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5. Install the flywheel puller base to the flywheel with three bolts.



5409

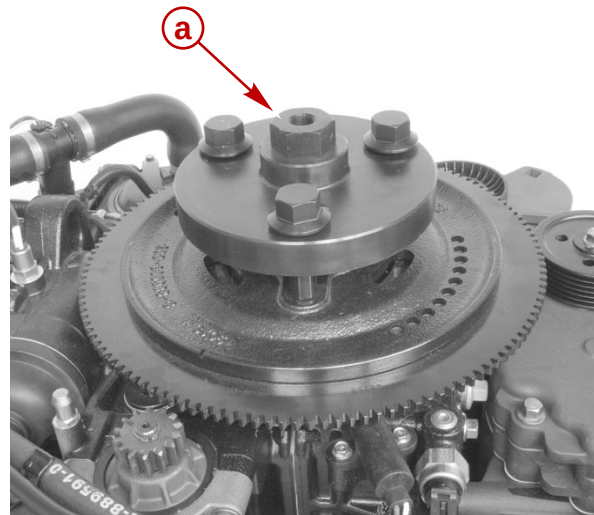
a - Puller base

b - Bolts

Flywheel Puller/Lifting Ring	91-895343T01
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91-895343T01

6. Thread the flywheel puller adapter into the puller base until it bottoms out.



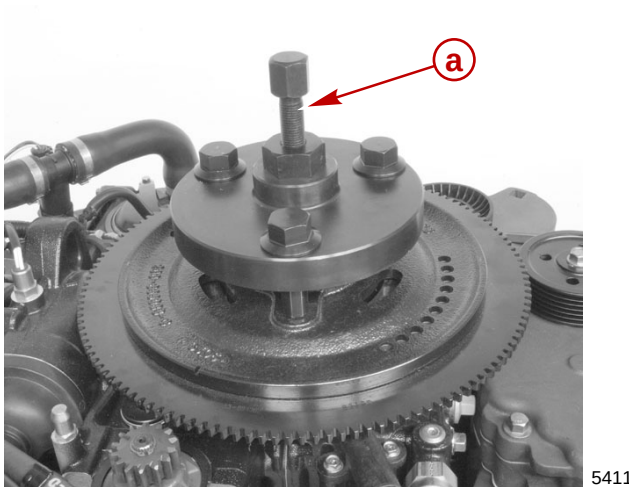
5410

a - Puller adapter

Flywheel Puller/Lifting Ring	91-895343T01
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91-895343T01

7. Thread the flywheel puller bolt into the flywheel puller adapter.



a - Puller bolt

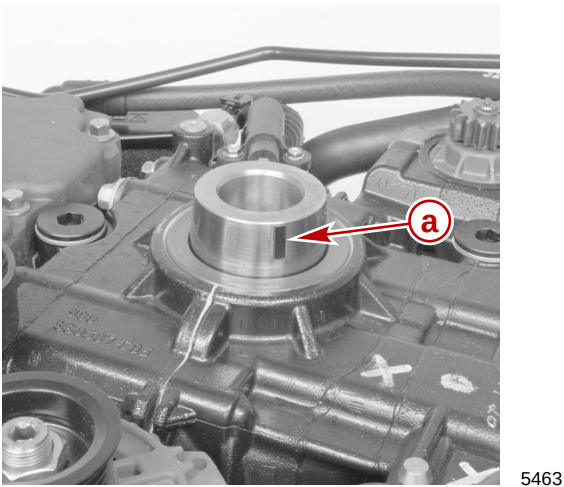
Flywheel Puller/Lifting Ring	91-895343T01
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8. Tighten the flywheel puller bolt until the flywheel becomes loose and remove flywheel.

FLYWHEEL INSTALLATION

IMPORTANT: Clean flywheel/crankshaft taper with solvent and assemble dry.

1. Install flywheel key in crankshaft.



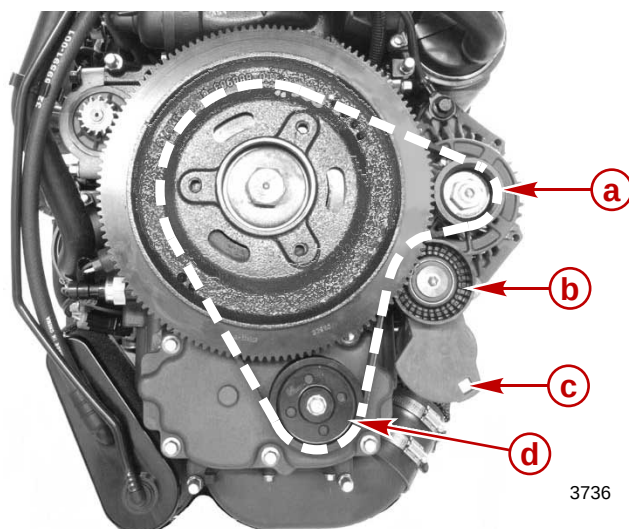
a - Flywheel key

2. Align flywheel with key and install flywheel onto crankshaft.
3. Secure flywheel with bolt and washer. Use Flywheel Holding Tool to hold flywheel and torque bolt to specification.

Flywheel Puller/Lifting Ring	91-895343T01
Flywheel Holding Tool	91-52344

Description		Nm	lb. in.	lb. ft.
Flywheel bolt	First	60		44
	Final	120		133

4. Using breaker bar in tensioner release slot, reinstall alternator/supercharger belt.



a - Alternator
b - Tensioner pulley

c - Tensioner release slot
d - Supercharger

5. Install flywheel cover.

Propulsion Control Module (PCM)

The propulsion control module requires 8 VDC minimum to operate. If the PCM should fail, the engine will stop running.

The inputs to the PCM can be monitored and tested by the Digital Diagnostic Terminal or by using the Computer Diagnostic System available from the SPX Corporation in Warren, Michigan.



a - Propulsion control module (PCM)

Digital Diagnostic Terminal	91-823686A2
Computer Diagnostic System	Order from SPX

The PCM controls the following functions:

- Electronic shift control
- Electronic throttle control
- Electronic boost control

- Main power relay
- Fuel injectors
- Ignition coils
- Power steering
- Vent canister purge valve
- Trim up
- Trim down
- Start relay
- Lift fuel pump
- Diagnostics
- Engine guardian
- Tachometer link (analog tachometer output or link gauge driver)

The PCM operates in four modes; Power Off, Stall, Crank and Run. The PCM also provides for a smooth throttle response between varying throttle positions and engine loads. A Warm-up Mode is integrated with the Run Mode and disengaged after the engine accumulates a given amount of power.

Power Off Mode - With the key switch "OFF", PCM function does not exist. Power, 12 VDC, is available from the battery at the starter battery terminal, fuses, positive cable terminal in the electrical box and at the alternator.

Stall Mode - With the key switch in the "RUN" position, the PCM is energized and powers the main power relay and the fuel pump relay for five seconds. It also provides 5 VDC power to the sensors. The PCM records barometric pressure from the MAP sensor, intake air temperature from the manifold intake air temperature (MAT) sensor and coolant temperature from the coolant temperature sensors. The PCM will use this information to establish a warm-up strategy that will control fuel delivery and engine speed during warm-up and idle.

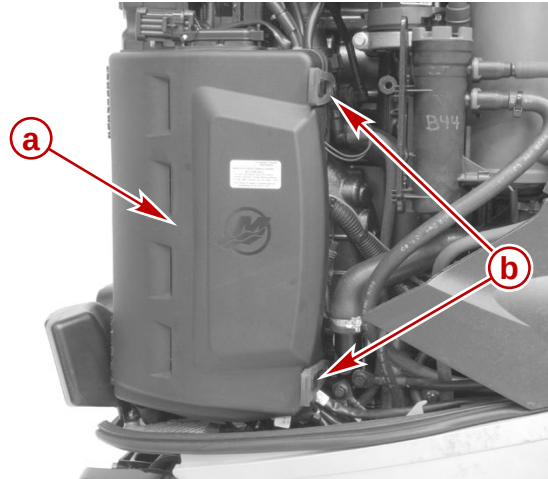
Crank Mode - When the key switch is turned to the "START" position, the start relay and the starter solenoid will be energized and battery power will turn the starter motor. With the engine rotating, a pulse will be generated at the crankshaft sensor which provides the PCM engine speed information. The PCM will then supply power to the fuel pump and ignition coils through the main power relay and the fuel pump relay.

Run Mode - At approximately 500 RPM, the PCM will transition to the Run Mode.

- The warm-up strategy will continue to adjust engine speed with the fuel injector pulse width and engine spark advance until the engine accumulates a given amount of power.
- The camshaft position sensor provides cylinder compression phasing information to the PCM for sequential fuel injection.
- The manifold air temperature (MAT), throttle position and manifold absolute pressure (MAP) are monitored to determine proper spark timing, boost control and the fuel needs necessary to develop the amount of power asked for by the operator.

PCM REMOVAL

1. Release straps securing electrical box cover.

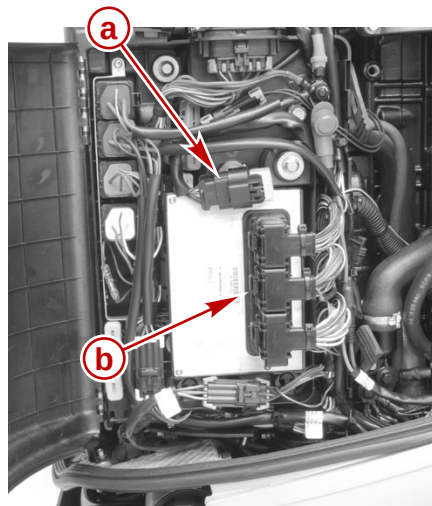


5520

a - Electrical box cover

b - Straps

2. Remove terminator connector.
3. Disconnect three harness connectors.

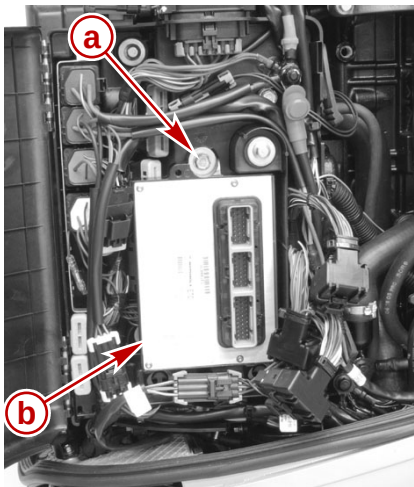


5518

a - Terminator connector

b - Harness connectors

4. Remove screw securing PCM and remove PCM.

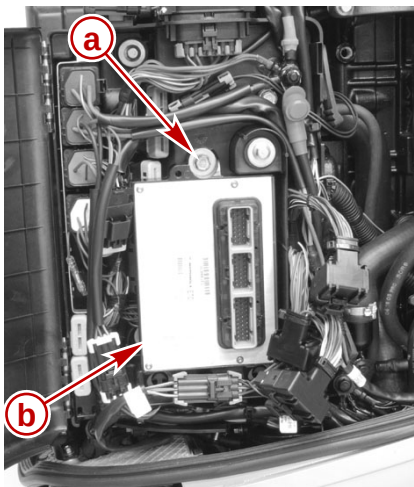


5519

a - PCM attaching screw **b** - PCM

PCM INSTALLATION

1. Install PCM into electrical box and secure PCM with screw. Torque screw to specification.

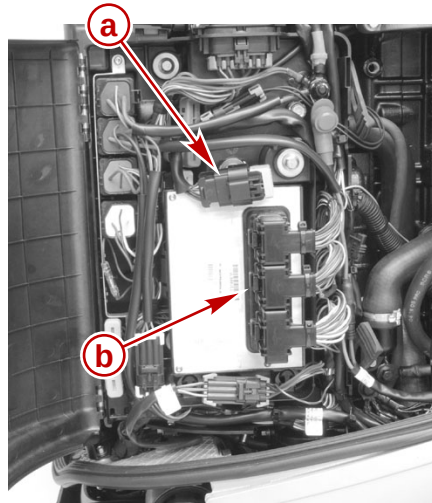


5519

a - PCM attaching screw **b** - PCM

Description	Nm	lb. in.	lb. ft.
PCM attaching screw (M8 x 13)	9	80	

2. Reinstall terminator connector and three harness connectors.

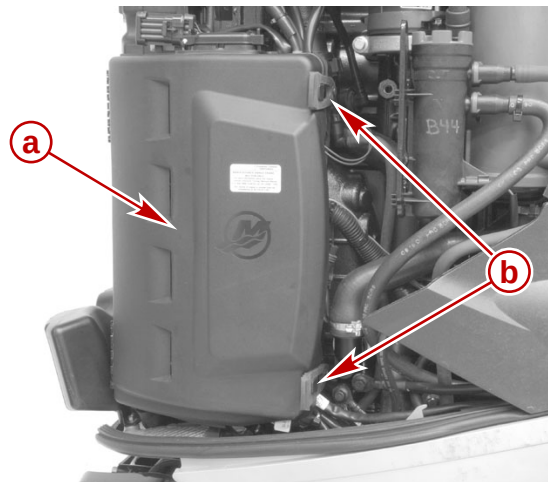


5518

a - Terminator connector

b - Harness connectors

3. Close electrical box cover and secure cover with two straps.



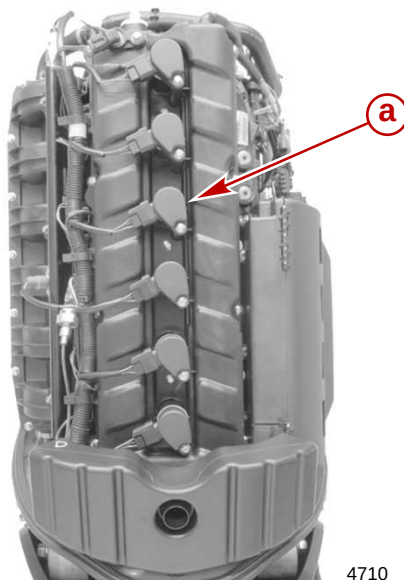
5520

a - Cover

b - Straps

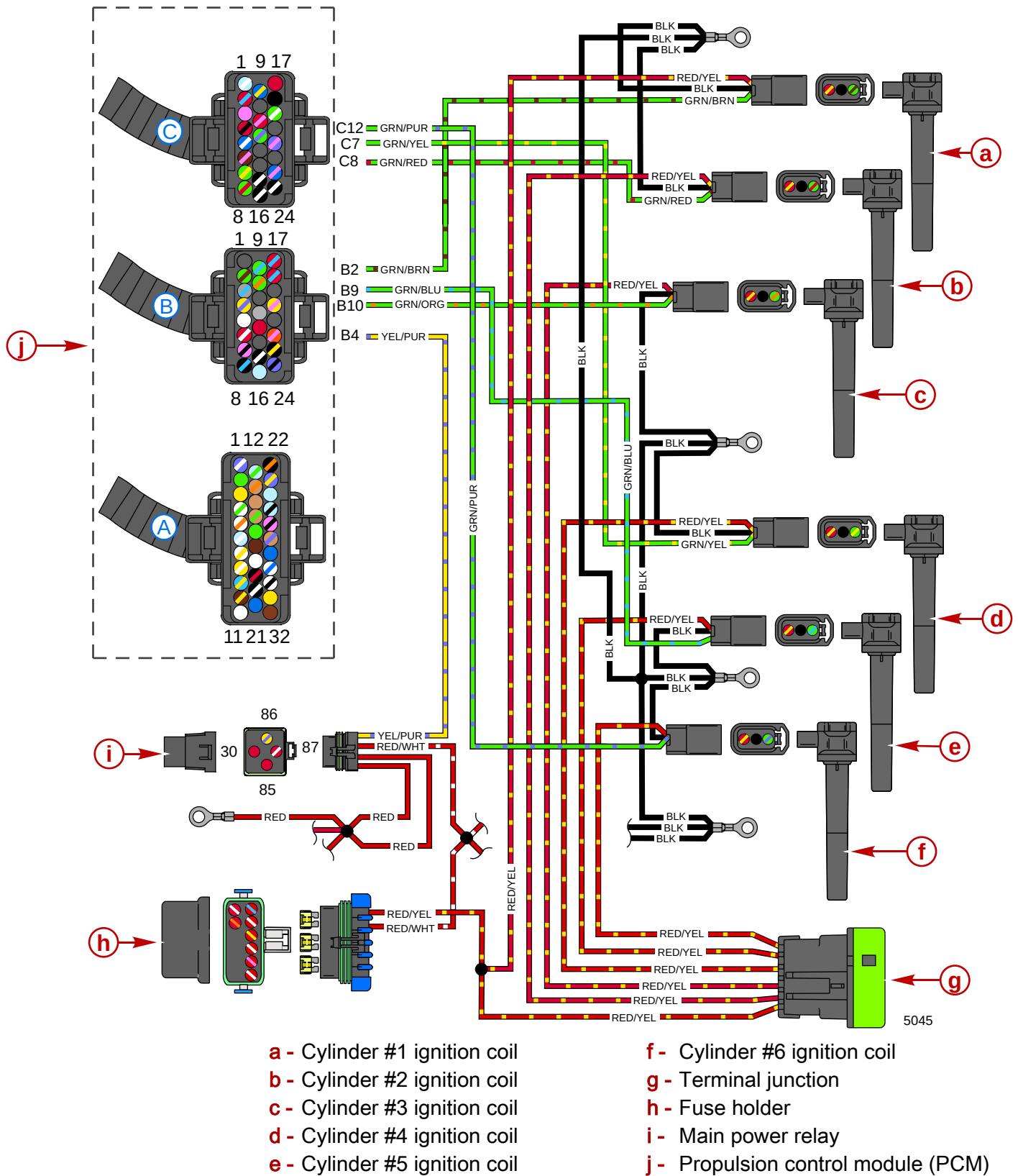
Ignition Pencil Coil

The engine ignition system utilizes six ignition coils, one for each cylinder. The ignition coils are inductive type coils with each coil having its own integrated driver. Battery voltage is present at each coil (red/yellow lead) whenever the main power relay is activated. Each coil is triggered by a 5 VDC digital pulse from the Propulsion Control Module (PCM). Each ignition coil is capable of producing a 40,000 volt spark.



a - Ignition coil (6 each) (1 for each cylinder)

IGNITION COIL TEST



⚠ WARNING

To prevent electrical shock, do not touch any ignition or wiring components when starting or running the engine.

Condition: With key switch in the "RUN" position and the engine "OFF", power (battery voltage) is only available (red/yellow lead) for three seconds when no crank position sensor signal is being received by the Propulsion Control Module (PCM).

1. Disconnect the connector from the coil being tested.
2. Perform a visual inspection of the pins at the coil and the wires coming to the connector. Look for broken, bent, and corroded pins at the coil; and loose, broken, or corroded wires at the connector.

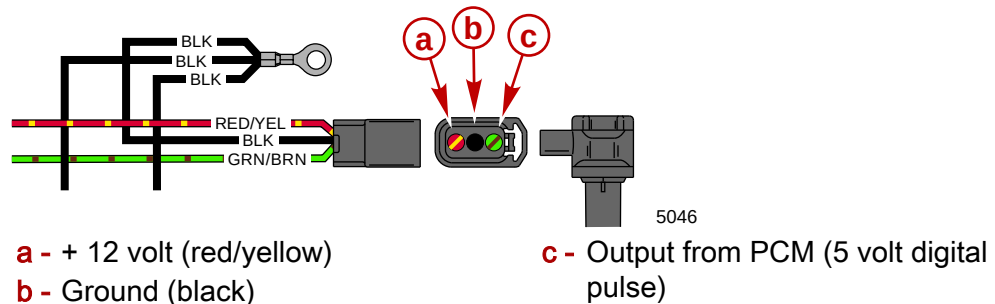
NOTE: Shake or move the harness and connector when performing the following tests. If the voltmeter readings vary during the tests, inspect for a broken, loose or corroded wire. Repair the problem wire and retest the circuit as follows.

3. Connect a voltmeter across the red/yellow and the black wires at the connector.

NOTE: The main power relay must be on for 12 VDC (battery voltage) to be present at the red/yellow wire. If voltage is not present, main power relay may be defective or 20 ampere fuse in fuse holder is blown.

4. The voltmeter must read 12 VDC (battery voltage), if not, connect the voltmeter across the red/yellow wire and the engine ground. If the voltmeter indicates 12 VDC (battery voltage), there is an open in the ground circuit.

NOTE: All coil ground wires are spliced together and connected to a common engine ground. The most likely failure would be at the connector or in between the connector and the engine ground.



5. If the voltmeter does not indicate 12 VDC (battery voltage), there is an open circuit between the splice point and the connector (red/yellow lead).

NOTE: All 12 VDC power wires for the coils are spliced together. Unless all the coils have failed, the most likely failure would be at the splice point, the connector or in between the connector and the splice point.

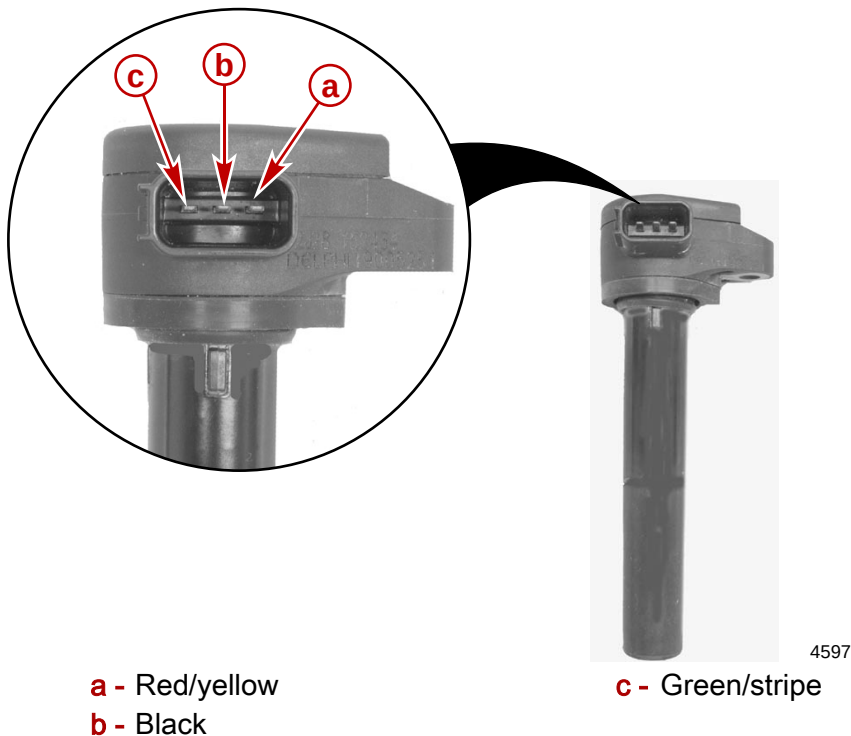
6. Check the input wire (5 VDC) for continuity between the connector and the PCM. Repair if needed.
7. Remove the coil and install a spark tester between the high voltage tower and ground to see if there is a strong blue spark. If the spark is weak or is not blue in color, replace the coil and retest.

IGNITION COIL OHM TEST

NOTE: Perform coil ohm tests using a DMT 2004 or equivalent ohm meter.

DMT 2004	91-892647A01
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NOTE: Some meter brands may require the test lead polarity to be reversed in order to obtain correct ohm specifications.

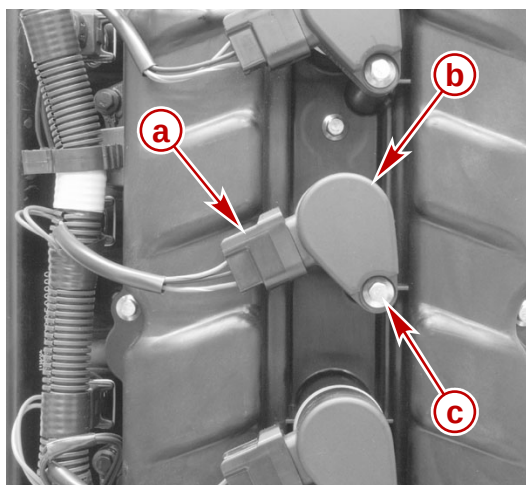


Ignition Coil Ohm Test					
Red Ohm Meter Lead		Black Ohm Meter Lead			
		Electronic spark trigger	Ground	Battery +	Secondary
Terminal	Wire Color	green with stripe	black	red/yellow	spring/output
Electronic spark trigger	green with stripe	n/a	4.3 - 5.3 kΩ (switching circuit)	2 - 4 M ohms (power circuit)	infinite (O.L.)
Ground	black	4.3 - 5.3 kΩ (switching circuit)	n/a	2 - 4 M ohms (power circuit)	infinite (O.L.)
Battery +	red/yellow	infinite (O.L.)	infinite (O.L.)	n/a	infinite (O.L.)
Secondary	spring/output	infinite (O.L.)	infinite (O.L.)	infinite (O.L.)	n/a

IGNITION COIL REMOVAL

1. Disconnect electrical harness from coil.

2. Remove screw securing coil.

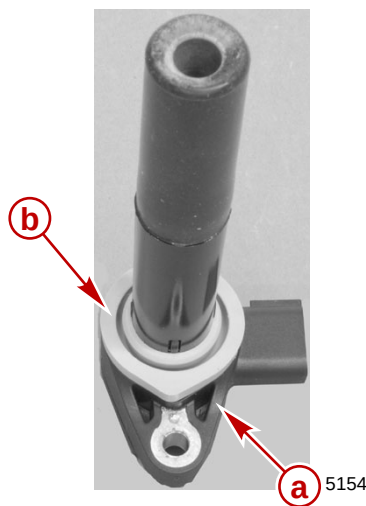


a - Electrical harness

c - Screw

b - Ignition coil

3. Inspect coil sealing ring for cuts or abrasion. If sealing ring is damaged, replace ring.



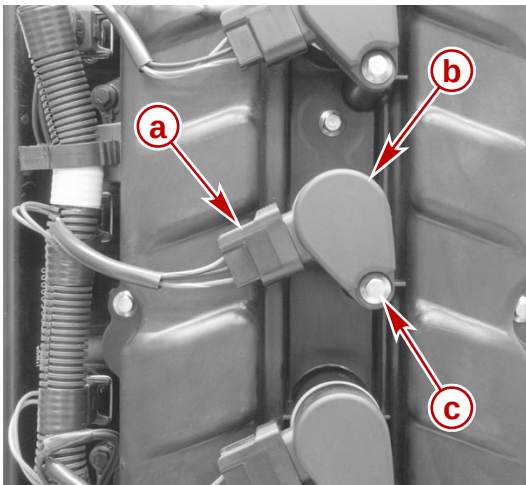
a - Ignition coil

b - Sealing ring

IGNITION COIL INSTALLATION

1. Insert ignition coil into spark plug access hole in cylinder head. Secure ignition coil with screw. Torque screw to specification.

2. Reconnect electrical harness to ignition coil.



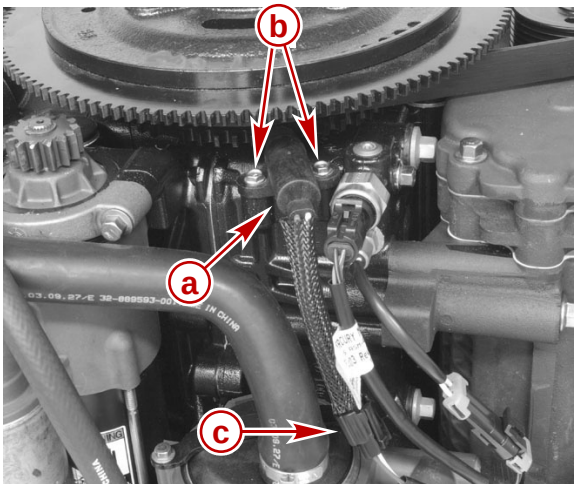
5143

- a** - Electrical harness
- b** - Ignition coil
- c** - Ignition coil screw

Description	Nm	lb. in.	lb. ft.
Ignition coil screw (M6 x 25)	8	70	

Crankshaft Position Sensor (CPS)

The crankshaft position sensor is located at the top of the cylinder block next to the flywheel. The sensor contains a magnet which is positioned next to the flywheel's lower ring gear. This ring gear has 54 teeth with six gaps (or missing teeth) at specific locations. The close proximity of the crank position sensor magnet to the 54 teeth allows a magnetic field to be created each time a tooth passes the sensor. This field collapses and creates a AC voltage pulse. This AC pulse is sent to the propulsion control module (PCM). The timing and frequency of these pulses allows the PCM to regulate ignition and fuel injector timing. If the crank position sensor fails, the engine will run rough or stop running.



5522

- a** - Crank position sensor
- b** - Attaching screws
- c** - Harness connector

CRANKSHAFT POSITION SENSOR TEST

NOTE: It is recommended that the flywheel cover and flywheel be removed to gain access to the crank position sensor.

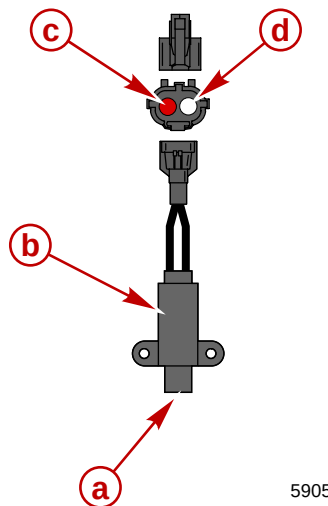
1. Perform a visual inspection of the sensor. The tip of the sensor must be flush across the end; if not, replace the sensor.
2. The tip of the sensor must be clean. There should be no metal debris (ring gear filings) attached to the sensor tip.

NOTE: There is a magnet mounted in the sensor's tip. If the magnet is missing, the sensor will not operate properly.

3. Inspect the flywheel timing wheel for:
 - Excessive corrosion
 - The teeth should have square edges
 - There should only be one missing tooth on either side of the two tooth, three tooth or four tooth groups.
4. Replace the flywheel if it does not meet inspection requirements.
5. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent or corroded pins at the sensor and loose, broken or corroded wires at the connector.
6. Disconnect the connector from the sensor. Measure the resistance across the sensor pins. Replace the sensor if out of specification.

Crankshaft Position Sensor	
Resistance	300 - 350 ohms

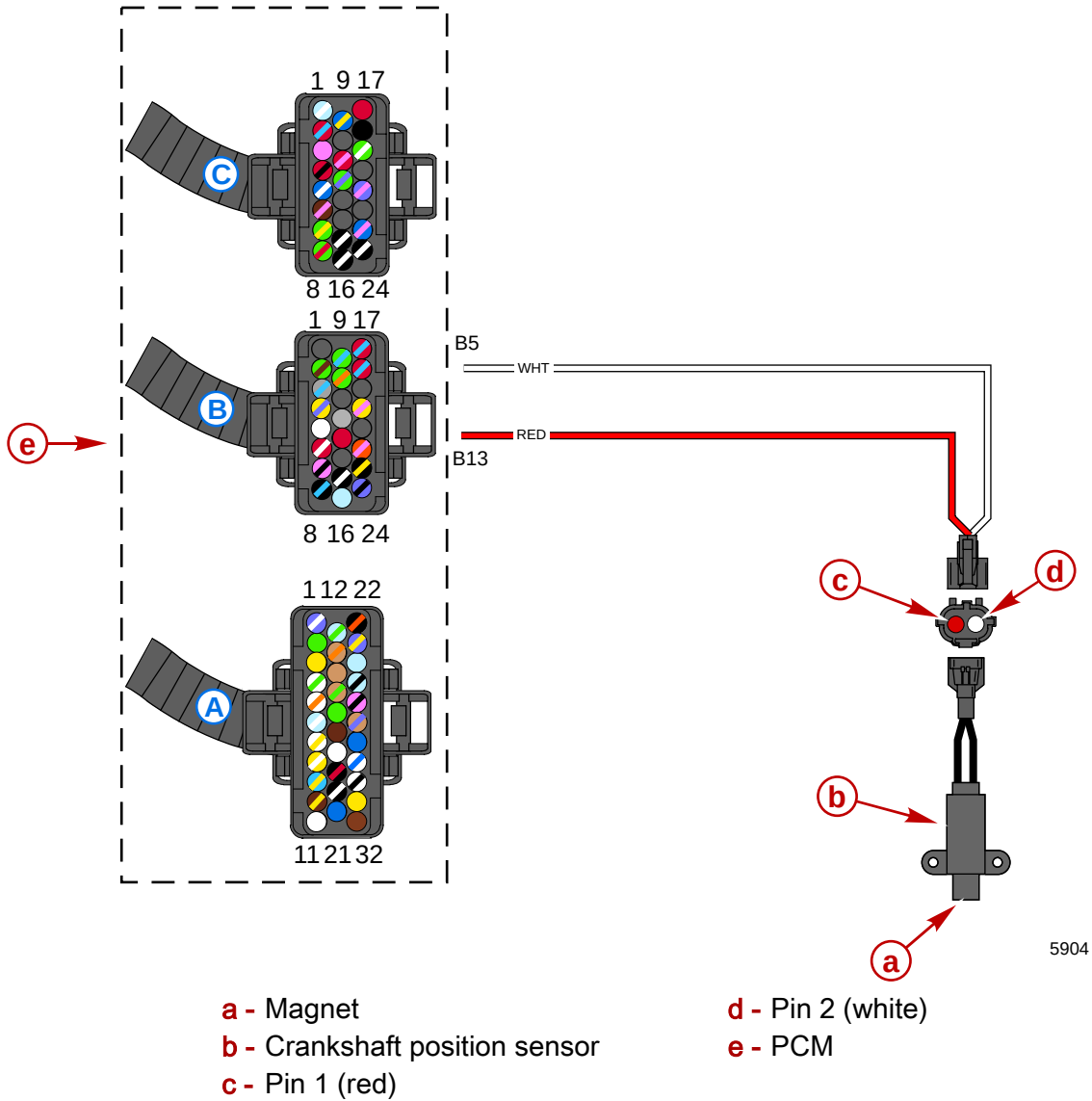
NOTE: If engine problem occurs above 3000 RPM (runs rough, no high RPM), ohm test of crank position sensor may be good but sensor can still be defective.



- a - Magnet
 b - Crankshaft position sensor
 c - Pin 1 (red)
 d - Pin 2 (white)

7. Reconnect the harness to the sensor. Disconnect the B connector from the PCM and measure the resistance across pins 5 and 13. Resistance must be within specification. If not, repair the wiring between the PCM and the sensor.

Crankshaft Position Sensor	
Resistance	300 - 350 ohms



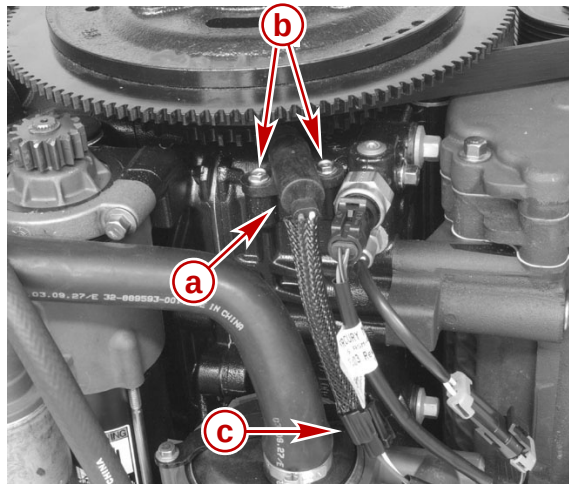
5904

8. If the tests in the preceeding steps are satisfactory, replace the PCM.

CRANKSHAFT POSITION SENSOR REMOVAL

1. Remove flywheel cover and flywheel.
2. Disconnect sensor harness connector.

3. Remove two screws securing sensor and remove sensor.



5522

a - Crank position sensor
b - Attaching screws

c - Harness connector

CRANKSHAFT POSITION SENSOR INSTALLATION

1. Position sensor on engine and secure sensor with two screws. Torque screws to specification.
2. Connect sensor harness to sensor.

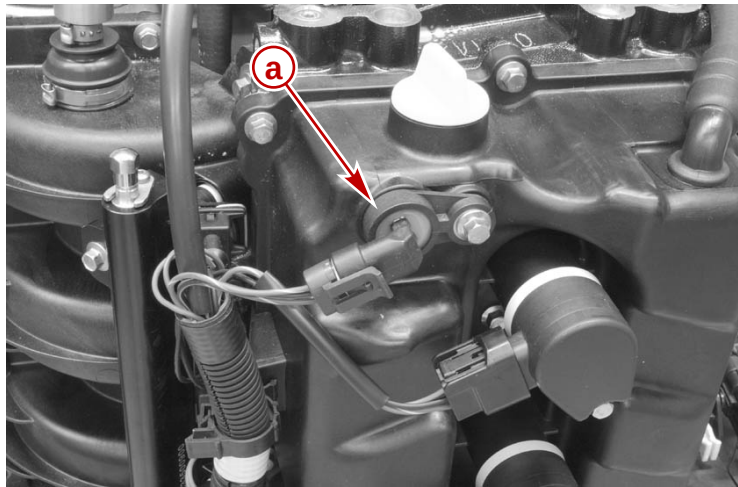
Description	Nm	lb. in.	lb. ft.
Screw (M5 x 16)	5	45	

Camshaft Position Sensor

The camshaft position sensor is located at the top of the valve cover. It supplies the PCM with timing and RPM information. When the camshaft position sensor is functioning, the PCM controls the fuel injection in a sequential, multi-port timing strategy. When the camshaft position sensor has failed, the PCM controls the fuel injection in a batch fire strategy. The engine may not start as quickly and the Guardian System will limit power to 75%. The PCM will generate and store a failure code when the camshaft position sensor fails.

A sequential firing strategy means that the fuel injectors fire once per engine cycle (every two crankshaft revolutions). The fuel injection event is complete just before the intake valve closes and the coils fire only once per engine cycle. Sequential is ideal for emissions, driveability transients and slight horsepower advantages.

Batch fire strategy means that the fuel injectors fire every revolution (1/2 the fuel needed per revolution/per cycle) and the coils also fire every revolution (wasted spark). This strategy does not consider the phase of the engine; i.e. whether a particular cylinder is on a compression or exhaust stroke. Batch fire engines do not require a camshaft position sensor and are less expensive to build.



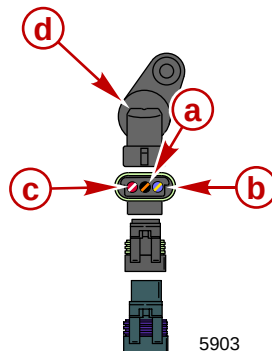
5540

a - Camshaft position sensor

CAMSHAFT POSITION SENSOR TEST

The cam position sensor output to the PCM will change from +5 volts to 0 volts each time the number 1 or number 6 cylinder reaches top dead center. This voltage change can be monitored by the Computer Diagnostic System (CDS). If the voltage change is not occurring, shake or move the harness by hand. If the voltage readings vary, look for a broken, loose or corroded wire.

1. Disconnect the connector from the sensor.
2. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor and loose, broken, or corroded wires at the connector.
3. If the wiring appears serviceable, perform an ohm check on the sensor. The normal resistance for the cam sensor at 21° C (70° F) is:
 - Between pins A and B is 23.2 mohms
 - Between pins B and C is 23.2 mohms



5903

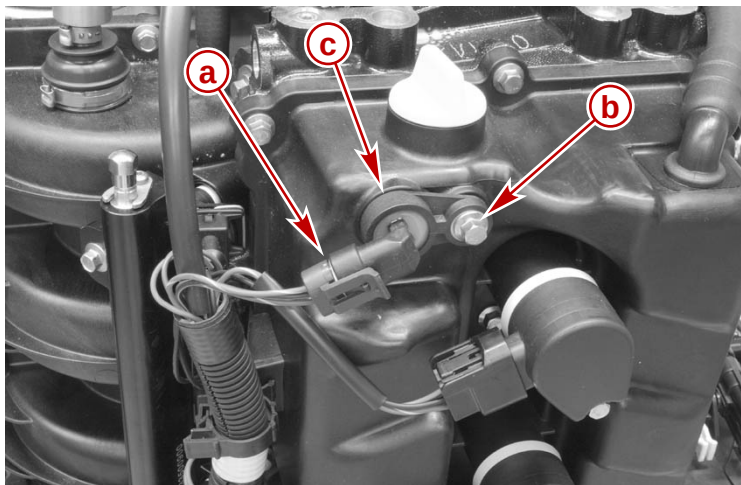
a - Pin B (black/orange)
b - Pin C (purple/yellow)

c - Pin A (red/white)
d - Camshaft position sensor

4. If the ohm check of the camshaft position sensor indicates that the sensor is serviceable, perform an ohm check of the sensor wiring between the sensor connector and the PCM as follows:
 - PCM connector B pin 6 to red/white pin of sensor connector is less than 1 ohm.
 - PCM connector A pin 22 to black/orange pin of sensor connector is less than 1 ohm.
 - PCM connector A pin 23 to purple/yellow pin of sensor connector is less than 1 ohm.

CAMSHAFT POSITION SENSOR REMOVAL

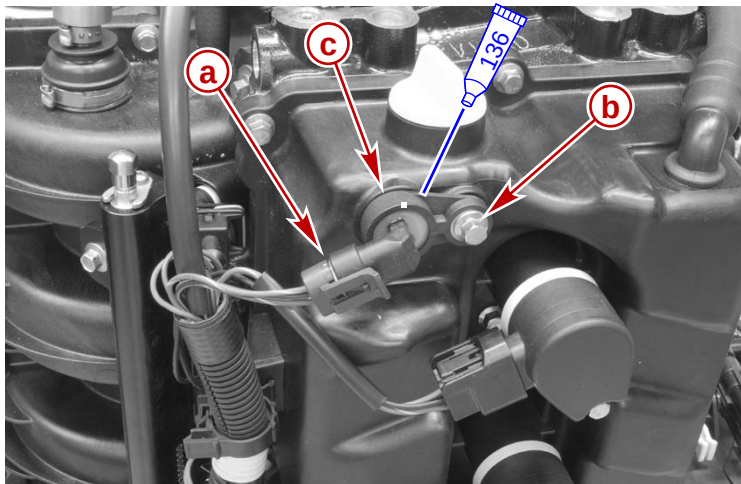
- 1. Disconnect sensor harness from sensor.
- 2. Remove screw securing camshaft sensor and remove sensor.



a - Sensor harness
b - Sensor attaching screw
c - Camshaft position sensor

CAMSHAFT POSITION SENSOR INSTALLATION

- 1. Apply Lubriplate SPO 255 to sensor O-ring.
- 2. Install sensor into valve cover.
- 3. Secure sensor with screw. Torque screw to specification.
- 4. Connect harness to sensor.



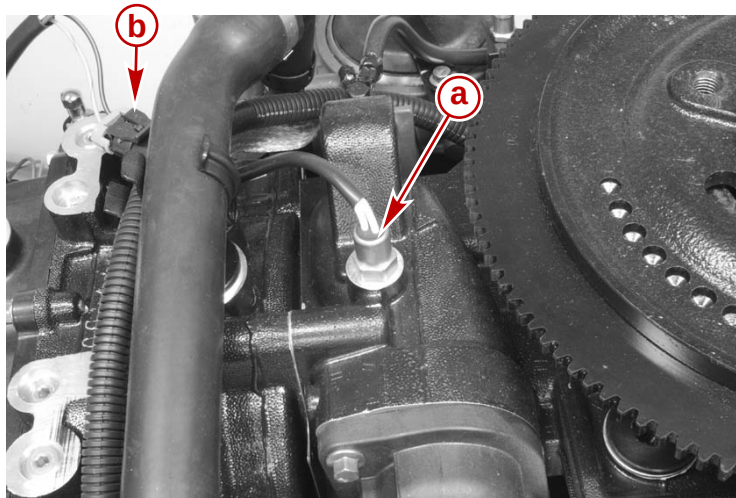
a - Harness connector
b - Screw
c - Camshaft position sensor

Tube Ref No.	Description	Where Used	Part No.
 136	Lubriplate SPO 255	Camshaft position sensor O-ring	Obtain Locally

Description	Nm	lb. in.	lb. ft.
Screw (M6 x 16)	8	70	

Cylinder Block Temperature Sensor

The cylinder block temperature sensor is located at the top of the cylinder block, aft of the flywheel. It is a thermistor immersed in the engine coolant path. It supplies the PCM with engine temperature information. The PCM adjusts the timing and the amount of fuel delivered according to the water temperature in the cylinder block. Low coolant temperature produces high resistance, while high temperature causes low resistance. The normal resistance value for the sensor at 21° C (70° F) is 11.3 kΩ.



a - Temperature sensor

b - Sensor harness connector

CYLINDER BLOCK TEMPERATURE SENSOR TEST

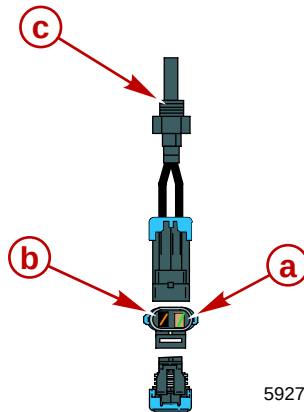
The Computer Diagnostic System (CDS) and the Digital Diagnostic Terminal (DDT) will both determine the proper functioning of the cylinder block temperature sensor by providing a numerical readout of the block temperature before and after the engine is started. With the engine not running, block temperature should be approximately the same as the ambient air temperature. After the engine is started, the temperature sensor should indicate a rise in block temperature to approximately 60° - 70° C (140° - 158° F). Outside air temperature and the temperature of the water that the engine is operating in will directly affect the engine block temperature.

1. With the engine running and the CDS or DDT connected to the engine, if the block temperature sensor does not appear to be indicating a temperature change, shake or move the sensor harness and connector. If the temperature begins to change, look for a broken, loose or corroded wire.

Computer Diagnostic System (CDS)	Order from SPX
Digital Diagnostic Terminal	91-823686A2

2. Disconnect the connector from the sensor.

3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent or corroded pins at the sensor and loose, broken or corroded wires at the connector.



a - Pin A (tan/green)

b - Pin B (black/orange)

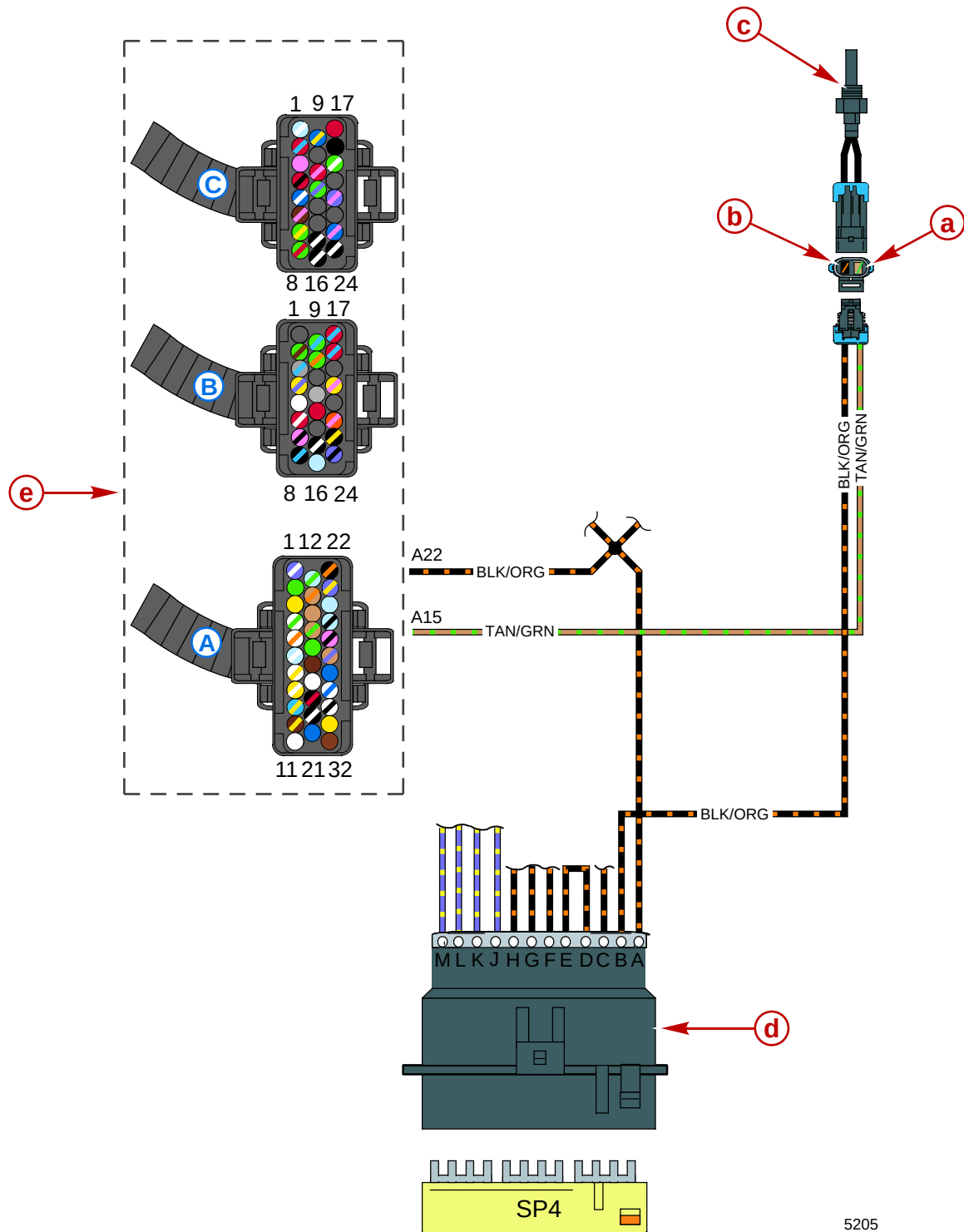
c - Cylinder block temperature sensor

4. The sensor can be tested with an ohmmeter by disconnecting it from the harness and heating or cooling the end of the sensor at a controlled temperature. If the readings do not match those in the table, replace the sensor and retest.

Block Temperature Sensor Ohm Test				
Degree Centigrade	-10	21	38	65
Degree Fahrenheit	14	70	100	150
KΩ	20 kΩ	11.3 kΩ	5.7 kΩ	2.1 kΩ

5. If the ohm check of the block temperature sensor indicates that the sensor is serviceable, perform an ohm check of the sensor wiring between the sensor connector and the PCM as follows:
 - PCM connector A pin 22 to pin B of sensor connector is less than 1 ohm.
 - PCM connector A pin 15 to pin A of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connect to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector or in between the connector and the splice point.



- a - Pin A (tan/green)
- b - Pin B (black/orange)
- c - Cylinder block temperature sensor

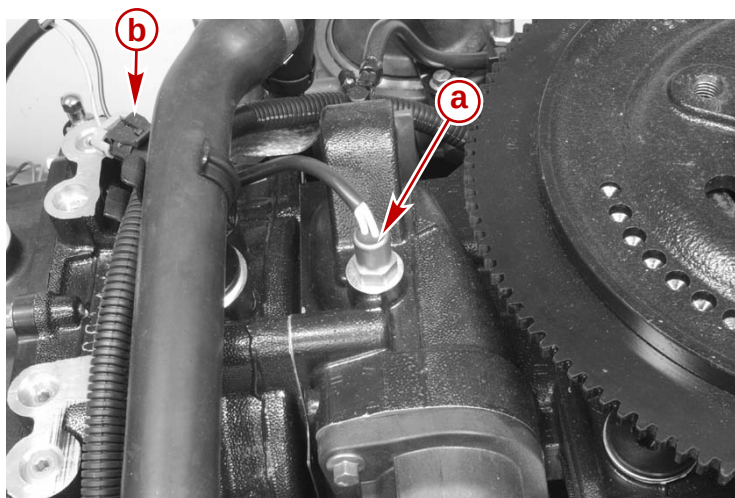
- d - Splice saver SP4
- e - PCM

6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the Computer Diagnostic System or Digital Diagnostic Terminal.

Computer Diagnostic System (CDS)	Order from SPX
Digital Diagnostic Terminal	91-823686A2

CYLINDER BLOCK TEMPERATURE SENSOR REMOVAL

1. Remove flywheel cover.
2. Disconnect sensor harness connector.
3. Remove sensor from cylinder block.



4574

a - Temperature sensor

b - Harness connector

CYLINDER BLOCK TEMPERATURE SENSOR INSTALLATION

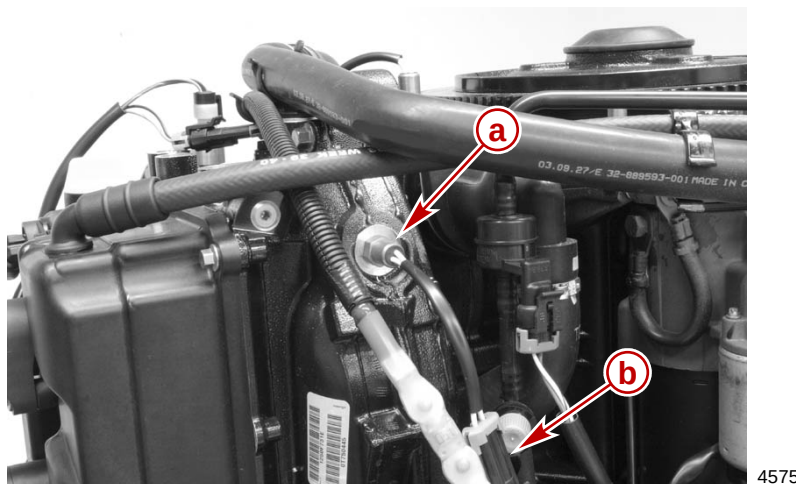
1. Inspect sensor O-ring for cuts or abrasions. Replace O-ring as required.
2. Install sensor with O-ring into cylinder block. Torque sensor to specification.

Description	Nm	lb. in.	lb. ft.
Temperature sensor	15	133	

3. Connect sensor harness to sensor.
4. Install flywheel cover.

Cylinder Head Coolant Temperature Sensor

The head coolant temperature sensor is a thermistor immersed in the engine coolant stream. It is located on the starboard side of the head near the top of the head. It supplies the PCM with temperature information. The PCM adjusts the timing and the amount of fuel delivered according to the water temperature in the head. Low coolant temperature produces high resistance, while high temperature causes low resistance. The normal resistance value for the sensor at 21° C (70° F) is 11.3 kΩ.



a - Cylinder head temperature sensor **b** - Harness connector

CYLINDER HEAD COOLANT TEMPERATURE SENSOR TEST

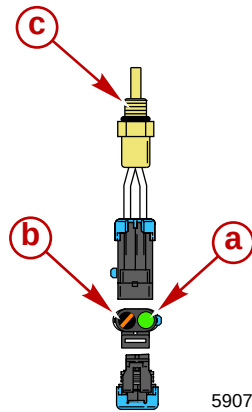
The Computer Diagnostic System (CDS) and the Digital Diagnostic Terminal (DDT) will both determine the proper functioning of the cylinder head temperature sensor by providing a numerical readout of the head temperature before and after the engine is started. With the engine not running, cylinder head temperature should be approximately the same as the ambient air temperature. After the engine is started, the temperature sensor should indicate a rise in head temperature to approximately 40° to 50° C (104° to 122° F). Outside air temperature and the temperature of the water that the engine is operating in will directly affect the engine block temperature.

1. With the engine running and the CDS or DDT connected to the engine, if the head temperature sensor does not appear to be indicating a temperature change, shake or move the sensor harness and connector. If the temperature begins to change, look for a broken, loose or corroded wire.

Computer Diagnostic System (CDS)	Order from SPX
Digital Diagnostic Terminal (DDT)	91-823686A2

2. Disconnect the connector from the sensor.
3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent or corroded pins at the sensor and loose, broken or corroded wires at the connector.

4. The sensor can be tested with an ohmmeter by disconnecting it from the harness and heating or cooling the end of the sensor at a controlled temperature. If the readings do not match those in the table, replace the sensor and retest.



a - Pin A (green)

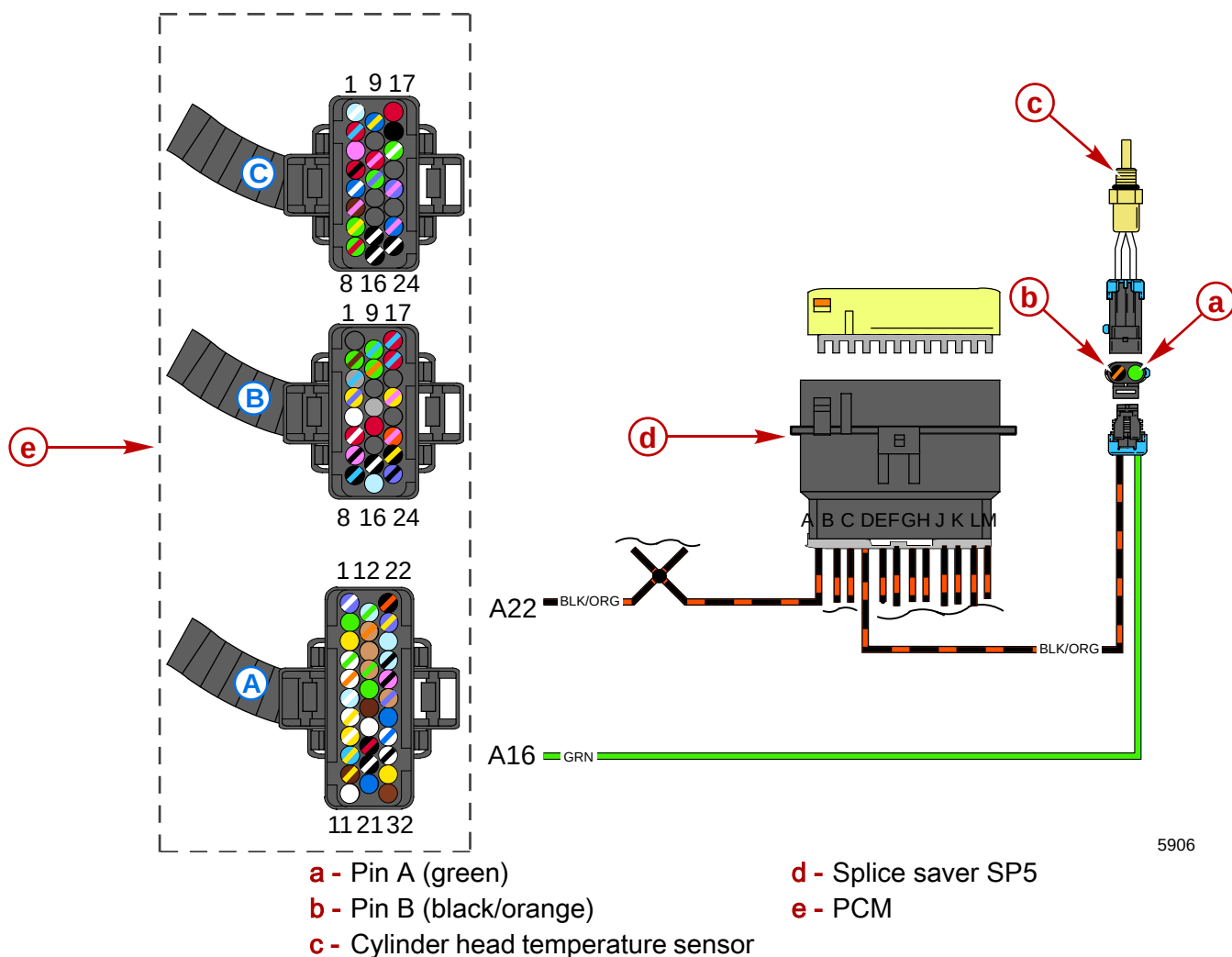
b - Pin B (black/orange)

c - Cylinder head coolant temperature sensor

Cylinder Head Temperature Sensor Ohm Test					
Degree Centigrade	-10	21	38	65	95
Degree Fahrenheit	14	70	100	150	203
KΩ	20 kΩ	11.3 kΩ	5.67 kΩ	2.05 kΩ	800 Ω

5. If the ohm check of the cylinder head coolant temperature sensor indicates that the sensor is serviceable, perform an ohm check of the sensor wiring between the sensor connector and the PCM as follows:
 - PCM connector A pin 22 to pin B of sensor connector is less than 1 ohm.
 - PCM connector A pin 16 to pin A of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connect to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector or in between the connector and the splice point.



5906

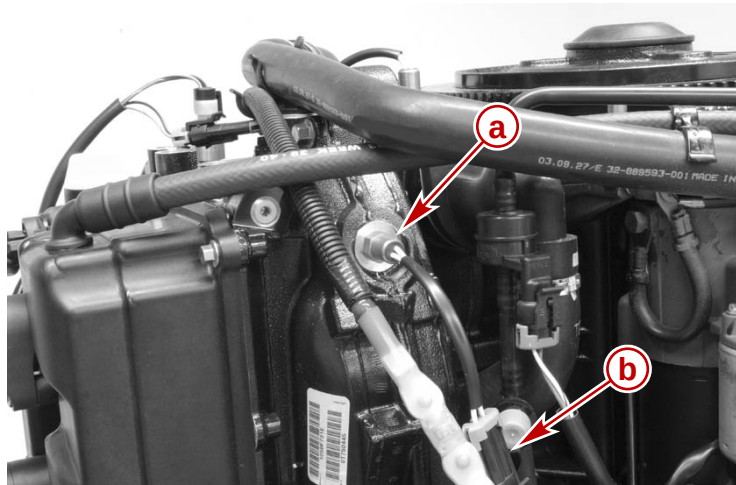
6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the Computer Diagnostic System or Digital Diagnostic Terminal.

Computer Diagnostic System (CDS)	Order from SPX
Digital Diagnostic Terminal (DDT)	91-823686A2

CYLINDER HEAD COOLANT TEMPERATURE SENSOR REMOVAL

1. Disconnect sensor harness connector.

2. Remove sensor from cylinder block.



a - Cylinder head temperature sensor **b** - Harness connector

CYLINDER HEAD COOLANT TEMPERATURE SENSOR INSTALLATION

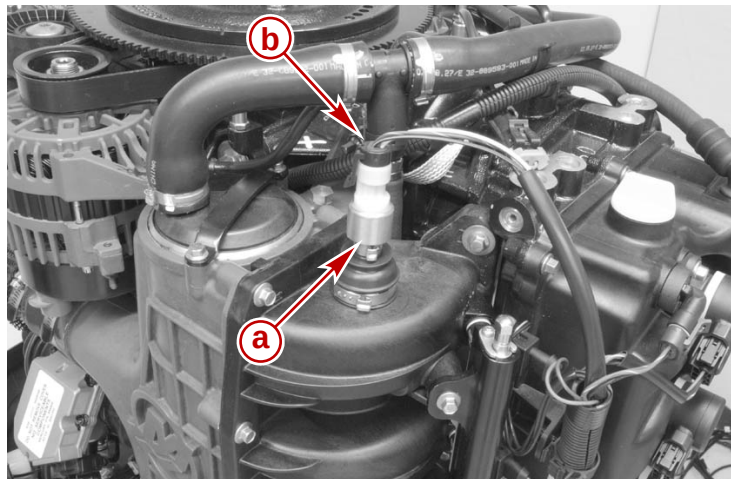
1. Inspect sensor O-ring for cuts or abrasions. Replace O-ring as required.
2. Install sensor with O-ring into cylinder block. Torque sensor to specification.

Description	Nm	lb. in.	lb. ft.
Temperature sensor	15	133	

3. Connect sensor harness to sensor.

Manifold Absolute Pressure (MAP) Sensor

The manifold absolute pressure (MAP) sensor measures the changes in the intake manifold pressure. It is located at the top of the intake manifold. When the key is turned "ON" the MAP sensor reads the ambient atmospheric pressure. This information is used by the PCM as an indication of altitude and is referred to as BARO. The manifold absolute pressure will change as a result of engine load and speed changes.



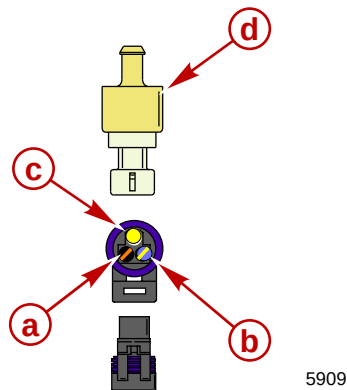
a - MAP sensor **b** - Harness connector

MANIFOLD ABSOLUTE PRESSURE SENSOR TEST

The Computer Diagnostic System (CDS) and the Digital Diagnostic Terminal (DDT) will both determine the proper functioning of the MAP sensor by providing a numerical readout of the sensor after the engine is started.

Manifold Absolute Pressure Sensor Readings	
@ idle	35 to 48 kPa (5 to 7 psi)
@ wide open throttle	195 to 200 kPa (28 to 29 psi)

1. With the engine running and the CDS or DDT connected to the engine, if the MAP sensor does not appear to be indicating a pressure change, shake or move the sensor harness and connector. If the pressure begins to change, look for broken, loose, or corroded wires.
2. Disconnect the connector from the sensor.
3. Perform a visual inspection of the pins at the sensor, and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor; and loose, broken, or corroded wires at the connector.
4. An ohm check of the MAP sensor can be made by disconnecting the sensor harness and measuring the resistance between pins A, B and C. The normal resistance values for the MAP sensor at 21° C (70° F) are:
 - Between pin A and pin B is 9.33 kΩ.
 - Between pin A and pin C is 3.89 kΩ.



a - Pin A (black/orange)

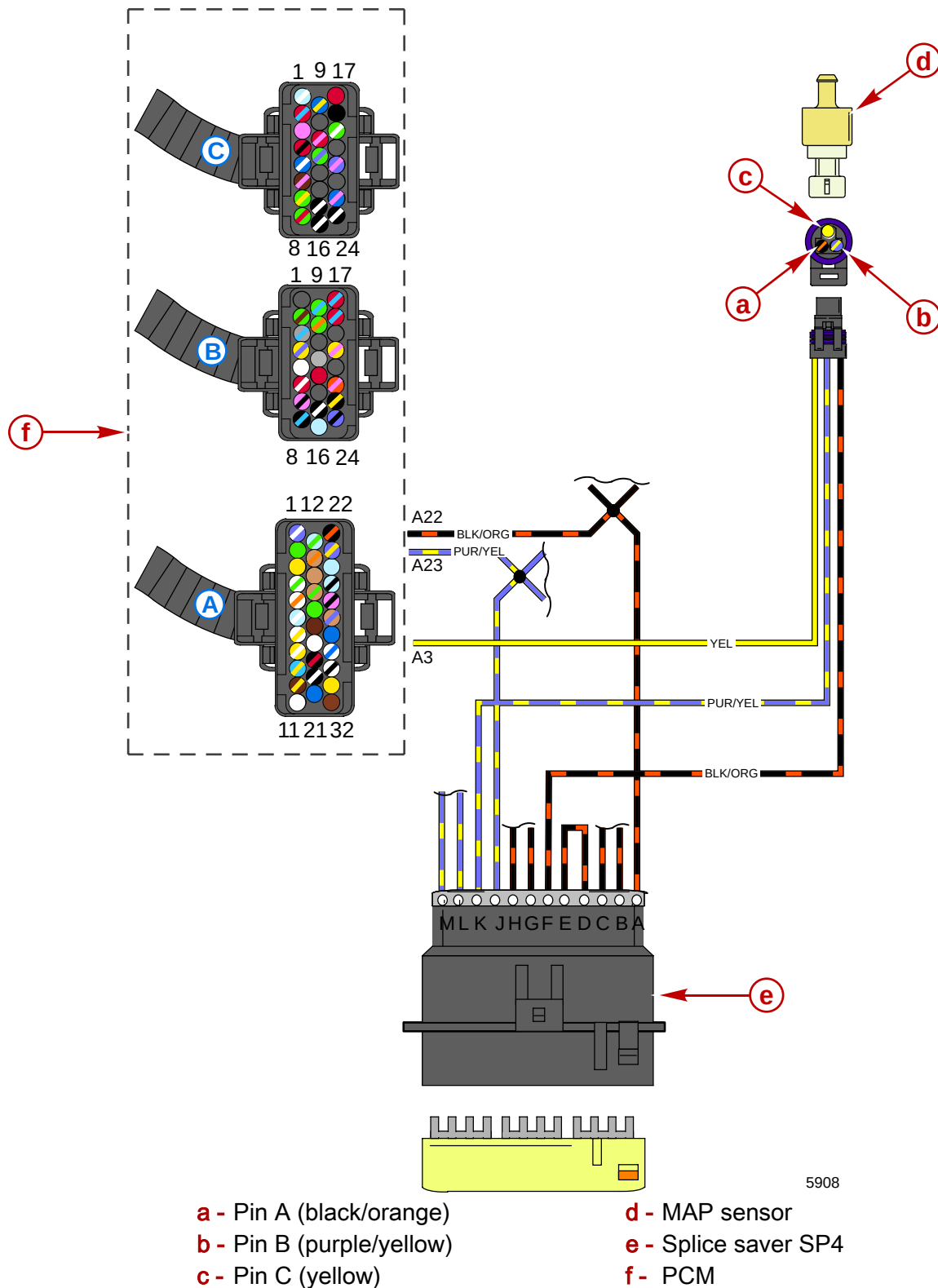
b - Pin B (purple/yellow)

c - Pin C (yellow)

d - MAP sensor

5. If the ohm check of the MAP sensor indicates that the sensor is serviceable, perform and ohm check of the sensor wiring between the sensor connector and the PCM as follows:
 - PCM connector A pin 22 to pin A of sensor connector is less than 1 ohm.
 - PCM connector A pin 3 to pin C of sensor connector is less than 1 ohm.
 - PCM connector A pin 23 to pin B of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connect to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector or in between the connector, and the splice point.

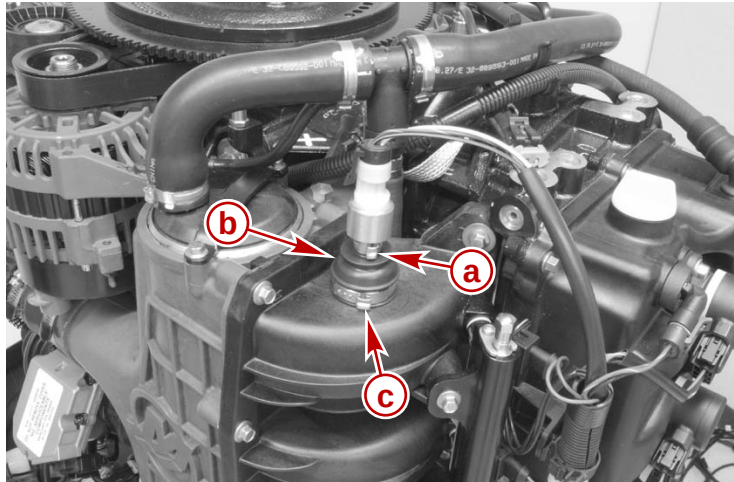


6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the Computer Diagnostic System or Digital Diagnostic Terminal.

Computer Diagnostic System	Order through SPX
Digital Diagnostic Terminal (DDT)	91-823686A2

MANIFOLD ABSOLUTE PRESSURE SENSOR REMOVAL

1. Disconnect sensor harness connector.
2. Remove attaching clamp and remove sensor from adaptor boot.
3. Inspect adaptor boot for cuts, cracks or abrasion. Replace boot as required.



5628

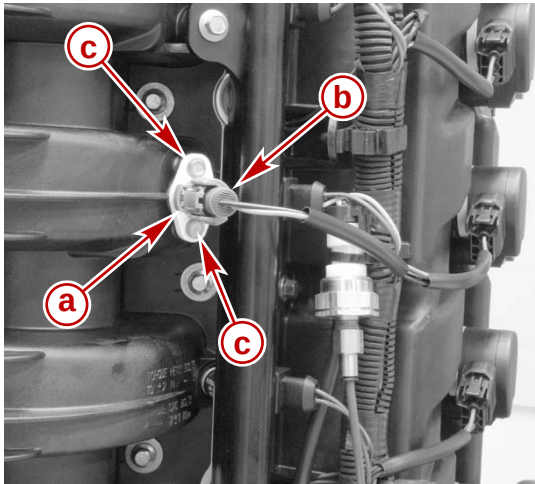
a - Clamp 15.7 diameter**c** - Clamp 36.1 diameter**b** - Boot

MANIFOLD ABSOLUTE PRESSURE SENSOR INSTALLATION

1. Install sensor into adaptor boot. Secure sensor with new 15.7 diameter clamp.
2. Connect sensor harness to sensor.

Manifold Intake Air Temperature (MAT) Sensor

The manifold intake air temperature sensor is a thermistor that controls a signal voltage to the PCM. It is located in the middle of the intake manifold close to the fuel rail. It informs the PCM of the air temperature inside the intake manifold. The PCM adjusts the fuel injection duration needed to run the engine at optimum efficiency according to the MAT information. When intake air is cold, the sensor resistance is high. As the air temperature rises, resistance lowers.



a - MAT sensor
b - Harness connector
c - Screws (M4 x 16)

MANIFOLD INTAKE AIR TEMPERATURE SENSOR TEST

The Computer Diagnostic System (CDS) and the Digital Diagnostic Terminal (DDT) will both determine the proper functioning of the MAT sensor by providing a numerical readout of the sensor temperature before and after the engine is started. With the engine not running, intake air temperature should be approximately the same as the ambient air temperature. After the engine is started, the temperature sensor should indicate a rise in air intake temperature. Outside air temperature will directly affect the engine manifold air intake temperature.

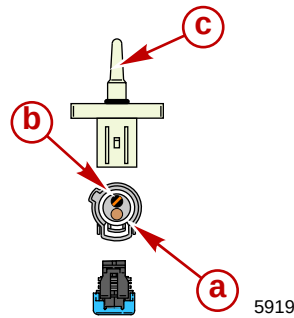
Manifold Intake Air Temperature Sensor Resistance	
@ 21° C (70° F)	2.26 kΩ ± 5%

1. With the engine running and the CDS or DDT connected to the engine, if the MAT sensor does not appear to be indicating a temperature change, shake or move the sensor harness and connector. If the temperature begins to change, look for a broken, loose or corroded wire.

Computer Diagnostic System	Order through SPX
Digital Diagnostic Terminal (DDT)	91-823686A2

2. Disconnect the connector from the sensor.

3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent or corroded pins at the sensor and loose, broken or corroded wires at the connector.



a - Pin A (tan)

c - MAT sensor

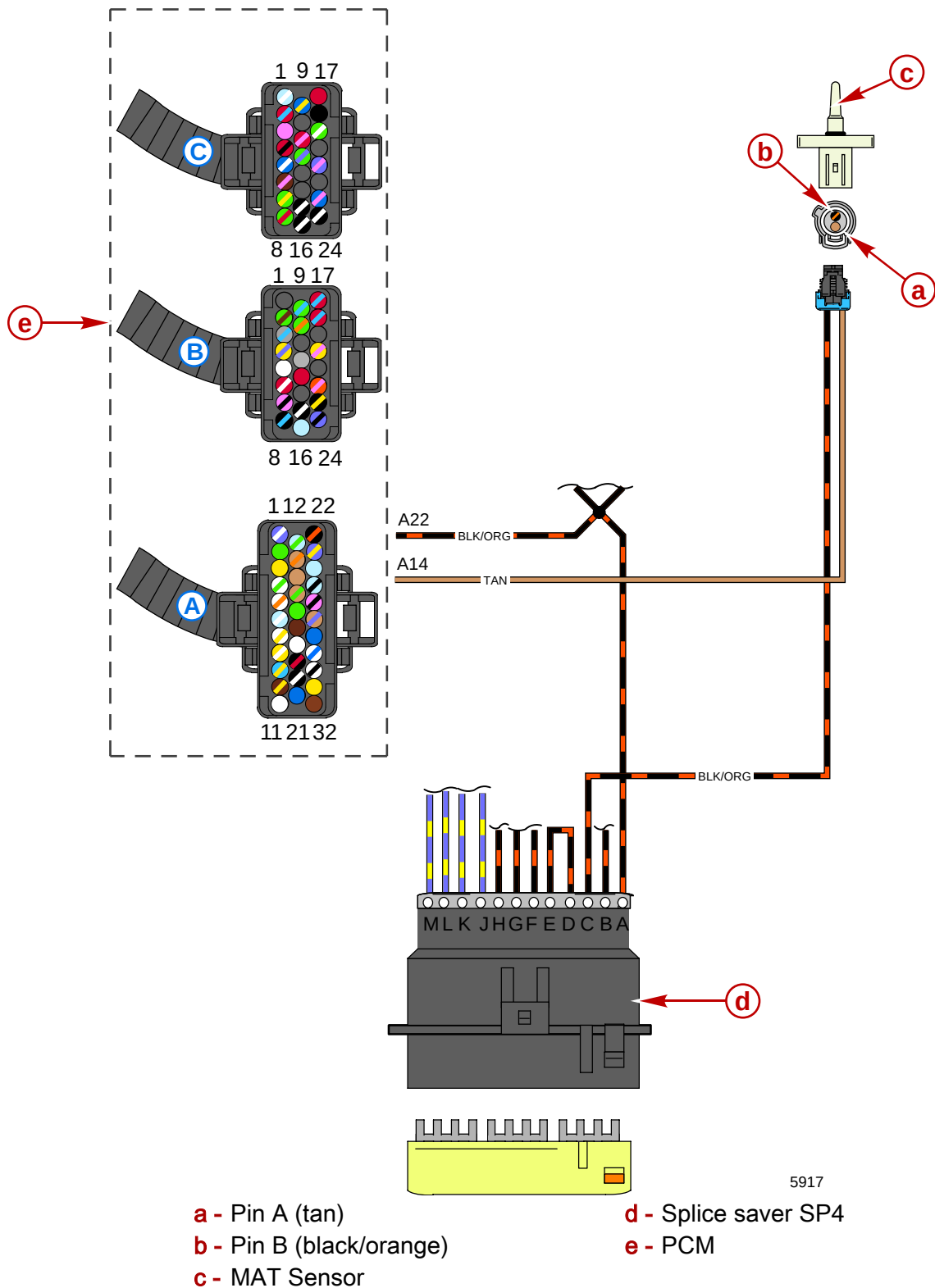
b - Pin B (black/orange)

4. The sensor can be tested with an ohmmeter by disconnecting it from the harness and heating or cooling the end of the sensor at a controlled temperature. If the readings do not match those in the table, replace the sensor and retest.

Manifold Air Intake Temperature Sensor Ohm Test				
Degree Centigrade	-8	20	40	60
Degree Fahrenheit	18	68	104	140
KΩ	9.82 kΩ ± 5%	2.57 kΩ ± 5%	1.13 kΩ ± 5%	0.54 kΩ ± 5%

5. If the ohm check of the MAT sensor indicates that the sensor is serviceable, perform and ohm check of the sensor wiring between the sensor connector and the PCM as follows:
 - PCM connector A pin 22 to pin B of sensor connector is less than 1 ohm.
 - PCM connector A pin 14 to pin A of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connect to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector or in between the connector, and the splice point.

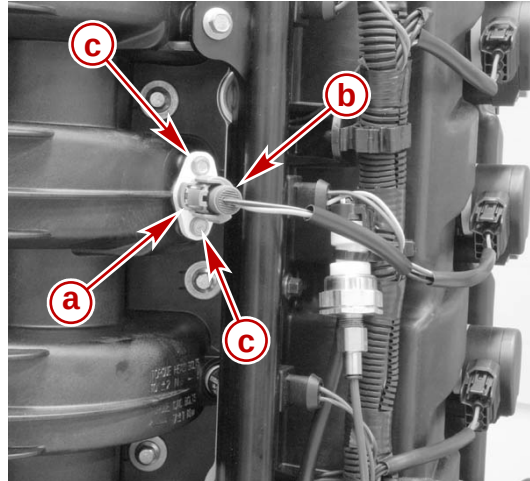


6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the Computer Diagnostic System or Digital Diagnostic Terminal.

Computer Diagnostic System	Order through SPX
Digital Diagnostic Terminal (DDT)	91-823686A2

MANIFOLD INTAKE AIR TEMPERATURE SENSOR REMOVAL

1. Disconnect sensor harness connector.
2. Remove two screws securing sensor and remove sensor.



a - MAT sensor

c - Screws

b - Harness connector

MANIFOLD AIR TEMPERATURE SENSOR INSTALLATION

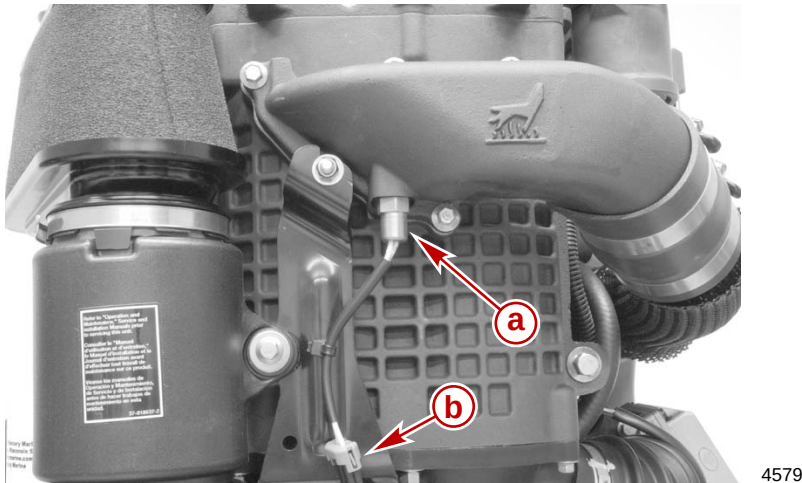
1. Inspect sensor O-ring for cuts or abrasions. Replace O-ring as required.
2. Install sensor with O-ring into cylinder block. Torque sensor screws to specification.

Description	Nm	lb. in.	lb. ft.
Sensor Screw (M4 x 16)	1.7	15	

3. Connect sensor harness to sensor.

Supercharger Outlet Temperature Sensor

The supercharger outlet temperature sensor is a thermistor immersed in the boost pressure outlet stream. It is located in the front of the engine, at the base of return duct. Low air temperature produces high resistance while high temperature causes low resistance. The PCM will reduce engine RPM and warn the helm of the high temperature.



a - Post supercharger temperature sensor **b** - Harness connector

SUPERCHARGER OUTLET TEMPERATURE SENSOR TEST

The Computer Diagnostic System (CDS) and the Digital Diagnostic Terminal (DDT) will both determine the proper functioning of the supercharger outlet temperature sensor by providing a numerical readout of the sensor temperature before and after the engine is started. With the engine not running, the sensor temperature should be approximately the same as the ambient air temperature. After the engine is started, the temperature sensor should indicate a rise in temperature.

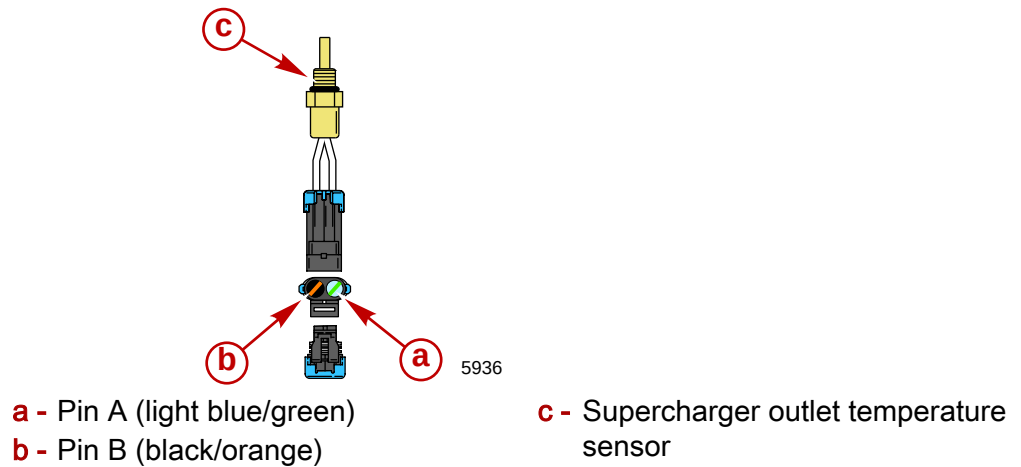
Supercharger Outlet Temperature Sensor Resistance	
@ 21° C (70° F)	11.3 kΩ

- 1. With the engine running and the CDS or DDT connected to the engine, if the sensor does not appear to be indicating a temperature change, shake or move the sensor harness and connector. If the temperature begins to change, look for a broken, loose or corroded wire.

Digital Diagnostic Terminal (DDT)	91-823686A2
Computer Diagnostic System	Order through SPX

- 2. Disconnect the connector from the sensor.

3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent, or corroded pins at the sensor; and loose, broken, or corroded wires at the connector.

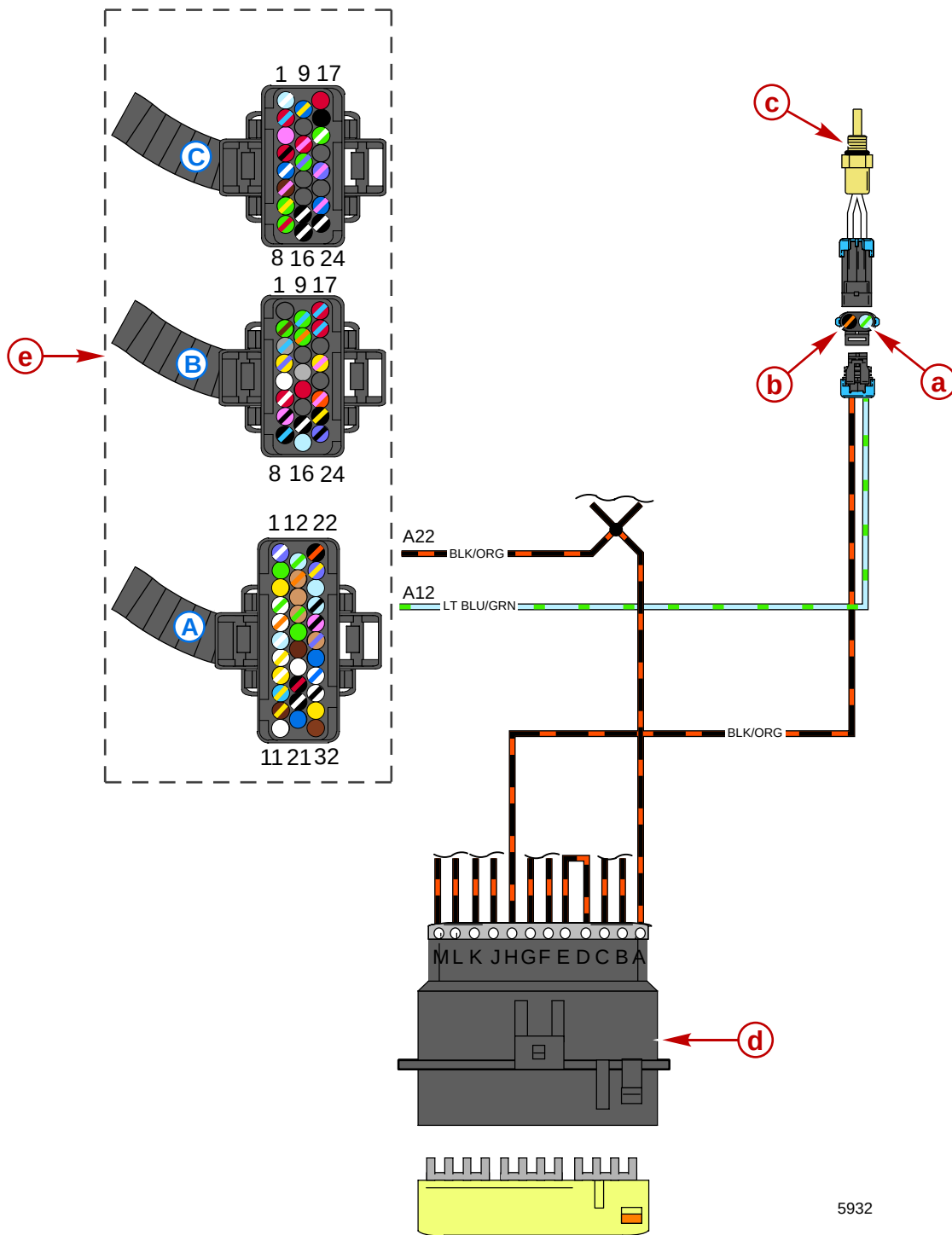


4. The sensor can be tested with an ohmmeter by disconnecting it from the harness and heating or cooling the end of the sensor at a controlled temperature. If the readings do not match those in the table, replace the sensor and retest.

Supercharger Outlet Temperature Sensor Ohm Test					
Degree Centigrade	10	21	38	65	160
Degree Fahrenheit	48	70	100	150	320
KΩ	17.63 kΩ	10.90 kΩ	5.05 kΩ	2.01 kΩ	174 Ω

5. If the ohm check of the sensor indicates that the sensor is serviceable, perform and ohm check of the sensor wiring between the sensor connector and the PCM as follows:
 - PCM connector A pin 22 to pin B of sensor connector is less than 1 ohm.
 - PCM connector A pin 12 to pin A of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connect to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector or in between the connector, and the splice point.



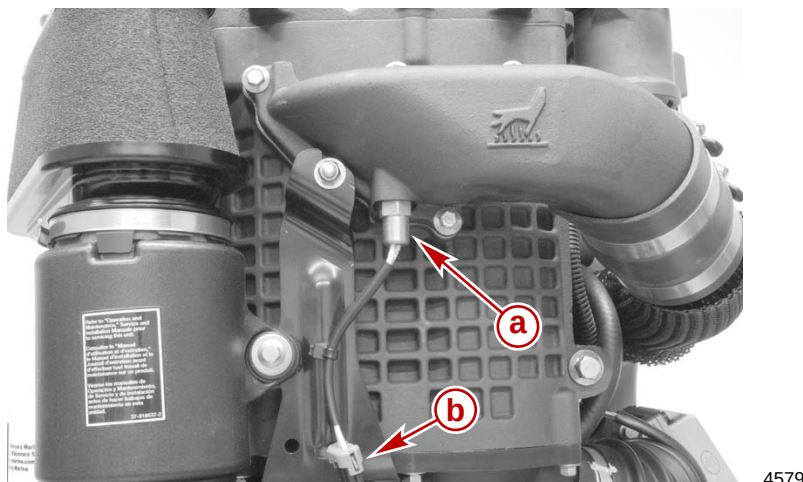
- a - Pin A (light blue/green)
- b - Pin B (black/orange)
- c - Supercharger outlet temperature sensor
- d - Splice saver SP5
- e - PCM

6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the Computer Diagnostic System or Digital Diagnostic Terminal.

Digital Diagnostic Terminal (DDT)	91-823686A2
Computer Diagnostic System	Order through SPX

SUPERCHARGER OUTLET TEMPERATURE SENSOR REMOVAL

1. Disconnect sensor harness connector.
2. Remove sensor from cylinder block.



a - Supercharger outlet temperature sensor **b** - Harness connector

SUPERCHARGER OUTLET TEMPERATURE SENSOR INSTALLATION

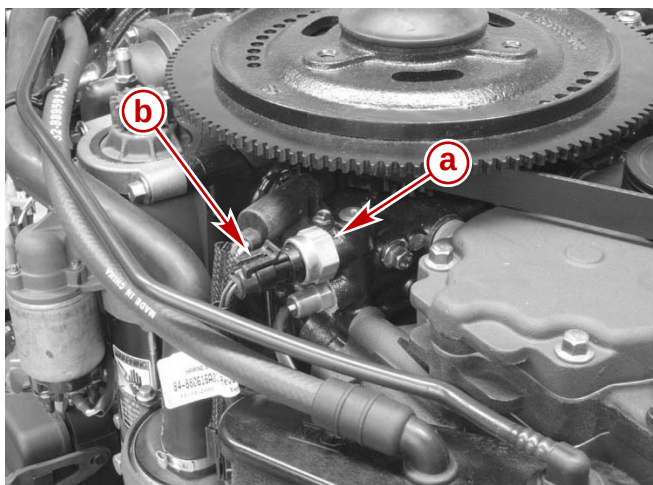
1. Inspect sensor O-ring for cuts or abrasions. Replace O-ring as required.
2. Install sensor with O-ring into cylinder block. Torque sensor to specification.

Description	Nm	lb. in.	lb. ft.
Temperature sensor	15	133	

3. Connect sensor harness to sensor.

Oil Pressure Sensor

The oil pressure sensor measures cylinder block oil pressure. It is located below the crank position sensor on the starboard side of the engine. In the event of low oil pressure, the PCM will limit engine power based on the amount of oil pressure available at a specific engine RPM.



5772

a - Oil pressure sensor**b** - Harness connector

OIL PRESSURE SENSOR TEST

The Computer Diagnostic System (CDS) and the Digital Diagnostic Terminal (DDT) will both determine the proper functioning of the oil pressure sensor by providing a numerical readout of the sensor after the engine is started.

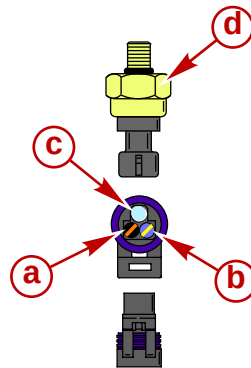
Oil Pressure Sensor	
@ idle	48 to 69 kPa (7 to 10 psi)
@ wide open throttle	448 to 655 kPa (65 to 95 psi)

1. With the engine running and the CDS or DDT connected to the engine, if the oil pressure sensor does not appear to be indicating a pressure change, shake or move the sensor harness and connector. If the pressure begins to change, look for a broken, loose, or corroded wires.

Computer Diagnostic System	Order through SPX
Digital Diagnostic Terminal (DDT)	91-823686A2

2. Disconnect the connector from the sensor.

3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent or corroded pins at the sensor and loose, broken or corroded wires at the connector.

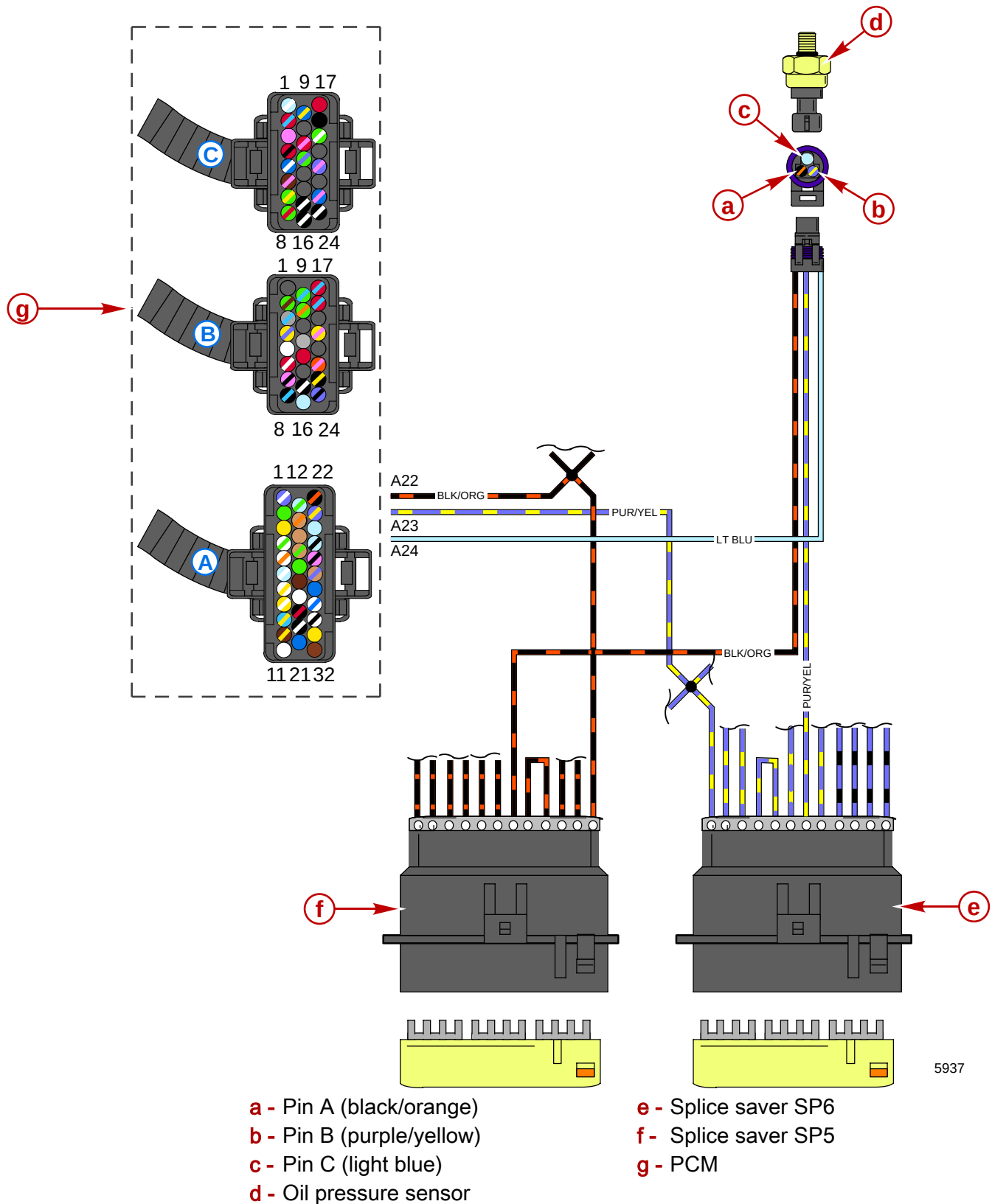


5938

a - Pin A (black/orange)**b** - Pin B (purple/yellow)**c** - Pin C (light blue)**d** - Oil pressure sensor

4. An ohm check of the oil pressure sensor can be made by disconnecting the sensor harness and measuring the resistance between pins A, B and C. The normal resistance values for the oil pressure sensor at 21° C (70° F) are:
 - Between pin A and pin B is 9.33 kΩ.
 - Between pin A and pin C is 3.89 kΩ.
5. If the ohm check of the oil pressure sensor indicates that the sensor is serviceable, perform an ohm check of the sensor wiring between the sensor connector and the PCM as follows:
 - PCM connector A pin 22 to pin A of sensor connector is less than 1 ohm.
 - PCM connector A pin 23 to pin B of sensor connector is less than 1 ohm.
 - PCM connector A pin 24 to pin C of sensor connector is less than 1 ohm.

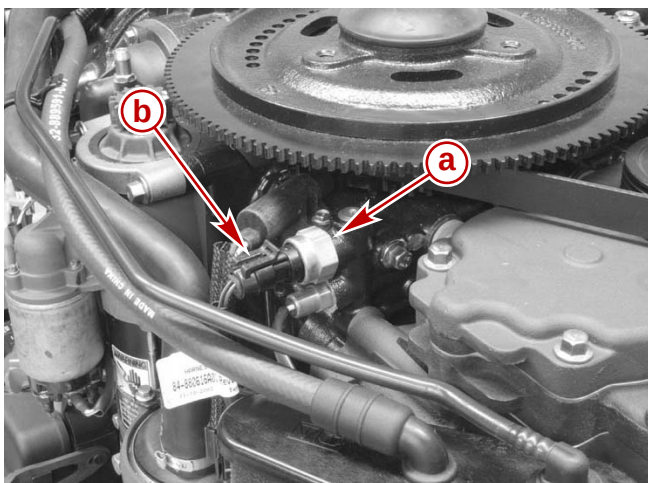
NOTE: All sensor ground wires are spliced together and connect to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector or in between the connector, and the splice point.



6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the Computer Diagnostic System or Digital Diagnostic Terminal.

OIL PRESSURE SENSOR REMOVAL

1. Disconnect sensor harness connector.
2. Remove sensor from cylinder block.



5772

a - Oil pressure sensor**b** - Harness connector

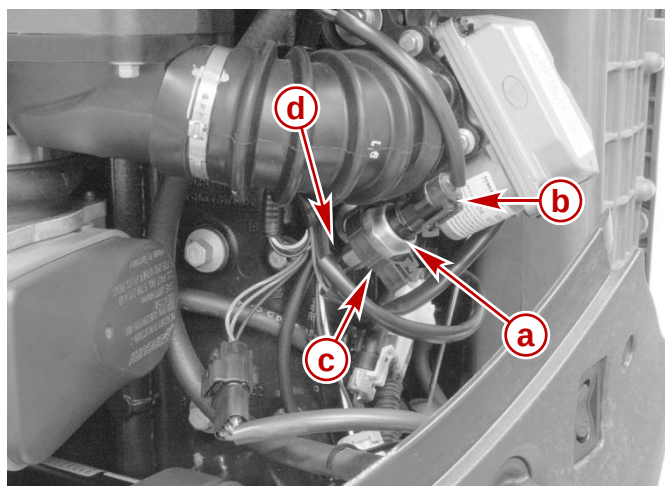
OIL PRESSURE SENSOR INSTALLATION

1. Install sensor into cylinder block. Torque sensor to specification.
2. Connect sensor harness to sensor.

Description	Nm	lb. in.	lb. ft.
Oil pressure sensor	15	133	

Pitot Pressure Sensor

The pitot pressure sensor measures the force of the water at the front of the gearcase. The sensor converts this pressure to a voltage which is sent to the PCM. The PCM uses this voltage signal to determine boat speed. The pitot pressure sensor is located beneath the electronic boost control front tube on the port side of the engine.



4578

a - Pitot pressure sensor**c** - Sensor retainer**b** - Harness connector**d** - Sensor water tube

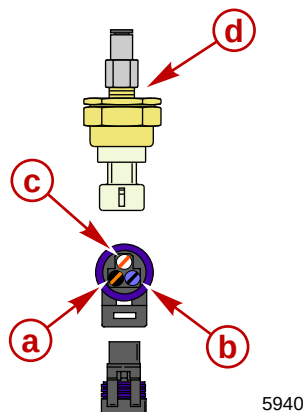
PITOT PRESSURE SENSOR TEST

The Computer Diagnostic System (CDS) and the Digital Diagnostic Terminal (DDT) will both determine the proper functioning of the pitot pressure sensor by providing a numerical readout of the sensor after the engine is started and the boat is moving forward through the water.

1. With the engine running and the boat moving forward and the CDS or DDT connected to the engine, if the pitot pressure sensor does not appear to be indicating a speed change, shake or move the sensor harness and connector. If the speed begins to change, look for a broken, loose, or corroded wires.

Computer Diagnostic System	Order through SPX
Digital Diagnostic Terminal (DDT)	91-823686A2

2. Disconnect the connector from the sensor.
3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent or corroded pins at the sensor and loose, broken or corroded wires at the connector.



a - Pin A (black/orange)

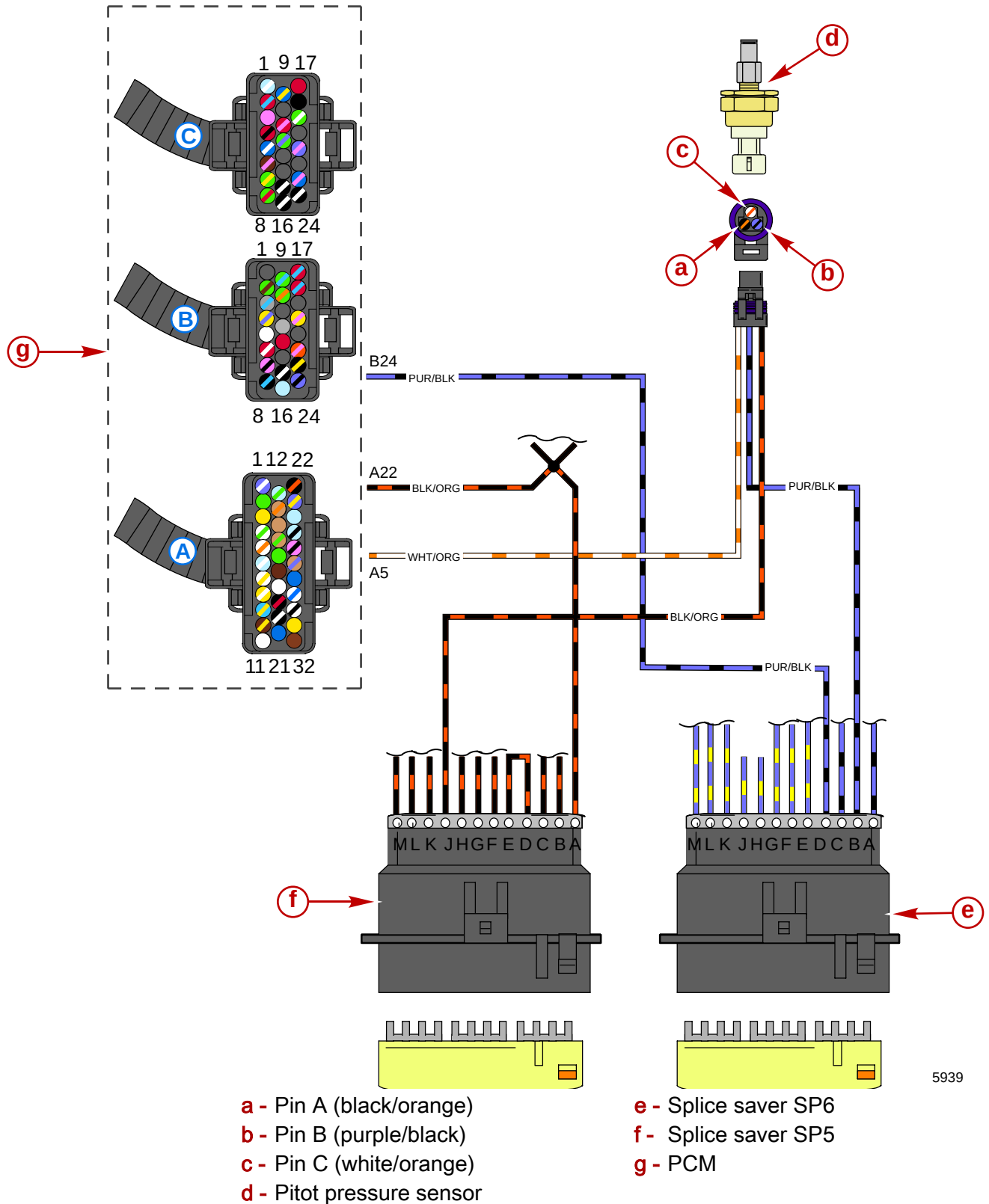
b - Pin B (purple/black)

c - Pin C (white/orange)

d - Pitot pressure sensor

4. An ohm check of the pitot pressure sensor can be made by disconnecting the sensor harness and measuring the resistance between pins A, B and C. The normal resistance values for the pitot sensor at 21° C (70° F) :
 - Between pin A and pin B is 9.33 kΩ.
 - Between pin A and pin C is 3.89 kΩ.
5. If the ohm check of the pitot pressure sensor indicates that the sensor is serviceable, perform an ohm check of the sensor wiring between the sensor connector and the PCM as follows:
 - PCM connector A pin 22 to pin A of sensor connector is less than 1 ohm.
 - PCM connector B pin 24 to pin B of sensor connector is less than 1 ohm.
 - PCM connector A pin 5 to pin C of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connect to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector or in between the connector, and the splice point.

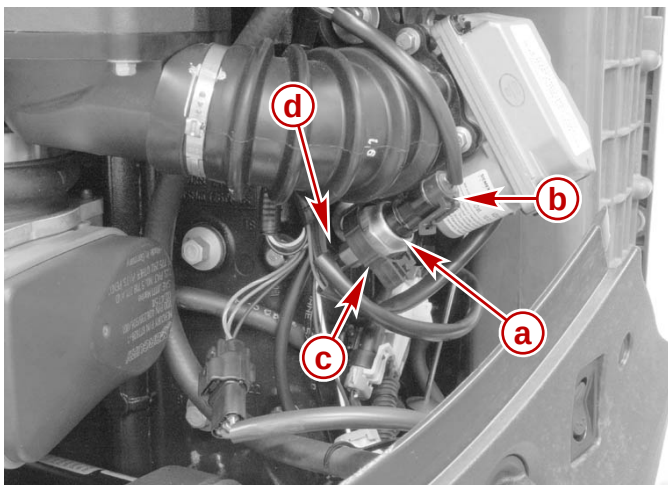


6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the Computer Diagnostic System or Digital Diagnostic Terminal.

Computer Diagnostic System	Order through SPX
Digital Diagnostic Terminal (DDT)	91-823686A2

PITOT PRESSURE SENSOR REMOVAL

1. Disconnect sensor harness connector.
2. Disconnect sensor water tube.
3. Unlock sensor retainer and remove sensor.



a - Pitot pressure sensor
b - Harness connector

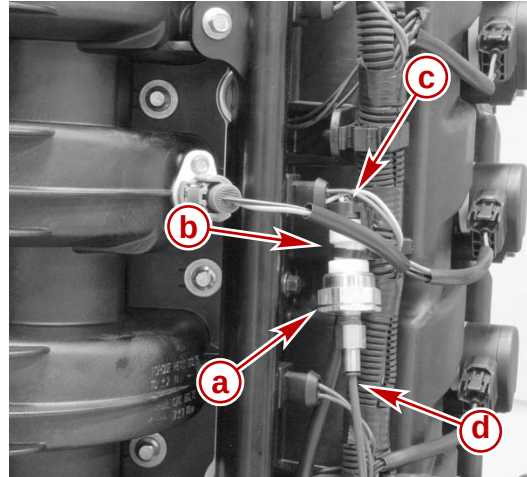
c - Sensor retainer
d - Sensor water tube

PITOT PRESSURE SENSOR INSTALLATION

1. Secure sensor with retainer.
2. Connect sensor harness to sensor.
3. Reconnect sensor water tube.

Block Water Pressure Sensor

The block water pressure sensor measures the amount of coolant being supplied by the water pump to the cylinder block. The sensor converts this pressure to a voltage which is sent to the PCM. The PCM will limit engine power if the coolant supply (water pressure) is insufficient at a given RPM. The water pressure sensor is located on the aft side of the engine and is secured to the fuel injector harness with a cable tie.



a - Block water pressure sensor

b - Cable tie

c - Harness connector

d - Sensor coolant tube

BLOCK WATER PRESSURE SENSOR TEST

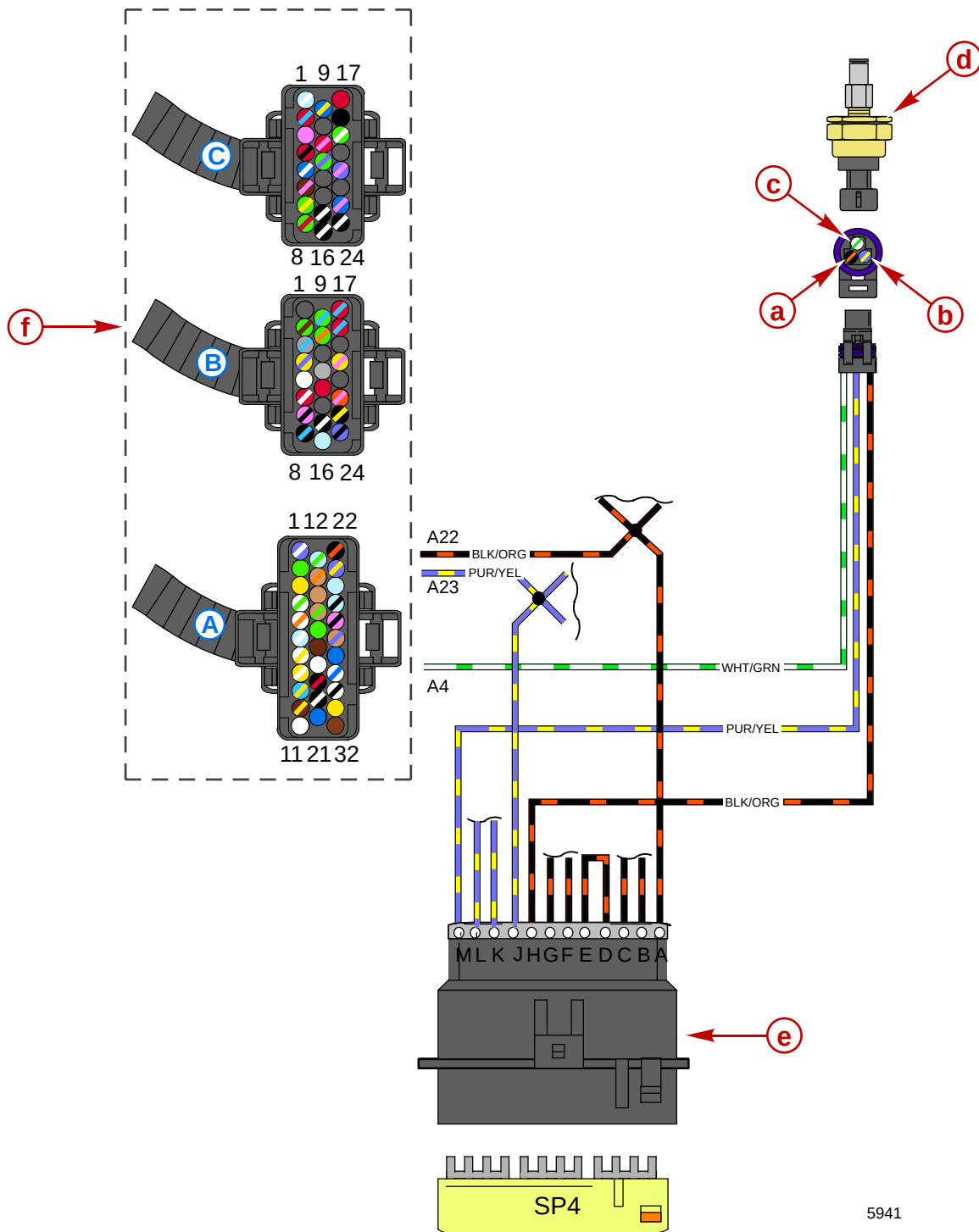
The Computer Diagnostic System (CDS) and the Digital Diagnostic Terminal (DDT) will both determine the proper functioning of the water pressure sensor by providing a numerical readout of the sensor after the engine is started and engine RPM is varied.

1. With the engine running and the CDS or DDT connected to the engine, if the water pressure sensor does not appear to be indicating a pressure change when engine RPM is varied, shake or move the sensor harness and connector. If the pressure begins to change, look for a broken, loose or corroded wires.

Computer Diagnostic System (CDS)	Order from SPX
Digital Diagnostic Terminal (DDT)	91-823686A2

2. Disconnect the connector from the sensor.
3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent or corroded pins at the sensor and loose, broken or corroded wires at the connector.
4. Perform an ohm check of the sensor wiring between the sensor connector and the PCM as follows:
 - PCM connector A pin 22 to pin A of sensor connector is less than 1 ohm.
 - PCM connector A pin 23 to pin B of sensor connector is less than 1 ohm.
 - PCM connector A pin 4 to pin C of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connect to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector, or in between the connector and the splice point.

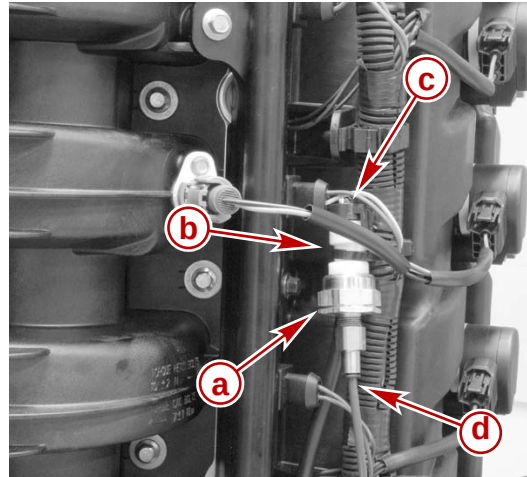


- If the wiring is serviceable, the PCM can be tested using the Digital Diagnostic Terminal or the Computer Diagnostic System with the pinpoint guided diagnostic instructions. If the PCM is serviceable, replace the sensor.

Computer Diagnostic System (CDS)	Order from SPX
Digital Diagnostic Terminal (DDT)	91-823686A2

BLOCK WATER PRESSURE SENSOR REMOVAL

1. Disconnect sensor harness connector.
2. Remove the water pressure sensor coolant tube.
3. Cut the cable tie securing the sensor and remove the sensor.



a - Block water pressure sensor
b - Cable tie

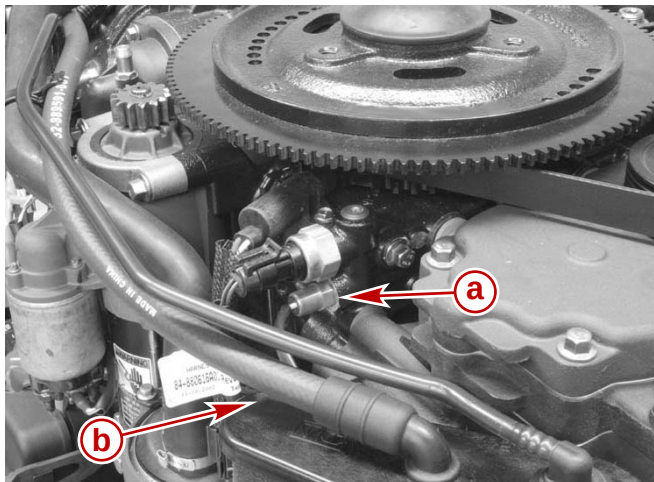
c - Harness connector
d - Coolant tube

BLOCK WATER PRESSURE SENSOR INSTALLATION

1. Connect sensor harness.
2. Install coolant tube to sensor.
3. Secure sensor to fuel injector wiring harness with cable tie.

Oil Temperature Sensor

The oil temperature sensor is located at the top of the cylinder block, below the oil pressure sensor. It is a thermistor immersed in the engine oil passage way. It supplies the PCM with engine oil temperature information. The PCM adjusts the timing and the amount of fuel delivered according to the oil temperature in the cylinder block. Low oil temperature produces high resistance, while high temperature causes low resistance. The normal resistance value for the sensor at 21° C (70° F) is 11.3 kΩ.



5851

a - Oil temperature sensor

b - Sensor harness connection (not shown)

OIL TEMPERATURE SENSOR TEST

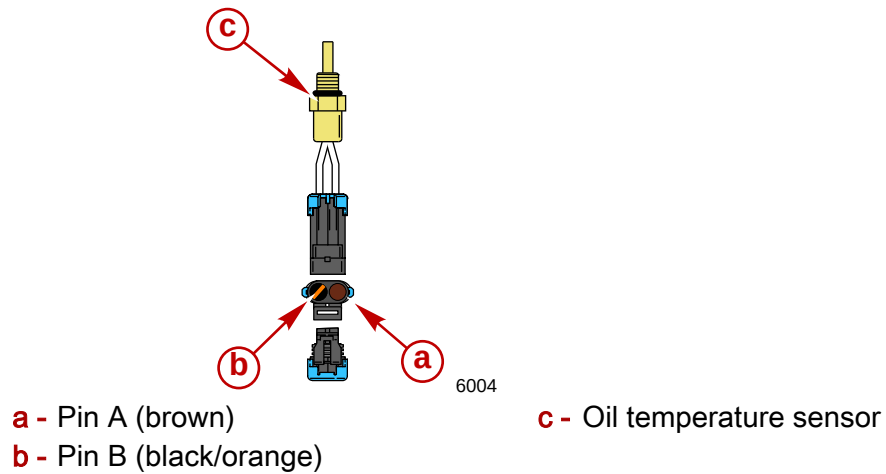
The Computer Diagnostic System (CDS) and the Digital Diagnostic Terminal (DDT) will both determine the proper functioning of the oil temperature sensor by providing a numerical readout of the oil temperature before and after the engine is started. With the engine not running, oil temperature should be approximately the same as the ambient air temperature. After the engine is started, the temperature sensor should indicate a rise in oil temperature to approximately 75° to 110° C (167° to 230° F). Outside air temperature and the temperature of the water that the engine is operating in will directly affect the engine oil temperature.

1. With the engine running and the CDS or DDT connected to the engine, if the oil temperature sensor does not appear to be indicating a temperature change, shake or move the sensor harness and connector. If the temperature begins to change, look for a broken, loose or corroded wire.

Computer Diagnostic System (CDS)	Order from SPX
Digital Diagnostic Terminal (DDT)	91-823686A2

2. Disconnect the connector from the sensor.

3. Perform a visual inspection of the pins at the sensor and the wires coming from the connector. Look for broken, bent or corroded pins at the sensor and loose, broken or corroded wires at the connector.

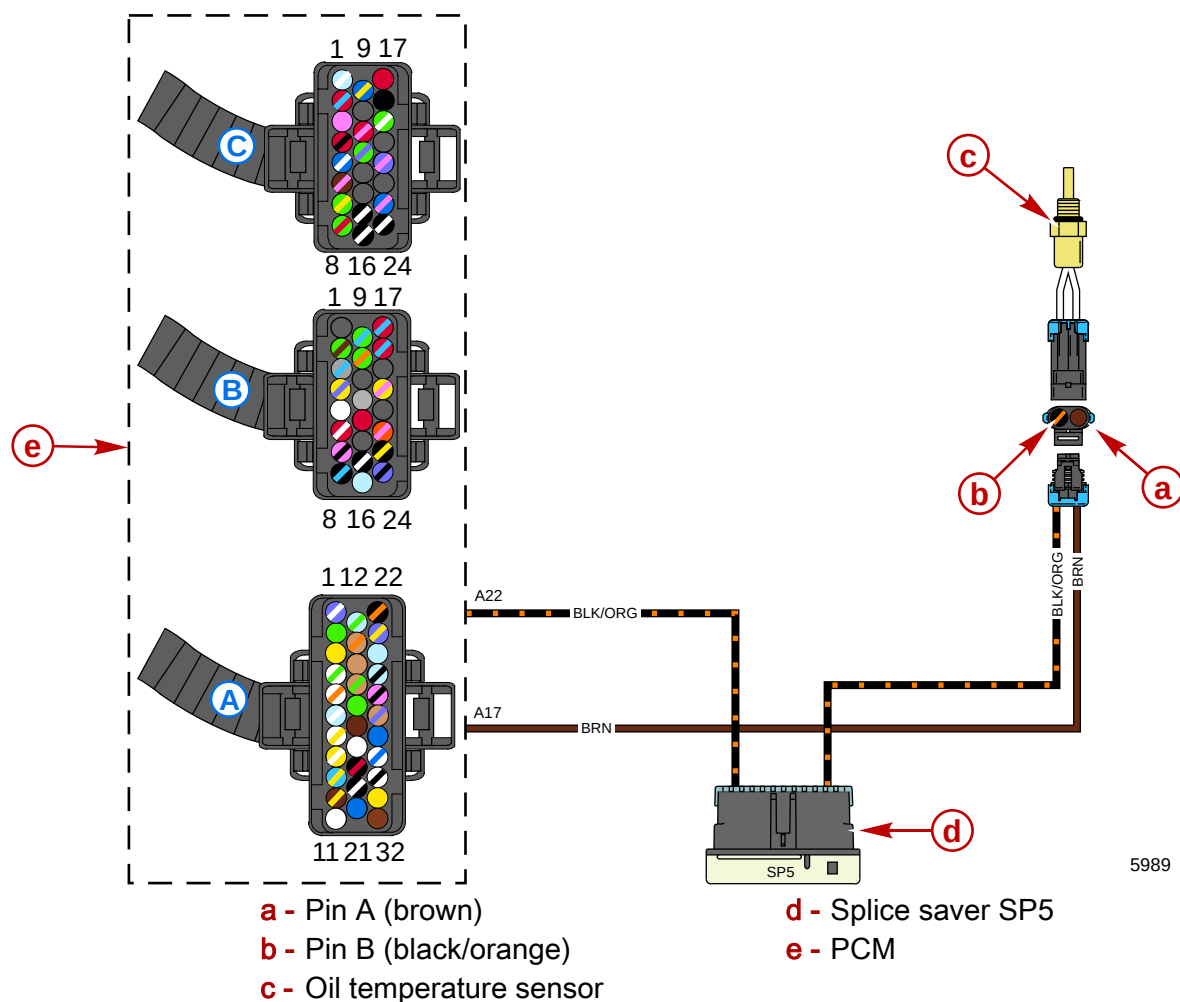


4. The sensor can be tested with an ohmmeter by disconnecting it from the harness and heating or cooling the end of the sensor at a controlled temperature. If the readings do not match those in the table, replace the sensor and retest.
5. If the ohm check of the oil temperature sensor indicates that the sensor is serviceable, perform an ohm check of the sensor wiring between the sensor connector and the PCM as follows:

Oil Temperature Sensor Ohm Test					
Degree Centigrade	-10	21	38	65	95
Degree Fahrenheit	14	70	100	150	203
KΩ	20 kΩ	11.3 kΩ	5.67 kΩ	2.05 kΩ	800 Ω

- PCM connector A pin 22 to pin B of sensor connector is less than 1 ohm.
- PCM connector A pin 17 to pin A of sensor connector is less than 1 ohm.

NOTE: All sensor ground wires are spliced together and connect to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector, or in between the connector and the splice point.



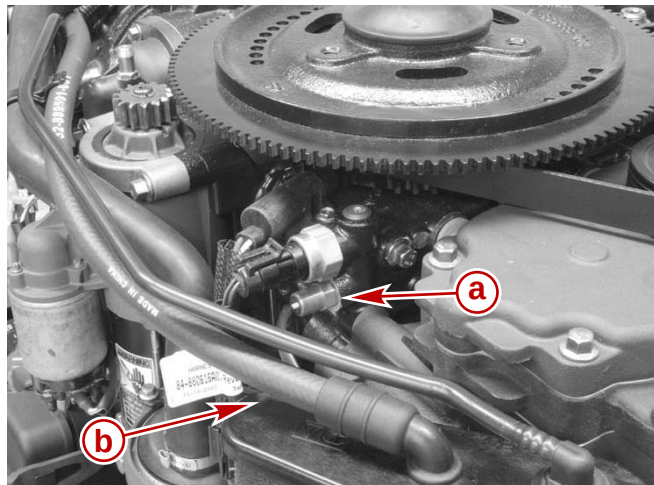
6. If the wiring is serviceable, replace the PCM and recheck the sensor function using the Computer Diagnostic System or Digital Diagnostic Terminal.

Computer Diagnostic System (CDS)	Order from SPX
Digital Diagnostic Terminal (DDT)	91-823686A2

OIL TEMPERATURE SENSOR REMOVAL

1. Disconnect sensor harness connector.

2. Remove sensor from cylinder block.



a - Oil temperature sensor

b - Harness connection (not shown)

OIL TEMPERATURE SENSOR INSTALLATION

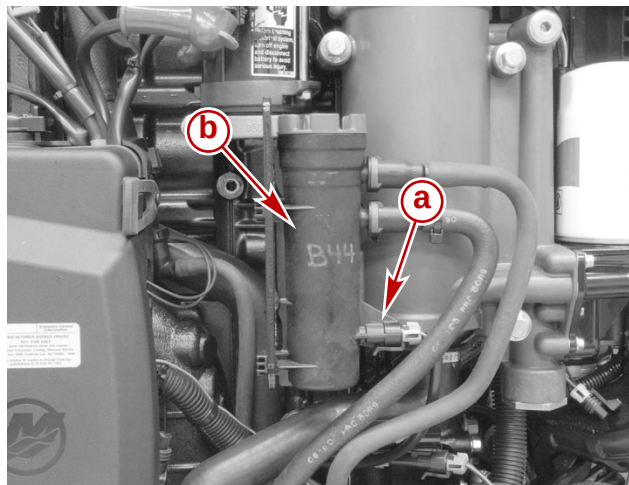
1. Inspect sensor O-ring for cuts or abrasions. Replace O-ring as required.
2. Install sensor with O-ring into cylinder block. Torque sensor to specification.

Description	Nm	lb. in.	lb. ft.
Oil temperature sensor	15	133	

3. Connect sensor harness to sensor.

Water in Fuel (WIF) Sensor

The water in fuel sensor is located in the lower portion of the engine fuel filter which is mounted on the starboard side of the engine. The sensor is a normally open switch which when exposed to water completes a circuit and activates a warning horn.

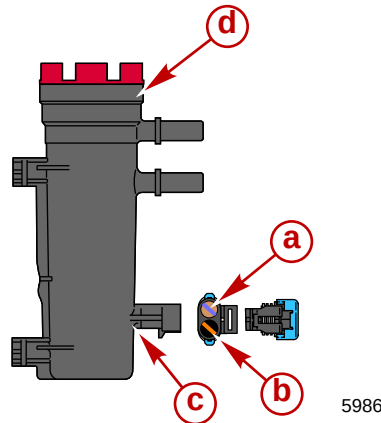


a - Water in fuel sensor

b - Fuel filter assembly

WATER IN FUEL SENSOR TEST

1. If the water in fuel warning horn activates, remove the fuel filter assembly from the engine and pour the contents into a clear container. If no water is present, disconnect the water in fuel sensor harness and perform a continuity check between the two sensor pins. There should be no continuity. If there is continuity, the sensor is defective and the fuel filter assembly must be replaced.

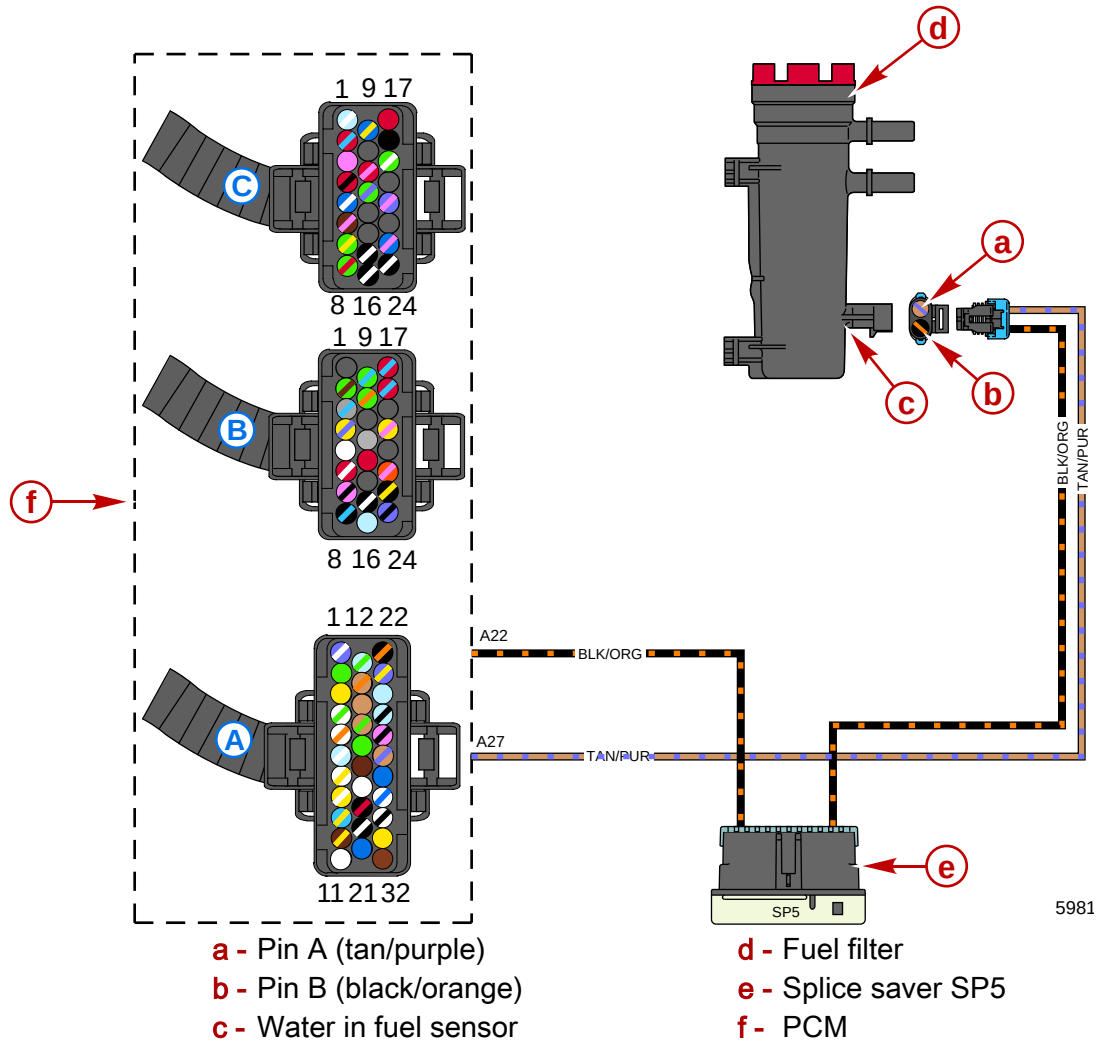


a - Pin A (tan/purple)
b - Pin B (black/orange)

c - Water in fuel sensor
d - Fuel filter

2. If the sensor is serviceable, perform a continuity check on the sensor harness between the sensor connector and the PCM. Check for shorts to ground.
 - PCM connector A pin 22 to pin B of sensor connector is less than 1 ohm.
 - PCM connector A pin 27 to pin A of sensor connector is less than 1 ohm. There should be no shorts to ground.

All sensor ground wires are spliced together and connect to the PCM at pin 22 of the A connector. Unless there are multiple sensor failures, the most likely failure would be at the splice point, connector, or in between the connector and the splice point.



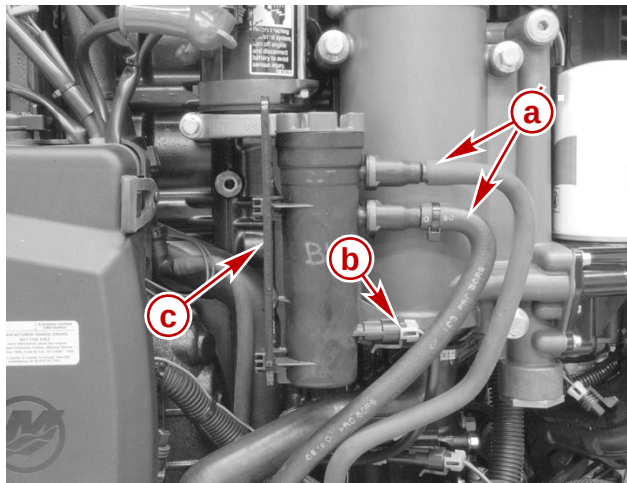
If the sensor harness is serviceable, replace the PCM.

WATER IN FUEL SENSOR REMOVAL

NOTE: The water in fuel sensor is not replaceable as an individual component. It must be replaced as part of the fuel filter assembly.

1. Disconnect sensor harness.
2. Remove two fuel hoses from fuel filter.

3. Slide fuel filter assembly up and out of the retaining bracket.



a - Fuel hoses

b - Harness connector

c - Retaining bracket

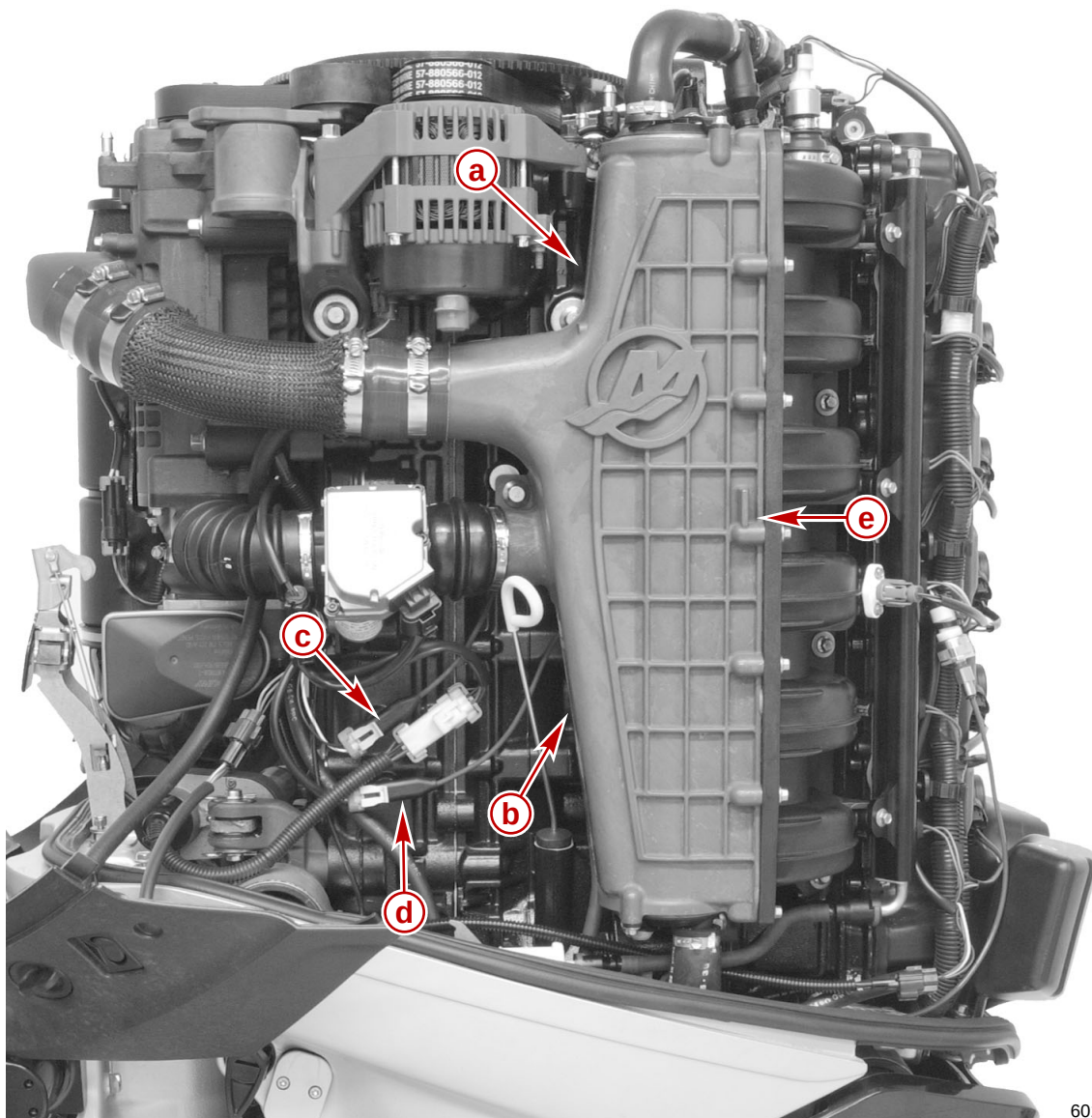
WATER IN FUEL SENSOR INSTALLATION

1. Slide fuel filter assembly into retaining bracket.
2. Reconnect fuel hoses.
3. Reconnect sensor harness.

Knock Sensor

There are two knock sensors located on the port side of the engine behind the charge cooler/intake manifold. The knock sensors are piezoelectric transducers with a 1-2 mv per G - force output signal. When detonation occurs in a cylinder, a vibration is generated in the cylinder block which activates the knock sensors to produce their output signal to the PCM. The PCM will reduce timing and/or increase fuel into the cylinders until the detonation stops.

IMPORTANT: The knock sensor harness connections must not be interchanged with one another. The PCM is calibrated to receive detonation information from a specific location. Switching harness connections between knock sensors may allow certain levels of detonation to occur unimpeded by the PCM resulting in engine damage.



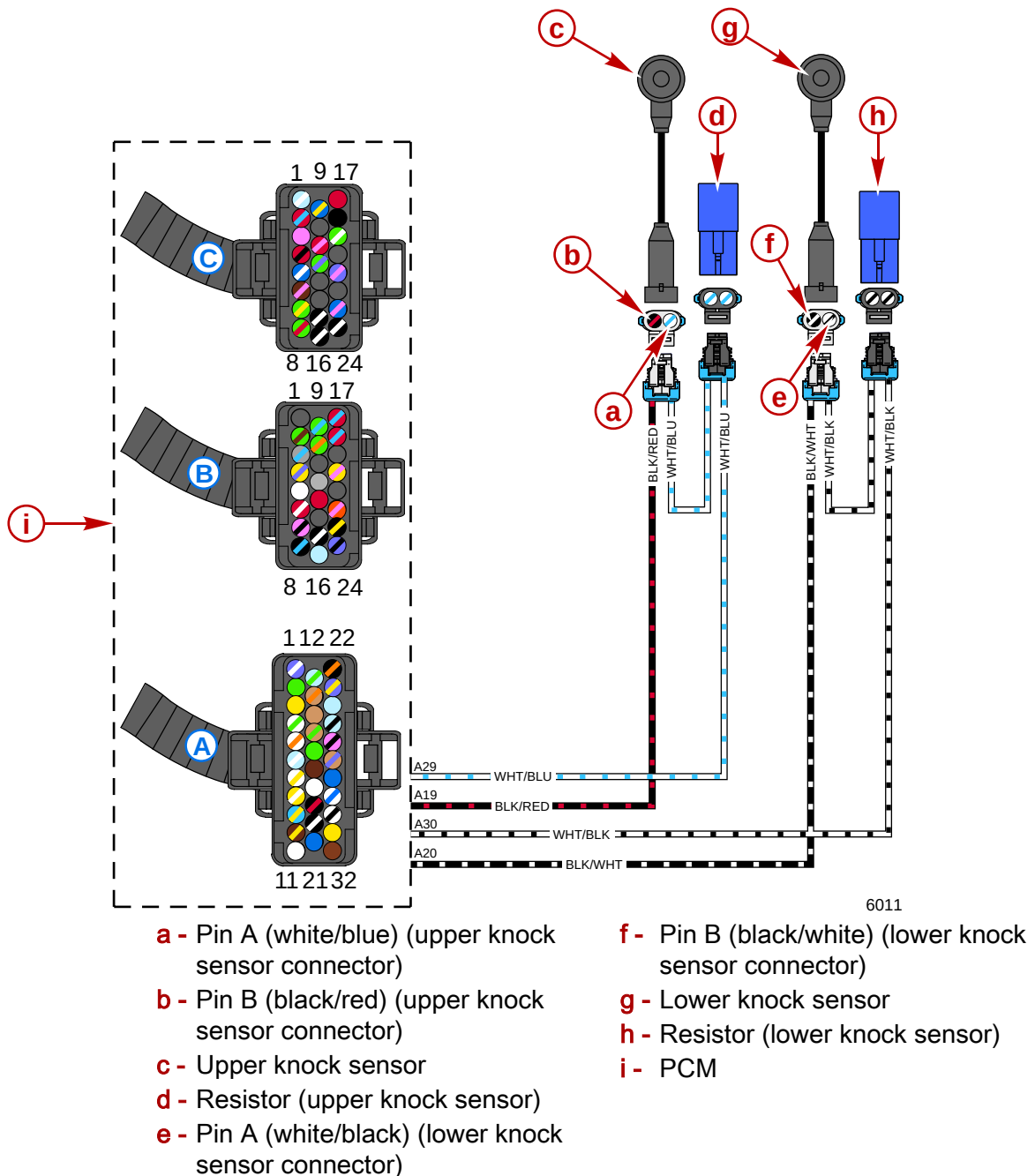
6010

- a** - Upper knock sensor (hidden behind charge cooler/intake manifold)
- b** - Lower knock sensor (hidden behind charge cooler/intake manifold)
- c** - Upper knock sensor connector (white/blue wire)
- d** - Lower knock sensor connector (white/black wire)
- e** - Charge cooler/intake manifold

KNOCK SENSOR TEST

There is no practical field test for this device. Check connector for bent, broken, or corroded pins. Perform continuity check between knock sensor connectors and PCM. Consult the PCM fault codes. If the PCM indicates a fault, test the connector and wire connections.

- PCM connector A pin 29 to pin A (white/blue) of upper knock sensor connector is 20 kohms (+/- 10%).
- PCM connector A pin 19 to pin B (black/red) of upper knock sensor connector is less than 1 ohm.
- PCM connector A pin 30 to pin E (white/black) of lower knock sensor is 20 kohms (+/- 10%).
- PCM connector A pin 20 to pin F (black/white) of lower knock sensor connector is less than 1 ohm.



KNOCK SENSOR REMOVAL

1. Refer to Section 4 for charge cooler/intake manifold removal procedures.
2. Disconnect knock sensor harness connectors.
3. Remove screw and washer securing knock sensor and remove sensor.

KNOCK SENSOR INSTALLATION

1. Secure knock sensor with screw and washer. Torque screw to specification.

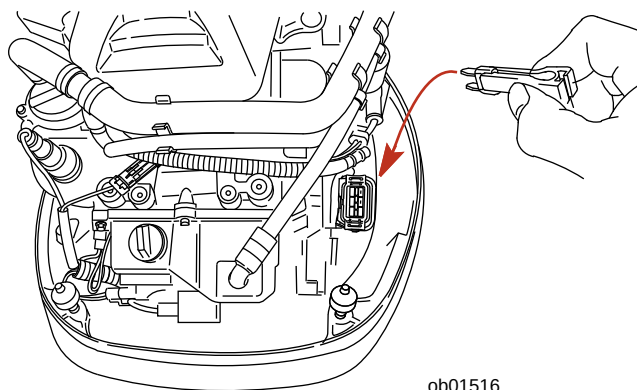
Description	Nm	lb. in.	lb. ft.
Screw (M10 x 35)	20		15

2. Reconnect sensor harness to sensor.
3. Refer to Section 4 for installation procedures for charge cooler/intake manifold.

Fuses

The electrical wiring circuits on the outboard are protected from overload by fuses in the wiring. If a fuse is blown, try to locate and correct the cause of the overload. If the cause is not found, the fuse may blow again.

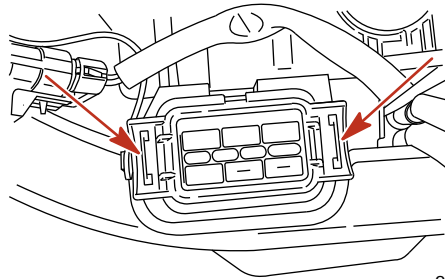
1. Remove top cowl. Locate fuse holder on starboard side of engine.



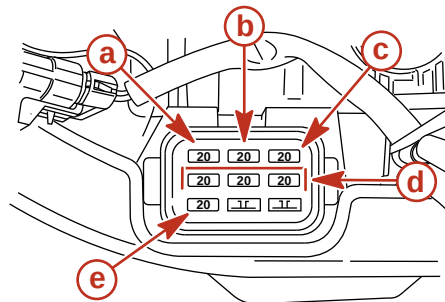
ob01516

2. Remove the plastic cover from the fuse holder.
3. Remove fuse puller from fuse holder.
4. Remove suspected blown fuse to determine if the silver colored band is broken.

5. Replace fuse with a new fuse of the same amperage rating.



ob01252



ob01259

- a** - Electronic Control Module and purge valve "ECM" - 20 amp fuse
- b** - Ignition coils "IGN. COILS" - 20 amp fuse
- c** - Fuel delivery "FUEL" - 20 amp fuse
- d** - Spare fuses - 20 amp fuse
- e** - Injector power and boost valve "INJ. PWR." - 20 amp fuse

Electrical

Section 2B - Charging and Starting System

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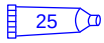
**2
B**

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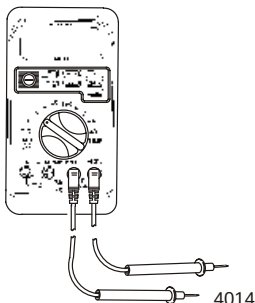
Charging and Starting Specifications

Charging and Starting Specifications	
Alternator Output (Regulated)	
Output @ Battery (@ 1000 RPM)	37 - 44 Amperes
Output @ Battery (@ 3000 RPM)	53 - 69 Amperes
Output @ Alternator (@ 1000 RPM)	48 - 54 Amperes
Output @ Alternator (@ 3000 RPM)	65 - 72 Amperes
Voltage Set Point	14.5 +/- 0.25 Volts
Regulator Current Draw ¹ .	
Ignition Switch "OFF" (maximum)	1.0 mA
Ignition Switch "ON"	350 mA
Starter Draw (Under Load)	160 Amperes
Starter Draw (No Load)	60 Amperes
Minimum Brush Length	65.4 mm (0.25 in.)
Battery Rating	
Marine Cranking Amperes (minimum)	1000
Cold Cranking Amperes (minimum)	800
Ampere Hour (Ah) (minimum)	180

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Liquid Neoprene	Starter motor threads and cable ends	92-25711-3
		Alternator cable ends	
		Starter bolt; ground wire eyelet	
		Starter exciter wire terminal; battery starter cable	

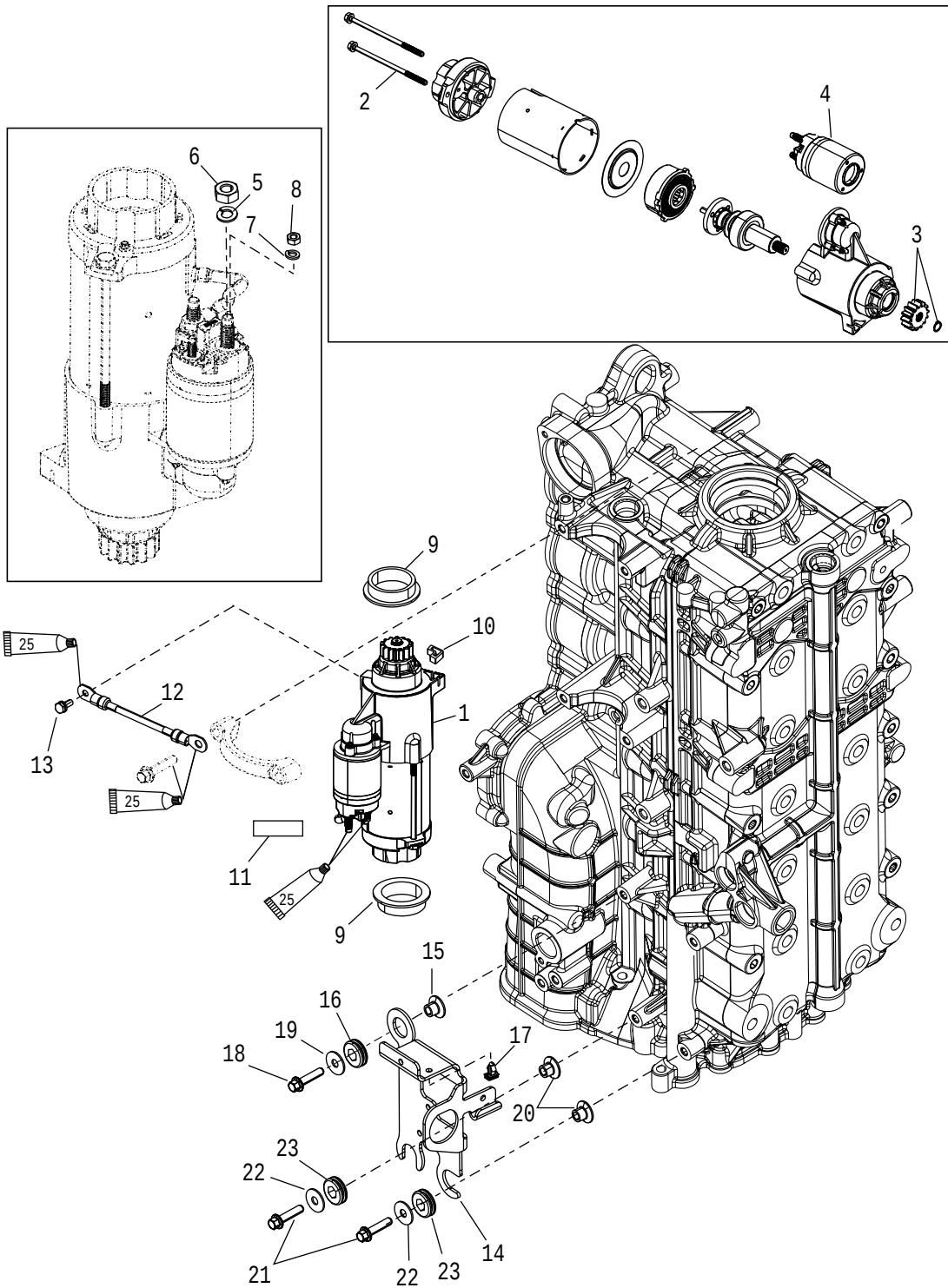
Special Tools - Charging and Starting System

DMT 2004 Digital Tachometer Multi-meter	91-892647A01
	Measures RPM, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

1. All model alternator specifications require an amperage draw of less than 1.0 mA with the ignition key in the "OFF" position and an amperage draw of not more than 350.0 mA with key in the "ON" position.

Notes:

Starter Motor Components



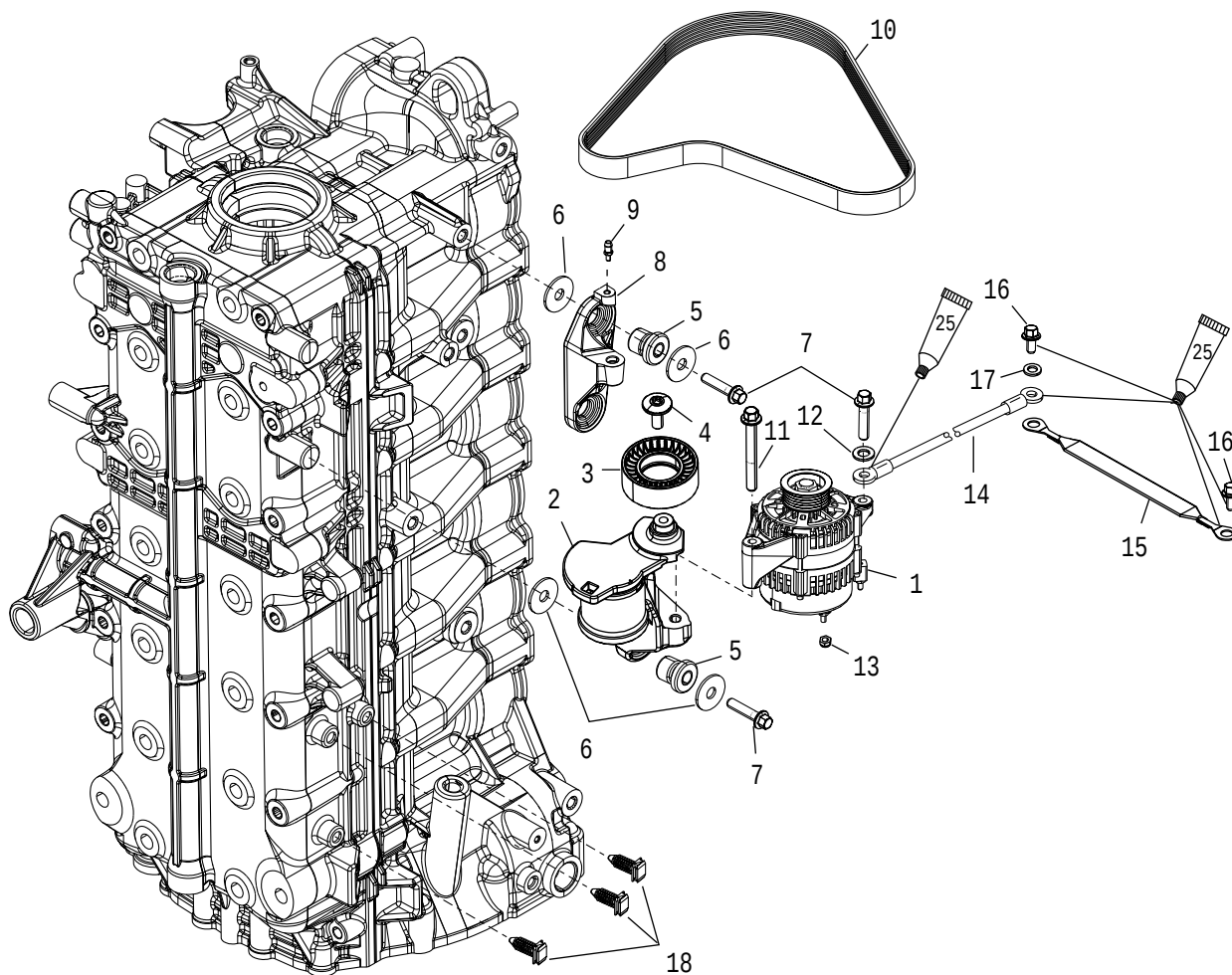
2392

Starter Motor Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Starter motor			
2	2	Bolt	12.5	110	
3	1	Gear kit			
4	1	Solenoid			
5	1	Lock washer			
6	1	Nut (M8)	9	80	
7	1	Lock washer			
8	1	Nut (M5)	2.5	22	
9	2	Collar			
10	1	Stop			
11	1	Decal			
12	1	Cable			
13	1	Screw (1/4-20 x .62)	9	80	
14	1	Bracket			
15	1	Bushing			
16	1	Grommet			
17	1	Clip			
18	1	Screw (M8 x 35)	24		17.7
19	1	Washer			
20	2	Bushing			
21	2	Screw (M8 x 35)	24		17.7
22	2	Washer			
23	2	Grommet			

Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Starter motor threads and cable ends	92-25711-3

Alternator and Belt Tensioner



2391

Alternator and Belt Tensioner

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Alternator (70 Ampere)			
2	1	Belt tensioner			
3	1	Pulley			
4	1	Screw			
5	4	Mount			
6	8	Washer			
7	5	Screw (M8 x 45)	47.5		35
8	1	Bracket			
9	1	Pin	8	71	
10	1	Drive belt			
11	1	Screw (M10 x 85)	47.5		35
12	1	Washer			
13	1	Nut (M6)	7	62	
14	2	Cable			
15	1	Cable (braided)			
16	2	Screw (M6 x 16)	8	71	
17	1	Washer			
18	3	Clip			

Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Alternator cable ends	92-25711-3

Battery Cable Test

This test is used to determine if there is excessive resistance in the battery's positive or negative cables, or if the cable is sized properly to carry the necessary current needed to crank the engine at the proper RPM.

IMPORTANT: This test must be performed while the key switch is in the "START" position. Ignore any voltage readings taken without the circuit under load.

WARNING

Avoid the possibility of serious injury when working on a running engine. When performing tests or checking adjustments on a running engine, always wear eye protection, and keep hands, hair and clothing away from moving parts.

1. Perform a load test on the battery following the instructions supplied with the load tester. Ensure that the battery is brought to a full charge after being tested.
2. With the key switch in the "START" position, measure the voltage across the battery posts **not the cable clamps**. Record the voltage reading. If the voltage is less than 10 VDC, replace the battery.

NOTE: The voltage reading in step 2 is the base voltage. The base voltage reading will be compared to the voltage readings obtained in the following steps.

3. With the key switch in the "START" position, measure the voltage from the battery positive post (not the cable clamp) to the starter post (the stud where the battery positive cable is connected). Record the voltage reading.
4. With the key switch in the "START" position, measure the voltage from the starter case to the battery negative post (not the cable clamp). Record the voltage reading.
5. If the voltage reading in step 3 was more than 1.0 VDC:
 - a. Check the cable connections for tightness and corrosion.
 - b. If the cable is tight and not corroded, replace the cable with a larger diameter cable.
6. If the voltage reading in step 4 was more than 1.0 VDC:
 - a. Check the cable connections for tightness and corrosion.
 - b. If the cable is tight and not corroded, replace the cable with a larger diameter cable.

Resistance in the cables can cause a voltage drop and limit current to the starter. If corrosion is present, or if the starter is worn, there may not be enough amperage to turn the starter motor.

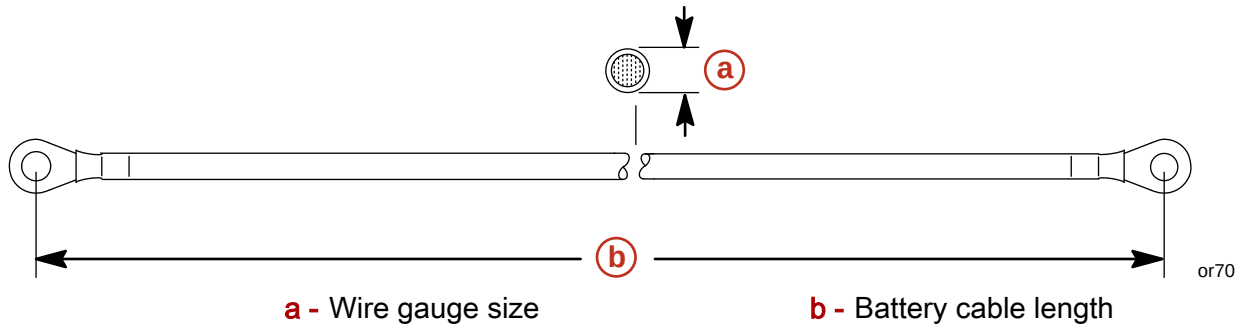
NOTE: If the voltage at the starter is less than 11 VDC, the engine may not start.

Battery Cable Size For Outboard Models

IMPORTANT: Only use copper battery cables. Do not use aluminum cables for any outboard marine installations.

- If longer battery cables are required, the wire gauge size must increase. See chart following for correct wire gauge size.

- DTS L models are equipped with 3.7 m (12 ft.) cables. DTS XL and XXL models are not shipped with battery cables.



Copper Battery Cable Wire Gauge Size					
Wire Gauge Size Number SAE					
Models		6-25 hp	30-115 hp (except OptiMax)	125-250 hp (except OptiMax)	OptiMax/Verado
Cable Length	2.4 m (8 ft.)	8 ¹ .	6 ¹ .	-	-
	2.7 m (9 ft.)	6	4	-	-
	3.0 m (10 ft.)	6	4	6 ¹ .	-
	3.4 m (11 ft.)	6	4	4	-
	3.7 m (12 ft.)	6	4	4	4 ¹ .
	4.0 m (13 ft.)	6	2	4	2
	4.3 m (14 ft.)	4	2	4	2
	4.6 m (15 ft.)	4	2	4	2
	4.9 m (16 ft.)	4	2	2	2
	5.2 m (17 ft.)	4	2	2	2
	5.5 m (18 ft.)	4	2	2	2
	5.8 m (19 ft.)	4	2	2	2
	6.1 m (20 ft.)	4	2	2	2
	6.4 m (21 ft.)	2	1	2	1
	6.7 m (22 ft.)	2	1	2	1
	7.0 m (23 ft.)	2	1	2	1
	7.3 m (24 ft.)	2	1	2	1
	7.6 m (25 ft.)	2	1	2	1
	7.9 m (26 ft.)	2	1/0	1	1/0
	8.2 m (27 ft.)	2	1/0	1	1/0
	8.5 m (28 ft.)	2	1/0	1	1/0
	8.8 m (29 ft.)	2	1/0	1	1/0
	9.1 m (30 ft.)	2	1/0	1	1/0
	9.4 m (31 ft.)	2	1/0	1	1/0
	9.8 m (32 ft.)	2	1/0	1	1/0
	10.1 m (33 ft.)	2	2/0	1/0	2/0
	10.4 m (34 ft.)	2	2/0	1/0	2/0
	10.7 m (35 ft.)	1	2/0	1/0	2/0
	11.0 m (36 ft.)	1	2/0	1/0	2/0
	11.3 m (37 ft.)	1	2/0	1/0	2/0
	11.6 m (38 ft.)	1	2/0	1/0	2/0
	11.9 m (39 ft.)	1	2/0	1/0	2/0
	12.2 m (40 ft.)	1	2/0	1/0	2/0

1. Standard (original) cable length and wire gauge size.

Replacement Parts

WARNING

Electrical, ignition and fuel system components on Mercury Marine Power Products are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

CAUTION

Deep-cycle batteries are not suitable for use as engine starting batteries or for use as accessory batteries that are connected to high output engine charging systems. Deep-cycle battery life may be shortened by high output engine charging systems. Refer to individual battery manufacturer instructions for specific battery charging procedures and applications.

Recommended Battery

A 12 volt marine battery with a minimum Cold Cranking amperage rating of 800 amperes or 1000 (minimum) Marine Cranking amperes should be used.

Battery Precautions

CAUTION

If battery acid comes in contact with skin or eyes, wash skin immediately with a mild soap. Flush eyes with water immediately and seek medical attention.

When charging batteries, and explosive gas mixture forms in each cell. Part of this gas escapes through holes in vent plugs and may form an explosive atmosphere around battery if ventilation is poor. This explosive gas may remain in or around battery for several hours after it has been charged. Sparks or flames can ignite this gas and cause an internal explosion which may shatter the battery.

The following precautions should be observed to prevent an explosion.

1. Do not smoke near batteries being charged or which have been charged very recently.
2. Do not break live circuits at terminals of batteries because a spark usually occurs at the point where a live circuit is broken. Always be careful when connecting or disconnecting cable clamps on chargers. Poor connections are a common cause of electrical arcs which cause explosions.
3. Do not reverse polarity of battery terminal to cable connections.

Charging a Discharged Battery

WARNING

Hydrogen and oxygen gases are produced during normal battery operation or charging. Sparks or flame can cause this mixture to ignite and explode if they are brought near the vent openings. Sulphuric acid in battery can cause serious burns if spilled on skin or in eyes. Flush or wash away immediately with clear water.

The following basic rules apply to any battery charging situation:

1. Any battery may be charged at any rate (in amperes) or as long as spewing of electrolyte (from violent gassing) does not occur and for as long as electrolyte temperature does not exceed 52° C (125° F). If spewing of electrolyte occurs, or if electrolyte temperature does exceed 52° C (125° F), charging rate (in amperes) must be reduced or temporarily halted to avoid damage to the battery.
2. Battery is fully charged when, over a 2 hour period at a low charging rate (in amperes), all cells are gassing freely (not spewing liquid electrolyte), and no change in specific gravity occurs. Full charge specific gravity is 1.260 - 1.275, corrected for electrolyte temperature with electrolyte level at 4.8 mm (3/16 in.) over plate, unless electrolyte loss has occurred (from age or over-filling) in which case specific gravity reading will be lower. For most satisfactory charging, lower charging rates in amperes are recommended.
3. If, after prolonged charging, specific gravity of at least 1.230 on all cells cannot be reached, battery is not in optimum condition and will not provide optimum performance; however, it may continue to provide additional service, if it has performed satisfactorily in the past.
4. To check battery voltage while cranking engine with electric starting motor at ambient air temperature of 23.8° C (75° F), place red (+) lead of tester on positive (+) battery terminal and black (–) lead of tester on negative (–) battery terminal. If the voltage drops below 10-1/2 volts while cranking, the battery is weak and should be recharged or replaced.

Winter Storage of Batteries

Battery companies are not responsible for battery damage either in winter storage or in dealer stock if the following instructions are not observed:

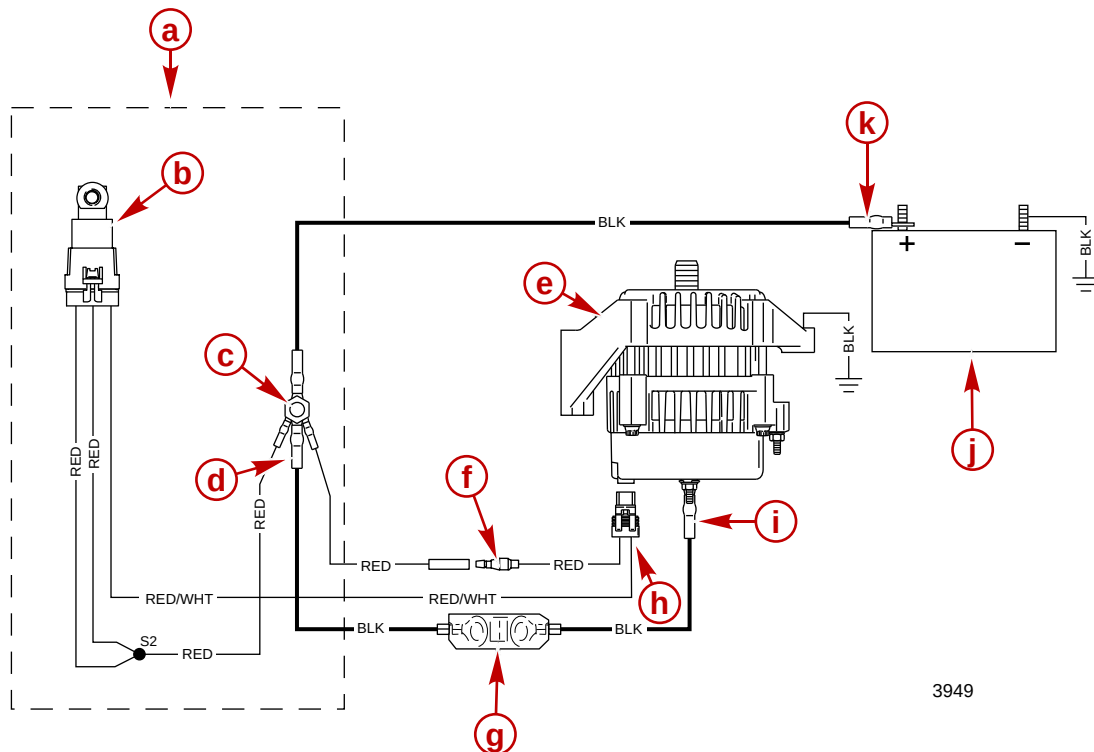
1. Remove battery from its installation as soon as possible and remove all grease, sulfate and dirt from top surface by running water over top of battery. Be sure, however, that vent caps are tight beforehand and blow off all excess water thoroughly with compressed air. Check water level, making sure that plates are covered.
2. When adding distilled water to battery, be extremely careful not to fill more than 4.8 mm (3/16 in.) above perforated baffles inside battery. Battery solution or electrolyte expands from heat caused by charging. Overfilling battery will cause electrolyte to overflow (if filled beyond 4.8 mm [3/16 in.] above baffles).
3. Grease terminal bolts well with 2-4-C with Teflon and store battery in a cool-dry place. Remove battery from storage every 30-45 days, check water level and put on charge for 5 or 6 amperes. Do not fast charge.
4. If specific gravity drops below 1.240, check battery for reason and recharge. When gravity reaches 1.260, discontinue charging. To check specific gravity, use a hydrometer, which can be purchased locally.

5. Repeat preceding charging procedure every 30 - 45 days, as long as battery is in storage, for best possible maintenance during inactive periods to ensure a good serviceable battery in spring. When ready to place battery back in service, remove excess grease from terminals (a small amount is desirable on terminals at all times), recharge again as necessary and reinstall battery.

Alternator System

System Components

The charging system consists of the alternator, battery, 150 ampere fusible link, main power relay and wiring that connects these components.



3949

- | | |
|--|---|
| a - Electrical box | g - 150 Ampere fusible link |
| b - Main power relay | h - Alternator excitation lead |
| c - Positive cable terminal | i - Alternator output lead (black with red sleeve) |
| d - Black cable with red sleeve | j - 12 VDC battery |
| e - 70 Ampere alternator | k - Positive battery lead (black with red sleeve) |
| f - Alternator sense lead | |

PRECAUTIONS

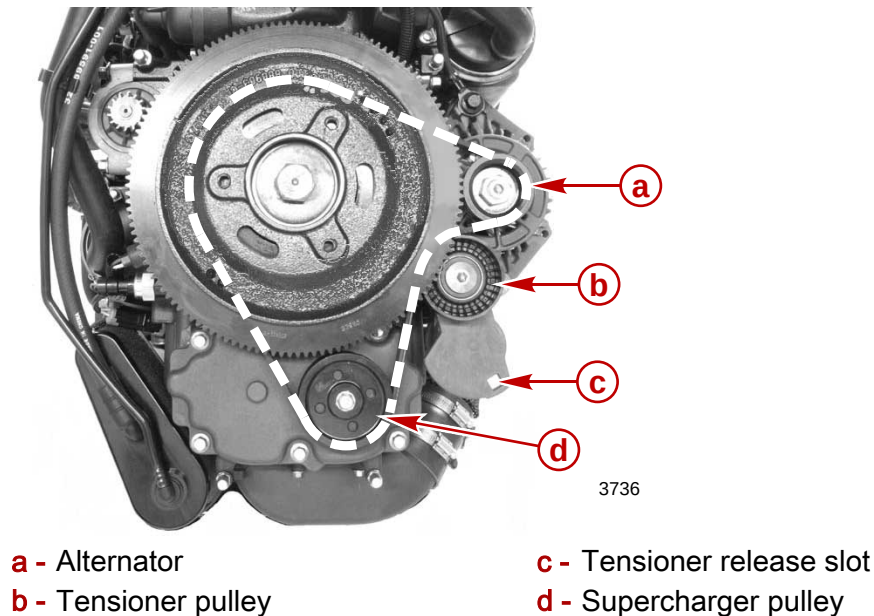
The following precautions must be observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator system.

1. Do not attempt to polarize the alternator.
2. Do not short across or ground any of the terminals on the alternator, except as specifically instructed.
3. Never disconnect the alternator output lead, regulator harness or battery cables when the alternator is being driven by the engine.
4. Always remove negative (–) battery cable from battery before working on alternator system.

5. When installing battery, be sure to connect the negative (–) (grounded) battery cable to negative (–) battery terminal and the positive (+) battery cable to positive (+) battery terminal. Connecting the battery cables to the battery in reverse will result in blowing the 150 ampere fusible link in the output lead of the alternator. The alternator will not be able to charge the battery and the battery will be quickly discharged if the engine is run.
6. When using a charger or booster battery, connect it in parallel with existing battery (positive to positive; negative to negative).

Alternator and Supercharger Belt Tension Adjustment

Correct alternator and supercharger belt tension is maintained by a belt tensioner assembly.



Alternator Description

The alternator employs a rotor is supported in 2 end frames by ball bearings, and is driven at 2.8 times engine speed. The rotor contains a field winding enclosed between 2 multiple-finger pole pieces. The ends of the field winding are connected to 2 brushes which make continuous sliding contact with the slip rings. The current (flowing through the field winding) creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

The 3-phase stator is mounted directly over the rotor pole pieces and between the 2 end frames. It consists of 3 windings wound 120 degrees electrically out of phase on the inside of a laminated core.

The rectifier bridge contains 6 diodes which allows current to flow from ground, through the stator and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge changes this alternating current to direct current which appears at the output terminal. The diode trio is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by a transistorized voltage regulator that senses the voltage at the battery, and regulates the field current to maintain alternator voltage for properly charging the battery. Current output of the alternator does not require regulation, as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cutout relay in the voltage regulator also is not required, as the rectifier diodes prevent the battery from discharging back through the stator.

A small amount of current is supplied by the excitation circuit in the regulator to the rotor field to initially start the alternator charging. Once the alternator begins to produce output, field current is supplied solely by the diode trio.

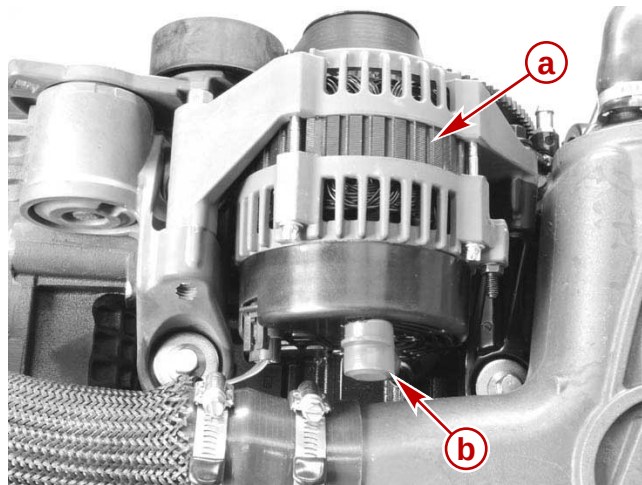
The alternator is equipped with 2 fans which induce air flow through the alternator to remove heat created by the rectifier and stator.

Diagnosis of Alternator System on Engine

1. If problem is an undercharged battery, verify condition has not been caused by excessive accessory current draw or by accessories which have accidentally left on.
2. Check physical condition and state of charge of battery. Battery must be at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery before testing system.
3. Inspect entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly battery cable clamps and battery terminals.

IMPORTANT: Red output lead from alternator must be tight. A darkened red sleeve indicates lead was loose and becoming hot. Verify output lead attaching nut is torqued to specification

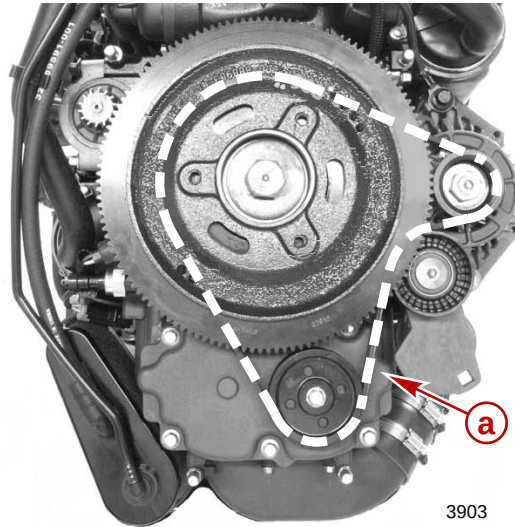
Description	Nm	lb. in.	lb. ft.
Nut	7	62	



a - Alternator

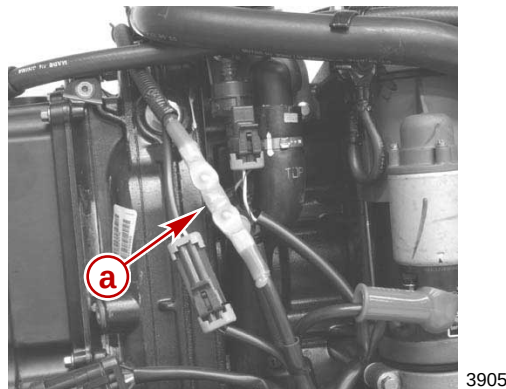
b - Red sleeved output lead (under red boot)

4. Check alternator drive belt for excessive wear, cracks, glazed surfaces and fraying. Replace if necessary. Check belt tension.



a - Alternator/supercharger drive belt

5. Inspect 150 ampere fuseable link located in alternator red sleeved output lead. If link is blown, check battery leads for reversal and replace alternator red sleeved output lead.



a - 150 ampere fuseable link

Alternator System Circuitry Test

Perform the following tests with a DMT 2004 Digital Tachometer Multi-meter to ensure that all of the circuits between the alternator and the other components within the charging system are in good condition.

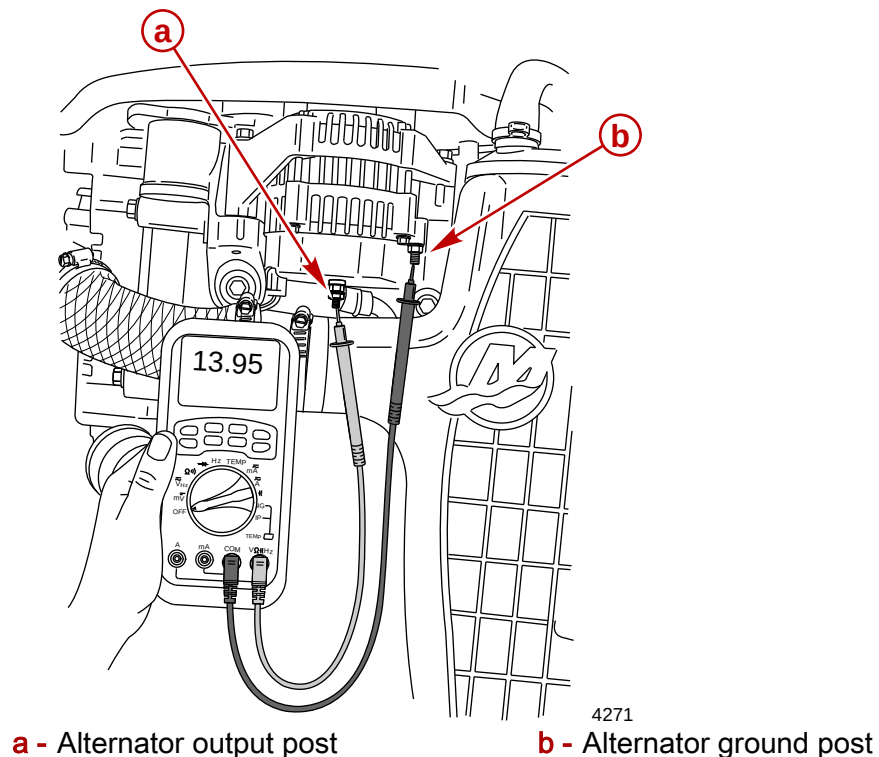
DMT 2004 Digital Tachometer	91-892647A01
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1. Check the belt condition and tension.
2. Check wire connections at alternator for tightness and absence of corrosion.
3. Check wire connections at battery for tightness and absence of corrosion.
4. Check the battery condition. The battery should be fully charged.

OUTPUT CIRCUIT

1. Connect the DMT positive (+) lead to the battery positive (+) post.
2. Connect the DMT negative (-) lead to the battery negative (-) post.
3. Supply cooling water to the engine.

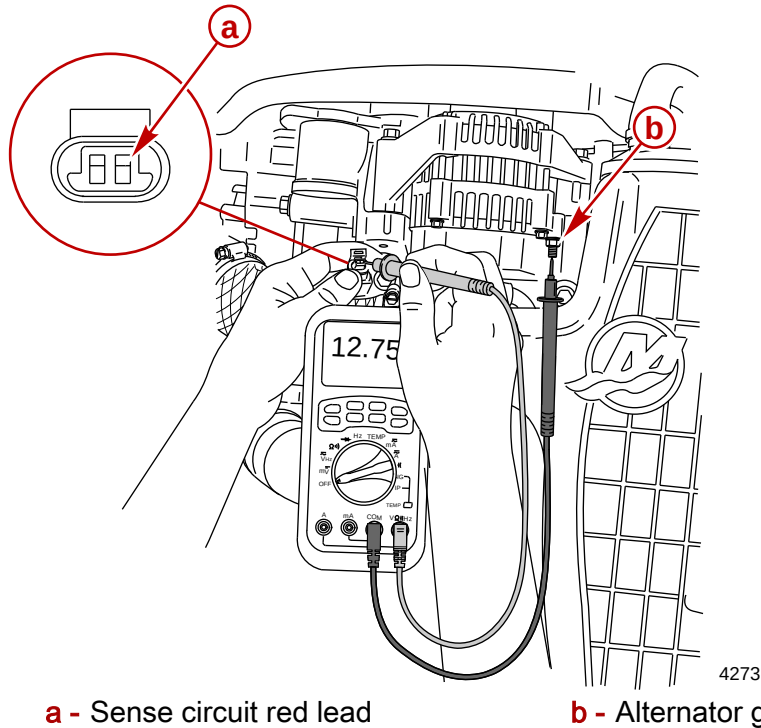
4. Start the engine and increase engine speed to approximately 1300 RPM.
5. Observe the voltage reading.
6. If the reading is between 13.5 and 14.8 volts, switch the DMT to the AC volt position. A reading of 0.25 AC volts or less indicates that the alternator diodes are fully functional. A reading above 0.25 AC volts indicates that the diodes are faulty and the alternator must be replaced.
7. If the reading is below 13.5 volts:
 - a. Connect the positive (+) DMT lead to the alternator output post.
 - b. Connect the negative (-) DMT lead to the ground post on the alternator.
 - c. Wiggle the engine wiring harness while observing the voltmeter. The meter should indicate the approximate battery voltage and should not vary. If no reading is obtained or if the reading varies, inspect the wiring harness for loose connections, corrosion, breaks or shorts. Repair or replace harness as required.
8. If reading above 15 volts at the battery, the alternator is overcharging and must be replaced.



SENSING CIRCUIT

1. Unplug the red and red/white connector from the alternator.
2. Connect the positive (+) DMT lead to the red pin and the negative (-) DMT lead to the ground terminal.

3. The DMT should indicate the battery voltage. If battery voltage is not present, check the Red lead for loose or dirty connection or damaged wiring.



a - Sense circuit red lead

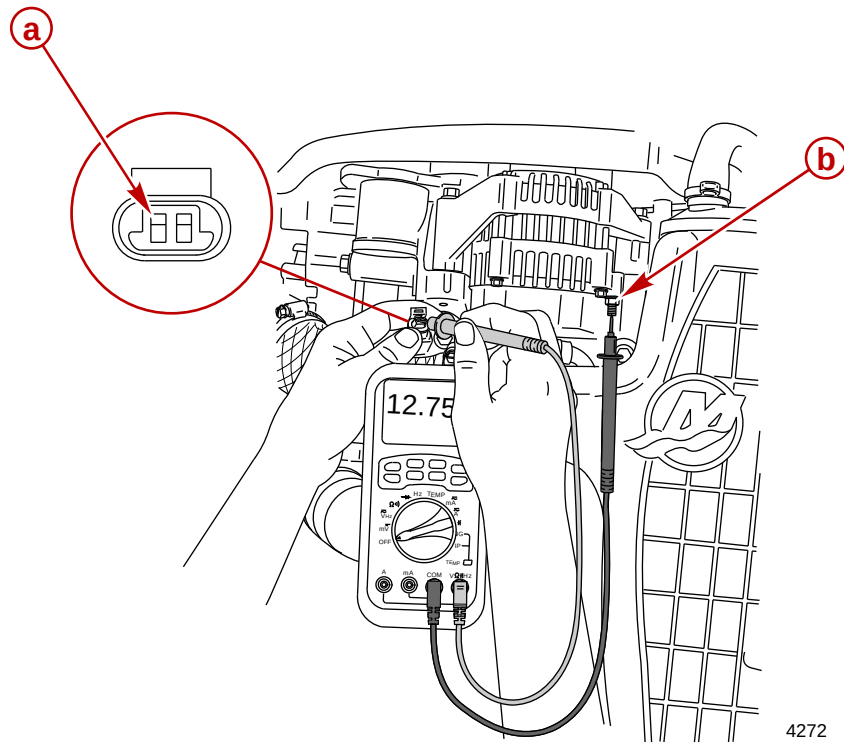
b - Alternator ground post

EXCITATION CIRCUIT

NOTE: The ignition key must be in the "ON" position (engine not running). Battery voltage will be present at the red/white pin for approximately 5 seconds before the main power relay times out due to the engine not running. After main power relay times out, no voltage will be present.

1. Unplug the red and red/white connector from the alternator.
2. Connect the positive (+) DMT lead to the red/white pin and the negative (-) DMT lead to the ground terminal.

3. The DMT should indicate battery voltage. If battery voltage is not present, check the red/white lead for loose or dirty connection or damaged wiring.



a - Excitation circuit red/white lead

b - Alternator ground post

Alternator Removal

⚠ CAUTION

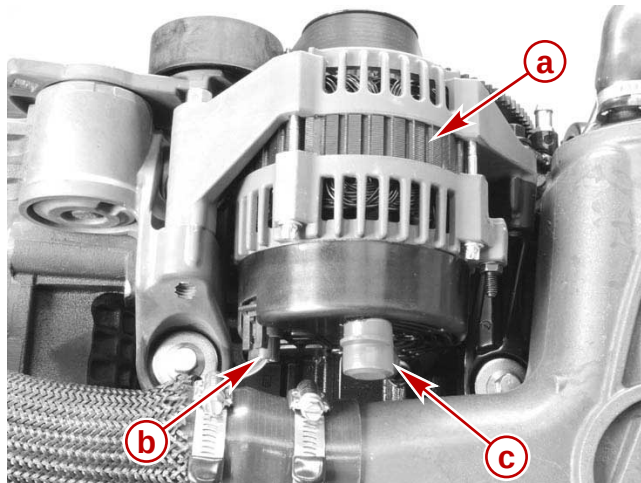
Disconnect battery leads from battery before removing alternator

1. Disconnect battery leads from battery.
2. Remove flywheel cover.



a - Flywheel cover

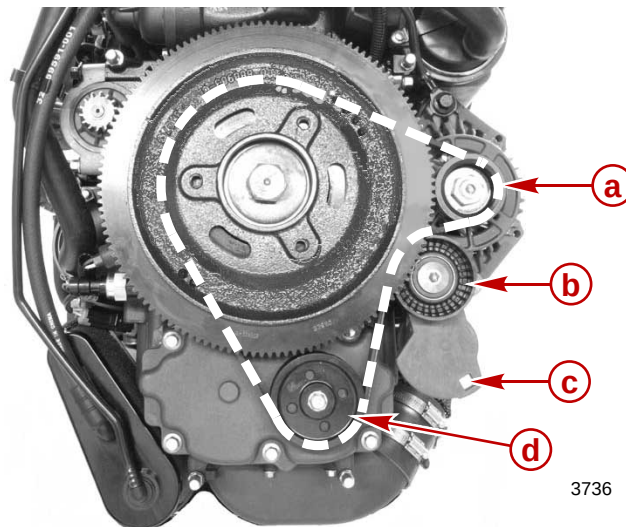
3. Disconnect output lead and sense harness connector from alternator.



3881

- a** - Alternator
b - Sense harness connector
c - Output lead

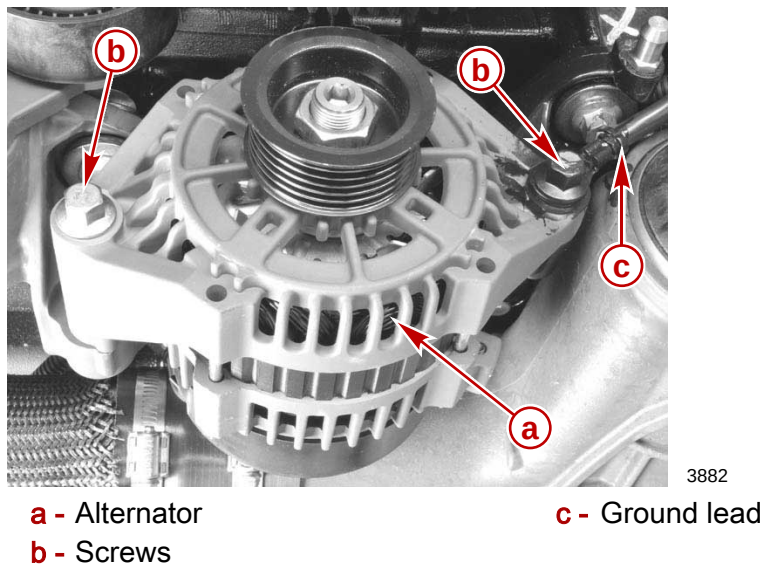
4. Use a breaker bar to release belt tension and remove alternator/supercharger belt.



3736

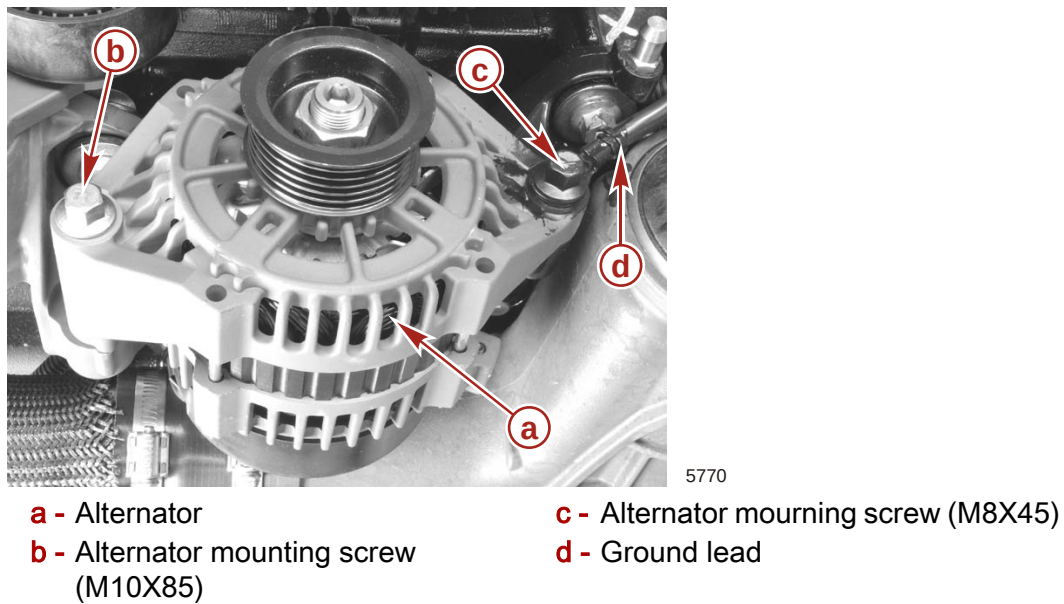
- a** - Alternator
b - Tensioner pulley
c - Tensioner release slot
d - Supercharger pulley

5. Remove 2 screws securing alternator.



Alternator Installation

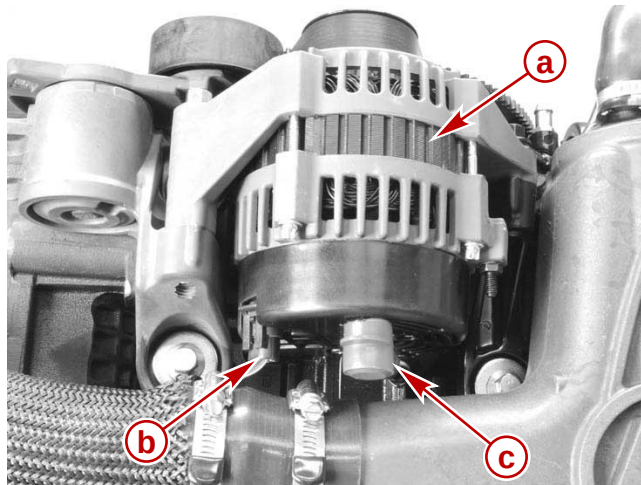
- 1. Install ground lead eyelet through M8X45 alternator mounting screw.
- 2. Install M10X85 alternator mounting screw.
- 3. Tighten alternator mounting screws to specified torque.



Description	Nm	lb. in.	lb. ft.
Alternator mounting screw (M10X85)	47.5		35
Alternator mourning screw (M8X45)	47.5		35

4. Connect sense harness to alternator.

5. Secure output lead to alternator with nut. Torque nut to specification.



3881

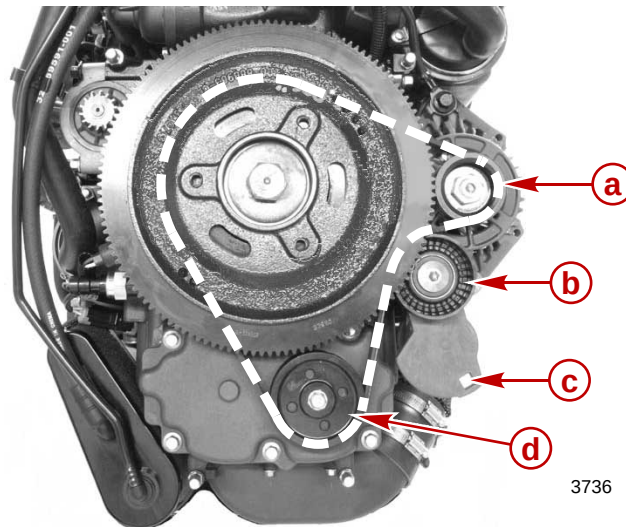
a - Alternator

b - Sense harness

c - Output lead

Description	Nm	lb. in.	lb. ft.
Output lead nut	7	62	

6. Reinstall alternator/supercharger belt. Use breaker bar to release belt tensioner to ease installation.



3736

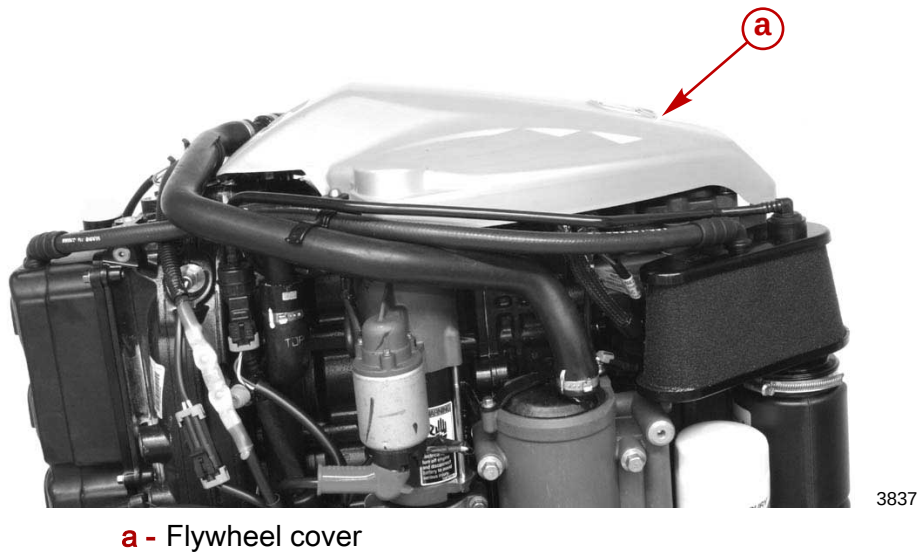
a - Alternator

b - Tensioner pulley

c - Tensioner release slot

d - Supercharger pulley

7. Reinstall flywheel cover.

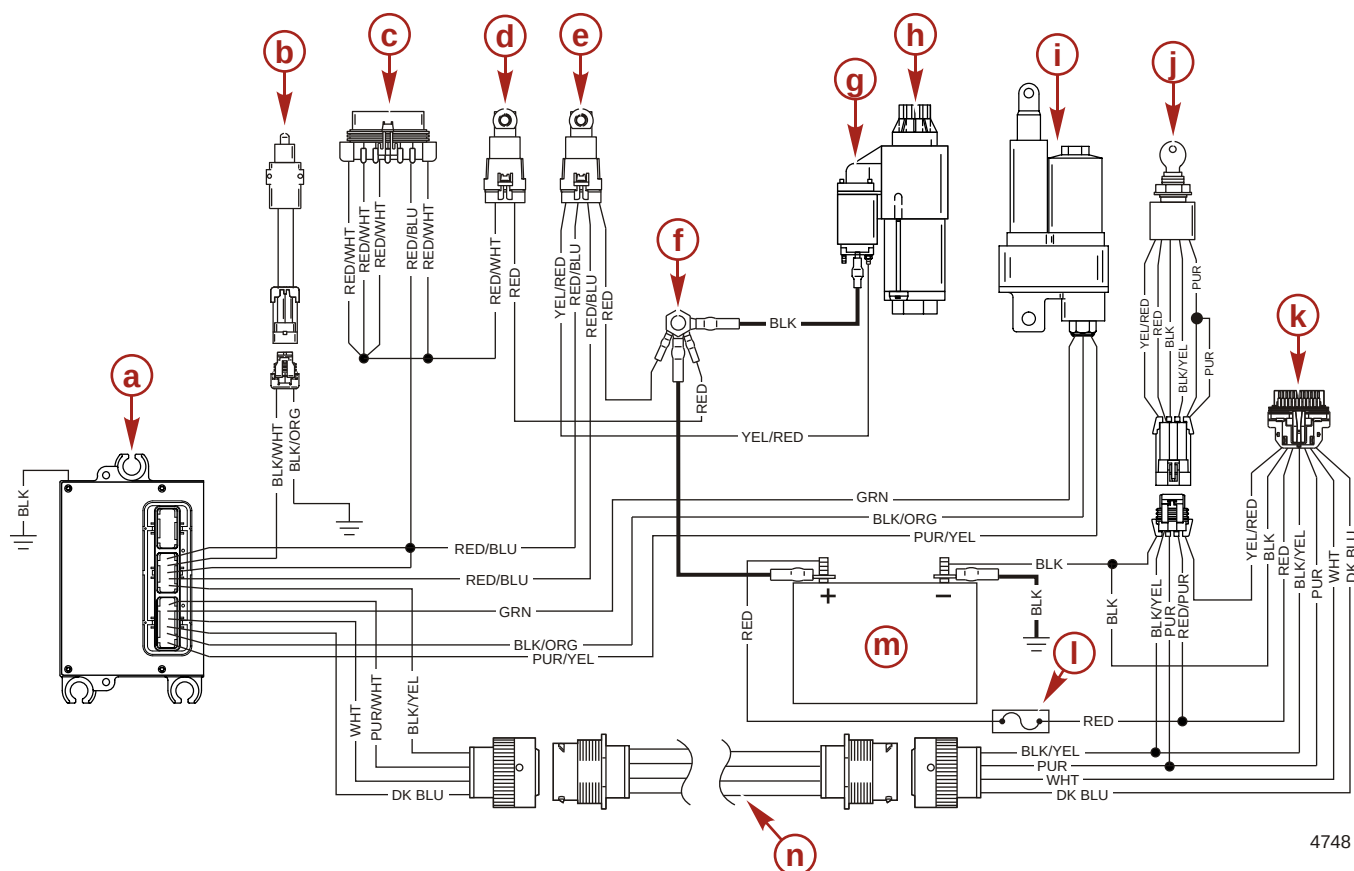


Starter System

Starter Motor Amperes Draw

Starter Motor (part number 50-892339)	
No Load Ampere Draw	60 amperes
Normal Ampere Draw	160 amperes

Starter System Components

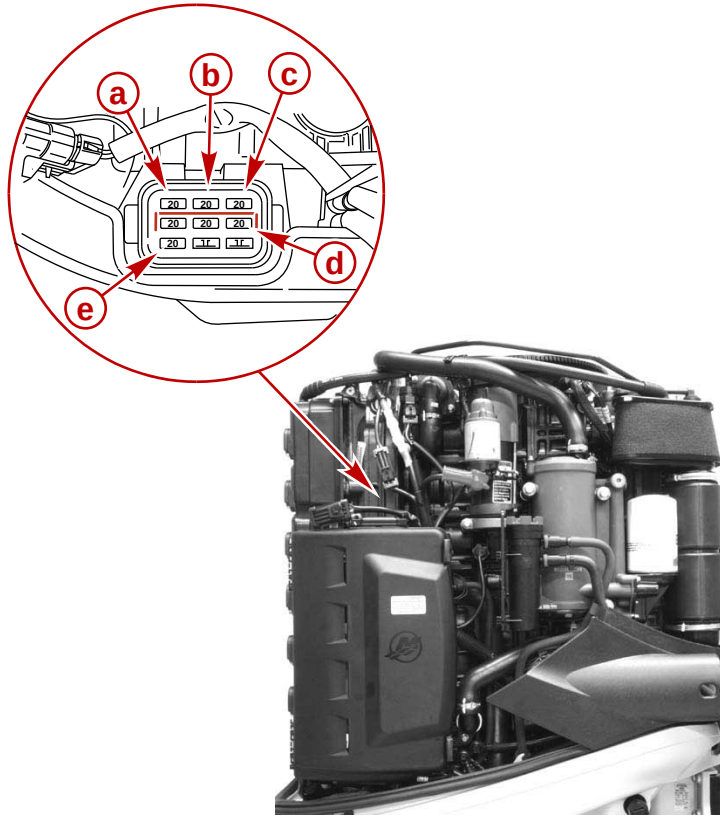


4748

- | | |
|--|--|
| a - Propulsion control module (PCM) | h - Starter motor |
| b - Neutral start switch | i - Shift actuator |
| c - Fuse holder | j - Ignition switch |
| d - Start relay | k - Command module |
| e - Main power relay | l - 5 Ampere fuse (digital power and shift) |
| f - Positive cable terminal | m - 12 VDC Battery |
| g - Starter solenoid | n - Control area network (CAN) harness |

Starting System Test

1. Inspect the 20 ampere fuse in the fuse holder. This fuse protects the PCM, start relay and associated wiring.



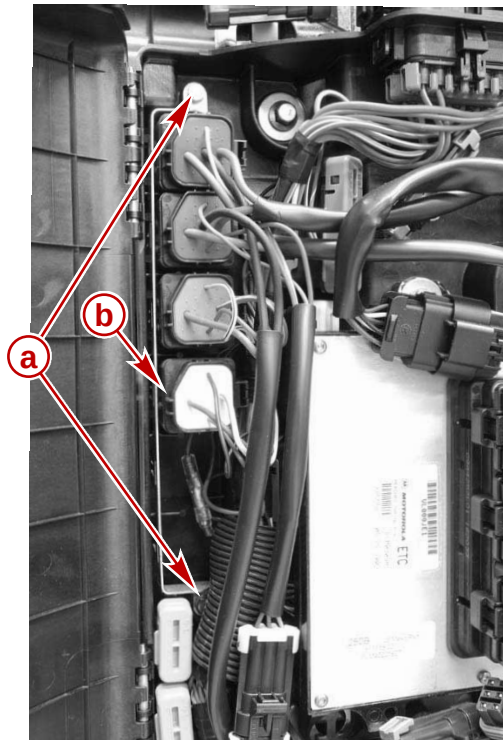
a - PCM
b - Ignition coils
c - Fuel pumps

d - Spare fuses
e - Injector power

4794

2. Inspect the 5 ampere DTS fuse located on the engine starting battery. This fuse protects the CAN harness and key switch related wiring.
3. The battery must deliver a minimum of 11 VDC to the starter. Perform a load test on the battery following the instructions supplied with the load tester.
4. Inspect all power and ground connections at the battery, starter solenoid, starter relay, starter motor and the engine wiring harness connector for tightness and corrosion. Clean or repair as necessary.
5. Disconnect the engine wiring harness connector and check for continuity between pins **C** (purple) and **B** (red/purple) going through the hull wiring with the key switch in "START" position. If the circuit is interrupted, investigate the hull wiring for the possible cause: key switch, lanyard switch, and repair as needed. If the circuit is complete, proceed to the next step.

6. Remove the push-on terminal connector from the starter relay and measure the resistance between relay terminal, 85 (red/blue lead) and terminal 86 (black/blue lead). Replace the relay if resistance is not within specification.



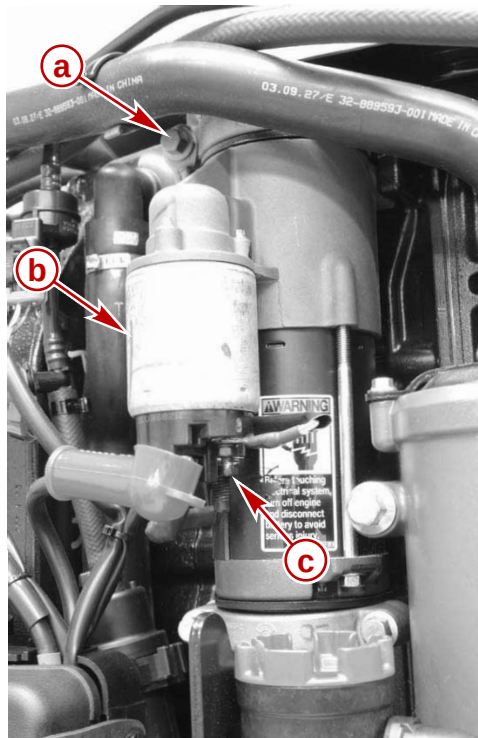
4304

a - Relay retainer screws

b - Start relay

Starter Relay	
Resistance (R x1)	80 - 100 ohms

7. With the key switch in the "START" position, the starter drive should engage the engine flywheel. If not, measure the resistance between the yellow/red terminal on the starter solenoid and engine ground. If resistance is not within specification, the starter solenoid is defective and must be replaced.



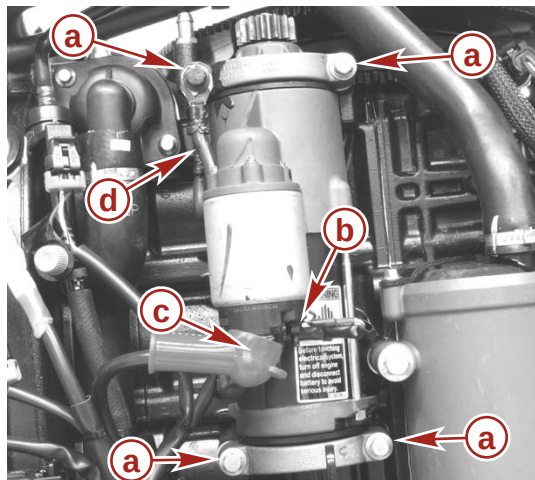
4305

a - Ground screw
b - Starter solenoid

c - Yellow/red terminal

Starter Solenoid	
Resistance (R x1)	0.4 - 0.8 ohms

8. If the starter drive audibly engages the engine flywheel, but the starter does not rotate, remove the starter and test the no-load amperage draw. If the amperage draw is not within the specification, replace the starter and or starter solenoid assembly.



3839

a - Starter retaining screws
b - Yellow/red lead

c - Black/red sleeved lead
d - Starter ground lead

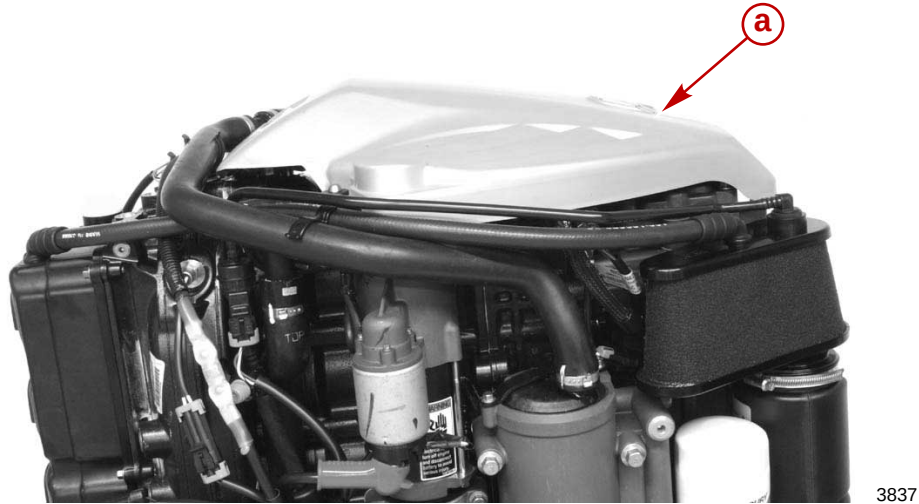
Starter	
No-load amperage draw	60 - 90 Amps

Starter Removal

⚠ CAUTION

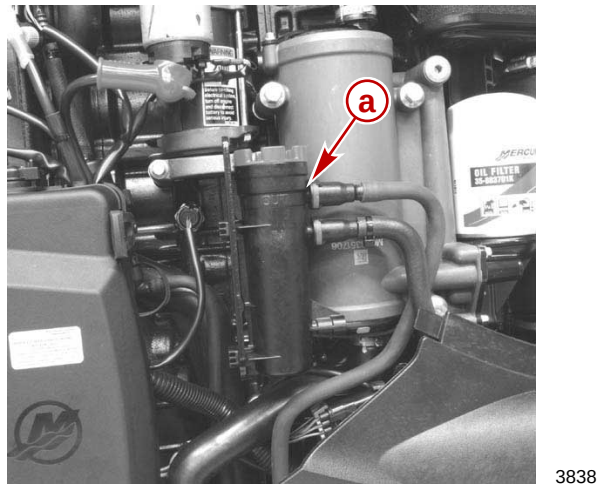
Disconnect battery leads from battery before removing starter.

1. Remove flywheel cover.



a - Flywheel cover

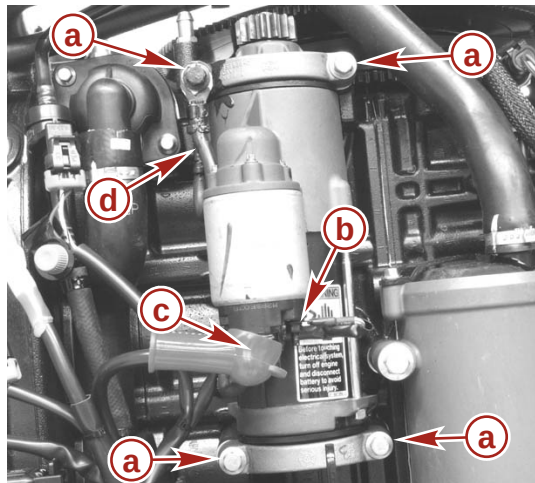
2. Slide fuel/water separator filter up and out of retaining bracket.



a - Fuel/water separator filter

3. Remove yellow/red exciter lead from starter solenoid.
4. Remove black/red sleeved battery lead from starter solenoid.

- Remove starter retaining screws.



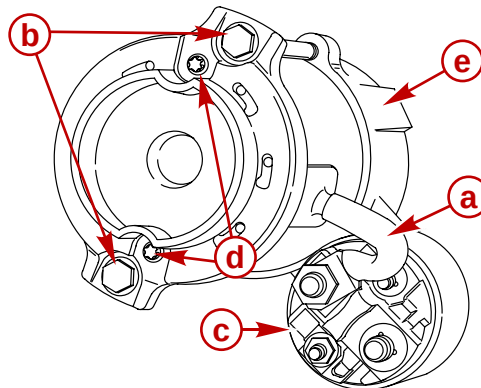
3839

a - Starter retaining screws
b - Yellow/red lead

c - Black/red sleeved lead
d - Starter ground lead

Starter Disassembly

- Remove brush lead from solenoid and thru-bolts from end frame.



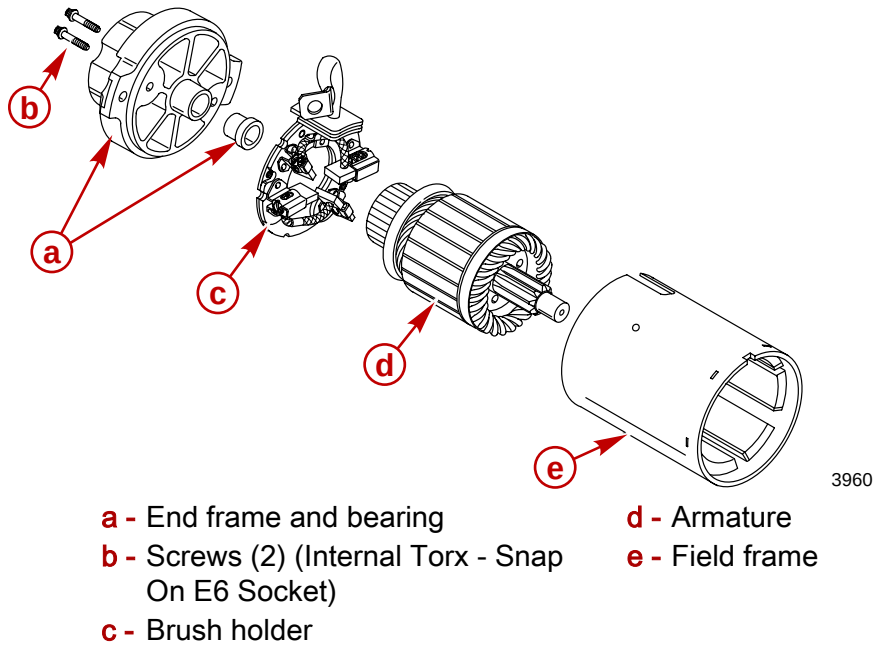
3959

a - Brush lead
b - Thru-bolts
c - Starter solenoid

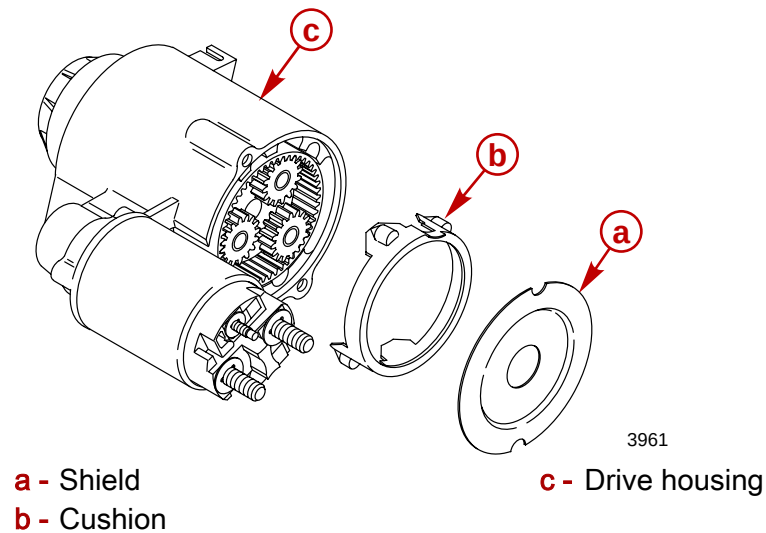
d - Brush plate screws
e - End frame

- Remove armature and field frame from drive housing.

NOTE: Permanent magnets inside field frame will be holding armature in place.

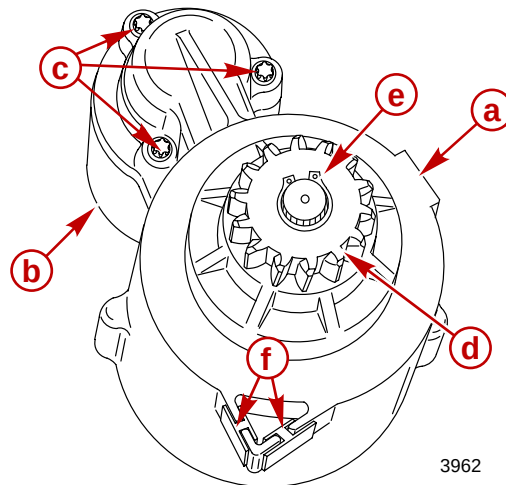


3. Remove shield and cushion from drive housing.



4. Remove 3 screws retaining starter solenoid. Remove solenoid from drive housing.

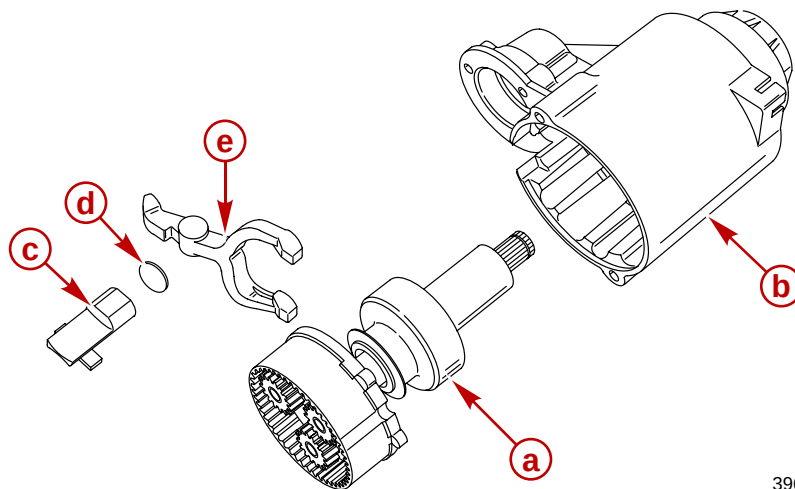
5. Remove snap ring and gear from starter shaft.



3962

- | | |
|---|------------------------|
| a - Drive housing | d - Pinion gear |
| b - Starter solenoid | e - Snap ring |
| c - Screws (3) (Internal Torx - Snap On E6 Socket) | f - Bumpers |

6. Remove planetary gear and clutch assembly from drive housing.
7. Remove solenoid arm, metal disc and plug from drive housing.

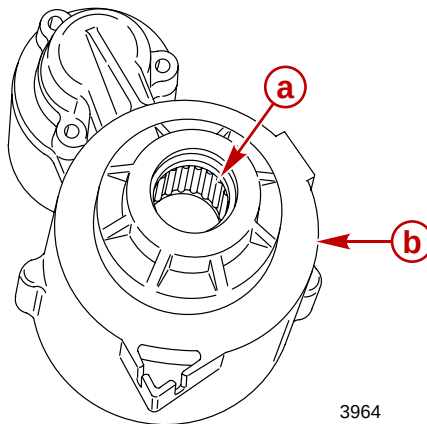


3963

- | | |
|---|-------------------------|
| a - Planetary gear and clutch assembly | d - Metal disc |
| b - Drive housing | e - Solenoid arm |
| c - Plug | |

8. Inspect drive housing needle bearing for roughness. If bearing is worn or damaged, bearing can be removed by using an appropriate mandrel to drive/press bearing from drive housing.

NOTE: If bearing has spun in drive housing bore, drive housing must be replaced.



a - Needle bearing

b - Drive housing

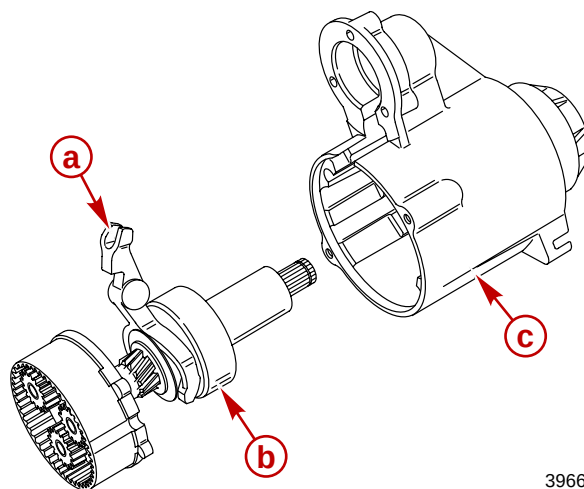
Cleaning and Inspection

IMPORTANT: Do not use grease dissolving solvents to clean electrical components, planetary gears or drive clutch. Solvent will damage insulation and wash the lubricant out of the clutch drive and gears. Use clean rags and compressed air to clean components.

1. Test over-running clutch action of drive. Pinion should turn freely in over-running direction and must not slip in cranking direction.
2. Inspect pinion teeth for wear.
3. Inspect spring for tension and drive collar for wear.
4. Check that bearings roll freely. If any roughness is felt, replace bearing.
5. Inspect planetary gear assembly. Gears must mesh easily and roll freely with no binding.

Starter Reassembly

1. Install solenoid arm with planetary gear and clutch assembly into drive housing.

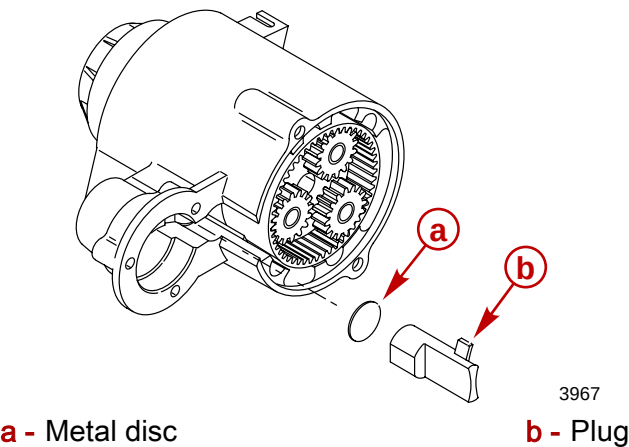


a - Solenoid arm

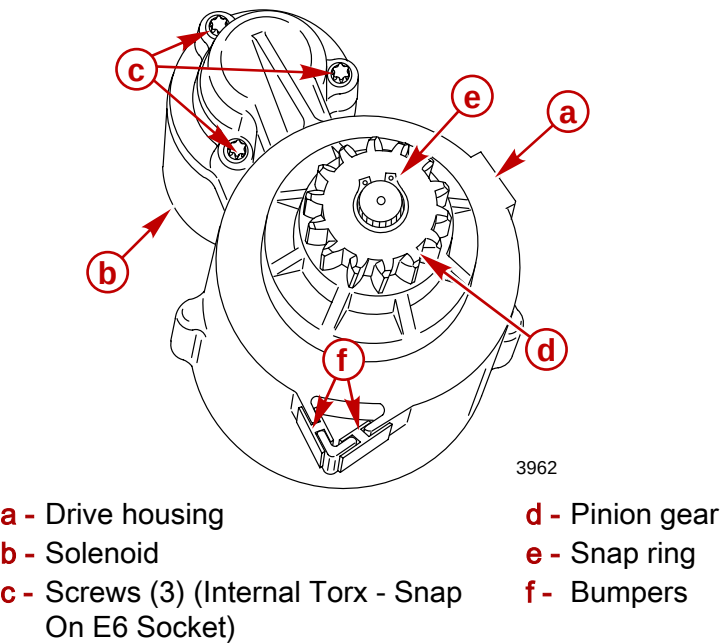
b - Planetary gear and clutch assembly

c - Drive housing

2. Install metal disc and plug into drive housing.

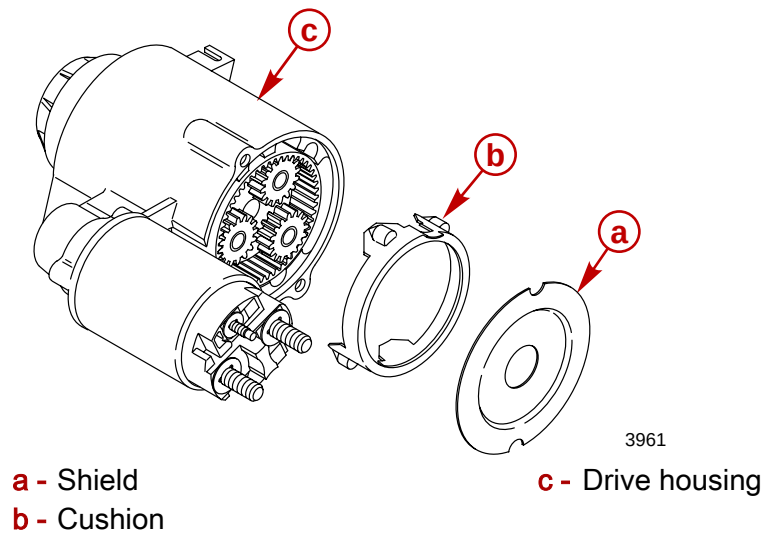


3. Attach arm to starter solenoid. Install starter solenoid in drive housing and secure with 3 screws. Tighten solenoid mounting screws to specified torque.
4. Install drive gear and secure with snap ring.
5. Reinstall rubber bumper on housing.



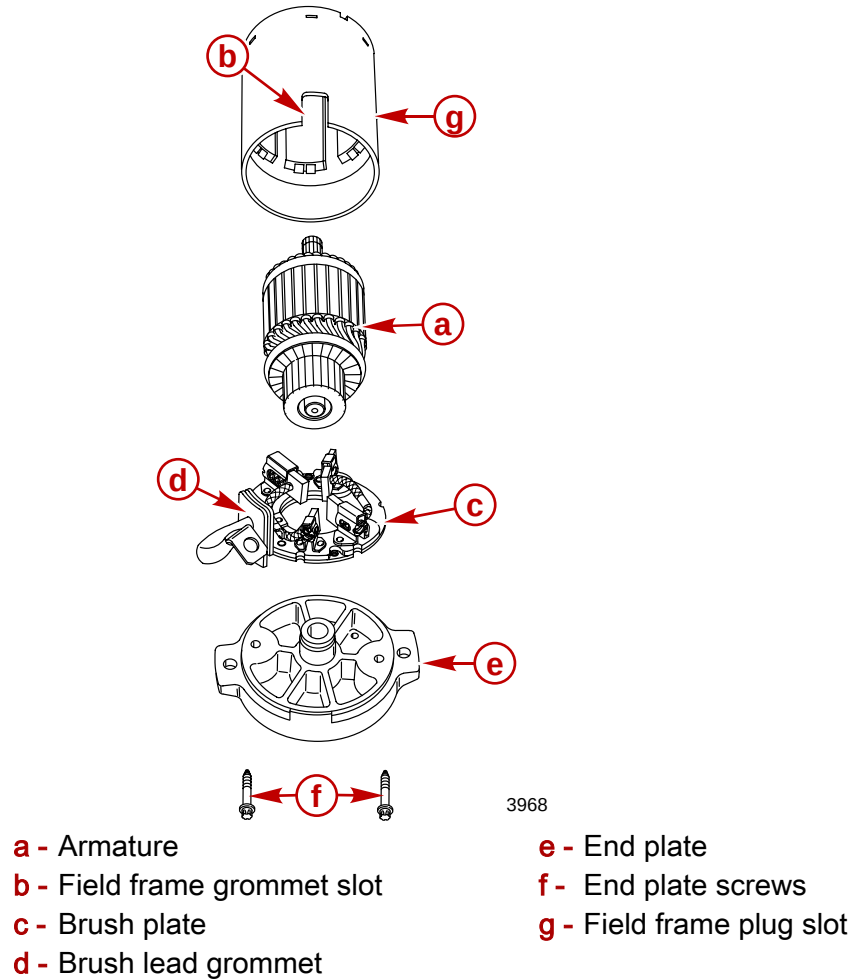
Description	Nm	lb. in.	lb. ft.
Solenoid mounting screws (3) internal torx	4.5	40	

6. Install cushion and shield in drive housing.



7. Install field frame over armature.
8. While holding brushes back, slide brush plate onto armature while aligning brush lead grommet with slot in frame.
9. Secure end plate to brush assembly with 2 screws. Tighten screws to specified torque.

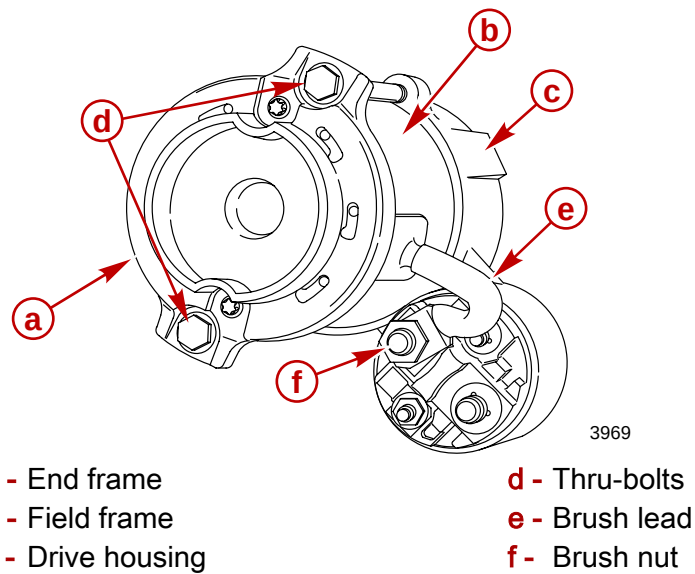
NOTE: Prior to installing field frame assembly into drive housing, align slot in field frame with plug in drive housing.



Description	Nm	lb. in.	lb. ft.
End plate screws	3.4	30	

10. Install field frame and end frame in drive housing.

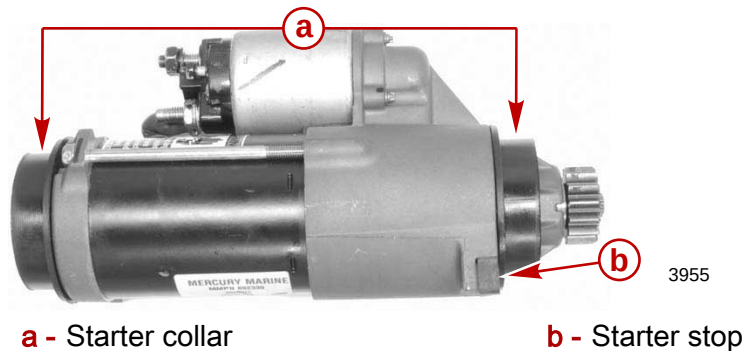
11. Install thru-bolts and brush lead. Tighten thru-bolts and brush nut to specified torque.



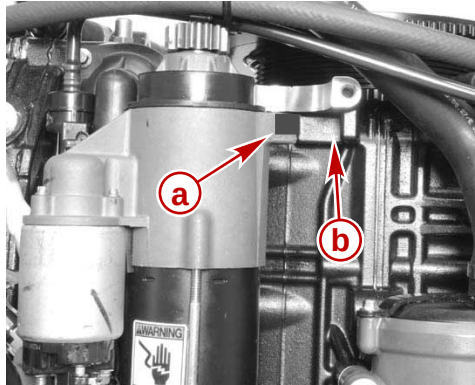
Description	Nm	lb. in.	lb. ft.
Thru-bolts	12.5	110	
Brush nut	6	55	

Starter Installation

1. Ensure the bottom and top collars are on the starter end caps.
2. Ensure the starter stop is on the upper end cap.



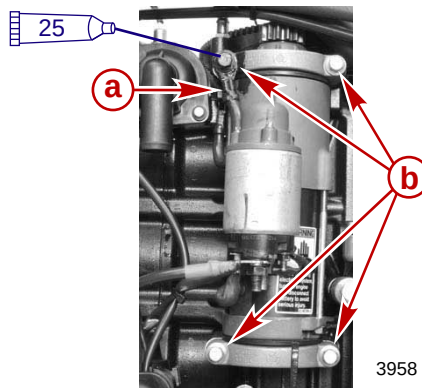
3. Place the starter onto the cylinder block starter mounting boss with the starter stop facing starter stop boss.



3956

a - Starter stop**b - Starter stop boss**

4. Insert a starter bolt through the starter ground eyelet.
5. Secure the starter to the cylinder block with the starter retainers and starter bolts. Tighten the starter bolts to the specified torque.
6. Cover the bolt and starter ground wire eyelet with liquid neoprene.



3958

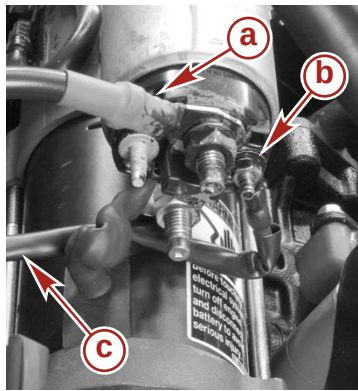
a - Starter ground wire**b - Starter bolt**

Tube Ref No.	Description	Where Used	Part No.
	Liquid Neoprene	Starter bolt; ground wire eyelet	92-25711-3

Description	Nm	lb. in.	lb. ft.
Starter bolt (M8 x 40)	17	150	

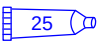
7. Guide the starter yellow/red exciter wire behind the solenoid and connect the exciter wire to the solenoid exciter wire terminal. Tighten the exciter wire terminal nut to the specified torque.
8. Connect the battery black/red sleeved starter cable to the starter solenoid terminal. Tighten the battery starter cable nut to the specified torque.

9. Cover the starter exciter wire terminal and battery starter cable with liquid neoprene.



3965

- a** - Battery starter cable **c** - Starter exciter wire
b - Solenoid exciter wire terminal

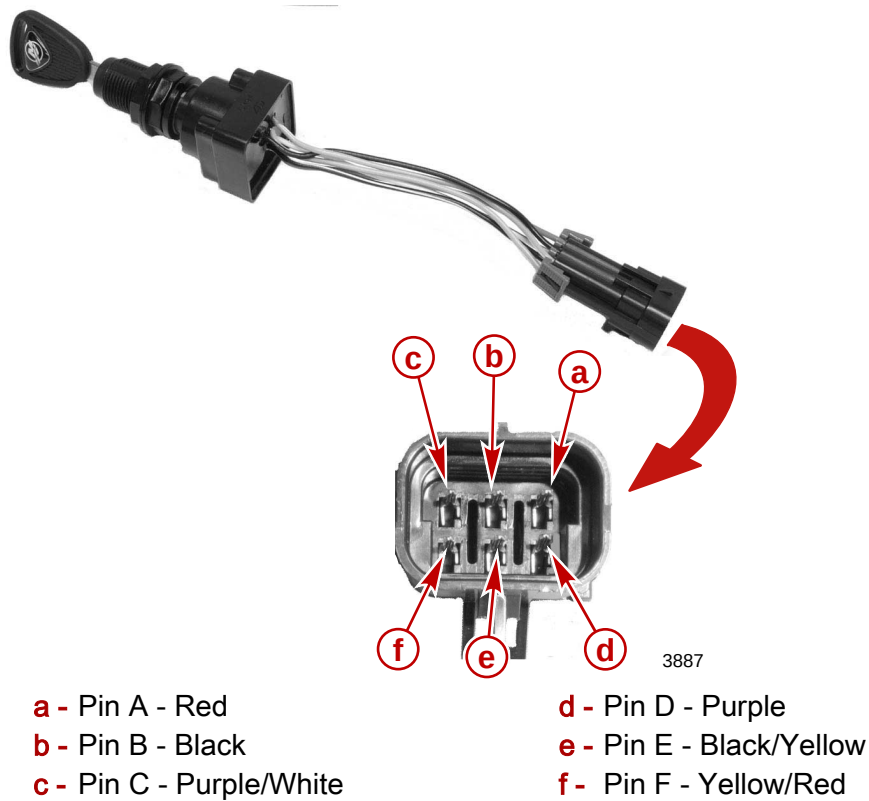
Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Starter exciter wire terminal; battery starter cable	92-25711-3

Description	Nm	lb. in.	lb. ft.
Exciter Wire Terminal Nut	2.5	22	
Battery Starter Cable Nut	9	80	

Key Switch Test (4 Position)

1. Disconnect key switch from command module harness.
2. Set ohm meter on R x 1 scale for the following tests.

3. If meter readings are other than specified in the following tests, verify that switch and not wiring is faulty. If wiring checks ok, replace switch.



Key Position	Continuity should be indicated at the following points:	
Off	B	E
Accessories	A	C
Run	A	D
Start	A	F
	F	D
	A	D

Electrical

Section 2C - Timing, Synchronizing and Adjusting

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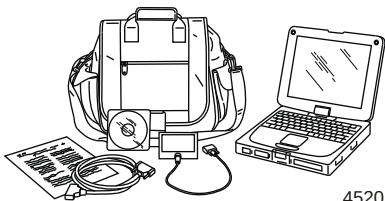
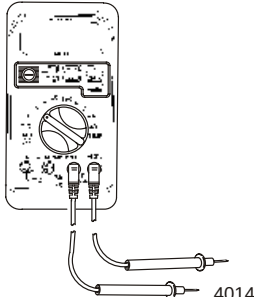
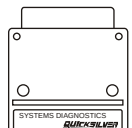
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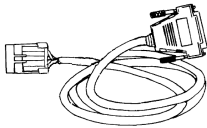
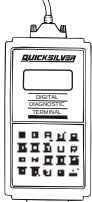
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Idle Timing Adjustment (All Models).....	2C-3	Alternator and Supercharger Belt Tension	
		Adjustment (All Models).....	2C-4

Ignition Specifications

Ignition Specifications	
Full Throttle RPM (All Models)	5800 - 6400
Idle RPM (All Models)	550
Ignition Type	Digital Inductive
Spark Plug Type	NGK ILFR6G
Spark Plug Gap	0.8 mm (0.031 in.)
Spark Plug Hex Size	16 mm
Spark Plug Torque	20.5 Nm (19 lb. ft.)
Spark Plug Hole Size	14 mm
Firing Order	1-3-5-6-4-2
Ignition Timing @ Idle	Not Adjustable; Controlled by PCM
Ignition Timing @ WOT	Not Adjustable; Controlled by PCM
PCM Over Speed Limiter	Activates @ 6500 RPM

Special Tools - Timing, Synchronizing and Adjusting

Computer Diagnostic System	Order through SPX
 4520	Monitors all electrical systems for proper function and diagnostic purposes. NOTE: For additional information, pricing, or to order the Computer Diagnostic system contact: SPX Corporation 28365 Mound Rd. Warren, MI 48092 or call: USA - 1-800-345-2233 Canada - 800-345-2233 Europe - 49 6182 959 149 Australia - (03) 9544-6222
DMT 2004 Digital Tachometer Multi-meter	91-892647A01
 4014	Measures RPM, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.
DDT Cartridge v1.31	91-880118A04
 4013	Contains a diagnostic program for the PCM, allowing technicians to access all diagnostic capabilities available through the engine's PCM. Used with Digital Diagnostic Terminal (91-823686A2).

Digital Diagnostic Terminal Reference Manual	90-881204003
 6160	Lists procedures, specifications and sensor outputs that can be monitored using the Digital Diagnostic Terminal.
Adaptor Harness	84-822560A13
 5400	Data link harness between engine and Computer Diagnostic System (CDS) or Digital Diagnostic Terminal (DDT).
Digital Diagnostic Terminal (DDT)	91-823686A2
 4011	Displays problem codes. Also monitors various sensors, circuits and components. Performs self-test procedures on select engine electrical systems. Cartridges and harnesses to use on the engines are sold separately.
Extension Cable	84-825003A1
 4012	Data link extension harness (3.05 m [10 ft.]) between adaptor harness and Digital Diagnostic Terminal.

Idle Timing Adjustment (All Models)

Idle timing is not adjustable. Idle timing is controlled by the Propulsion Control Module (PCM). Idle timing can be monitored with the Digital Diagnostic Terminal or the Computer Diagnostic System through the PCM.

Maximum Timing Adjustment (All Models)

Maximum timing is not adjustable. Maximum timing is controlled by the Propulsion Control Module (PCM). Maximum timing can be monitored with the Digital Diagnostic Terminal or the Computer Diagnostic System through the PCM.

Idle Speed Adjustment (All Models)

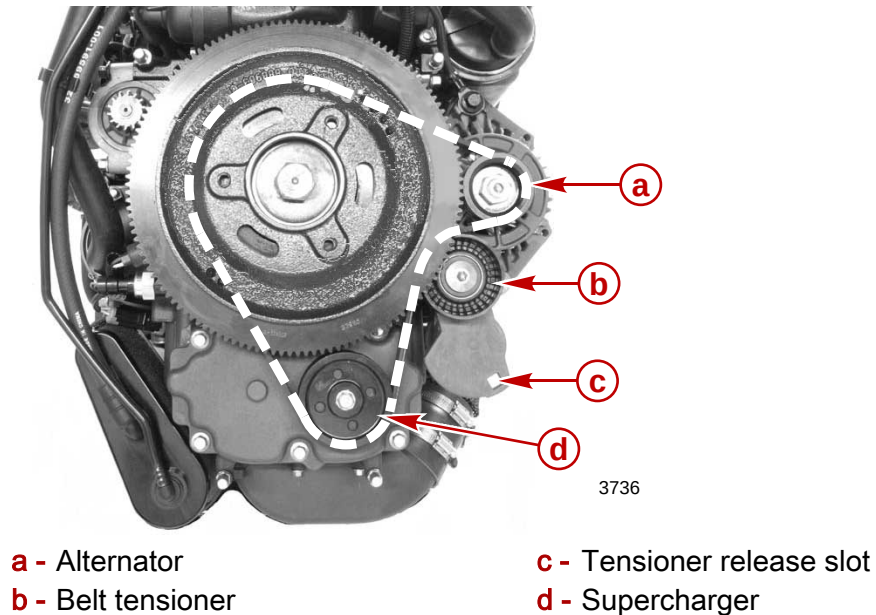
Engine idle speed is not adjustable. The parameters affecting idle speed can be checked and monitored by the Digital Diagnostic Terminal (DDT) or the Computer Diagnostic System (CDS).

Throttle Adjustment (All Models)

All throttle inputs are relayed electronically from the helm to the engine. There are no mechanical linkages or adjustments to be made or checked.

Alternator and Supercharger Belt Tension Adjustment (All Models)

Correct alternator and supercharger belt tension is maintained by a belt tensioner assembly.



Electrical

Section 2D - Digital Throttle and Shift

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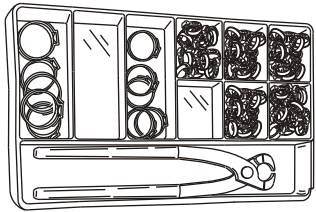
**2
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Special Tools - Digital Throttle and Shift.....	2D-2	Electronic Throttle Control (ETC) Harness	
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Lubricant, Sealant, Adhesives

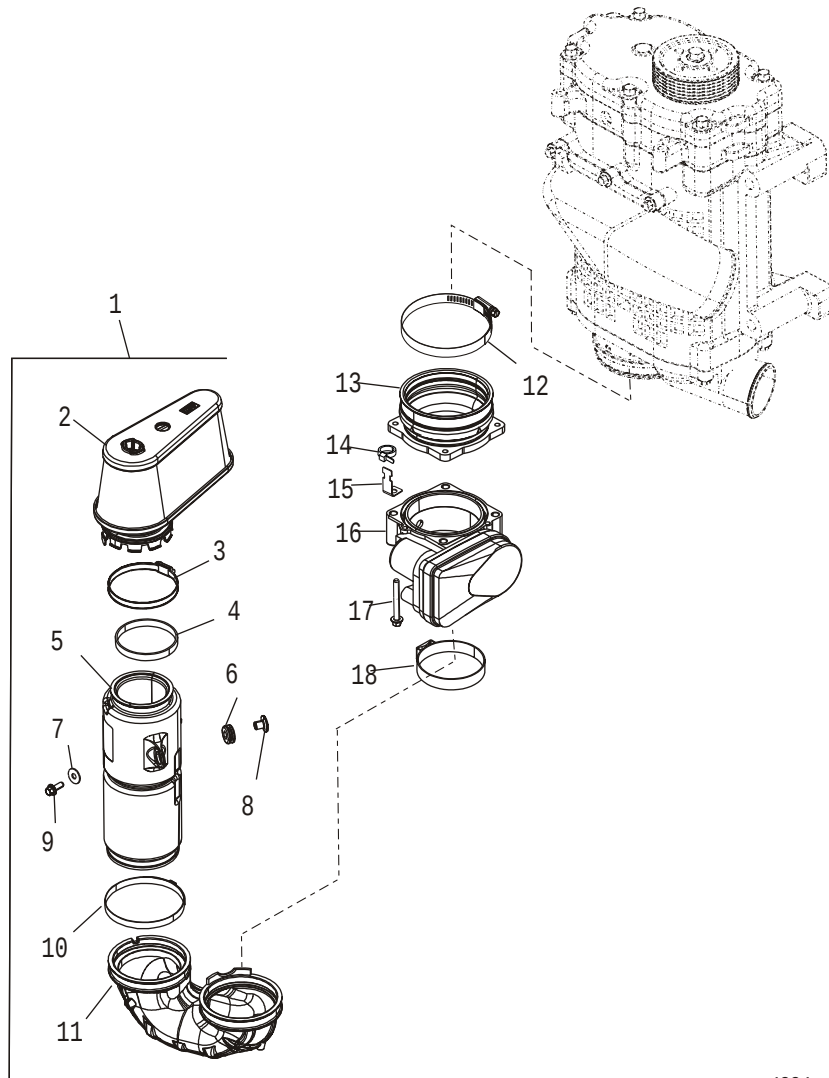
Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Pivot pin	92-802859A1

Special Tools - Digital Throttle and Shift

Hose Clamp Tool Kit	91-803146A2
 5819	Aids in the installation of high pressure (Oetiker ®) hose clamps.

Notes:

Electronic Throttle Control (ETC) Components

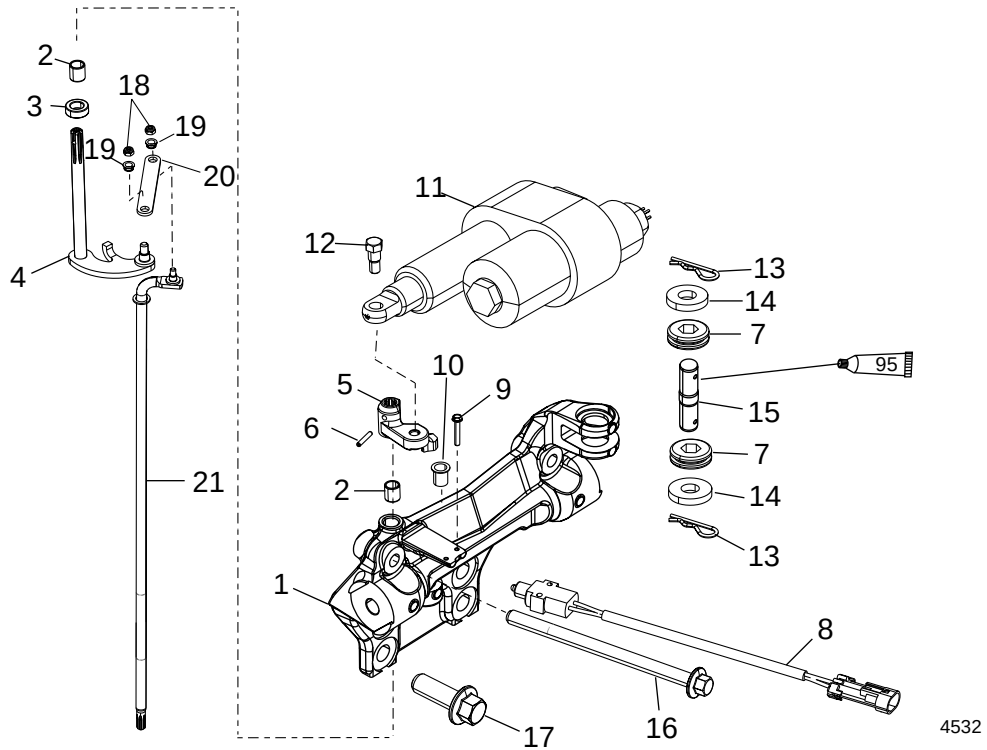


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Electronic Throttle Control (ETC) Components

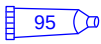
Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Air intake assembly			
2	1	Filter			
3	1	Clamp			
4	1	Gasket			
5	2	Resonator			
6	2	Grommet			
7	1	Washer			
8	4	Bushing			
9	2	Screw (M6 x 25)	7.4	66	
10	1	Clamp (96.5)			
11	1	Boot, Rubber			
12	1	Clamp	6.2	55	
13	1	Isolator			
14	1	Cable tie			
15	1	Bracket			
16	1	Electronic Throttle Control assembly			
17	1	Screw (M6 x 50)	11	97	
18	1	Clamp (96.5)			

Electronic Shift Control (ESC) Components



Electronic Shift Control (ESC) Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Bracket			
2	2	Bushing			
3	1	Spacer			
4	1	Shift shaft - Bellcrank			
5	1	Bellcrank - Upper			
6	1	Roll pin			
7	2	Grommet			
8	1	Switch			
9	2	Screw	2.2	20	
10	1	Bushing			
11	1	Shift actuator			
12	1	Screw	20	177	
13	2	Cotter pin			
14	2	Washer			
15	1	Pivot pin			
16	2	Screw	40 Nm (29.5 lb. ft.) plus additional 45° turn		
17	4	Screw	185		136.5
18	2	Nut	6	53	
19	2	Bushing			
20	1	Shift shaft link			
21	1	Shift shaft			

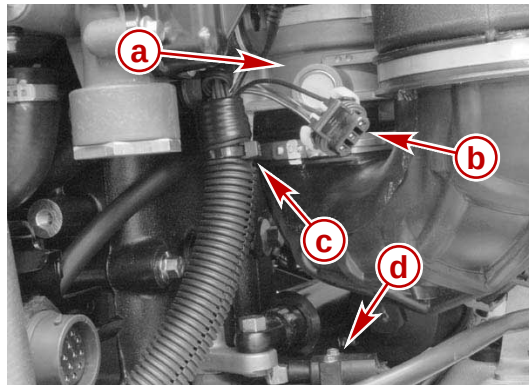
Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Pivot pin	92-802859A1

Electronic Throttle Control (ETC)

The ETC consists of a single bore cylindrical valve with a DC electric motor to control the position of the throttle valve. A positive spring force returns the throttle valve to a defined position when no electrical signal is connected to the DC motor. Idle airflow is controlled by the throttle valve; there is no additional idle air control system in the ETC. The ETC contains two throttle position sensors operating in opposite directions of one another to provide a position feedback signal. As the voltage increases in one, it decreases on the other. However, the PCM processes the signals from both throttle position sensors so that the Digital Diagnostic Terminal display will show both TPS's increasing and decreasing together.

Electronic Throttle Control (ETC) Removal

1. Remove the starboard front cowl.
2. Remove the cable tie securing the engine harness to the ETC.



a - ETC

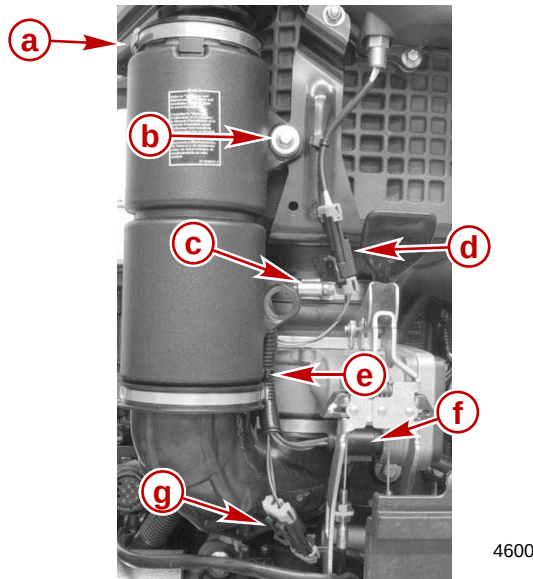
b - Power steering harness

c - Cable tie

d - Shift indicator switch

3. Loosen the hose clamp securing the air filter to the resonator.
4. Remove the air filter.
5. Remove the bolt securing resonator to the support bracket.
6. Remove the cable tie securing the engine harness to the ETC.
7. Disconnect the Boost Air Temperature sensor harness.
8. Disconnect the ETC engine harness from the ETC.
9. Disconnect the shift position indicator harness.

10. Loosen the hose clamp securing the ETC to the supercharger.

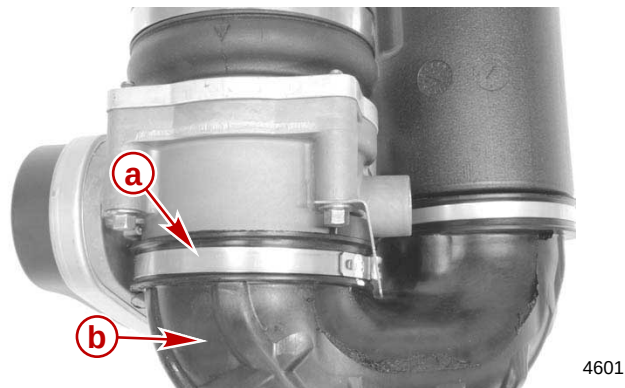


- | | |
|--|---|
| a - Hose clamp securing air filter to resonator | e - Cable tie securing the engine harness to the ETC |
| b - Bolt securing resonator to support bracket | f - ETC engine harness connector |
| c - Hose clamp securing ETC to supercharger | g - Shift position indicator harness |
| d - Boost air temperature sensor harness | |

11. Push down on the ETC to remove the ETC from the supercharger.

Electronic Throttle Control (ETC) Disassembly

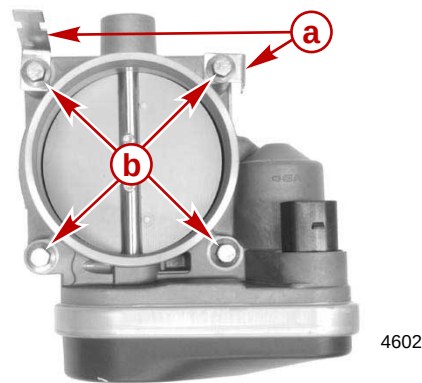
1. Remove the hose clamp securing resonator boot to the ETC.



- | | |
|-----------------------|---------------------------|
| a - Hose clamp | b - Resonator boot |
|-----------------------|---------------------------|

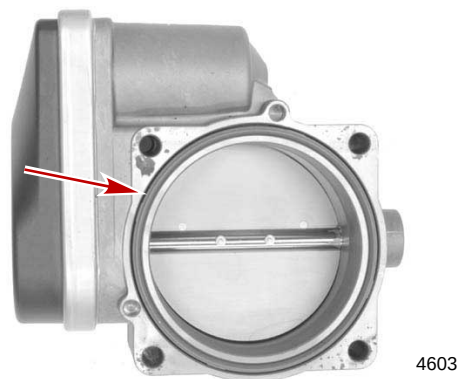
2. Remove the resonator boot.

3. Remove the 4 screws securing the isolator to the ETC. Do not lose the two harness support brackets.

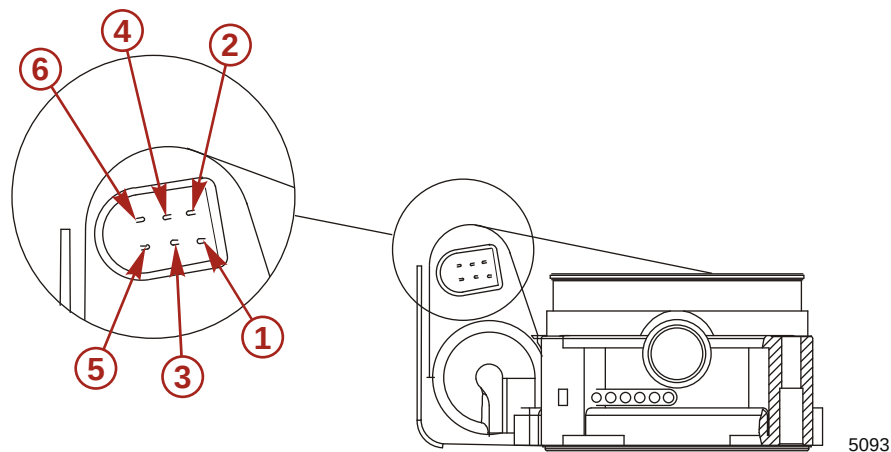


a - Harness support brackets **b** - Screws securing isolator to ETC

4. Remove isolator seal and inspect for damage.



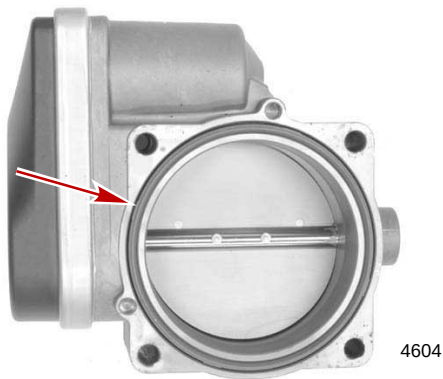
Electronic Throttle Control (ETC) Harness Connection Pin-Out



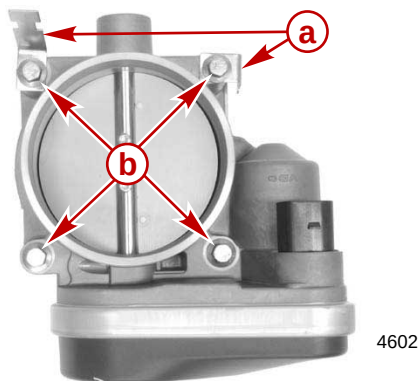
Pin Number	Assignment
1	TPI 1 voltage
2	Transducer reference power
3	Motor driver
4	TPI 2 voltage
5	Motor driver
6	Transducer ground

Electronic Throttle Control (ETC) Reassembly

- 1. Install seal onto the ETC.



- 2. Install the isolator onto the ETC.
- 3. Install the 4 isolator mounting screws. Ensure the harness support brackets are installed as shown.
- 4. Tighten the ETC screws to the specified torque.



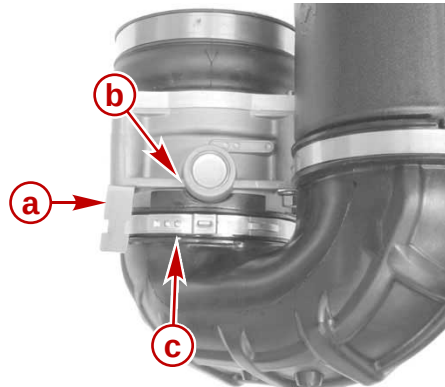
a - Harness support brackets

b - Screws securing isolator to ETC

Description	Nm	lb. in.	lb. ft.
Isolator screw (M6 x 50)	97	11	

- 5. Install a 96.5 diameter hose clamp onto the resonator boot.

6. Install the resonator boot onto the ETC. Ensure the resonator boot is in proper alignment with the ETC throttle shaft and crimp hose clamp.



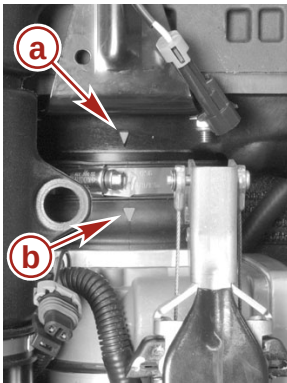
a - Harness support bracket
b - Resonator boot alignment

c - 96.5 diameter hose clamp

Hose Clamp Tool Kit	91-803146A2
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Electronic Throttle Control (ETC) Installation

1. Install a hose clamp onto the isolator.
2. Install the ETC assembly onto the supercharger.
3. Align the arrows on the supercharger and the ETC boot.

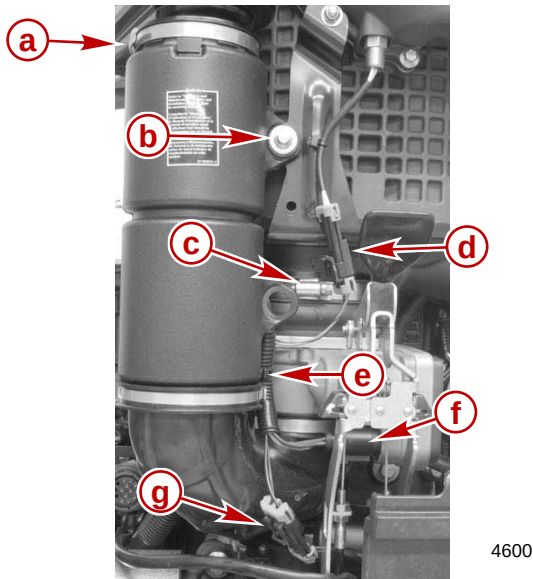


a - Arrow on supercharger

b - Arrow on ETC boot

4. Tighten the hose clamp to the specified torque.
5. Connect the Boost Air Temperature sensor harness, (blue/black, black/orange).
6. Connect the ETC harness.
7. Connect the shift indicator harness to the shift indicator, (black/white, black/orange).
8. Secure the resonator to the resonator support bracket. Tighten bolt to the specified torque.

9. Secure the air filter to the resonator.



- a** - Hose clamp securing air filter to resonator

b - Bolt securing resonator to support bracket

c - Hose clamp securing ETC to supercharger

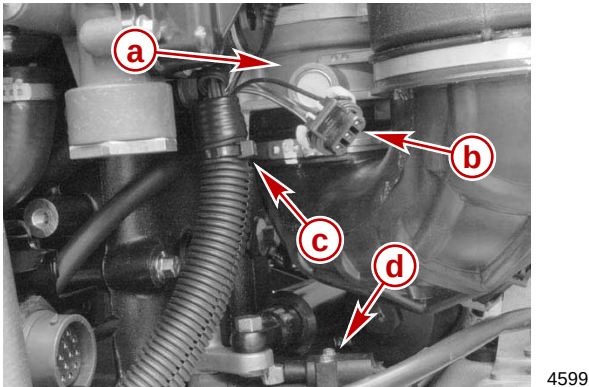
d - Boost Air Temperature sensor harness
- e** - Cable tie

f - ETC engine harness connector

g - Shift position indicator harness

Description	Nm	lb. in.	lb. ft.
Bolt Securing Resonator (M6 x 25)	7.4	66	
Hose Clamp Securing ETC To Supercharger	6.2	55	

10. Cable tie the engine harness to the harness support brackets that are mounted to the ETC.



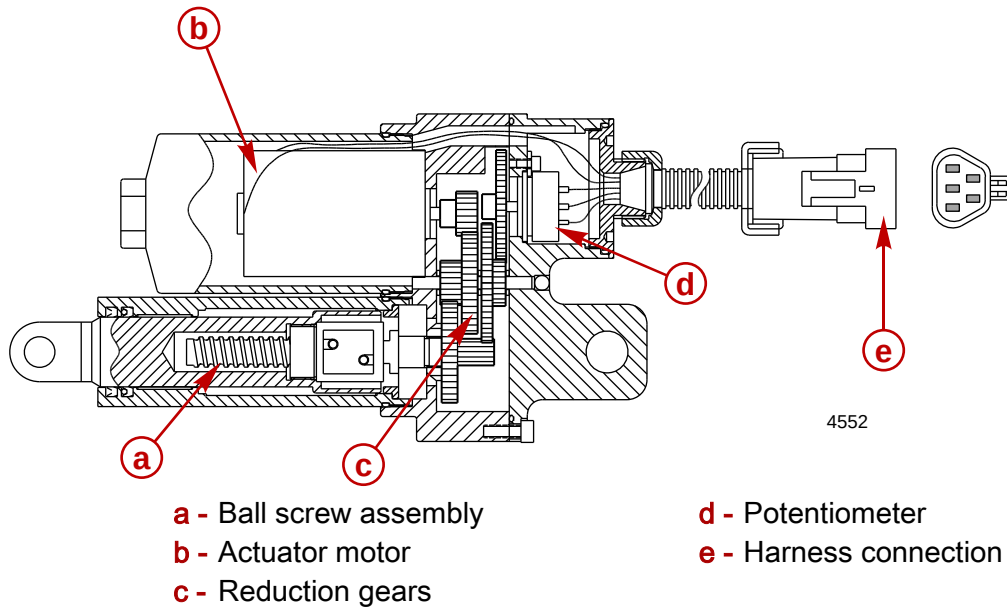
- a** - ETC

b - Power steering harness
- c** - Cable tie

d - Shift indicator switch

11. Install starboard front cowl.

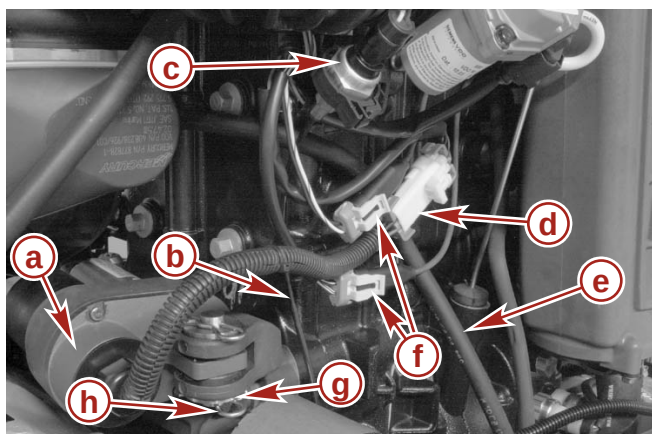
Electronic Shift Control (ESC)



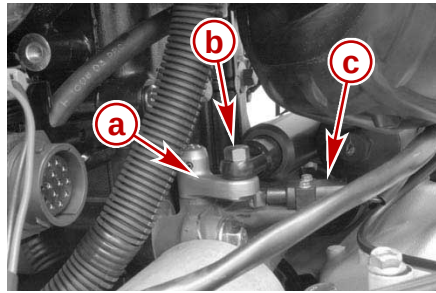
The ESC/shift actuator is used to shift the engines gearcase into forward, neutral, and reverse gears without mechanical cables from the shift/throttle controls. The actuator motor rotates a ball screw assembly through reduction gears in the actuator. The screw shaft then extends or retracts the actuator shaft while at the same time the gear set rotates a potentiometer in the actuator. The potentiometer receives a reference voltage (5.0 volts) from the PCM, and its signal confirms the position of the actuator shaft.

Electronic Shift Control (ESC) Removal

1. Slide shift actuator harness connector aft to remove from mounting bracket.
2. Disconnect electrical harness.
3. Remove bottom cotter pin securing pin assembly.
4. Push pin up and remove. Retain clips, pin and washers for reassembly.



5. Remove the shift actuator bolt from the upper bell crank. Remove the shift actuator.



3596

a - Upper bell crank
b - Shift actuator bolt

c - Shift indicator switch

6. Remove electronic shift control assembly.

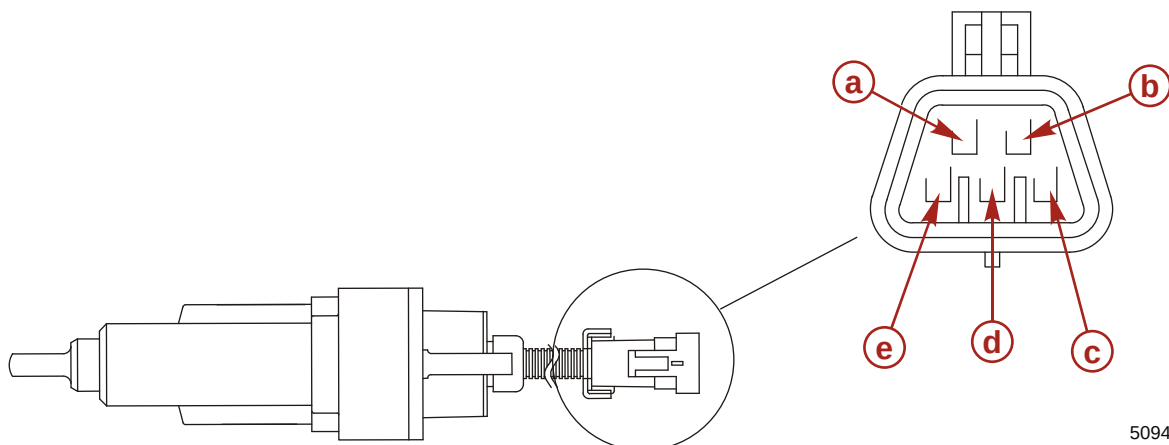
⚠ WARNING

To avoid serious injury or death from a collision resulting from a shifting malfunction, install cable ties through electronic shift control piston to ensure piston does not rotate from original factory position. Remove cable ties just prior to installation. Do not rotate the piston more than 1/4 turn after removing the cable ties. If the piston is accidentally rotated, contact Mercury Customer Service for recalibration.



4982

Electronic Shift Control (ESC) Harness Connection Pin-Out



5094

a - Transducer ground
b - Shift position input
c - Transducer reference power

d - Motor driver
e - Motor driver

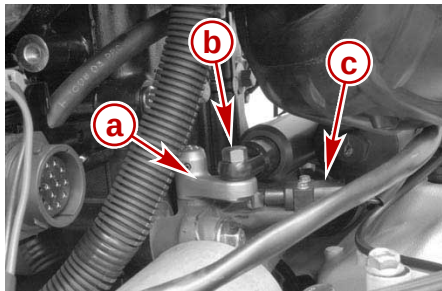
Electronic Shift Control (ESC) Installation

⚠ WARNING

To avoid serious injury or death from a collision resulting from a shifting malfunction, install cable ties through electronic shift control piston to ensure piston does not rotate from original factory position. Remove cable ties just prior to installation. Do not rotate the piston more then 1/4 turn after removing the cable ties. If the piston is accidentally rotated, contact Mercury Customer Service for recalibration.



- 1. Remove cable tie prior to installation.
- 2. Install electronic shift control assembly.
- 3. Install bolt and torque to specification.



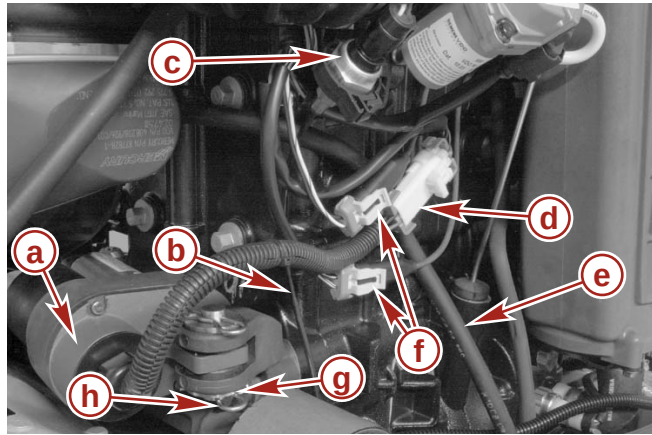
- a - Upper bell crank

b - Shift actuator bolt
- c - Shift indicator switch

Description	Nm	lb. in.	lb. ft.
Shift actuator bolt	20	177	

- 4. Install pin using two washers securing in place with clips.
- 5. Connect electrical harness.

6. Slide harness connector forward to connect to mounting bracket.



a - Shift actuator

b - Speedometer hose

c - Speedometer sensor

d - Shift actuator harness connector

e - Tell tale hose

f - Knock sensor harness connector
(2)

g - Washer

h - Cotter pin

Fuel System

Section 3A - Fuel System Operation

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Air Induction System

Induction System Key Components

- Flame arrester
- Air attenuator
- Electronic Throttle Control (ETC)
- Supercharger
- Charge Air Cooler (CAC)
- Intake manifold
- Electronic Boost Control (EBC)

Air Flow

Fresh air enters the cowl and is drawn into the flame arrester. The flame arrester filters out small air borne debris. Air passing through the filter enters the air attenuator where the throttle noise of the engine is baffled for quiet operation. The air volume entering the engine is controlled by the Electronic Throttle Control (ETC).

The ETC with the assistance of the Propulsion Control Module (PCM), meters the amount of air entering the system. The ETC is operated with an electric motor. The position of the ETC blade is monitored with 2 Throttle Position Sensors (TPS). The ETC performs operations similar to an Idle Air Control (IAC) valve. Should the ETC fail, the ETC blade is spring loaded to return to off idle setting of about 1200 RPM in gear operation. After passing the ETC, the air enters the supercharger.

The supercharger is belt driven from crankshaft rotation. As the air passes the ETC it enters at the bottom of the supercharger where two close tolerance internal roots or vanes (one male, one female) rotate in opposite direction to compress and accelerate the air towards the exit port of the supercharger. The compressed and accelerated air has potentially risen in temperature beyond 80° C (176° F) and must be cooled before entering the combustion chamber. The supercharged air can increase two atmospheres 101.325 kPa (14.7 PSI) above ambient barometric pressure during maximum boost. The supercharged air enters the Charge Air Cooler (CAC).

The CAC is water cooled and chills the supercharged air temperature significantly. Water pushed up from the lower unit, circulates through the CAC heat exchanger. Air passing over the CAC chills and increases the density of the supercharged air. The air which has passed the CAC enters the manifold where it enters the combustion chamber when the intake valve opens.

The manifold has 6 runners for the air to flow smoothly to the combustion chamber. Each runner has a single fuel injector controlled by the PCM. The fuel injector is unique and has two pintels or nozzles. The two pintel design allows for a better atomization of the fuel with the supercharged air. The pintels spray the fuel directly at the intake valves. Excess chilled air is recirculated (bypassed) back into the bottom of the supercharger (intake). The amount of recirculated chilled air is controlled by the Electronic Boost Control (EBC) valve.

The EBC has a motor that operates the boost control valve and is controlled by the PCM. This valve is spring loaded to the open position. The open position allows the excess air to be recirculated to the bottom of the supercharger. During hard acceleration, the PCM looks at the throttle position, Manifold Air Pressure (MAP) sensor, Manifold Air Temperature (MAT) sensor and engine RPM to determine the amount of valve closure needed to supply supercharged air to the engine. At 60% demand, the PCM will start to close the valve. There is no demand for supercharged air at idle or wide open throttle. Tampering with the EBC will generate an error and subsequently will not develop the engine's rated horsepower.

Fuel Injection System

The Verado fuel injection system is a true multi-port timed injection. Fuel is injected into the cylinder head when the valves are open, one cylinder at a time. This type of injection gives the Verado a significant fuel efficiency and performance advantage over synchronous (batch timed) fuel injection engines.

The fuel delivery system, in conjunction with the ignition, is controlled by the Propulsion Control Module (PCM). The PCM requires input information from multiple sensors to maintain optimum fuel injection volume (pulse width), fuel injection timing, amount of boost air pressure, and throttle position. The PCM converts the input signals from the various input sensors and sends digital instructions for the throttle, fuel injection timing/volume, position the Electronic Boost Control (EBC) valve and controls the amount of engine timing.

The PCM also controls the modulation of the fuel lift pump after the Fuel System Module (FSM) is initially filled. The modulation of the fuel lift pump is dependent on the demands of the engine and the subsequent amount of fuel consumption. The fuel lift pump is activated through the fuel pump ground circuit inside the PCM. While the engine is in operation, the PCM calculates how many grams of fuel is used at any RPM, engine load and cycles the fuel lift pump according to the calculated fuel consumption. The fuel lift pump should never be at 100% duty cycle (constantly on). The fuel lift pump will always be an on/off cycle. The fuel lift pump will become disabled in the event of a FSM overflow. The PCM recognizes the FSM overflow with the activation of the Vent Canister Switch (VCS).

Fuel pressure is also changing with engine demands. When the engine is under low or high demands the Manifold Absolute Pressure (MAP) changes. The demands of the engine are known to PCM by way of the MAP sensor digital signal change and throttle position. Fuel pressure will change in conjunction with the manifold absolute pressure change. A tube on the intake manifold is connected to the fuel pressure regulator inside the Fuel System Module (FSM). The manifold pressure changes will push or pull the fuel pressure regulator diaphragm, changing the amount of fuel pressure in the fuel rail. The excessive pressure is released into the FSM.

Fuel injection volume is initially charted in the PCM when the system is activated with turning the key to the "ON" position. The PCM reads the MAP (Manifold Absolute Pressure) sensor in the intake manifold to determine the ambient barometric (BARRO) pressure. The PCM then looks at the cylinder block, cylinder head and air temperatures. The BARRO pressure, cylinder block, cylinder head and air temperature readings are the base for all fueling strategies at start up. Fuel strategy changes constantly during engine operation.

A supercharger is used to boost the air volume. Supercharged air loses density and must be cooled by passing through the Charged Air Cooler (CAC) to increase the air density. The increased air density is forced into the combustion area creating a significant amount of usable horsepower. The amount of boost required for the engine to operate at maximum horsepower capacity, is controlled by the PCM. The PCM closes the Electronic Boost Control (EBC) valve to increase the amount of air forced into the combustion chamber. The amount of EBC valve closure is dependent on the demands of the engine based on the throttle position, MAP, and engine RPM.

The fuel is water cooled. While the engine is running, water is pumped up to the powerhead by the water pump located in the lower unit, driven by the driveshaft. Water is pumped up to the engine via a water tube, then passes through the adaptor plate main water galley where it enters the powerhead, and is distributed to different locations via flexible hoses. The tell tale, exhaust cooling, and fuel cooling system use these flexible hoses. The water tube for cooling the fuel is connected to a ridged hose passing through the adaptor plate where it connects to a ridged hose attached to the Fuel System Module (FSM). The water enters the FSM and passes through a coiled metal tube and exits outside the FSM. The metal tube is completely submerged in fuel while the engine is in operation.

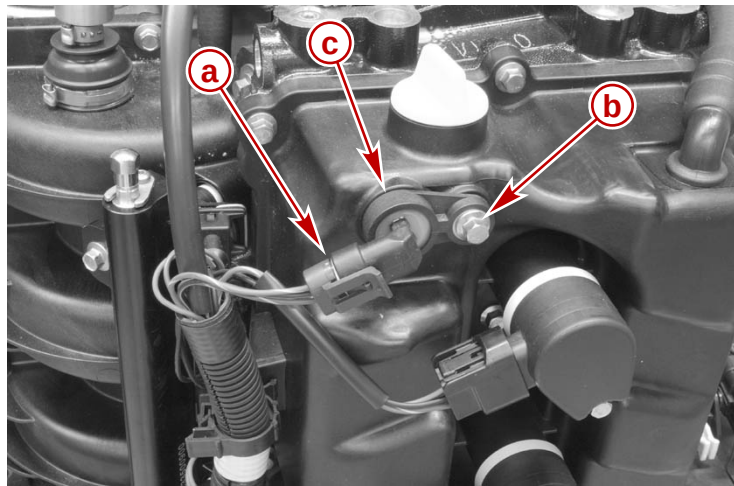
The neutral switch sends a signal to the PCM indicating when it is in neutral. While in neutral, the PCM will limit the engine from an over-rev RPM condition.

The Electronic Throttle Control (ETC) is modulated by the PCM. The PCM converts digital position signals at the helm, and positions the ETC throttle plate accordingly. The ETC has two Throttle Position Sensors (TPS). This redundancy ensures the accuracy of the throttle plate position, matching the digital position signal at the helm. The ETC also acts as a Idle Air Controller (IAC), increasing or decreasing the ETC plate opening, depending on the air temperature and engine temperature.

Powerhead Sensors

Camshaft Position Sensor

The camshaft position sensor is located at the top of the valve cover. It supplies the PCM with fuel injection timing and RPM information. When the camshaft position sensor is functioning, the PCM controls the fuel injection in a multi-port timing strategy. When the camshaft position sensor is failed, the PCM controls the fuel injection in a synchronous (batch) method. The PCM will generate and store a failure code when the camshaft position sensor fails.



4569

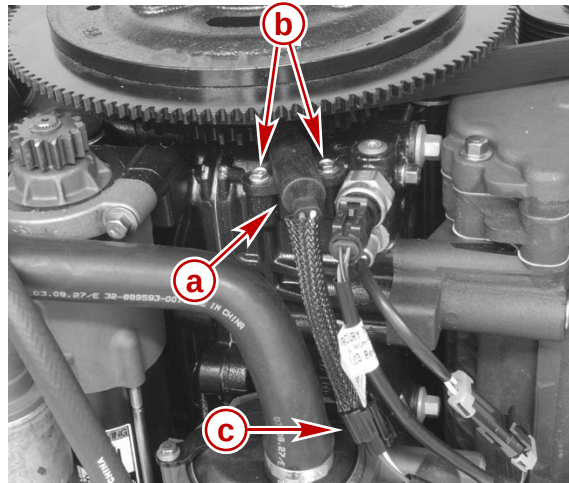
a - Cam position sensor harness connector

c - Cam position sensor retaining screw

b - Cam position sensor

Crankshaft Position Sensor (CPS)

The CPS is located at the top of the cylinder block, next to the flywheel. It supplies the PCM with timing and RPM information. If a failure occurs in the circuit, the engine will run rough or stop running. The PCM will generate and store a failure code.

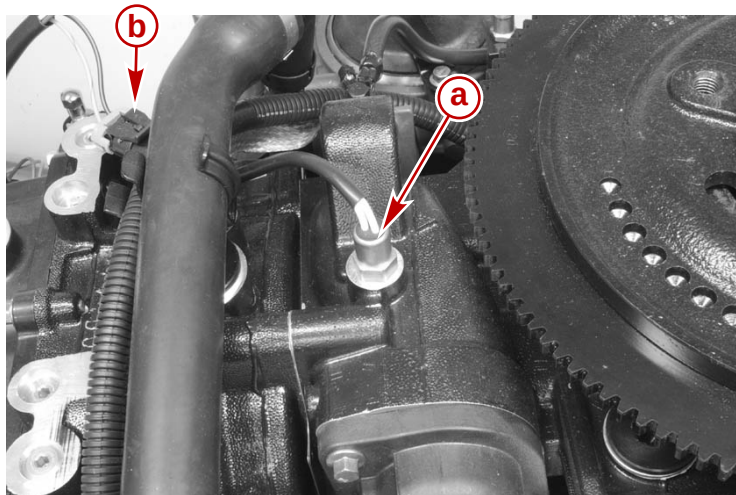


- a** - Crank position sensor
b - Crank position sensor retaining screw

- c** - Crank position sensor wire harness connector

Cylinder Block Temperature Sensor

The cylinder block temperature sensor is located at the top of the cylinder block, aft of the flywheel. It is a thermistor immersed in the engine coolant path. It supplies the PCM with engine temperature information. The PCM adjusts the timing and the amount of fuel delivered according to the water temperature in the cylinder block.

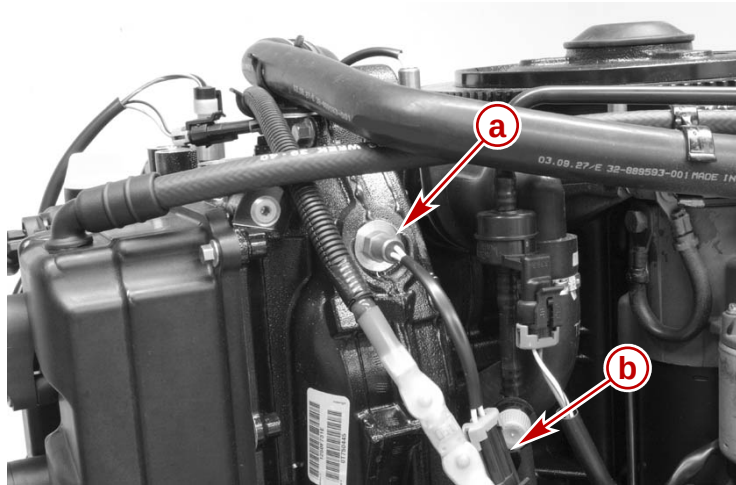


- a** - Cylinder block temperature sensor

- b** - Cylinder block temperature sensor wire harness connector

Cylinder Head Coolant Temperature Sensor

The cylinder head coolant temperature sensor is a thermistor immersed in the engine coolant stream. It is located on the starboard side of the head near the top of the head. It supplies the PCM with temperature information. The PCM adjusts the timing and the amount of fuel delivered according to the water temperature in the head.



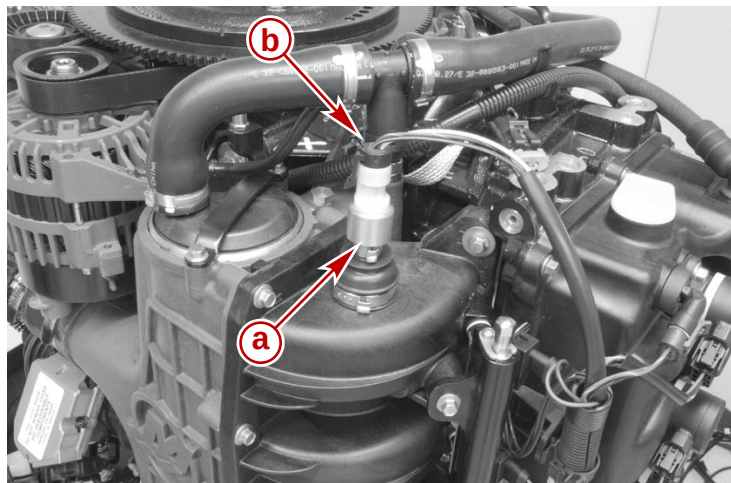
4575

a - Cylinder head coolant temperature sensor

b - Cylinder head coolant temperature sensor wire harness connector

Manifold Absolute Pressure (MAP) Sensor

The manifold absolute pressure (MAP) sensor, measures the changes in the intake manifold pressure. It is located at the top of the intake manifold. When the key is turned "ON" the MAP sensor reads the ambient atmospheric pressure. This key on pressure information is used by the PCM as an indication of the altitude and is referred to as BARRO.



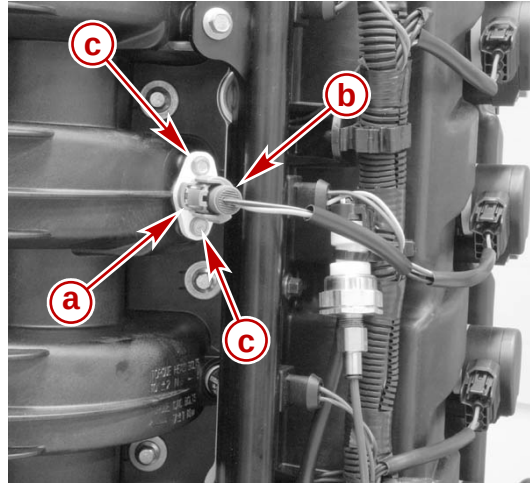
4576

a - MAP sensor

b - MAP sensor harness connector

Manifold Intake Air Temperature (MAT) Sensor

The manifold intake air temperature sensor is a thermistor that sends a signal voltage to the PCM. It is located in the middle of the intake manifold close to the fuel rail. It informs the PCM of the air temperature inside the intake manifold. The PCM adjusts the fuel injection duration needed to run the engine at optimum efficiency according to the MAT information.

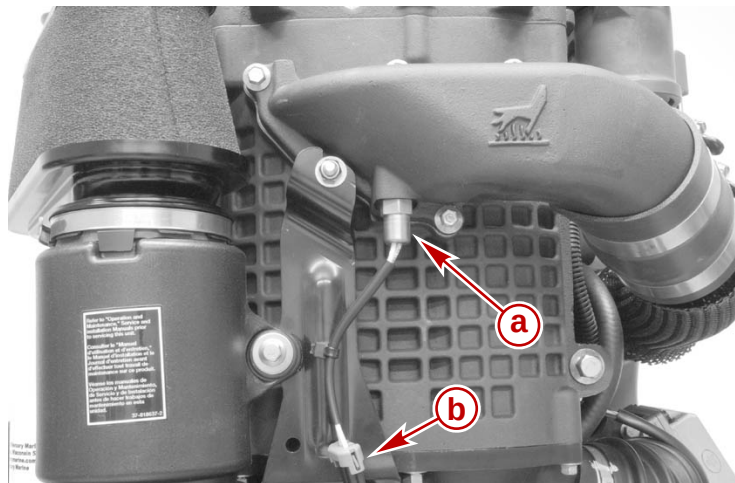


4577

a - MAT sensor**c** - MAT sensor retaining screw**b** - MAT sensor wire harness connector

Boost Air Temperature Sensor

The supercharger boost air temperature sensor is a thermistor immersed in the boost pressure stream. It is located in the front of the engine, on the supercharger boost pressure duct. The PCM will reduce engine RPM and warn the helm of the high temperature.



4579

a - Boost air temperature sensor**b** - Boost air temperature sensor wire harness connector

Fuel System

Fuel System Description

The components of the fuel system are:

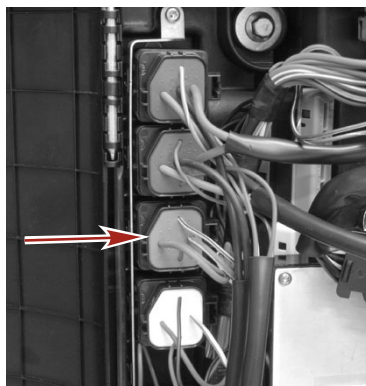
- Main Power Relay (MPR)
- Water Sensor
- Propulsion Control Module (PCM)
- Fuel System Module (FSM)
- Fuel Float Switch
- Vent Canister Switch (VCS)
- Vent Canister Purge Valve (VCPV)
- Fuel Lift Pump
- High Pressure Fuel Pump
- Fuel Pressure Regulator
- Fuel Cooler
- Fuel Injector
- Fuel Rail Pressure Damper
- Supercharger

IMPORTANT: No external electric fuel pump is allowed by the USCG. The system does not require an external primer bulb. Using an external primer bulb will cause a warning horn to sound and cause a flooding condition.

Main Power Relay (MPR)

The Main Power Relay (MPR) is located inside the electrical box on the starboard side of the engine. The MPR will remain active for approximately 180 seconds or until the Fuel System Module is full, the first time the system is powered up. The MPR is controlled by the PCM. After the first system power up, the MPR is active for approximately 2 seconds after the key is turned on. The PCM will not continue to activate the MPR unless one or more various sensors, or solenoid activation signal the PCM to initiate the MPR. The main power relay supplies 12 volts to the power trim, power steering, fuel lift pump, high pressure fuel pump, ignition pencil coils, fuel injectors, Electronic Shift Control, Electronic Throttle Control, Electronic Boost Control and alternator. The MPR is activated by:

- Power trim
- Power steering
- Moving the control handle
- Starting the engine



5894

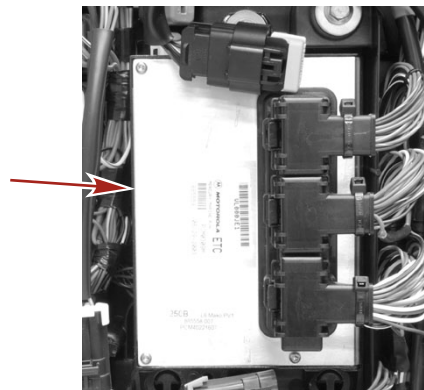
Propulsion Control Module (PCM)

The PCM needs 9 volts minimum to operate. If the PCM fails, the engine will stop running. The inputs to the PCM can be monitored and tested by the Digital Diagnostic Terminal or Computer Diagnostic System.

The PCM performs the following functions:

- Calculates the precise fuel and ignition timing requirements based on engine speed, throttle position, manifold pressure, manifold air temperature and cylinder head and cylinder block coolant temperature.
- Directly controls the ground circuit to: fuel injectors, ignition coil driver, Electronic Throttle Control motor drive, Electronic Boost Control motor drive, Electronic Shift Control motor drive, Main Power Relay activation, power steering pump, Vent Canister Purge Valve (VCPV), trim up, trim down, fuel lift pump, diagnostics, engine guardian, tachometer link (analog tachometer output or Link Gauge driver).
- Indirectly controls the positive circuit to: fuel injectors, ignition coils, Electronic Throttle Control motor drive, Electronic Boost Control motor drive, Electronic Shift Control motor drive, Main Power Relay activation, Vent Canister Purge Valve (VCPV), high pressure fuel pump.

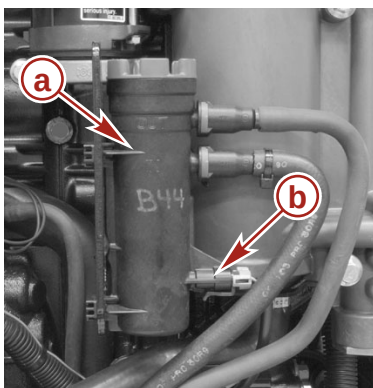
The PCM controls the ignition timing, the fuel injection timing, the fuel injection volume, activation of the fuel pumps, activation of the power steering pump, throttle and shift; while maintaining the optimal air-fuel ratio and the amount of manifold boost in all operating conditions. The PCM converts the signals from the input sensors and sends electrical voltage instructions to each part of the fuel management system, power steering pump motor, throttle/shift controls and ignition system. The PCM records all operations of the engine.



5910

Water Sensor

The water sensor is located in the fuel filter housing on the starboard side of the engine. The sensor has two probes that are highly conductive when water is present. The water completes a 5 volt negative reference to the PCM. The PCM will generate an error history and activate a warning horn to inform the operator. If SmartCraft gauges are installed, the PCM will flash a visual warning to the operator.



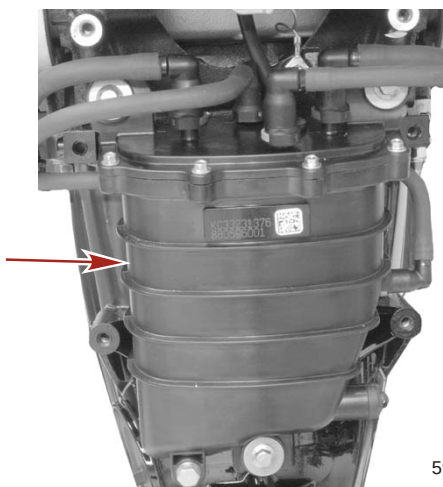
5911

a - Fuel filter housing

b - Water sensor

Fuel System Module (FSM)

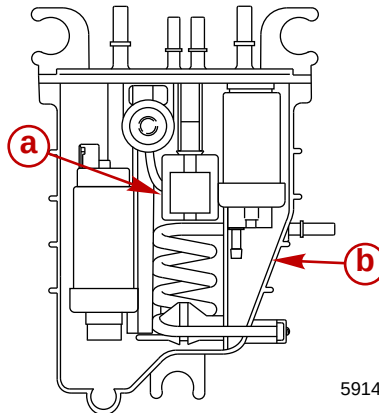
The Fuel System Module contains the fuel lift pump, high pressure fuel pump, fuel level float switch, fuel pressure regulator and a fuel cooler. The FSM is mounted aft and outside of the driveshaft housing, directly below the lower adaptor plate. There is no needle and seat controlling the amount of fuel entering the FSM. The filling of the FSM is controlled by the fuel level float switch inside the FSM. This switch is only for filling the FSM during the initial ignition key "ON". After the FSM is recognized as full, the PCM modulates the fuel lift pump to fill the FSM.



5913

Fuel Float Switch

The fuel float switch is a reed type switch sending an open or closed (off or on) signal to the PCM. The float has a magnet in it. As the fuel level increases in the FSM, the float will rise causing the magnet to open the reed switch sending the off signal to the PCM.

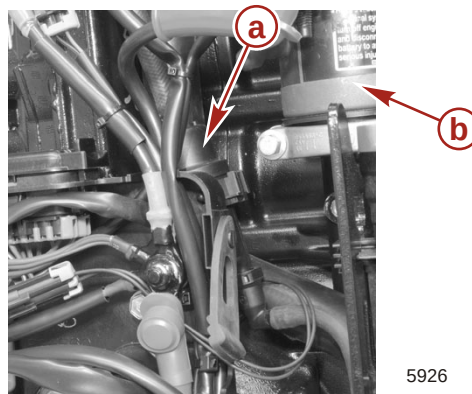


a - Fuel float switch

b - Fuel system module

Vent Canister (VCS) Switch

The vent canister switch (VCS) is located on the starboard side of the powerhead, aft of the starter. The VCS is an on/off signal to the PCM. The VCS switch is normally closed, completing a 5 volt reference from the PCM. The VCS switch will open during a Fuel System Module overflow condition. A open VCS switch will cause the PCM to close the Vent Canister Purge Valve.



a - Vent Canister Float Switch (VCS)

b - Starter

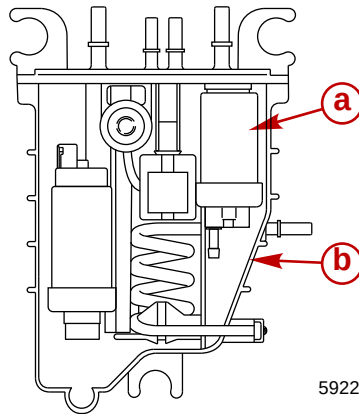
Vent Canister Purge Valve (VCPV)

The vent canister purge valve is closed when the engine is not running. This prevents the FSM fuel vapors from building up in the cowl. When the engine is running, the PCM completes the ground circuit of the purge valve, opening the valve to allow fuel vapors from the FSM to be vented into the air filter. This allows the fuel vapors to be burned in the combustion chamber. The VCPV is modulated of and on by the PCM.

Fuel Lift Pump

Fuel is pulled from the fuel tank, by the fuel lift pump located inside the FSM. The fuel lift pump is activated with 12 volts through the Main Power Relay when the key is turned to the "ON" position. The grounding of the fuel lift pump is completed in the PCM. The PCM circuit grounding of the fuel lift pump is dependent upon three conditions.

- **Condition one:** if there is no change in the fuel float switch signal during the first time an engine is put into service.
- **Condition two:** after a pre-determined programmed time limit, the PCM will open the grounding circuit.
- **Condition three:** when the fuel float switch and the vent canister float switch are closed, the PCM grounds the return electrical lead completing the circuit of the fuel lift pump.

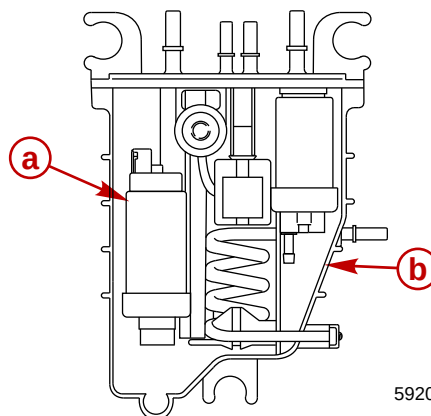


a - Fuel lift pump

b - Fuel system module

High Pressure Fuel Pump

The high pressure fuel pump is active when the PCM initiates the main power relay. The PCM does not have logic to detect the high pressure fuel pump operation. In the event of a high pressure fuel pump failure, no fault will be generated and the engine will not run. The high pressure fuel pump sends the fuel through a 20 micron fuel filter, into the bottom of the fuel rail. There is an internal regulation of the high pressure pump of 689.5 kPa (100 psi). The fuel rail pressure is controlled by a fuel pressure regulator.

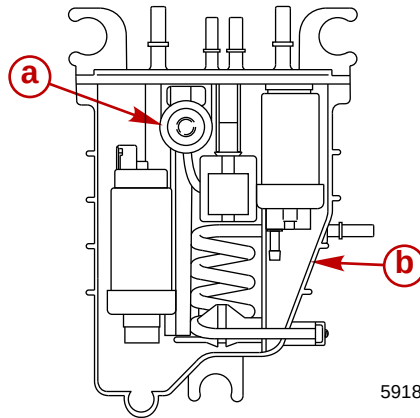


a - High pressure fuel pump

b - Fuel system module

Fuel Pressure Regulator

The fuel pressure regulator located inside the Fuel System Module, controls the amount of fuel pressure required for the engine to run efficiently. The fuel pressure regulator changes the pressurization of the fuel depending on the demands of the engine. The air pressure changes in the intake manifold to a higher or lower pressure during RPM changes. These manifold air pressure changes are linked to the fuel pressure regulator. The changes which take place at the fuel pressure regulator are managed by a hose that is connected to the intake manifold integrated air/fuel module. The air pressure change that is positive or negative on the fuel pressure regulator diaphragm, increases or decreases the amount of fuel that is dumped back into the FSM.

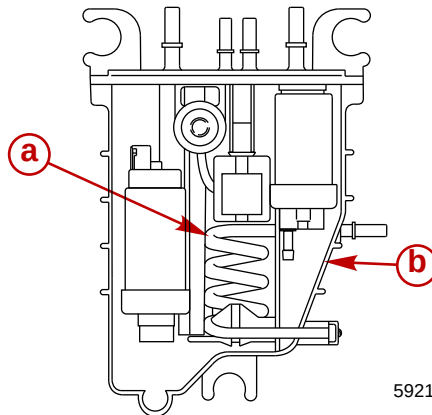


a - Fuel pressure regulator

b - Fuel system module

Fuel Cooler

The fuel cooler receives its supply of water from the filtered water outlet on the upper adaptor plate. The water outlet removes large debris from the water supply. The water is then directed with a pre-formed hose down to the FSM fuel cooler inlet. The fuel cooler is a metal line with several wound coils to help cool the fuel. After the water has passed through the fuel cooler it is dumped immediately outside of the FSM.

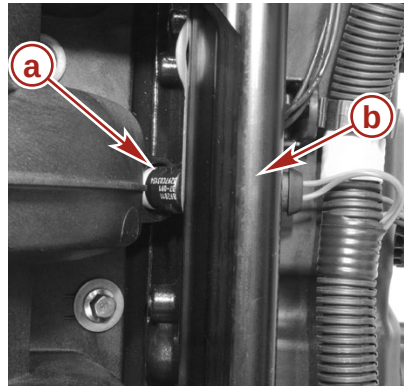


a - Fuel cooler

b - Fuel system module

Fuel Injector

The fuel injector is an electrically operated spring-loaded solenoid, which delivers a metered amount of fuel into the intake manifold runner, just ahead of the intake valve. The injectors are electrically charged as the key switch is set to the "RUN" position. The PCM controls the injection by completing the ground circuit, lifting the solenoid, which allows high-pressure fuel to flow. The PCM then opens the ground circuit allowing the spring to close the injector and stop the fuel flow. The fuel injector is not serviceable and is not common with any other engine. There are two separate split streams of fuel aimed at the intake valves for better atomization of the fuel. An injector filter is located on the fuel inlet side of the injector. The filter is not replaceable but can be cleaned of debris.



5925

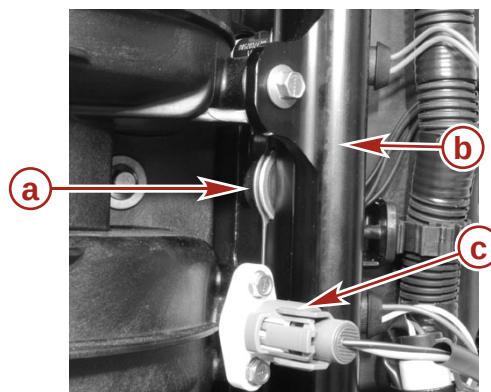
a - Fuel injector

b - Fuel rail

Fuel Rail Pressure Damper

The fuel rail pressure damper is located on the fuel rail assembly. Its designed to reduce fuel pressure changes caused by pulses generated by the fuel injectors opening and closing. The fuel rail pressure damper contains a spring on the dry side of the diaphragm. This spring positions the diaphragm against the diaphragm seat when the engine is not running and there is no fuel pressure present.

While the fuel pressure reaches normal operating range, the fuel pressure will compress the spring and the diaphragm will move slightly away from the normal position. Any fuel pressure spikes will be equalized with the pressure of the spring pushing on the diaphragm, which helps maintain a constant pressure within the fuel system.



5924

a - Fuel rail pressure damper

b - Fuel rail

c - Manifold Air Temperature (MAT) sensor

Supercharger

DESCRIPTION

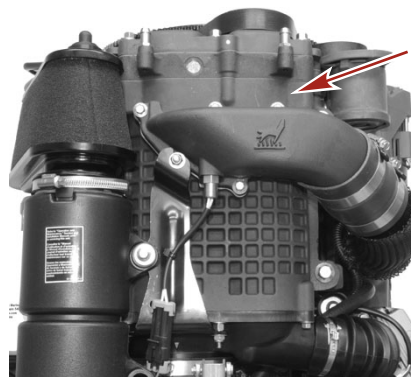
The supercharger is a crankshaft belt driven positive displacement true air compressor. It delivers increased air density and pressures up to two atmospheres (101.35 kPa [14.7 psi]) of boost to the intake manifold. The added density and pressure increases the horsepower. It is located on the front of the engine.

The supercharger uses horsepower from the crankshaft. This loss of horsepower is minimal and is outweighed by the supercharger horsepower gains at full load. A bypass called an electronic boost control valve, diverts air from the intake manifold back into the supercharger during idle speeds. Little or no boost is present during idle speeds.

When air is compressed, its ambient temperature rises and loses density. A cooler air intake charge results in more available horsepower due to the increase of air density. The charge air cooler located inside the intake manifold, minimizes the heat added to the charged air by transferring the heat to seawater before the charge reaches the combustion chamber.

COMPRESSION SEQUENCE

1. **Inlet phase** - The supercharger has two helix rotors that spin counter of each other. The helix rotors do not contact each other. As the lobes on the rotors mesh at the inlet ports, air is captured and moved toward the discharge ports.
2. **Compression phase** - As captured air cells are moved toward the discharge ports, the space between the lobes progressively decrease, resulting in compression and an increase in the air temperature.
3. **Discharge phase** - The compressed air cells are moved to the discharge port and passes through the intercooler in the intake manifold. The bypass valve will close when there is a demand for boost. The bypass valve is controlled by the PCM.



5928

Fuel System

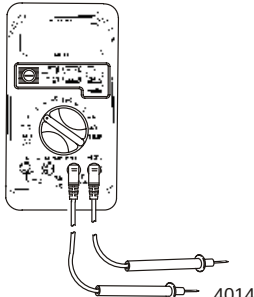
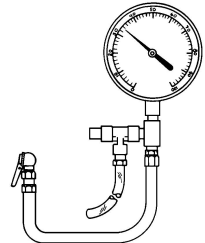
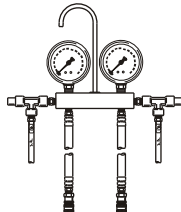
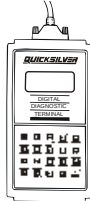
Section 3B - Troubleshooting and Diagnostics

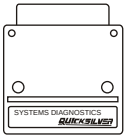
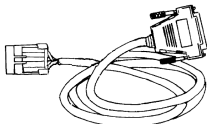
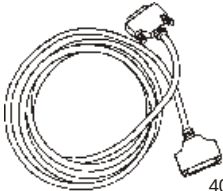
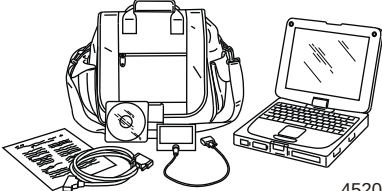
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**3
B**

Special Tools - Fuel System Troubleshooting And Diagnostics

DMT 2004 Digital Tachometer Multi-meter	91-892647A01
 4014	Measures RPM, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.
Fuel Pressure Gauge Kit	91-881833A03
 rms32	Checking fuel pressure, relieve fuel pressure
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
 5822	Tests fuel and air pressure; the dual gauges allow the viewing of both pressures simultaneously.
Digital Pressure Meter	91-892651A01
 5786	Connects to the fuel system/manifold and can be used in conjunction with Computer Diagnostic System (CDS)
Digital Diagnostic Terminal (DDT)	91-823686A2
 4011	Displays problem codes. Also monitors various sensors, circuits and components. Performs self-test procedures on select engine electrical systems. Cartridges and harnesses to use on the engines are sold separately.

DDT Cartridge v1.31	91-880118A04
 4013	Contains a diagnostic program for the PCM, allowing technicians to access all diagnostic capabilities available through the engine's PCM. Used with Digital Diagnostic Terminal (91-823686A2).
Digital Diagnostic Terminal Reference Manual	90-881204003
 6160	Lists procedures, specifications and sensor outputs that can be monitored using the Digital Diagnostic Terminal.
Adaptor Harness	84-822560A13
 5400	Data link harness between engine and Computer Diagnostic System (CDS) or Digital Diagnostic Terminal (DDT).
Extension Cable	84-825003A1
 4012	Data link extension harness (3.05 m [10 ft.]) between adaptor harness and Digital Diagnostic Terminal.
Computer Diagnostic System	Order through SPX
 4520	Monitors all electrical systems for proper function and diagnostic purposes. NOTE: For additional information, pricing or to order the Computer Diagnostic System contact: SPX Corporation 28635 Mound Rd. Warren, MI 48092 or call: USA - 1-800-345-2233 Canada - 800-345-2233 Europe - 49 6182 959 149 Australia - (03) 9544-6222

Electrical Component Troubleshooting And Diagnostics

Using the Digital Diagnostic Terminal (DDT) or Computer Diagnostic System (CDS)

Computer Diagnostic System (CDS)	Order through SPX
Digital Diagnostic Terminal (DDT)	91-82368A2

The Propulsion Control Module (PCM) is designed that if a sensor fails, the PCM will compensate so that the engine does not go into an over-rich condition. Because of this, disconnecting a sensor for troubleshooting purposes may have no noticeable effect.

IMPORTANT: Any sensor that is disconnected while the engine is running will be recorded as a fault in the PCM Fault History. Use the DDT or CDS to view and clear the fault history when troubleshooting/repair is completed.

The Quicksilver Digital Diagnostic Terminal (DDT) and Computer Diagnostic System (CDS) has been developed specifically to help technicians diagnose and repair Mercury Marine 2 and 4 cycle engines.

Attach the diagnostic cable to the PCM diagnostic connector and plug in the software. You will be able to monitor sensors and PCM data values including status switches. The PCM program can help diagnose intermittent engine problems. It will record the state of the engine sensors and switches for a period of time and then can be played back to review the recorded information.

When using the DDT for troubleshooting, refer to the DDT Reference Manual for complete diagnostic procedures. When using the CDS for troubleshooting, follow the CDS driven troubleshooting menu for the complete diagnostic troubleshooting procedures.

Troubleshooting Without DDT Or CDS

Troubleshooting without the DDT or CDS is limited to checking resistance on some of the sensors.

Typical failures usually do not involve the PCM. Most likely at fault are the connectors, set-up, and mechanical wear.

- The engine may not run or may not run above idle with the wrong spark plugs installed.
- Swap ignition coils to see if the problem follows the coil or stays with the particular cylinder.

NOTE: *PCM's are capable of performing a cylinder misfire test to isolate problem cylinders. Once a suspect cylinder is located, an output load test on the ignition coil or fuel injector can be performed using the DDT.*

- Any sensor or connection can be disconnected and reconnected while the engine is operating without damaging the PCM. Disconnecting the crank position sensor will stop the engine.

IMPORTANT: Any sensor that is disconnected while the engine is running will be recorded as a Fault in the PCM Fault History. Use the DDT to view and clear the fault history when troubleshooting/repair is completed.

- If all cylinders exhibit similar symptoms, the problem is with a sensor or harness input to the PCM.
- If problem is speed related or intermittent, it is probably connector or contact related. Inspect connectors for corrosion, loose wires or loose pins. Secure connector seating. If dielectric compound was used to protect the wire connections, the dielectric compound must be removed.
- Inspect the harness for obvious damage: pinched wires, chaffing.
- Secure grounds and all connections involving ring terminals. Coat grounds and ring terminals with Liquid Neoprene.
- Check fuel pump connections and fuel pump pressure.

Guardian Protection System

The guardian protection system monitors critical engine functions and will reduce engine power accordingly in an attempt to keep the engine running within safe operating parameters.

IMPORTANT: The Guardian System cannot guarantee that powerhead damage will not occur when adverse operating conditions are encountered. The Guardian System is designed to 1) warn the boat operator that the engine is operating under adverse conditions and 2) reduce power by limiting maximum RPM in an attempt to avoid or reduce the possibility of engine damage. The boat operator is ultimately responsible for proper engine operation.

Fuel Component Troubleshooting And Diagnostics

Anti-Siphon Valves

While anti-siphon valves may be helpful from a safety stand-point, they clog with debris, they may be too small, or they may have too heavy a spring. Summarizing, the pressure drop across these valves can, and often does, create operational problems and/or powerhead damage by restricting fuel to the fuel lift pump and subsequently the high pressure fuel pump. Some symptoms of restricted (lean) fuel flow, which could be caused by use of an anti-siphon valve, are:

- Severe fuel rail pressure fluctuation
- Loss of fuel pump pressure
- High speed surging
- Outboard cuts out or hesitates upon acceleration
- Outboard runs rough
- Outboard quits and cannot be restarted
- Outboard will not start
- Vapor lock

Since any type of anti-siphon device must be located between the outboard fuel inlet and fuel tank outlet, a simple method of checking if such a device (or bad fuel) is a problem source, is to operate the outboard with a separate fuel supply which is known to be good, such as a remote fuel tank.

If, after using a separate fuel supply, it is found that the anti-siphon valve is the cause of the problem, there are 2 solutions to the problem; either 1) replace the anti-siphon valve with one that has lighter spring tension or 2) replace it with a solenoid-operated fuel shut off valve.

Referencing Fuel Pressure Readings

The fuel rail pressure reading will vary according to whether the intake manifold is under vacuum during idle, or under pressure when the demands of the engine load are highest. This change from vacuum to pressure variance, and the subsequent changes of the fuel pressure reading, is maintained by a reference hose connection at the intake manifold to the fuel pressure regulator inside the Fuel System Module (FSM).

During slow throttle advancement to WOT, the Propulsion Control Module (PCM) determines the demands of the engine are light based on the Manifold Absolute Pressure (MAP) reading, throttle position, and engine RPM; and will not close the boost control valve. The manifold remains in a vacuum state. During quick throttle advancement to WOT, the PCM determines the demands of the engine are high based on the MAP reading change, the throttle position, and what the engine RPM is in relation to the throttle position; and closes the boost control valve to change the manifold from a vacuum state to a pressurized state.

When the manifold is in a pressurized state, air is forced into the combustion chamber as the valves open. More fuel is needed to have a correct stoichiometric air to fuel ratio (14.7:1). The additional air pressure, is transferred to the fuel pressure regulator via the reference line. This reference line, connected to the fuel pressure regulator inside the FSM, applies the additional pressure from the manifold to the fuel pressure regulator diaphragm. The additional pressure on the fuel pressure regulator diaphragm changes the pressure needed to unseat the fuel pressure regulator, increasing the amount of fuel pressure in the fuel rail.

The fuel pressure regulator is factory set to open at 350 ± 32 kPa (50.76 ± 4.64 PSI). Fuel pressure will be less than regulator set pressure when there is a vacuum in the engines intake manifold (less than barometric pressure), and be more than regulator set pressure when there is boost pressure in the engines intake manifold (higher than barometric pressure).

Fuel Pressure Calculations, Engine Running

When calculating the fuel pressure at different points of engine RPM, a simple formula can be used to determine what the fuel pressure should approximately be; **(MAP - Barro) + regulator set point**.

The following examples are with a ambient barometric pressure of 101 kPa (14.65 PSI).

If the intake manifold absolute pressure is below the barometric pressure (vacuum), and the DDT or CDS displays 32 kPa (4.64 PSI) the formula appears as:

- **kPa:** $32 - 101 = -69 + 350 = 281$. 281 kPa is the calculated fuel pressure reading.
- **PSI:** $4.64 - 14.65 = -10.1 + 50.76 = 40.76$. 40.76 PSI is the calculated fuel pressure reading.

If the intake manifold absolute pressure is above the barometric pressure (boost) and the DDT or CDS displays 191 kPa (27.70 PSI) the formula appears as:

- **kPa:** $191 - 101 = 90 + 350 = 440$. 440 kPa is the calculated fuel pressure reading.
- **PSI:** $27.70 - 14.65 = 13.05 + 50.76 = 63.81$. 63.81 PSI is the calculated fuel pressure reading.

Fuel Lift Pump

The fuel lift pump can be tested with the DDT or CDS.

The fuel lift pump is Pulse Width Modulated (PWM) by the ground side of the pump through the PCM. The positive side is powered through the Main Power Relay (MPR). The fuel lift pump PWM is dependent on the Vent Canister Switch (VCS), and the FSM float level switch state.

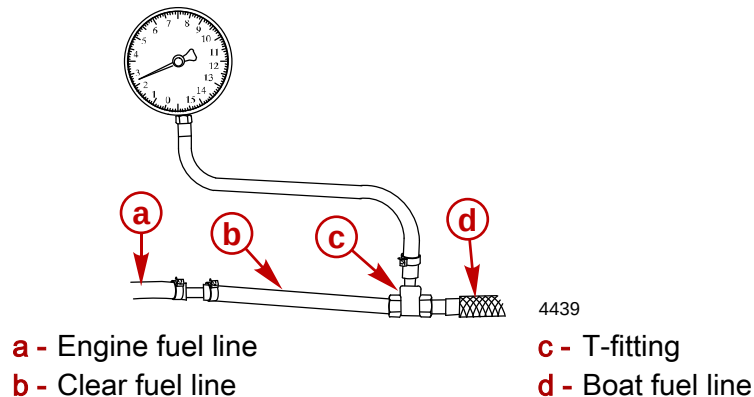
There are four possible dependencies for the PWM.

- **FSM Low, VCS Low:** The fuel lift pump runs until the FSM is full. Normally this is about 1 minute or until it times out which is about 180 seconds. If the fuel lift pump times out, a "Lift Pump Time Out" fault will be set and the fuel lift pump will be turned off.
- **FSM High, VCS Low:** The fuel lift pump is turned off. No fault will be set.

- FSM Low, VCS High: The fuel lift pump is turned off, the Vent Canister Purge Valve (VCPV) is closed, and a "Vent Switch High" fault is set. Possible cause is a faulty fuel float level switch, fuel in the line between the VCS and the VCPV which can be eliminated by opening the purge vent schader valve (under green cap).
- FSM High, VCS High: The fuel lift pump is turned off, VCPV is closed and a "Vent Switch High" fault is set.
 - If the PCM does not see a fuel lift pump (open circuit) a "Fuel Pump CKT" fault will be set.
 - If the FSM fuel float switch sticks in the up position (FSM full, lift pump turned off) no fault is set and the engine will run out of fuel.

TESTING FUEL LIFT PUMP VACUUM

1. Separate the engine fuel line and the boat fuel line.
2. Install a t-fitting on the boat fuel line.
3. Install a clear fuel line on the opposite side of the t-fitting.
4. Connect the clear fuel line to the engine fuel line.
5. Install a fuel vacuum gauge (obtain locally) on the t-fitting.
6. Clamp all fuel line connections securely to prevent vacuum leaks.
7. Start engine.
8. Observe clear fuel line for air bubbles.
9. The vacuum gauge reading should be within the listed specification when the pump is active.



Fuel Lift Pump Vacuum Specification		
Sea level	3.76 Hg	12.73 kPa
231.6 m (760 ft.)	3.0 Hg	10.16 kPa
305 m (1000 ft.)	2.76 Hg	9.35 kPa
609.9 m (2000 ft.)	1.76 Hg	5.96 kPa

High Pressure Fuel Pump

High Pressure Fuel Pump Specification	
Fuel pressure, engine not running	350 ± 32 kPa (50.7 ± 4.6 psi)
Fuel pressure, engine running	Pressure dependent on manifold vacuum/pressure

The high pressure fuel pump can be tested for operation electrically with the DDT or CDS. The high pressure fuel pump power comes from the Main Power Relay (MPR) and is grounded through the engine wire harness.

There is no logic in the PCM to know if the high pressure fuel pump is functioning or not. No fault will be set if the high pressure fuel pump fails and the engine will not run.

1. Connect a fuel pressure gauge to the fuel rail schrader valve.
2. With the DDT or CDS, operate the fuel pump load test.
3. The fuel pressure gauge should read 350 ± 32 kPa (50.7 ± 4.6 psi) when the pump is running, engine not running.
4. If there is little or no pressure reading on the gauge, ensure the FSM has enough fuel to supply the high pressure pump.

Vent Canister Switch (VCS)

The Vent Canister Switch (VCS) is controlled by the PCM. The PCM supplies 5V to the VCS. The VCS is normally closed or low when the FSM is empty of fuel. The VCS can be checked with an ohm meter while it is still mounted on the engine or with the CDS.

If the VCS sticks open or high, a fault "Vent Switch High" will be set, the Vent Canister Purge Valve (VCPV) will close, the lift pump will be turned off, and the engine will run out of fuel. The PCM will not turn on the fuel lift pump when the VCS fault is on or high. The VCS must be closed before the PCM will turn the lift pump on.

If the VCS sticks closed or low, and the FSM fuel level switch is functioning correctly, the engine will operate without faults or driveability issues. If the Fuel System Module should overflow (a primer bulb or an electric primer pump will cause an overflow, a faulty fuel float level switch may cause an overflow) and the VCS sticks closed, a rich condition from unmetered fuel entering the air induction system at the air cleaner, may cause the engine to operate less than optimal.

Vent Canister Purge Valve (VCPV)

The VCPV is powered by the Main Power Relay (MPR). The ground is Pulse Width Modulated (PWM) by the PCM. The PWM is based on engine RPM.

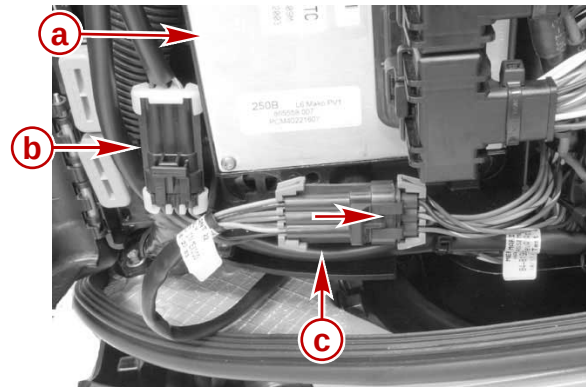
The VCPV is normally closed. During initial start up, the VCPV remains closed until the engine RPM is stable is complete. The VCPV is then modulated (cycles open and closed) by the PCM.

- If the VCPV fails electrically or becomes unplugged while the engine is running, the valve will close. Since the VCPV is normally closed, the PCM has no logic to detect this failure.
- If the VCPV fails mechanically open, the PCM has no logic to detect this failure, no fault will be set. If the VCS fails low and the FSM overflows with fuel, the engine could have driveability issues due to unmetered fuel entering the the air intake filter.

Fuel System Module (FSM)

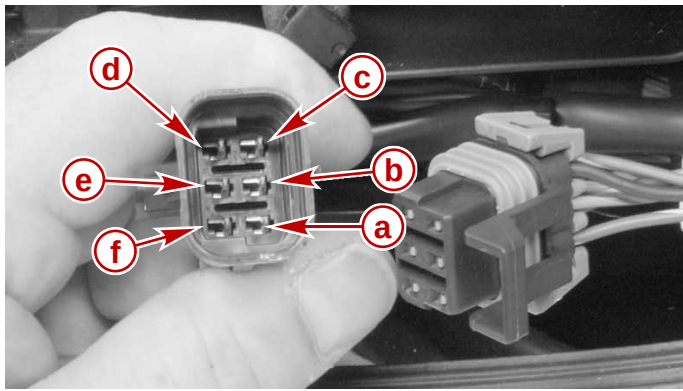
The FSM fuel lift pump and fuel pressure pump can be tested with the DDT or CDS.

The FSM harness connector is inside the electrical box. Push the FSM harness connector towards the front of the engine to disengage the harness clip. Disconnect the FSM harness from the engine harness.



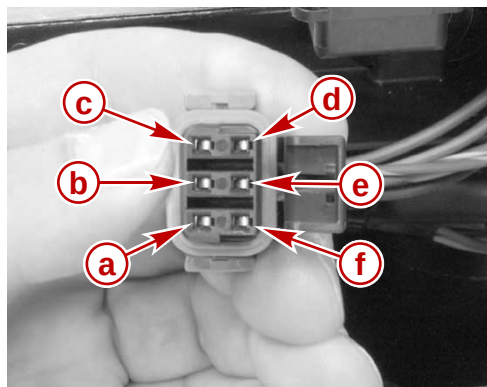
- a** - PCM
- b** - Trim motor wire harness connector
- c** - FSM harness connector

The following graphics show the FSM wire color - pin location and its purpose.



4937

- a** - Pin A, red wire, positive to high pressure pump
- b** - Pin B, orange wire, positive to lift pump
- c** - Pin C, blue wire, ground to fuel float level switch
- d** - Pin D, black wire, ground to high pressure pump
- e** - Pin E, brown wire, ground to lift pump
- f** - Pin F, purple wire, positive 5V to fuel float level switch



4938

- a** - Pin A, red/pink wire, positive to high pressure pump
- b** - Pin B, red/pink wire, positive to lift pump
- c** - Pin C, blue/yellow wire, fuel float level switch ground inside PCM
- d** - Pin D, black wire, ground to high pressure pump
- e** - Pin E, pink/black wire, lift pump ground inside PCM
- f** - Pin F, purple/yellow wire, positive 5V to fuel float level switch from PCM

Electronic Throttle Control (ETC)

The ETC is controlled through the PCM. The PCM receives information from the helm, based on the position of the throttle control handle/pedal. This information is sent to the PCM and the PCM activates the ETC motor to open or close the throttle valve. The two throttle valve position sensors in the ETC are also monitored by the PCM.

The ETC functions as an Idle Air Control (IAC) valve. During hard deceleration, the ETC will remain open slightly until the engine RPM has stabilized, to eliminate engine stalling.

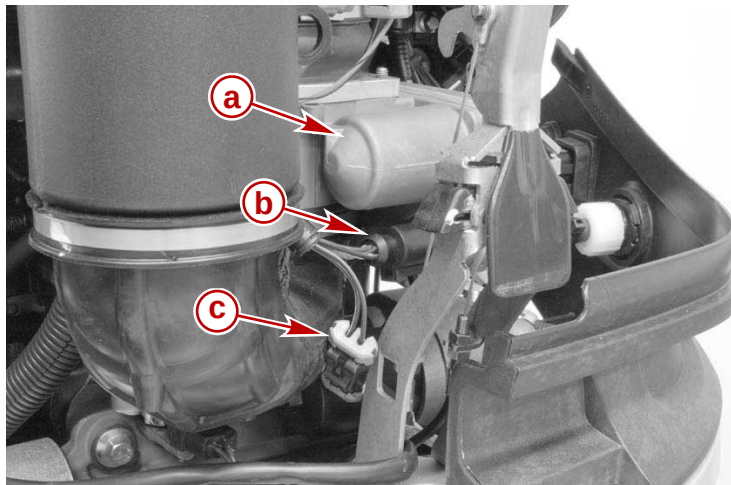
A built in fail-safe is designed into the ETC. The ECT is spring loaded to an off idle position to maintain engine RPM at approximately 1200 RPM in gear.

The ETC can be tested with the DDT or CDS.

The following step will assist you in determining if the failure is electrical or mechanical.

1. Remove the starboard front cowl.

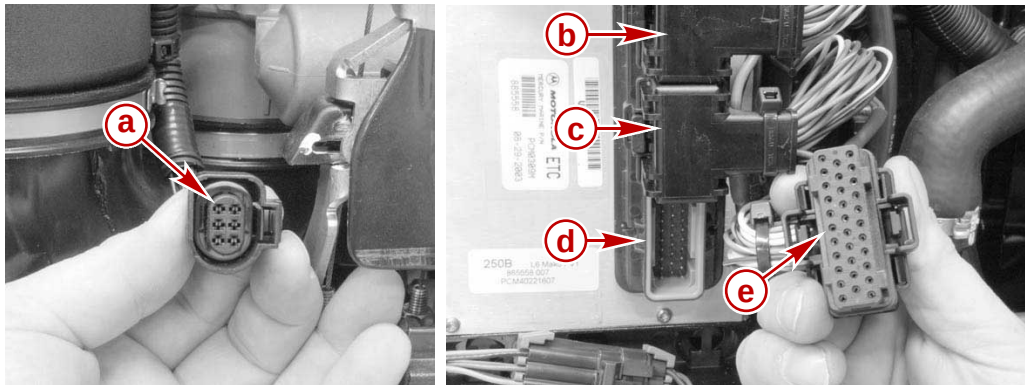
2. Remove the harness connector at the ETC.



4586

- a** - ETC
- b** - ETC harness connection
- c** - Shift indicator harness connection

3. Remove engine harness connector A1 at the PCM.
4. Check for continuity between pin #1 on the ETC harness connector and pin #6 on engine harness connector A1.

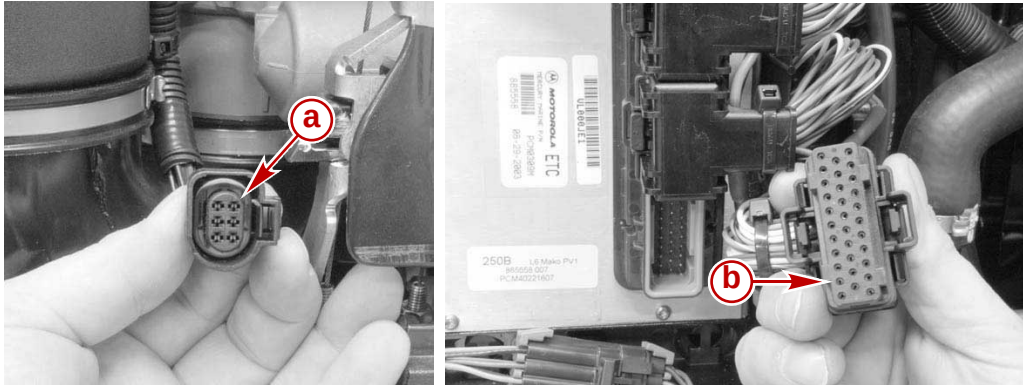


4587

- a** - ETC harness connector pin #1
- b** - C1 engine harness connector
- c** - B1 engine harness connector
- d** - A1 engine harness connector
- e** - A1 engine harness connector pin #6

5. If no continuity is found or there is high resistance, the engine harness must be replaced.
6. Check for continuity between pin #2 on the ETC harness connector and pin #10 on engine harness connector A1.
7. If no continuity is found or there is high resistance, check the Vapor Canister Switch (VCS). The VCS is normally closed.

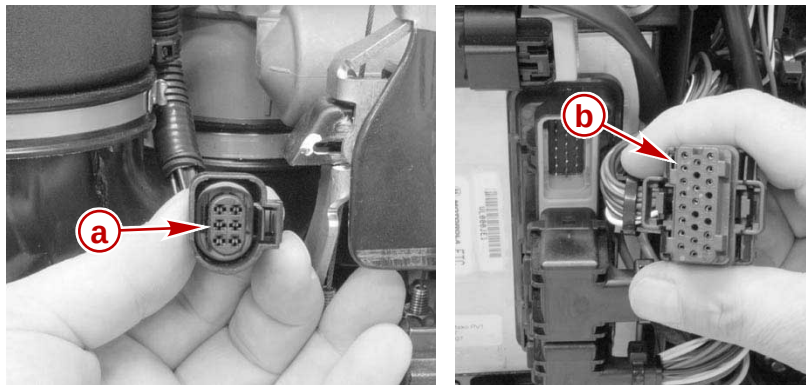
8. If the VCS is closed and no continuity or high resistance is found, the engine harness must be replaced.



4588

- a** - ETC harness connector pin #2
b - A1 engine harness connector pin #10

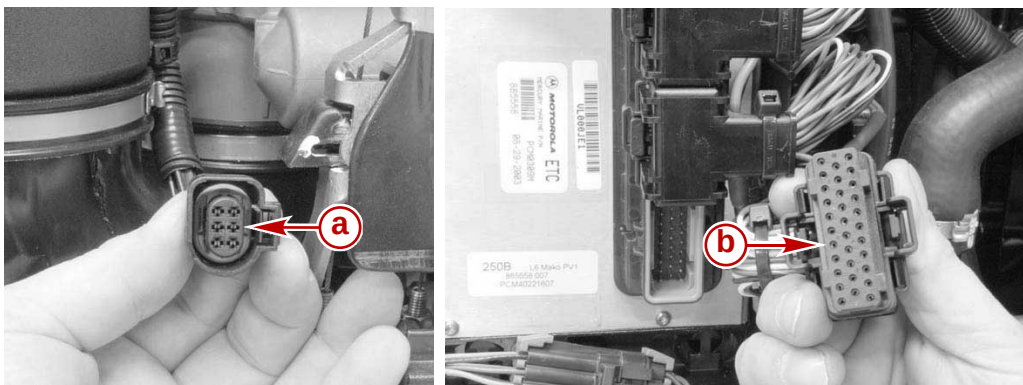
9. Remove engine harness connector C1 (top) at the PCM.
10. Check for continuity between pin #3 on the ETC harness connector and pin #2 on engine harness connector C1.



4589

- a** - ETC harness connector pin #3 **b** - C1 engine harness connector pin #2

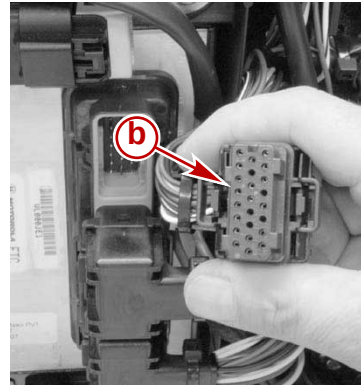
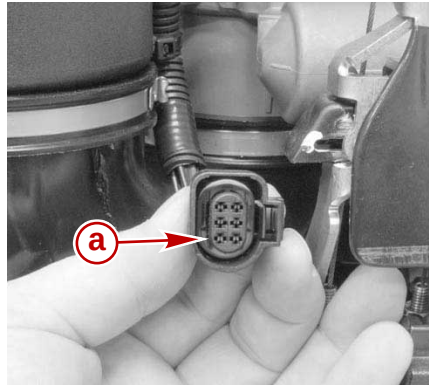
11. If no continuity is found or there is high resistance, the engine harness must be replaced.
12. Check for continuity between pin #4 on the ETC harness connector and pin #7 on engine harness connector A1.



4591

- a** - ETC harness connector pin #4 **b** - A1 engine harness connector #7

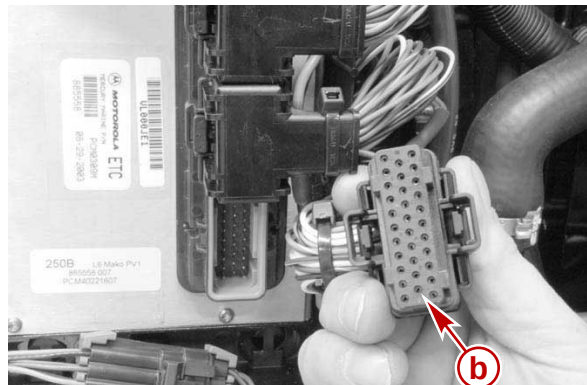
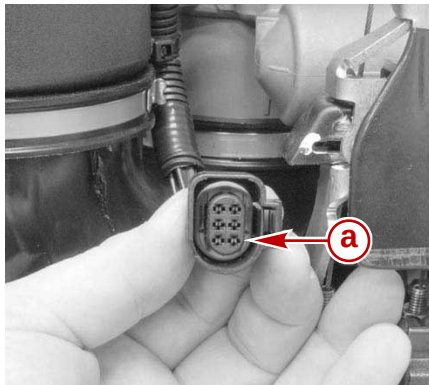
13. If no continuity is found or there is high resistance, the engine harness must be replaced.
14. Check for continuity between pin #5 on the ETC harness connector and pin #4 on engine harness connector C1.



4592

a - ETC harness connector pin #5 **b** - C1 engine harness connector #4

15. If no continuity is found or there is high resistance, the engine harness must be replaced.
16. Check for continuity between pin #6 on the ETC harness connector and pin #22 on engine connector A1. This connection is a positive 5v reference circuit from the PCM.



4593

a - ETC harness connector pin #6 **b** - A1 engine harness connector #22

17. If no continuity is found, there are multiple connections throughout the engine harness for this 5v reference circuit. Refer to the wire diagrams in Section 9 to trace the wire harness.
18. If the pin continuity checks are good, the failure is mechanical.

Refer to **Section 2D - Electronic Throttle Control Assembly** for the removal and replacement of the ETC.

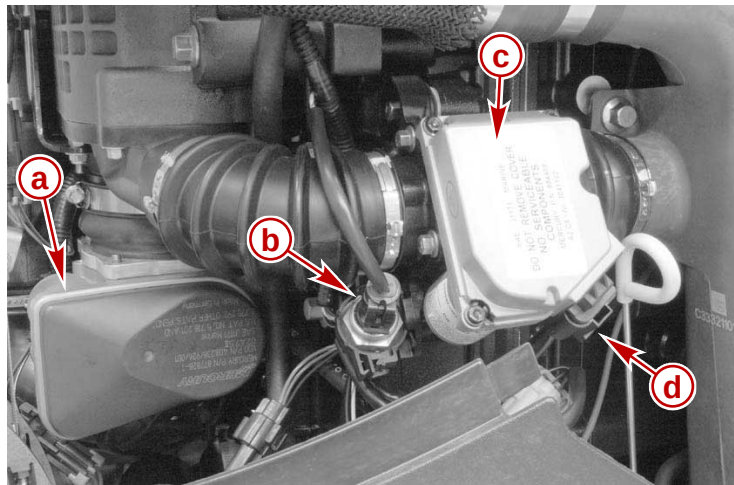
Electronic Boost Control (EBC)

The EBC is controlled through the PCM. The PCM receives data from several sensors to help determine the amount of boost needed for the engine to perform efficiently. The PCM activates the EBC valve motor to close or open. The EBC valve is normally open.

The EBC can be tested with the CDS or the DDT.

The following steps will assist you in determining if the failure is electrical or mechanical.

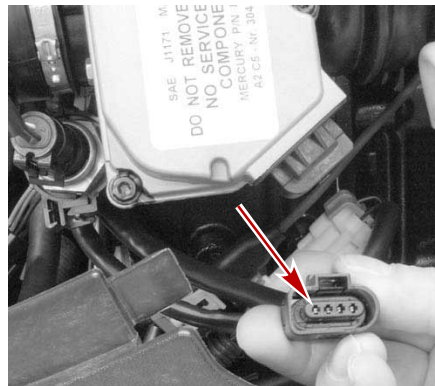
1. Remove the harness connector at the EBC.



4557

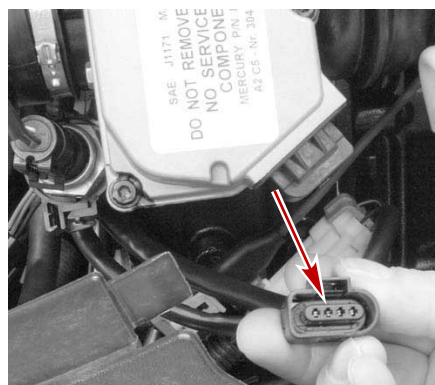
- | | |
|-------------------------------|----------------------------------|
| a - ETC | c - EBC |
| b - Speedometer sensor | d - EBC harness connector |

2. Check for continuity between the #1 pin and engine ground.



4558

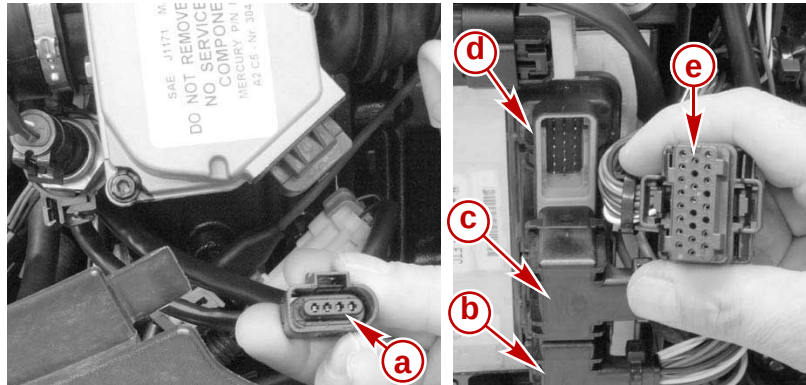
3. If continuity is not found or high resistance is present, the engine harness must be checked to determine if the harness is at fault or there is a poor ground connection to the cylinder block. Refer to the wire diagram in **Section 9** to trace the wire harness and check the ground locations.
4. Connect the positive volt meter lead to pin #2, and the negative volt meter lead to a known good engine ground.
5. Turn the ignition key on. The Main Power Relay (MPR) should be on (fuel pump will activate). Battery voltage should be at the #2 pin.



4560

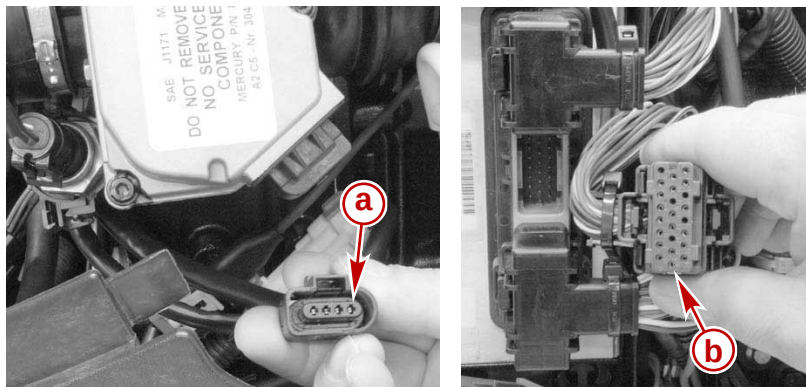
6. If you have no voltage and the MPR did not activate, check the MPR fuse.

7. If the MPR activated and there is no battery voltage, a continuity test of the engine wire harness must be completed to determine the location of the open connection. Refer to the wire diagrams in **Section 9** to trace the wire harness to the MPR.
8. Disconnect the engine harness C1 (top) at the PCM.
9. Check for continuity between pin #3 at the EBC and pin #9 at the C1 engine harness connector. An open circuit indicates a repair or replacement of the engine harness is required.



- a** - EBC harness connector pin #3
- b** - A1 engine harness connector
- c** - B1 engine harness connector
- d** - C1 engine harness connector
- e** - C1 engine harness connector pin #9

10. Connect the C1 engine harness to the PCM.
11. Disconnect the engine harness B1 (center) at the PCM.
12. Check the continuity between pin #4 at the EBC and pin #16 at the B1 engine harness connector. An open circuit indicates a repair or replacement of the engine harness is required.



- a** - EBC harness connector pin #4
- b** - B1 engine harness connector pin #16

13. Connect the B1 engine harness connector to the PCM. If no problems were found with the wire harness, the failure is mechanical.

Fuel System

Section 3C - Service Procedures

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**3
C**

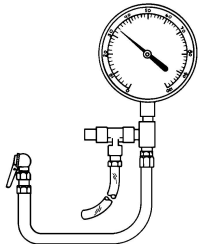
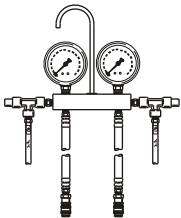
Fuel System Specifications

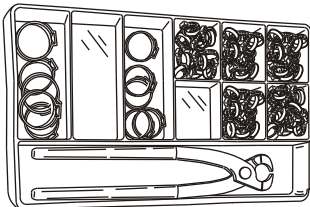
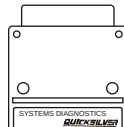
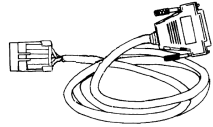
Fuel System Specifications	
Type of fuel	
149 kw (200 hp), 168 kw (225 hp), 186 kw (250 hp)	Automotive unleaded with a minimum pump posted octane rating of 87 (90 RON)
205 kw (275 hp)	Automotive unleaded with a minimum pump posted octane rating of 91 (96 RON)
Approximate fuel pressure @ idle	279 - 289 kPa (40 - 42 psi)
Fuel filtration	
Fuel inlet water separator	2 Microns
High pressure	20 Microns

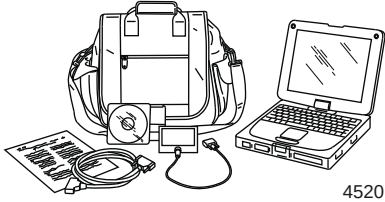
Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Fuel system module mounting screws	92-809821
		Fuel system module shroud mounting screw threads	
 136	Lubriplate SPO 255	Fuel injector O-rings	Obtain Locally
		Fuel injector O-ring, damper O-ring.	

Special Tools - Fuel System Service

Fuel Pressure Gauge Kit  rms32	91-881833A03 Checking fuel pressure, relieve fuel pressure
Dual Fuel/Air Pressure Gauge Kit  5822	91-881834A 1 Tests fuel and air pressure; the dual gauges allow the viewing of both pressures simultaneously
Digital Pressure Meter  5786	91-892651A01 Connects to the fuel system/manifold and can be used in conjunction with Computer Diagnostic System (CDS)

Hose Clamp Tool Kit	91-803146A2
 5819	Aids in the installation of high pressure (Oetiker®) hose clamps.
Digital Diagnostic Terminal (DDT)	91-823686A2
 4011	Displays problem codes. Also monitors various sensors, circuits and components. Performs self-test procedures on select engine electrical systems. Cartridges and harnesses to use on the engines are sold separately.
DDT Cartridge v1.31	91-880118A04
 4013	Contains a diagnostic program for the PCM , allowing technicians to access all diagnostic capabilities available through the engine's PCM. Used with Digital Diagnostic Terminal (91-823686A2)
Digital Diagnostic Terminal Reference Manual	90-881204003
 6160	Lists procedures, specifications and sensor outputs that can be monitored by using the Digital Diagnostic Terminal
Adaptor Harness	84-822560A13
 5400	Data link harness between engine and Computer Diagnostic System (CDS) or Digital Diagnostic Terminal (DDT).
Extension Cable	84-825003A1
 4012	Data link extension harness (3.05 m [10 ft.]) between adaptor harness and Digital Diagnostic Terminal

Computer Diagnostic System	Order through SPX
 4520	Monitors all electrical systems for proper function and diagnostic purposes. NOTE: For additional information, pricing or to order the Computer Diagnostic System contact: SPX Corporation 28635 Mound Rd. Warren, MI 48092 or call: USA - 1-800-345-2233 Canada - 800-345-2233 Europe - 49 6182 959 149 Australia - (03) 9544-6222

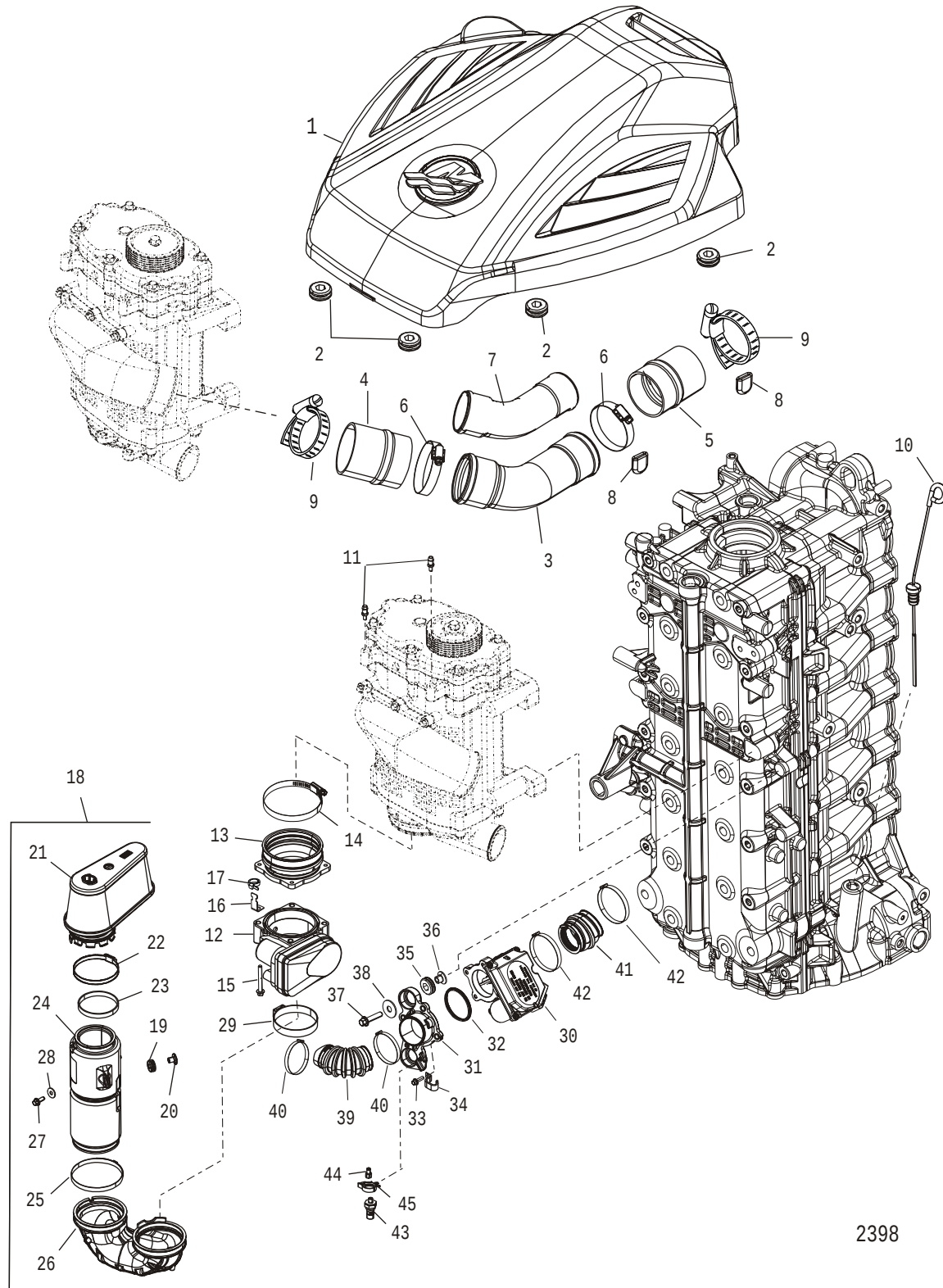
Notes:



Fuel System Module Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Harness			
2	1	Clip			
3	3	Grommet			
4	3	Bushing			
5	1	Cover			
6	8	Screw	5	45	
7	1	Regulator with O-ring			
8	2	Clamp			
9	1	Hose			
10	1	Seal			
11	1	Fuel pump, high pressure			
12	1	Seal			
13	1	Float			
14	1	Seal			
15	1	Fuel pump, lift			
16	1	Isolator			
17	1	Seal			
18	1	Housing			
19	1	Plug	5.7	50	
20	1	O-ring			

Induction Components



2398

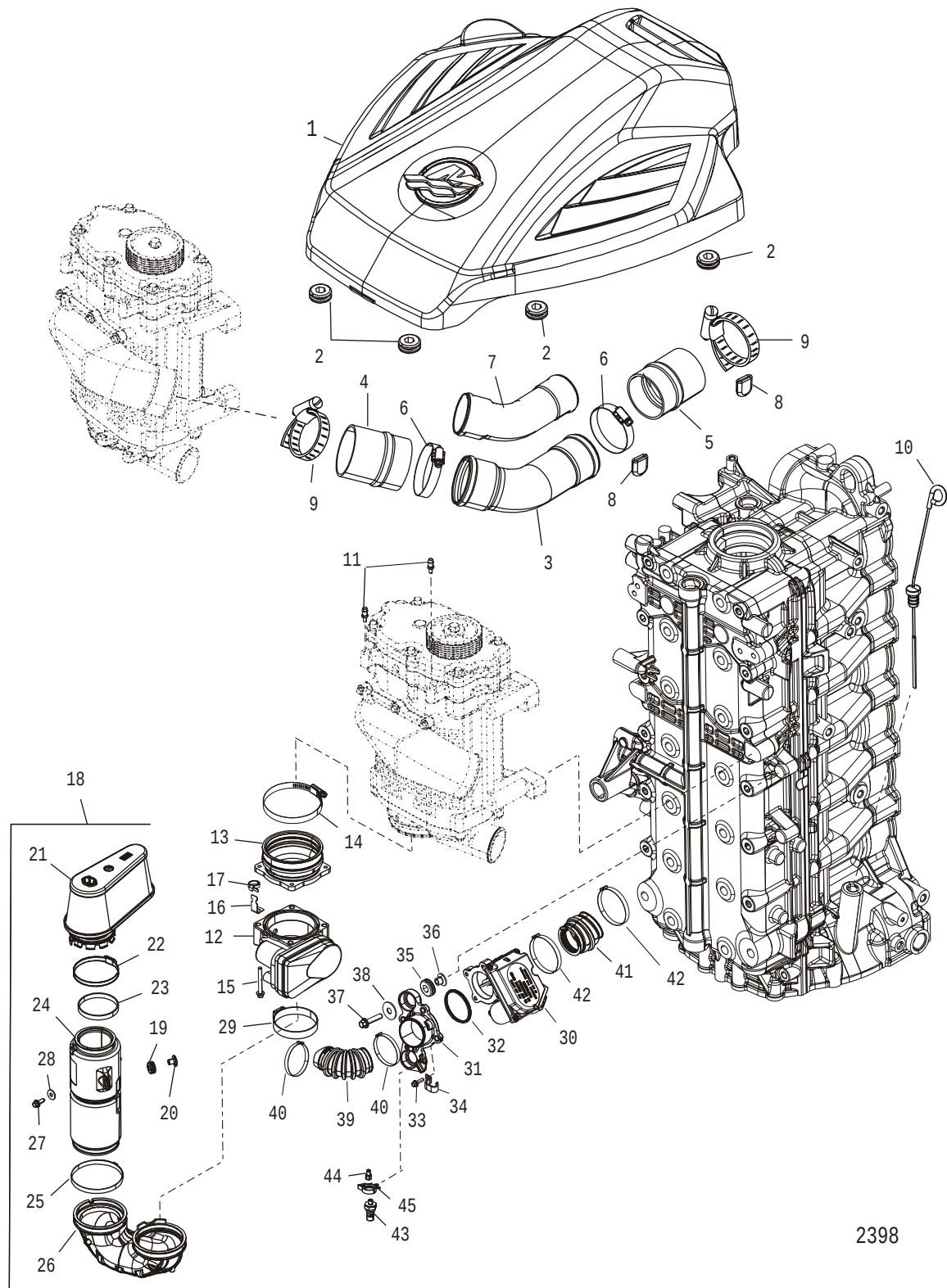
Induction Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Cover			
2	4	Grommet			
3	1	Tube assembly			
4	1	Hose 65 mm (2.56 in.) ID			
5	1	Hose 60 mm (2.36 in.) ID			
6	2	Clamp	6.2	55	
7	1	Sleeve, hose			
8	2	Cover			
9	2	Clamp	6.2	55	
10	1	Dipstick			
11	2	Pin	8	71	
12	1	Electronic Throttle Control (ETC) Assembly			
13	1	Isolator			
14	1	Clamp	6.2	55	
15	4	Screw (M6 x 50)	11	97	
16	2	Bracket			
17	2	Cable-tie			
18	1	Air intake assembly			
19	1	Grommet			
20	1	Bushing			
21	1	Filter			
22	1	Clamp			
23	1	Gasket			
24	1	Resonator			
25	1	Clamp (96.5)			
26	1	Boot, Rubber			
27	1	Screw (M6 x 25)	7.4	66	
28	1	Washer			
29	1	Clamp (96.5)			
30	1	Electronic Boost Control (EBC) Assembly			
31	1	Bracket			
32	1	O-ring			
33	4	Screw (M6 x 20)	10	88	
34	1	J-clip			
35	2	Grommet			
36	2	Bushing			
37	2	Screw (M8 x 35)	24	212	
38	2	Washer			
39	1	Tube			
40	2	Clamp 57.5			

Service Procedures

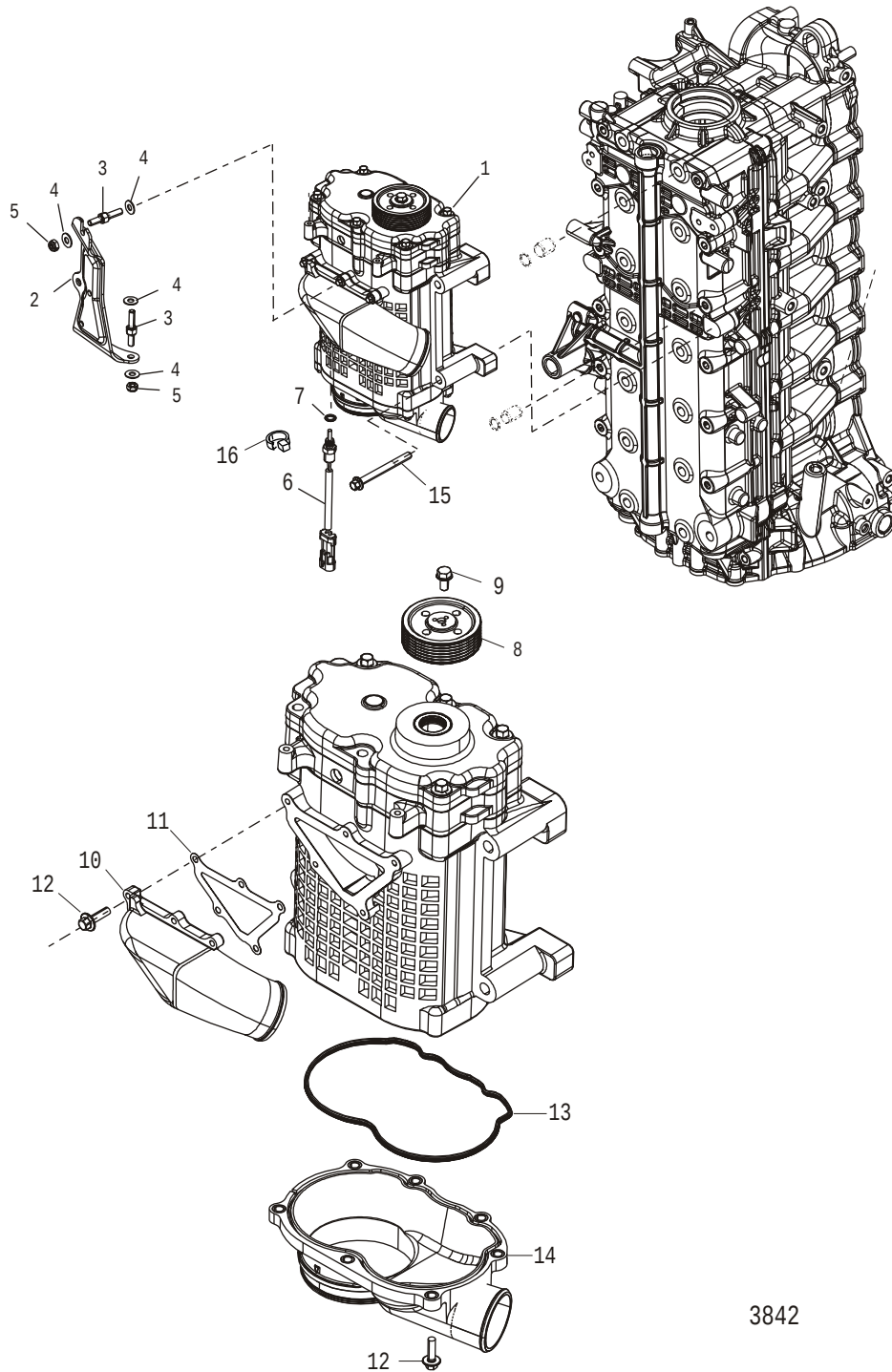
Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
41	1	Tube			
42	2	Clamp 62.0			
43	1	Sensor, pitot			
44	1	Fitting			
45	1	Clip			

Induction Components



2398

Supercharger

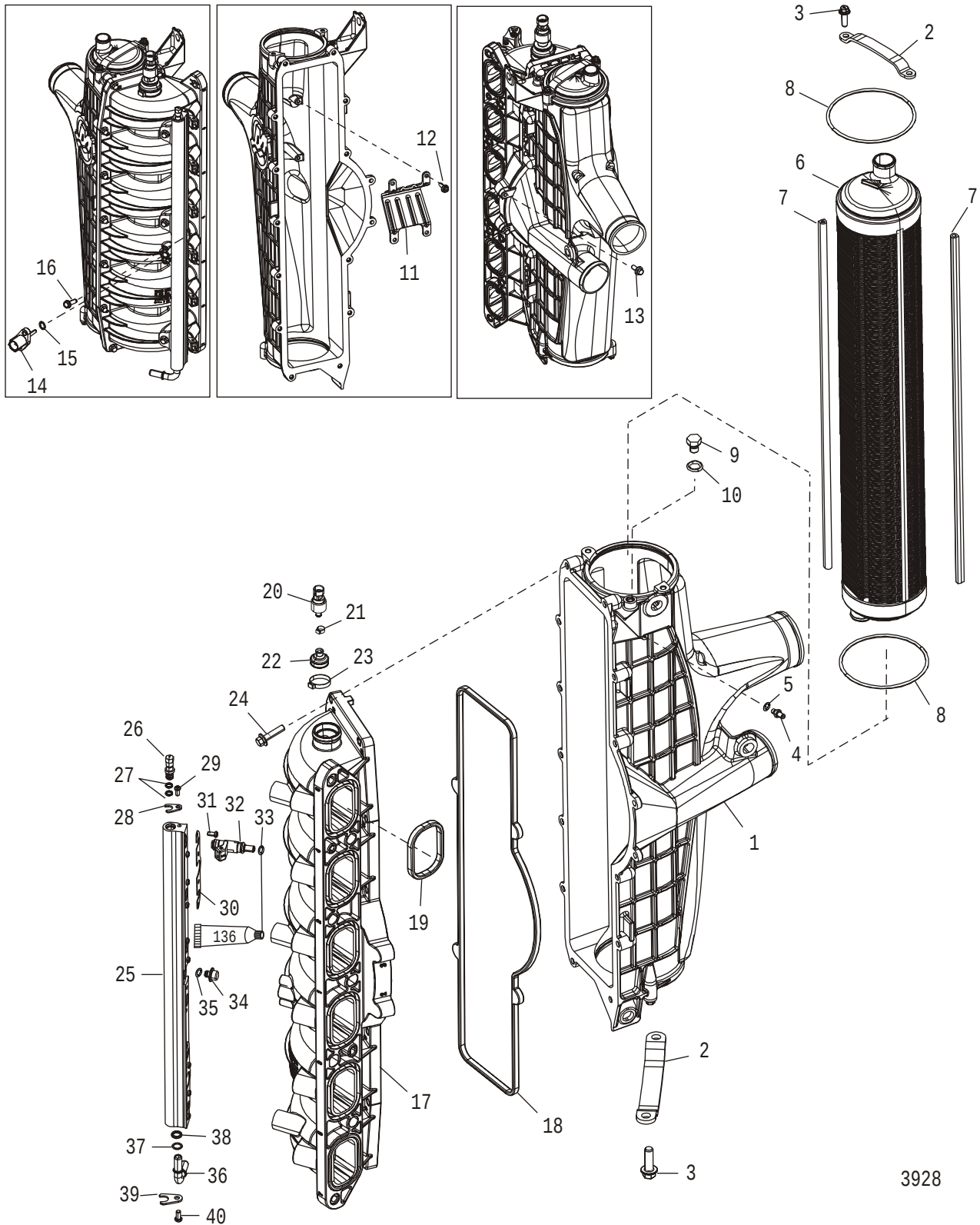


3842

Supercharger

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Supercharger			
2	1	Bracket			
3	3	Stud, Shoulder	8	71	
4	5	Washer			
5	5	Nut (M6)	8	71	
6	4	Sensor, Temperature	15	133	
7	1	O-ring			
8	4	Pulley			
9	1	Screw	36		26.5
10	1	Duct, Outlet			
11	1	Gasket			
12	5	Bolt	8	71	
13	1	Seal			
14	1	Duct, Inlet			
15	4	Screw (M10 x 105)	First torque	15	133
			Final torque	43	32

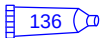
Charge Air Cooler - Intake Manifold



3928

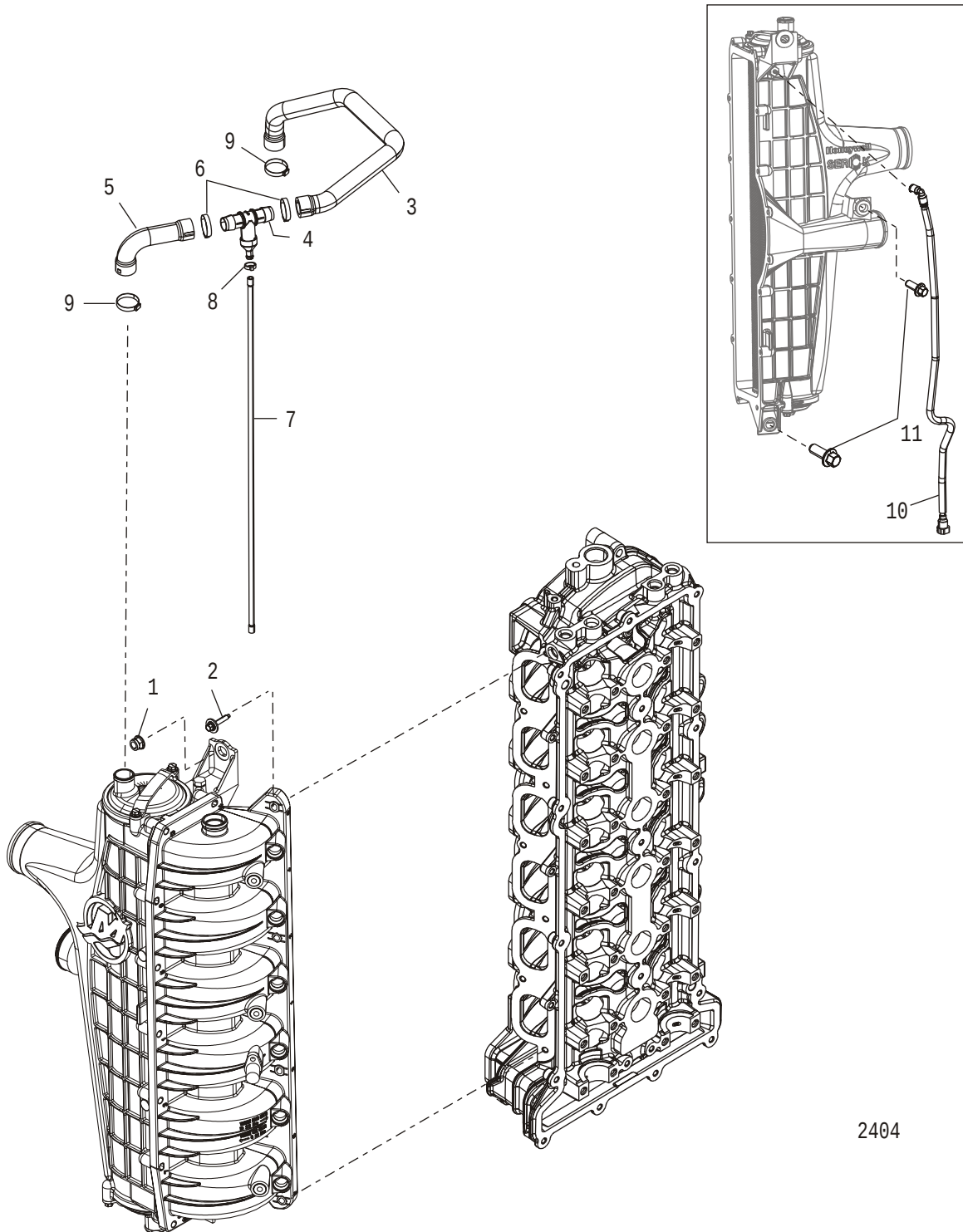
Charge Air Cooler - Intake Manifold

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Charge Air Cooler (CAC) Assembly			
2	2	Strap			
3	4	Screw (M6 x 18)	10	88	
4	1	Fitting			
5	1	O-ring			
6	1	Stack assembly			
7	2	Seal			
8	2	O-ring			
9	1	Fitting			
10	1	O-ring			
11	1	Plate			
12	4	Screw (M5 x 16)	7	62	
13	2	Screw (M6 x 15)	7	62	
14	1	Sensor, Air temperature with O-ring			
15	1	O-ring			
16	2	Screw (M4 x 16)	2	17.7	
17	1	Intake manifold assembly			
18	1	Seal			
19	6	Seal			
20	1	Sensor, Manifold Air Pressure (MAT)			
21	1	Clamp (15.7)			
22	1	Boot			
23	1	Clamp (36.1)			
24	13	Screw (M6 x 25)	7	62	
25	1	Fuel rail			
26	1	Valve, Schrader			
27	2	O-ring			
28	1	Bracket			
29	1	Screw (M5 x 10)	7	62	
30	3	Bracket			
31	12	Screw (M5 x 10)	7	62	
32	6	Injector, Fuel			
33	6	O-ring			
34	1	Damper			
35	1	O-ring			
36	1	Tube, Fuel inlet			
37	1	Washer			
38	1	O-ring			
39	1	Bracket			
40	1	Screw (M5 x 10)	7	62	

Tube Ref No.	Description	Where Used	Part No.
 136	Lubriplate SPO 255	Fuel injector O-rings	Obtain Locally

Notes:

Charge Air Cooler, Intake Manifold Hose Routing

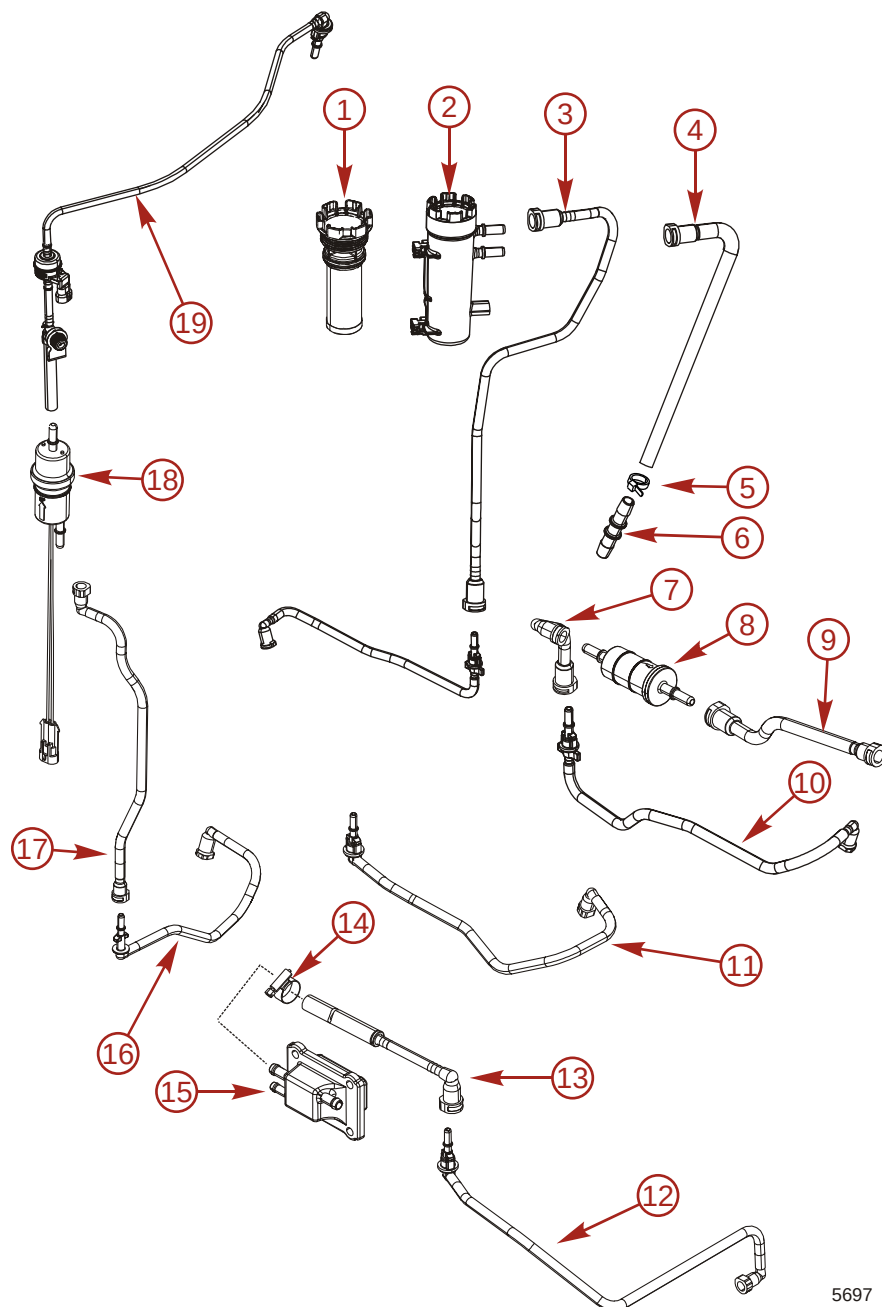


2404

Charge Air Cooler, Intake Manifold Hose Routing

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Nut (M10)	32.5		24
2	7	Screw	9	80	
3	1	Hose			
4	1	Fitting, Flush			
5	1	Hose			
6	2	Clamp (34.6)			
7	1	Hose			
8	1	Cable tie			
9	2	Clamp (34.6)			
10	1	Hose, Manifold reference upper			
11	2	Screw (M10 x 30)	32.5		24

Fuel Lines



5697

Fuel Lines

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Fuel filter			
2	1	Filter housing			
3	1	Hose, Fuel to lift pump			
4	1	Hose, Fuel inlet			
5	1	Cable tie (8 in.)			
6	1	Connector			
7	1	Hose, To high pressure 20 micron filter			
8	1	20 micron filter			
9	1	Hose, Filter to fuel rail			
10	1	Hose, FSM high pressure to fuel filter hose			
11	1	Hose, Manifold reference			
12	1	Hose, Water to FSM (lower)			
13	1	Hose, Water to FSM (upper)			
14	1	Clamp			
15	1	Manifold housing, Water			
16	1	Hose, Vent (lower)			
17	1	Hose, Vent (upper)			
18	1	Vent canister			
19	1	Vent Canister Purge Valve (VCPV) assembly			

Fuel System Module (FSM) Removal/Installation

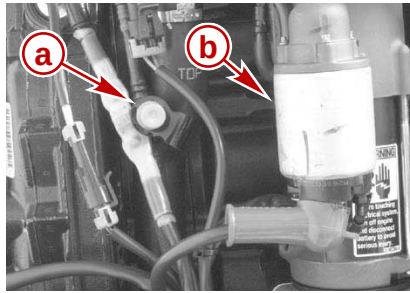
Fuel System Module Removal

1. Disconnect the battery cables from the battery.
2. Remove the top cowl.
3. Remove the rear cowl.
4. Remove the front starboard cowl.
5. Remove the lower chaps.

⚠ CAUTION

Pressurized fuel system! Release all pressure before servicing any part of the fuel system. This system can build pressure if the engine has not run for an extended period of time. If the fuel system is not relieved of pressure, fuel and vapors may be expelled at a significant velocity. Always protect your eyes and skin from pressurized fuel and vapors when servicing the fuel system.

6. Remove the cap to access the pressure relieve valve for the FSM.

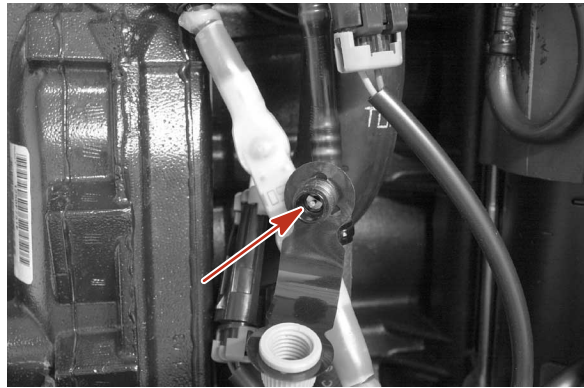


3570

a - FSM pressure relief valve

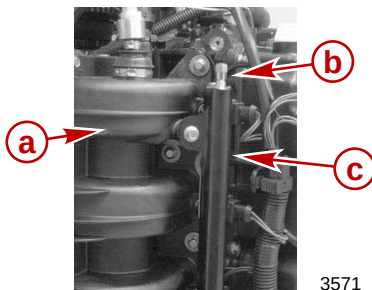
b - Starter solenoid

7. Place a rag over the valve and press on the center of the valve to relieve any pressure inside the FSM.



3472

8. Attach a fuel pressure gauge to the fuel pressure valve on the fuel rail. Relieve the fuel pressure into an appropriate container.



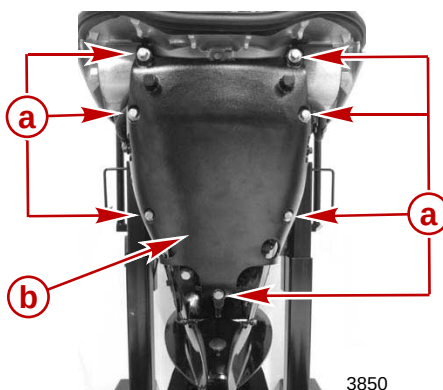
a - Intake manifold

b - Fuel pressure valve

c - Fuel rail

Fuel Pressure Gauge Kit	91-881833A03
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
Digital Pressure Meter	91-892651A01

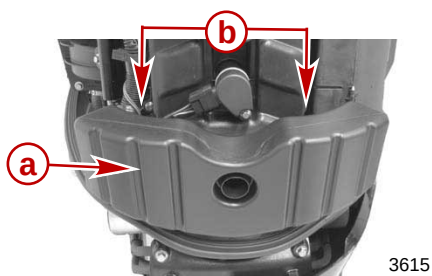
9. Remove 7 screws securing the FSM shroud to the driveshaft housing.



a - Shroud attaching screws

b - FSM shroud

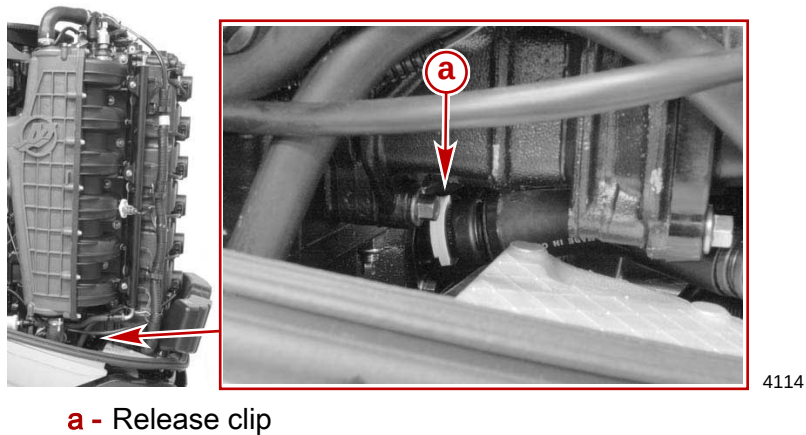
10. Remove the two screws holding the exhaust plenum to the mount cradle.



a - Exhaust plenum

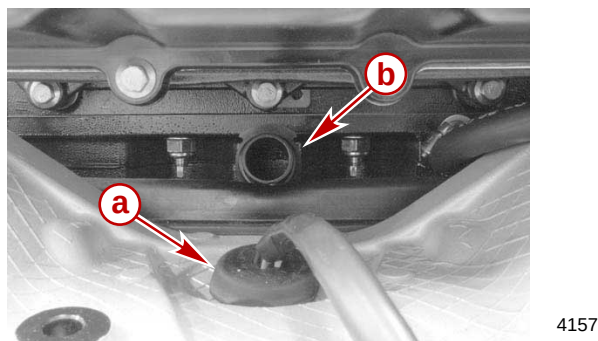
b - Exhaust plenum screws.

11. Disconnect the exhaust plenum tube by pushing in the release clip.



a - Release clip

12. Push the FSM harness grommet through the mount cradle.

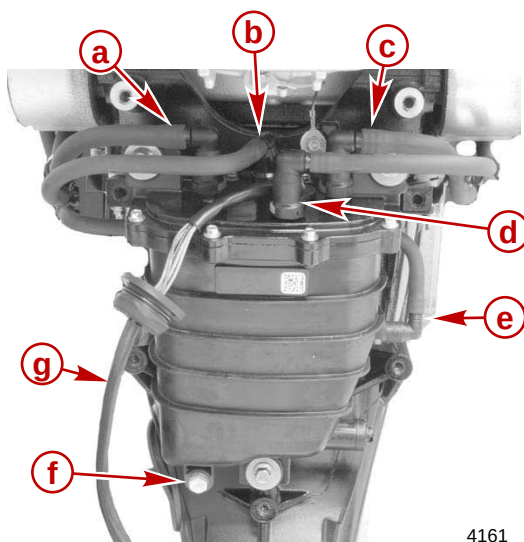


a - FSM harness grommet

b - Exhaust relief tube

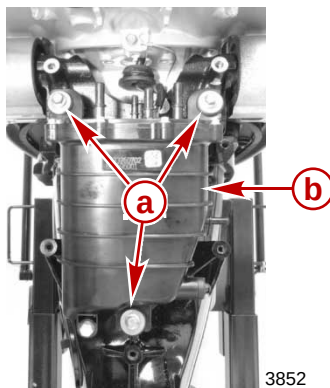
13. Remove the FSM drain plug. Capture draining fuel into an appropriate container.
14. Disconnect the fuel cooler line.
15. Disconnect the vent canister line.
16. Disconnect the fuel in line. Capture any fuel leaking from fuel line.
17. Disconnect the high pressure fuel out line. Capture any fuel leaking from fuel line.

18. Disconnect the manifold reference line.



- a** - High pressure fuel out line (10 mm red tab)
- b** - Manifold reference line (8 mm white tab)
- c** - Fuel in line (10 mm red tab)
- d** - Vent canister line (0.375 in. blue tab)
- e** - Fuel cooler line (8 mm blue tab)
- f** - FSM drain plug
- g** - FSM wire harness

19. Remove the bolts securing the FSM to the driveshaft housing.

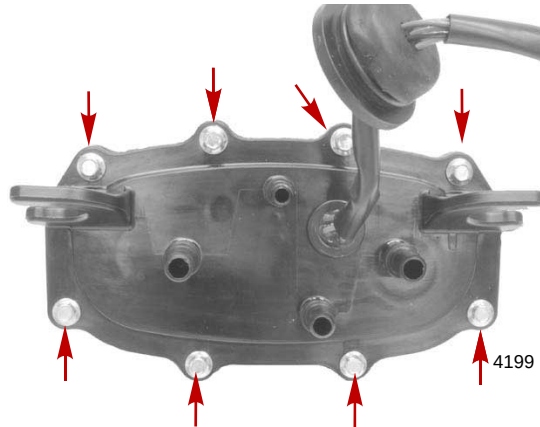


- a** - Fuel system module attaching screws
- b** - Fuel system module

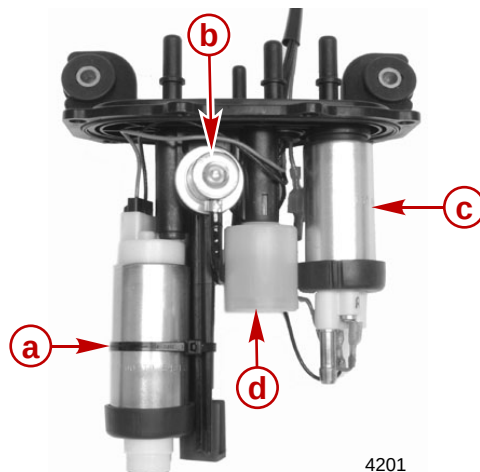
Fuel System Module Disassembly And Inspection

FSM DISASSEMBLY

1. Remove the bolts securing the FSM cover to the FSM housing. Remove the FSM cover.



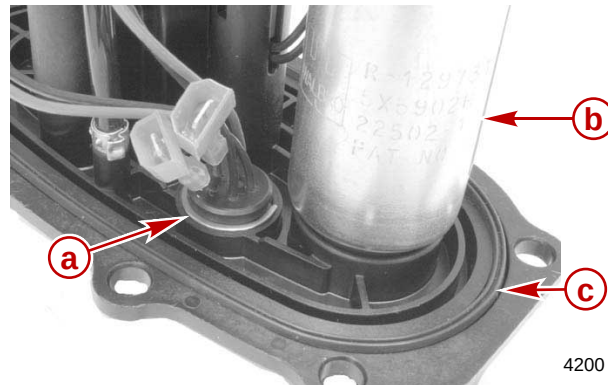
2. Cut cable tie securing fuel pump
3. Disconnect the fuel lift pump, high pressure fuel pump and float switch from the FSM wire harness.



- | | |
|---|---------------------------|
| a - Cable tie securing high pressure fuel pump | c - Fuel lift pump |
| b - Fuel pressure regulator | d - Float switch |

4. Remove the FSM cover gasket.

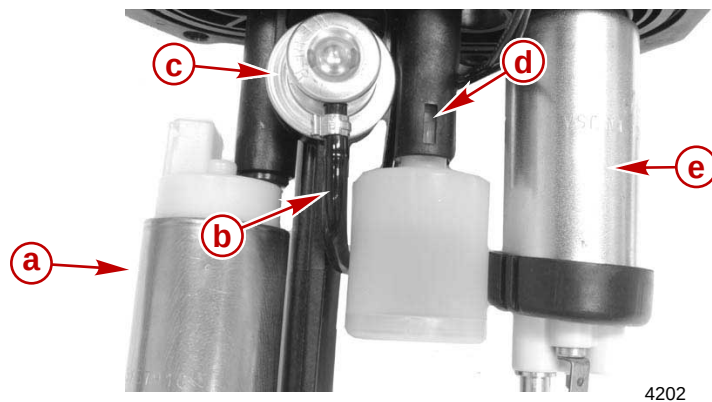
5. Remove the clip securing the FSM wire harness to the FSM cover. Remove the FSM wire harness from the FSM cover.



a - FSM wire harness clip
b - Fuel lift pump

c - FSM cover gasket

6. Push on the tabs to remove the float switch.
7. Pull on the high pressure fuel pump to remove the pump from the FSM cover.
8. Pull the fuel lift pump to remove the pump from the FSM cover.
9. Remove the manifold reference hose from the fuel pressure regulator.
10. Pull the fuel pressure regulator off the FSM cover.



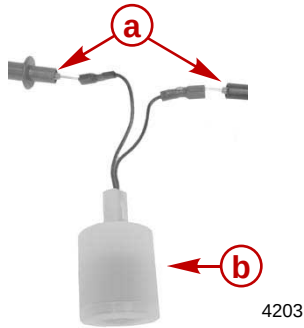
a - High pressure fuel pump
b - Manifold reference hose
c - Fuel pressure regulator

d - Float switch tab
e - Fuel lift pump

FSM INSPECTION

1. Visually check the float switch to ensure fuel has not leaked into the float.
2. Connect a ohm meter to the float switch wires.

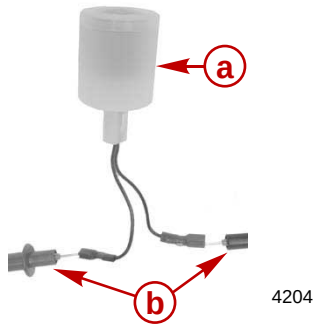
3. With the float switch in a normal operating position, wires facing up, there should be continuity. Replace the float switch if no continuity is found.



a - Ohm meter leads

b - Float switch in a normal operating position

4. Invert the float switch, wires facing down, there should be no continuity. Replace the float switch if there is continuity.



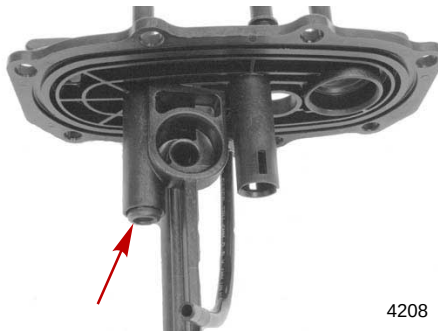
a - Float switch inverted

b - Meter leads

5. Remove the grommets on the high pressure fuel pump.
6. Remove the grommets and screen on the fuel lift pump.
7. Inspect the screen for debris. Clean as needed.
8. Visually inspect the fuel pressure regulator. Replace the fuel pressure regulator if debris is found on the fuel pressure regulator screen.

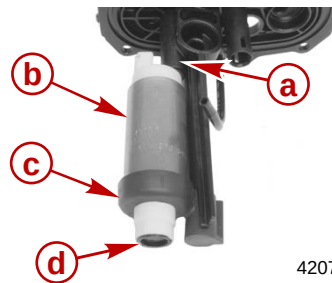
Fuel System Module Assembly

1. Insert the small grommet into the FSM cover.



2. Install the high pressure fuel pump.

3. Ensure the filter on the high pressure fuel pump is clear of debris.

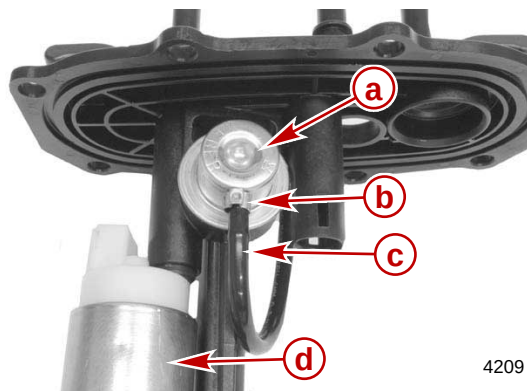


4207

- | | |
|------------------------------------|---------------------|
| a - Grommet in FSM cover | c - Isolator |
| b - High pressure fuel pump | d - Filter |

4. Install the fuel pressure regulator onto the FSM cover. Secure the manifold reference hose to the fuel pressure regulator.

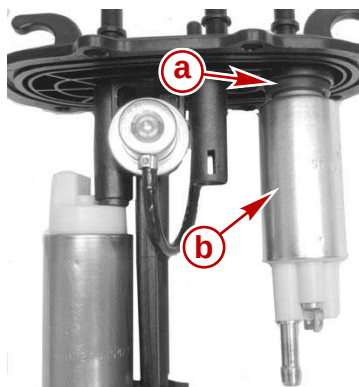
NOTE: The fuel pressure regulator O-rings cannot be purchased separately.



4209

- | | |
|---|------------------------------------|
| a - Fuel pressure regulator | c - Manifold reference hose |
| b - Fuel pressure regulator hose clamp (6.5) | d - High pressure fuel pump |

5. Insert the lift pump grommet into the FSM cover.
6. Insert the fuel lift pump into the grommet. Ensure the fuel lift pump is fully seated into the grommet.

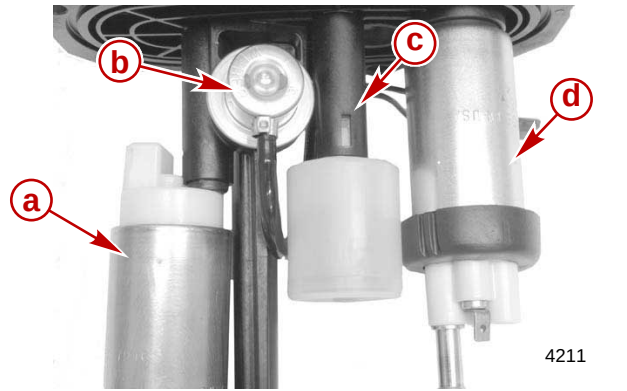


4210

- | | |
|-----------------------------------|---------------------------|
| a - Fuel lift pump grommet | b - Fuel lift pump |
|-----------------------------------|---------------------------|

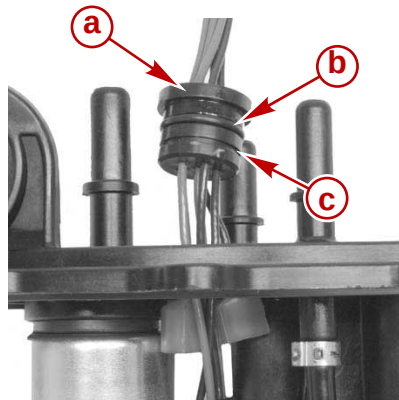
7. Guide the float switch wires into the slot on the FSM cover.
8. Align the float switch tabs with the FSM retaining holes.

9. Push the float switch completely into the FSM cover.



- a** - High pressure fuel pump
b - Fuel pressure regulator
c - Float switch tab
d - Fuel lift pump

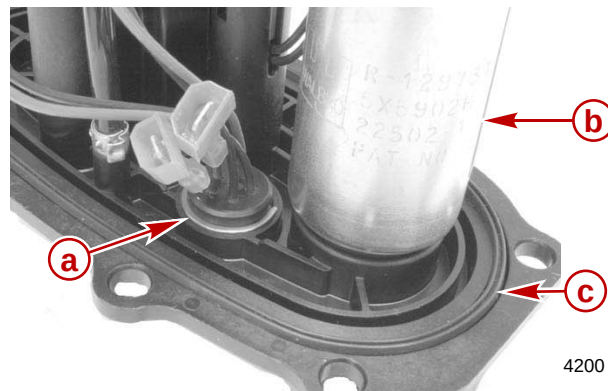
10. Ensure the O-ring on the FSM harness grommet is not damaged.
11. Guide the FSM harness connectors through the FSM cover.
12. Push the FSM harness grommet into the FSM cover until it bottoms out.



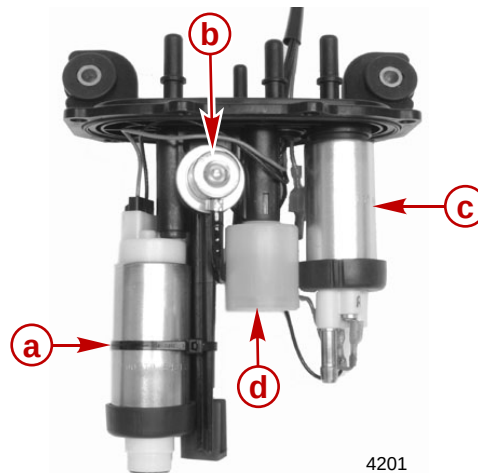
- a** - FSM harness grommet
b - O-ring
c - Grommet recess for retaining ring

13. Install the FSM harness grommet retaining ring.
14. Connect the high pressure fuel pump harness.
15. Connect the fuel lift pump harness.
16. Connect the float switch harness.

17. Install the FSM cover gasket

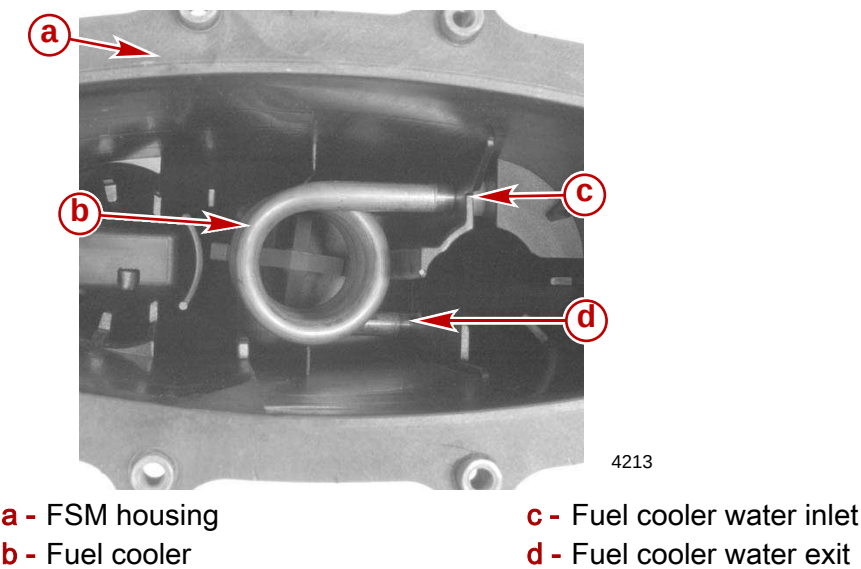
**a** - FSM wire harness clip**b** - Fuel lift pump**c** - FSM cover gasket

18. Secure fuel pump with a cable tie.

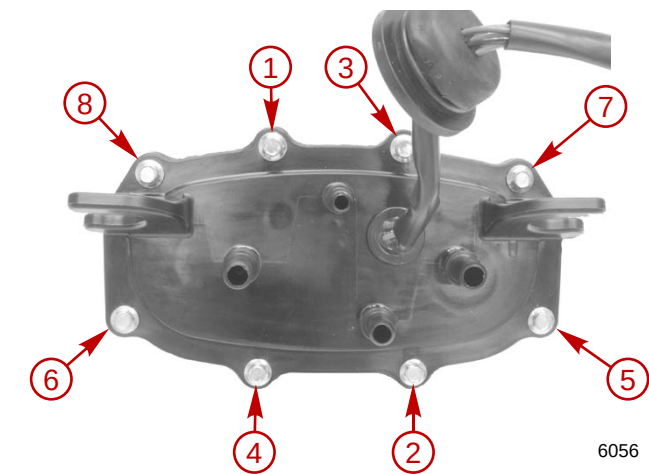
**a** - Cable tie securing high pressure
fuel pump**b** - Fuel pressure regulator**c** - Lift pump**d** - Float switch

19. Inspect the fuel cooling coil inside the FSM housing for damage.

NOTE: If damage to the fuel cooling coil is severe enough to cause water flow restriction, or if the coil is suspected of leaking water into the FSM, the Fuel System Module housing must be replaced.



- 20. Install the FSM cover to the FSM housing.
- 21. Secure the FSM cover to the FSM housing. Tighten the FSM cover bolts in sequence to the specified torque.

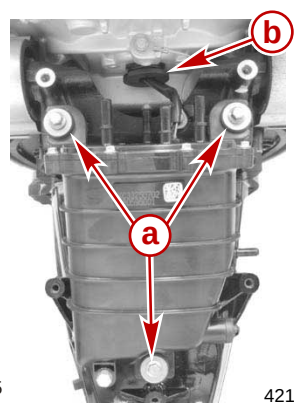
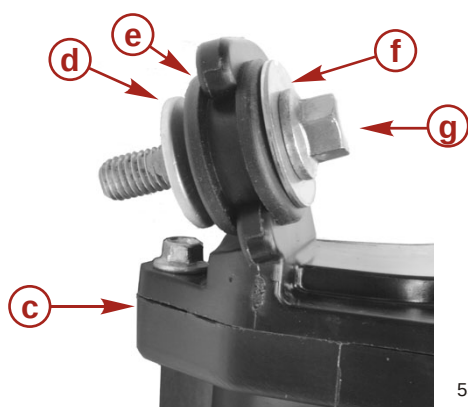


Description	Nm	lb. in.	lb. ft.
FSM Cover Bolt	5	45	

Fuel System Module Installation

- 1. Install rubber grommets onto the FSM.
- 2. Insert bushings from the rear of the FSM, into the rubber grommets.
- 3. Install washer onto the FSM mounting screws.
- 4. Insert FSM screw/washer into each bushing.
- 5. Apply Loctite 242 to fuel system module mounting screw threads.
- 6. Install FSM onto the driveshaft housing. Tighten to the specified torque.
- 7. Guide FSM wire harness through the cradle mount hole.
- 8. Push FSM wire harness grommet into the cradle mount hole.

NOTE: The fuel hoses have been removed for visual clarification.



- a** - FSM mounting screws
- b** - FSM wire harness grommet
- c** - Fuel system module
- d** - Bushing (3)

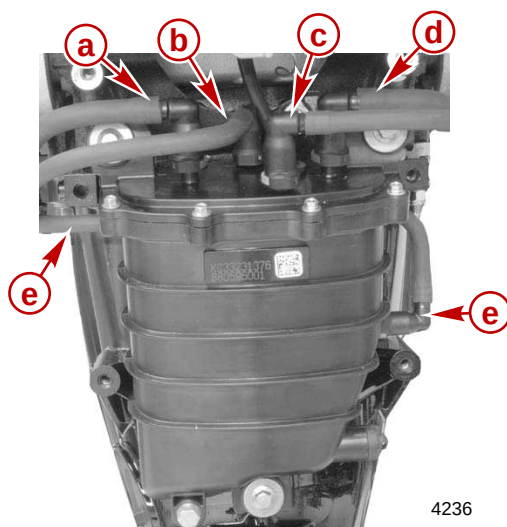
- e** - Grommet (3)
- f** - Washer (3)
- g** - Mounting screw (3) M8 x 35

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Fuel system module mounting screws	92-809821

Description	Nm	lb. in.	lb. ft.
FSM mounting screws (M8 x 35)	24		17.6

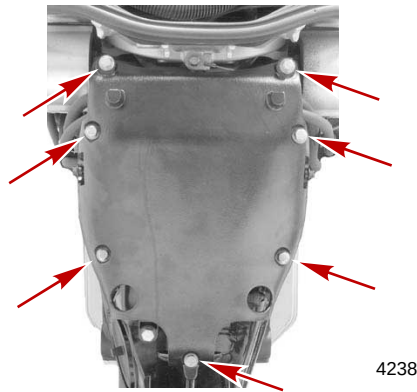
9. Connect the fuel out line, manifold reference line, fuel in line, vent canister line and the fuel cooler line.

NOTE: The fuel lines at the Fuel System Module are pre-formed and only fit on the correct FSM port.



- a** - High pressure fuel out line (10 mm red tab)
- b** - Manifold reference line (8 mm white tab)
- c** - Vent canister line (0.375 in. blue tab)
- d** - Fuel in line (10 mm red tab)
- e** - Fuel cooler line (8 mm blue tab)

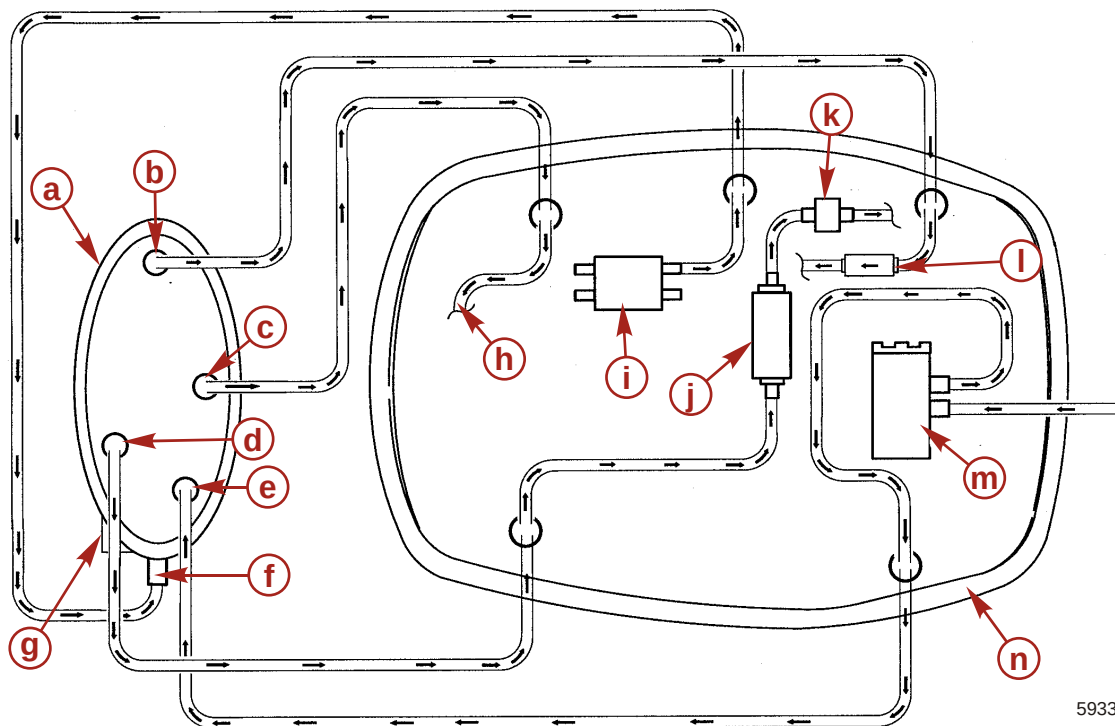
10. Apply Loctite 242 to seven fuel system module shroud mounting screw threads.
11. Install the FSM shroud. Tighten the FSM shroud mounting screws to the specified torque.



Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Fuel system module shroud mounting screw threads	92-809821

Description	Nm	lb. in.	lb. ft.
FSM Cover Bolts (M8 x 40, M8 x 50, M8 x 75, M8 x 120)	24		17.6

Fuel System Module Hose Routing Diagram



5933

- | | |
|--|--|
| a - Fuel system module | h - Manifold reference to intake manifold |
| b - Fuel out | i - Water manifold |
| c - Manifold reference | j - Vent canister switch |
| d - To vent canister switch/vent canister purge valve | k - Vent canister purge valve |
| e - Fuel in | l - 20 micron fuel filter |
| f - Water in | m - 2 micron fuel filter/water separator |
| g - Water out | n - Adaptor plate |

Charge Air Cooler (CAC) - Intake Manifold Removal/Installation

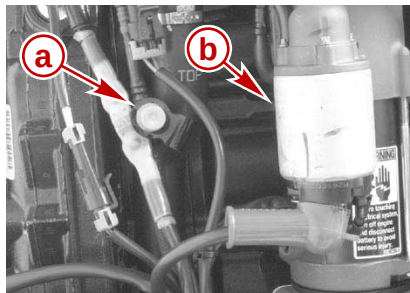
Charge Air Cooler Removal

⚠ CAUTION

Pressurized fuel system! Release all pressure before servicing any part of the fuel system. This system can build pressure if the engine has not run for an extended period of time. If the fuel system is not relieved of pressure, fuel and vapors may be expelled at a significant velocity. Always protect your eyes and skin from pressurized fuel and vapors when servicing the fuel system.

1. Disconnect the battery.

2. Remove the cap to access the pressure relief valve for the FSM.

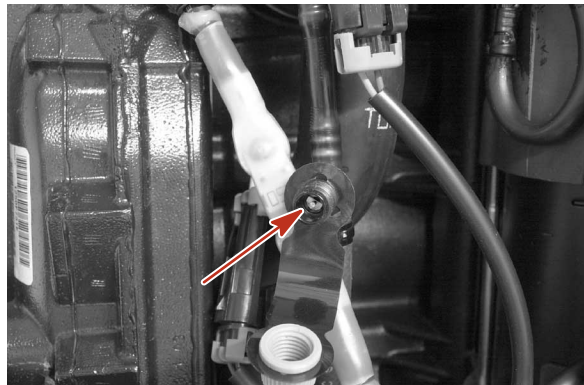


3570

a - FSM pressure relief valve

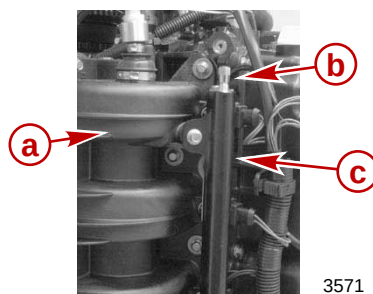
b - Starter solenoid

3. Place a rag over the valve and press on the center of the valve to relieve any pressure inside the FSM.



3472

4. Attach a fuel pressure gauge to the fuel pressure valve on the fuel rail. Relieve the fuel pressure into an appropriate container.



3571

a - Intake manifold

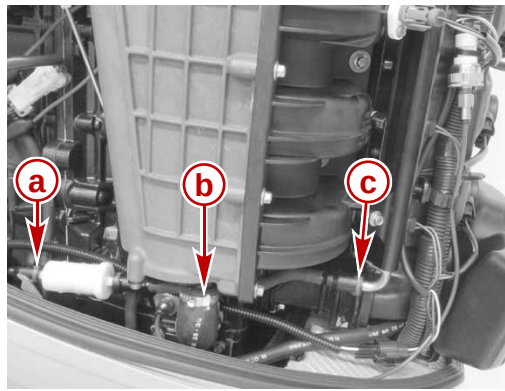
b - Fuel pressure valve

c - Fuel rail

Fuel Pressure Gauge Kit	91-881833A03
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
Digital Pressure Meter	91-892651A01

5. Disconnect the fuel inlet at the fuel filter.
6. Disconnect the fuel line at the fuel rail inlet.
7. Remove the fuel filter and fuel line.

8. Remove the hose clamp at the bottom charge air cooler.



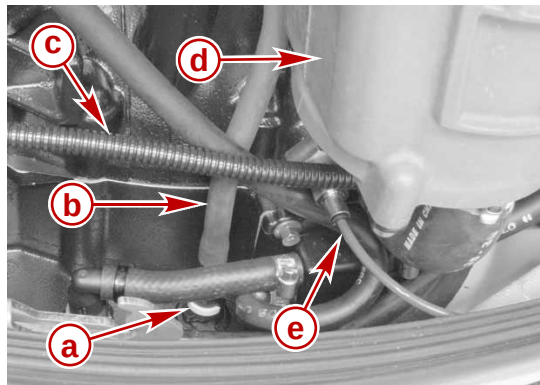
4225

a - Fuel inlet at fuel filter

c - Fuel line at the fuel rail inlet

b - Hose clamp

9. Disconnect the MAP sensor reference hose from the adapter plate.



3614

a - MAP sensor reference hose clip

d - Intake manifold

b - MAP sensor reference hose

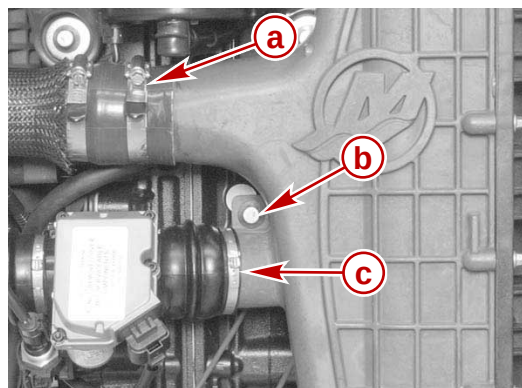
e - Water pressure line

c - Trim position sensor wire harness

10. Loosen the hose clamp at the charged air intake port.

11. Remove the front manifold bolt.

12. Remove the hose clamp at the manifold port for the EBC.



4226

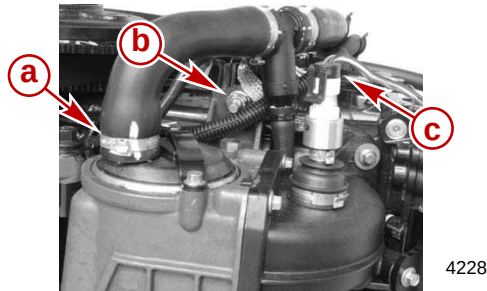
a - Hose clamp at charge air intake

c - Hose clamp at manifold port for EBC

b - Front manifold bolt

13. Remove the hose clamp at the upper charge air cooler.

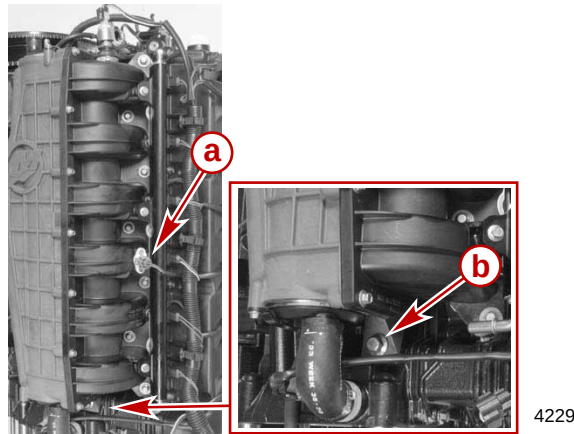
14. Remove the hose from the charge air cooler.
15. Remove the nut securing the charge air cooler - intake manifold assembly to the cylinder head.
16. Disconnect the MAP sensor harness.



a - Hose clamp
b - Nut

c - MAP sensor harness

17. Disconnect the MAT sensor harness.
18. Remove the lower bolt securing the charge air cooler - intake manifold to the cylinder block.

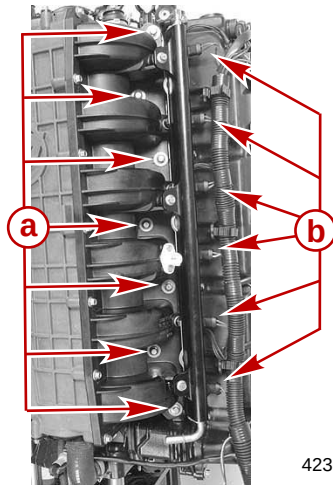


a - MAT sensor harness

b - Lower bolt

19. Disconnect the fuel injector harnesses.
20. Remove the 7 bolts securing the charge air cooler - intake manifold to the cylinder head.

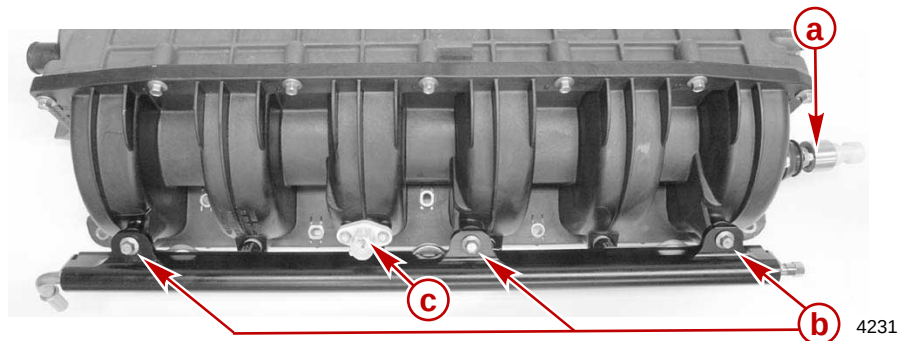
21. Remove the charge air cooler - intake manifold.



a - Bolts securing charge air cooler - intake manifold (7) **b** - Fuel injector harness

Charge Air Cooler - Intake Manifold Disassembly

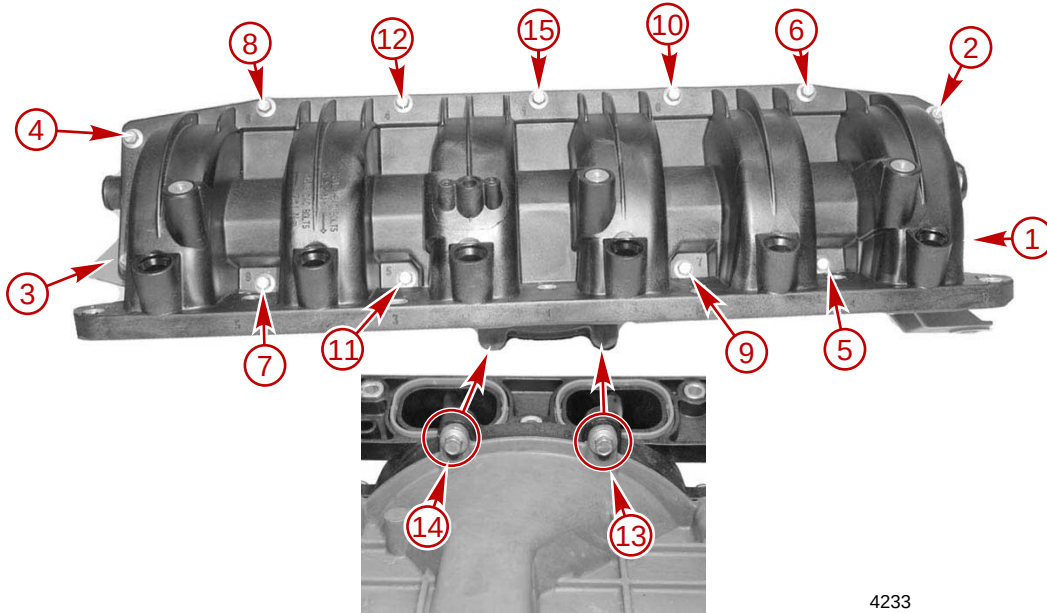
1. Remove the fuel rail bolts. Remove the fuel rail.
2. Remove the MAT sensor screws. Remove the MAT sensor.
3. Remove the MAP sensor.



a - MAP sensor
b - Fuel rail bolt

c - MAT sensor

4. Remove the bolts securing the intake manifold to the charge air cooler in the sequence shown.



4233

5. Separate the charge air cooler from the intake manifold.

Cleaning Inspection

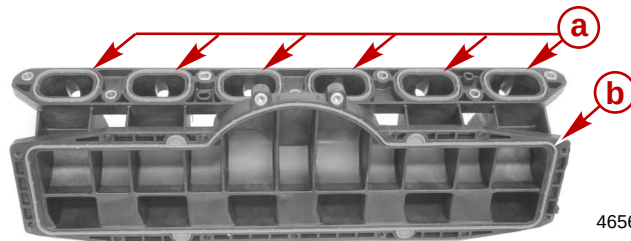
NOTE: The charge air cooler is a non-serviceable component and must be replaced as an assembly if suspected of leaking or is severely fouled.



4251

Charge Air Cooler - Intake Manifold Assembly

1. Install new seals on the intake manifold.



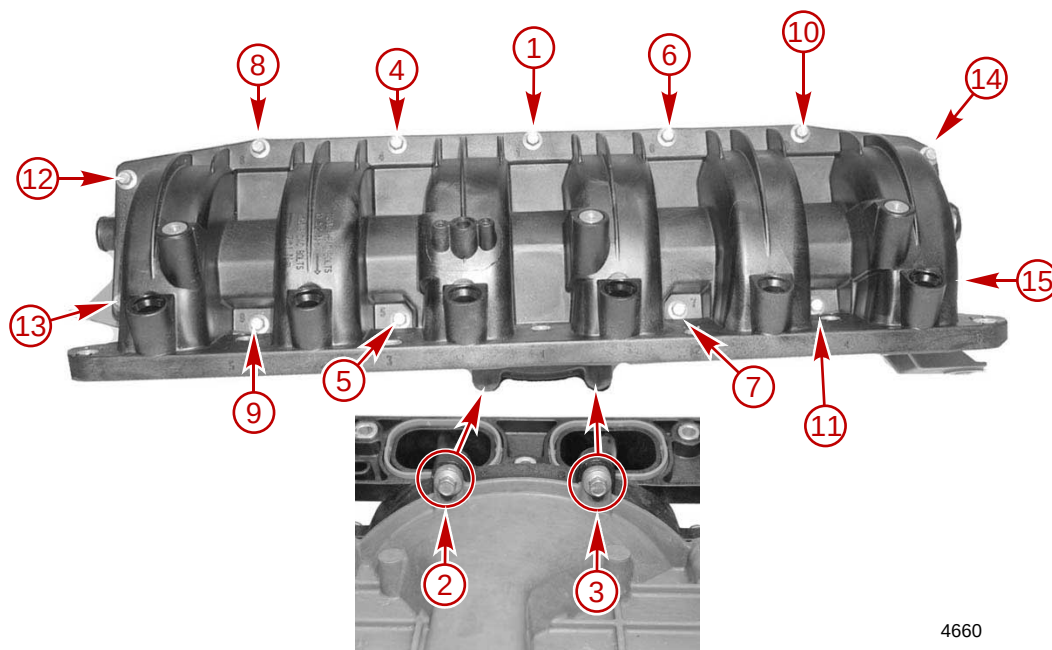
4656

a - Manifold port seal

b - Manifold seal

2. Place the intake manifold onto the charge air cooler.
3. Install all intake manifold bolts.

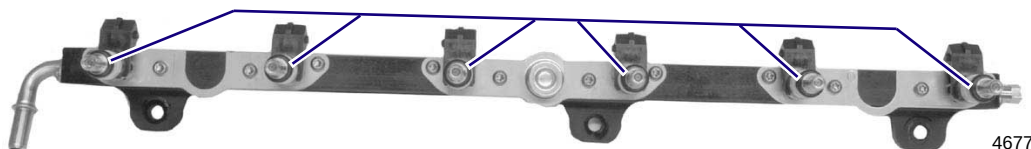
4. Tighten intake manifold bolts in the sequence shown to the specified torque.



4660

Description	Nm	lb. in.	lb. ft.
Intake Manifold Bolts (M6 x 15, M6 x 25)	7	62	

5. Apply SPO 255 to the O-ring on each of the fuel injectors.

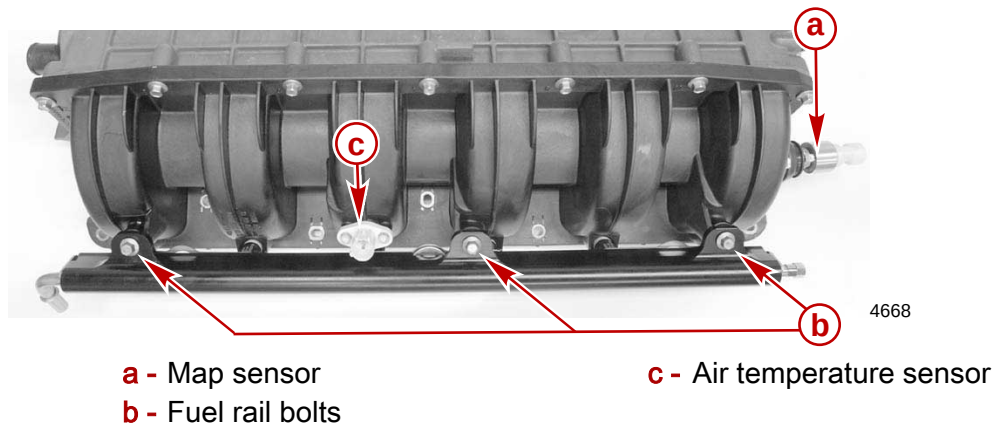


4677

Tube Ref No.	Description	Where Used	Part No.
 136	Lubriplate SPO 255	Fuel injector O-rings	Obtain Locally

6. Install the fuel rail assembly. Tighten the fuel rail bolts to the specified torque.
 7. Install the MAT sensor. Tighten the MAT sensor screws to the specified torque.
 8. Install the MAP sensor. Secure with hose clamp.

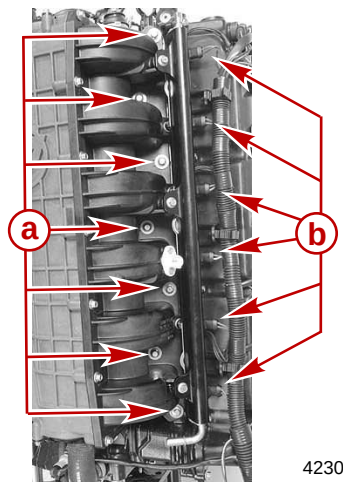
9. Crimp the hose clamp with tool.



Description	Nm	lb. in.	lb. ft.
Fuel Rail Bolts (M6 x 15)	6	53	
Air Temperature Sensor Screw (M4 x 6)	2	18	
Hose Clamp Tool Kit	91-803146A2		

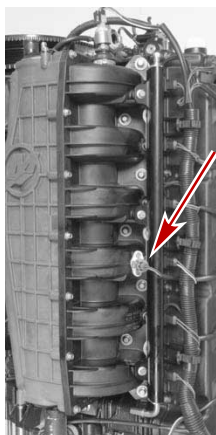
Charge Air Cooler Installation

1. Install a 34.6 mm diameter hose clamp onto the lower charge air cooler water hose.
2. Install a 62.0 mm diameter hose clamp onto the rear EBC hose.
3. Insert the charge air cooler lower water inlet into the lower charge air cooler hose.
4. Carefully align the charged air inlet tube and EBC rear tube with the charge air cooler.
5. Push the charge air cooler onto the charge air inlet tube and EBC rear tube. The charge air cooler should align with the upper charge air cooler mounting stud.
6. Install all the charge air cooler mounting bolts and nut.
7. Tighten the charge air cooler manifold bolts to the specified torque.



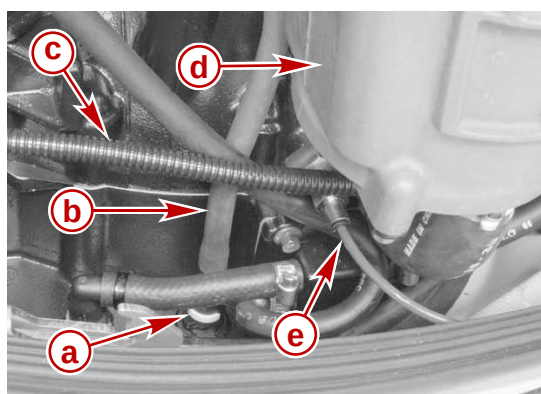
Description	Nm	lb. in.	lb. ft.
Charge Air Cooler Manifold Bolt	10	88	

8. Connect the fuel injector harness and MAT sensor harnesses.



4687

9. Install the MAP reference hose.



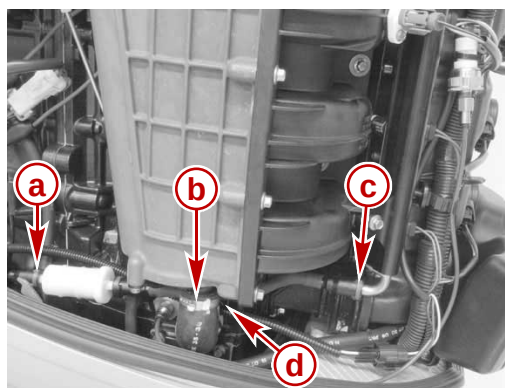
3614

- a** - MAP sensor reference hose clip **d** - Intake manifold
b - MAP sensor reference hose **e** - Water pressure line
c - Trim position sensor wire harness

10. Tighten the lower manifold bolt to the specified torque.

11. Install the fuel line with fuel filter.

12. Crimp the lower hose clamp with tool.



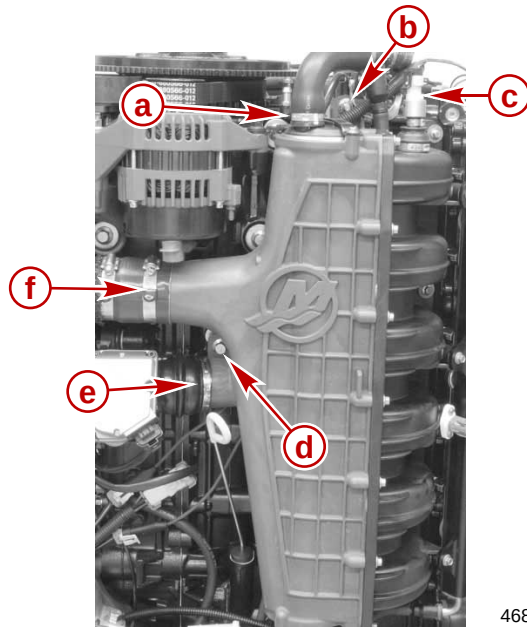
4686

- a** - Fuel inlet at fuel filter **c** - Fuel line at the fuel rail inlet
b - 34.6 mm diameter lower charge air cooler water hose clamp **d** - Lower manifold bolt (hidden)

Description	Nm	lb. in.	lb. ft.
Lower Manifold Bolt (M10 x 30)	32.5		24

Hose Clamp Tool Kit	91-803146A2
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13. Install a 34.6 mm diameter hose clamp on the upper charge air cooler hose. Install the hose onto the upper charge air cooler outlet and crimp to secure hose to charge air cooler with tool.
14. Tighten the upper mounting nut to the specified torque.
15. Connect the MAP sensor harness.
16. Tighten the front charge air cooler bolt to the specified torque.
17. Crimp the 62.0 mm hose clamp on the rear EBC tube with tool.
18. Tighten the hose clamp on the charge air cooler inlet to the specified torque.



- | | |
|--|--|
| a - 34.6 mm diameter hose clamp | d - Front charge air cooler bolt |
| b - Upper mounting nut | e - 62.0 mm diameter hose clamp |
| c - MAP sensor harness | f - Hose clamp on charge air cooler inlet |

Description	Nm	lb. in.	lb. ft.
Upper Mounting Nut	32.5		24
Front Charge Air Cooler Bolt (M10 x 30)	32.5		24
Hose Clamp On Charge Air Cooler Inlet	6	53	

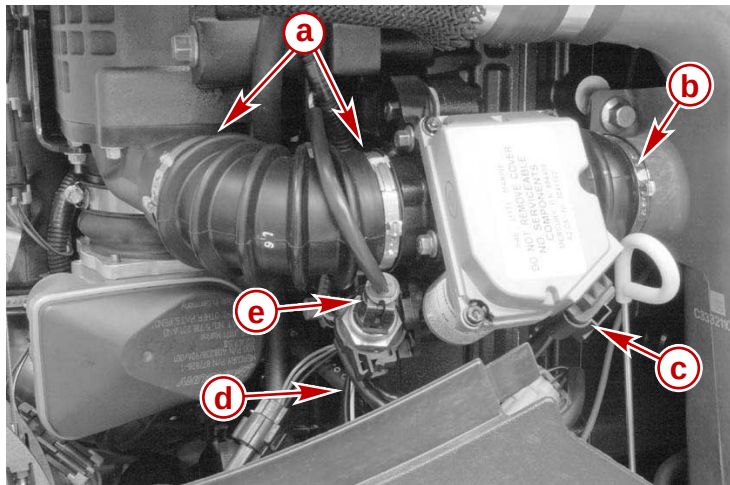
Hose Clamp Tool Kit	91-803146A2
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Electronic Boost Control (EBC) Assembly Removal/Installation

Electronic Boost Control Assembly Removal And Disassembly

1. Remove the 2 hose clamps securing the front tube.
2. Remove the hose clamp securing the rear tube to the charge air cooler.
3. Disconnect the EBC engine harness.
4. Disconnect the pitot sensor harness.
5. Disconnect the pitot sensor hose.

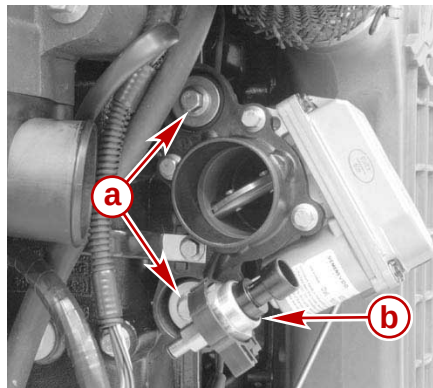
6. Remove the front tube.



4607

- a** - Hose clamps securing front tube **d** - Pitot sensor hose
b - Hose clamp securing the rear tube **e** - Pitot sensor harness
c - EBC engine harness

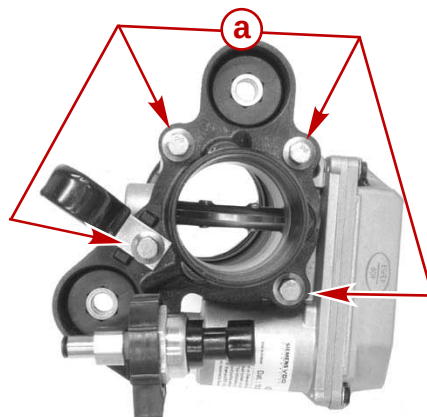
7. Remove the 2 bolts securing the EBC mounting bracket to the cylinder block.



4608

- a** - Bolts securing EBC mounting bracket **b** - Pitot sensor

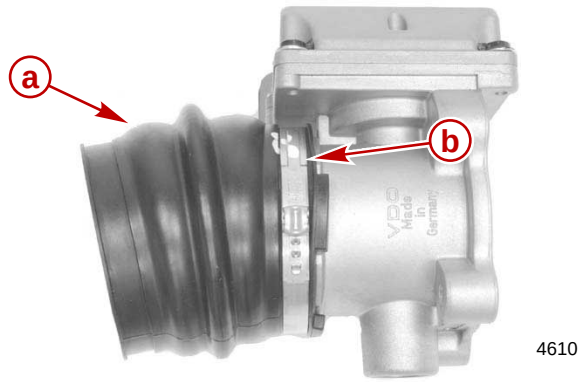
8. Pull the EBC assembly off the charge air cooler.
9. Remove the 4 bolts securing the EBC mounting bracket to the EBC.



4609

- a** - EBC mounting bracket bolts

10. Remove the hose clamp securing the rear hose to the EBC.

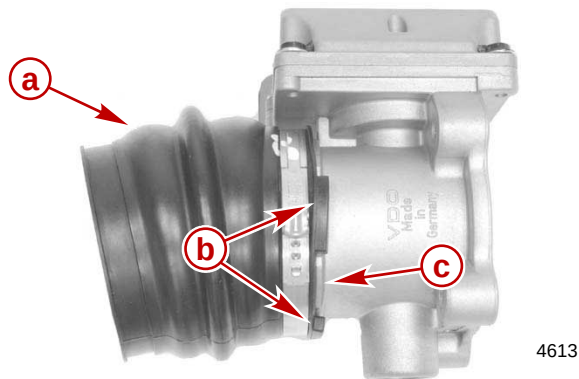


a - Rear hose

b - Hose clamp

Electronic Boost Control Assembly

1. Place a 62.0 mm diameter hose clamp on the end of the rear hose that has molded alignment key.
2. Install the rear hose onto the EBC. Ensure the hose molded key is in proper alignment with the cast key on the EBC.
3. Crimp the hose clamp with tool.



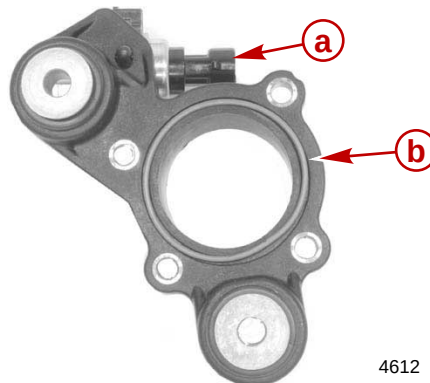
a - Rear hose

b - Hose molded key

c - Cast key on EBC

Hose Clamp Tool Kit	91-803146A2
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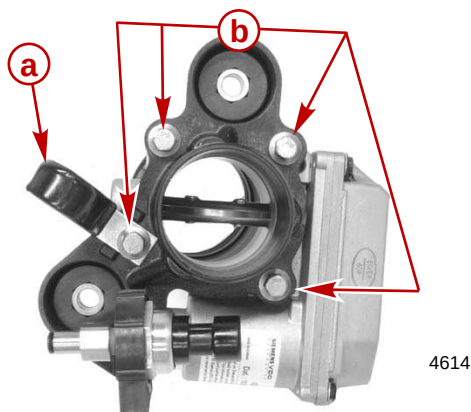
4. Install a new O-ring onto the EBC mounting bracket.



a - Pitot sensor

b - EBC mounting bracket O-ring

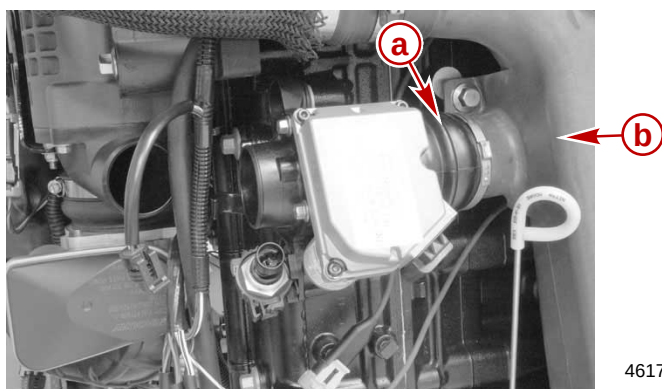
5. Install the EBC mounting bracket onto the EBC.
6. Secure the EBC mounting bracket to the EBC. Ensure the J-clip is mounted in the correct location. Tighten the EBC mounting bracket bolts to the specified torque.

**a** - J-clip**b** - EBC mounting bracket bolts

Description	Nm	lb. in.	lb. ft.
EBC Mounting Bracket Bolts (M6 x 20)	10	88	

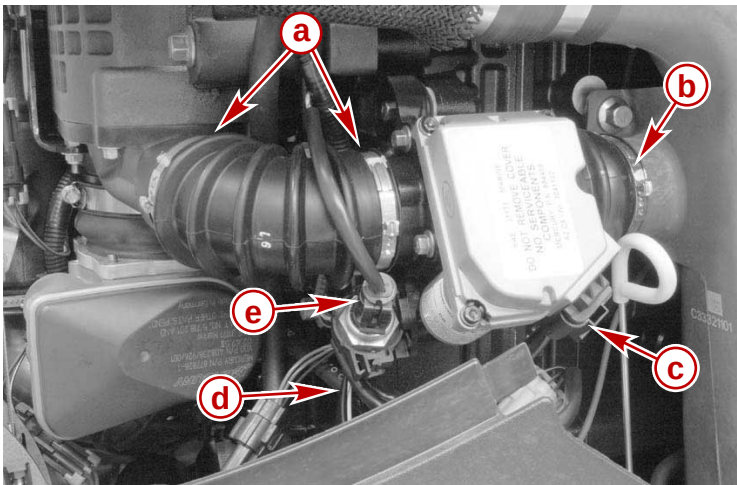
Electronic Boost Control Assembly Installation

1. Install a 62.0 mm diameter hose clamp on the rear tube.
2. Install the EBC assembly onto the charge air cooler. Do not crimp the rear tube hose clamp.

**a** - Rear tube**b** - Charge air cooler

3. Install two 57.5 mm diameter hose clamps onto the front tube, one at each end.
4. Install the front tube onto the supercharger and the EBC mounting bracket at the same time. Ensure the tube does not fold over when installing the front tube.
5. Align the EBC mounting bracket bolt holes with the cylinder block. Install the EBC mounting bracket bolts with washers. Tighten to the specified torque.
6. Install the speedometer hose into the pitot sensor.
7. Connect the pitot harness to the pitot sensor.
8. Connect the EBC harness to the EBC.

9. Crimp the the front and rear tube hose clamps with tool.



- a** - Hose clamps securing front tube

b - Hose clamp securing the rear tube

c - EBC engine harness
- d** - Pitot sensor hose

e - Pitot sensor harness

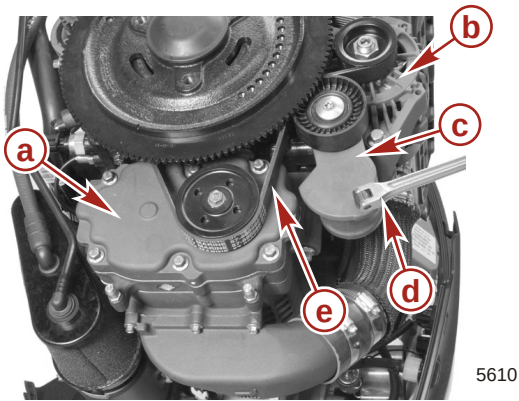
Description	Nm	lb. in.	lb. ft.
EBC Mounting Bracket Bolt (M8 x 35)	24	212	

Hose Clamp Tool Kit	91-803146A2
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Supercharger Removal/Installation

Supercharger Removal

1. Install a breaker bar into the supercharger/alternator tensioner.
2. Release the belt tension and remove the belt from the alternator and supercharger.



- a** - Supercharger

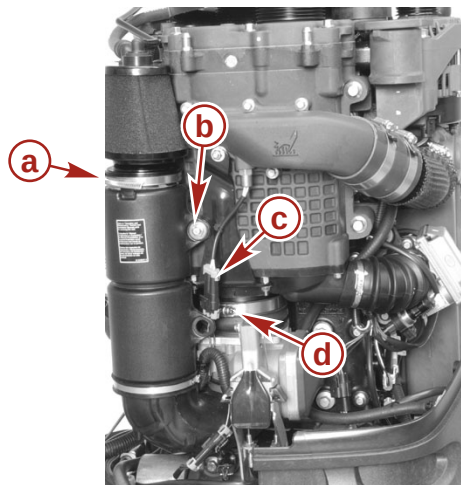
b - Alternator

c - Tensioner
- d** - Breaker bar

e - Belt

3. Disconnect the Boost Air Temperature sensor harness.
4. Loosen the air cleaner hose clamp.
5. Remove the resonator support bolt.
6. Loosen the hose clamp securing the ETC to the supercharger.

7. Push the ETC/resonator assembly down and off the supercharger inlet.

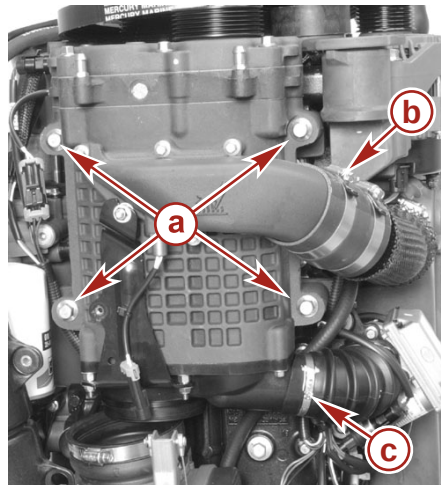


5612

- a** - Air cleaner hose clamp
b - Resonator support bolt

- c** - Boost air temperature sensor harness
d - Hose clamp securing ETC to supercharger

8. Loosen hose clamp securing supercharger outlet to CAC.
9. Remove hose clamp securing bypass boot to the supercharger.
10. Remove 4 bolts securing supercharger to the cylinder block.
11. Pull supercharger off the cylinder block and hoses.



5614

- a** - 4 bolts securing supercharger to cylinder block
b - Hose clamp securing supercharger outlet to CAC

- c** - Hose clamp securing bypass boot to supercharger

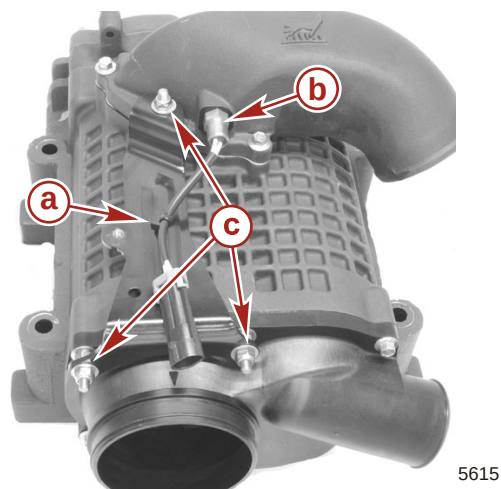
Supercharger Disassembly/Assembly

DISASSEMBLY

NOTE: The supercharger is a non-serviceable component and must be replaced as an assembly when damage to supercharger is suspected.

1. Cut cable tie securing Boost Air Temperature sensor to the resonator support bracket.
2. Remove the Boost Air Temperature sensor.

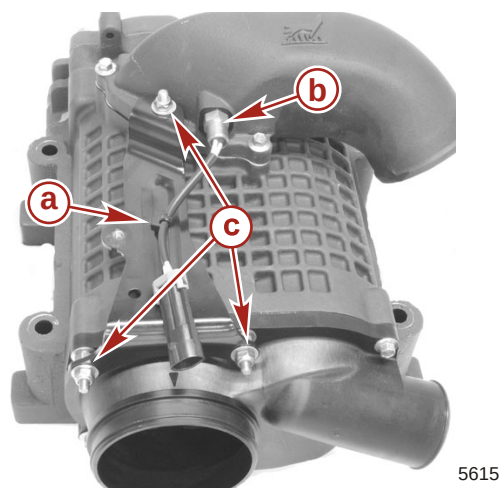
3. Remove 3 nuts and washers securing resonator support bracket to supercharger.



- a** - Cable tie
- b** - Boost Air Temperature sensor
- c** - 3 nuts securing resonator support bracket to supercharger

REASSEMBLY

1. Install a new O-ring onto the Boost Air Temperature sensor.
2. Install Boost Air Temperature sensor onto supercharger and tighten to the specified torque.
3. Install the resonator support bracket to the supercharger with 3 nuts and washers. Tighten the 3 nuts to the specified torque.
4. Retain the Boost Air Temperature sensor onto supercharger with a cable tie.

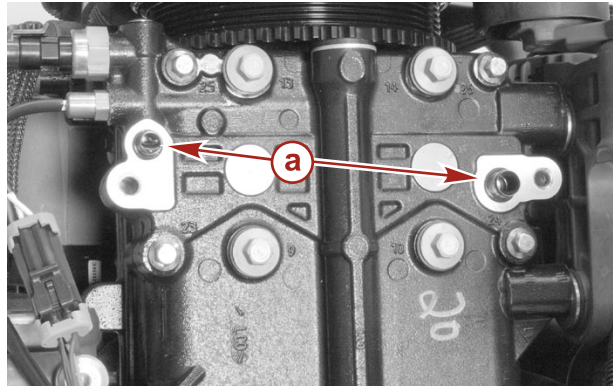


- a** - Cable tie
- b** - Boost Air Temperature sensor
- c** - 3 nuts securing resonator support bracket to supercharger

Description	Nm	lb. in.	lb. ft.
Boost Air Temperature sensor	15	132.7	
Resonator support bracket nut	8	71	

Supercharger Installation

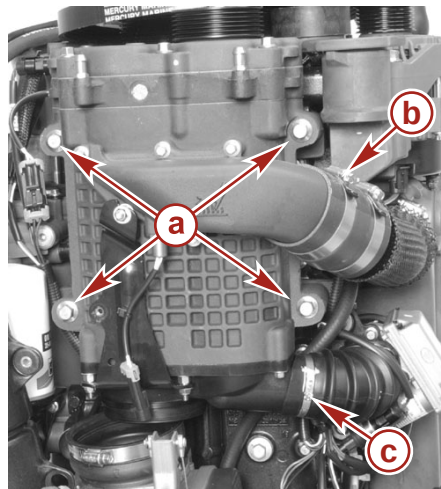
1. Install new O-rings onto the supercharger dowels.



5617

a - Supercharger dowel O-ring

2. Install a 57.5 diameter hose clamp on the rear EBC tube.
3. Ensure a hose clamp is on the supercharger outlet tube.
4. Install the supercharger onto the rear EBC tube and supercharger outlet tube.
5. Place the supercharger onto the supercharger dowels.
6. Secure the supercharger to cylinder block with 4 bolts.
7. Tighten the 4 bolts in two steps.
8. Secure the 57.5 rear EBC hose clamp with tool.
9. Tighten the supercharger outlet tube hose clamp to the specific torque.



5614

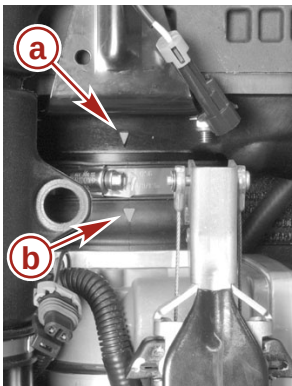
a - 4 bolts securing supercharger to cylinder block

b - Supercharger outlet tube hose clamp

c - Hose clamp securing front tube to supercharger

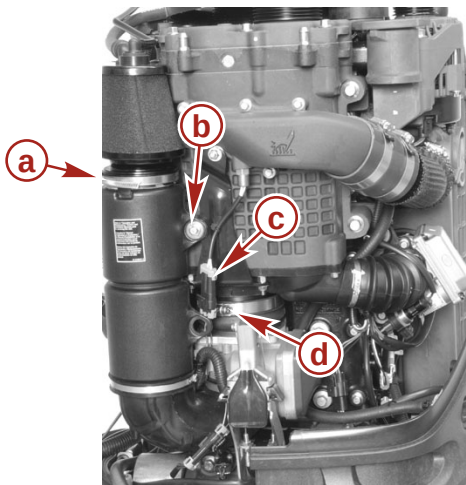
Description		Nm	lb. in.	lb. ft.
Bolts securing supercharger (M10 x 105)	First	15	132.7	
	Final	43		31.7
Supercharger outlet tube hose clamp		6	53	
Hose Clamp Tool Kit		91-803146A2		

- 10. Ensure a hose clamp is on ETC isolator.
- 11. Install the ETC assembly onto the supercharger.
- 12. Align the arrows on the supercharger and the ETC boot.



a - Arrow on supercharger **b** - Arrow on ETC boot

- 13. Tighten the ETC isolator hose clamp to the specified torque.
- 14. Connect the Boost Air Temperature sensor harness. (blue/black, black/orange)
- 15. Secure the resonator to the resonator support bracket. Tighten bolt to the specified torque.
- 16. Secure the air filter to the resonator.

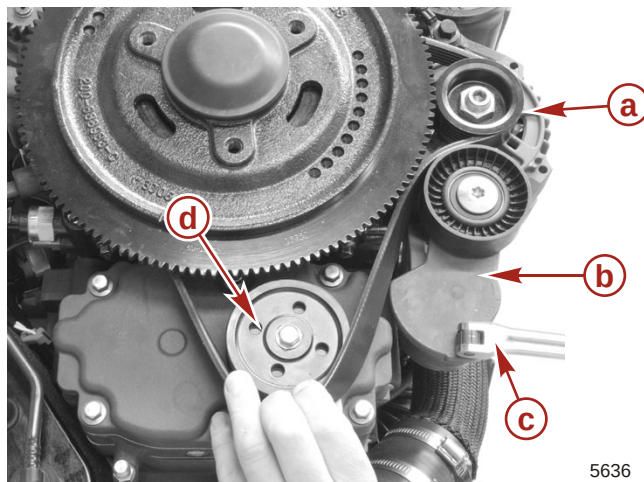


a - Air cleaner hose clamp **c** - Boost Air Temperature sensor harness
b - Resonator support bolt **d** - Hose clamp securing ETC isolator to supercharger

Description	Nm	lb. in.	lb. ft.
Bolt Securing Resonator (M6 x 25)	7.4	66	
Hose clamp securing ETC isolator to supercharger	6.2	55	

- 17. Insert a breaker bar into the tensioner and compress the tensioner spring.
- 18. Guide the belt onto the alternator. Ensure the belt is centered on the alternator pulley.

19. Guide the belt onto the supercharger pulley. Ensure the belt is centered on the supercharger pulley.



a - Alternator pulley

b - Tensioner

c - Breaker bar

d - Supercharger pulley

20. Slowly release the tension to the belt.

21. Check the belt for proper belt alignment on the flywheel, alternator and supercharger.

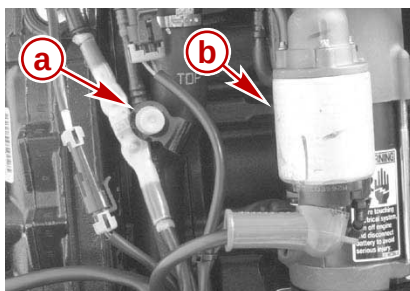
Fuel Rail Removal/Installation

Fuel Rail Removal

⚠ CAUTION

Pressurized fuel system! Release all pressure before servicing any part of the fuel system. This system can build pressure if the engine has not run for an extended period of time. If the fuel system is not relieved of pressure, fuel and vapors may be expelled at a significant velocity. Always protect your eyes and skin from pressurized fuel and vapors when servicing the fuel system.

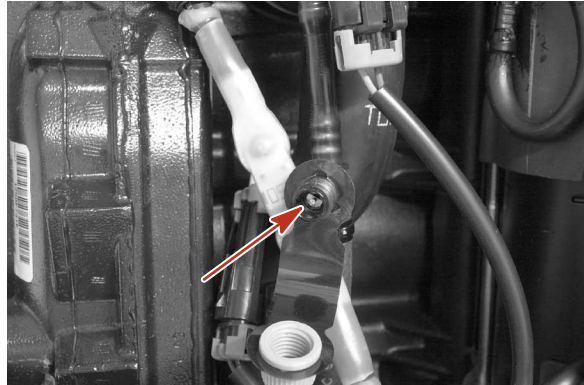
1. Remove the cap to access the pressure relieve valve for the FSM.



a - FSM pressure relief valve

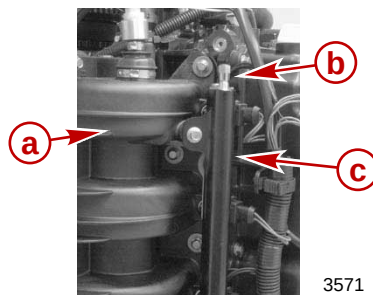
b - Starter solenoid

2. Place a rag over the valve and press on the center of the valve to relieve any pressure inside the FSM.



3472

3. Attach a fuel pressure gauge to the fuel pressure valve on the fuel rail. Relieve the fuel pressure into an appropriate container.



3571

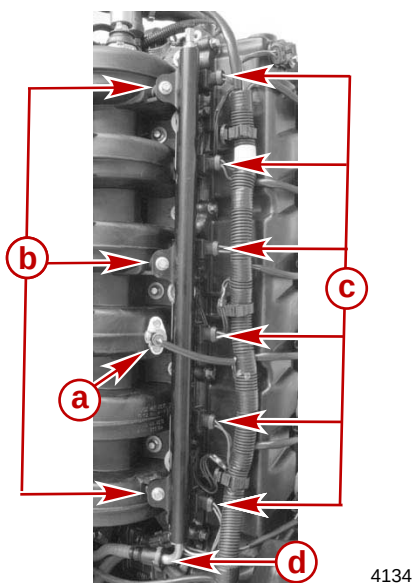
a - Intake manifold
b - Fuel pressure valve

c - Fuel rail

Fuel Pressure Gauge Kit	91-881833A03
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
Digital Pressure Meter	91-892651A01

4. Disconnect the fuel injector harness at each fuel injector.
5. Disconnect the Manifold Air Temperature (MAT) sensor harness.
6. Place a rag or shop towel under the fuel line. Remove the fuel line. Dispose of fuel soaked rag/shop towel in an appropriate container.

- Remove the bolts securing fuel rail to the intake manifold.

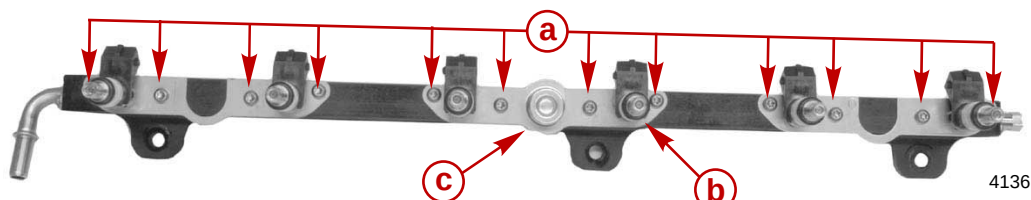


- a** - Manifold Air Temperature sensor **c** - Fuel injector harness (6)
b - Fuel rail bolts (3) **d** - Fuel line

- Pull the fuel rail off of the intake manifold.

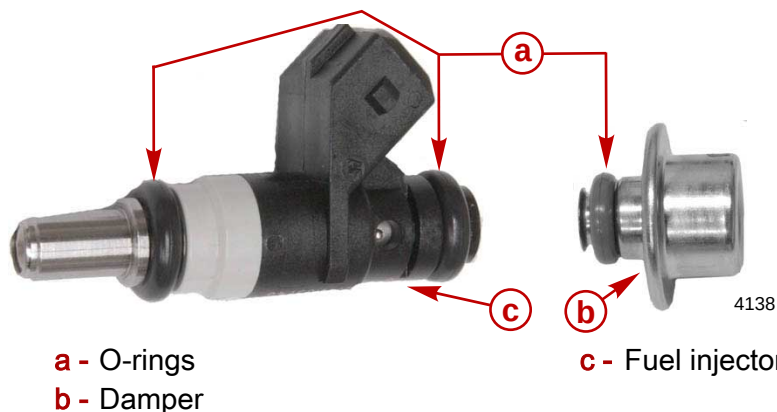
Fuel Rail Disassembly

- Remove the T20 Torx screws holding the fuel injector retainers.



- a** - T20 Torx screw (6) **b** - Fuel injector
c - Damper

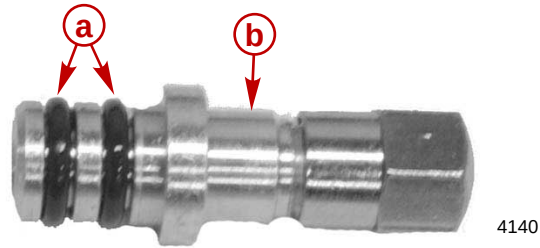
- Remove the fuel injectors and damper.
- Inspect the O-rings on the fuel injector and damper. Replace the O-rings on fuel injectors and damper if damaged.



- a** - O-rings **b** - Damper
c - Fuel injector

- Remove the T20 Torx screw securing the schrader valve bracket to the fuel rail.

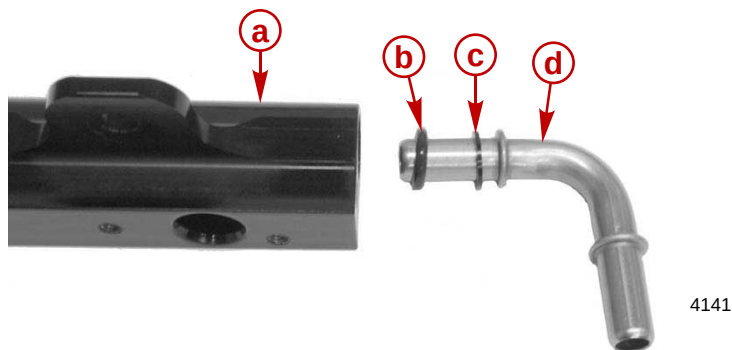
5. Remove the schrader valve.
6. Inspect the O-rings on the schrader valve. Replace the O-rings if damaged.



a - O-rings

b - Schrader valve

7. Remove the T20 Torx screw securing the fuel inlet bracket to the fuel rail.
8. Remove the fuel inlet.
9. Remove the O-ring and washer.



a - Fuel rail

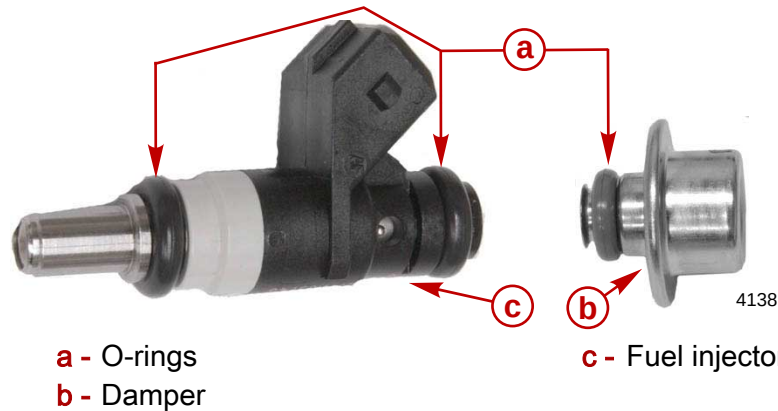
b - O-ring

c - Washer

d - Fuel inlet

Fuel Rail Assembly

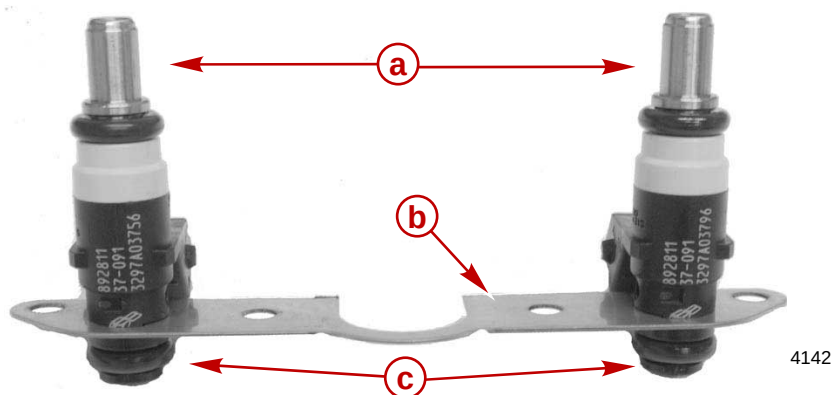
1. Use a solvent and compressed air to remove debris inside the fuel rail.
2. Install new O-rings onto the fuel injectors and damper.
3. Lubricate the fuel injector and damper O-rings with SPO 255.



Tube Ref No.	Description	Where Used	Part No.
 136	Lubriplate SPO 255	Fuel injector O-ring, damper O-ring.	Obtain Locally

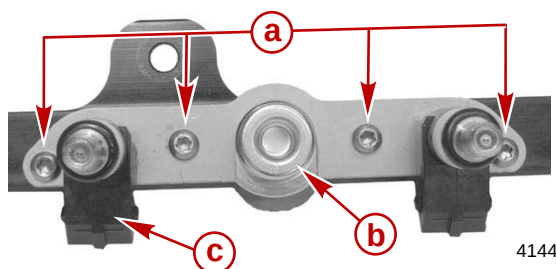
4. Install the damper onto the fuel rail.

5. Slide the fuel injector onto the fuel injector retainer bracket.



- a** - Manifold side of fuel injector
b - Fuel injector retainer bracket
c - Fuel rail side of fuel injector

6. Install fuel injectors onto fuel rail.
 7. Secure fuel injector retainer bracket with T20 Torx screws.

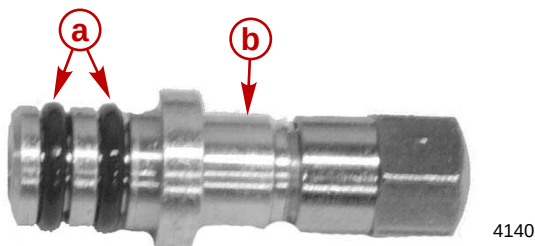


- a** - T20 Torx screws
b - Damper
c - Fuel injector

8. Assemble the other injectors to the injector retainer and secure to the fuel rail. Tighten the T20 Torx screws to the specified torque.

Description	Nm	lb. in.	lb. ft.
T20 Torx Screw (M5 x 10)	6	53	

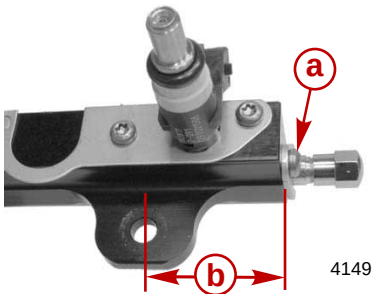
9. Install new O-rings onto the schrader valve.



- a** - O-rings
b - Schrader valve

10. Measure from the edge of the fuel rail to the center of the mounting hole of the fuel rail.
 11. Install the schrader valve onto the fuel rail side that measures approximately 38 mm (1.5 in.).

12. Secure schrader valve to the fuel rail with a retaining bracket. Tighten the retaining bracket T20 Torx screw to the specified torque.

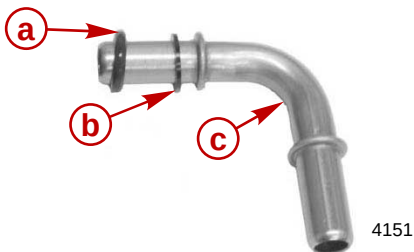


a - Schrader valve bracket T20 Torx screw **b** - 38 mm (1.5 in.)

Description	Nm	lb. in.	lb. ft.
T20 Torx screw (M5 x 10)	6	53	

13. Install a washer onto the fuel inlet.
14. Install an O-ring onto the fuel inlet.

NOTE: The fuel inlet is the same on both ends.



a - O-ring **c** - Fuel inlet
b - Washer

15. Install the fuel inlet onto the fuel rail.
16. Secure the fuel inlet to the fuel rail with a retaining bracket. Tighten the retaining bracket T20 Torx screw to the specified torque.

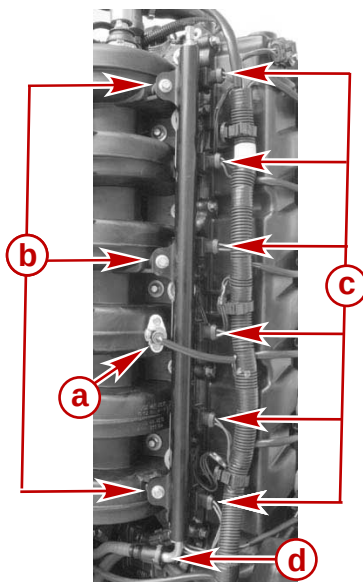


Description	Nm	lb. in.	lb. ft.
T20 Torx screw (M5 x 10)	6	53	

Fuel Rail Installation

1. Install the fuel rail assembly onto the intake manifold.
2. Secure the fuel rail assembly to the intake manifold. Tighten the fuel rail bolts to the specified torque.

3. Connect the fuel line to the fuel inlet.
4. Connect the injector harnesses to the injectors.
5. Connect the MAT sensor harness.



a - MAT sensor
b - Fuel rail bolts (3)

c - Fuel injector harness (6)
d - Fuel line

Description	Nm	lb. in.	lb. ft.
Fuel Rail Bolts (M6 x 15)	10	88.5	

Fuel System

Section 3D - Emissions

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**3
D**

Exhaust Emission Standards

Through the Environmental Protection Agency (EPA), the federal government has established exhaust emissions standards for all new marine engines sold in the U.S.

What Are Emissions?

Emissions are what comes out of the exhaust system in the exhaust gas when the engine is running. They are formed as a result of the process of combustion or incomplete combustion. To understand exhaust gas emissions, remember that both air and fuel are made of several elements. Air contains oxygen and nitrogen among other elements; gasoline contains mainly hydrogen and carbon. These four elements combine chemically during combustion. If combustion were complete, the mixture of air and gasoline would result in these emissions: water, carbon dioxide and nitrogen, which are not harmful to the environment. But combustion is not usually complete. Also, potentially harmful gases can be formed during and after combustion.

All marine engines must reduce the emission of certain pollutants, or potentially harmful gases, in the exhaust to conform with levels legislated by the EPA. Emissions standards become more stringent each year. Standards are set primarily with regard to three emissions: hydrocarbons (HC), carbon monoxide (CO) and oxides of nitrogen (NO_x).

Hydrocarbons – HC

Gasoline is a hydrocarbon fuel. The two elements of hydrogen and carbon are burned during combustion in combination with oxygen. But they are not totally consumed. Some pass through the combustion chamber and exit the exhaust system as unburned gases known as hydrocarbons.

Carbon Monoxide – CO

Carbon is one of the elements that make up the fuel burned in the engine along with oxygen during the combustion process. If the carbon in the gasoline could combine with enough oxygen (one carbon atom with two oxygen atoms), it would come out of the engine in the form of carbon dioxide (CO₂). CO₂ is a harmless gas. But carbon often combines with insufficient oxygen (one carbon atom with one oxygen atom). This forms carbon monoxide, CO. Carbon monoxide is the product of incomplete combustion and is a dangerous, potentially lethal gas.

Oxides of Nitrogen - NO_x

NO_x is a slightly different by-product of combustion. Nitrogen is one of the elements that makes up the air going into the engine. Under extremely high temperatures it combines with oxygen to form oxides of nitrogen (NO_x). This happens in the engines combustion chambers when temperatures are too high. NO_x itself is not harmful, but when exposed to sunlight it combines with unburned hydrocarbons to create the visible air pollutant known as smog. Smog is a serious problem in California as well as many other heavily populated areas of the United States.

Controlling Emissions

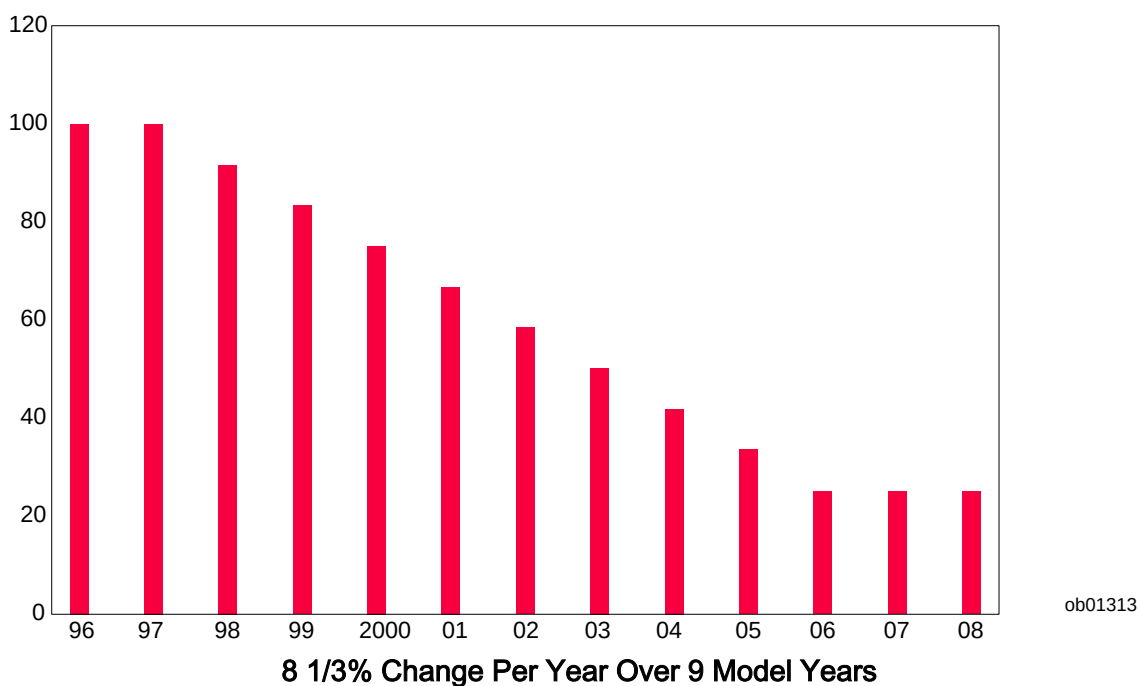
There are two principle methods of reducing emissions from a two-stroke-cycle marine engine. The first method is to control the air/fuel ratio that goes into the combustion chamber. The second is to control the time when this air/fuel mixture enters the combustion chamber. Timing is important, to prevent any unburned mixture from escaping out of the exhaust port.

Stoichiometric (14.7:1) Air/Fuel Ratio

In the search to control pollutants and reduce exhaust emissions, engineers have discovered that they can be reduced effectively if a gasoline engine operates at an air/fuel ratio of 14.7:1. The technical term for this ideal ratio is stoichiometric. An air/fuel ratio of 14.7:1 provides the best control of all three elements in the exhaust under almost all conditions. The HC and CO content of the exhaust gas is influenced significantly by the air/fuel ratio. At an air/fuel ratio leaner than 14.7:1, HC and CO levels are low, but with a ratio richer than 14.7:1 they rise rapidly. It would seem that controlling HC and CO by themselves might not be such a difficult task; the air/fuel ratio only needs to be kept leaner than 14.7:1. However, there is also NO_x to consider.

As the air/fuel ratio becomes leaner, combustion temperatures increase. Higher combustion temperatures raise the NO_x content of the exhaust. But, enriching the air/fuel ratio to decrease combustion temperatures and reduce NO_x also increases HC and CO, as well as lowering fuel economy. So the solution to controlling NO_x - as well as HC and CO - is to keep the air/fuel ratio as close to 14.7:1 as possible.

Outboard Hydrocarbon Emissions Reduction



Emissions Information

Manufacturers Responsibility

Beginning with 1998 model year engines, manufacturers of all marine propulsion engines must determine the exhaust emission levels for each engine horsepower family and certify these engines with the United States Environmental Protection Agency (EPA). A certification decal/emissions control information label, showing emission levels and engine specifications directly related to emissions, **must** be placed on each engine at the time of manufacture.

Dealer Responsibility

When performing service on all 1998 and later outboards that carry a certification, attention must be given to any adjustments that are made that affect emission levels.

Adjustments must be kept within published factory specifications.

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

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

Exceptions include manufacturers prescribed changes, such as that for altitude adjustments.

Owner Responsibility

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

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

Exceptions

- Carburetor jets may be changed for high altitude use in accordance with factory recommendations.
- Single engine exceptions may be allowed with permission from the EPA for racing and testing.

EPA Emission Regulations

All new 1998 and later outboards manufactured by Mercury Marine are certified to the United States Environmental Protection Agency as conforming to the requirements of the regulations for the control of air pollution from new outboard motors. This certification is contingent on certain adjustments being set to factory standards. For this reason, the factory procedure for servicing the product must be strictly followed and, whenever practicable, returned to the original intent of the design.

The responsibilities listed above are general and in no way a complete listing of the rules and regulations pertaining to the EPA laws 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: <http://www.epa.gov/omswww>

Manufacturer's Certificate Label

The certification label must be placed on each engine at the time of manufacture and must be replaced in the same location if damaged or removed. Shown below is a typical certification label and is not representative of any one model. Label shown below is not to scale.

MERCURY		EMISSION CONTROL INFORMATION	
THIS ENGINE CONFORMS TO ☐ CALIFORNIA AND U.S. EPA EMISSION REGULATIONS FOR SPARK IGNITION MARINE ENGINES			
REFER TO OWNERS MANUAL FOR REQUIRED MAINTENANCE. SPECIFICATIONS AND ADJUSTMENTS			
a →	IDLE SPEED (in gear) :		f →
b →	hp	cc	g →
c →	TIMING (IN DEGREES):		h →
d →		SPARK PLUG :	i →
		GAP :	
e →	COLD VALVE CLEARANCE (mm) :	INTAKE :	
		EXHAUST :	

ob00366

- a** - Idle speed
- b** - Engine horsepower
- c** - Piston displacement
- d** - Date of Manufacture
- e** - Valve Clearance (if applicable)
- f** - Family Number
- g** - Maximum emissions output for the engine family
- h** - Timing specifications
- i** - Recommended spark plug and gap

Family Number

The following is a illustration of a typical family number and is not a representation of any one model.

① → 3 M9X M 03.4 2 G 0 ← ⑦

↑ ↑ ↑ ↑ ↑
 ② ③ ④ ⑤ ⑥

ob01314

- 1** - Model year (3 = 2003)
- 2** - Manufacturer (Mercury Marine)
- 3** - Regulations (M = Marine)
- 4** - Engine displacement (Decimal point = Liters [03.4 = 3.4L]) (No decimal point = C.I. [0113 = 113 Cubic Inches])
- 5** - Technology type (1 = OB old tech, 2 = OB new tech, 3 = SportJet, 4 = OptiJet)
- 6** - Engine class (C = two stroke, G = four stroke)
- 7** - Product type (0 = all except, J = SportJet, E = EFI SportJet and 4 strokes, 3 = OptiMax, H = high performance)

Service Replacement Certification Label

IMPORTANT: By federal law, it is required that all 1998 and newer Mercury Marine outboards have a visible and legible emission certification label. If this label is missing or damaged, contact Mercury Marine Service for a replacement.

Removal

Remove all remaining pieces of the damaged or illegible label. Do not install new label over the old label. Use a suitable solvent to remove any traces of the old label adhesive from the display location.

Date Code Identification

Cut and remove a "V" notch through the month of engine manufacture before installing the new label. The month of manufacture can be found on the old label. If the label is missing or the date code illegible, contact Mercury Marine Technical Service for assistance.

MERCURY		Emission Control Information	
THIS ENGINE CONFORMS TO 2005 CALIFORNIA AND U.S EPA EMISSION REGULATIONS FOR SPARK IGNITION MARINE ENGINES			
REFER TO OWNERS'S MANUAL FOR MAINTENANCE SPECIFICATIONS AND ADJUSTMENTS			
IDLE SPEED (in gear)		550	FAMILY: 5M902.62GO
250 HP	2598 cc	FEL: 16.1100 g/kWh	
TIMING (IN DEGREES):		NOT ADJUSTABLE	
JUN 2004	SPARK PLUG: NGK ILFR6G GAP: MM (.32")		
COLD VALVE INTAKE: 0.15 - 0.23 MM			
CLEARANCE (mm) EXHAUST: 0.35 - 0.43 MM			
JAN	FEB	MAR	APR
			MAY
			JUNE
			JULY
			AUG
			SEP
			OCT
			NOV
			DEC

5648

a - "V" notch

b - Month of manufacture

Installation

Install the label on a clean surface in the original factory location.

Model	Service Part Number	Location on Engine
2005 Mercury/Mariner 200/225/250/275 EFI (4-Stroke) Verado	37-895282A05	Electrical box cover

Powerhead

Section 4A - Cylinder Block/Crankcase

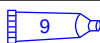
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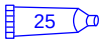
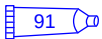
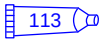
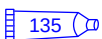
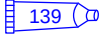
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Cylinder Block/Crankcase Specifications

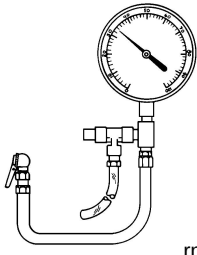
Cylinder Block/Crankcase Specifications	
Number of cylinders	6
Displacement	2.6 Liters (158.6 CID)
Compression ratio	8.25:1
Standard bore	82.00 mm (3.228 in.)
Stroke	82.0 mm (3.228 in.)
Cylinder bore maximum taper (service)	0.0762 mm (0.003 in.)
Cylinder bore maximum out of round (service)	0.0762 mm (0.003 in.)
Cylinder block main bearing	65.997 - 66.013 mm (2.5982 - 2.5989 in.)
Crankshaft main bearing journal	59.985 - 60.001 mm (2.3616 - 2.3622 in.)
Crankshaft pin journal	49.982 - 50.0 mm (1.9678 - 1.968 in.)
Crankshaft end play	0.08 - 0.19 mm (0.003 - 0.007 in.)
Crankshaft run out	0.05 mm (0.002 in.)
Crankshaft main bearing oil clearance (without expansion)	0.014 - 0.042 mm (0.0005 - 0.0016 in.)
Crankshaft pin bearing oil clearance (without expansion)	0.020 - 0.050 mm (0.0008 - 0.0019 in.)
Connecting rod wrist pin bore diameter	22.005 - 22.014 mm (0.8663 - 0.8666 in.)
Connecting rod crankshaft pin diameter	53.000 - 53.018 mm (2.0866 - 2.0873 in.)
Piston skirt standard diameter	81.975 mm (3.2273 in.)
Piston wrist pin bore diameter	22.004 - 22.011 mm (0.8662 - 0.8665 in.)
Wrist pin diameter	21.997 - 22.000 mm (0.8660 - 0.8661 in.)
Top ring groove width	1.25 mm (0.049 in.)
Second ring groove width	1.25 mm (0.049 in.)
Third ring groove width	2.05 mm (0.081 in.)
Top ring thickness	1.19 mm (0.047 in.)
Second ring thickness	1.19 mm (0.047 in.)
Third ring thickness	1.98 mm (0.078 in.)
Top ring side clearance	0.04 - 0.08 mm (0.001 - 0.003 in.)
Second ring side clearance	0.04 - 0.08 mm (0.001 - 0.003 in.)
Third ring side clearance	0.05 - 0.17 mm (0.002 - 0.006 in.)
Top ring end gap	0.27 - 0.42 mm (0.010 - 0.016 in.)
Second ring end gap	0.42 - 0.62 mm (0.016 - 0.024 in.)
Oil ring end gap	0.2 - 0.7 mm (0.007 - 0.027 in.)

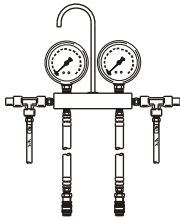
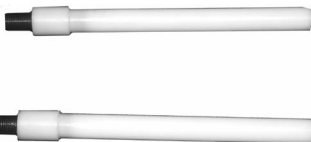
Lubricant, Sealant, Adhesives

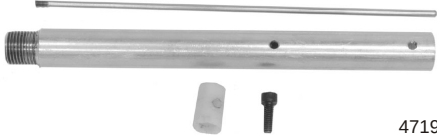
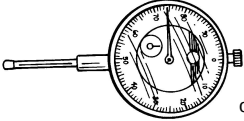
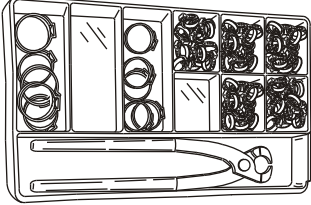
Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Water and Oil galley plugs	92-809822

Tube Ref No.	Description	Where Used	Part No.
	Liquid Neoprene	Ground Stud	92-25711-3
		Starter ground screws	
		Starter exciter wire, battery cable	
		Alternator mounting/ground bolt	
		Alternator output lead nut	
		Alternator battery charging lead and alternator ground	
		Battery ground and electrical harness ground	
		Ignition pencil coil ground and fuel injector ground	
		Battery stud inside electrical box	
		Alternator ground cable at cylinder block and cylinder head	
		Starter power leads and ground cables	
		Battery positive and negative cable connection on engine	
	Engine Coupler Spline Grease	Driveshaft splines	92-802869A1
	Loctite Moly Paste (Molybdenum Disulfide Grease)	Long main bearing bolt threads	Obtain Locally
	Three Bond 1217F	Crankcase Cover	Obtain Locally
		Cylinder block cover	
	Lubriplate SPO 255	Main Bearings	Obtain Locally
		O-rings	
		Fixed and movable chain guide retaining bolt	
		Main bearings, Crankshaft seal, Wrist pin, Connecting rod bearing	
		Piston pin	
		Connecting rod bearing	
		Crank pin	
		Main bearing	
		Chain guide bolts	
	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Cylinder bores	92-883722K01
		Integrated oil module O-rings	
		Piston rings	
		Piston rings, cylinder bore	
		Timing chain tensioner	
		Crankshaft seal inside diameter	

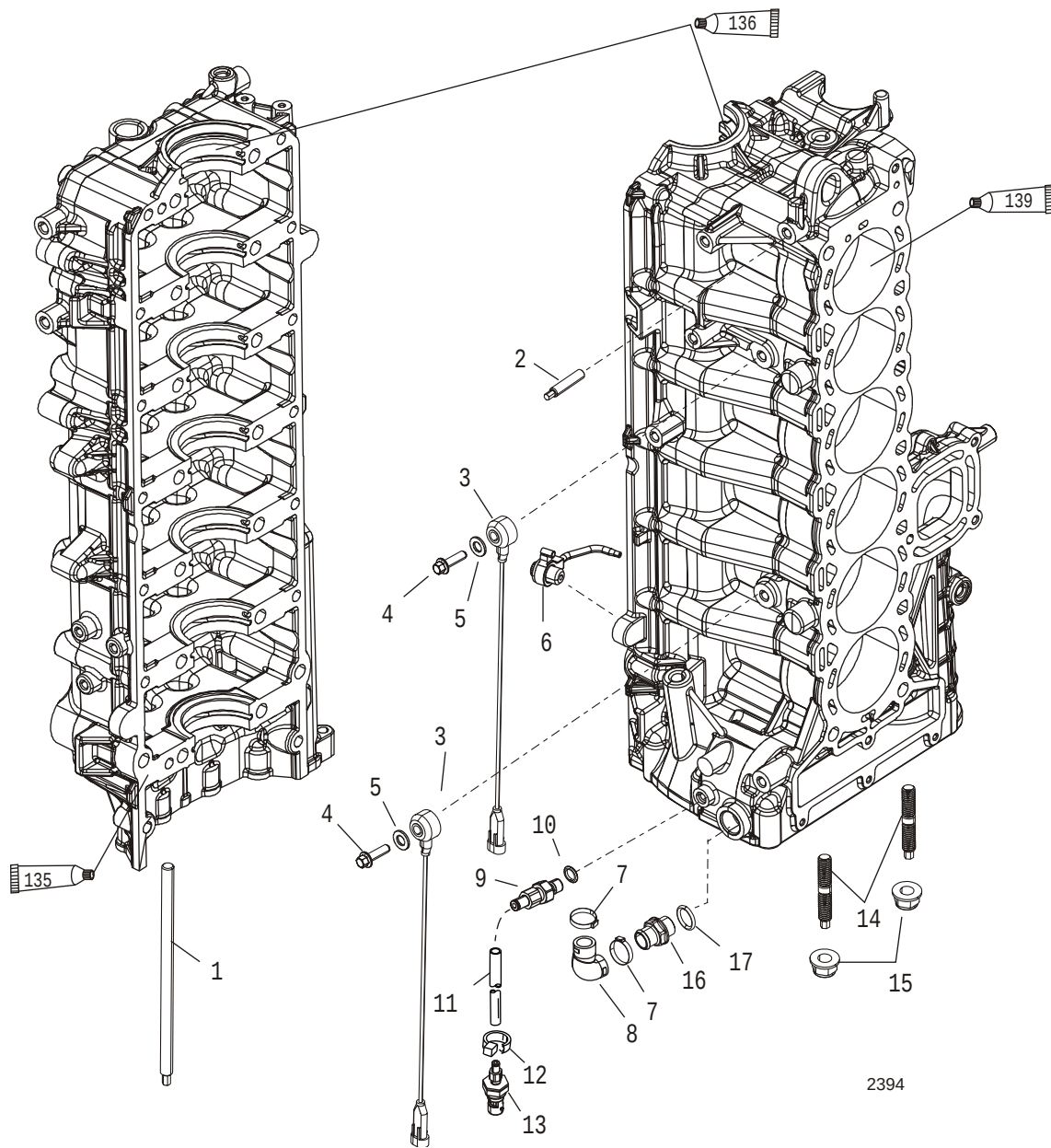
Special Tools - Cylinder Block/Crankcase

Fuel Pressure Gauge Kit	91-881833A03
 rms32	Checking fuel pressure, relieve fuel pressure

Dual Fuel/Air Pressure Gauge Kit  5822	91-881834A 1 Tests fuel and air pressure; the dual gauges allow the viewing of both pressures simultaneously
Digital Pressure Meter  5786	91-892651A01 Connects to the fuel system/manifold and can be used in conjunction with Computer Diagnostic System (CDS)
Flywheel Puller/Lifting Ring  4733	91-895343T01 Removes flywheel and used to install outboard on boat
13 mm Torque Adaptor  4631	91-809905001 Aids in the removal and installation of powerhead nuts, and torquing nuts to specification.
Rod Guide Dowel  4735	Part number currently not available for this printing. Prevents cylinder bore and crankshaft from damage while installing or removing connecting rod assembly.
Flywheel Holding Tool  4738	91-52344 Holds and/or turns the flywheel while making engine repairs, also used to torque the flywheel or the engine coupler.
Ring Compressor  4739	Part number currently not available for this printing. Compresses ring to install piston into cylinder bore.

Dial Indicator Extension Adaptor	Part number currently not available for this publication.
 4719	Extends the dial indicators reach.
Dial Indicator	91-58222A1
 ob01629	Measures gear backlash and pinion gear location.
Crankshaft Retainer	Part number currently not available for this printing.
 6191	Secures crankshaft to cylinder block while rotating block to install the cylinder head.
Crankshaft Seal Installation Tool	Part number currently not available for this printing.
Hose Clamp Tool Kit	91-803146A2
 5819	Aids in the installation of high pressure (Oetiker®) hose clamps.

Port Cylinder Block Components

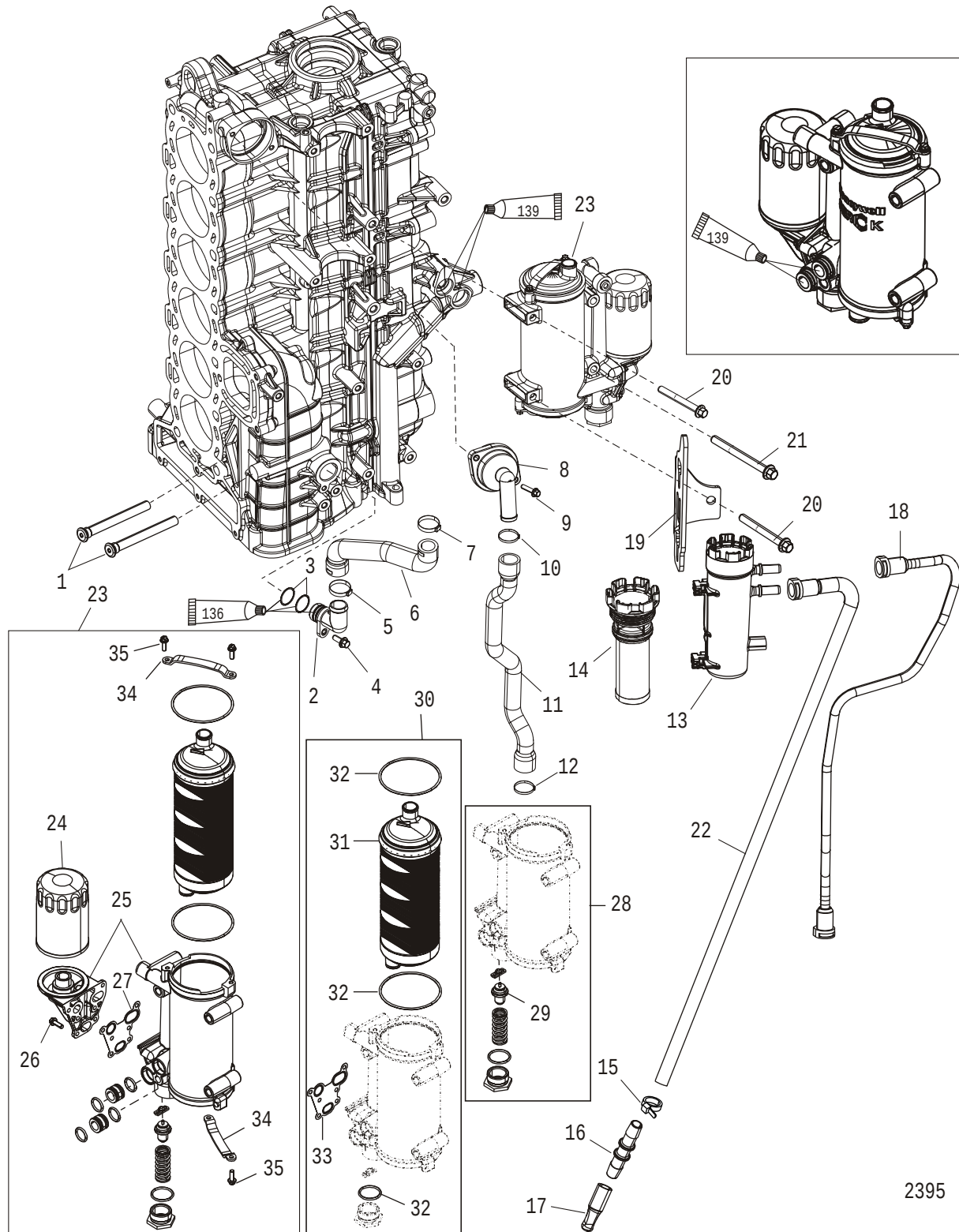


Port Cylinder Block Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	10	Stud	22.5		16.7
2	1	Stud	22		16.25
3	2	Sensor			
4	2	Screw (M10 x 35)	20	177	
5	2	Washer			
6	6	Oil jet assembly	24		17.4
7	2	Clamp (34.6 Diameter)			
8	1	Hose			
9	1	Fitting	15	133	
10	2	O-Ring			
11	1	Hose			
12	1	Cable tie (8.00 in.)			
13	1	Sensor, Water pressure			
14	2	Stud (M8 x 57)	10	88	
15	2	Nut	26		19
16	1	Fitting	20	177	
17	1	O-ring			

Tube Ref No.	Description	Where Used	Part No.
 135	Three Bond 1217F	Crankcase Cover	Obtain Locally
 136	Lubriplate SPO 255	Main Bearings	Obtain Locally
 139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Cylinder bores	92-883722K01

Starboard Cylinder Block/Oil Cooler

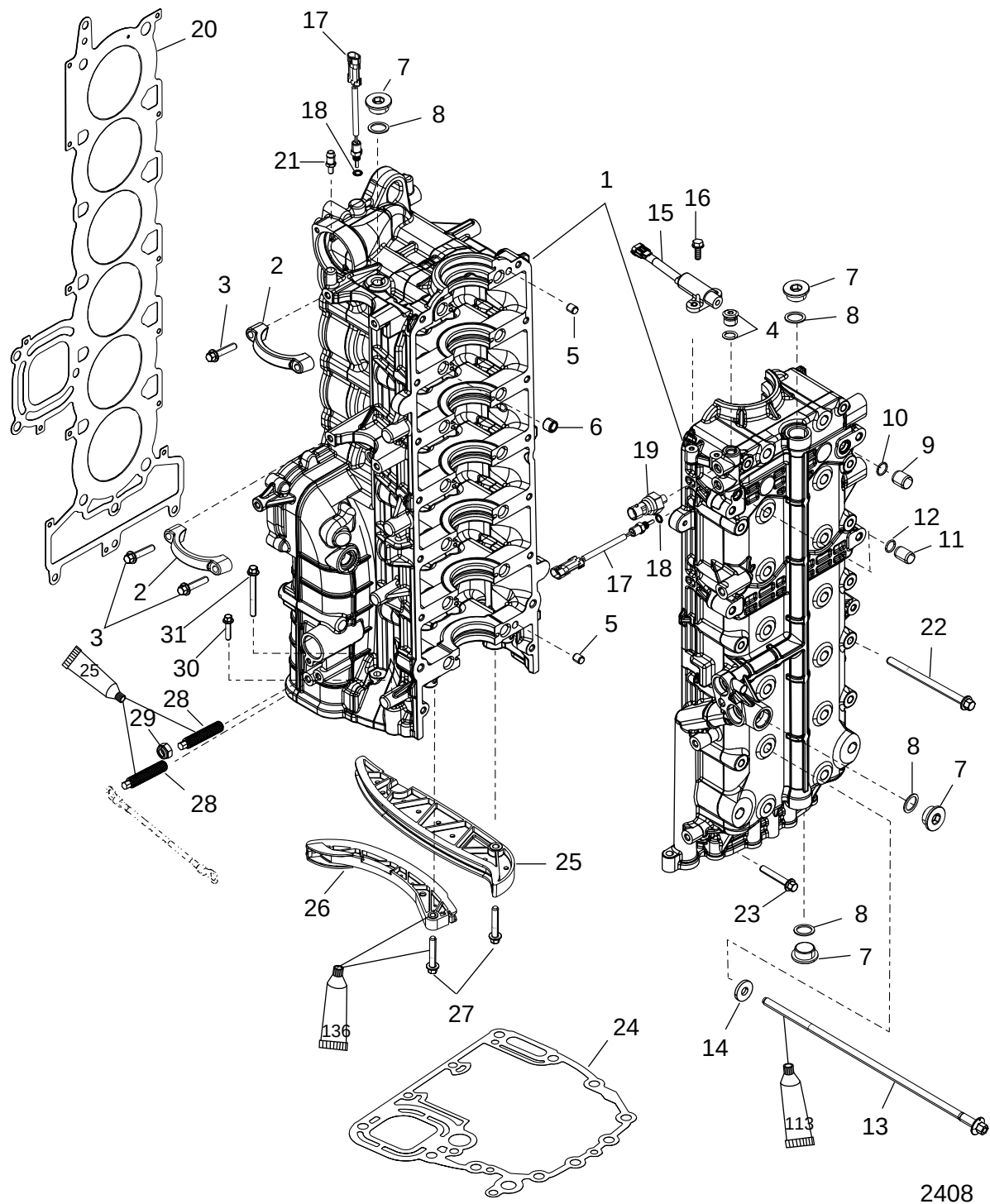


Starboard Cylinder Block/Oil Cooler

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	2	Water deflector assembly	9	80	
2	1	Fitting			
3	2	O-Ring			
4	1	Screw (M6 x 16)	10	88	
5	1	Clamp 38.1			
6	1	Hose			
7	1	Clamp 34.6			
8	1	Housing, Thermostat			
9	2	Screw (M6 x 25)	8	71	
10	1	Clamp 36.1			
11	1	Hose			
12	1	Clamp 42.5			
13	1	Filter, Housing			
14	1	Filter			
15	1	Cable tie			
16	1	Connector			
17	1	Grab tab			
18	1	Hose, Fuel filter to lift pump			
19	1	Bracket			
20	3	Screw (M10 x 85)	31		24
21	1	Screw (M10 X 105)	31		24
22	1	Integrated Oil Module (IOM)			
23	1	Oil filter			
24	1	Hose, Fuel inlet			

Tube Ref No.	Description	Where Used	Part No.
 136	Lubriplate SPO 255	O-rings	Obtain Locally
 139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Integrated oil module O-rings	92-883722K01

Cylinder Block Components

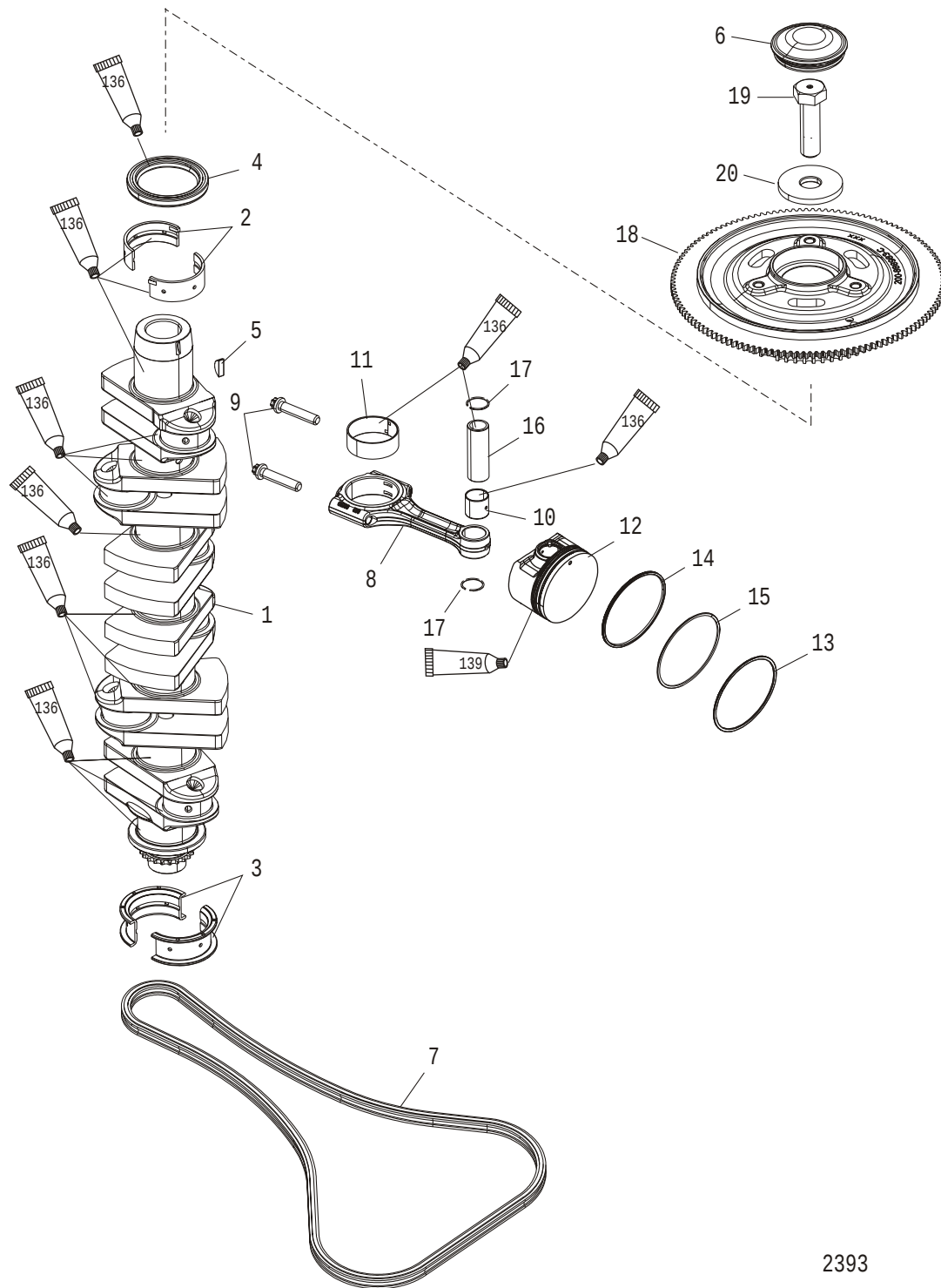


Cylinder Block Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Cylinder Block			
2	2	Bracket, Starter Mounting			
3	4	Screw (M8 x 40)	17	150	
4	1	Plug (M12 mm)	9	80	
5	2	Pin, Dowel			
6	14	Dampener			
7	4	Plug (M24 mm)	50		36.8
8	4	Washer			
9	1	Pin, Dowel (14 mm)			
10	1	O-Ring			
11	1	Pin, Dowel (11 mm)			
12	1	O-Ring			
13	14	Bolt	First Torque	27	19.9
			Second Torque	55	40.5
			Turn Additional 270° After Second Torque		
14	14	Washer			
15	1	Sensor, Crank Position			
16	2	Screw (M5 x 16)	5	44	
17	2	Sensor, Temperature	15	133	
18	2	O-Ring			
19	1	Sensor, Oil Pressure	15	133	
20	1	Gasket, Head			
21	1	Pin			
22	12	Screw (M8 x 115)	35		25.8
23	2	Screw (M8 x 50)	35		25.8
24	1	Gasket			
25	1	Guide, fixed			
26	1	Guide, Movable			
27	2	Screw	24		17.7
28	2	Stud	10	88	
29	1	Nut (M8)	17	150	
30	1	Screw (M8 x 35)	27		20
31	1	Screw (M8 x 75)	27		20

Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Ground Stud	92-25711-3
 113	Loctite Moly Paste (Molybdenum Disulfide Grease)	Long main bearing bolt threads	Obtain Locally
 136	Lubriplate SPO 255	Fixed and movable chain guide retaining bolt	Obtain Locally

Crankshaft, Piston, Connecting Rod Components



2393

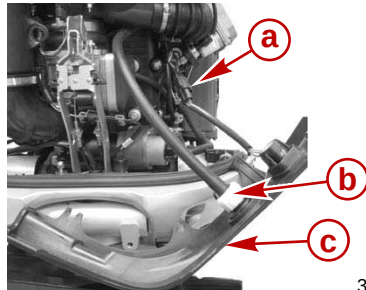
Crankshaft, Piston, Connecting Rod Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Crankshaft			
2	A/R	Bearing, Main			
3	A/R	Bearing, Thrust			
4	1	Seal			
5	1	Key, Woodruff			
6	1	Cap, Flywheel bolt			
7	1	Chain			
8	6	Connecting rod			
9	12	Bolt, Connecting rod	15	133	
			30		22.
			Turn Additional 90° After Second Torque		
10	6	Bushing			
11	A/R	Bearing, Connecting rod			
12	6	Piston assembly			
13	6	Piston ring, Top			
14	6	Piston ring, Oil			
15	6	Piston ring, Second			
16	6	Pin, Piston			
17	12	Circlip			
18	1	Flywheel			
19	1	Bolt, Flywheel (M20 x 68)	60		44
			120		88
20	1	Washer			

Tube Ref No.	Description	Where Used	Part No.
 136	Lubriplate SPO 255	Main bearings, Crankshaft seal, Wrist pin, Connecting rod bearing	Obtain Locally
 139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Piston rings	92-883722K01

Dressed Powerhead Removal

1. Drain the engine oil from the sump.
2. Disconnect the battery cables from the battery.
3. Remove the top cowl.
4. Remove the rear cowl.
5. Remove the lower chaps.
6. Remove the port and starboard front cowls.
7. Disconnect the trim switch harness.
8. Remove the fresh water flush from the cowl.
9. Remove the adaptor from the flush hose. Retain the adaptor for reassembly.



a - Trim switch harness

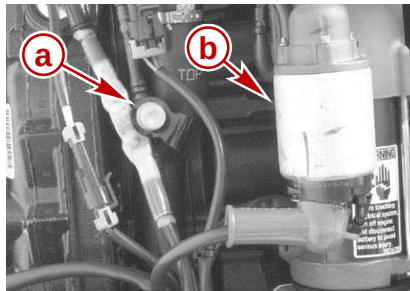
b - Fresh water flush adaptor

c - Port front cowl

10. Remove the cap to access the fuel vapor purge relief valve for the FSM.

⚠ CAUTION

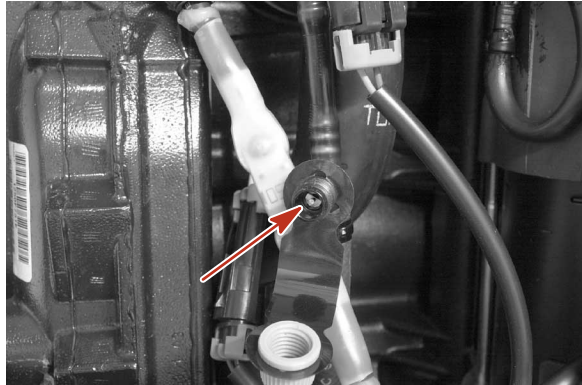
Pressurized fuel system! Release all pressure before servicing any part of the fuel system. This system can build pressure if the engine has not run for an extended period of time. If the fuel system is not relieved of pressure, fuel and vapors may be expelled at a significant velocity. Always protect your eyes and skin from pressurized fuel and vapors when servicing the fuel system.



a - Fuel vapor purge relief valve

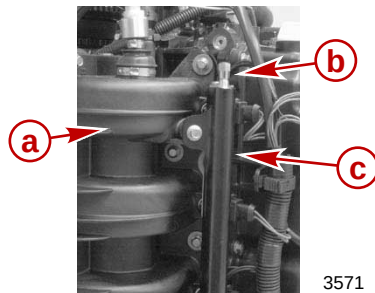
b - Starter solenoid

11. Place a rag over the valve and press on the center of the valve to relieve any pressure inside the FSM.



3472

12. Attach a fuel pressure gauge to the fuel pressure valve on the fuel rail. Relieve the fuel pressure into an appropriate container.



3571

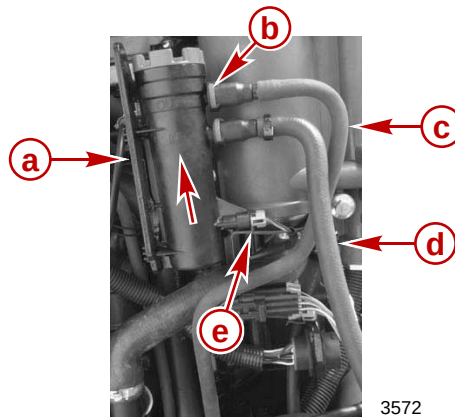
a - Intake manifold

b - Fuel pressure valve

c - Fuel rail

Fuel Pressure Gauge	91-881833A03
---------------------	--------------

13. Push in the fuel line retaining clip and remove both of the fuel lines from the fuel filter. Drain the lines into an appropriate container.
14. Disconnect the fuel filter water sensor from the engine harness.
15. Push the fuel filter assembly up to disengage it from the fuel filter bracket. Drain the fuel filter into an appropriate container.



3572

a - Fuel filter bracket

b - Fuel line retaining clip

c - Fuel line to adaptor plate

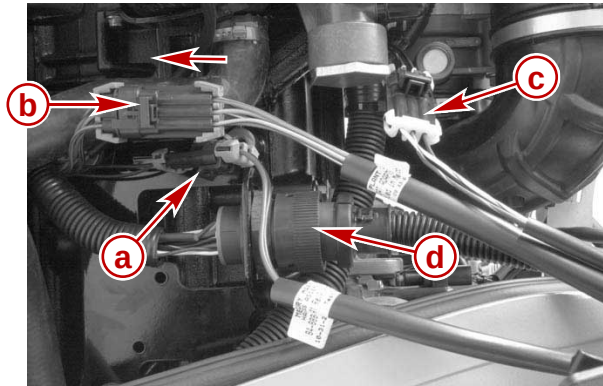
d - Fuel delivery line from boat

e - Fuel filter water sensor

16. Install the fuel filter assembly on the fuel filter bracket.

17. Disconnect the DTS power harness, boat sensor harness, power steering sensor harness and 14 pin engine harness.

NOTE: The boat sensor harness is attached to the harness bracket. Push the boat sensor harness aft to disengage the boat sensor harness from the harness bracket.



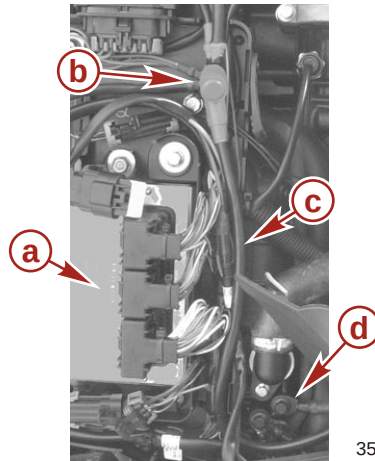
3573

a - DTS power harness
b - Boat sensor harness

c - Power steering sensor harness
d - 14 pin engine harness

18. Disconnect the battery negative and positive cable from the engine.

19. Disconnect the green and blue trim harness wires.

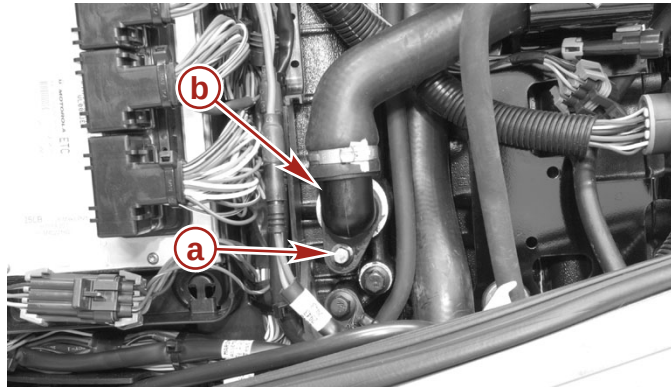


3577

a - PCM
b - Battery positive cable

c - Green and blue trim harness wires
d - Battery negative cable

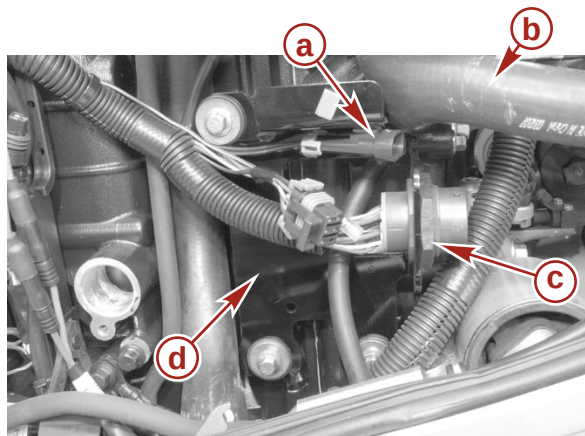
20. Remove the bolt securing the lower IOM hose elbow to the cylinder block. Remove the elbow from the cylinder block.



5375

a - Bolt securing elbow**b** - Lower IOM hose elbow

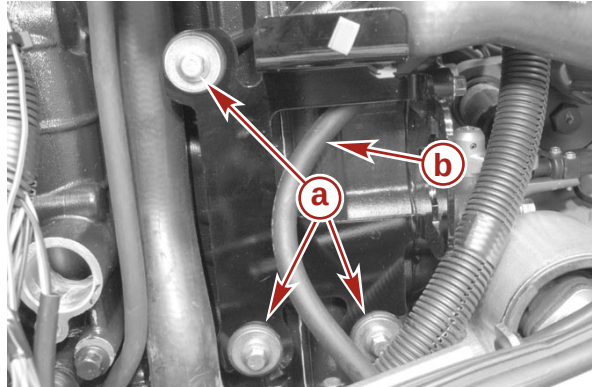
21. Place the lower IOM hose in a position that will not interfere with removing the electrical bracket.
22. Remove the nut securing the 14 pin connector to the harness bracket. Remove the 14 pin connector from the harness bracket. Install the 14 pin connector nut to the connector.
23. Push the DTS power harness towards the front of the engine to disconnect the harness from the support.



5376

a - DTS power harness**c** - 14 pin connector nut**b** - Lower IOM hose**d** - Harness bracket

24. Remove the 3 bolts securing the harness bracket to the cylinder block. Retain the harness bracket and hardware for reassembly.

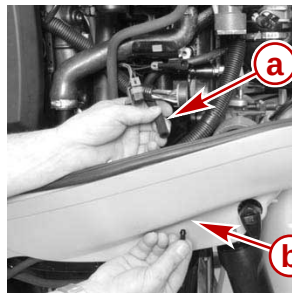


5377

a - Bolts securing harness bracket **b** - Tell Tale hose

25. Pull up on the tell tale hose to remove it from the tell tale fitting in the mount cradle. Do not lose the tell tale fitting.

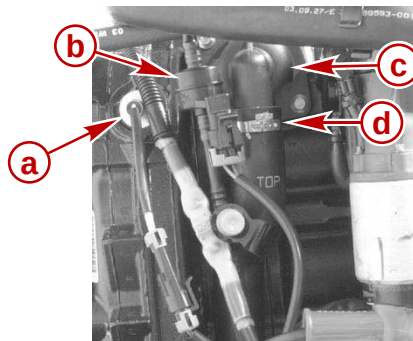
NOTE: The tell tale fitting will drop out of the mount cradle when removing the tell tale hose.



3695

a - Tell tale hose **b** - Tell tale fitting

26. Remove the hose clamp securing the hose to the thermostat housing. Remove the hose from the thermostat housing.

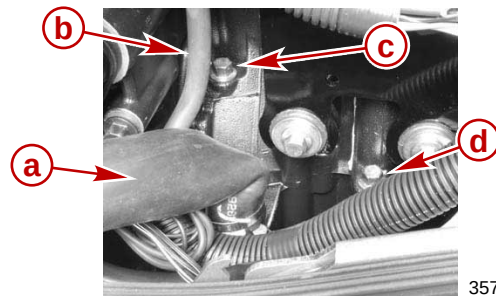


3578

a - Cylinder head temperature sensor **c** - Thermostat housing
b - Purge control valve **d** - Hose clamp, remove

27. Carefully guide the thermostat hose while pulling it down and out of the way to access the hidden bolt behind the thermostat hose, securing the powerhead to the adaptor plate.

28. Remove the two bolts securing the powerhead to the adaptor plate.

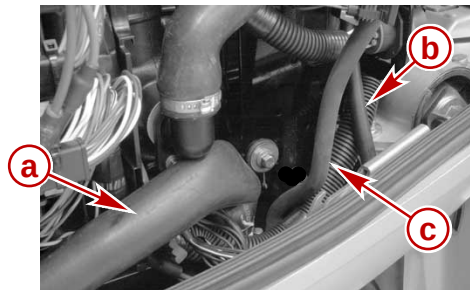


3579

a - Thermostat hose
b - Purge hose

c - Bolt behind the thermostat hose
d - Bolt securing powerhead

29. Remove the fuel line from the adaptor plate.



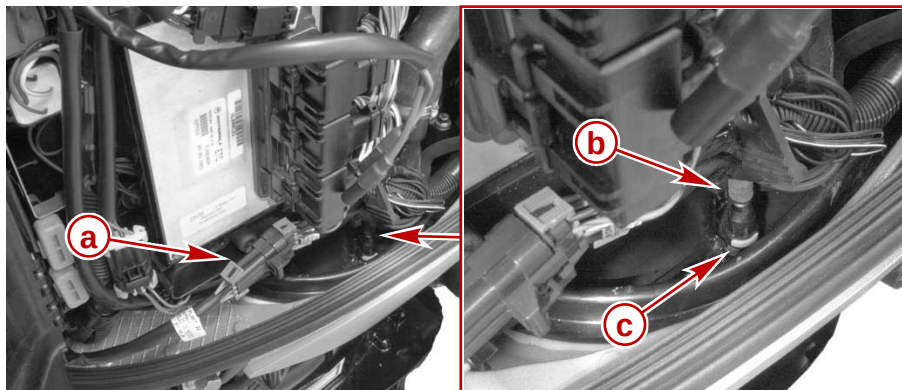
3580

a - Thermostat hose
b - Tell tale hose

c - Fuel line

30. Disconnect the FSM harness.

31. Press the purge line retaining clip in and disconnect the purge line from the adaptor plate.

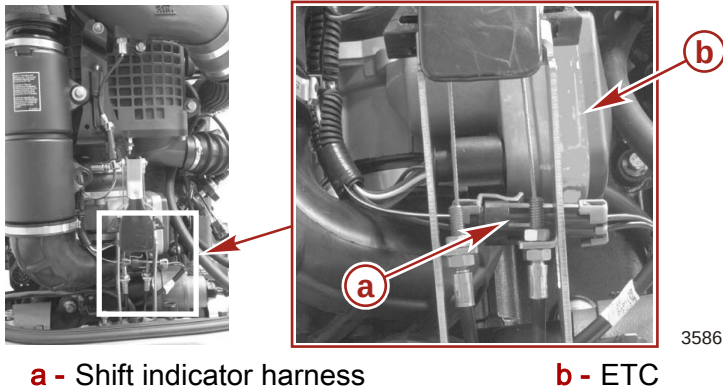


3582

a - FSM harness
b - Purge line

c - Retaining clip

32. Disconnect the shift indicator harness.



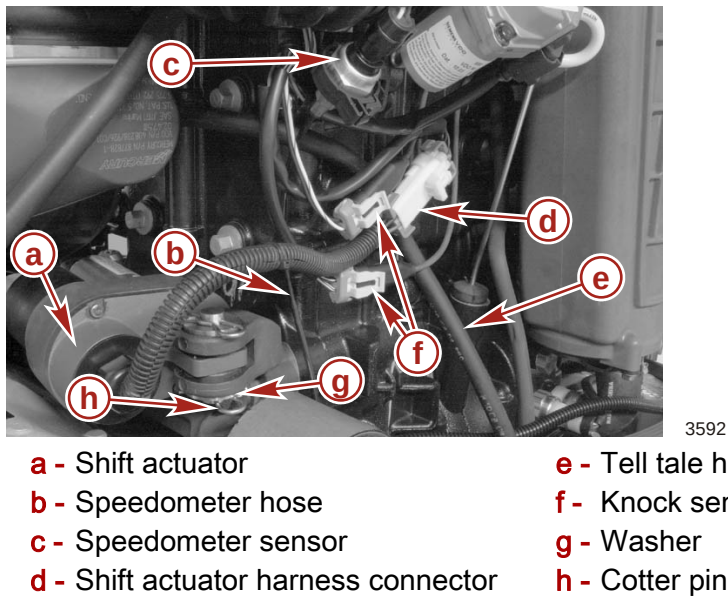
33. Push the shift actuator harness connector aft to disengage it from the connector retainer.

34. Disconnect the shift actuator harness from the engine harness.

35. Remove the speedometer hose from the speedometer sensor.

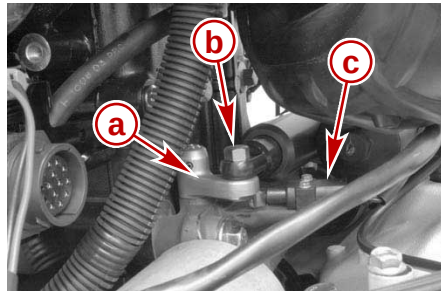
36. Remove the lower cotter pin and washer from the shift actuator pin. Remove the shift actuator pin.

37. Carefully pull the tell tale hose out from behind the knock sensor harnesses.



38. Remove the shift actuator bolt from the upper bell crank. Remove the shift actuator.

IMPORTANT: Do not rotate the shift actuator piston.



3596

a - Upper bell crank
b - Shift actuator bolt

c - Shift indicator switch

39. Cable tie the actuator to prevent the piston from rotating.

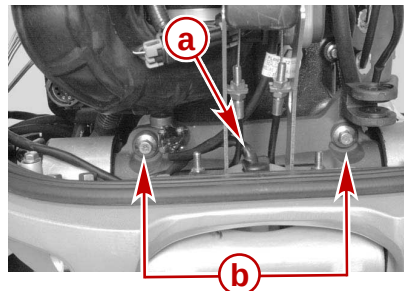
! WARNING

To avoid serious injury or death from a collision resulting from a shifting malfunction, install cable ties through electronic shift control piston to ensure piston does not rotate from original factory position. Remove cable ties just prior to installation. Do not rotate the piston more than 1/4 turn after removing the cable ties. If the piston is accidentally rotated, contact Mercury Customer Service for recalibration.



4982

40. Remove the two front powerhead mounting bolts.



3644

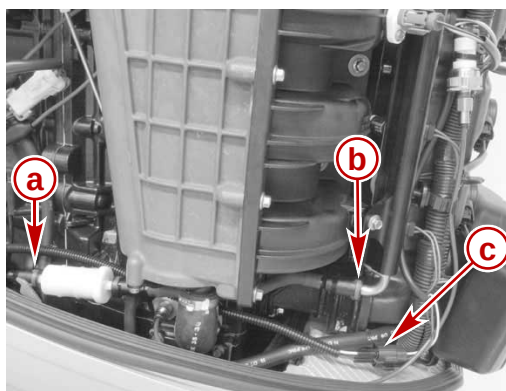
a - Power trim wire harness

b - Front powerhead mounting bolts

41. Disconnect the fuel inlet at the fuel filter and fuel rail.

42. Remove the fuel filter and fuel line.

43. Disconnect the trim position sensor harness from the engine harness.



3612

a - Fuel inlet at fuel filter

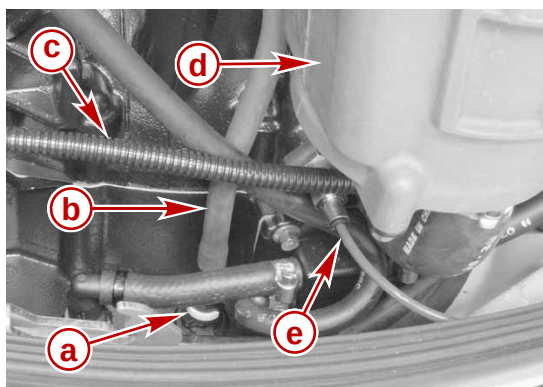
b - Fuel line at the fuel rail inlet

c - Trim position sensor harness

44. Disconnect the MAP sensor reference hose from the adaptor plate.

45. Pull the trim wire harness out from underneath the charge air cooler.

46. Disconnect the block water pressure line.



3614

a - MAP sensor reference hose clip

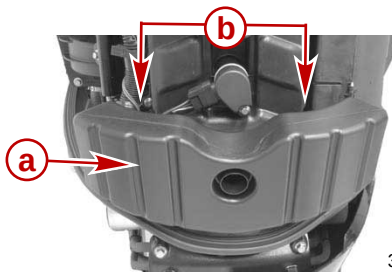
b - MAP sensor reference hose

c - Trim wire harness

d - Charge air cooler

e - Block water pressure line

47. Remove the two exhaust plenum screws holding the exhaust plenum to the mount cradle.

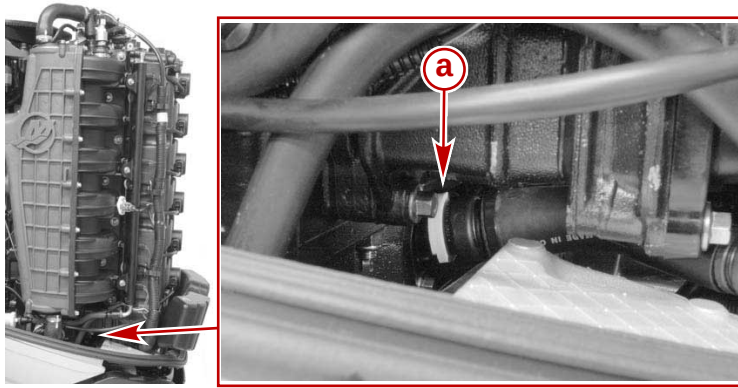


3615

a - Exhaust plenum

b - Exhaust plenum screws

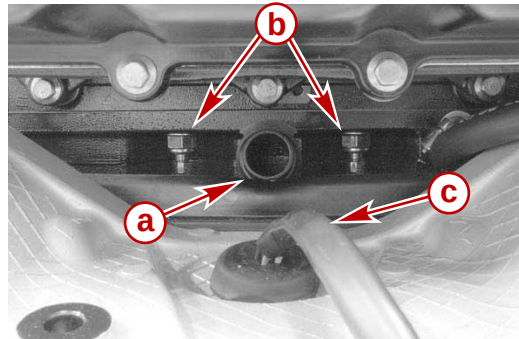
48. Disconnect the plenum tube by pushing in the release clip and pulling the plenum off.



4114

a - Release clip

49. Remove the two aft nuts securing the powerhead to the adaptor plate using torque adapter.



3617

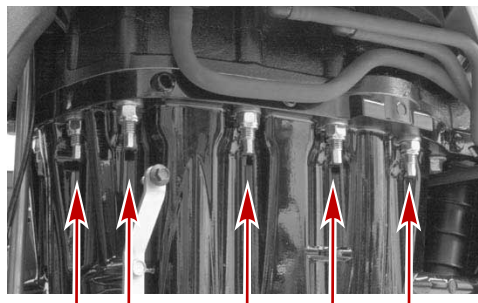
a - Exhaust relief tube

c - FSM harness

b - Aft nuts securing powerhead

Torque Adapter	91-809905001
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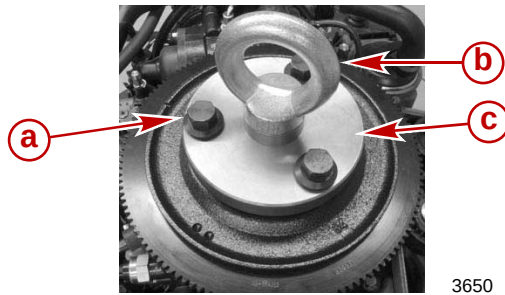
50. Remove the 10 nuts (five on each side) securing the powerhead to the adaptor plate.



3645

51. Install the lifting tool to the top of the flywheel. Tighten the lifting base bolts securely so they bottom out on the flywheel.

52. Thread the lifting eye into the lifting base securely so it bottoms out on the lifting base.



a - Lifting base bolts
b - Lifting eye

c - Lifting base

Flywheel Puller/Lifting Eye	91-895343T01
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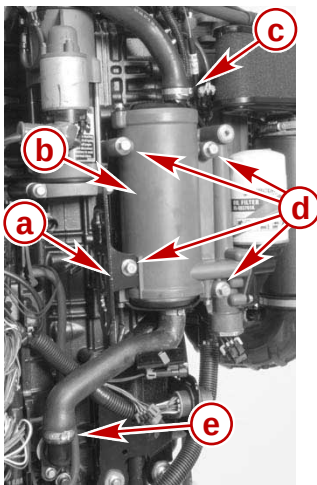
53. Carefully lift the dressed powerhead off the adaptor plate.

NOTE: While lifting the powerhead off the adaptor plate, it may be necessary to gently rock the powerhead fore and aft to prevent the powerhead mounting studs binding in the adaptor plate.

Removing Powerhead Components

IOM (Integrated Oil Module)

1. Remove the clamp securing IOM top cooling hose. Remove the hose from the IOM.
2. Remove the clamp securing the IOM bottom cooling hose at the cylinder block elbow. Remove the hose from the cylinder block elbow.
3. Remove the 4 bolts securing the IOM to the cylinder block.

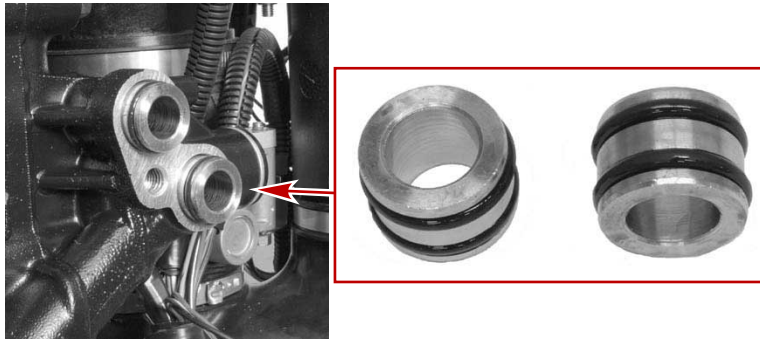


a - Fuel filler bracket
b - IOM
c - IOM top cooling hose clamp

d - Bolts securing IOM
e - IOM bottom cooling hose clamp

4. Pull the IOM off of the oil delivery and return dowels.
5. Remove the dowels from the cylinder block.

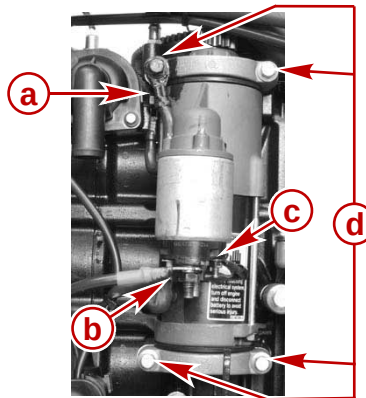
6. Remove the O-rings from the IOM dowels and discard the O-rings.



3772

Starter

1. Remove the starter solenoid battery cable.
2. Remove the starter solenoid exciter wire.
3. Remove the 4 bolts retaining the starter to the cylinder block.



3948

a - Starter ground cable

b - Starter solenoid battery cable

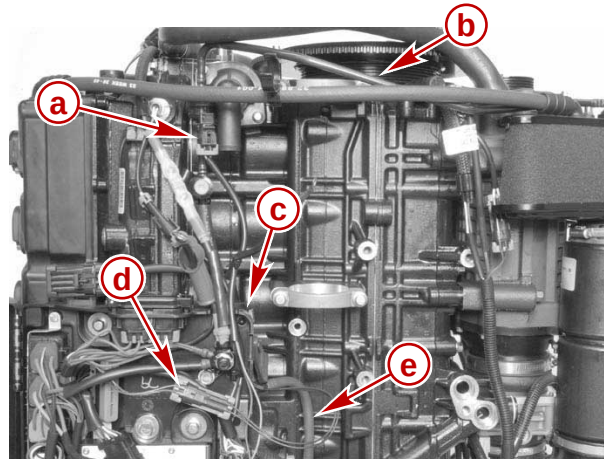
c - Starter solenoid exciter wire

d - Starter bolts.

Purge Line

1. Disconnect the purge valve harness connector from the purge valve.

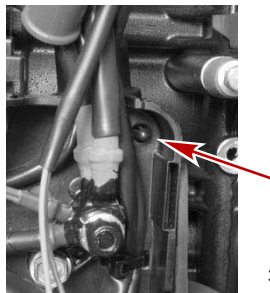
2. Disconnect the FSM vent canister float switch harness connector.



3773

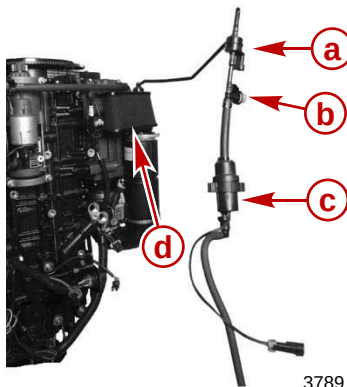
- | | |
|--|---|
| a - Purge valve harness connector | d - FSM vent canister float switch harness connector |
| b - Purge line to air intake assembly | e - FSM vent line |
| c - FSM vent canister float switch | |

3. Pinch the FSM vent canister float switch retainer with a pair of pliers. Push the retainer through the electrical box.



3790

4. Carefully remove the vent line assembly from behind the electrical box.
NOTE: Do not kink the purge vent line when removing purge vent line from the air intake filter.
5. To unlock the purge vent line from the air intake assembly, move the purge vent line assembly so it is approximately 90° to the ports side of the air intake filter assembly. The purge vent line can now be lifted off the air intake assembly.

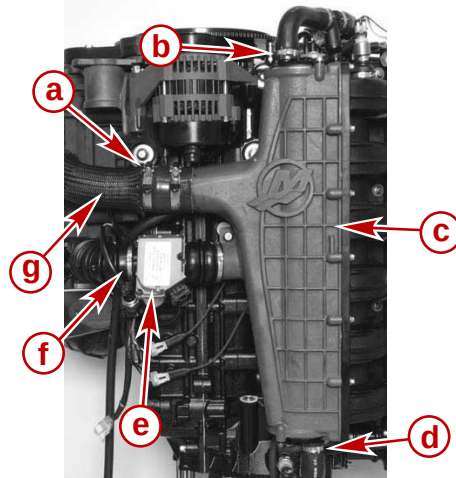


3789

- | | |
|---------------------------|---|
| a - Purge solenoid | c - Vent Canister Float Switch (VCS) |
| b - Purge valve | d - Air intake filter assembly |

Induction System

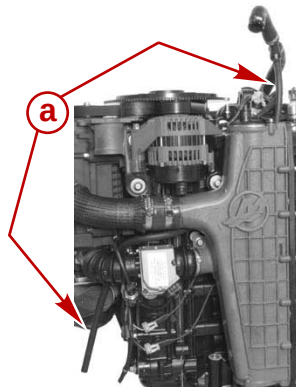
1. Loosen the hose clamp at the charge air cooler inlet.
2. Remove the upper charge air cooler hose clamp.
3. Remove the lower charge air cooler hose clamp.
4. Remove the hose clamp at the forward side of the electronic boost control.



3799

- | | |
|--|---|
| a - Hose clamp (loosen) | e - Electronic Boost Control (EBC) |
| b - Upper charge air cooler hose clamp (remove) | f - Hose clamp (remove) |
| c - Charge air cooler | g - Charged air exit hose |
| d - Lower charge air cooler hose clamp (remove) | |

5. Carefully pull the fresh water flush hose from behind the charge air cooler.

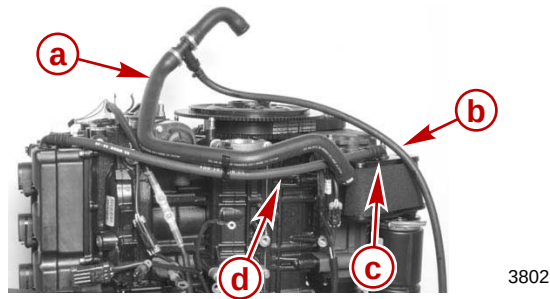


3801

- a** - Fresh water flush hose

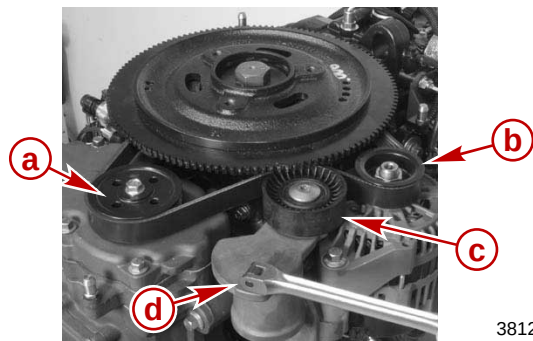
6. Remove the IOM, fresh water flush hose assembly.

7. Remove the breather hose from the air intake filter cover.



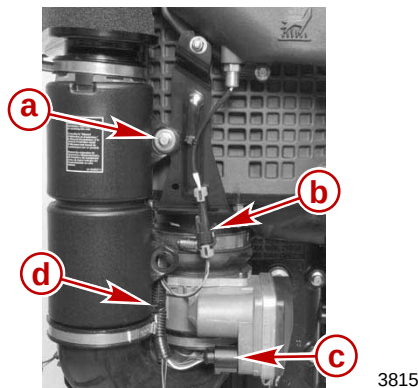
- a** - Hose from the IOM
b - Fresh water flush hose
c - Air intake filter cover
d - Breather hose

8. Install a 3/8 inch breaker bar into the belt tensioner socket.
9. Release the belt tension and remove the alternator/supercharger belt.



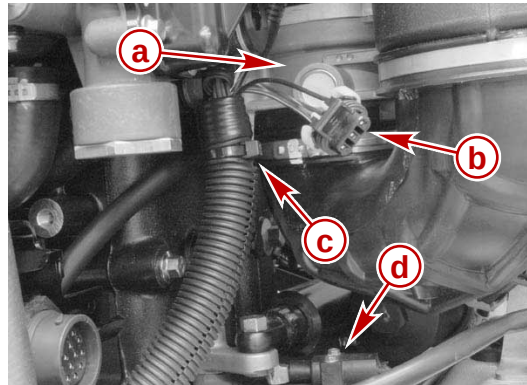
- a** - Supercharger pulley
b - Alternator pulley
c - Belt tensioner
d - 3/8 inch breaker bar

10. Remove the air intake support bolt from supercharger bracket.
11. Disconnect the engine harness from the post supercharger air temperature sensor.
12. Cut the cable tie securing the engine harness to the electronic throttle control harness support bracket.
13. Disconnect the engine harness from the electronic throttle control.



- a** - Air intake support bolt
b - Post supercharger air temperature sensor harness
c - Electronic throttle control harness
d - Cable tie

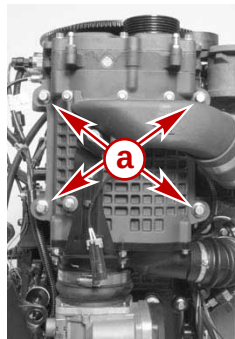
14. Cut the cable tie securing the engine harness to the support bracket at the rear of the electronic throttle control.



4599

- a** - Electronic throttle control
b - Power steering harness
c - Cable tie securing engine harness to support bracket at rear of electronic throttle control
d - Shift indicator switch

15. Remove the 4 bolts securing the supercharger to the cylinder block.

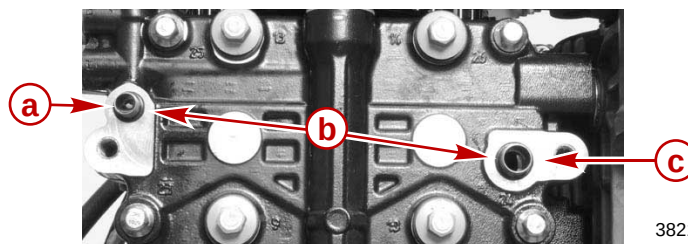


3820

- a** - Supercharger mounting bolts (4)

16. Pull the supercharger off the dowels.

17. Remove the supercharger dowel O-rings and discard. Do not attempt to remove the supercharger dowels unless they are damaged.

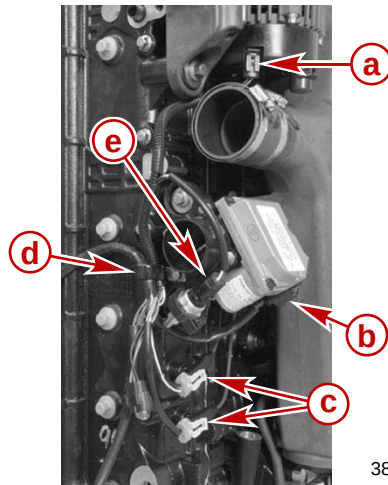


3821

- a** - Oil delivery to supercharger
b - Supercharger dowel O-rings
c - Oil return from supercharger

18. Disconnect the engine harness from the alternator.
 19. Disconnect the electronic boost control harness.
 20. Disconnect the 2 knock sensors.
 21. Disconnect the speedometer sensor harness.

22. Remove the engine harness from the retaining clip.



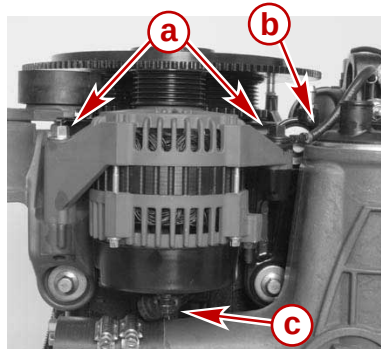
3822

- | | |
|---|---|
| a - Alternator harness connector | d - Harness retaining clip |
| b - Electronic boost control connector | e - Speedometer sensor harness connector |
| c - Knock sensor harness connectors | |

23. Remove the nut securing the battery charging lead to the alternator.

24. Remove the 2 bolts securing the alternator to the tensioner bracket and alternator support bracket.

25. Remove the alternator.

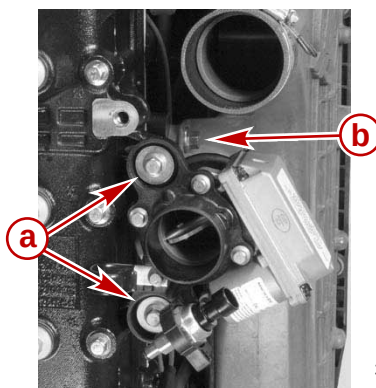


3823

- | | |
|--------------------------------------|---|
| a - Bolts securing alternator | c - Nut securing battery charging lead |
| b - Alternator ground lead | |

26. Remove the 2 bolts securing the electronic boost control to the cylinder block.

27. Remove the front bolt securing the charge air cooler to the cylinder block.



3824

a - Bolts securing the electronic boost control

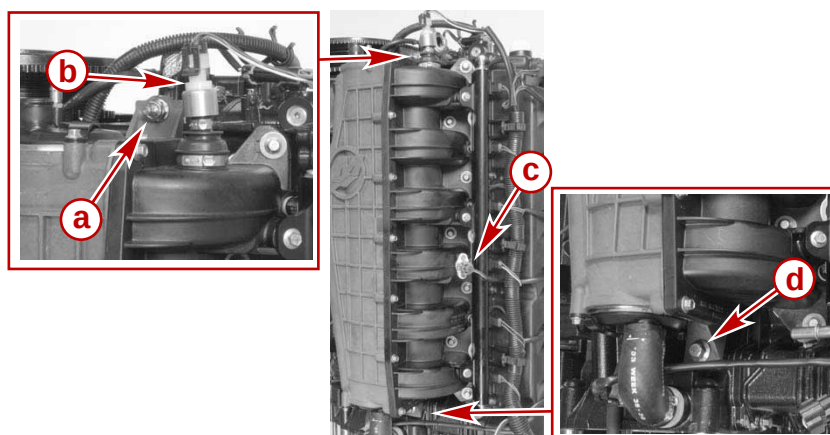
b - Front bolt securing charge air cooler to cylinder block

28. Disconnect the Manifold Absolute Pressure (MAP) sensor harness.

29. Disconnect the Manifold Air Temperature (MAT) sensor harness.

30. Remove the top nut securing the charge air cooler to the cylinder block.

31. Remove the bottom bolt securing the charge air cooler to the cylinder block.



3825

a - Nut securing charge air cooler to cylinder block

b - MAP sensor harness connector

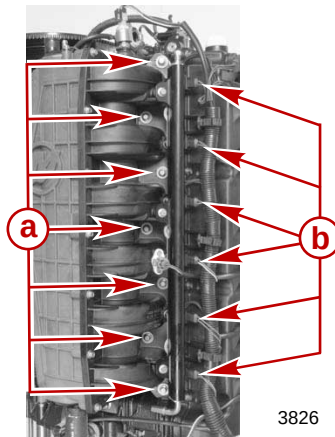
c - MAT sensor harness connector

d - Bolt securing charge air cooler to cylinder block

32. Remove the injector harness from the injectors.

33. Remove the 7 bolts securing the charge air cooler to the cylinder head.

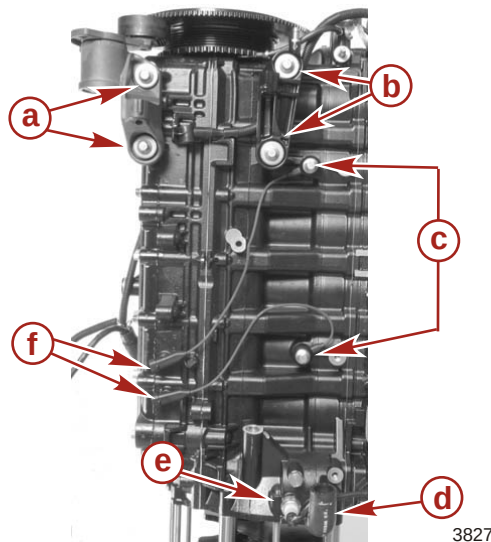
34. Pull the charge air cooler off the cylinder head and the lower cooling hose.



- a** - Bolts securing charge air cooler to cylinder head **b** - Injector harness connectors

Alternator Support Bracket And Knock Sensor

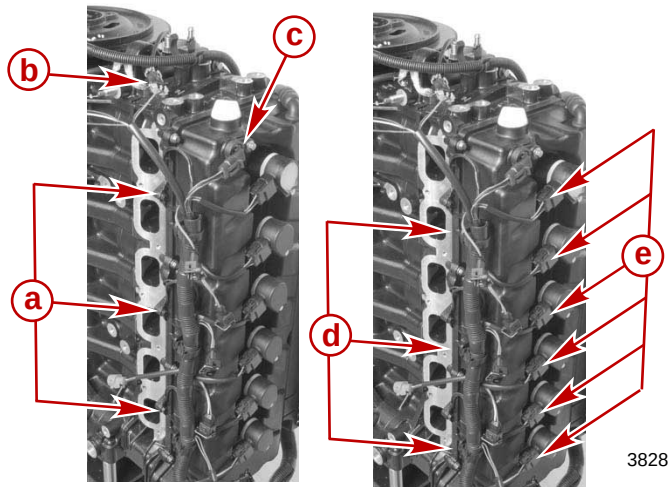
1. Remove the 2 bolts securing the alternator support bracket to the cylinder block. Do not lose the washers behind the support bracket.
2. Remove the 2 bolts securing the belt tensioner bracket to the cylinder block. Do not lose the washers behind the belt tensioner bracket.
3. Slide the upper and lower knock sensor harness connectors towards the front of the engine to remove the harness connectors from the harness supports.
4. Remove the knock sensor retaining bolts.
5. Disconnect the water pressure hose at the cylinder block water pressure legris connector. Remove the legris connector from the cylinder block.
6. Remove the fitting with the water hose attached, from the cylinder block.



- a** - Bolts securing belt tensioner bracket **d** - Fitting with water hose attached
b - Bolts securing alternator support bracket **e** - Water pressure legris connector
c - Knock sensor retaining bolt **f** - Knock sensor harness connectors

Injector/Coil Harness

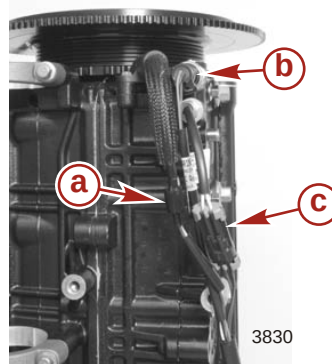
1. Disconnect the cylinder block temperature sensor.
2. Disconnect the Camshaft Position Sensor.
3. Remove the 3 screws securing the engine harness grounds to the cylinder head.
4. Disconnect the ignition harness connectors from the coils.
5. Pinch the back of the harness retainers with a pair of pliers to remove the harness retainer from the valve cover.



- a** - Engine harness grounds
b - Cylinder block temperature sensor
c - Camshaft position sensor
d - Engine harness retainers
e - Ignition coil harness connectors

Oil Pressure/Temperature Sensor

1. Disconnect the oil pressure sensor harness.
2. Disconnect the oil temperature sensor harness.
3. Disconnect the Crank Position Sensor (CPS) harness.
4. Remove the oil temperature sensor, oil pressure sensor and CPS.

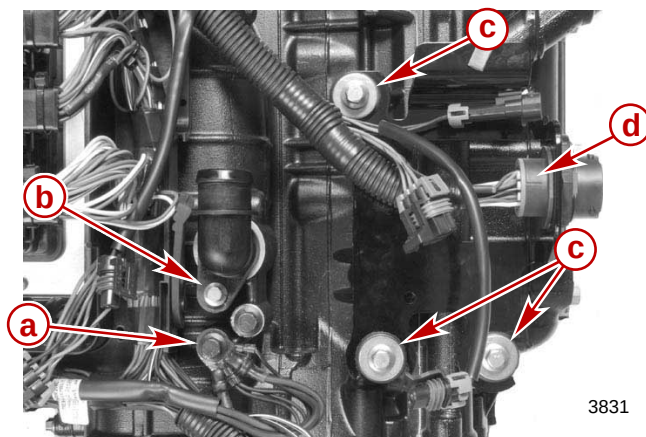


- a** - CPS harness connector
b - Oil pressure sensor harness connector
c - Oil temperature sensor harness connector

Engine Harness Bracket

1. Remove the 3 bolts securing the engine harness bracket to the cylinder block.
2. Remove the bolt securing the engine harness grounds to the cylinder block.

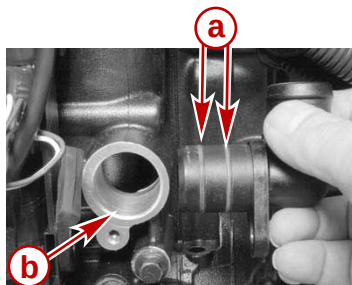
3. Remove the bolt securing the elbow to the cylinder block.



- a** - Bolt securing engine harness grounds
b - Bolt securing elbow

- c** - Bolts securing engine harness bracket
d - 14 pin engine harness

4. Remove the elbow from the cylinder block.
5. Remove the O-rings from the elbow.
6. Remove any sealant from the cylinder block hole.



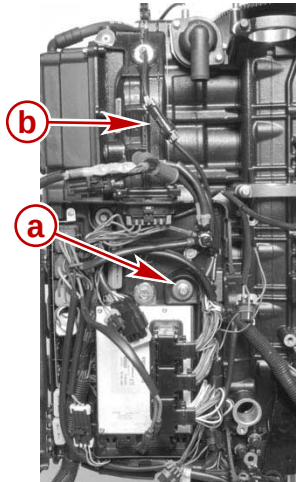
- a** - O-rings (discard)

- b** - Remove sealant from cylinder block

Electrical Box

1. Disconnect the cylinder head temperature sensor.
2. Remove the electrical box retaining bolt.

3. Slide the electrical box towards the rear of the engine to remove the electrical box from the support grommets.

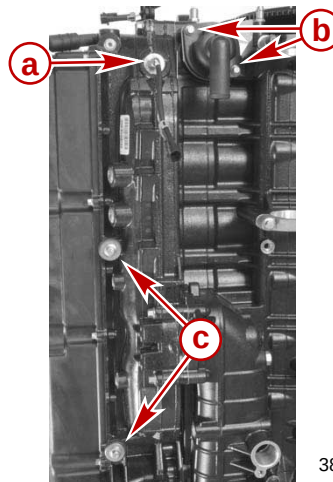


3833

a - Electrical box retaining bolt**b** - Cylinder head temperature sensor

Thermostat Housing

1. Remove the cylinder head temperature sensor from the cylinder head.
2. Remove the bolts securing the thermostat housing to the cylinder block.
3. Remove the electrical box support bolts with grommets.



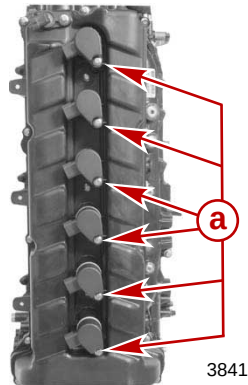
3834

a - Cylinder head temperature sensor**b** - Thermostat housing bolts**c** - Electrical box support bolts with grommets

Ignition Coil

1. Remove the screws securing the ignition coils to the powerhead.
2. Pull the ignition coils off of the spark plugs.

NOTE: Do not bend the ignition coil. Bending the ignition coil will damage the coil and or the spark plug.



a - Ignition coil screw

3. Remove the spark plugs

Powerhead Disassembly

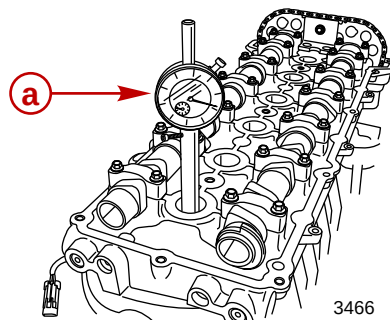
Cylinder Head Removal

IMPORTANT: The removal and disassembly procedure of the cylinder head and cams must be strictly followed. Failure to follow the removal outline procedure may damage the valve train components.

IMPORTANT: Do not inter-mix the location of the valve train parts.

IMPORTANT: This engine is an interference valve train design. Do not rotate the crankshaft or cams when the timing chain is loose or removed from the cam gears unless advised to do so. Failure to adhere to this important information, will result in valve and or piston damage.

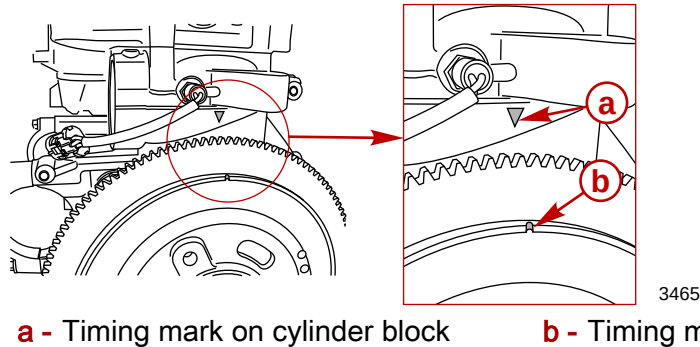
1. Remove the screws retaining the valve cover to the cylinder head.
2. Install a dial indicator gauge with extension kit and rotate the engine so the number one piston is at compression stroke top dead center (TDC).



a - Dial indicator

Dial Indicator	91-58222A1
Dial Indicator Extension Adaptor	Part number currently not available for this printing.

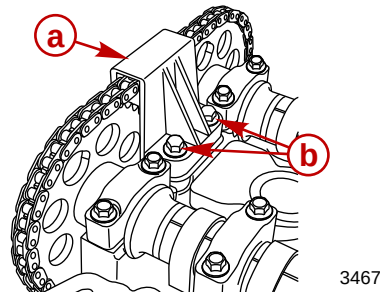
NOTE: The timing mark on the flywheel will be aligned with the timing mark on the cylinder block.



a - Timing mark on cylinder block

b - Timing mark on flywheel

3. Remove the short span chain guide bolts. Remove the short span chain guide.

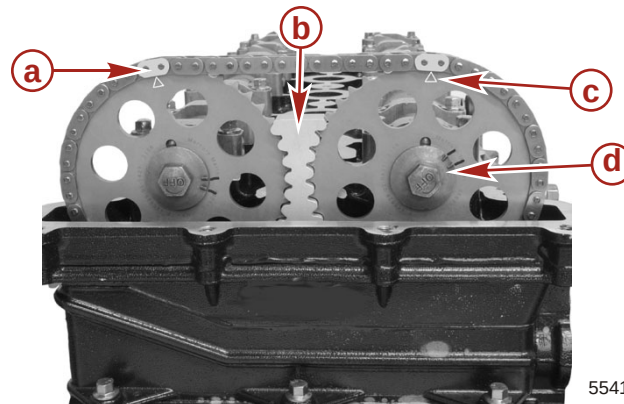


a - Short span chain guide

b - Short span chain guide bolts

4. Install the cam gear brake between the intake and exhaust cam. (Tool part number not available at this printing.)

NOTE: When installing the cam gear brake, it may be necessary to rotate one of the cams slightly to align the cam gear brake to the cam gears.



a - Timing chain anodized link

b - Cam gear brake

c - Cam gear timing mark

d - Cam gear retaining bolt (left hand thread)

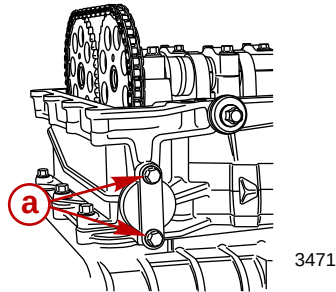
Cam Break	Part number currently no available for this publication.
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NOTE: Cams must be locked with a special tool to prevent loading of the cam gears and chain. Loading the cam gear and chain may damage the cam gear and chain.

5. Loosen the cam gear retaining screws.

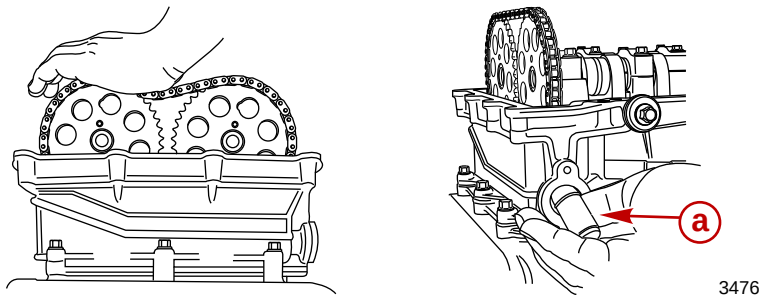
NOTE: Cam gear retaining screws are left hand thread.

6. Remove the cam brake and cam gear retaining screws.
7. Remove the cam tensioner cover bolts.



a - Cam tensioner cover bolts

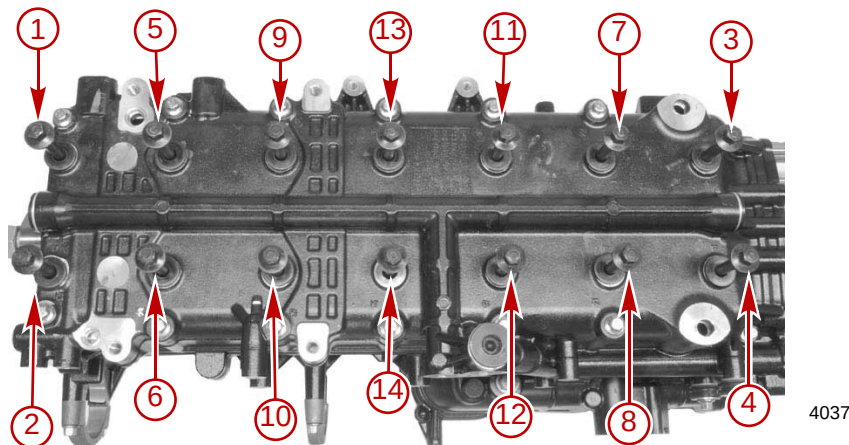
8. Place your hand over the cam tensioner bore. With the heel of your other hand, press on the timing chain between the cam gears. This will assist to dislodge the tensioner from cylinder head bore.



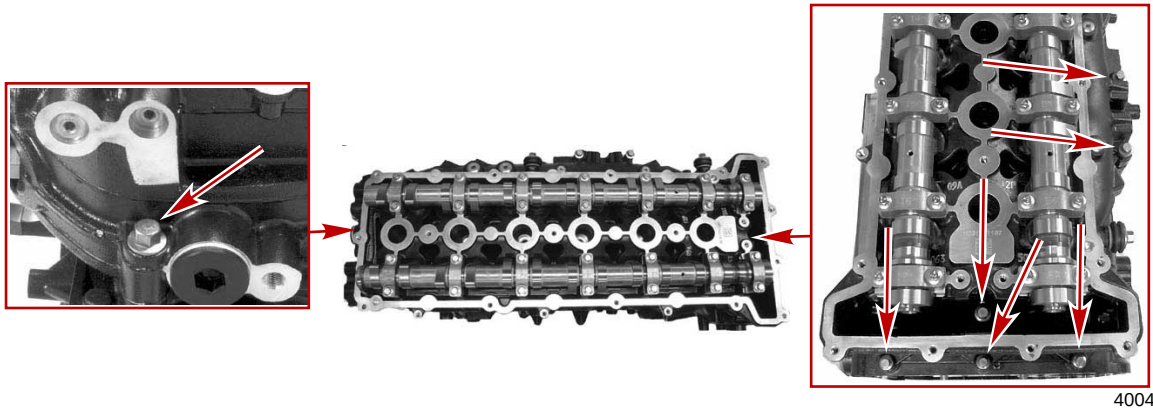
a - Cam tensioner

9. Remove the cam gears. Allow the timing chain to drop into the cylinder block area.
 10. In a chronological sequence, loosen the long main bolts. Remove the long main bolts.
- IMPORTANT:** It is not necessary to remove the long main bolts when repairing the cylinder head only. If the cylinder block is to be disassembled, the long main bolts must be removed and replaced.

NOTE: The cylinder block has rubber dampeners for the long main bolts. The long main bolt threads will be difficult to pull past the dampeners. Unthread the main long bolts past the rubber dampeners.



11. Remove the cylinder head perimeter screws. Remove the cylinder head.

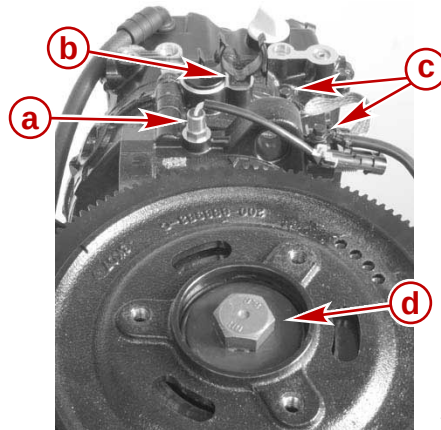


IMPORTANT: Do not set the cylinder head down on its deck. Damage to the valves may result. Set the cylinder head on pillow blocks to prevent damage to the valves.

Refer to **Section 4B-Cylinder Head Disassembly, Inspection/Cleaning/Repair.**

Flywheel

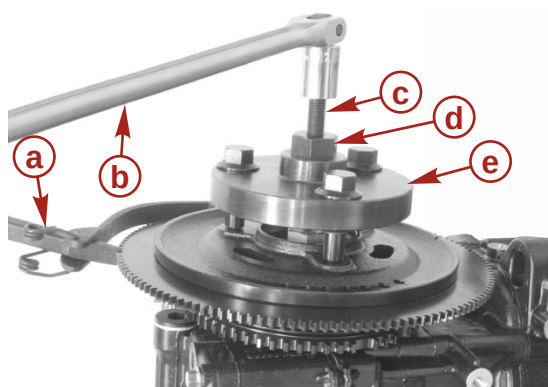
1. Remove the cylinder block temperature sensor.
2. Remove the screws securing the ground wires to the cylinder head and cylinder block.
3. Un-thread the Integrated Oil Module (IOM) hose support from the cylinder block.
4. Rotate the flywheel to align the timing marks.
5. Loosen the flywheel bolt. Turn the flywheel bolt 4 turns out from a light seat.



- | | |
|---|-------------------------------|
| a - Cylinder block temperature sensor | c - Ground wire screws |
| b - Integrated Oil Module hose support | d - Flywheel bolt |

6. Install the flywheel puller base to the flywheel.
7. Thread the flywheel puller adaptor onto the puller base until it bottoms out on the puller base.
8. Thread the flywheel puller bolt into the flywheel puller adaptor.
9. Tighten the flywheel puller bolt until the flywheel becomes loose.

IMPORTANT: Do not use power tools to remove the flywheel. Using power tools to remove the flywheel will damage the flywheel puller bolt.

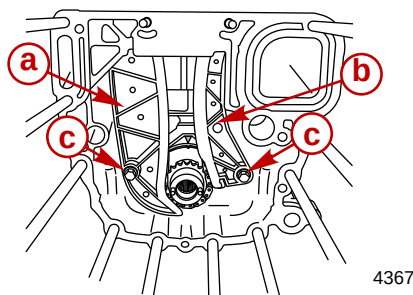


- a** - Flywheel holder
b - Breaker bar
c - Flywheel puller bolt
d - Flywheel puller adaptor
e - Flywheel puller base

Flywheel Puller/Lifting Ring	91-895343A01
Flywheel Holding Tool	91-52344

CRANKCASE AND CRANKSHAFT DISASSEMBLY/REMOVAL

1. Remove the timing chain guide, tensioner and timing chain.



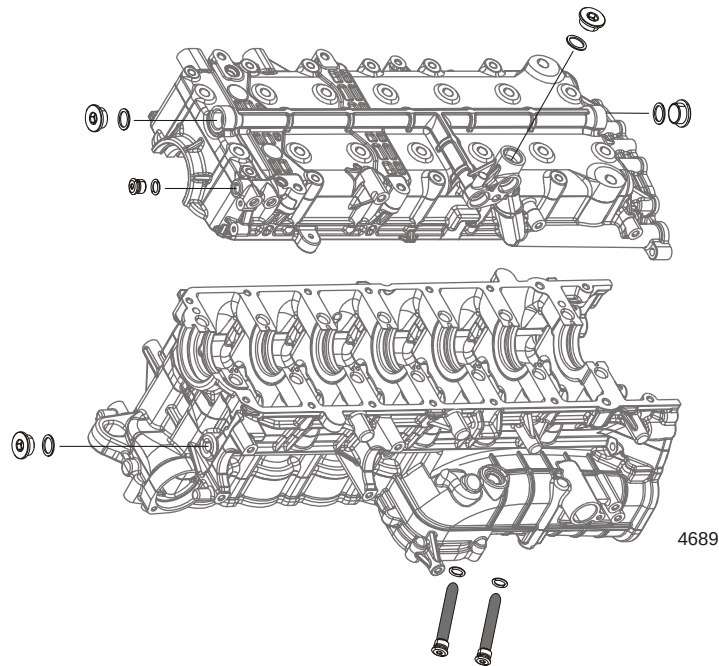
- a** - Timing chain guide
b - Timing chain tensioner
c - Timing chain tensioner and guide bolts

2. Remove the timing chain.

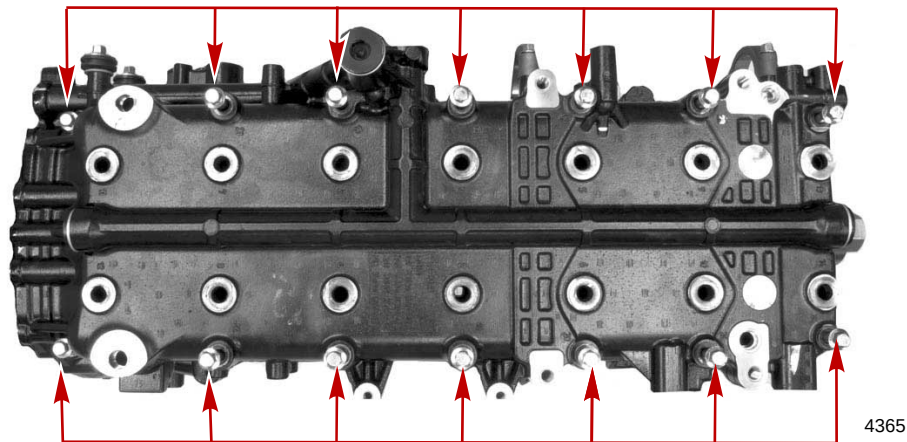
NOTE: If the timing chain's three anodized links can not be identified, a new chain must be installed.

3. Remove all of the anodized aluminium oil passage plugs from the crankcase cover and cylinder block.

NOTE: If the any of the oil passage plugs or water galley plugs are difficult to remove, place a brass drift on the anodized plug and strike the brass drift lightly with a hammer to assist in breaking loose the plugs.



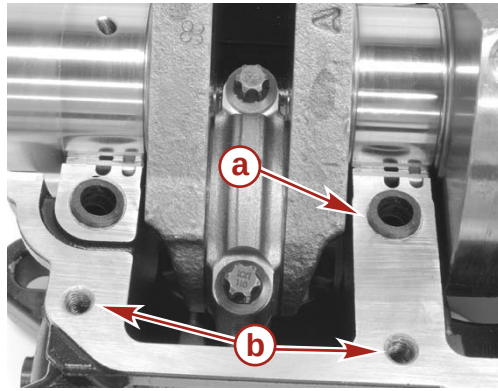
4. Remove the perimeter crankcase cover bolts .



5. Pry the crankcase cover loose with two large screwdrivers. Lift the crankcase cover off of the cylinder block.
6. Mark all of the connecting rod caps and rods locations with indelible magic marker or paint, (Example: 1,2,3,4,5,6).

IMPORTANT: Do not use a scribe or a metal punch on the connecting rod or rod cap for identification purpose. Using a scribe or metal punch will damage the connecting rod and may cause premature engine failure.

7. Remove the rubber dampeners



a - Rubber dampeners

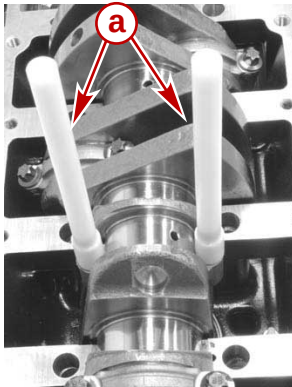
b - Perimeter crankcase cover bolt holes

8. Paint the rod cap bolts to identify them as used.

IMPORTANT: Rod cap bolts that have been torqued to specification, must not be used for reassembly.

9. Remove the rod cap bolts with a Torx #E-12. Remove the rod cap.

10. Install the rod guides to protect the crank pin and cylinder bore from damage.



a - Rod guide dowel

Rod Guide Dowel	Part number currently not available for this printing.
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11. Push the connecting rod assembly out of the cylinder bore.

12. Mark the connecting rod up side orientation with indelible magic marker or paint. **Do not use a scribe or punch for identification of the connecting rod orientation.**

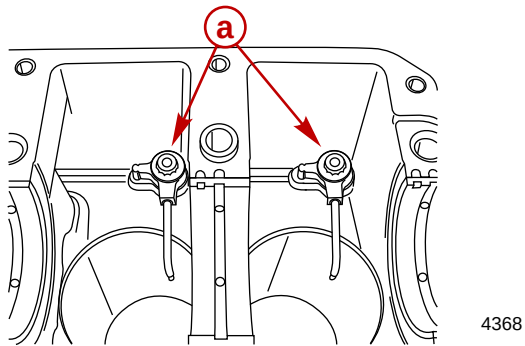
NOTE: The up side orientation of the connecting rod is the same orientation as the dot on the dome of the piston.

13. Re-install the rod cap to the connecting rod assembly. Ensure the rod cap fits perfect. Thread the rod cap screw into the connecting rod. Tighten the rod screws securely, but do not torque.

14. Remove the remaining connecting rod assemblies the same way.

15. Remove the crankshaft. Secure the crankshaft in a manner that will prevent damage.

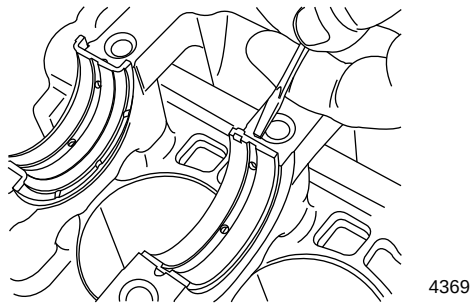
16. Remove the piston cooling jets.



a - Piston cooling jet

17. Remove the crankshaft main bearings from the cylinder block and crankcase cover.

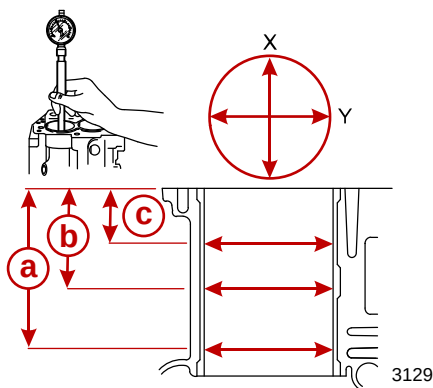
NOTE: A small screwdriver or awl will assist in removing the crankshaft main bearings.



Cleaning, Inspection, and Repair

Measuring Cylinder Bore

Measure the cylinder walls for taper, out of round or excessive ridge at the top of the ring travel. This should be done with a cylinder bore dial indicator or an inside micrometer. Carefully move the gauge up and down the cylinder bore to determine taper. Turn the gauge to different points around the cylinder wall to determine the out of round condition. The measurement for cylinder taper should be taken at three depth locations: 20 mm (0.8 in.), 60 mm (2.4 in.) and 100 mm (3.9 in.).



a - 100 mm (3.9 in.)

b - 60 mm (2.4 in.)

c - 20 mm (0.8 in.)

Cylinder Bore Specification	
Standard	82.0 mm (3.228 in.)

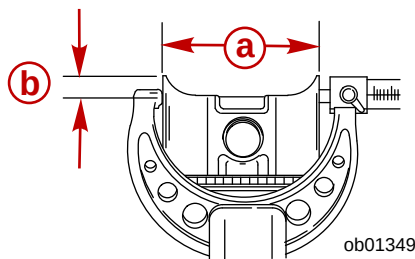
Cylinder Bore Specification	
Out of round (production)	0.015 mm (0.0006 in.)
Out of round (service)	0.0762 mm (0.003 in.)
Taper (production)	0.015 mm (0.0006 in.)
Taper (service)	0.0762 mm (0.003 in.)

Measuring Piston

Inspect piston wall for wear or damage. Replace piston if necessary.

PISTON DIAMETER

1. Measure the piston at a point 6 mm (0.236 in.) from the bottom, 90° to the piston pin. Replace piston if out of specification.



a - Piston diameter

b - Measure point 6 mm (0.236 in.)

Piston	
Diameter	81.975 mm (3.227 in.)

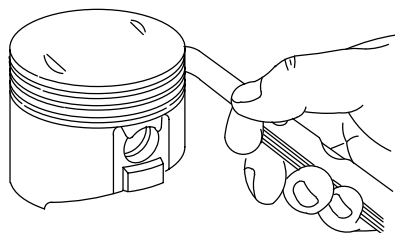
2. Measure piston to cylinder clearance. If out of specification examine piston and cylinder bore further to determine repair/replacement.

The minimum piston to cylinder wall clearance is defined by the formula: **Minimum cylinder bore measurement - Maximum piston diameter measurement = Piston to Cylinder Clearance.**

Piston To Cylinder Wall Clearance	
Minimum Clearance	0.06 mm (0.0024 in.)

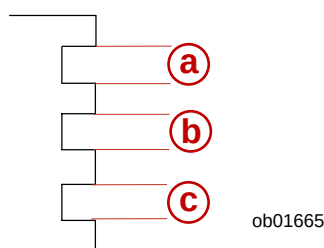
PISTON RING GROOVE

Measure piston ring groove. Replace the piston if out of specification.



a - Top ring groove

b - Middle ring groove

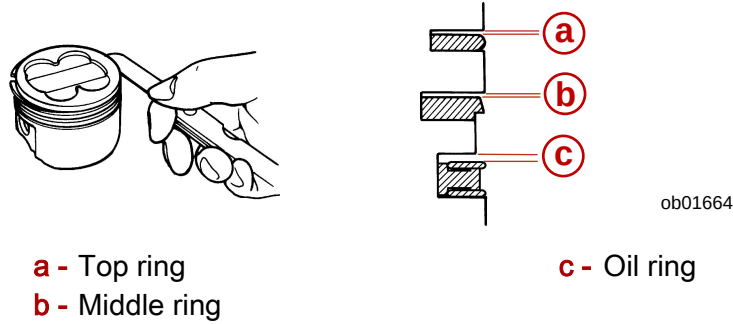


c - Oil ring groove

Piston Ring Groove	
Top "a"	1.25 mm (0.049 in.)
Middle "b"	1.25 mm (0.049 in.)
Oil "c"	2.05 mm (0.081 in.)

PISTON RING SIDE CLEARANCE

Measure piston ring side clearance. Replace piston rings as a set if out of specification.

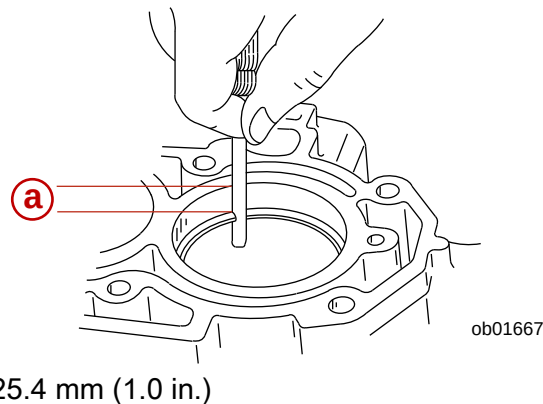


Piston Ring Side Clearance	
Top "a"	0.04 - 0.08 mm (0.0015 - 0.0033 in.)
Middle "b"	0.04 - 0.08 mm (0.0015 - 0.0033 in.)
Oil "c"	0.05 - 0.17 mm (0.002 - 0.0066 in.)

PISTON RING END GAP

Measure piston ring end gap clearance. Replace piston rings as a set if out of specification.

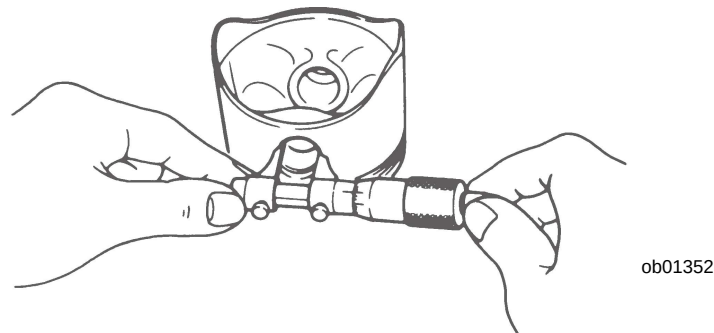
NOTE: Ring must be level for measurement. Push ring 25.4 mm (1.0 in.) into bore with crown of piston.



Piston Ring End Gap	
Top	0.27 ± 0.42 mm (0.0106 ± 0.0165 in.)
Middle	0.42 ± 0.62 mm (0.016 ± 0.024 in.)
Oil	0.20 ± 0.70 mm (0.007 ± 0.027 in.)

PISTON WRIST PIN DIAMETER

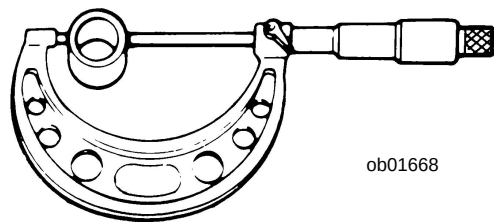
Measure the piston pin bore diameter. Replace the piston if out of specification.



Piston Pin	
Bore Diameter	22.004 - 22.011 mm (0.8662 - 0.8665 in.)

PISTON PIN

Measure the piston pin diameter. Replace the piston pin if out of specification.



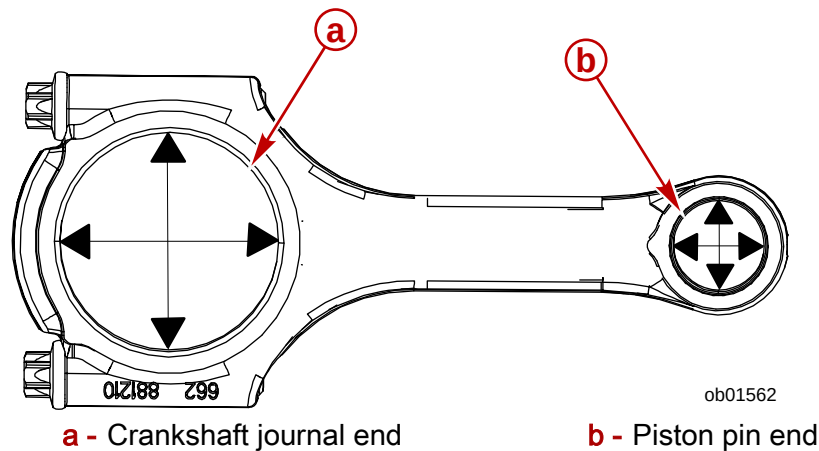
Piston Pin	
Diameter	21.997 - 22.0 mm (0.8660 - 0.8664 in.)

Measuring Connecting Rod

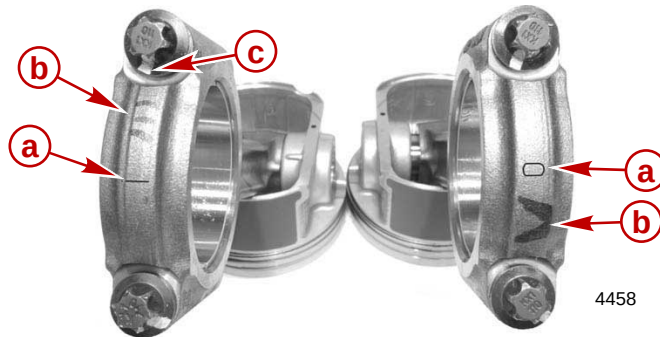
- 1. Ensure the rod cap fits perfect. Tighten the connecting rod cap bolts to the specified torque.

Description	Nm	lb. in.	lb. ft.
Rod cap bolts	10	88	

- 2. Measure the small (piston pin) and large (crank pin journal) ends of the connecting rod.



- Compare the connecting rod crank pin journal measurement with the crank pin journal grade specifications listed in the following chart. If the connecting rod crank pin journal measurement does not match the stamped connecting rod crank pin journal grade, replace the connecting rod.



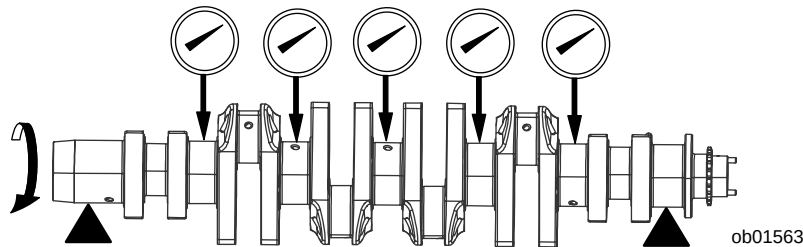
- a** - Stamped connecting rod crank pin journal grade **c** - Paint on rod cap screw
b - Magic marker cylinder location

Connecting Rod	
Piston Pin	22.005 - 22.014 mm (0.8662 - 0.8665 in.)
Crank Pin Journal Grade "I"	53.000 - 53.009 mm (2.0866 - 2.0869 in.)
Crank Pin Journal Grade "0"	53.009 - 53.018 mm (2.0869 - 2.0873 in.)

Measuring Crankshaft

CRANKSHAFT RUN-OUT

- Thoroughly clean crankshaft and inspect bearing surfaces. Replace crankshaft if bearing surfaces are pitted, scored or discolored.
- Measure run-out on all of the main bearing journals. Replace crankshaft if out of specification.
- Clean oil holes in crankshaft.

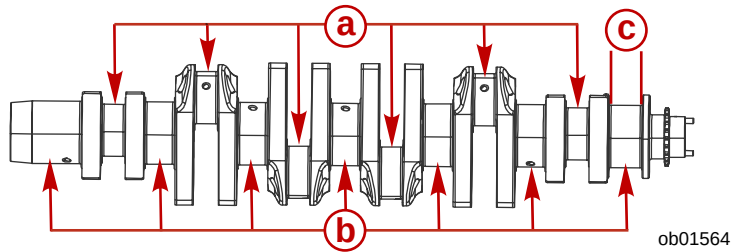


Crankshaft	
Run-out limit	0.05 mm (0.002 in.)

CRANKSHAFT MAIN BEARING AND CRANK PIN MEASUREMENT

- Measure crankshaft journal diameter and crank pin diameter. Replace if out of specification.

2. Measure the bottom main bearing width. Replace if out of specification.



a - Crank pin journals

b - Main bearing journals

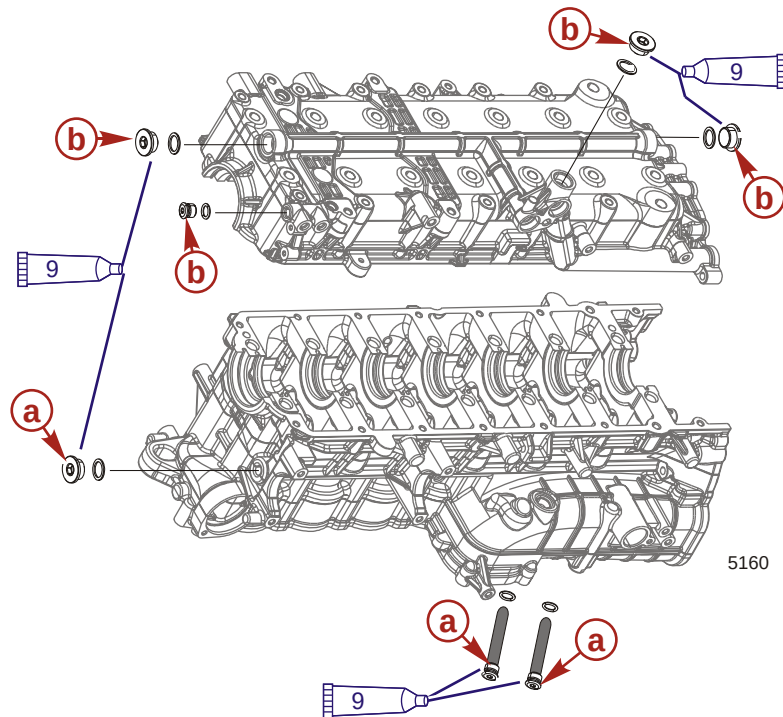
c - Bottom main bearing width

Crankshaft Journal Specifications		
Description	Dimension	Grade
Main Bearing Journal	59.993 - 60.001 mm (2.3619 - 2.3622 in.)	A
	59.985 - 59.993 mm (2.3616 - 2.3619 in.)	B
Crank Pin Journal	49.991 - 50.000 mm (1.9681 - 1.9685 in.)	C
	49.982 - 49.991 mm (1.9677 - 1.9681 in.)	D
Bottom Main Bearing Width	31.4 - 31.6 mm (1.236 - 1.244 in.)	

Powerhead Assembly

Installing Water And Oil Jacket Plugs

1. Install new O-rings onto the water and oil galley plugs.
2. Apply Loctite 567 Pipe Sealant on the threads of the water and oil galley plugs.
3. Install the water galley plugs. Tighten to the specified torque.
4. Install the oil galley plugs. Tighten to the specified torque.



a - Water galley plugs

b - Oil galley plugs

Description		Nm	lb. in.	lb. ft.
Water Galley Plugs	M24 x 2	50		36.8
	M12 x 1.5	9	80	
Oil Galley Plugs	M24 x 2	50		36.8
	M12 x 1.5	9	80	

Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Water and Oil galley plugs	92-809822

Powerhead Pre-Assembly Cleaning Recommendations

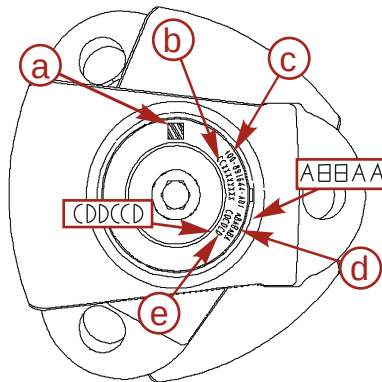
IMPORTANT: Any threaded hole or bolt with thread-locking compound that is contaminated with oil, must be thoroughly cleaned with a solvent to remove all traces of oil contamination. Failure to remove oil contamination will result in poor thread-locking compound adhesion.

Prior to assembling the powerhead, all threaded holes on the cylinder head and cylinder block must be cleared of thread-locking compound dust. Use compressed air to clear thread-locking compound dust.

Wash the cylinder block and crankcase cover with hot soapy water to remove debris and honing compound. Dry the cylinder block with compressed air. Failure to thoroughly clean the cylinder block of honing compound and/or debris will result in premature engine failure.

Selecting New Crankshaft Bearings

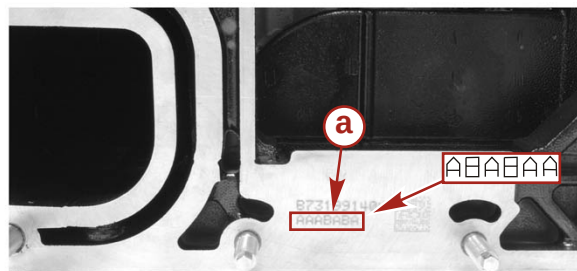
When replacing the crankshaft main bearings and crank pin bearings, select the suitable bearing from the bearing grade identifier located at the flywheel end of the crankshaft and on the bottom of the cylinder block.



5142

- a** - Bar code
- b** - Manufacture date
- c** - Part number

- d** - Main bearing journal grade
- e** - Crank pin journal grade



4423

- a** - Cylinder block main bearing journal grade

NOTE: When reading the main bearing journal grade on the crankshaft, the journal grade is in sequential order from J1 to J7 in a clockwise orientation.

NOTE: When reading the crank pin bearing journal grade on the crankshaft, the journal grade is in sequential order from P1 to P6 in a clockwise orientation.

NOTE: When reading the main bearing journal grade on the cylinder block, the journal grade is in sequential order from the top main bearing to the bottom thrust bearing.

Crankshaft Main Bearing Grade Selection

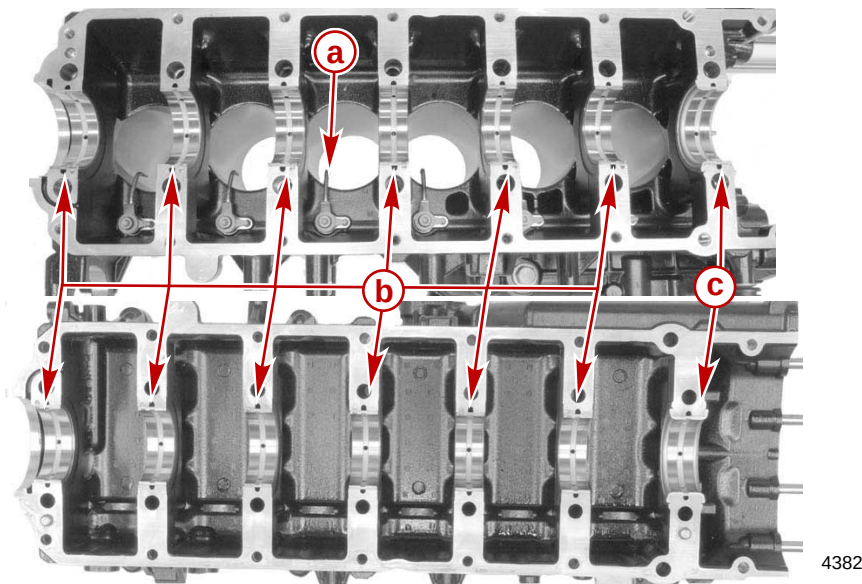
Crankshaft	
Main bearing oil clearance	0.014 - 0.042 mm (0.0005 - 0.0016 in.)

IMPORTANT: Ensure all mating surfaces, oil passages, water jackets and cylinder bores are clean prior to assembling the powerhead. Always install new gaskets, seals, O-rings, piston ring and wrist pin retaining clips. Replace torque to yield screws where advised to do so. Follow all advised lubrication during assembly.

1. Check the crankshaft journal size code and the cylinder block main bearing code.
2. Refer to the bearing selection chart to select the correct crankshaft main bearings.

IMPORTANT: After selecting the correct bearing, install the bearing halves in the cylinder block and crankcase cover matching journal location to avoid mixing bearing sizes.

Crankshaft Journal Code	Cylinder Block Code	Bearing Color Selection
A	A	Green
A	B	Blue
A	C	White
B	A	Blue
B	B	White
B	C	Orange

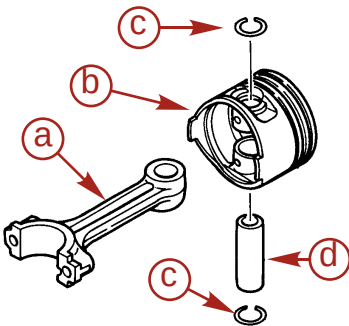


- a** - Piston cooling jet **c** - Main thrust bearing
b - Main bearings

3. Ensure debris is removed from the cylinder block and crankcase cover main bearing area, and install the selected main bearings.

Piston/Connecting Rod Assembly

- 1. Lubricate the piston pin with SPO 255.
 - 2. Assemble the piston, connecting rod, piston pin and new piston pin retaining clips.
- IMPORTANT:** Always install new piston pin retaining clips.



6366

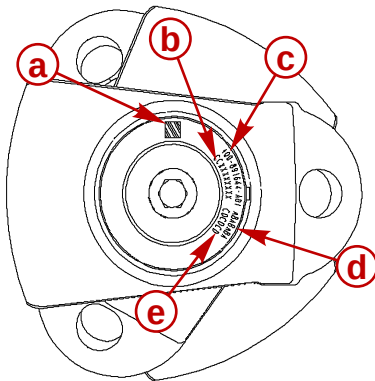
- a** - Paint on connecting rod
- b** - Piston
- c** - Piston pin retaining clip
- d** - Piston pin

Tube Ref No.	Description	Where Used	Part No.
 136	Lubriplate SPO 255	Piston pin	Obtain Locally

Connecting Rod Bearing Grade Selection

Connecting Rod	
Bearing oil clearance	0.020 - 0.050 mm (0.0008 - 0.0019 in.)

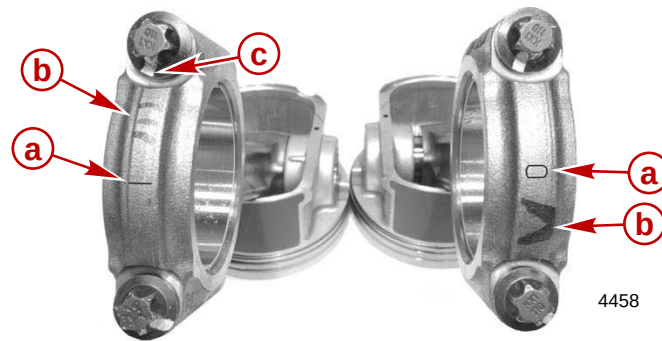
- 1. Check the crank pin journal size code on the flywheel end of the crankshaft



ob01568

- a** - Bar code
- b** - Manufacture date
- c** - Part number
- d** - Main bearing journal grade
- e** - Crank pin journal grade

- Check the journal code on the connecting rod cap.



- a** - Stamped connecting rod crank pin journal grade **c** - Paint on rod cap screw
b - Magic marker cylinder location

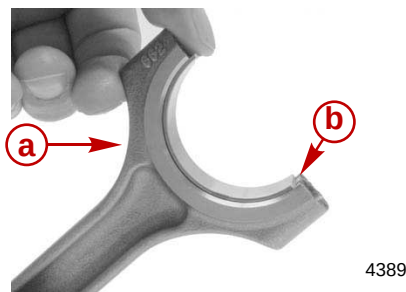
Connecting Rod Specifications	
Piston Pin	22.005 - 22.014 mm (0.8662 - 0.8665 in.)
Crank Pin Journal Grade "I"	53.000 - 53.009 mm (2.0866 - 2.0869 in.)
Crank Pin Journal Grade "0"	53.009 - 53.018 mm (2.0869 - 2.0873 in.)

- Refer to the bearing selection chart following, to select the correct crankshaft connecting rod bearings.

IMPORTANT: After selecting the correct bearing, install the bearing halves in the connecting rod and the matching connecting rod cap to avoid mixing bearing sizes.

Connecting Rod Journal Code	Crankshaft Pin Journal Code	Bearing Color Selection
I	C	Blue
I	D	White
0	C	White
0	D	Orange

- Ensure the connecting rod bearing area is free of debris.
- Install the locating tab of the upper half of the bearing into the slot on the connecting rod, and the locating tab of the lower half of the bearing into the slot on the connecting rod cap. Carefully push the bearing onto the connecting rod and connecting rod cap.



- a** - Connecting rod **b** - Connecting rod locating tab

Piston Ring Installation

IMPORTANT: Do not re-use the original rings during reassembly. Always install new rings when rebuilding engine.

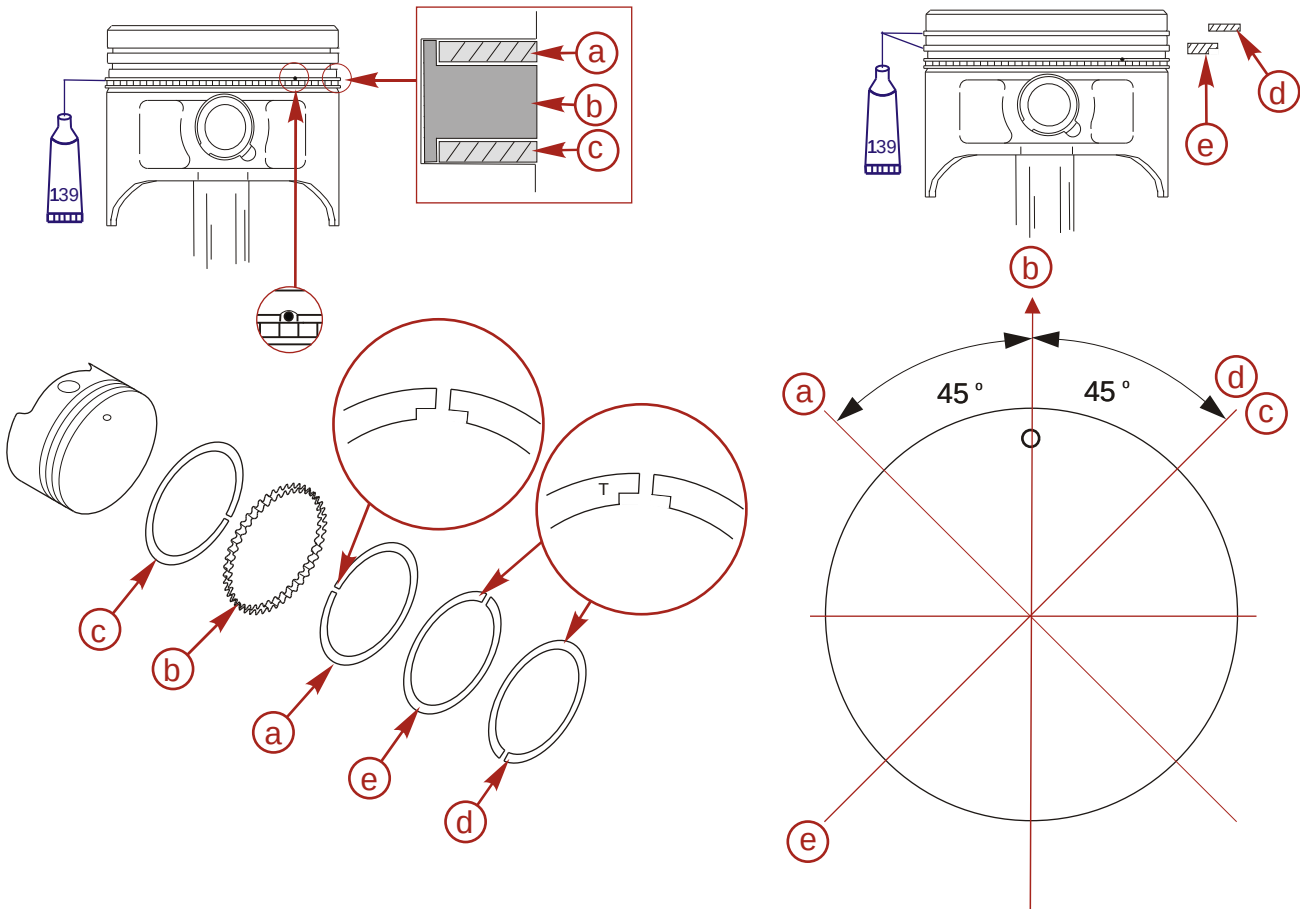
IMPORTANT: Use caution when installing piston rings to avoid scratching piston.

- 1. Apply Synthetic Blend 4-Stroke Outboard Oil 25W-40 engine oil to the piston ring grooves.
- 2. Install the oil ring spacer onto the lower ring groove of the piston.

NOTE: Ensure the oil ring spacer gap is properly orientated on the piston. The oil ring spacer cannot be rotated after the bottom and top oil control rings are installed.

- 3. Install the bottom oil control ring.
- 4. Install the top oil control ring. The top oil ring uses a locating pin on the piston.
- 5. Install the second compression ring.
- 6. Install the top compression ring.
- 7. Position the piston ring gaps as shown.

NOTE: The second and top piston compression rings must be installed with the "T" side up. Spread rings just enough to slip over piston.



ob01565

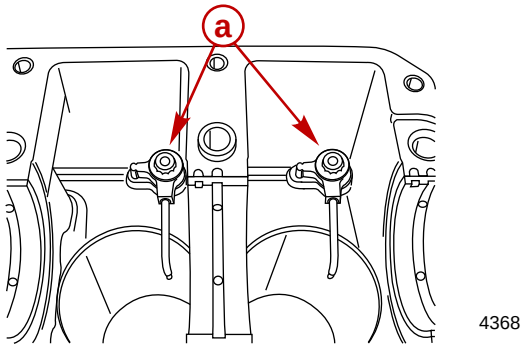
- a - Top oil control ring
- b - Oil ring spacer
- c - Bottom oil control ring
- d - Top compression ring
- e - Second compression ring

- f - Bottom compression ring gap
- g - Oil ring spacer
- h - Top oil control ring gap
- i - Top compression ring gap
- j - Second compression ring gap

Tube Ref No.	Description	Where Used	Part No.
 139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Piston rings	92-883722K01

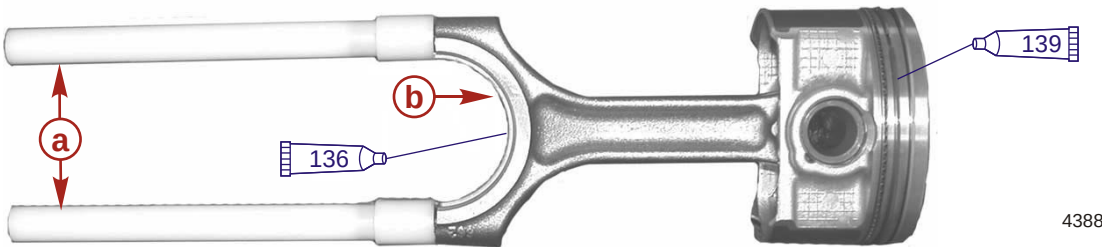
Piston Assembly Installation

- 1. Install the piston cooling jets. Tighten to the specified torque.



Description	Nm	lb. in.	lb. ft.
Piston Cooling Jet	23.6		17.3

- 2. Install the piston rod guide dowels onto the connecting rod assembly. Lubricate the piston, rings with Synthetic Blend 4-Stroke Outboard Oil 25W-40.
- 3. Lubricate the connecting rod bearing with SPO255.
- 4. Lubricate the cylinder bore with Synthetic Blend 4-Stroke Outboard Oil 25W-40.

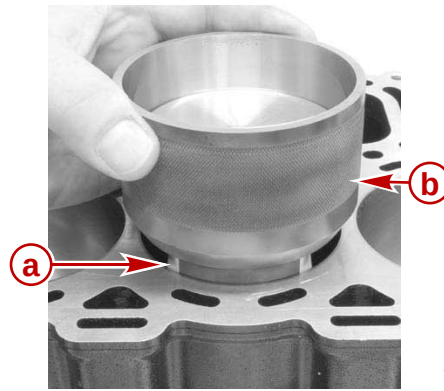


a - Piston rod guide dowel b - Connecting rod bearing

Rod Guide Dowel	Part number currently not available for this printing.		
Tube Ref No.	Description	Where Used	Part No.
	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Piston rings, cylinder bore	92-883722K01
	Lubriplate SPO 255	Connecting rod bearing	Obtain Locally

- 5. Slide piston ring compressor over piston so about 50% of piston is showing below the ring compressor.
- 6. Insert the piston assembly into the cylinder bore. Ensure the dot on the piston is pointing towards the flywheel end of the crankshaft.
- 7. Ensure the ring compressor is fully seated on the cylinder block.

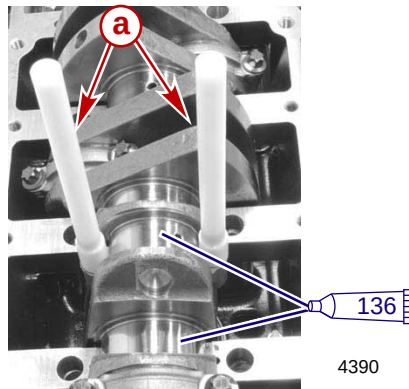
8. Ensure the rod guide straddles the crank pin.



a - Piston skirt

b - Ring compressor

9. Push the piston assembly into the cylinder bore and onto the crank pin.
 10. Remove the rod guides.
 11. Lubricate the crank pin with SPO 255.



a - Rod guide

Tube Ref No.	Description	Where Used	Part No.
 136	Lubriplate SPO 255	Crank pin	Obtain Locally

12. Install the rod cap/bearing assembly.
 13. Ensure the rod cap orientation is correct. The rod cap must fit perfect.
 14. Lubricate the new rod cap screw threads and head with Synthetic Blend 4-Stroke Outboard Oil 25W-40.
 15. Install new rod cap screws.
 16. Torque the rod cap screws to 15 Nm (133 lb. in.). Then torque to 30 Nm (22 lb. ft.).
NOTE: After the second torque, paint a line on the rod cap screw parallel with crankshaft. This will help distinguish when the rod cap screw has turned the additional 90°.
 17. Turn the rod cap screw an additional 90° after the second torque

Description		Nm	lb. in.	lb. ft.
Connecting rod screw	First	15	133	
	Second	30		22
	Final	Turn additional 90°		

18. Install the remaining connecting rod assemblies in the same sequence.

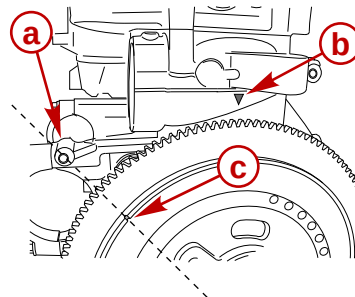
Cylinder Head Installation

⚠ CAUTION

This engine is an interference valve train design. Do not rotate the crankshaft or cams when the timing chain is loose or removed from the cam gears unless advised to do so. Failure to adhere to this caution may result in valve and or piston damage.

IMPORTANT: The installation of the cylinder head must be strictly followed. Failure to follow the installation outline procedure may damage the valve train components.

1. Install the flywheel key on the crankshaft and install the flywheel.
2. Install the flywheel retaining bolt and washer. Tighten the flywheel bolt until it is snug.
3. Rotate the engine so the flywheel timing mark aligns with the rear starter mount. This will allow sufficient piston to valve clearance to rotate the cams.



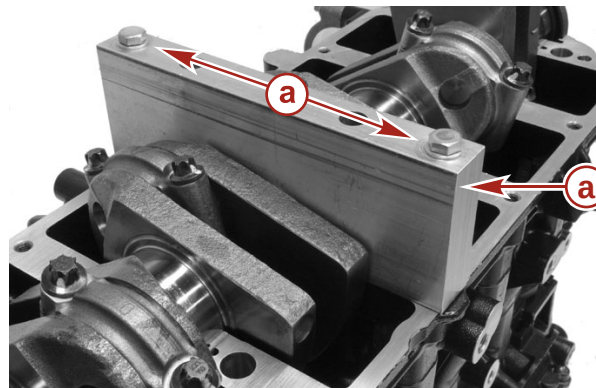
4035

a - Rear starter mount

c - Flywheel timing mark

b - Cylinder block timing mark

4. Install the crankshaft retainer on one of the center main bearings. Tighten the crankshaft retainer bolts securely.



5755

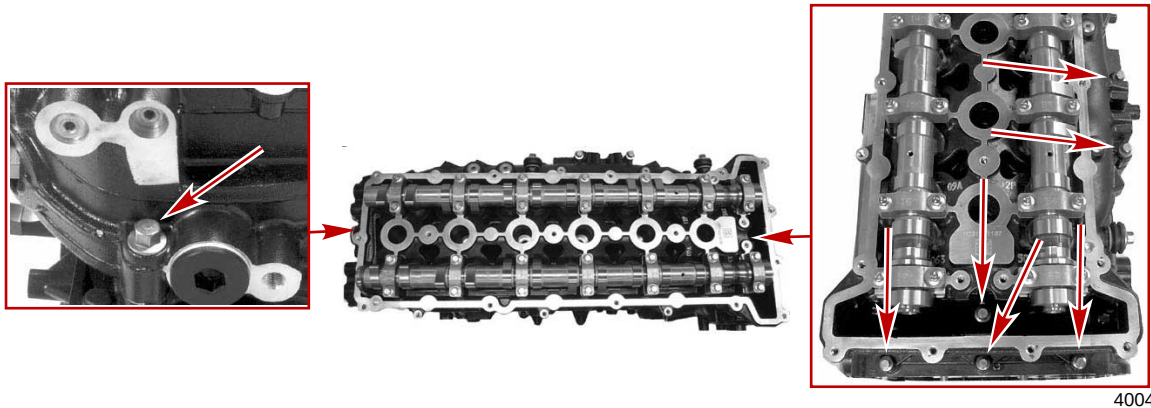
a - Crankshaft retainer bolts

b - Crankshaft retainer

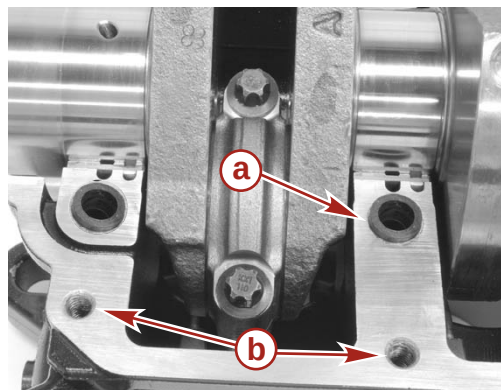
Crankshaft Retainer	Part number currently not available for this printing.
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5. Rotate the cylinder block to install the head.
6. Place a new head gasket on the cylinder block.
7. Install the cylinder head to the cylinder block.

8. Install the cylinder head perimeter screws so they are snug. Do not tighten the cylinder head perimeter bolts.



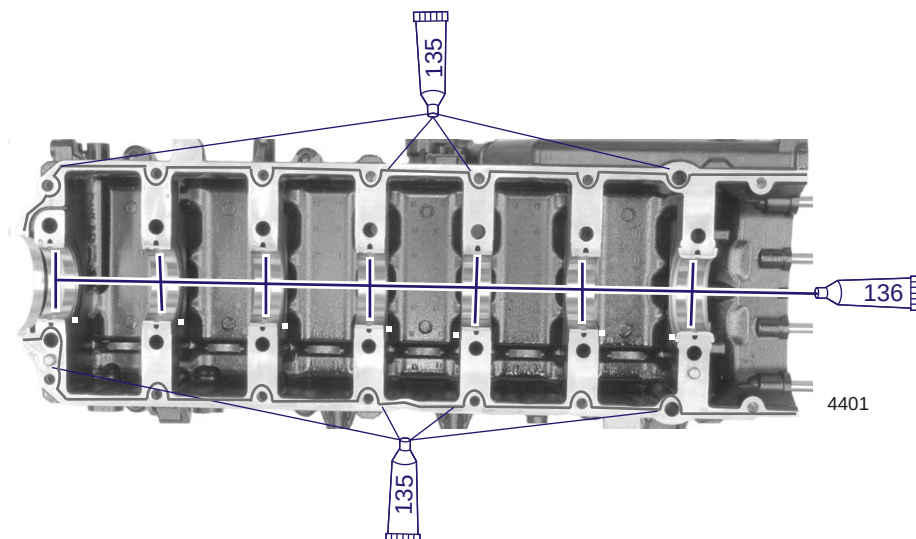
9. Rotate the cylinder block and remove the crankshaft retainer.
 10. Install the rubber dampeners into the cylinder block. Ensure the dampeners are seated completely in the cylinder block.



a - Rubber dampener seated

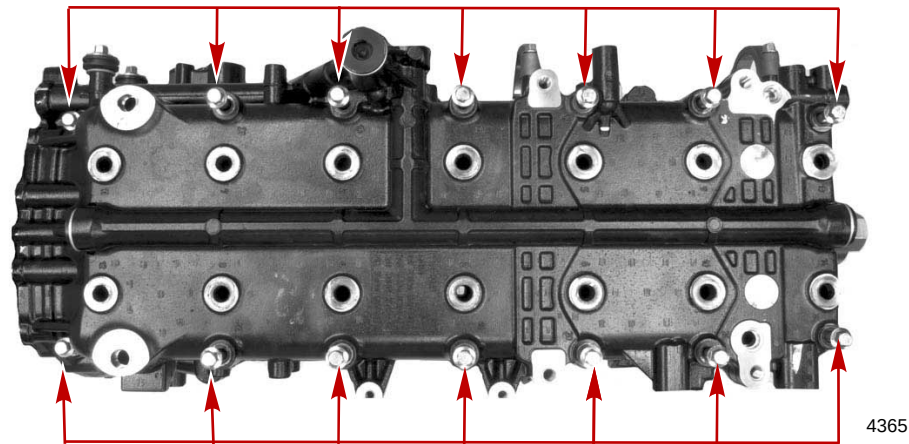
b - Crankcase cover perimeter bolt holes

11. Apply a 1 mm (0.040 in.) by 1 mm (0.040 in.) thin continuous bead of Three Bond 1217F around the cylinder block cover perimeter. Do not allow Three Bond 1217F to contact the main bearings.
 12. Lubricate the crankshaft main bearings with SPO 255.

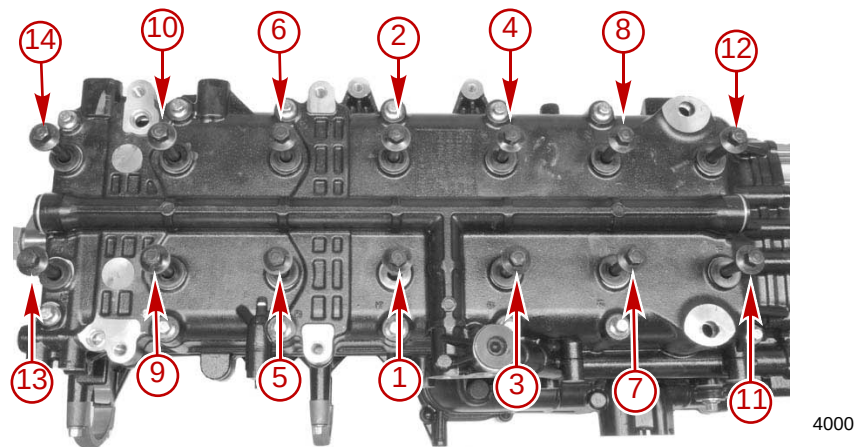


Tube Ref No.	Description	Where Used	Part No.
 135	Three Bond 1217F	Cylinder block cover	Obtain Locally
 136	Lubriplate SPO 255	Main bearing	Obtain Locally

13. Carefully place the cylinder block cover onto the cylinder block.
14. Install the perimeter bolts but do not tighten.



15. Lubricate the threads of the main bearing long bolts with molybdenum disulfide grease.
16. Insert the main bearing long bolts into the cylinder block cover. Thread the main bearing long bolts into the rubber dampeners and into the cylinder head.
- NOTE:** Do not force the main bearing long bolts past the cylinder block rubber dampeners. Forcing the main bearing long bolts past the cylinder block rubber dampeners may damage or fold the cylinder block rubber dampeners.
17. In the chronological order listed on the cylinder block cover, tighten the long main bolts in three steps.
18. After the second torque is attained, mark all of the long main bolt heads with a line of paint, parallel to the crankshaft. This will help ensure the 270° turn is correctly attained.



Description		Nm	lb. in.	lb. ft.
Long Main Bolt	First	27		19.9
	Second	55		40.6
	Final	Turn additional 270° after 2nd torque is attained		

19. Tighten the cylinder block perimeter bolts in the order listed on the cylinder block to the specified torque

20. Tighten the cylinder head perimeter bolts to the specified torque.

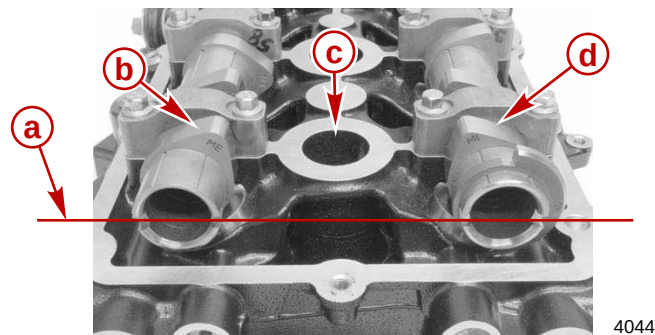
Description		Nm	lb. in.	lb. ft.
Cylinder Block Perimeter Bolts		35		25.8

Description		Nm	lb. in.	lb. ft.
Cylinder Head Perimeter Bolts	(M8 x 60)	28		20.6
	(M6 X 40)	11	97	

21. Check the valve lash clearance on all the valves. If the valve lash is not within specification, refer to **Section 4A - Valve Clearance and Adjustments**. If the valve lash is within specification, proceed with the next step.

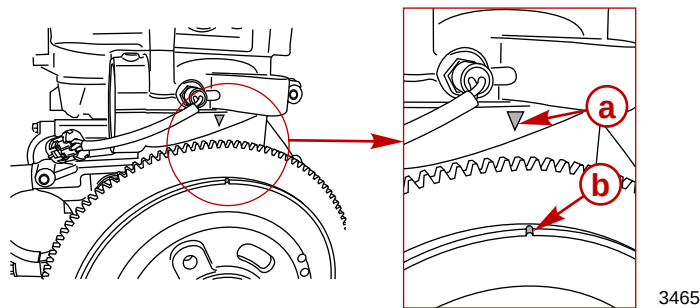
22. Rotate the cams so the cam lobes for cylinder number one, intake and exhaust, point towards the spark plug coil.

NOTE: The cams will be in correct alignment when the machined groove on the top of the cam are aligned.



- a** - Machined groove on top of cams **c** - #1 spark plug hole
b - Exhaust cam lobe position **d** - Intake cam lobe position

23. Rotate the flywheel clockwise so the flywheel timing mark aligns with the arrow on the cylinder block.



- a** - Timing mark on cylinder block **b** - Timing mark on flywheel

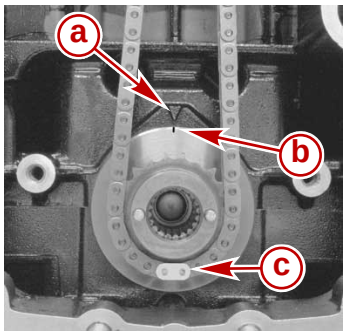
Timing Chain

⚠ CAUTION

This engine is an interference valve train design. Do not rotate the crankshaft or cams when the timing chain is loose or removed from the cam gears unless advised to do so. Failure to adhere to this caution may result in valve and or piston damage.

IMPORTANT: The removal, disassembly, reassembly, and installation procedure of the head and cams must be strictly followed. Failure to follow the removal outline procedure may damage the valve train components.

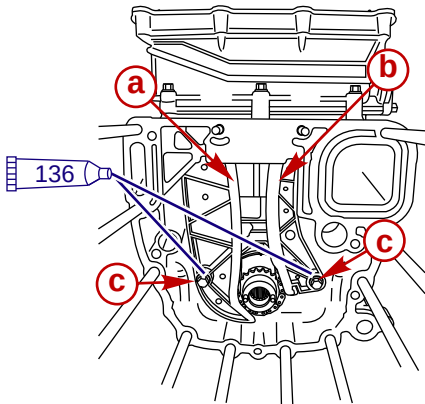
- 1. Ensure the crankshaft timing mark is in alignment with the cylinder block timing mark.
- 2. Install the timing chain with the anodized link directly below the timing marks on the cylinder block and the crankshaft.



4047

- a - Cylinder block timing mark
- b - Crankshaft timing mark
- c - Timing chain anodized link

- 3. Install the fixed chain guide and the movable chain guide to the cylinder block.
- 4. Lubricate the chain guide bolts with SPO 255.
- 5. Tighten the chain guide bolts to the specified torque.



4049

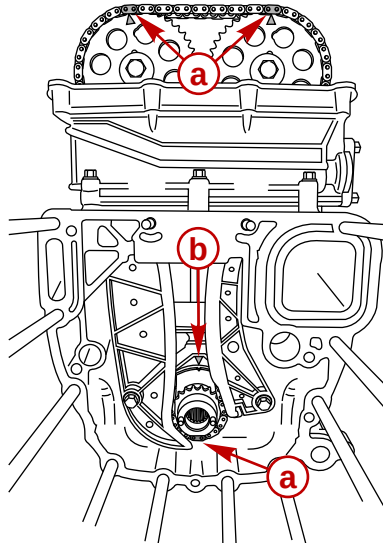
- a - Fixed chain guide
- b - Movable chain guide
- c - Chain guide retaining bolts

Tube Ref No.	Description	Where Used	Part No.
	Lubriplate SPO 255	Chain guide bolts	Obtain Locally

Description	Nm	lb. in.	lb. ft.
Fixed And Movable Chain Guide Bolt	24	212	

- 6. Install the cam gear on the intake cam. Retain the cam gear with the cam gear screw and washer. **Do not tighten the cam gear screw.**
NOTE: Cam gear screws are left hand thread.
- 7. Install the timing chain on the intake cam gear. The anodized link of the timing chain must align with the timing mark on the cam gear. Rotating the crankshaft a few degrees may ease the installation of the timing chain/cam gear onto the cam. Secure with the cam gear retaining screw and washer. **Do not tighten the cam gear screw.**

8. Place the exhaust cam timing gear in the chain, ensuring the timing mark on the cam gear and the anodized timing chain link are aligned. Install the cam gear with the timing chain onto the exhaust cam. Secure with the cam gear retaining screw and washer. **Do not tighten the cam gear screw.**
9. Inspect the timing chain installation for correct alignment of the timing chain anodized links. Ensure the crankshaft timing mark and the cylinder block timing marks are in alignment.



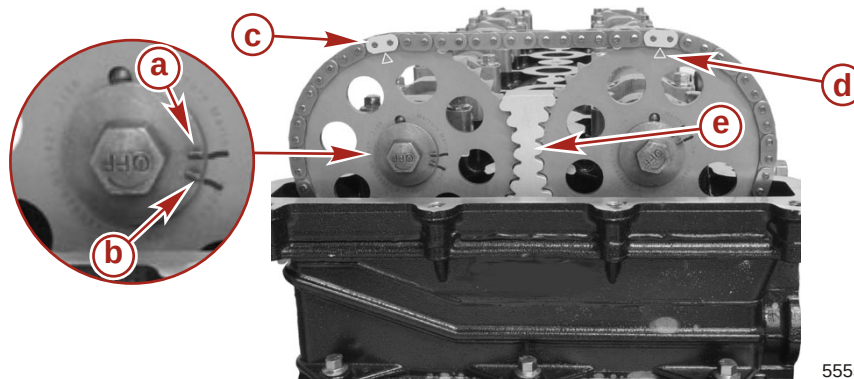
4054

a - Timing chain anodized links**b** - Cylinder block timing mark

10. Install the cam brake.

NOTE: Cams must be locked with a special tool to prevent loading of the cam gears and chain. Loading the cam gear and chain may damage the cam gear and chain.

11. The cam gear screws should be tightened in two steps. Tighten the cam gear screw to 45 Nm (33 lb. ft.).
12. Paint an orientation line on the cam gear, in-line with the mark on the cam gear washer. Turn the cam gear screw so the second mark on the cam gear washer aligns with the paint orientation line. This is the additional 20° turn after the first torque is attained.



5555

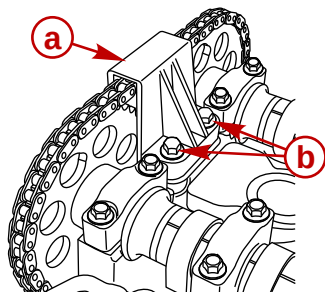
a - First torque**b** - Second torque**c** - Anodized link**d** - Cam gear timing mark**e** - Cam break

NOTE: Cam gear screws are left hand thread.

Description		Nm	lb. in.	lb. ft.
Cam Gear Screw (M12 x 40) LEFT HAND	First	45		33
	Final	Turn additional 20° after first torque is attained		
Cam Break	Part number currently not available for this publication.			

13. Remove the cam gear break.

14. Install the short span chain guide. Tighten the short span chain guide bolts to the specified torque.



a - Short span chain guide

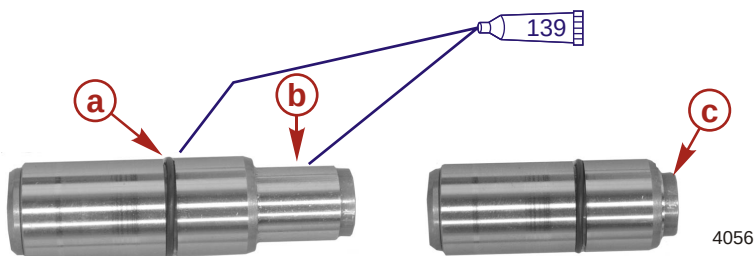
b - Short span chain guide bolts

Description	Nm	lb. in.	lb. ft.
Short Span Chain Guide Bolt (M6 x 30)	12	106	

15. Replace a new O-ring on the timing chain tensioner assembly.

16. Compress the timing chain tensioner assembly and release the tensioner slowly. The tensioner should remain compressed.

17. Lubricate the timing chain tensioner with Synthetic Blend 4-Stroke Outboard Oil 25W-40.



a - O-ring

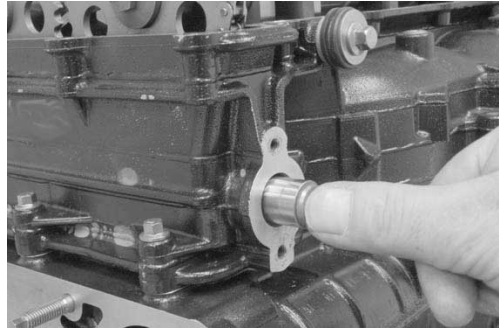
b - Tensioner extended

c - Tensioner compressed

Tube Ref No.	Description	Where Used	Part No.
	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Timing chain tensioner	92-883722K01

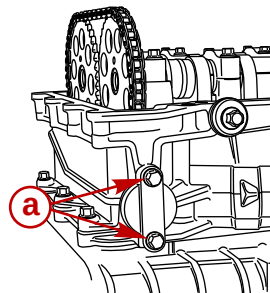
18. Carefully push the timing chain tensioner assembly into the cylinder head.

NOTE: The timing chain tensioner O-ring will retain the timing chain tensioner in the cylinder head.



4057

19. Install a new O-ring onto the timing chain tensioner cover.
20. Tighten the chain tensioner cover screws to the specified torque.

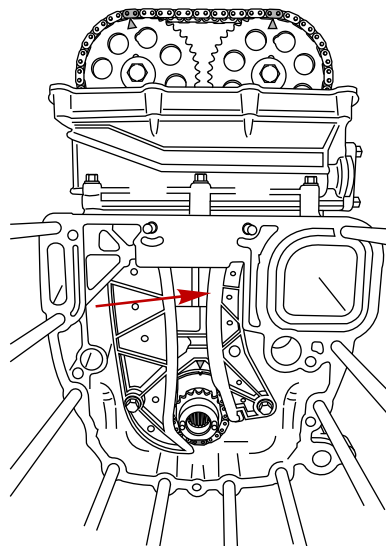


3471

a - Chain tensioner cover screw

Description	Nm	lb. in.	lb. ft.
Chain Tensioner Cover Screw (M6 x 25)	11	97	

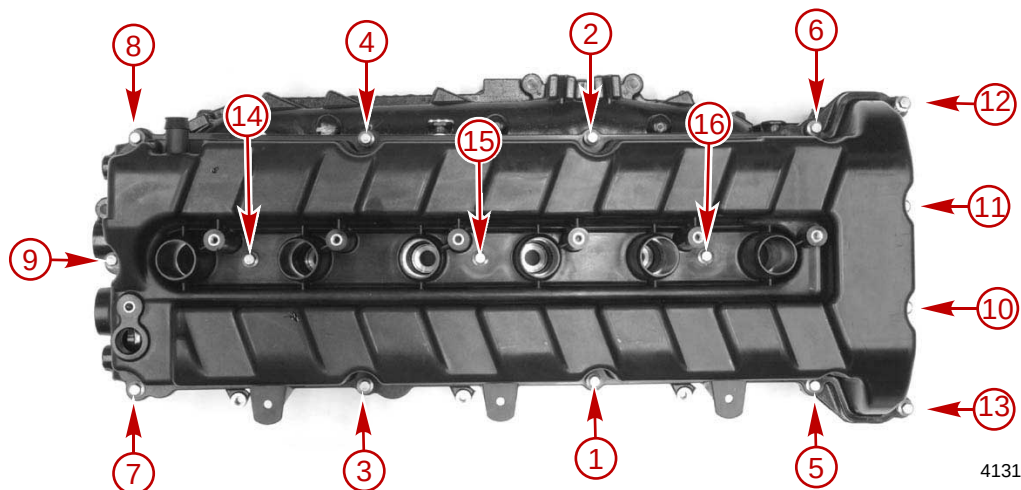
21. Push on the movable chain guide towards the timing chain tensioner. The timing chain tensioner should expand and maintain proper timing chain tension.



4133

22. Install a new gasket on the valve cover.
23. Install the valve cover.
24. Install all of the valve cover screws.
25. Tighten the valve cover screws to the specified torque, in the sequence shown.

26. After final valve cover screw has been torqued, check the center valve cover screws for proper torque.



4131

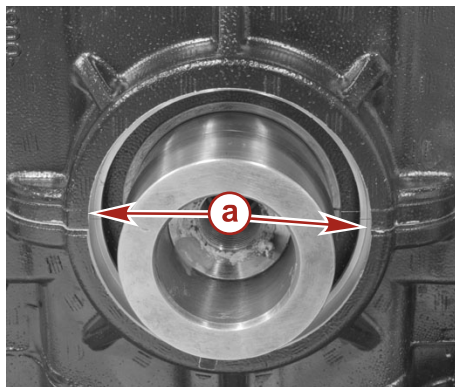
Description	Nm	lb. in.	lb. ft.
Valve Cover Screw (M6 x 25)	8	71	

Installing Upper Crankshaft Seal

⚠ CAUTION

Ensure the cylinder block upper crankshaft seal area is totally free of oil contamination. Failure to ensure the cylinder block upper crankshaft seal area is completely void of oil contamination, may result in the oil seal blowing off during engine operation.

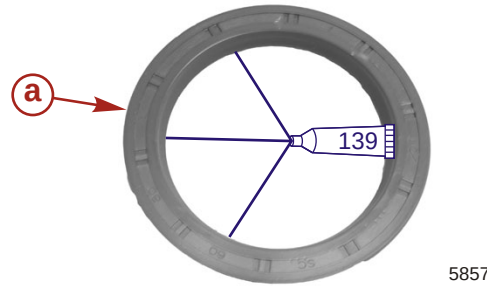
1. Thoroughly clean the inside diameter of the cylinder block crankcase seal area.



5856

a - Area to be clean of oil contamination

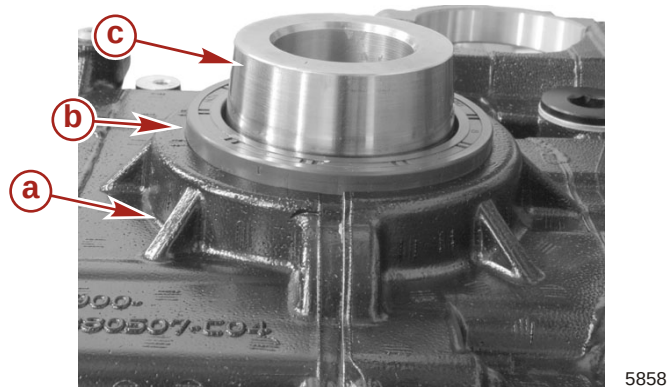
2. Lightly lubricate the crankshaft seal inside diameter with Synthetic Blend 4-Stroke Outboard Oil 25W-40.



a - Keep outer seal diameter free of oil contamination

Tube Ref No.	Description	Where Used	Part No.
	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Crankshaft seal inside diameter	92-883722K01

3. Install the crankshaft seal with the cup of the seal facing towards the cylinder block.



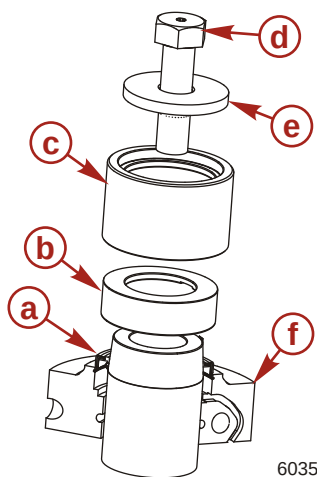
a - Cylinder block

c - Crankshaft

b - Outer crankshaft seal void of oil contamination

4. Place the seal installer guide ring on the crankshaft. If the flywheel key is installed on the crankshaft, ensure the seal installer guide ring flywheel key groove aligns with the flywheel key.
5. Place the seal installer sleeve over the seal installer guide.
6. Place the flywheel washer on the seal installer sleeve.

7. Thread the flywheel bolt into the crankshaft.



a - Crankshaft seal

b - Seal installer guide ring

c - Seal installer sleeve

d - Flywheel bolt

e - Flywheel washer

f - Cylinder block

8. Tighten the flywheel bolt to the specified torque.

Description	Nm	lb. in.	lb. ft.
Flywheel bolt torque for seal installation	Torque level currently not available for this printing		

Seal Installation Tool	Part number currently not available for this printing.
------------------------	--

9. Remove the flywheel bolt, flywheel washer and crankshaft tool.

10. Install the flywheel key, flywheel, flywheel washer and flywheel bolt.

11. Tighten the flywheel bolt to the specified torque.

Description		Nm	lb. in.	lb. ft.
Flywheel bolt	First	60		44
	Final	120		88.5

Installing Powerhead Components

Ignition Coil

1. Install spark plugs. Tighten to the specified torque.

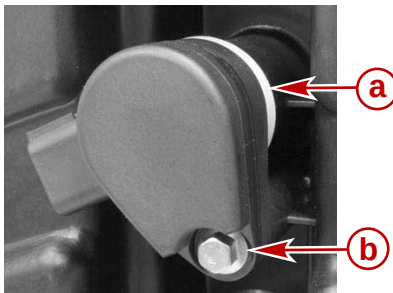
Description	Nm	lb. in.	lb. ft.
Spark Plug	27		20

2. Install the ignition coil onto the spark plug.

3. Ensure the ignition coil seal is not distorted.

4. Align the ignition coil mounting hole.

5. Install the ignition coil bolt and tighten to the specified torque.



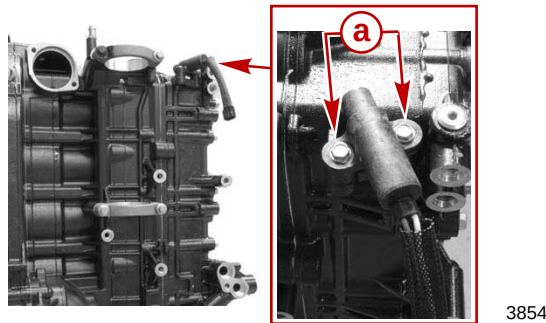
a - Ignition coil seal

b - Ignition coil bolt

Description	Nm	lb. in.	lb. ft.
Ignition Coil Bolt	8	71	

Crank Position Sensor Installation

1. Position sensor on engine and secure sensor with two screws. Torque screws to specification.
2. Connect engine harness to the sensor.



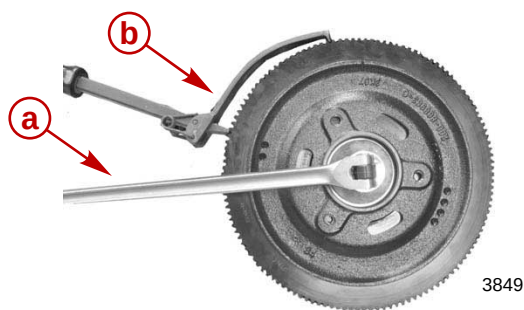
a - Crank position sensor mounting screw

Description	Nm	lb. in.	lb. ft.
Screw (M5 x 16)	5	45	

Flywheel Installation

1. Ensure the contact surface of the flywheel and the crankshaft are void of debris and oil.
2. Insert the flywheel key onto the crankshaft.
3. Align the flywheel and flywheel key. Install flywheel
4. Ensure the flywheel is completely seated on the taper of the crankshaft.
5. Install the washer and flywheel bolt.

6. Use flywheel holding tool and torque the flywheel bolt in 2 steps.

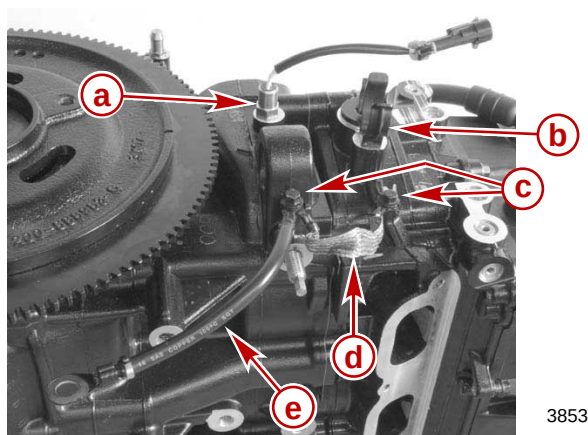


a - Torque wrench

b - Flywheel holding tool

Flywheel Holder		91-52344		
Description		Nm	lb. in.	lb. ft.
Flywheel bolt	First	60		44
	Final	120		88.5

7. Install a new O-ring onto the cylinder block temperature sensor.
8. Install the cylinder block temperature sensor. Tighten to the specified torque.
9. Install the IOM hose support.
10. Install the alternator ground wire and the braided ground wire from the cylinder block to the cylinder head. Tighten the ground wire bolts to the specified torque.



a - Cylinder block temperature sensor

d - Braided ground wire

b - IOM hose support

e - Alternator ground wire

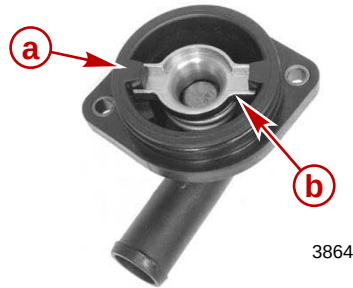
c - Ground wire bolt (M6 x 16)

Description	Nm	lb. in.	lb. ft.
Cylinder Block Temperature Sensor	15	133	
Ground Wire Bolt (M6 x 16)	8	71	

Thermostat

1. To remove the thermostat, push down on the thermostat retainer to disengage the thermostat retainer.

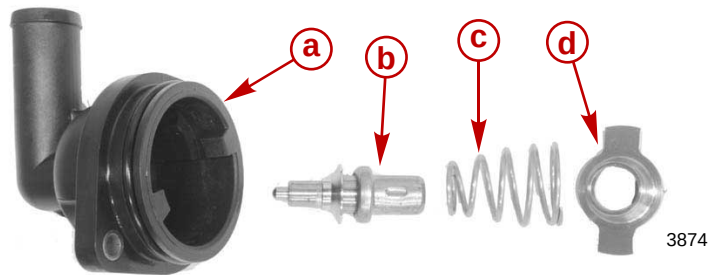
2. Turn the thermostat retainer to unlock.



a - Thermostat retainer lock

b - Thermostat retainer

INSTALLING THERMOSTAT



a - Thermostat housing

b - Thermostat

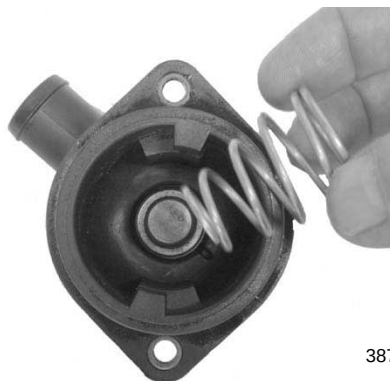
c - Thermostat spring

d - Thermostat retainer

1. Align the thermostat with the thermostat housing.

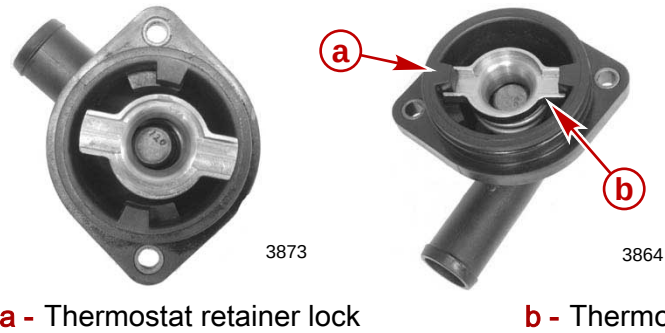


2. Install the thermostat spring. The small end of the spring is inserted first.



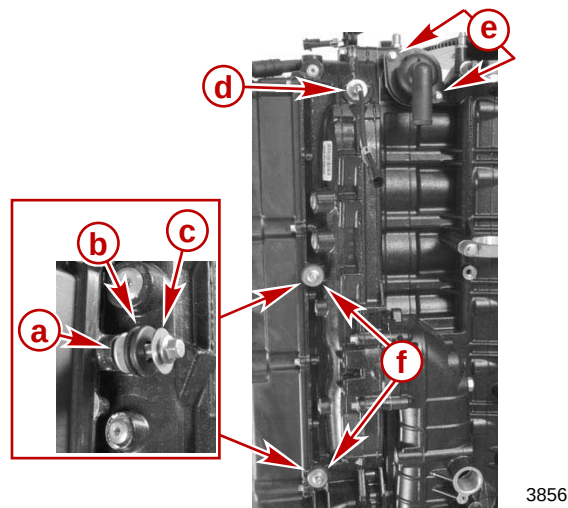
3. Install the thermostat retainer onto the thermostat spring.

4. Push down on the thermostat retainer, turn the retainer and lock into the thermostat housing.



Electrical Box

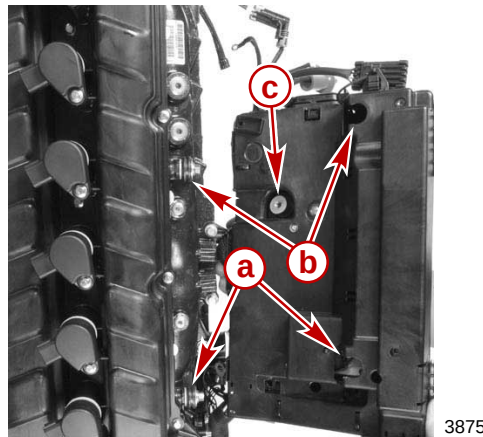
1. Install a new O-ring on the cylinder head temperature sensor.
2. Install the cylinder head temperature sensor. Tighten to the specified torque.
3. Install a new thermostat in the thermostat housing. Refer to **Section 4B-Thermostat**.
4. Install a new O-ring on the thermostat housing.
5. Install the thermostat housing. Tighten the thermostat housing bolts to the specified torque.
6. Install the 2 electrical box mounting bolts to the cylinder block. Tighten to the specified torque.



Description	Nm	lb. in.	lb. ft.
Cylinder head temperature sensor	15	133	
Thermostat housing bolt (M6 x 25)	8	71	
Electrical box mounting bolts (M8 x 35)	24		17.7

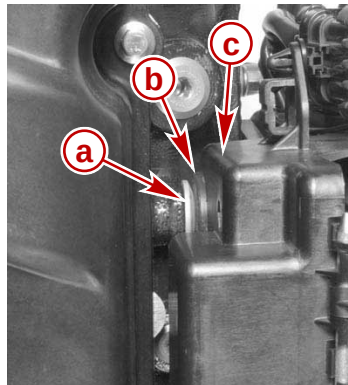
7. Align the electrical box mounting location with the electrical box mounting bolts.

8. Slide the electrical box onto the 2 mounting bolts.



- a** - Electrical box lower mount location **c** - Bushing
b - Electrical box upper mount location

9. Check the electrical box grommet before proceeding.

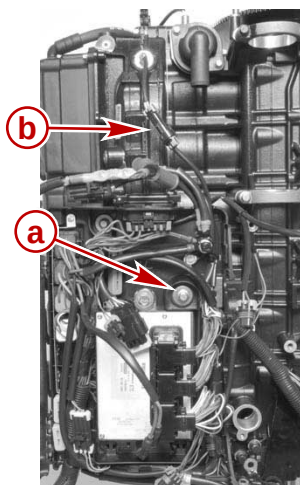


- a** - Bushing (upper shown) **c** - Electrical box
b - Half of the grommet

10. Align the electrical box mounting hole with the threaded hole on the cylinder block.
11. Secure the electrical box with a electrical box retaining bolt and washer. Tighten to the specified torque.

IMPORTANT: Do not strip the thread in the cylinder block when installing the electrical box retaining bolt and washer.

12. Connect the cylinder head temperature sensor to the engine harness.



3833

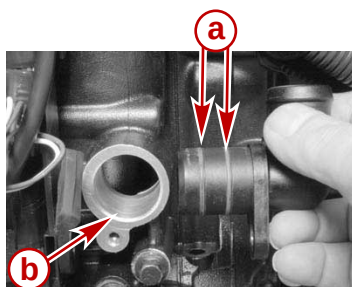
a - Electrical box retaining bolt and washer

b - Cylinder head temperature sensor

Description	Nm	lb. in.	lb. ft.
Electrical box mounting bolt (M8 x 35)	24		17.7

Engine Harness Bracket

1. Install a new O-rings onto the cylinder block elbow.
2. Ensure the hole for the cylinder block elbow does not have any old O-ring sealant remaining.



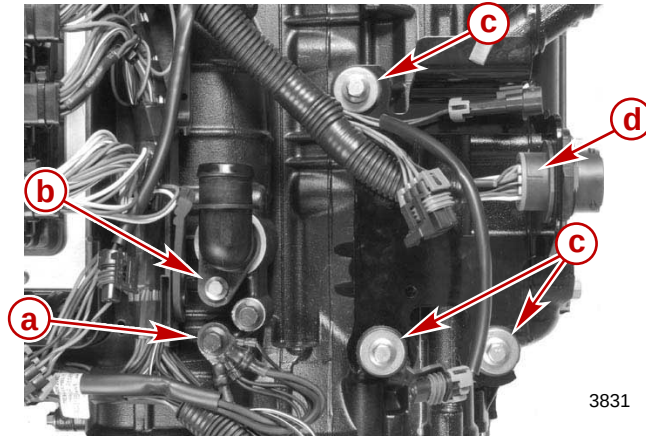
3832

a - O-rings

b - Cylinder block elbow installation location

3. Install the 14 pin engine harness connector bracket to the cylinder block. Tighten the bolts to the specified torque.

4. Install and the secure the engine harness grounds. Tighten the engine harness ground bolt to the specified torque.



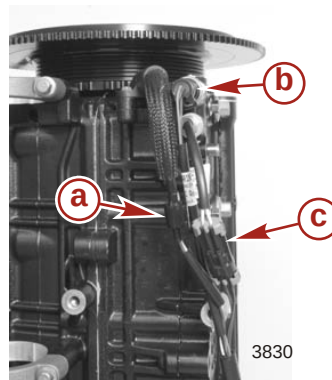
a - Engine harness ground bolt
b - Bolt securing elbow

c - Bolts securing engine harness bracket
d - 14 pin engine harness

Description	Nm	lb. in.	lb. ft.
Engine Harness Ground Bolt	10	88	
Bolt Securing Elbow (M6 x 16)	10	88	
Bolt Securing Engine Harness Bracket (M8 x 35)	24		17.7

Oil Pressure/Temperature Sensors

1. Install the oil pressure sensor. Tighten to the specified torque.
2. Install a new O-ring onto the oil temperature sensor.
3. Install the oil temperature sensor. Tighten to the specified torque.
4. Connect the engine harnesses to the CPS, oil pressure and oil temperature sensors.



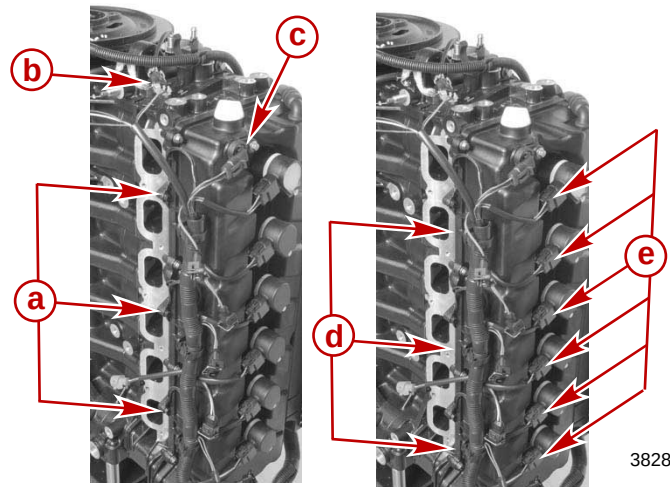
a - CPS harness connector (white, red)
b - Oil pressure sensor harness connector (blue, black/orange, purple/yellow)

c - Oil temperature sensor harness connector (black/orange, brown)

Description	Nm	lb. in.	lb. ft.
Oil Pressure Sensor	15	133	
Oil Temperature Sensor	15	133	

Injector/Coil Harness

1. Install the harness retainers into the valve cover.
2. Install the injector/coil grounds to the cylinder head. Secure the injector/coil ground with the ground retaining bolt. Tighten to the specified torque.
3. Connect the coil harnesses to the coils.
4. Connect the Camshaft Position Sensor harness to the CPS.
5. Connect the cylinder block temperature sensor harness to the cylinder block temperature sensor.



- a** - Harness retainer on valve cover **d** - Engine harness retainers
b - Cylinder block temperature sensor **e** - Ignition coil harness connectors
c - Camshaft position sensor

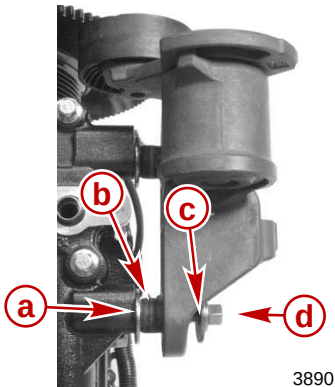
Description	Nm	lb. in.	lb. ft.
Injector/coil grounds	8	71	

Alternator Support/Knock Sensors

1. Install a new O-ring on the brass water plug.
2. Install the brass water plug. Tighten to the specified torque.
3. Install a new O-ring onto the cylinder block fitting
4. Install the cylinder block fitting with the hose attached, to the cylinder block. Tighten to the specified torque.
5. Install the water pressure sensor. Tighten to the specified torque.
6. Install the knock sensors. Tighten the knock sensor retaining bolts to the specified torque.

IMPORTANT: The knock sensor is an interrelated part of the ignition and fuel delivery system. It is imperative the knock sensor retaining bolts are torqued to the stated value. Failure to torque the knock sensor retaining bolts to the stated value may result in inaccurate knock sensor signal output to the PCM.

7. Install the belt tensioner. Tighten the belt tensioner retaining bolts to the specified torque.

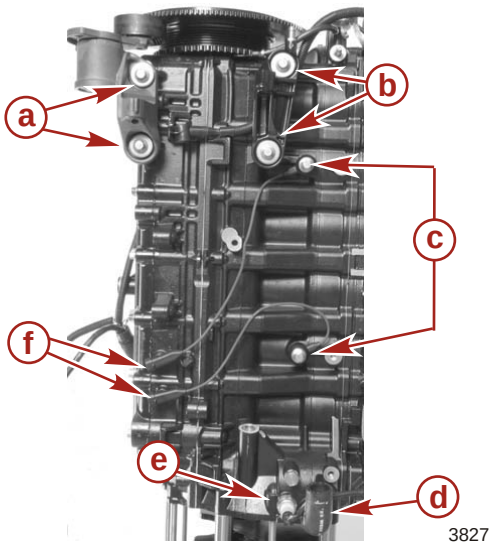


- a** - Washer

b - Mount
- c** - Washer

d - Bolt

8. Install the alternator support bracket. Tighten the alternator support bracket retaining bolts to the specified torque.



- a** - Bolts securing belt tensioner bracket

b - Bolts securing alternator support bracket

c - Knock sensor retaining bolt

d - Brass water plug
- e** - Fitting with water hose attached

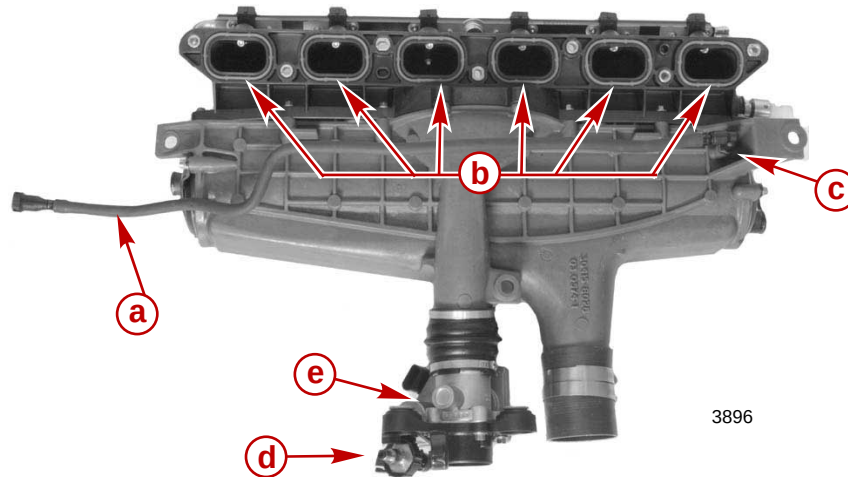
f - Water pressure sensor

g - Knock sensor harness connectors

Description	Nm	lb. in.	lb. ft.
Bolt Securing Belt Tensioner Bracket (M8 x 45)	35		47.5
Bolt Securing Alternator Support Bracket (M8 x 45)	35		47.5
Knock Sensor Retaining Bolt (M10 x 35)	20	177	
Brass Water Plug (M10 x 1)	20	177	

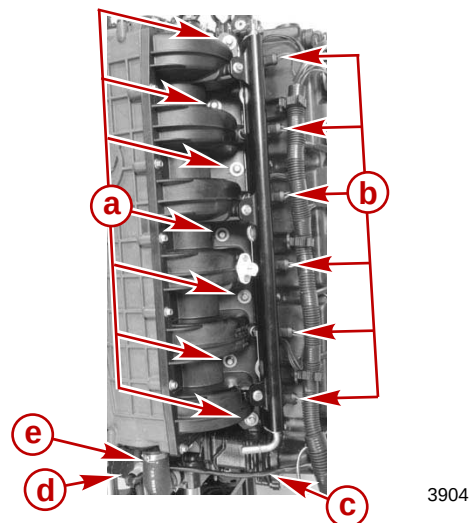
Induction System

1. Install new seal rings on the charge air cooler.



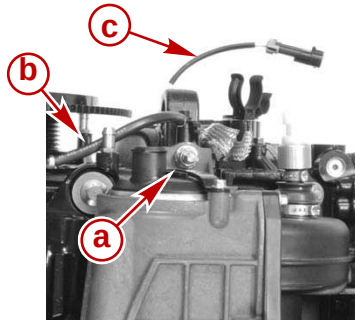
- a** - Manifold absolute pressure reference line
- b** - Seal rings
- c** - Manifold absolute pressure reference line manifold port
- d** - Speedometer sensor
- e** - Electric Boost Control Assembly

2. Install a 34.6 diameter hose clamp onto the lower charge air cooler hose.
3. Insert the charge air cooler lower intercooler fitting onto the lower charge air cooler hose.
4. Install the charge air cooler to the cylinder head. Secure the charge air cooler to the cylinder head with seven 6 x 33 mm bolts. Do not tighten the bolts at this time.
5. Connect the injector harness to the injectors.
6. Connect the water pressure sensor wire harness to the water pressure sensor.



- a** - Bolts retaining charge air cooler
- b** - Injector harness connectors
- c** - Water pressure sensor wire harness
- d** - Water pressure sensor
- e** - Lower charge air cooler hose

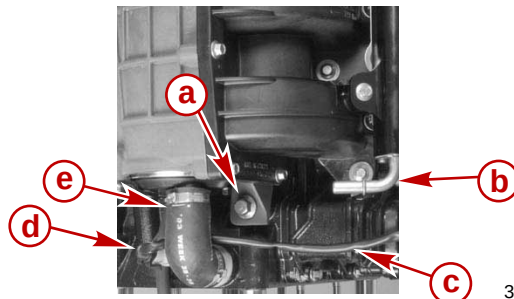
7. Install the upper charge air cooler mounting nut. Do not tighten at this time.



3907

- a** - Upper charge air cooler mounting nut
b - Ground wire for alternator
c - Cylinder block temperature sensor

8. Install the lower charge air cooler mounting bolt. Do not tighten at this time.

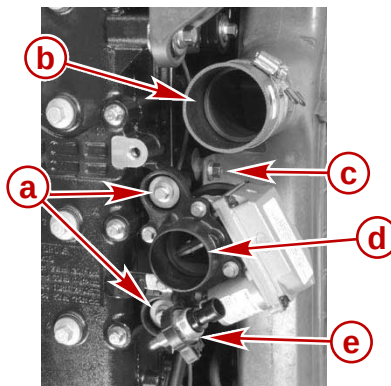


3909

- a** - Lower charge air cooler mounting bolt
b - Fuel rail inlet
c - Water pressure sensor wire harness
d - Water pressure sensor
e - Lower charge air cooler hose

9. Install the center charge air cooler mounting bolt. Do not tighten at this time.

10. Install 2 bolts to retaining the electronic boost control assembly to the cylinder block. Tighten the 2 bolts to the specified torque.

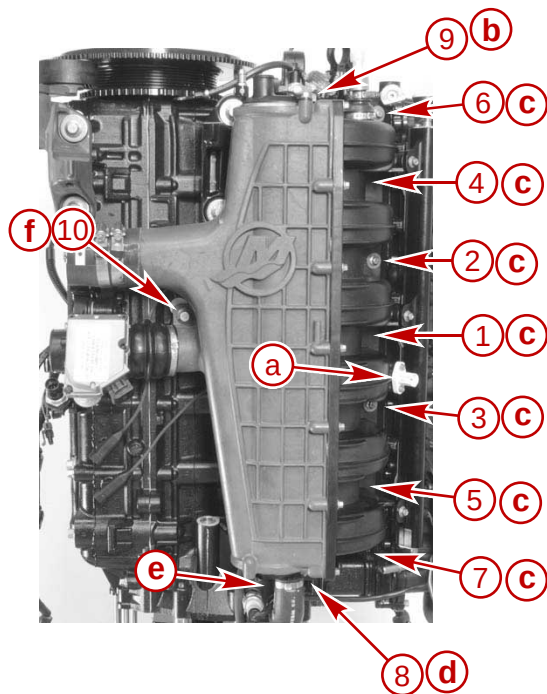
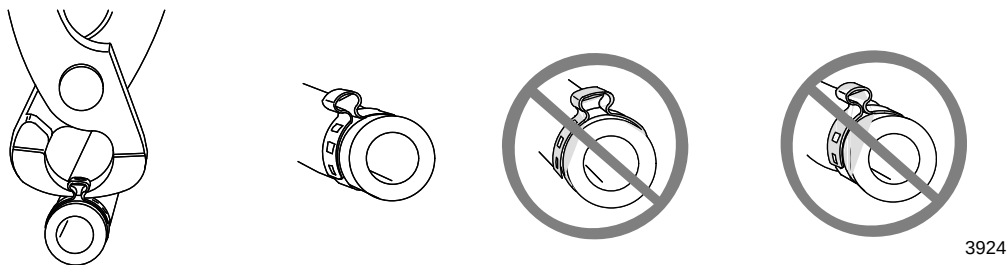


3910

- a** - Bolts retaining electronic boost control assembly
b - Air inlet
c - Center charge air cooler mounting bolt
d - Electronic boost control assembly
e - Speedometer sensor

- 11. Tighten the nut/bolts holding the charge air cooler to the cylinder head/cylinder block to the specified torque and in the sequence shown.
- 12. Connect the manifold air temperature harness to the MAT sensor.
- 13. Compress the lower charge air cooler hose clamp with tool.

IMPORTANT: Use only tool 91-803146T (or Snap-On equivalent YA3080) to crimp the full circle hose clamp. Using a different tool could result in a crimp that is too loose, or too tight. Do not use a screw type hose clamp as it may damage the hose.

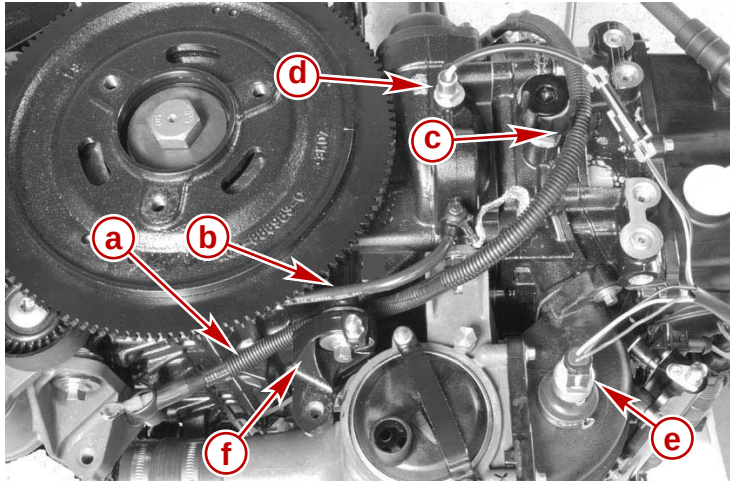


- a - Manifold air temperature sensor
- b - Upper charge air cooler mounting nut
- c - Bolts retaining charge air cooler (7)
- d - Lower charge air cooler mounting bolt
- e - Lower charge air cooler hose clamp
- f - Center charge air cooler mounting bolt

Description	Nm	lb. in.	lb. ft.
Upper charge air cooler mounting nut (b)	32.5		24
Bolt retaining charge air cooler, M6 x 33 (c)	9	80	
Lower charge air cooler mounting bolt, M10 x 30 (d)	32.5		24
Center charge air cooler mounting bolt, M10 x 30 (e)	32.5		24
Hose Clamp Tool Kit	91-803146A2		

- 14. Route the alternator battery charge wire behind the alternator support bracket. Insert the alternator battery charge wire into the support clip.

15. Connect the cylinder block temperature sensor wire harness to the cylinder block temperature sensor.
16. Connect the manifold absolute pressure sensor wire harness to the manifold absolute pressure sensor.



a - Alternator battery charge wire

b - Alternator ground wire

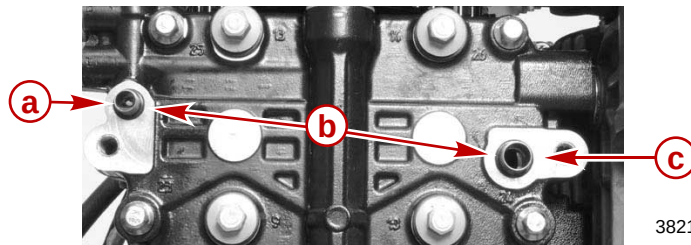
c - Support clip

d - Cylinder block temperature sensor

e - manifold absolute pressure sensor

f - Alternator support bracket

17. Install the supercharger dowels.
18. Install new O-rings on the supercharger dowels.



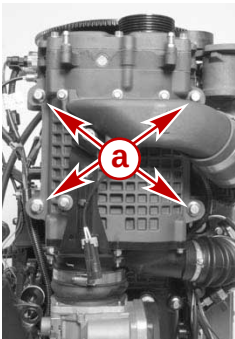
a - Oil delivery to supercharger

b - Supercharger dowel and O-ring

c - Oil return from supercharger

19. Install a hose clamp on the electronic boost control hose.
20. Guide the supercharger outlet tube to the intake manifold and the electronic boost control hose to the electronic boost control assembly while installing the supercharger on the dowels.

21. Secure the supercharger to the cylinder block. Torque the supercharger mounting bolts in two steps.

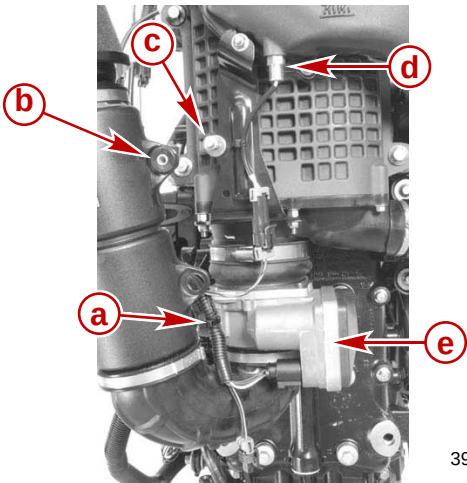


3820

a - Supercharger mounting bolts

Description		Nm	lb. in.	lb. ft.
Supercharger mounting bolt (M10 x 105)	First	15	133	
	Final	43		31.7

22. Connect the post supercharger air temperature sensor harness to the post supercharger air temperature sensor.
23. Connect the throttle control harness to the throttle control assembly.
24. Secure the throttle control harness to the throttle control assembly with a cable tie.
25. Secure the air intake to the air intake support bracket. Tighten to the specified torque.



3922

a - Cable tie

b - Air intake support

c - Air intake support bracket

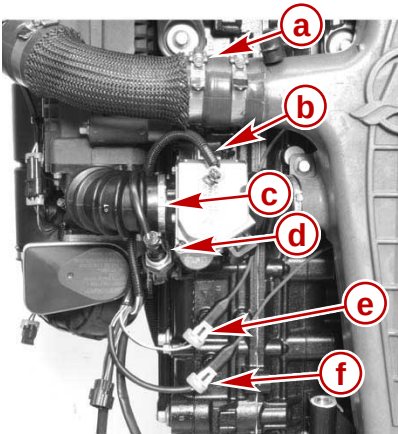
d - Post supercharger air temperature sensor

e - Throttle control assembly

Description	Nm	lb. in.	lb. ft.
Air intake support bolt (M6 x 25)	7.5	66	

26. Connect the knock sensor harness connector with the black sleeve to the lower knock sensor.
27. Connect the remaining knock sensor harness connector to the upper knock sensor.
28. Connect the speedometer harness connector to the speedometer sensor.
29. Tighten the hose clamp on the supercharger outlet to the specified torque.

30. Compress the electronic boost control assembly hose clamp with tool.



3925

- a** - Supercharger outlet hose clamp

b - Alternator exciter wire harness

c - electronic boost control assembly hose clamp
- d** - Speedometer sensor

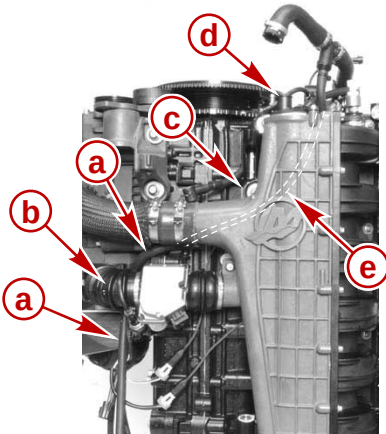
e - Upper knock sensor harness connector

f - Lower knock sensor harness connector with black sleeve

Description	Nm	lb. in.	lb. ft.
Supercharger Hose Clamp	6	55	

Hose Clamp Tool Kit	91-803146A2
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31. Guide the fresh water flush line behind the charge air cooler, under the alternator bracket, and behind the electric boost control hose.
32. Install a hose clamp onto the hose and install hose onto the upper charge air cooler port. Compress the hose clamp with tool to secure the hose to the charge air cooler port.



3927

- a** - Fresh water flush line

b - Electric boost control hose

c - Alternator bracket
- d** - Upper charge air cooler port

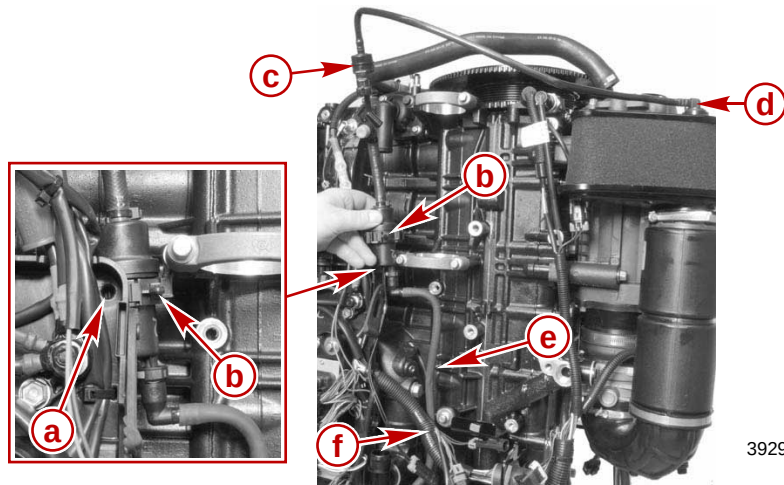
e - Approximate route of fresh water flush line

Hose Clamp Tool Kit	91-803146A2
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Purge Line

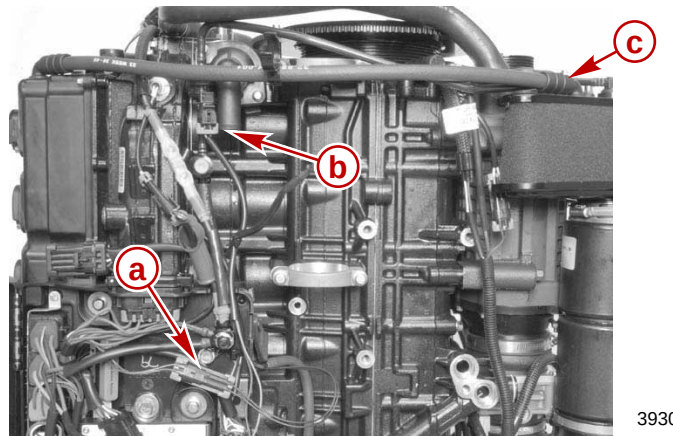
1. Install the locking end of the purge line into the air filter cover.
2. Place the vent canister float switch (VCS) vent line behind the engine harness.

3. Install the vent canister float switch retainer into the electrical box hole.



- | | |
|--|---|
| a - Electrical box hole | d - Locking end of purge line |
| b - Vent canister float switch retainer | e - Vent canister float switch vent line |
| c - Purge valve | f - Engine harness |

4. Connect the vent canister float switch harness connector to the vent canister float switch.
5. Connect the purge harness connector to the purge valve.
6. Install the breather hose onto the air cleaner cover.

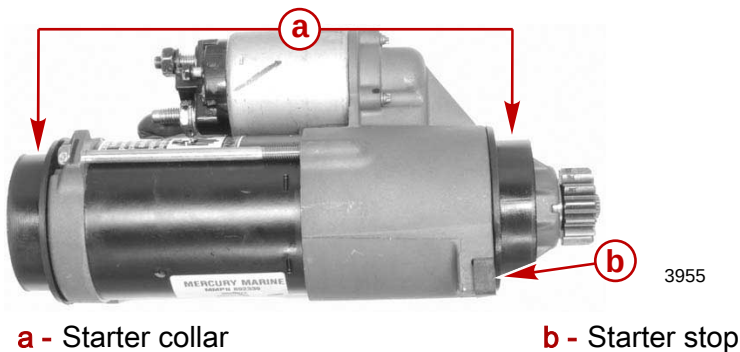


- | | |
|---|--------------------------|
| a - Vent canister float switch harness connector | c - Breather hose |
| b - Purge harness connector | |

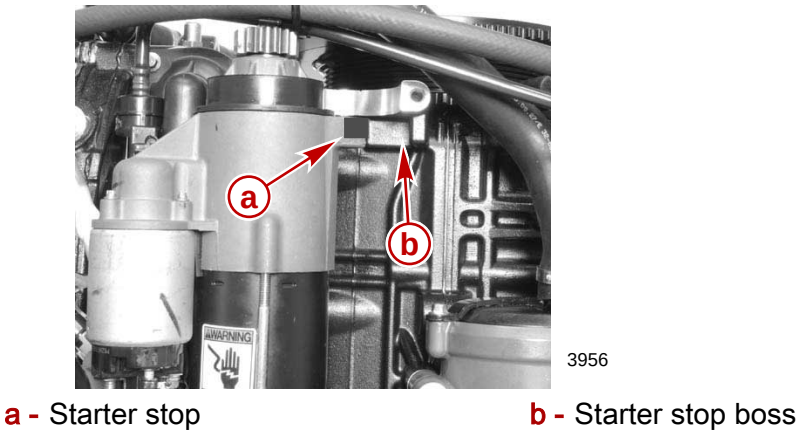
Starter

1. Ensure the bottom and top collars are on the starter end caps.

2. Ensure the starter stop is on the upper end cap.



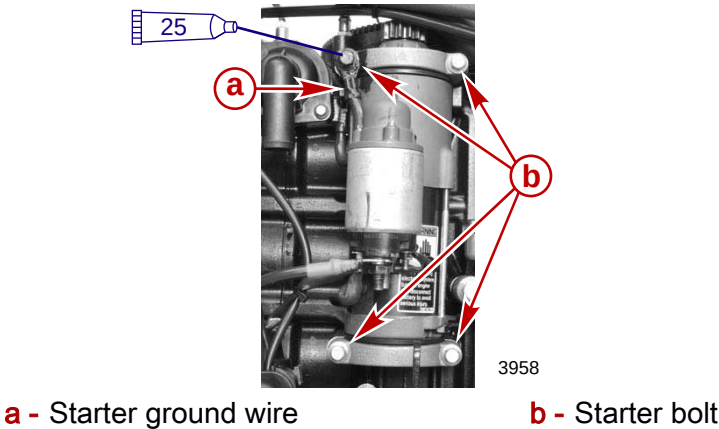
3. Place the starter onto the cylinder block starter mounting boss with the starter stop facing starter stop boss.



4. Insert a starter bolt through the starter ground eyelet.

5. Secure the starter to the cylinder block with the starter retainers and starter bolts. Tighten the starter bolts to the specified torque.

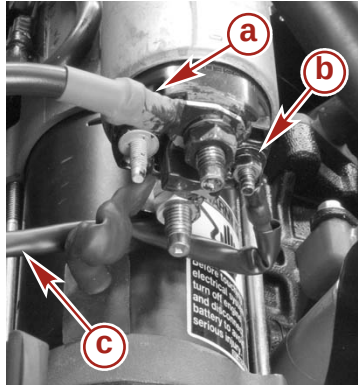
6. Cover the bolt and starter ground wire eyelet with liquid neoprene.



Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Starter ground screws	92-25711-3

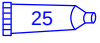
Description	Nm	lb. in.	lb. ft.
Starter bolt (M8 x 40)	17	150	

7. Guide the starter exciter wire behind the solenoid and connect the exciter wire to the solenoid exciter wire terminal. Tighten the exciter wire terminal nut to the specified torque.
8. Connect the battery starter cable to the starter solenoid terminal. Tighten the battery starter cable nut to the specified torque.
9. Cover the starter exciter wire/terminal and battery starter cable end/terminal with liquid neoprene.



3965

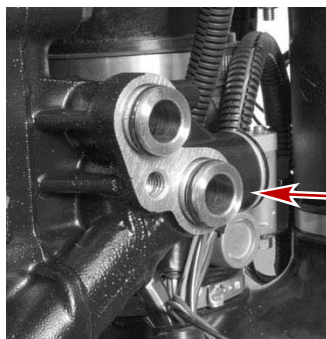
- a** - Battery starter cable **c** - Starter exciter wire
b - Solenoid exciter wire terminal

Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Starter exciter wire, battery cable	92-25711-3

Description	Nm	lb. in.	lb. ft.
Exciter Wire Terminal Nut	2.5	22	
Battery Starter Cable Nut	9	80	

(Integrated Oil Module) IOM

1. Install new O-rings on the integrated oil module dowels.
2. Install the integrated oil module dowels into the cylinder block.

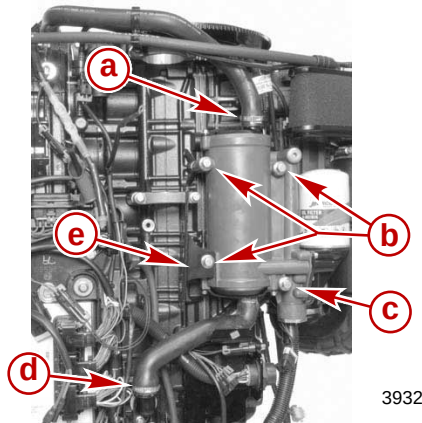


3772

3. Align the integrated oil module with the integrated oil module dowels on the cylinder block.
4. Secure the integrated oil module to the cylinder block. Tighten the integrated oil module bolts to the specified torque.

Description	Nm	lb. in.	lb. ft.
Integrated Oil Module Bolts	31		23

5. Install a hose clamp onto the integrated oil module lower hose.
6. Install and secure the lower integrated oil module hose onto the cylinder block elbow with tool.
7. Install a hose clamp onto the upper integrated oil module hose.
8. Install and secure the upper integrated oil module hose onto the integrated oil module with tool.



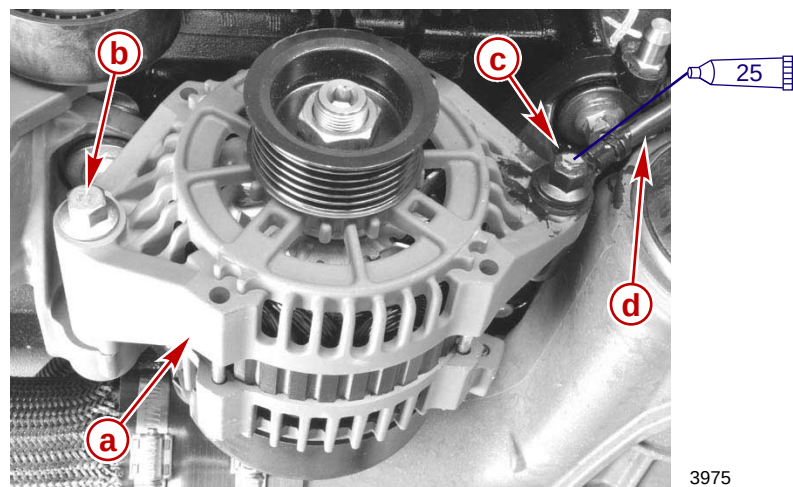
- a** - Upper integrated oil module hose clamp
- b** - Integrated oil module bolts (M10 x 85)
- c** - Integrated oil module bolt (M10 x 105)
- d** - Lower integrated oil module hose clamp
- e** - Fuel filter support bracket

Hose Clamp Tool Kit	91-803146A2
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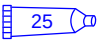
Alternator

1. Place the alternator on the alternator mounting brackets.
2. Insert the short alternator mounting bolt through the alternator ground wire eyelet.
3. Install the short alternator mounting bolt with the ground wire into the aft mounting hole of the alternator.
4. Install the long alternator mounting bolt into the fore mounting hole of the alternator.
5. Tighten the alternator mounting bolts to the specified torque.

6. Coat the ground wire eyelet and mounting bolt with liquid neoprene.

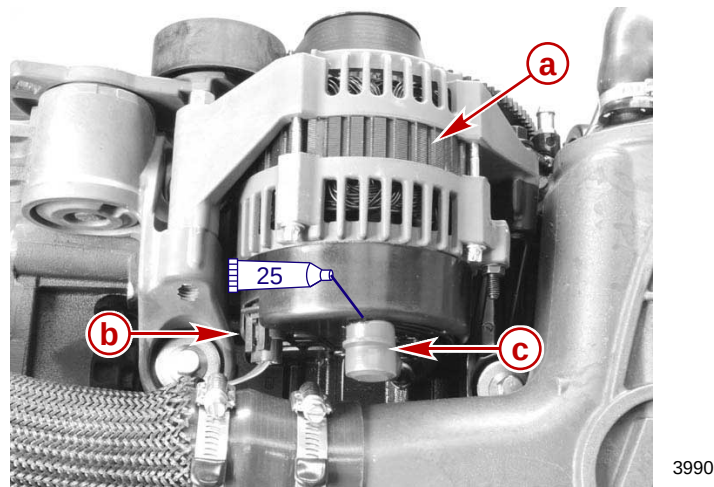


a - Alternator
b - Long alternator mounting bolt
c - Short alternator mounting bolt
d - Ground wire

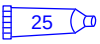
Tube Ref No.	Description	Where Used	Part No.
	Liquid Neoprene	Alternator monting/ground bolt	92-25711-3

Description	Nm	lb. in.	lb. ft.
Short Mounting Bolt (M8 x 45)	47.5		35
Long Mounting Bbolt (M8 x 85)	47.5		35

7. Connect the output lead and the field exciter harness connector.
8. Tighten to the output lead nut to the specified torque.
9. Coat the output lead with liquid neoprene.
10. Allow the liquid neoprene to dry. Cover the output lead with the insulator.



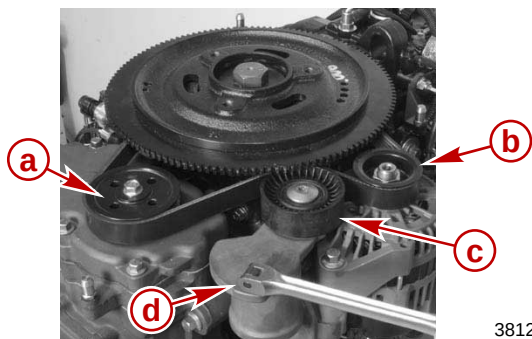
a - Alternator
b - Field exciter harness connector
c - Output lead insulator

Tube Ref No.	Description	Where Used	Part No.
	Liquid Neoprene	Alternator output lead nut	92-25711-3

Description	Nm	lb. in.	lb. ft.
Output lead nut	4	35	

Alternator/Supercharger Belt

1. Install a 3/8 inch breaker bar into the belt tensioner socket.
2. Compress the belt tensioner spring.
3. Install the alternator/supercharger belt.
4. Slowly release the belt tensioner.
5. Inspect the belt alignment.

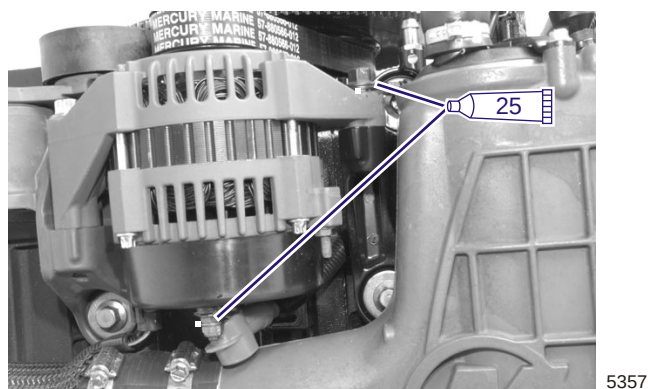


- a** - Supercharger pulley
b - Alternator pulley
c - Belt tensioner
d - 3/8 inch breaker bar

After Servicing Engine

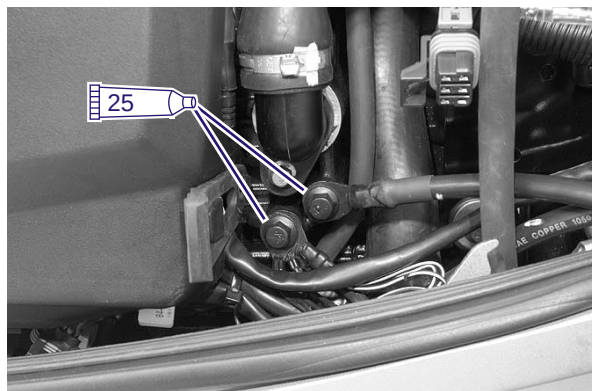
Applying liquid neoprene to the following specific locations after servicing the engine, will reduce the possibilities of ignition, starting, or charging disruptive failures. These points of interest are most important to protect when the outboard is used in harsh environments such as salt water.

- Alternator charging and ground location



Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Alternator battery charging lead and alternator ground	92-25711-3

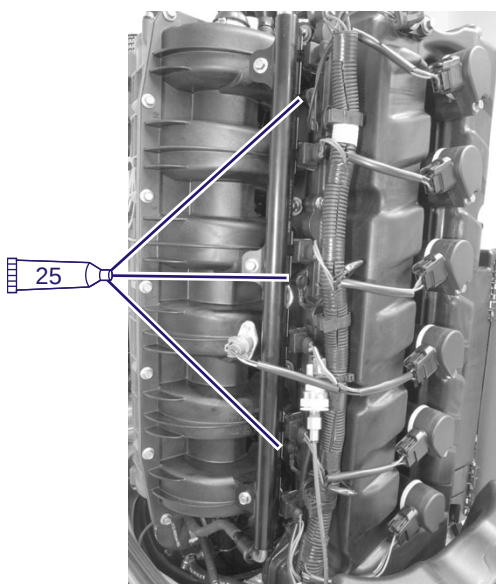
- Battery ground and electrical harness ground



5359

Tube Ref No.	Description	Where Used	Part No.
	Liquid Neoprene	Battery ground and electrical harness ground	92-25711-3

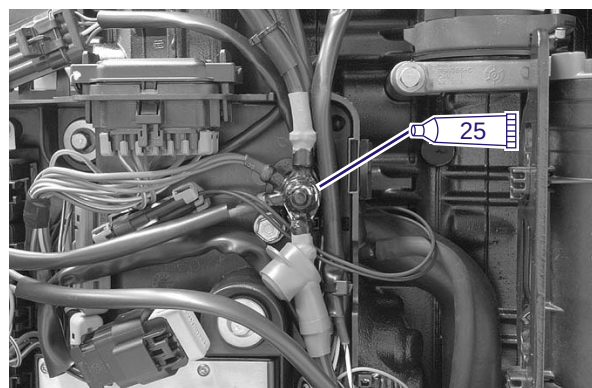
- Ignition pencil coil and fuel injector ground



5360

Tube Ref No.	Description	Where Used	Part No.
	Liquid Neoprene	Ignition pencil coil ground and fuel injector ground	92-25711-3

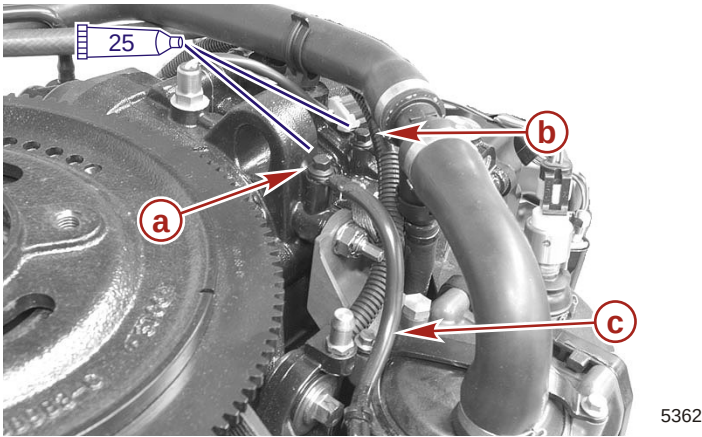
- Battery stud inside electrical box



5361

Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Battery stud inside electrical box	92-25711-3

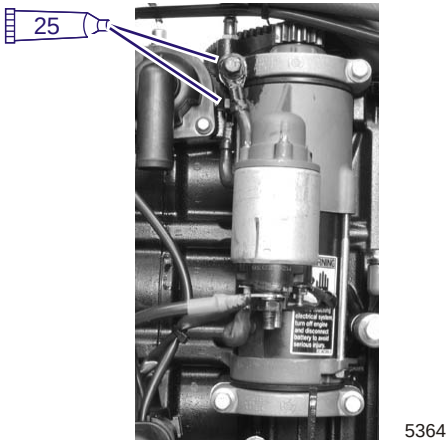
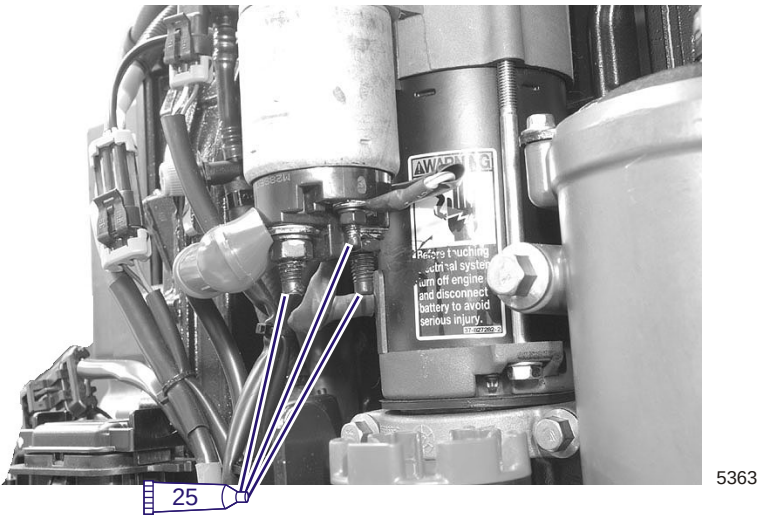
- Alternator ground cable to cylinder block and cylinder head



- a** - Cylinder block ground
- b** - Cylinder head ground
- c** - Alternator ground cable

Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Alternator ground cable at cylinder block and cylinder head	92-25711-3

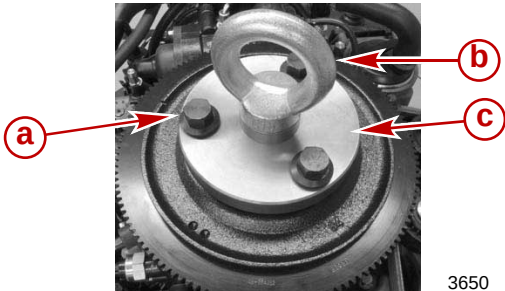
- Starter power leads and ground cables



Tube Ref No.	Description	Where Used	Part No.
	Liquid Neoprene	Starter power leads and ground cables	92-25711-3

Dressed Powerhead Installation

1. Ensure the flywheel points towards the timing mark on the cylinder block.
2. Install the lifting tool onto the flywheel. Tighten the base bolts securely so they bottom out on the flywheel.
3. Thread the lifting eye onto the lifting base securely so it bottoms out on the lifting base.



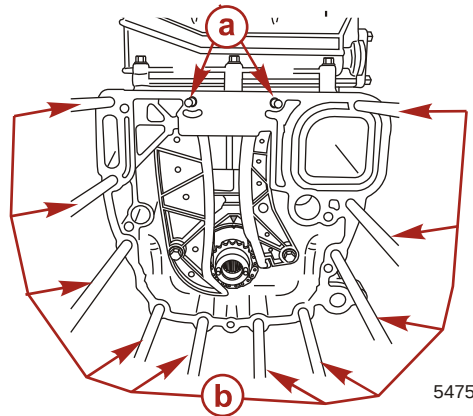
- a** - Lifting base bolts

b - Lifting eye
- c** - Lifting base

Flywheel Puller/Lifting Eye

91-895343T01

4. Install the 10 long powerhead mounting studs and the two short powerhead mounting studs. Tighten the long and short powerhead mounting studs to the specified torque.



a - Short powerhead mounting studs **b** - Long powerhead mounting studs

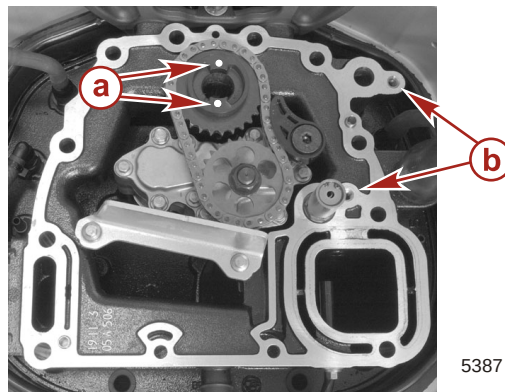
Description	Nm	lb. in.	lb. ft.
Short powerhead mounting studs	10	88	
Long powerhead mounting studs	22.6	200	

5. Place a new powerhead gasket on the adaptor plate.
6. Lubricate the driveshaft splines with Engine Coupler Spline Grease.

Tube Ref No.	Description	Where Used	Part No.
 91 	Engine Coupler Spline Grease	Driveshaft splines	92-802869A1

7. Turn the oil pump drive gear so the drive pins point fore and aft.
8. Use a q-tip to remove all the oil that may have accumulated in 2 of the adaptor plate threaded mounting holes.

IMPORTANT: Remove all traces of oil in the 2 adaptor plate threaded mounting holes. Failure to remove the oil will damage the adaptor plate during the torquing of the powerhead to the adaptor plate.

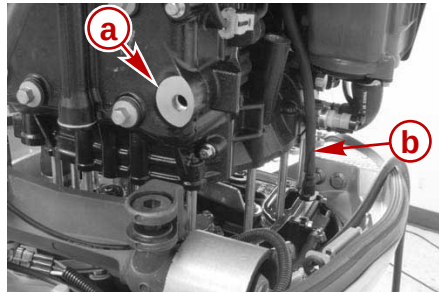


a - Drive pins point fore and aft **b** - Remove oil from threaded holes

9. Carefully lower the powerhead onto the adaptor plate while aligning the powerhead mounting studs with the adaptor plate holes.

NOTE: It may be necessary to gently rock the powerhead once the powerhead mounting studs are partially through the adaptor plate.

IMPORTANT: Do not damage the area of the powerhead front mounting boss and the front mounting support when lowering the powerhead onto the adaptor plate.

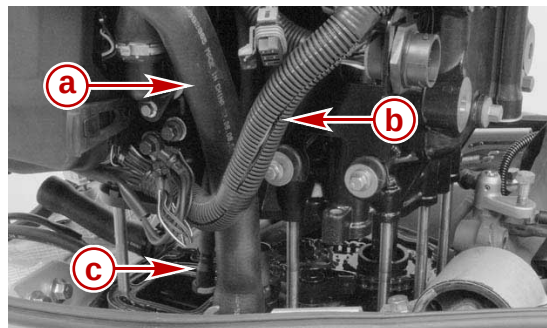


3657

a - Powerhead front mounting boss

b - Map sensor reference hose

10. Guide the thermostat hose and FSM purge line (hidden behind the thermostat hose in the following graphic) behind the engine harness while lowering the powerhead onto the adaptor plate.



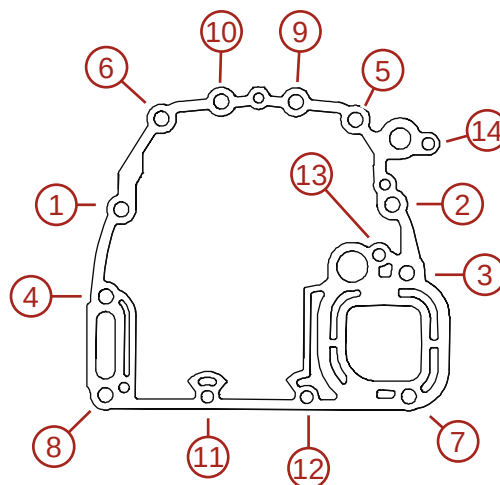
3656

a - Thermostat hose

c - FSM purge hose

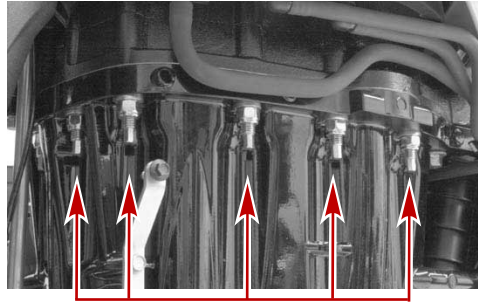
b - Engine harness

11. Use the torque sequence shown in the following graphic illustration, after all the nuts and bolts that secure the powerhead to the adaptor plate are installed.



5341

12. Install the 10 nuts (five on each side) securing the powerhead to the adaptor plate. Tighten to the specified torque.



3645

Description	Nm	lb. in.	lb. ft.
Powerhead nut	61		45

13. Install the two aft nuts securing the powerhead to the adaptor plate. Tighten aft nuts to the specified torque with tool.

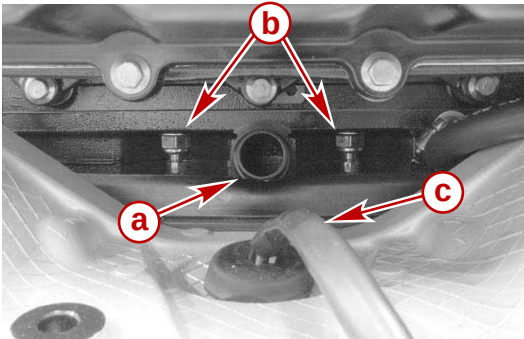
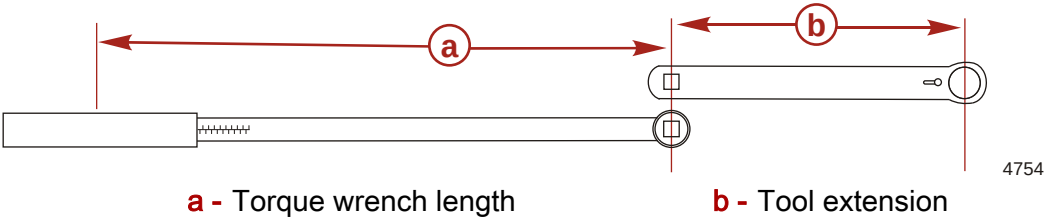
13 mm Torque Adapter	91-809905001
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Description	Nm	lb. in.	lb. ft.
Aft nuts securing powerhead	26		20

IMPORTANT: You must calculate the torque value of the aft nuts securing the power head to the adaptor plate.

- On beam type torque wrenches, measure from the square drive to the fulcrum (pivot) point of the handle. Follow steps d through g.
- On electronic digital type torque wrenches, measure from the square drive to the center of the handle. Follow steps d through g.
- On click-stop or dial type torque wrenches, adjust the torque wrench to the specified torque. Determine the effective length from the square drive to the center of the handle. Follow steps d through k.
- Measure tool extension from the center of the square drive to the center of the nut drive. Tool # 91-809905001 is 30.48 cm [12 in.].
- Add the torque wrench length and the tool length to find the sum.
- Divide the sum by the torque wrench length to find the quotient.
- Divide the torque specification by the quotient. This is the torque specification for the aft nut.
- Adjust the torque wrench to reflect the new torque calculation.
- For greater accuracy, redetermine the effective length of the torque wrench and the extension tool.
- Compute for the corrected torque setting.

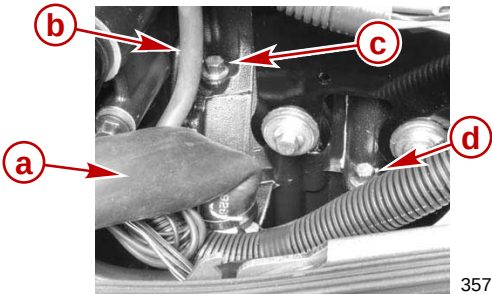
- k. Adjust the torque wrench to reflect the second new torque calculation. This is the final torque specification for the aft nut when using a click-stop or dial type torque wrench.



a - Exhaust relief tube
b - Aft nuts securing powerhead
c - FSM harness

Description	Nm	lb. in.	lb. ft.
Aft nut securing powerhead	26		19.2
Torque Adaptor	91-809905001		

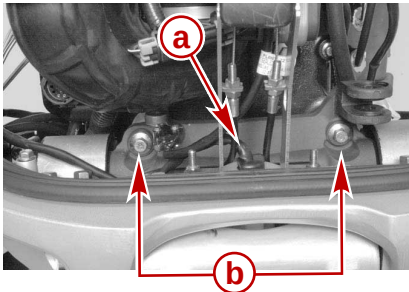
14. Install the two starboard side powerhead mounting bolts. Tighten to the specified torque.



a - Thermostat hose
b - FSM purge hose
c - Mounting bolt (M8 x 75)
d - Mounting bolt (M8 x 35)

Description	Nm	lb. in.	lb. ft.
Starboard side powerhead mounting bolts (M8 x 75), (M8 x 35)	27		20

15. Install the front powerhead mounting bolts. Tighten to the specified torque, then turn additional 45°.

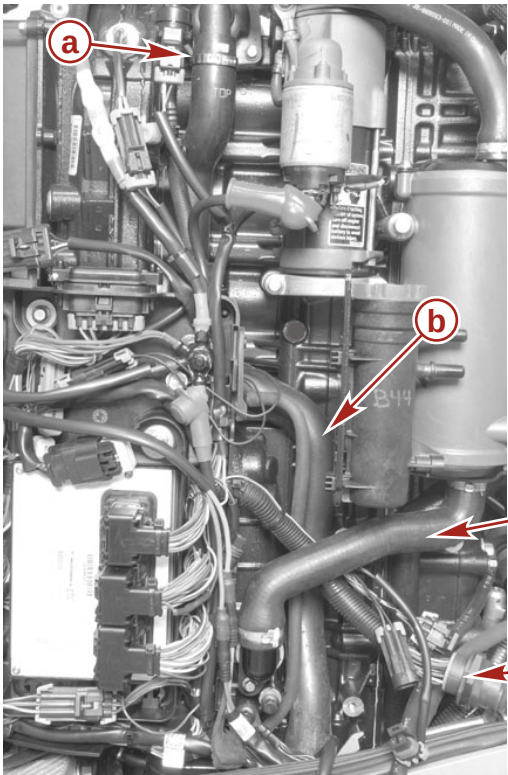


3644

a - Power trim wire harness **b** - Front powerhead mounting bolts

Description		Nm	lb. in.	lb. ft.
Front powerhead mounting bolts	First	40		29.5
	Final	Turn additional 45°		

16. Guide the thermostat hose behind the IOM lower hose and up to the thermostat housing.
17. Install a 36.1 diameter hose clamp onto the thermostat hose.
18. Install the thermostat hose to the thermostat housing. Secure the thermostat hose to the thermostat housing with tool.



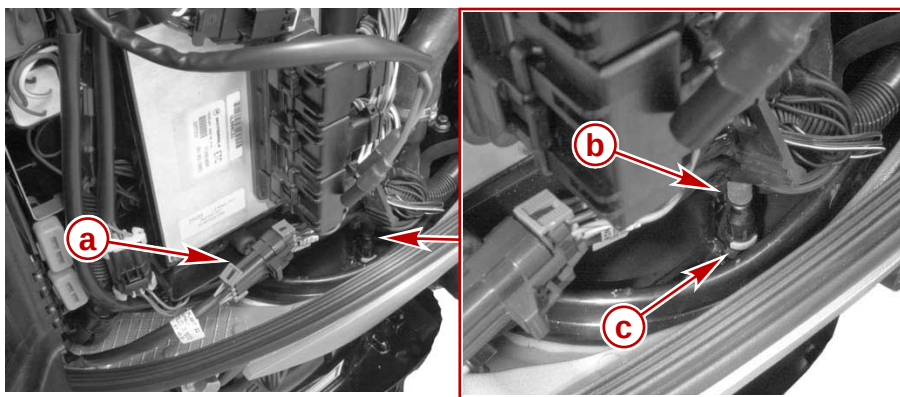
5389

a - 36.1 diameter hose clamp **c** - Lower IOM hose
b - Thermostat hose **d** - 14 pin connector

Hose Clamp Tool Kit	91-803146A2
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19. Connect the FSM harness to the engine harness.

20. Install the purge line into the adaptor plate



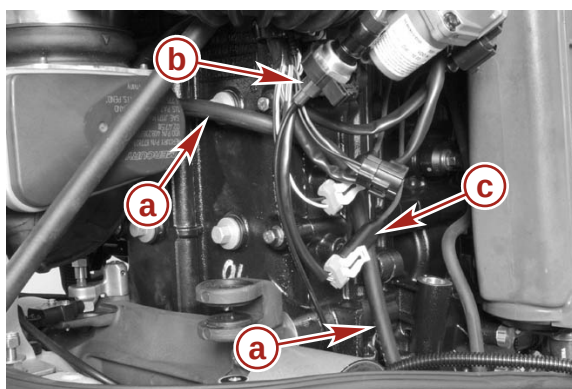
3582

a - FSM harness

b - Purge line

c - Retaining clip

21. Guide the tell tale hose behind the knock sensors, past the front of the motor, over to the starboard side of the engine.



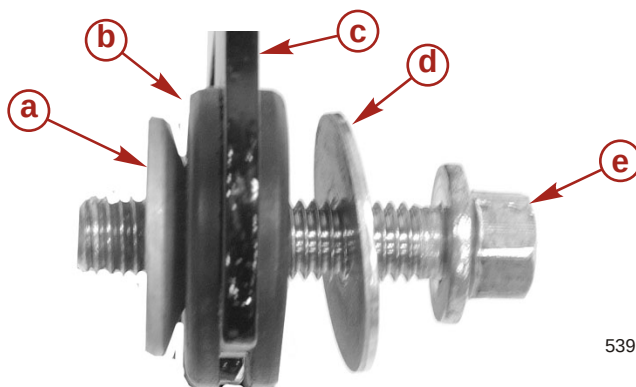
5402

a - Tell tale hose

b - Speedometer sensor

c - Knock sensor

22. Ensure the harness bracket mounting grommets are assembled correctly to the harness bracket.



5391

a - Bushing

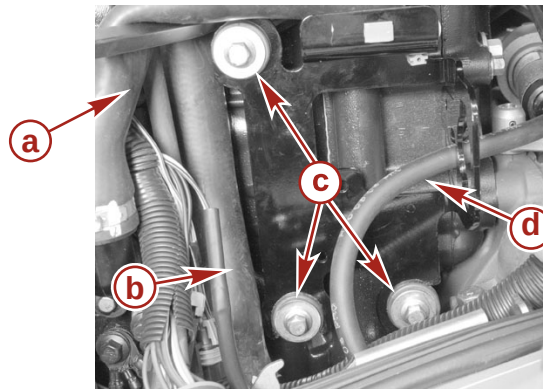
b - Grommet

c - Harness bracket

d - Washer

e - Bolt

23. Install the harness bracket retained during the powerhead removal, to the cylinder block. Tighten the harness bracket bolts to the specified torque.
24. Guide the tell tale hose through the harness bracket.



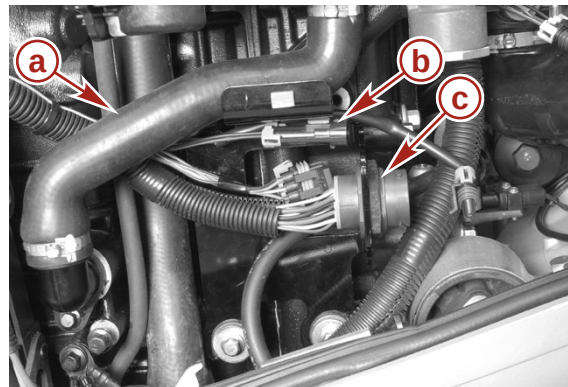
5392

a - Lower IOM hose
b - Thermostat hose

c - Harness bracket bolts
d - Tell tale hose

Description	Nm	lb. in.	lb. ft.
Harness bracket bolts (M8 x 35)	24	212	

25. Install the DTS power harness connector to the harness bracket. Install the 14 pin connector to the harness bracket. Tighten the 14 pin connector nut to the specified torque.



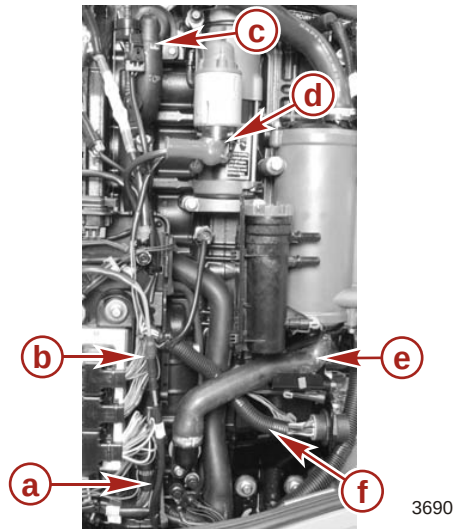
5393

a - Lower IOM hose
b - DTS power harness connector

c - 14 pin connector nut

Description	Nm	lb. in.	lb. ft.
14 pin connector nut	8	71	

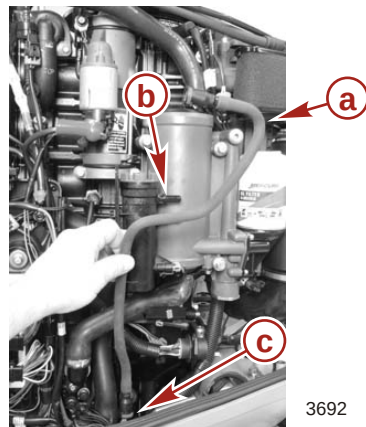
26. Connect the blue and green power trim harness to the blue and green power trim relay harness.



- | | |
|-------------------------------------|----------------------------------|
| a - Power trim harness | d - Starter battery cable |
| b - Power trim relay harness | e - Lower IOM hose |
| c - Thermostat hose | f - Engine harness |

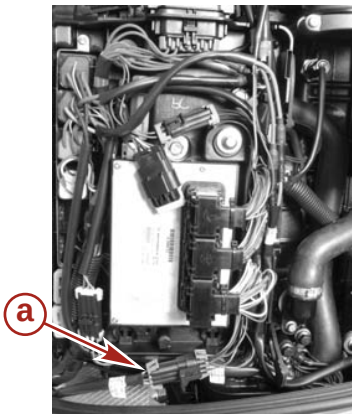
27. Install the fuel hose to the adaptor plate fitting.

28. Install the fuel hose to the fuel filter top fitting.



- | | |
|------------------------------------|----------------------------------|
| a - Fuel line | c - Adaptor plate fitting |
| b - Fuel filter top fitting | |

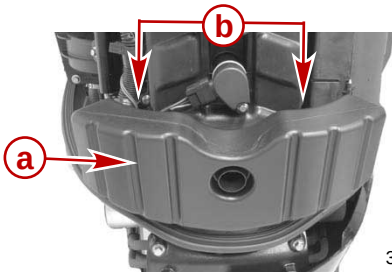
29. Connect the FSM harness to the engine harness.



3693

a - FSM harness

30. Install the exhaust plenum to the exhaust relief hose and secure it to the mount cradle. Tighten the exhaust plenum screws to the specified torque.



3615

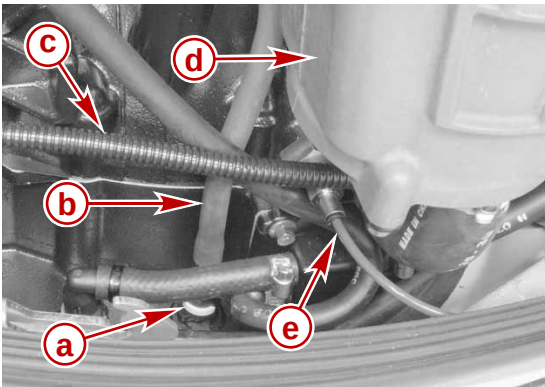
a - Exhaust plenum

b - Exhaust plenum screws

Description	Nm	lb. in.	lb. ft.
Exhaust plenum screw (M6 x 16)	6	53	

31. Connect the MAP sensor reference hose to the adaptor plate fitting.

32. Guide the trim position wire harness underneath the charge air cooler.



3614

a - MAP sensor referenced hose clip

d - Intake manifold

b - MAP sensor referenced hose

e - Block water pressure line

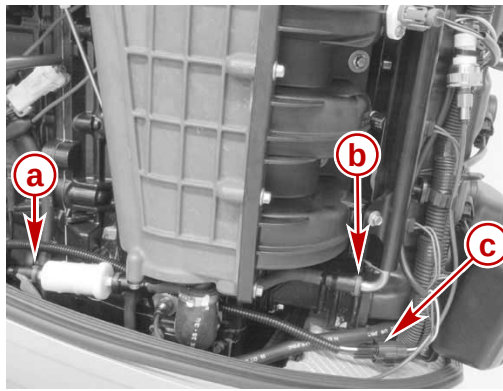
c - Trim position wire harness

33. Connect the trim position sensor to the engine harness.

34. Insert the fuel line/filter behind the charge cooler hose.

35. Connect the adaptor plate fuel fitting to the fuel filter.

36. Connect the fuel line to the fuel rail fitting.



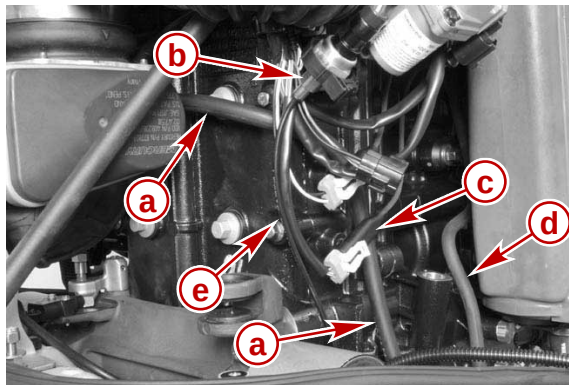
3612

a - Adaptor plate fuel fitting

b - Fuel rail fitting

c - Trim position sensor harness

37. Connect the speedometer hose to the speedometer sensor.



3694

a - Tell tale hose

b - Speedometer sensor

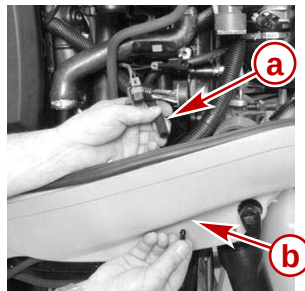
c - Knock sensor harness connector

d - MAP sensor reference hose

e - Speedometer hose

38. Insert tell tale fitting into the mount cradle.

39. Connect the tell tale hose to the tell tale fitting.

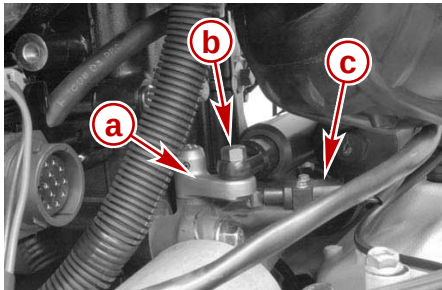


3695

a - Tell tale hose

b - Tell tale fitting

40. Install the shift actuator onto the upper bell crank. Secure with the shift actuator bolt. Tighten to the specified torque.



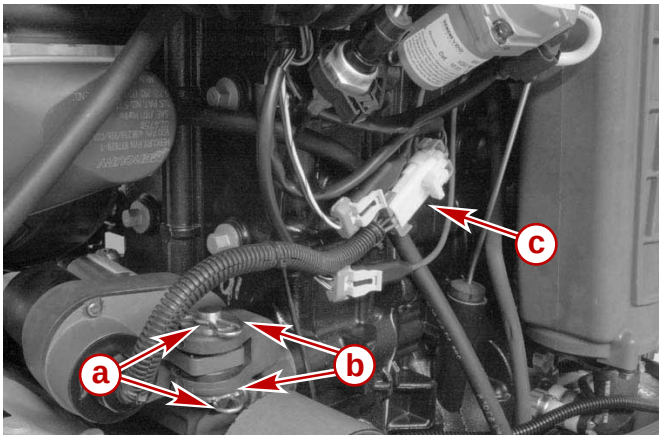
3596

- a - Upper bell crank

b - Shift actuator bolt
- c - Shift indicator switch

Description	Nm	lb. in.	lb. ft.
Shift actuator bolt	20	177	

41. Insert the shift actuator pin through the mounting boss and shift actuator. Install the washer and the cotter pin.
42. Attach the shift actuator harness connector to the connector retainer.
43. Connect the engine harness to the shift actuator harness.
44. Install the oil dipstick.

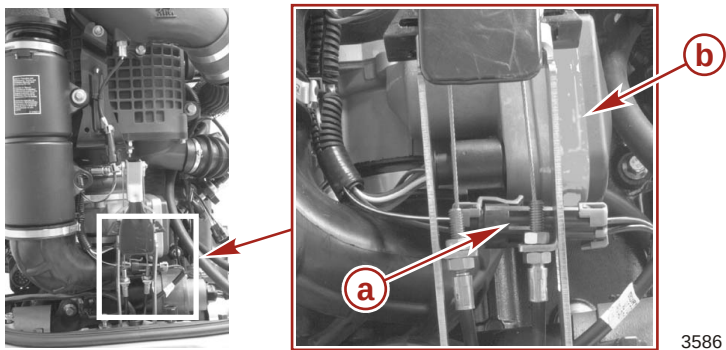


3696

- a - Cotter pin

b - Washer
- c - Shift actuator harness connector

45. Connect the shift indicator harness to the engine harness.

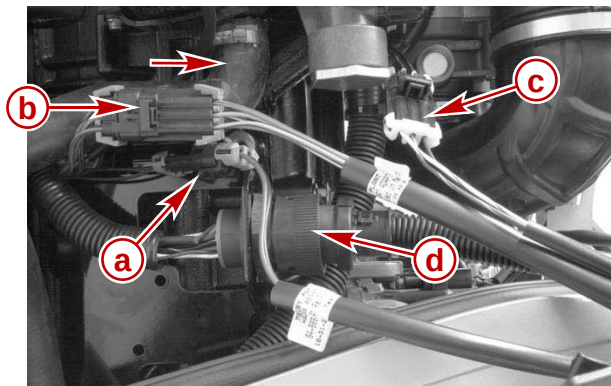


3586

- a - Shift indicator harness
- b - ETC

46. Connect the DTS power harness, boat sensor harness, power steering sensor harness and 14 pin engine harness.

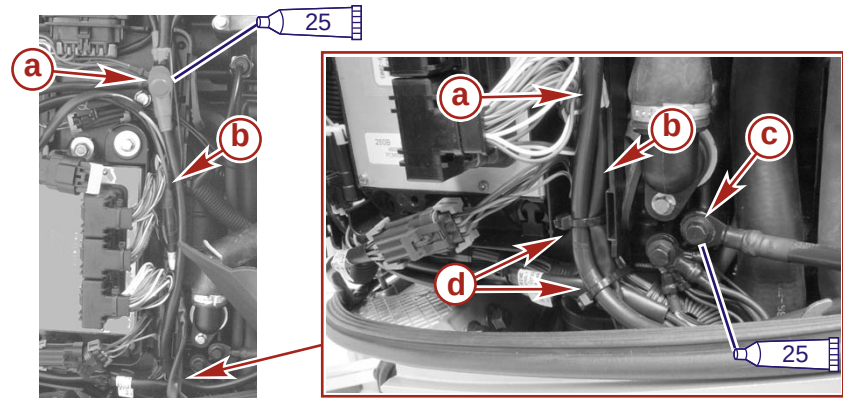
NOTE: The boat sensor harness connector must be supported with the harness retainer. Align the slot on the back of the boat sensor harness with the harness retainer. Slide the boat sensor harness connector onto the harness retainer.



3698

- a** - DTS power harness
- b** - Boat sensor harness
- c** - Power steering harness
- d** - 14 pin engine harness

47. Connect the battery positive and negative cables. Tighten to the specified torque. Secure the positive battery cable and the trim wire harness with two cable ties. Cover the battery positive and negative cable connection on engine with Liquid Neoprene.



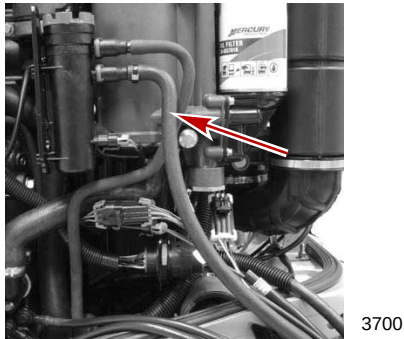
3702

- a** - Positive battery cable
- b** - Trim wire harness
- c** - Negative battery cable
- d** - Cable ties

Description	Nm	lb. in.	lb. ft.
Battery positive cable nut	9	80	
Battery negative cable nut	17	150.5	

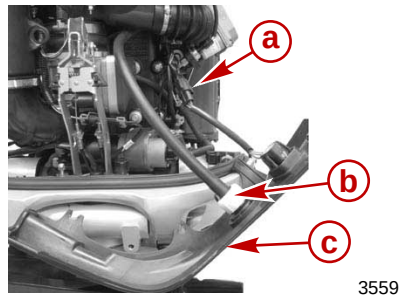
Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Battery positive and negative cable connection on engine	92-25711-3

48. Connect the fuel hoses to the fuel filter.



49. Connect the trim switch on the port front cowl with the engine harness.

50. Connect the fresh water flush to the engine cowl.



a - Trim harness connector

b - Fresh water flush

c - Port front cowl

51. Install the port and starboard front cowls.

52. Install the lower chaps.

53. Install the rear cowl.

54. Connect the engine battery cables to the battery.

55. Fill the oil pan with engine oil.

Powerhead

Section 4B - Cylinder Head

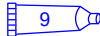
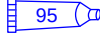
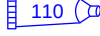
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Cylinder Head Specifications

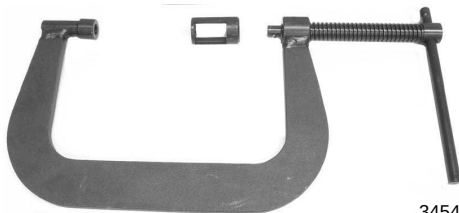
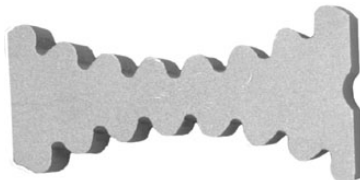
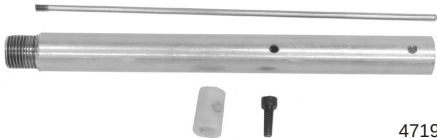
Cylinder Head Specifications	
Maximum deck warp	0.075 mm (0.003)
Number of valves	24
Number of valves per cylinder	4
Number of cams	2
Cam bearing journal (intake and exhaust)	28.95 mm (1.1398 in.)
Camshaft bearing cap ID	29.000 - 29.021 mm (1.1417 - 1.1425 in.)
Cam lobe	
Intake	42.50 mm (1.6732 in.)
Exhaust	43.55 mm 1.7145 in.)
Valve lash	
Intake	0.150 - 0.230 mm (0.0059 - 0.009)
Exhaust	0.350 - 0.430 mm (0.0137 - 0.0169 in.)
Valve seat angles	30°, 45°, 60°
Valve spring free length	48.77 mm (1.920 in.)
Valve outside diameter	
Intake	32.0 ± 0.15 mm (1.259 ± 0.0059 in.)
Exhaust	27.2 mm ± 0.190 (1.0708 ± 0.0059 in.)
Valve face width (intake and exhaust)	2.25 mm (0.0886 in.)
Valve margin	
Intake	0.75 mm (0.0295 in.)
Exhaust	0.65 mm (0.0256 in.)
Valve guide bore ID (intake and exhaust)	6.00 - 6.016mm (0.2362 - 0.2368 in.)
Valve stem diameter	
Intake	5.97 mm (0.235 in.)
Exhaust	5.96 mm (0.2346 in.)
Valve stem run-out (maximum)	0.038 mm (0.0015 in.)
Valve stem to valve guide clearance	
Intake	0.03 - 0.046 mm (0.0011 - 0.0018 in.)
Exhaust	0.04 - 0.056 mm (0.0015 - 0.0022 in.)
Valve seat contact width (intake and exhaust)	2.25 mm (0.0886 in.)

Lubricant, Sealant, Adhesives

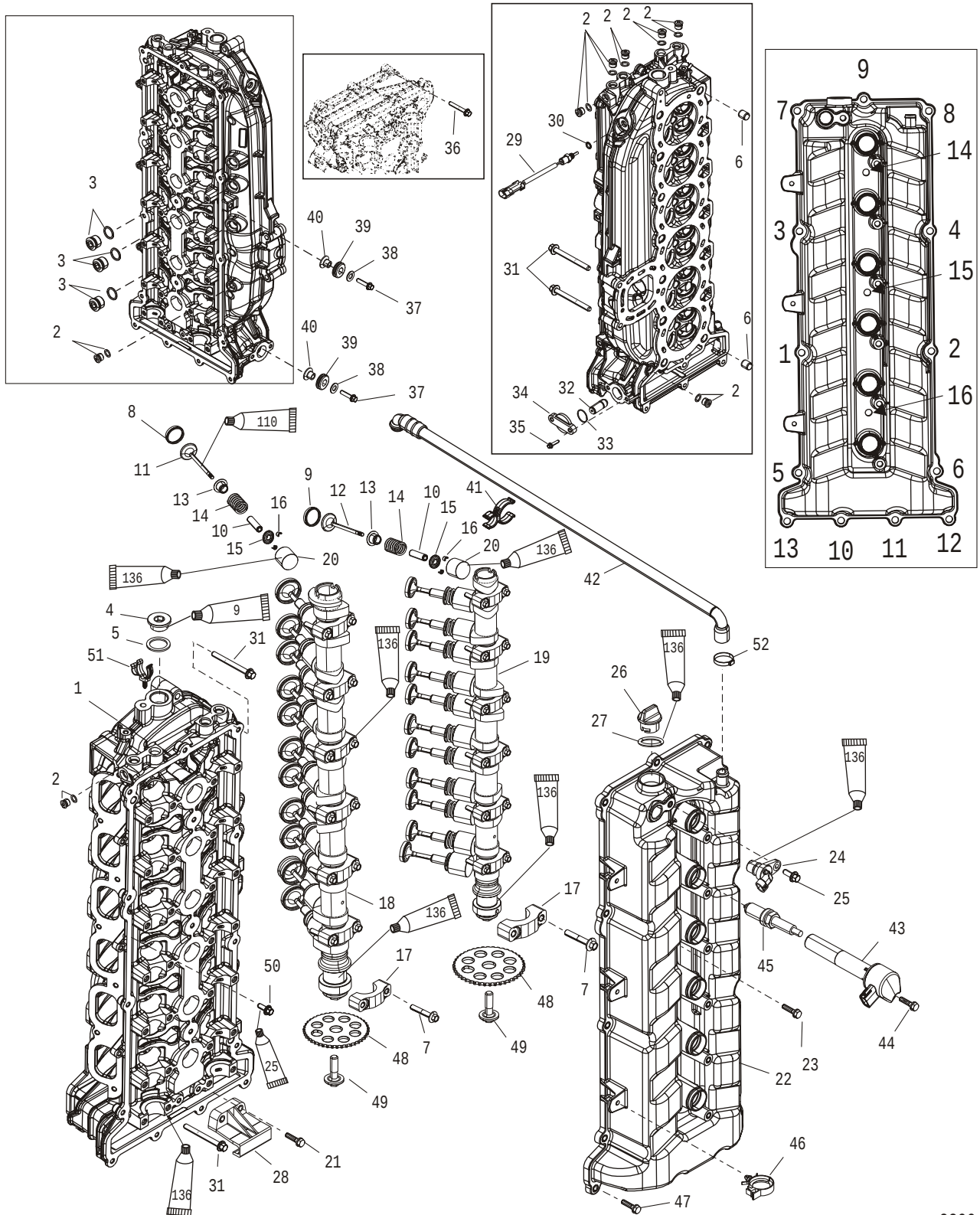
Tube Ref No.	Description	Where Used	Part No.
 9	Loctite 567 PST Pipe Sealant	Oil and water galley plugs	92-809822
 25	Liquid Neoprene	Ground Bolt	92-25711-3
 95	2-4-C with Teflon	Installing valve spring retaining cotter	92-802859A1
 110	4 Stroke 10W30 Outboard Oil	Valve Stem	92-802833A1

Tube Ref No.	Description	Where Used	Part No.
 136	Lubriplate SPO 255	Oil fill cap O-ring, Cam bearings, Valve bucket tappet	Obtain Locally
		Valve bucket tappet outside diameter	
		Cam bearing	
		Cam journal	
 139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Valve guide seal	92-883722K01
		Valve stem	

Special Tools - Cylinder Head

Valve Spring Compressor	91-809494A1
 3454	Removes and installs valve springs.
Cam Brake	Part number currently not available for this publication.
 5539	Prevents the intake and exhaust cam from turning while removing or installing cam retaining bolts.
13 mm Torque Adaptor	91-809905001
 4631	Aids in the removal and installation of powerhead nuts, and torquing nuts to specification.
Dial Indicator Extension Adaptor	Part number currently not available for this publication.
 4719	Extends the dial indicators reach.

Cylinder Head Components



2390

Cylinder Head Components

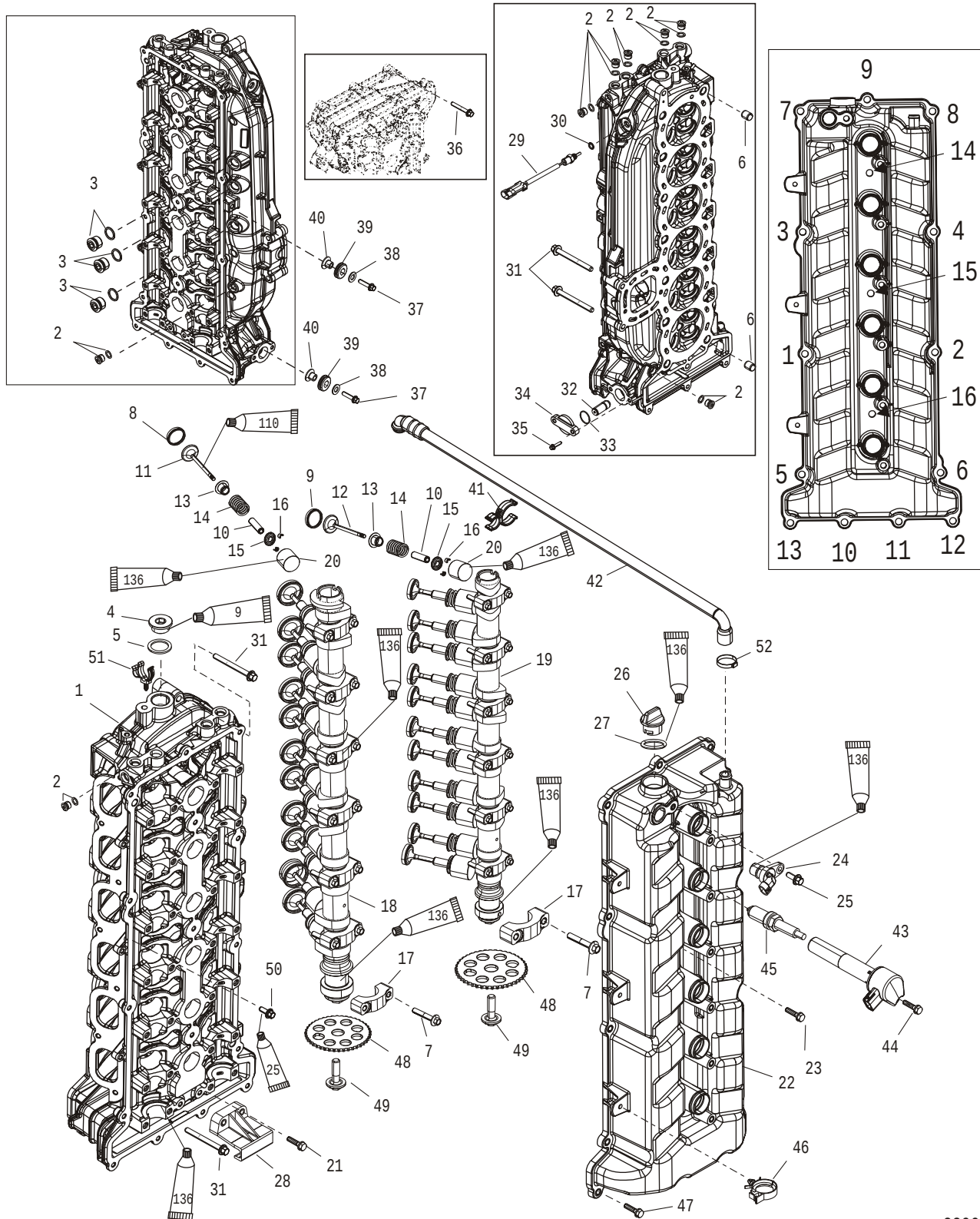
Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Cylinder head			
2	8	Plug (12 mm)	9	80	
3	3	Plug (18 mm)	22		16
4	1	Plug (24 mm)	50		36.8
5	1	Washer			
6	2	Dowl pin, (14 mm)			
7	28	Bolt (M6 x 36)	12	106	
8	12	Seat, Intake valve			
9	12	Seat, Exhaust valve			
10	24	Guide			
11	12	Intake valve			
12	12	Exhaust valve			
13	24	Seal, Valve - Spring seat			
14	24	Spring, Valve			
15	24	Retainer, Valve			
16	48	Key			
17	14	Cap			
18	1	Camshaft, Intake			
19	1	Camshaft, Exhaust			
20	24	Tappet, Bucket			
21	2	Screw (M6 x 30)	12	106	
22	1	Cover			
23	6	Screw (M6 x 25)	8	71	
24	1	Sensor			
25	1	Screw (M6 x 16)	8	71	
26	1	Plug, Oil			
27	1	O-Ring			
28	1	Guide, Short			
29	1	Temperature sensor			
30	1	O-Ring			
31	4	Screw (M8 x 60)	20		14.75
32	1	Tensioner, Timing chain			
33	1	O-Ring			
34	1	End Cap, Tensioner			
35	2	Screw (M6 x 25)	11	97	
36	3	Screw (M6 x 40)	8	71	
37	2	Screw (M8 x 35)	24		17.7
38	2	Washer			
39	2	Grommet			
40	2	Bushing			

Cylinder Head

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
41	1	Clip			
42	1	Hose, Breather			
43	6	Coil			
44	6	Screw (M6 x 25)	8	71	
45	6	Spark plug	27	239	19.9
46	3	Clip			
47	10	Screw (M6 x 25)	8	71	
48	2	Sprocket, Cam drive			
49	2	Screw (M6 x 40) Left Hand	45		33
			Turn additional 20° after initial torque		
50	2	Screw (M6 x 12)	8	71	
51	1	Clip			
52	1	Clamp (22.6)			

Tube Ref No.	Description	Where Used	Part No.
 25	Liquid Neoprene	Ground Bolt	92-25711-3
 110	4 Stroke 10W30 Outboard Oil	Valve Stem	92-802833A1
 136	Lubriplate SPO 255	Oil fill cap O-ring, Cam bearings, Valve bucket tappet	Obtain Locally
 9	Loctite 567 PST Pipe Sealant	Oil and water galley plugs	92-809822

Cylinder Head Components



2390

Cylinder Head Disassembly

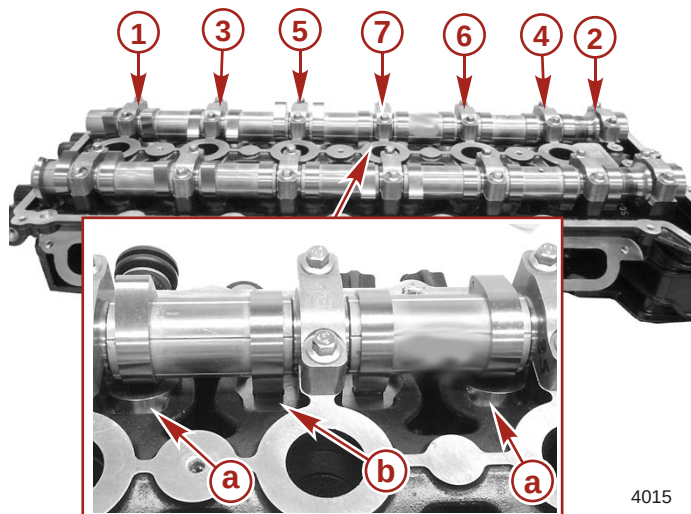
Cam Removal

IMPORTANT: The removal and disassembly procedure of the head and cams must be strictly followed. Failure to follow the removal outline procedure may damage the valve train components and or cylinder head.

1. Starting with the cam cap that is furthest away from the cam lobes that are engaging the valve bucket, and working towards the cam lobe that is not engaging the valve bucket, release the pressure on the cam caps one quarter (1/4) turn at a time. Continue with the sequence and release the pressure one quarter (1/4) turn at a time until all tension on the cam caps is released.

⚠ CAUTION

Do not release the tension on the cam caps more than one quarter (1/4) turn at a time. Turning the cam cap screws more than one quarter (1/4) turn at a time may damage the cam cap, cam cap guides, cam cap to cylinder head mating surface, or cam. Damage to any of these components is not repairable and must be replaced.



a - Cam lobe not engaging valve bucket

b - Cam lobe engaging valve bucket

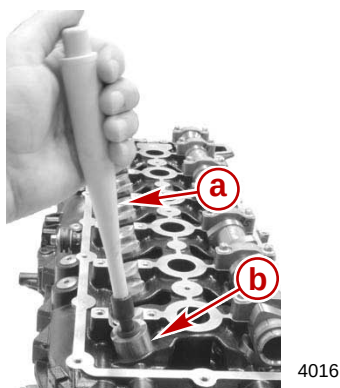
NOTE: All cam caps are marked in chronological sequence starting from the top with number 1 and working down to number 7. The cam caps also have a direction arrow pointing to the top of the head.

2. Remove the cam caps.
3. Lift the cam out of the cylinder head cam bearing.

Valve Removal

1. Clean the surface of the valve buckets with a solvent to remove any oil residue. With an indelible magic marker, write on the top of the valve bucket its location: E1, E2, E3, I1, I2, I3, etc.
2. Remove the valve bucket tappet with a vacuum assisted valve lashing tool. Do not use a magnet to remove the valve bucket tappets.

IMPORTANT: Do not inter-mix the location of the valve train parts. The valve bucket tappets have different dimensions to correct for proper valve lash clearance. Note the location of the valve bucket tappets and valves.



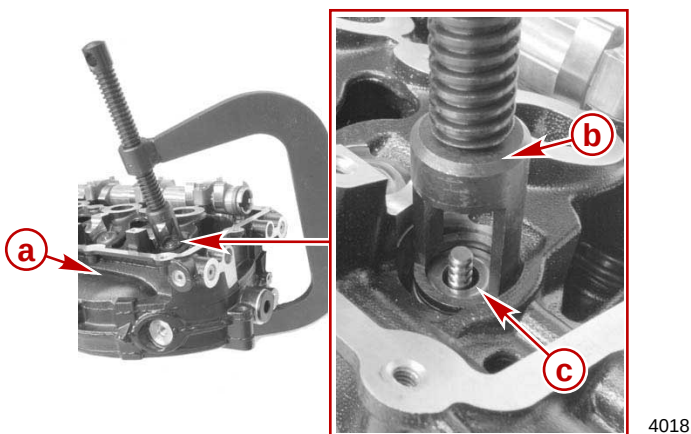
a - Vacuum assisted valve lashing tool

b - Valve bucket tappet

3. Use a valve spring compressor to collapse the valve spring to remove the valve spring cotters.

NOTE: Do not damage the cylinder head valve bucket tappet bore when using the valve spring compressor.

IMPORTANT: Do not inter-mix the valves and the location where they were removed.



a - Cylinder head

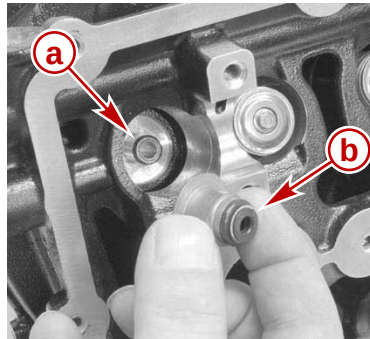
b - Valve spring compressor

c - Valve stem

Valve Spring Compressor	91-809494A1
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4. Release the valve spring compressor.
5. Remove the valve.

6. Remove the valve guide seal.



4019

a - Valve guide

b - Valve guide seal

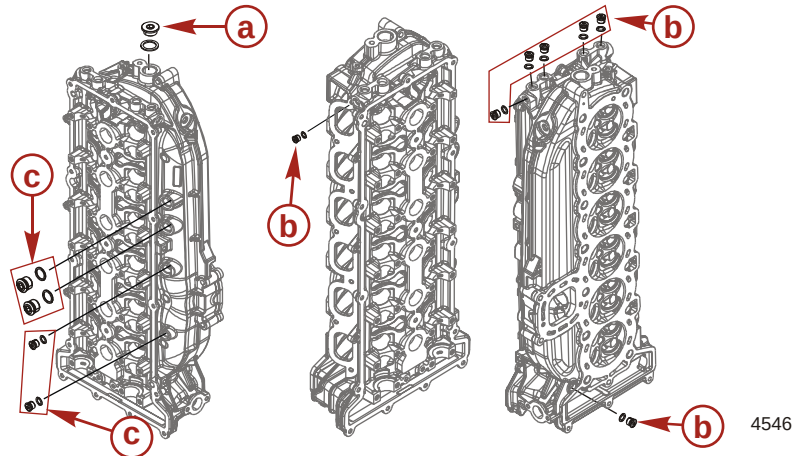
NOTE: Do not reuse valve guide seals after the valve has been removed.

Cylinder Head Galley Plug Removal

1. Remove all of the oil and water galley plugs from the cylinder head.

NOTE: It may be necessary to lightly tap on the galley plugs with a brass drift and hammer to break the galley plug seal.

2. Remove the O-rings from the oil and water galley plugs and discard the galley plug O-rings.



4546

a - Water galley plug

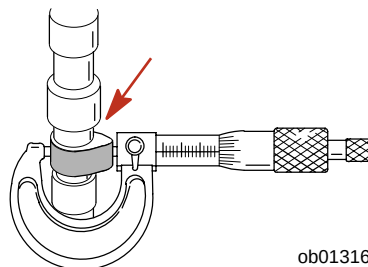
b - Oil galley plug (12 mm)

c - Water galley plug

Cleaning/Inspection/Repair

Camshaft

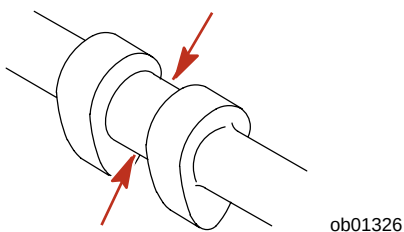
1. Measure the cam lobe at its valve open (maximum valve lift). Replace the cam if the dimensions are out of specification.



ob01316

Cam Lobe Specifications	
Intake cam	42.50 mm (1.673 in.)
Exhaust cam	43.55 mm (1.716 in.)

- Measure all of the camshaft bearing journals with a micrometer. Replace the cam if the journal dimensions are out of specification.

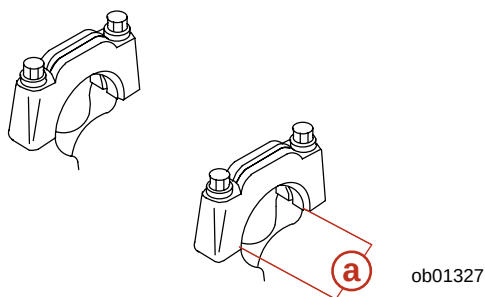


Cam Bearing	
Journal O.D.	28.950 mm (1.140 in.)

- Install the camshaft bearing caps in their correct location. Tighten the camshaft bearing screws to the specified torque.

Description	Nm	lb. in.	lb. ft.
Camshaft bearing cap screw	12	106	

- Measure the inside dimension of the camshaft bearing cap. Replace the cylinder head if the dimension is out of specification.

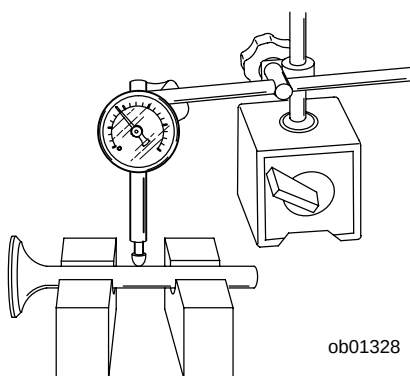


a - Camshaft bearing cap inside dimension

Camshaft Bearing Cap	
Inside diameter	29.0 - 29.21 mm (1.1417 - 1.145 in.)

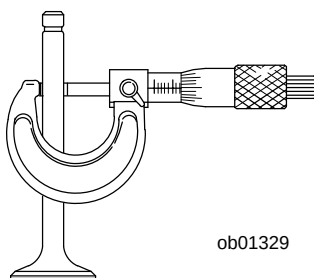
Valves

- Inspect valves for damage/warpage. Replace if necessary.
- Measure valve stem run-out. Replace valves if out of specification.



Valve Stem	
Run-Out	0.038 mm (0.0015 in.) Maximum

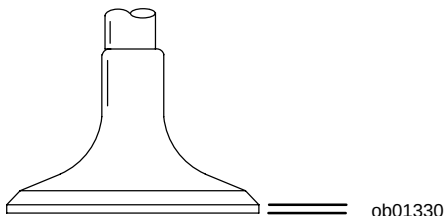
3. Measure the valve stem diameter. Replace valves if out of specification.



ob01329

Valve Stem Diameter	
Intake	5.970 mm (0.2350 in.)
Exhaust	5.960 mm (0.2346 in.)

4. Measure margin thickness. Replace valve if out of specification.

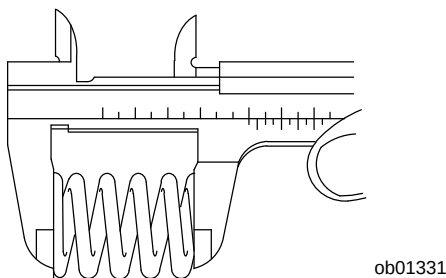


ob01330

Valve Margin thickness	
Intake	0.750 mm (0.0295 in.)
Exhaust	0.650 mm (0.0256 in.)

Valve Springs

1. Check free length of each spring. Replace valve springs if out of specification.



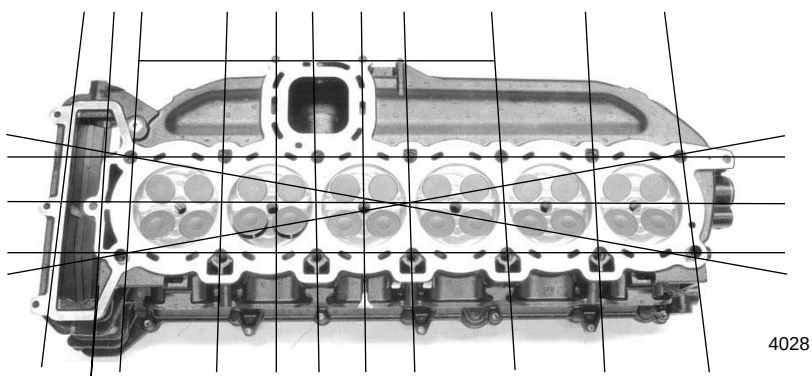
ob01331

Valve Spring	
Free length	48.77mm (1.920 in.)

Cylinder Head

1. Inspect the cylinder head for mineral deposits/corrosion in the water passage ways, clean any deposits/corrosion observed.
2. Inspect the cylinder head for carbon deposits in combustion chamber (use round scraper to clean away deposits). Be careful not to scratch or remove material.
3. Measure cylinder head warpage. Replace cylinder head if out of specification.

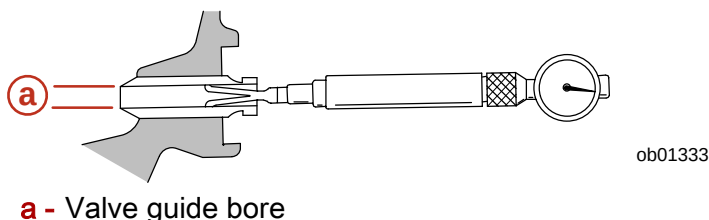
NOTE: Use a straight edge and a thickness gauge to inspect cylinder head for warpage.



Cylinder Head	
Maximum deck warp	0.075 mm (0.003 in.)

Valve Guides

Measure the valve guide bore with a valve guide bore gauge. If valve guide wear is out of specification, replace the valve guide.



Valve Guide Bore	
Intake and Exhaust	6.00 - 6.016 mm (0.2362 - 0.2368 in.)

VALVE GUIDE REPLACEMENT

NOTE: Inexperienced personnel should not attempt to replace the valve guide. A reputable engine machine shop will have the tools to replace the valve guides and ream the guides to proper tolerance.

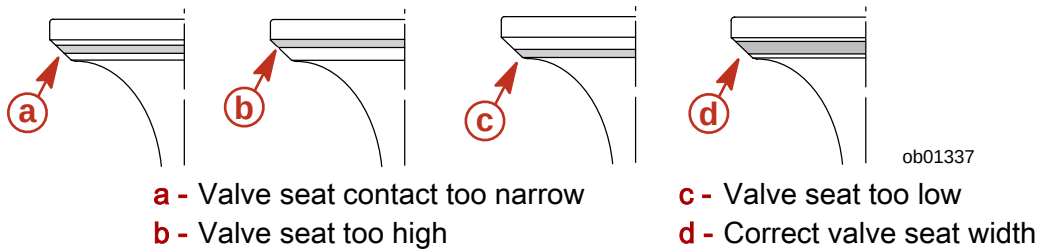
IMPORTANT: The valve guide must be removed and installed at room temperature. Use a pneumatic impact hammer to remove and install the valve guide.

Valve Stem To Valve Guide Clearance	
Intake	0.03 - 0.046 mm (0.0011 - 0.0018 in.)
Exhaust	0.04 - 0.056 mm (0.0015 - 0.0022 in.)

Valve Seat Reconditioning

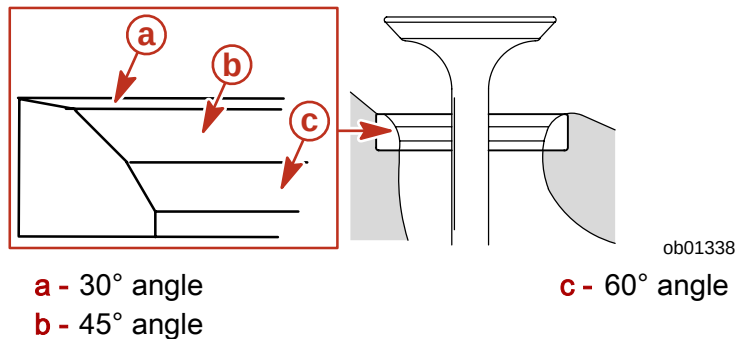
1. Clean the carbon deposits from the combustion chambers and valve seats. Check the valve seats for pitting.
2. Several different types of equipment are available for re-seating valve seats. Follow the equipment manufacturers instructions.
3. Apply a thin, even layer of mechanic's bluing dye (Dykem) onto the valve seat.
4. Insert the valve into the valve guide and lap the valve slowly on the valve seat.

5. Remove the valve and measure the valve seat contact pattern width. Resurface the valve seat if not in specification.



Valve Seat Contact Width	
Intake and Exhaust	2.25 mm (0.0886 in.)

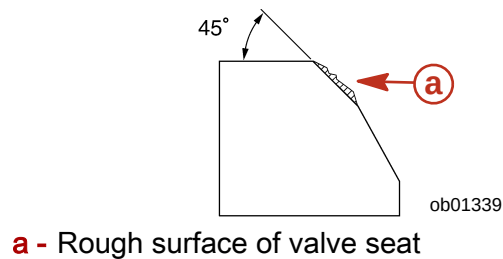
6. To re-face a valve seat, use a 30°, 45°, and 60° valve seat cutting tool.



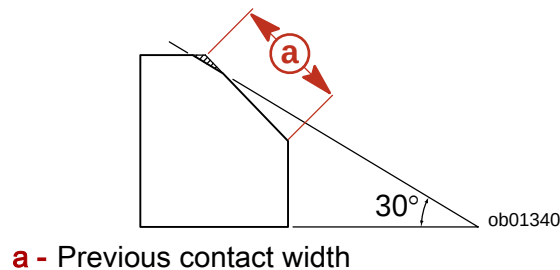
NOTE: When twisting cutter, keep an even downward pressure to prevent chatter marks.

NOTE: After re-facing the valve seat or replacing the valve and valve guide, the valve seat and valve face should be lapped.

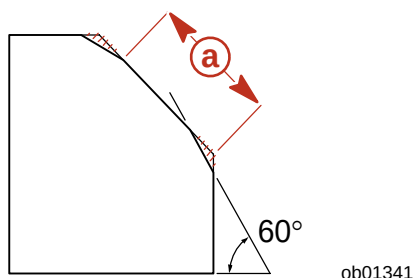
7. Start with 45° cutting tool to clean up any pitting or rough surface of the valve seat.



8. Use the 30° cutting tool to adjust the contact width of the top edge of the valve seat.

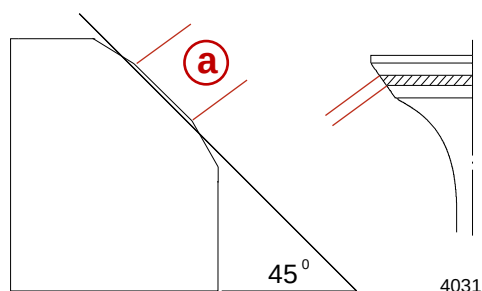


9. Use the 60° cutting tool to adjust the contact width of the bottom edge of the valve seat.



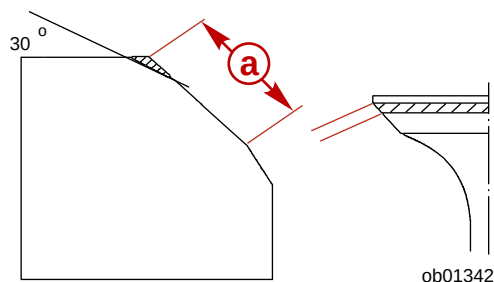
a - Previous contact width

10. If the valve seat contact area is too narrow and situated in the center of the valve face, use the 45° cutting tool to adjust its contact width.



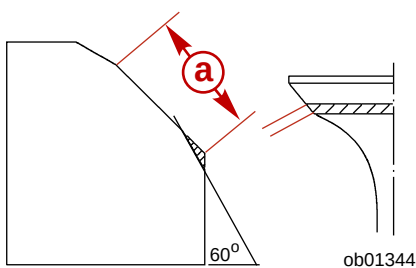
a - Previous contact width

11. If the valve seat contact area is too narrow and situated near the top of the valve face, use the 30° cutting tool to cut the top edge of the valve seat. If necessary, use the 45° cutting tool to center the area of contact and set its width.



a - Previous contact width

12. If the valve seat contact area is too narrow and situated near the bottom of the valve face, use the 60° cutting tool to cut the bottom edge of the valve seat. If necessary, use the 45° cutting tool to center the area of contact and set its width.



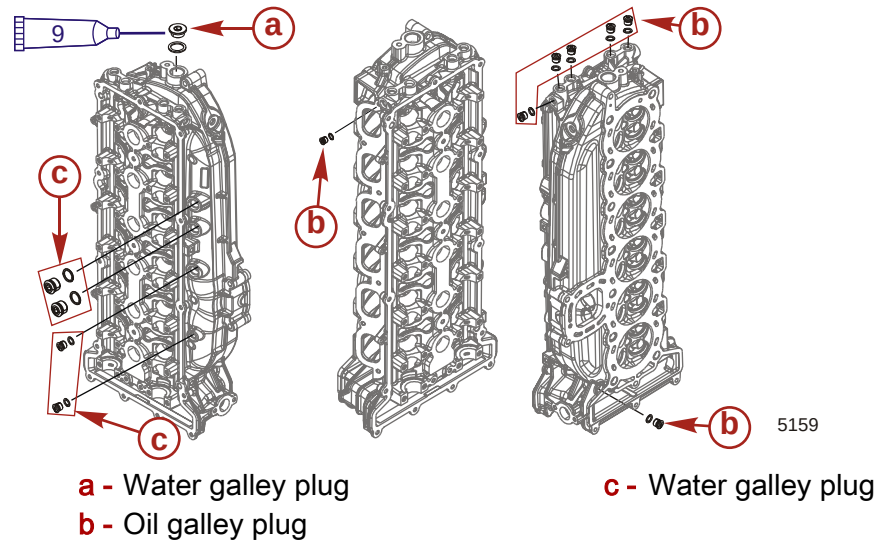
a - Previous contact width

13. After reconditioning the valve seat, the valve stem protrusion must be checked.

Cylinder Head Reassembly

Cylinder Head Galley Plug Installation

- 1. Install new O-rings on the oil and water galley plugs.
- 2. Seal the threads of the oil and water galley plugs with Loctite 567 PST Pipe Sealant.
- 3. Tighten the oil and water galley plug to the specified torque.



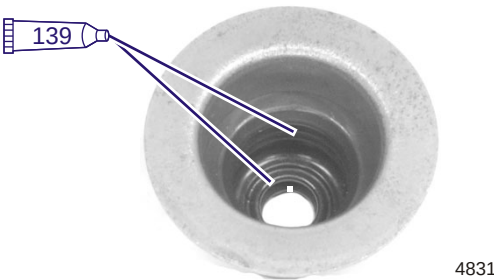
Description	Nm	lb. in.	lb. ft.
Water galley plug "a"	55		40.5
Oil galley plug "b"	9	80	
Water galley plug "c"	22		16.2

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Oil and water galley plugs	92-809822

Valves

IMPORTANT: The reassembly procedure of the cylinder head must be strictly followed. Failure to follow the assembly procedure may damage the valves, cam, or cylinder head.

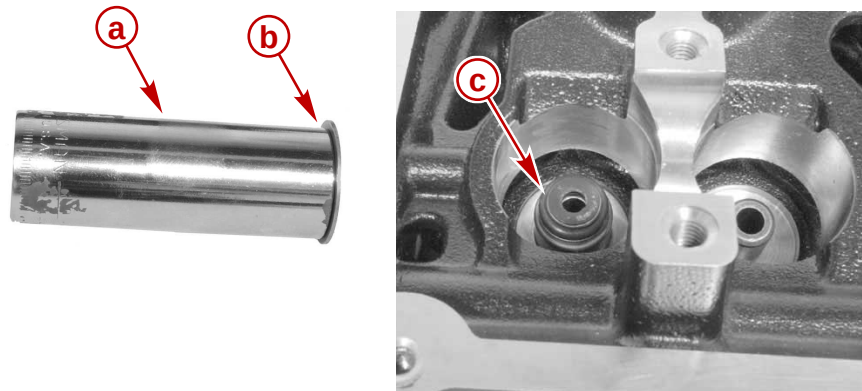
- 1. Lubricate valve guide seal with Synthetic Blend 4-Stroke Outboard Oil 25W-40.



Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Valve guide seal	92-883722K01

- 2. Insert the valve guide seal into a 17 mm (11/16 in.) deep well socket.

3. Install the valve guide seal onto the valve guide. Lightly push the valve guide seal with the socket until it is seated on the cylinder head.



4832

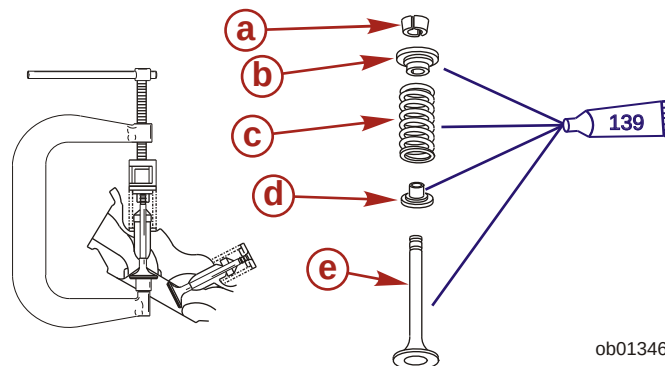
a - 17 mm (11/16 in.) socket
b - Valve guide seal

c - Valve guide installed on valve guide

4. Lubricate the valve stem with Synthetic Blend 4-Stroke Outboard Oil 25W-40 and push valve through valve guide seal.
5. Place the valve spring and valve spring retainer over the valve stem.
6. Compress the valve spring with a valve spring compressor.

NOTE: The valve springs can be install in any direction.

IMPORTANT: Use caution when compressing the valve spring. Do not damage the valve, valve spring retainer or the cylinder head valve tappet bucket bore.



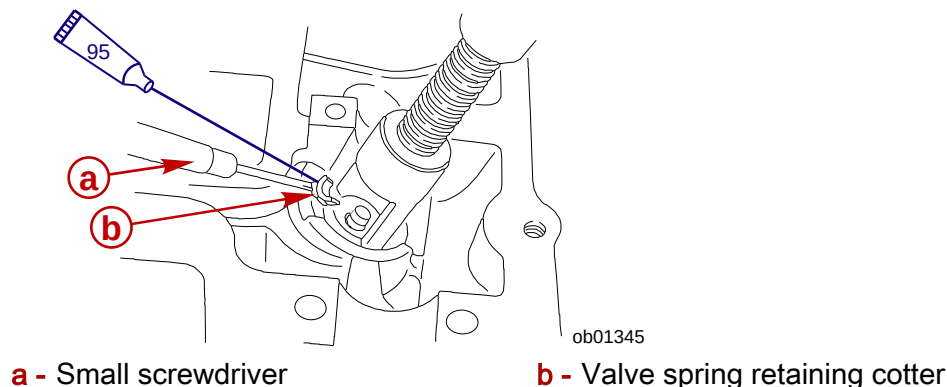
ob01346

a - Valve spring retaining cotter
b - Valve spring retainer
c - Valve spring

d - Valve guide seal
e - Valve (intake and exhaust)

Tube Ref No.	Description	Where Used	Part No.
	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Valve stem	92-883722K01
Valve Spring Compressor		91-809494A1	

7. Place the valve spring retaining cotter onto the end of a small screwdriver. A small amount of 2-4-C with Teflon applied to the end of the screwdriver will help the valve spring retaining cotter to adhere to the screwdriver. Install the valve spring retaining cotter onto the valve stem.



Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C with Teflon	Installing valve spring retaining cotter	92-802859A1

8. Release the valve spring compressor.
9. Continue to assemble all valves onto cylinder head.

Cams

1. Lubricate the valve bucket tappet outside diameter with SPO 255 and install in the same location it was removed from during disassembly.

Tube Ref No.	Description	Where Used	Part No.
 136	Lubriplate SPO 255	Valve bucket tappet outside diameter	Obtain Locally

IMPORTANT: If the valve or the valve seat was replaced/refaced, or the cam and/or cylinder head was replaced, you must install the 2.996 mm (0.118 in.) valve bucket tappet as a starting point to ensure an accurate valve measurement lash clearance.

2. Lubricate all of the cylinder head cam bearing journals with SPO 255.

Tube Ref No.	Description	Where Used	Part No.
 136	Lubriplate SPO 255	Cam bearing	Obtain Locally

3. Carefully place either cam on the cylinder head cam journals. The intake cam location is on the port side. The exhaust cam is on the starboard side. Ensure the cam lobes for the top cylinder (number 1 cylinder) are facing away from the valves.

NOTE: The intake cam is identified by the letters "MI" on the top side of all the cam lobes. The exhaust cam is identified by the letter "ME" on the top side of all the cam lobes.

4. Lubricate the cam journal with SPO 255.

Tube Ref No.	Description	Where Used	Part No.
 136	Lubriplate SPO 255	Cam journal	Obtain Locally

5. Install the cylinder head cam caps in their proper location.

NOTE: All of the cylinder head cam caps are identified as to which side, intake [I] and exhaust [E], and to which journal the cap was removed from. The number one (1) cylinder head cam cap location is at the top of the cylinder head.

6. Tighten the cam cap screws one quarter (1/4) turn at a time.

IMPORTANT: Maintain the cam parallel to the cylinder head cam journals while the cam caps are installed and tightened. Failure to keep the cam parallel to the cam journals, may damage the cylinder head, cam or cam caps.

7. After all the cam caps are seated on the cylinder head, tighten to the specified torque.

Description	Nm	lb. in.	lb. ft.
Cam cap bolt	12	106	

8. Install the other cam following the same procedure.

9. Check the valve lash as described in the Service Manual section **Valve Clearance and Adjustments**.

Valve Clearance and Adjustments

Valve Clearance Measurement Steps

Valve Lash Clearance Specification	
Intake	0.150 - 0.230 mm (0.0059 - 0.009 in.)
Exhaust	0.350 - 0.430 mm (0.0137 - 0.0169)

IMPORTANT: Accurate valve clearance measurements must be made on a cold engine at room temperature, with the cylinder head mated to the cylinder block and torqued to specification.

All of the cam caps must be at their torque specification prior checking the valve lash measurement.

The valve lash measurement must be made with the cam lobe facing 180° from the valve bucket tappet.

1. Insert the feeler gauge between the cam and the valve bucket tappet. A slight drag on the feeler gauge will indicate the feeler gauge dimension measurement is accurate.

NOTE: An offset feeler gauge will work best for checking the valve lash measurement. A straight feeler gauge will contact the cylinder head. This contact with the cylinder head may be misleading when checking the valve lash measurement.

2. Record the feeler gauge valve lash measurement and its location on all the valves.

3. If any of the valve lash measurements are out of specification, remove the cam as described in the **Section 4A-Cylinder Head Disassembly**.

NOTE: It is not necessary to remove the cylinder head from the cylinder block to change the valve lash. The powerhead must be removed from the adaptor plate when changing valve lash.

Changing Valve Clearance

IMPORTANT: The following procedure must be completed with the cylinder head mated to the cylinder block and torqued to specification. Failure to have the cylinder head mated and torqued to specification when changing the valve clearance will result with inaccurate formula measurements.

Valve Lash Clearance Specification	
Intake	0.150 - 0.230 mm (0.0059 - 0.009 in.)

Valve Lash Clearance Specification	
Exhaust	0.350 - 0.430 mm (0.0137 - 0.0169 in.)

1. If the valve lash clearance is out of valve lash clearance specification, remove the valve bucket tappet and measure its height. Record your measurement of the valve bucket tappet dimension.



2. Add the valve bucket tappet height measurement and the feeler gauge valve lash measurement.
3. Subtract the specified valve lash clearance from the sum of the valve bucket tappet height measurement/feeler gauge valve lash measurement. This is the valve bucket tappet height measurement you need to install.

EXAMPLE

If the removed valve bucket tappet height is 2.996 mm (0.118 in.), the feeler gauge valve lash measurement is 0.30 mm (0.012 in.) and the specified valve lash clearance is 0.20 mm (0.008 in.) then the formula will appear like:

Metric Measurement: $2.996 + 0.30 - 0.20 = 3.096$ mm . New valve bucket tappet height measurement is 3.096 mm.

English Measurement: $(0.118 + 0.012 - 0.008 = 0.122$ in.). New valve bucket tappet height measurement is 0.122 in.

NOTE: Photocopy the following table for additional valve clearance measurement work sheets.

MEASUREMENT TABLE								
INTAKE (cold) 0.150 - 0.230 mm (0.0059 - 0.009 in.)					EXHAUST (cold) 0.350 - 0.430 mm (0.0137 - 0.0169 in.)			
Cylinder	Valve Bucket Tappet Height	Feeler Gauge Valve Lash Measurement	Specified Clearance	New Valve Bucket Tappet Height	Valve Bucket Tappet Height	Feeler gauge Valve Lash Measurement	Specified Clearance	New Valve Bucket Tappet Height
#1								
#2								
#3								
#4								
#5								
#6								

Powerhead

Section 4C - Lubrication

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Engine Guardian System.....	4C-6	IOM Removal.....	4C-10
Low Oil Pressure, Engine Guardian.....	4C-6	IOM Disassembly.....	4C-10
Oil Pump Removal	4C-6	IOM Assembly.....	4C-11
		IOM Installation.....	4C-13

**4
C**

Oil System Specifications

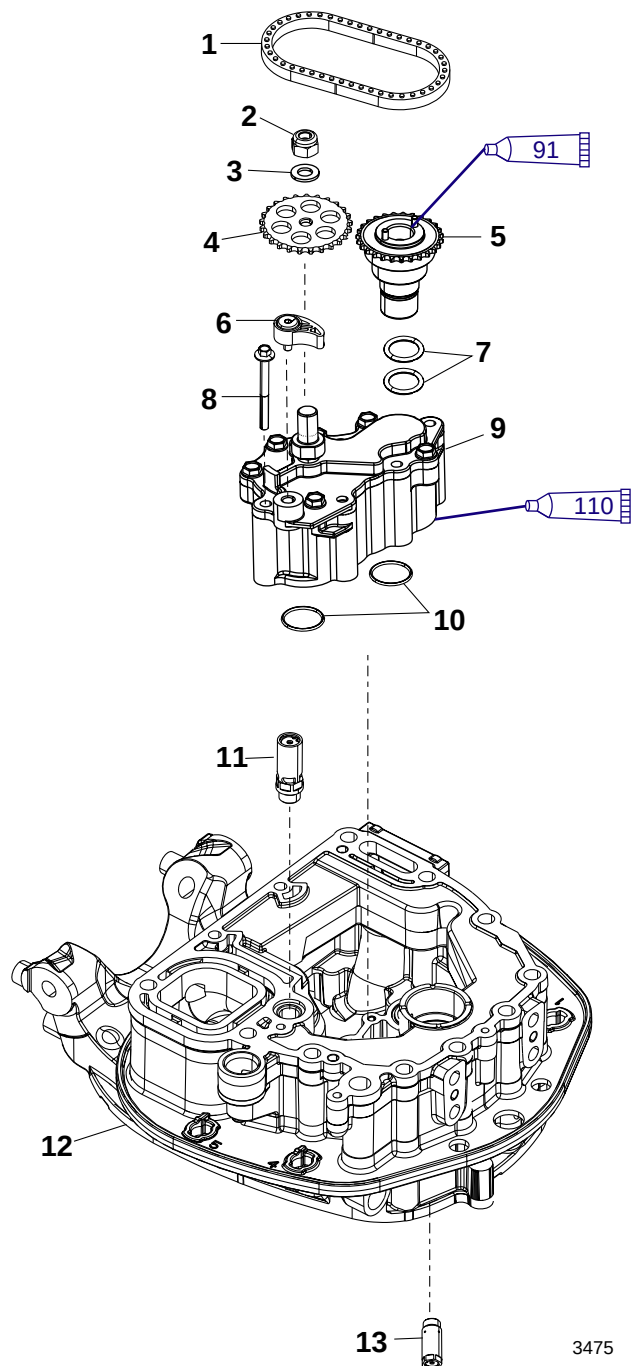
Oil System Specifications	
Engine Capacity Wet	7 liters (7.4 qts.)
Engine Capacity Dry	8 liters (8.4 qts.)
Oil Filter Part Number	35-883701K01
Oil Pressure (Minimum) @ 550 RPM	70 kPa (10 psi)
Oil Pressure (Minimum) @ 6000 RPM	220 kPa (32 psi)
IOM thermostat opening temperature	105 °C (221 °F)

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Oil pump mounting screw	92-809821
 91	Engine Coupler Spline Grease	Drive hub O-rings	92-802869A1
 139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Priming the oil pump prior to oil pump installation.	92-883722K01
		Driveshaft seals	

Notes:

Oil Pump And Adaptor Plate Components



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Oil Pump And Adaptor Plate Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Chain, Oil pump drive			
2	1	Nut, Driven sprocket	80		59
3	1	Washer			
4	1	Oil pump sprocket, driven			
5	1	Oil pump sprocket, drive			
6	1	Tensioner			
7	2	O-ring			
8	5	Screw (M6 x 65)	10	88	
9	1	Oil pump assembly			
10	2	O-ring			
11	1	Check valve assembly piston cooling			
12	1	Adaptor plate			
13	1	Check valve assembly			

Engine Guardian System

The Engine Guardian System monitors the critical sensors on the engine for any early indications of problems. The system will respond to a problem by emitting a continuous beep and/or reducing engine power in order to provide engine protection.

If Guardian System has been activated, reduce throttle speed. The problem will need to be identified and corrected, if possible. The system must be reset before the engine will operate at higher speeds. Moving the throttle lever back to the idle position will reset the system.

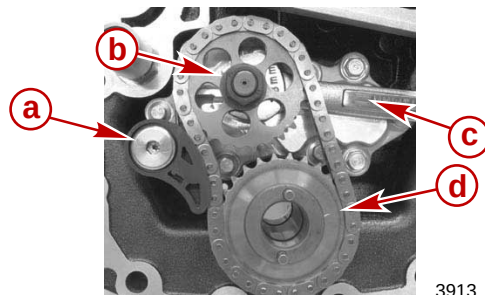
Low Oil Pressure, Engine Guardian

When the PCM receives digital information that the engine oil pressure is below a pre-determined value at any given RPM, the Engine Guardian System will sound a continuous horn and reduce the engine RPM. The amount of RPM reduction is dependent on the amount of oil pressure.

Oil Pump Removal

NOTE: The powerhead must be removed to access the oil pump.

1. Remove the powerhead. See **Section 4A - Powerhead Removal**
2. Remove the chain tensioner.
3. Place an 18 mm wrench on the oil pump shaft and remove the oil pump driven gear retaining nut.



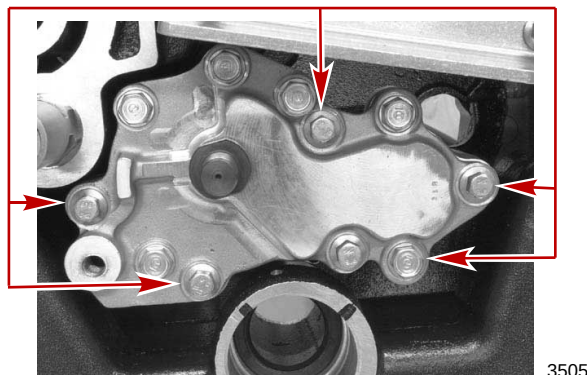
a - Chain tensioner, 6 mm internal hex

b - Oil pump driven gear retaining nut

c - 18 mm wrench

d - Oil pump drive gear

4. Carefully remove the oil pump driven gear, oil pump drive chain and the oil pump drive gear.
5. Remove the five 8 mm hex bolts securing the oil pump to the adaptor plate.

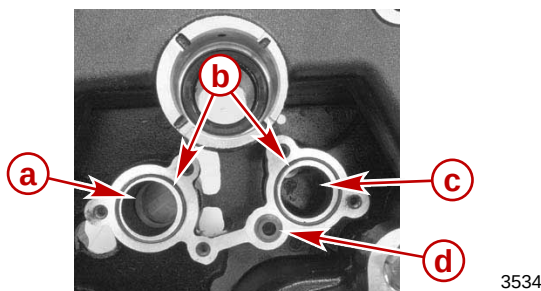


6. Lift the oil pump off the adaptor plate.

NOTE: The oil pump is a non-serviceable component and must be replaced as an assembly.

Oil Pump Installation

1. Install O-rings onto the adapter plate.



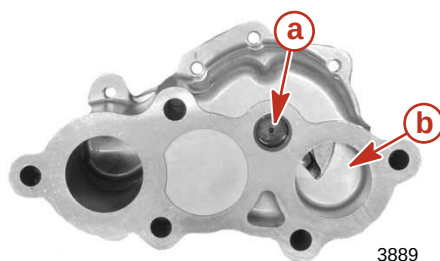
a - Oil pick up port

b - O-rings

c - Oil pump pressure relief port

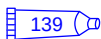
d - Oil pump locating dowel

2. Pre-lubricate oil pump by pouring 5 ml (1 teaspoon) of Synthetic Blend 4-Stroke Outboard Oil 25W-40 into oil pump port.
3. Rotate the oil pump driven shaft to distribute the oil throughout the oil pump.

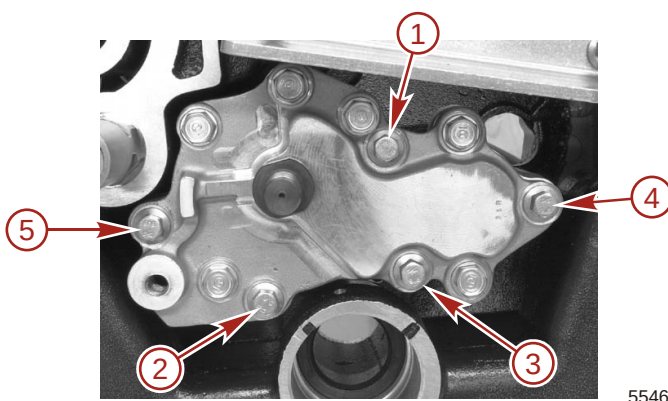


a - Oil pump driven shaft

b - Oil pump port

Tube Ref No.	Description	Where Used	Part No.
 139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Priming the oil pump prior to oil pump installation.	92-883722K01

4. Install the oil pump assembly onto the adapter plate.
5. Apply a small amount of Loctite 242 to the oil pump mounting screws.
6. Install the oil pump mounting screws and tighten in the sequence shown to the specified torque.

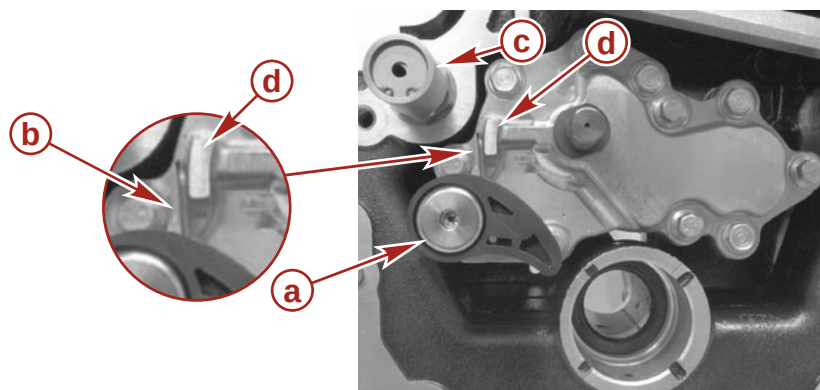


Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Oil pump mounting screw	92-809821

Description	Nm	lb. in.	lb. ft.
Oil pump mounting screw M6 x 65	10	88	

7. Install the chain tensioner. Tighten 6 mm internal hex pocket screw to the specified torque.

IMPORTANT: Ensure the chain spring leg is on the left side of the spring dam.



3539

a - Chain tensioner

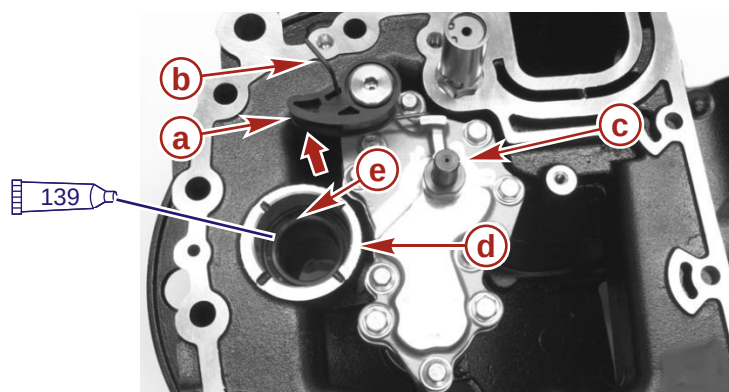
b - Chain tensioner spring leg

c - Piston cooling jet pressure control valve

d - Spring dam

Description	Nm	lb. in.	lb. ft.
Chain Tensioner Screw	19	168	

8. Rotate chain tensioner away from pump and hold in position with a retaining tool, a small drift pin or hex wrench.
9. Lubricate the driveshaft seals with Synthetic Blend 4-Stroke Outboard Oil 25W-40.



3891

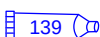
a - Chain tensioner

b - Hex wrench used to retain tensioner

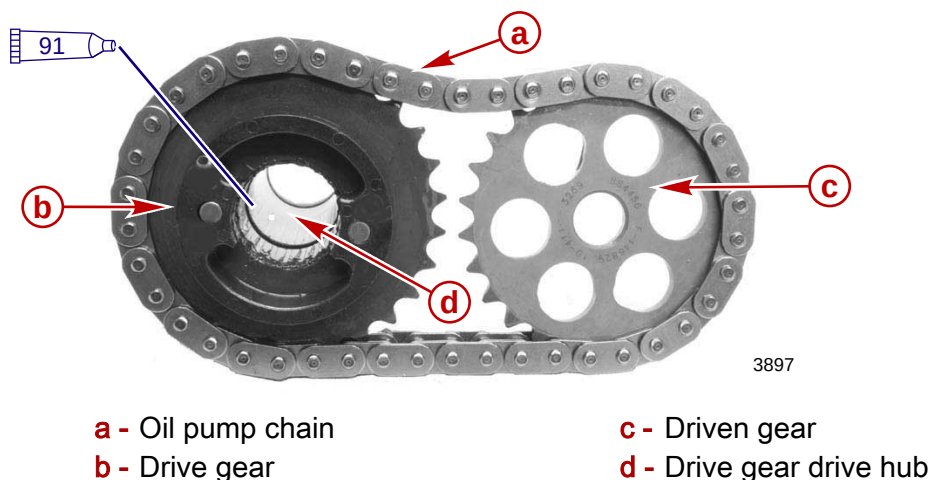
c - Oil pump shaft

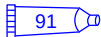
d - Drive hub cavity

e - Driveshaft seals

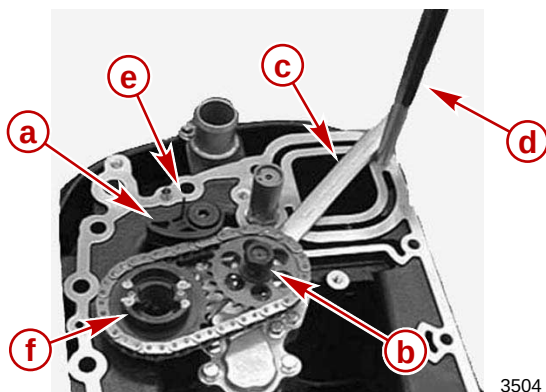
Tube Ref No.	Description	Where Used	Part No.
 139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Driveshaft seals	92-883722K01

10. Assemble the oil pump chain with the oil pump drive gear, and the oil pump driven gear with the number side facing up.
11. Lubricate the two O-rings inside the drive gear drive hub with Engine Coupler Spline Grease.



Tube Ref No.	Description	Where Used	Part No.
 91	Engine Coupler Spline Grease	Drive hub O-rings	92-802869A1

12. Slide the oil pump drive gear into the drive hub cavity while aligning the oil pump driven gear onto the oil pump shaft.
13. Align the chain tensioner and chain.
14. Place an 18 mm wrench on the oil pump shaft.
15. Place a drift pin in a bolt hole to retain wrench during torquing procedure.
16. Install washer and nut onto the oil pump shaft.
17. Tighten the oil pump driven gear nut to the specified torque.
18. Remove the retaining tool from the chain tensioner.



- a** - Chain tensioner
b - Oil pump driven gear nut and washer
c - 18 mm wrench
d - Drift pin
e - Retaining tool
f - Oil pump drive gear

Description	Nm	lb. in.	lb. ft.
Oil pump driven gear nut	80		59

Integrated Oil Module (IOM)

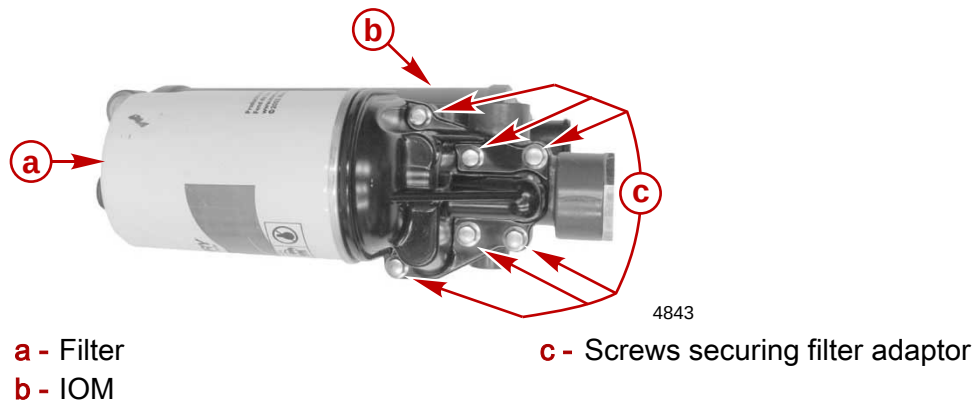
IOM Removal

Refer to section 4A - Removing Powerhead Components.

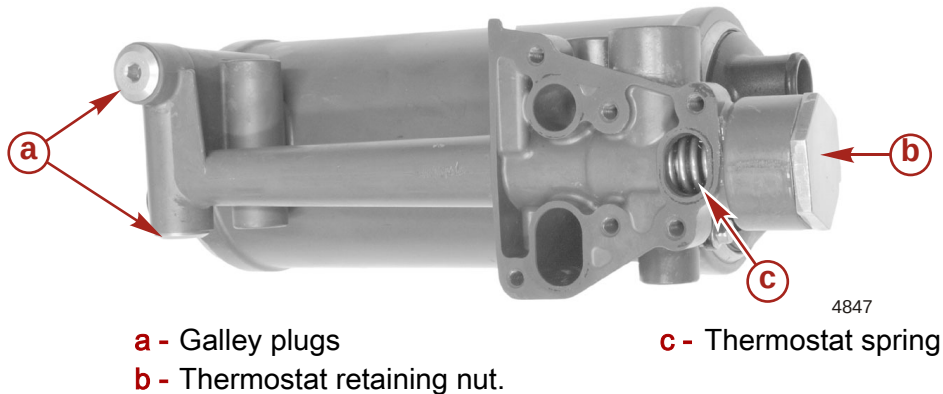
IOM Disassembly

IMPORTANT: The tube stack portion of the IOM is non-serviceable at the time of this printing. The IOM should be replaced as an assembly if fouled, damaged or blockage is suspected.

1. Remove the oil filter
2. Remove the 6 screws securing the oil filter adaptor to the IOM.
3. Remove the adaptor and gasket.

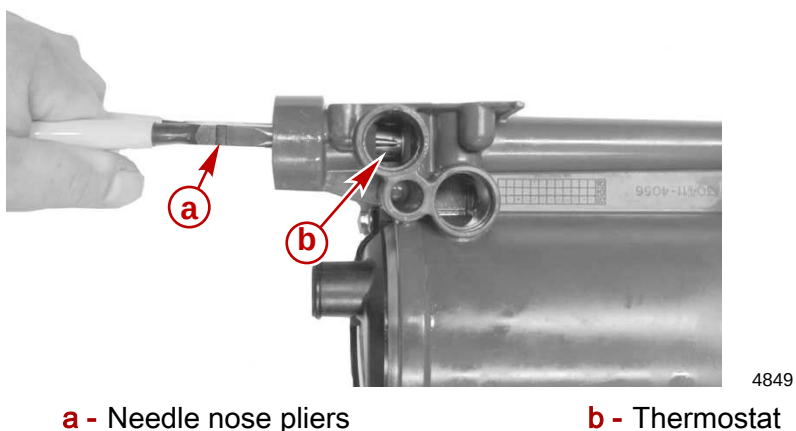


4. Remove the galley plugs.
5. Discard the galley plug O-rings.
6. Remove the thermostat retaining nut.



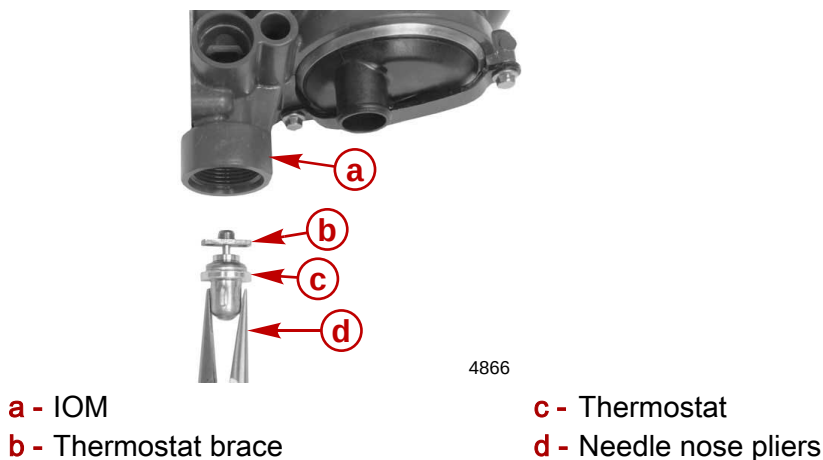
7. Remove the O-ring on the thermostat retaining nut and discard.
8. Remove the thermostat spring.

9. Use a needle nose pliers to carefully remove the thermostat and thermostat brace.

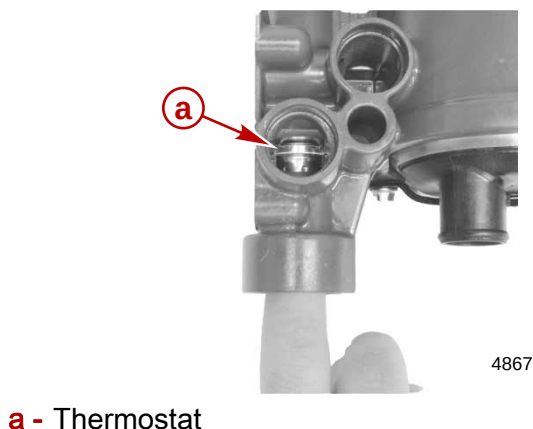


IOM Assembly

1. Install the thermostat brace onto the thermostat.
2. With a pair of needle nose pliers, slide the thermostat with the brace into the IOM thermostat cavity until it is seated in the IOM.

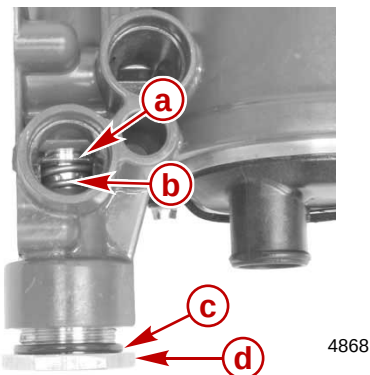


3. Check to ensure the thermostat brace has not fallen off the thermostat by pushing on the thermostat. The thermostat should spring back slightly when finger pressure is released.



4. Install the thermostat spring.

5. Install a new O-ring onto the thermostat retaining nut. Install the thermostat nut and tighten to the specified torque.

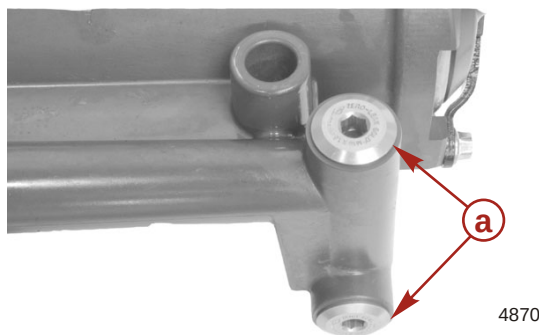


a - Thermostat
b - Thermostat spring

c - O-ring
d - Thermostat retaining nut

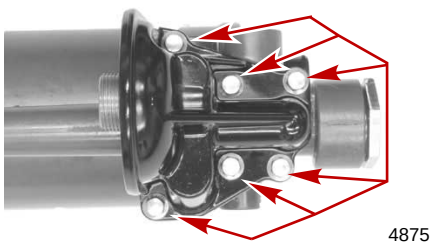
Description	Nm	lb. in.	lb. ft.
Thermostat retaining nut	24		18

6. Install new O-rings onto the galley plugs.
7. Install galley plugs and tighten the galley plugs to the specified torque.



Description	Nm	lb. in.	lb. ft.
Galley plug	22		16

8. Install a new gasket onto the IOM housing.
9. Install the oil filter adaptor onto the IOM housing. Secure the oil filter adaptor with 6 screws. Tighten the oil filter adaptor screws to the specified torque.



Description	Nm	lb. in.	lb. ft.
Oil filter adaptor screws (M6 x 18)	10	88	

10. After installing the IOM onto the powerhead, install a new oil filter.

IOM Installation

Refer to section **4B** - Installing Powerhead Components .

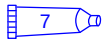
Mid-Section

Section 5A - Pedestal/Mount Cradle and Driveshaft Housing

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Lubricant, Sealant, Adhesives

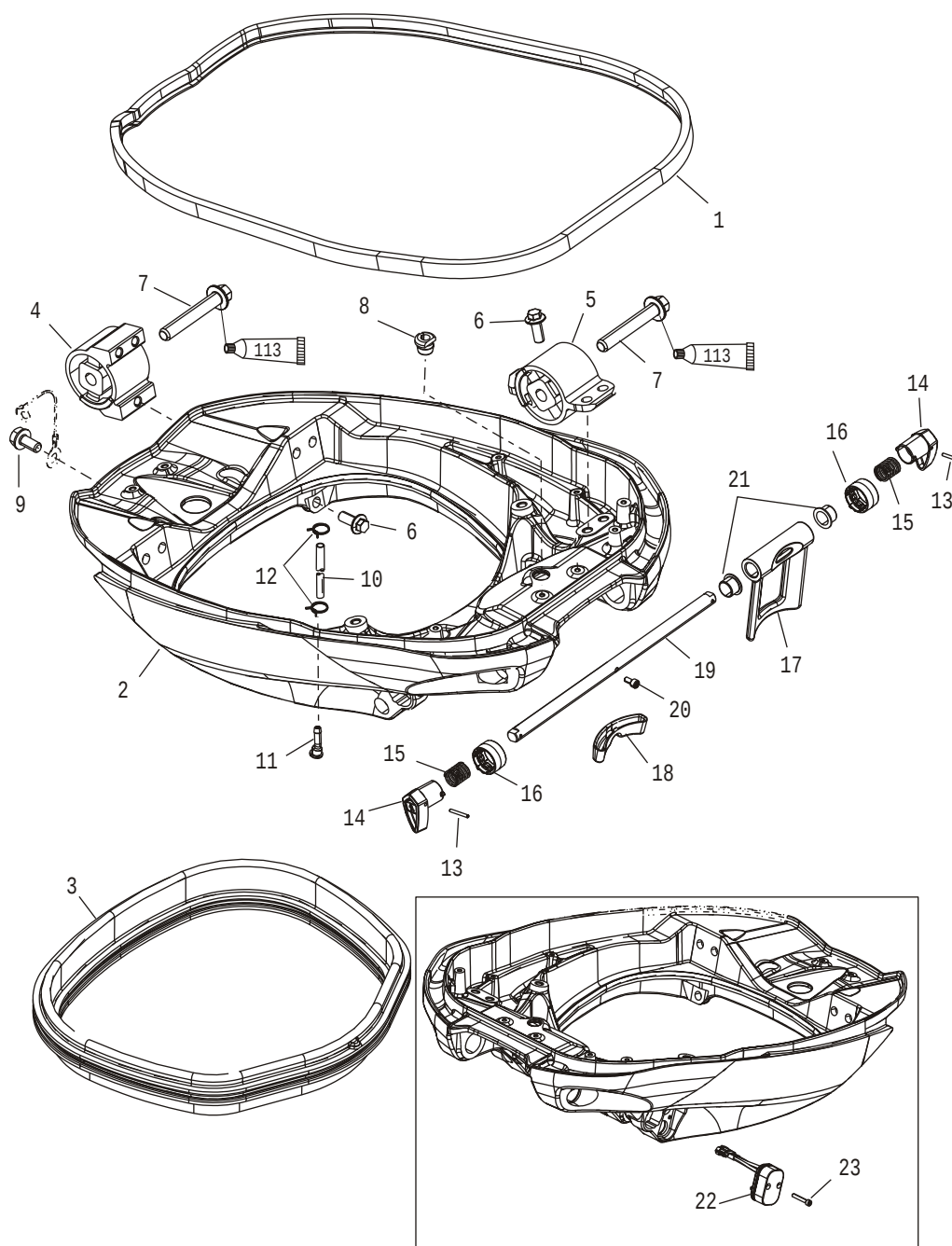
Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	M12 driveshaft housing mounting screws	92-809819
 66	Loctite 242 Threadlocker	Poppet cover screws	92-809821
		Rear motor mount screws	
		Tilt lock bracket screw	
		M8 driveshaft housing screw	
		Fuel system module mounting screws	
		Shroud mounting screws	

Special Tools - Pedestal/Mount Cradle and Driveshaft Housing

Slide Hammer Puller	91-34569A1
 ob01617	Removes tilt lock clutch from mount cradle.

Notes:

Mount Cradle Components

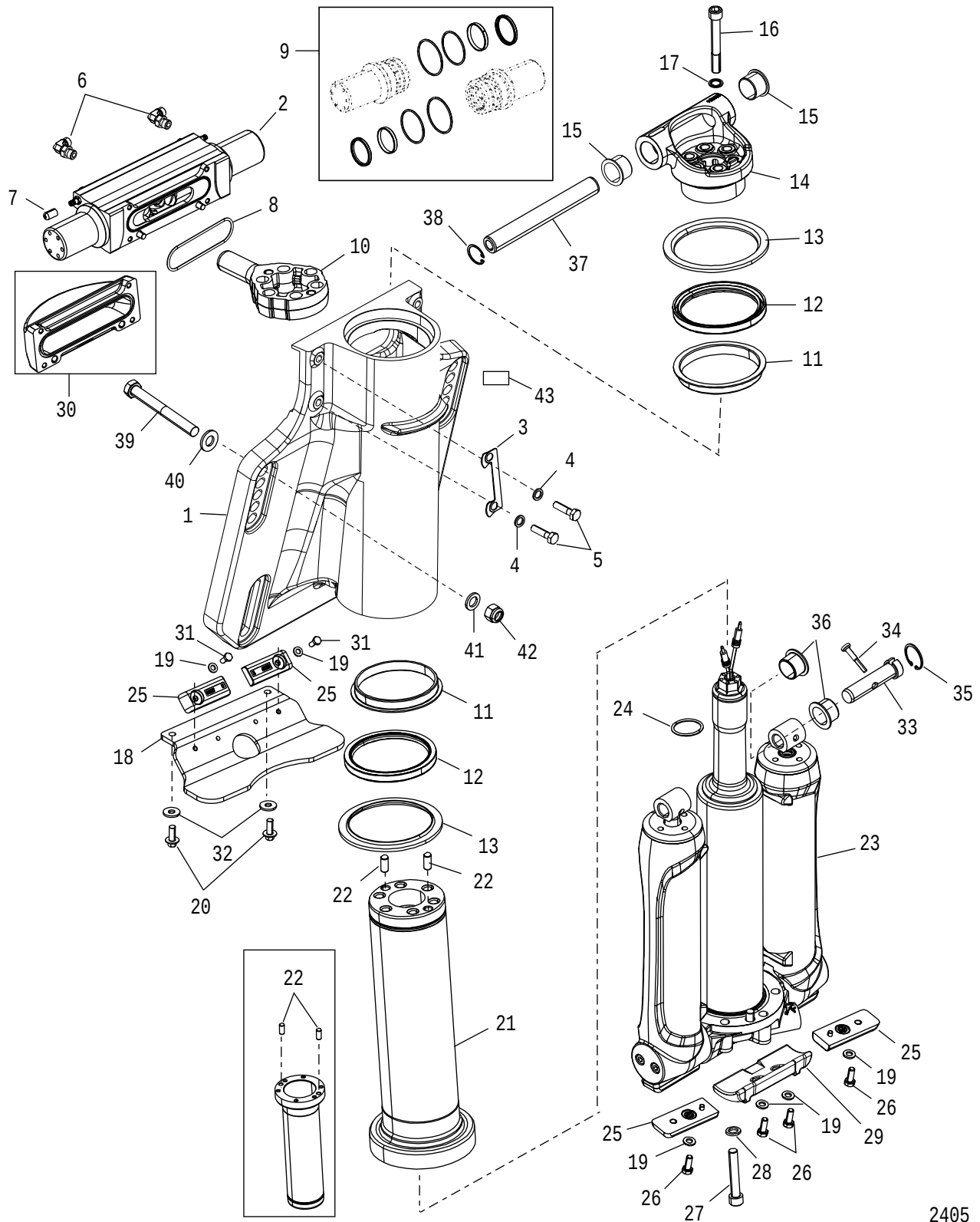


2403

Mount Cradle Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Seal			
2	1	Mount cradle			
3	1	Seal			
4	2	Mount - Rear			
5	2	Mount - Front			
6	12	Screw (M12)	125		92.2
7	4	Screw (M16)	225		166
8	1	Grommet			
9	1	Screw (M6 x 13)	8	71	
10	1	Tubing (35 in.)			
11	1	Fitting - Tell tale			
12	2	Clamp			
13	2	Roll pin (0.125 x 1.125 in.)			
14	2	Tilt lock lever			
15	2	Spring			
16	2	Tilt - Lock clutch			
17	1	Bracket - Tilt lock			
18	1	Pad - Tilt Lock			
19	1	Shaft-Tilt lock			
20	1	Screw (M5 x 10)	4	35	
21	2	Bearing (0.625 in.)			
22	1	Sensor - Trim angle			
23	2	Screw (M5 x 30)	4	35	

Pedestal/Power Trim/Steering Cylinder Components



2405

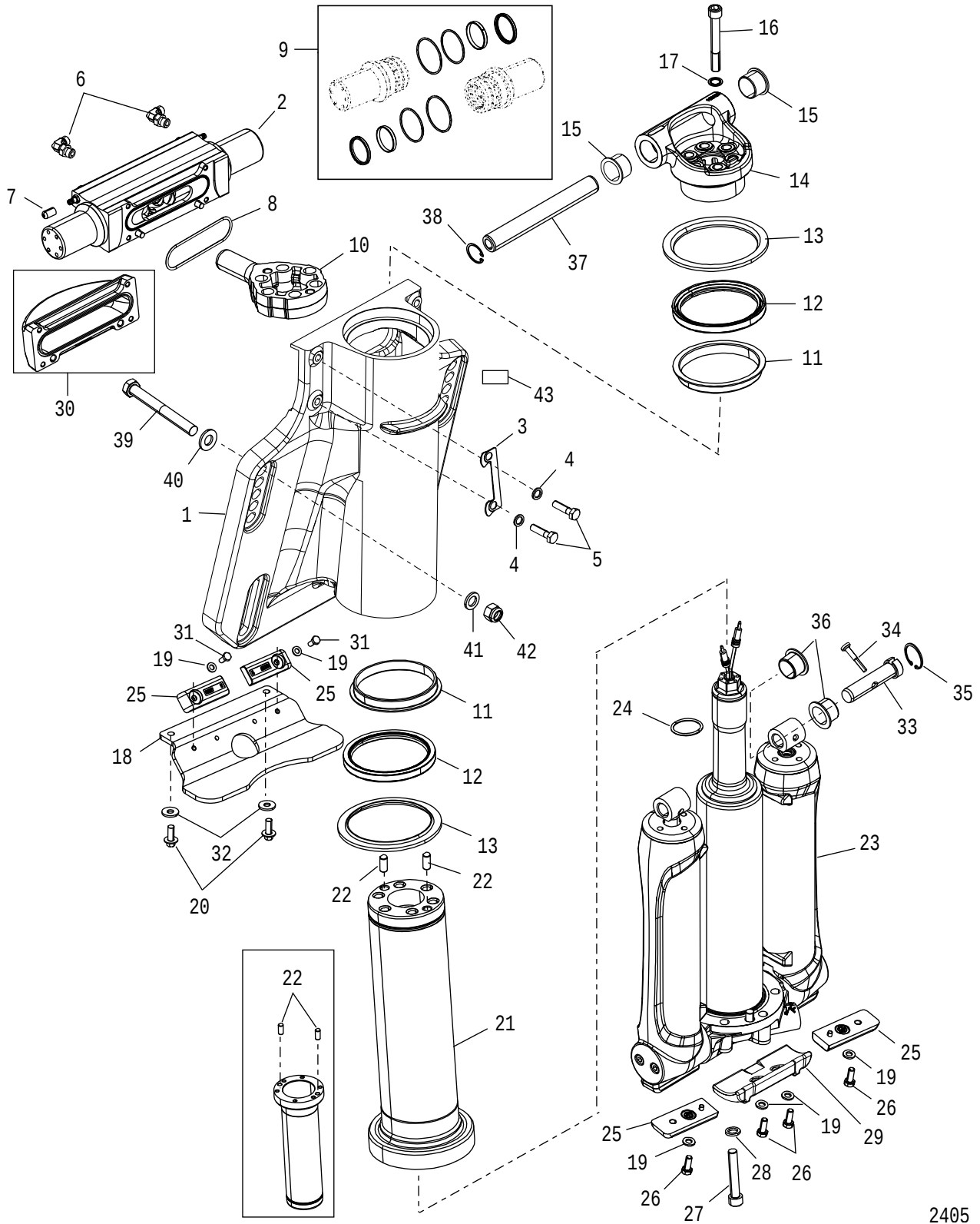
Pedestal/Power Trim/Steering Cylinder Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
0	1	Transom assembly			
1	1	Pedestal			
2	1	Steering cylinder assembly			
3	2	Retainer			
4	4	Washer			
5	4	Screw (M8 x 30)	25		18.4
6	2	Elbow	28		20.7
7	2	Cap - Bleeder			
8	1	Seal			
9	1	Seal kit, Steering cylinder			
10	1	Steering arm			
11	2	Bearing			
12	2	Seal			
13	2	Bearing			
14	1	Steering head			
15	2	Bearing (1.250 in.)			
16	6	Screw (M14 x 105)	108.5		80
17	6	Washer			
18	1	Plate, Deflector			
19	6	Washer			
20	2	Screw (M6 x 20)	14	123	
21	1	Steering tube			
22	6 or 8	Dowel pin (0.375 x 0.875 in.)			
23	1	Power trim assembly			
24	1	O-ring			
25	4	Anode			
26	4	Screw (M6 x 16)	5.6	50	
27	6	Screw (M10 x 60)	47.5		35
28	6	Washer			
29	1	Anode			
30	1	Cover, Counter rotation			
31	2	Screw (M6 x 14)	5.6	50	
32	2	Washer			
33	2	Pin-rod eye			
34	2	Pin - Trilobe			
35	2	Retaining ring			
36	4	Bearing (0.625 in.)			
37	1	Tilt pin			
38	1	Retaining ring			
39	4	Screw (0.500-20 x 4.500 in.)			

Pedestal/Mount Cradle and Driveshaft Housing

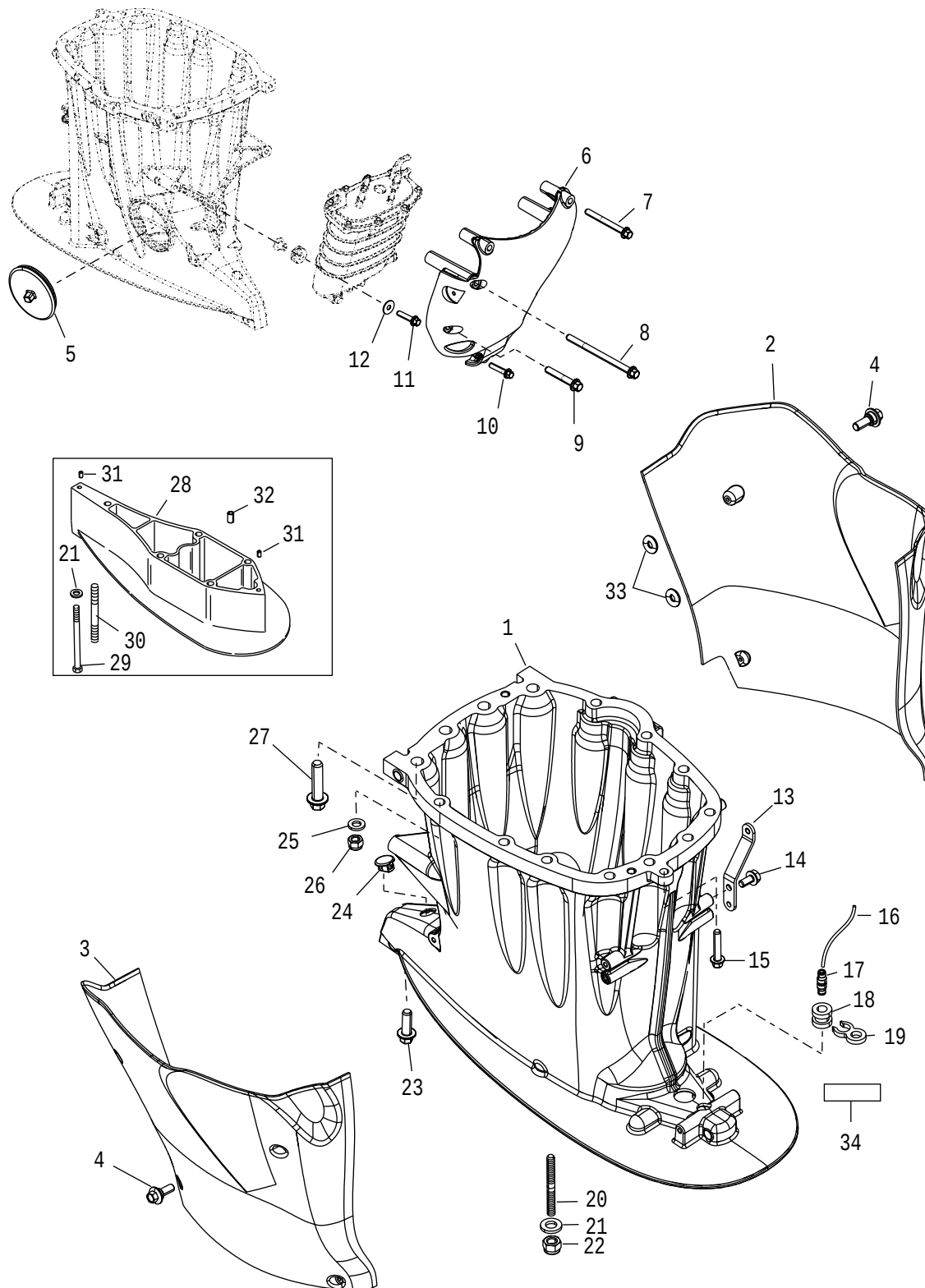
Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
40	4	Washer			
41	4	Washer			
42	4	Nut			
43	1	Decal, Serial overlamine			

Pedestal/Power Trim/Steering Cylinder Components



2405

Driveshaft Housing Components

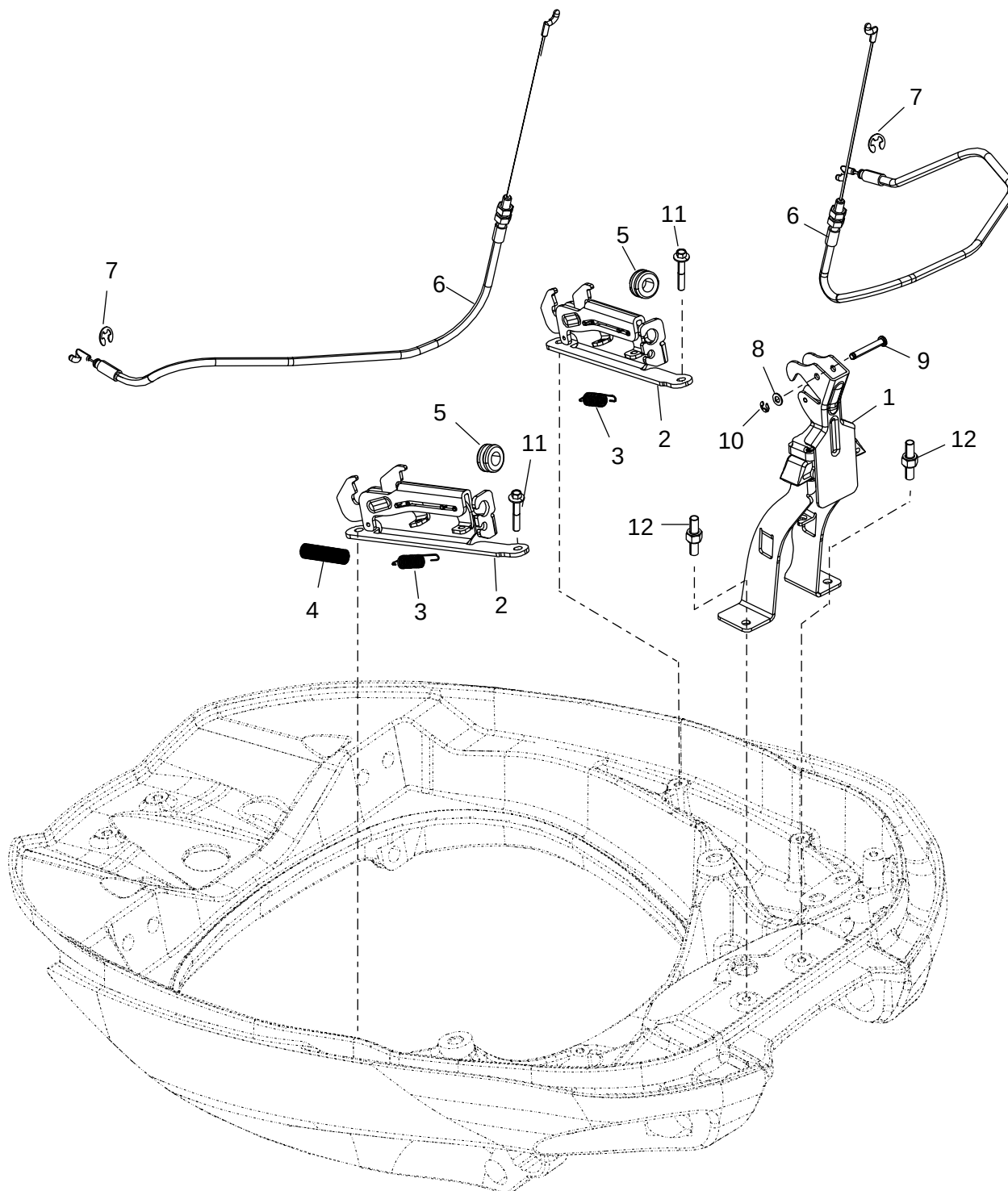


2402

Driveshaft Housing Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Driveshaft housing			
2	1	Chap - Port			
3	1	Chap - Starboard			
4	8 or 12	Screw	6	53	
5	1	Grommet			
6	1	Shroud - Fuel system module			
7	2	Screw (M8 x 75)	24		17.7
8	2	Screw (M8 x 120)	24		17.7
9	2	Screw (M8 x 50)	24		17.7
10	1	Screw (M8 x 40)	24		17.7
11	3	Screw (M8 x 35)	24		17.7
12	3	Washer			
13	2 or 4	Cowl bracket			
14	2 or 4	Screw (M6 x 13)	6	53	
15	1	Screw (M8 x 30)	24		17.7
16	1	Tubing (26 in.)			
17	1	Fitting			
18	1	Grommet			
19	1	Retainer			
20	4	Stud (M12 x 52) (Long/XL)	30		22
21	4	Washer			
22	4	Nut	75		55.3
23	1	Screw (M12 x 35)	75		55.3
24	1	Plug			
25	10	Washer			
26	10	Nut	61		45
27	4	Screw (M12 x 45)	48		35.4
28	1	Spacer (XXL)			
29	1	Screw (M12 x 160) (XXL)	75		55.3
30	4	Stud (M12 x 179) (XXL)	30		22
31	2	Dowel pin (XXL)			
32	1	Bushing (XXL)			
33	2	O-ring			
34	1	Decal - Oil drain			

Cowl Latching Components



2522

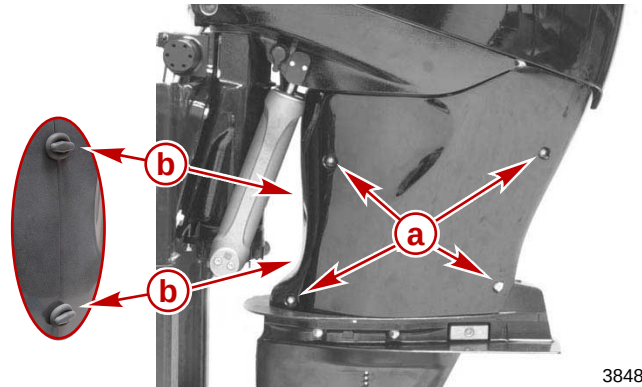
Cowl Latching Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Bracket - Latch base			
2	2	Side latch assembly			
3	4	Spring			
4	2	Grommet			
5	2	Cable			
6	2	Retaining ring			
7	1	Washer			
8	1	Clevis pin			
9	1	E-ring			
10	4	Screw (M6 x 16)	6	53	
11	2	Stud	6	53	
12	2	Stud	6	53	

Water Poppet Removal/Installation

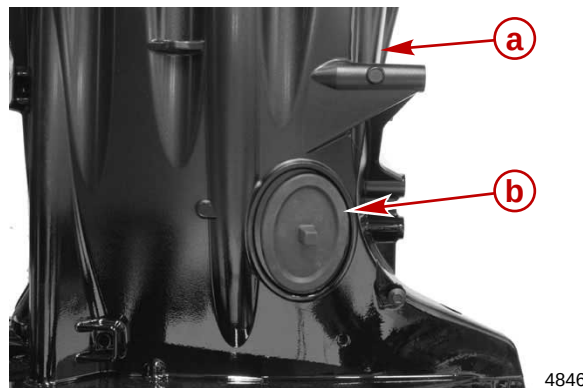
Removal and Disassembly

1. Remove two O-rings from front of chaps.
2. Remove screws (4 or 6 for XXL shaft) securing port chap to driveshaft housing and remove chap.



a - Chap mounting screw (M6 special) **b** - O-ring

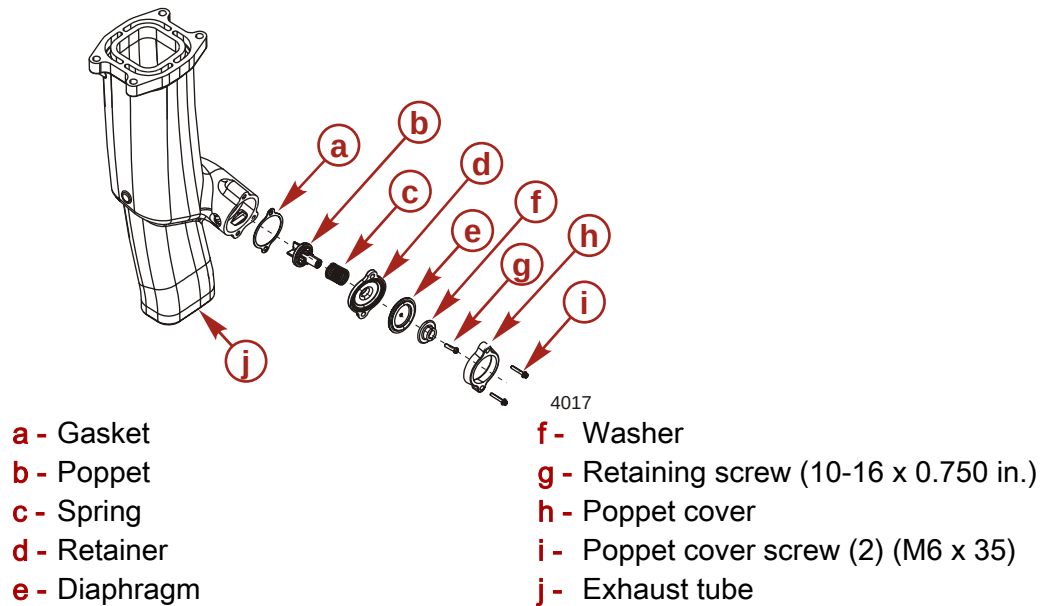
3. Remove grommet in driveshaft housing to access the water poppet.



a - Port side of driveshaft housing **b** - Water poppet grommet

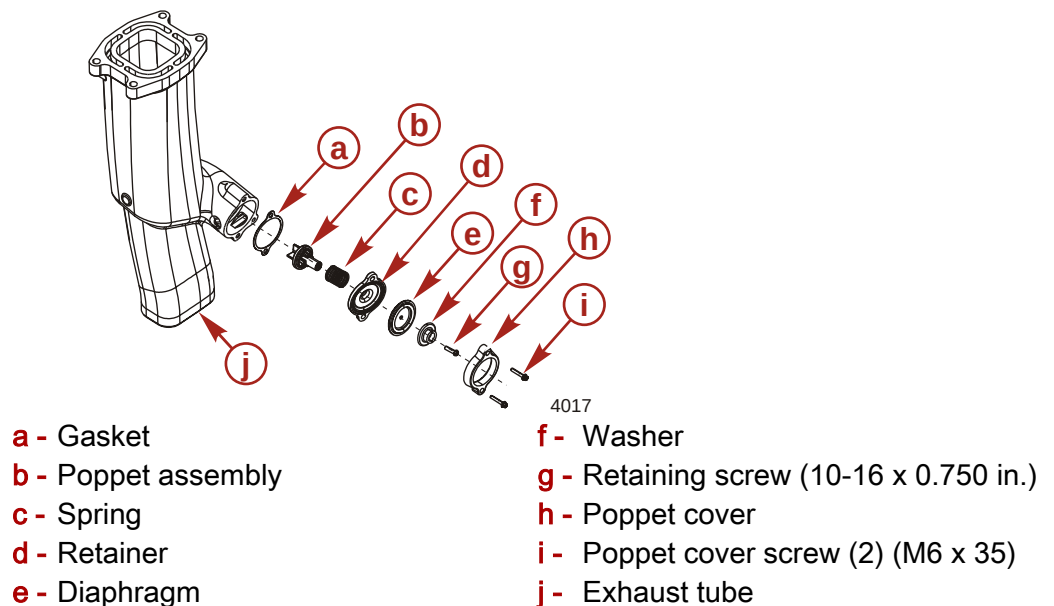
4. Remove 2 screws from the poppet cover. Remove cover.
5. Remove retainer and poppet assembly.
6. Remove retaining screw from poppet assembly.
7. Inspect components. Replace as required.

8. Remove gasket and clean gasket surfaces of exhaust tube and poppet retainer.



Reassembly and Installation

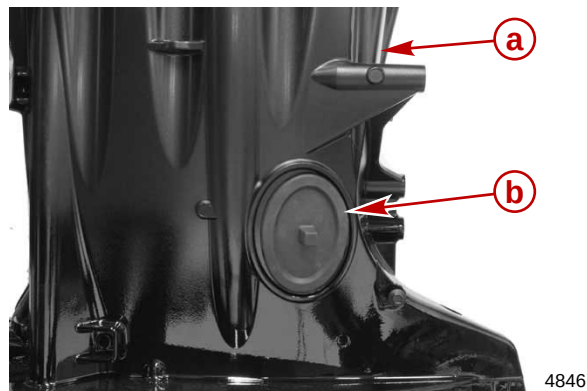
1. Assemble the poppet, spring, retainer, diaphragm and washer. Install retaining screw through components into poppet. Drive screw tight.
2. Install new gasket on clean surface.
3. Apply Loctite 242 to poppet cover screw threads.
4. Install 2 screws through poppet cover and assemble in exhaust tube. Tighten screws to specified torque.



Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Poppet cover screws	92-809821

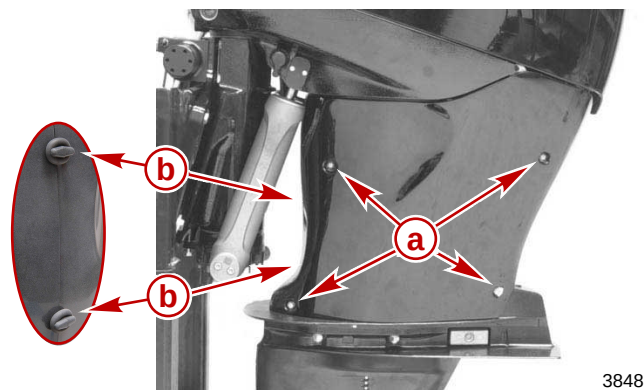
Description	Nm	lb. in.	lb. ft.
Poppet cover screw	5	44	

5. Install grommet in driveshaft housing.



a - Port side of driveshaft housing **b** - Water poppet grommet

6. Attach lower port chap to driveshaft housing. Secure with screws (4 or 6 for XXL shaft). Tighten screws to specified torque.
7. Attach O-rings to tabs on front of chaps.



a - Chap mounting screw (M6 special) **b** - O-ring

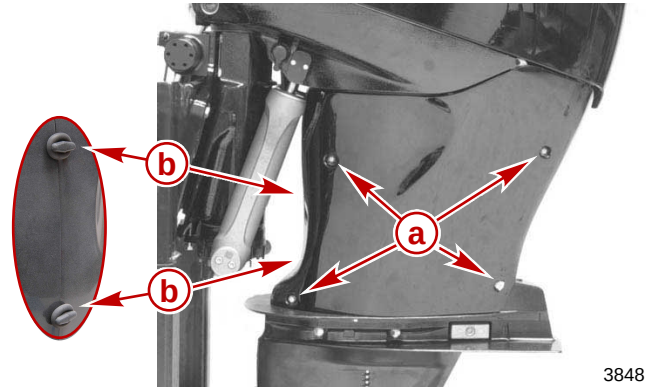
Description	Nm	lb. in.	lb. ft.
Chap mounting screws	6	53	

Mid-Section Disassembly

Preparing Outboard for Mid-Section Disassembly

1. Remove two O-rings from front of chaps.

2. Remove screws (4 or 6 for XXL shaft) securing port chap to driveshaft housing and remove chap.



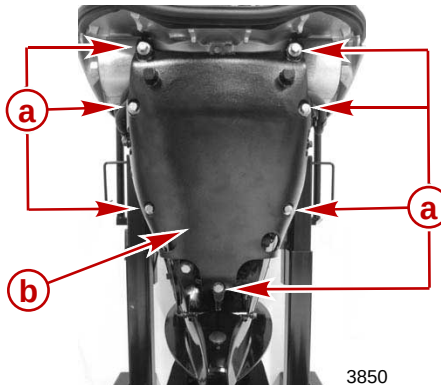
a - Chap mounting screws (M6 special)

b - O-ring

3. Remove screws (4 or 6 for XXL shaft) securing starboard chap to driveshaft housing and remove chap.
4. Remove powerhead from pedestal. Refer to **Section 4A - Dressed Powerhead Removal/Installation** for instructions.
5. Remove gearcase from driveshaft housing. Refer to **Section 6 - Gearcase Removal**.

Fuel System Module (FSM)

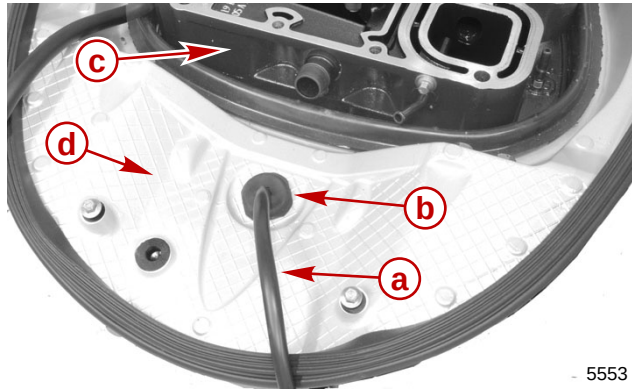
1. Remove 7 screws securing the fuel system module shroud to the driveshaft housing.



a - Shroud attaching screws

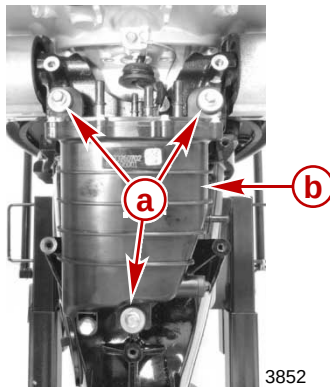
b - Fuel system module shroud

2. Push the fuel system module harness grommet through the adapter plate. Pull harness down through hole in mount cradle.



- | | |
|---|--------------------------|
| a - Fuel system module harness | c - Adapter plate |
| b - Fuel system module harness grommet | d - Mount cradle |

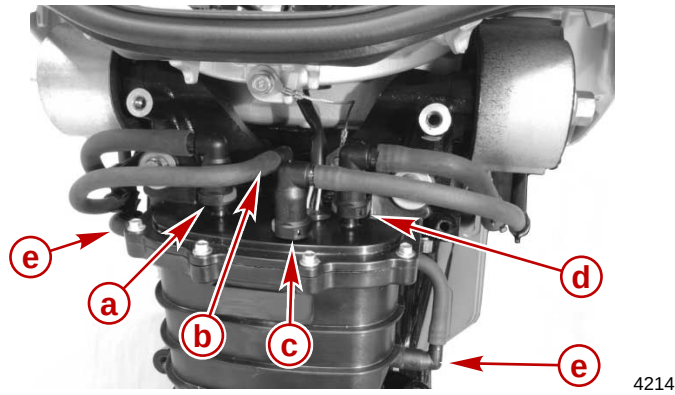
3. Remove 3 screws securing the fuel system module to the driveshaft housing.



- | | |
|--|-------------------------------|
| a - Fuel system module attaching screws | b - Fuel system module |
|--|-------------------------------|

4. Remove 4 hoses on top of fuel system module and 1 hose on starboard side.

NOTE: Fuel may be present in fuel lines. Use a proper container to capture fuel.

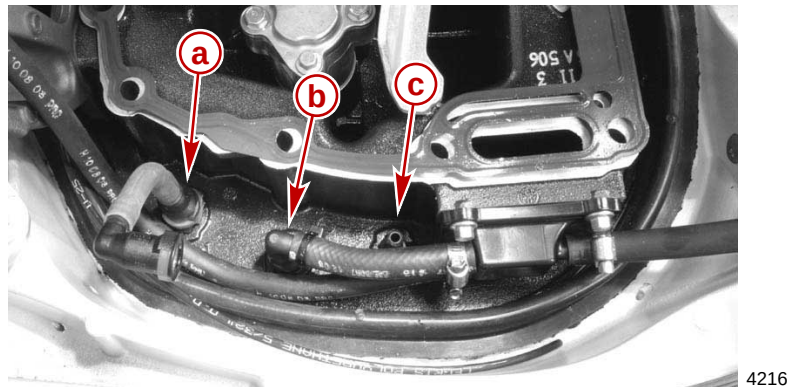


- a** - High pressure outlet (10 mm red tab)
- b** - Manifold reference to fuel pressure regulator (8 mm white tab)
- c** - Vent to vent canister switch (0.375 in. blue tab)
- d** - FSM fuel inlet from fuel filter/water separator (10 mm red tab)
- e** - Water cooling inlet hose (8 mm blue tab)

5. Remove fuel system module from driveshaft housing.

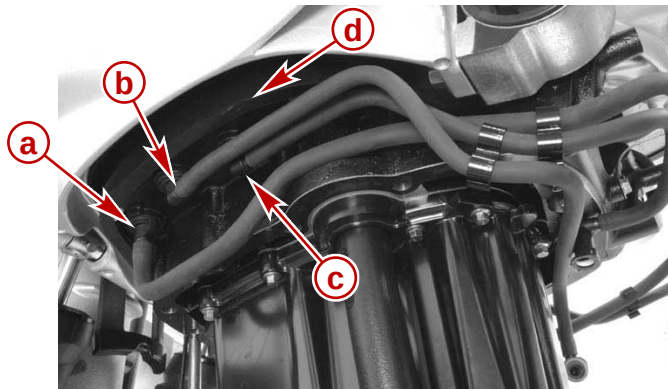
Hoses and Harnesses

1. Disconnect the 2 remaining hoses on top port side of adapter plate. Press the colored lock tab and pull up on the connector to remove.



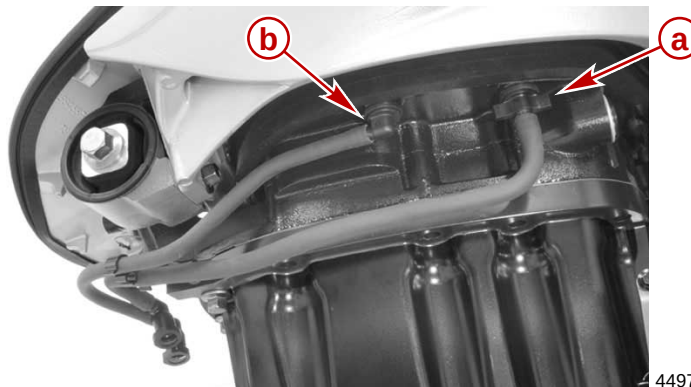
- a** - FSM outlet hose (10 mm red tab)
- b** - FSM water inlet hose (8 mm blue tab)
- c** - Manifold hose connector

2. Remove the 3 hoses from the bottom side of the adapter plate. Rotate the hose/connector counterclockwise to align the tab with the slot in the adapter plate and pull each hose down through adapter plate.



- a** - FSM high outlet hose (10 mm red tab) **c** - Manifold reference hose (8 mm white tab)
b - FSM water cooling inlet hose (8 mm blue tab) **d** - Adapter plate

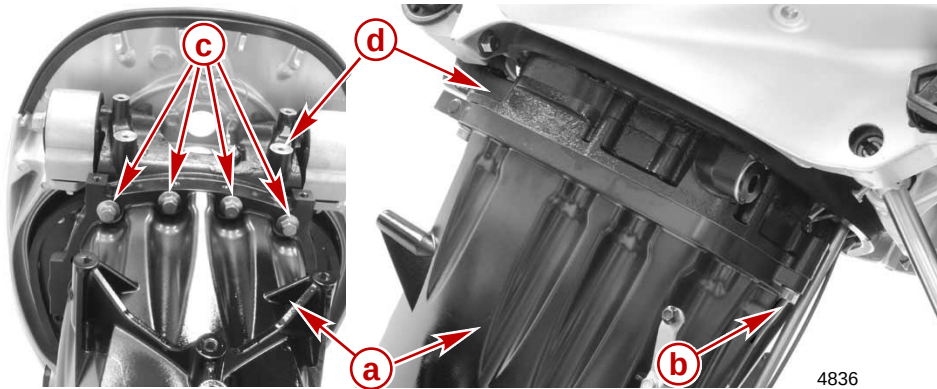
3. Remove 2 hoses from the bottom side of the adapter plate on starboard side following same procedure as above.



- a** - FSM fuel inlet hose (10 mm red tab) **b** - Vent hose (0.375 in. blue tab)

Driveshaft Housing

1. Remove 4 screws at rear and 1 screw in front securing the driveshaft housing to adapter plate.



a - Driveshaft housing

b - Driveshaft housing mounting screw (1) M8 x 30

c - Driveshaft housing mounting screw (4) M12 x 45

d - Adapter plate

2. Remove driveshaft housing.

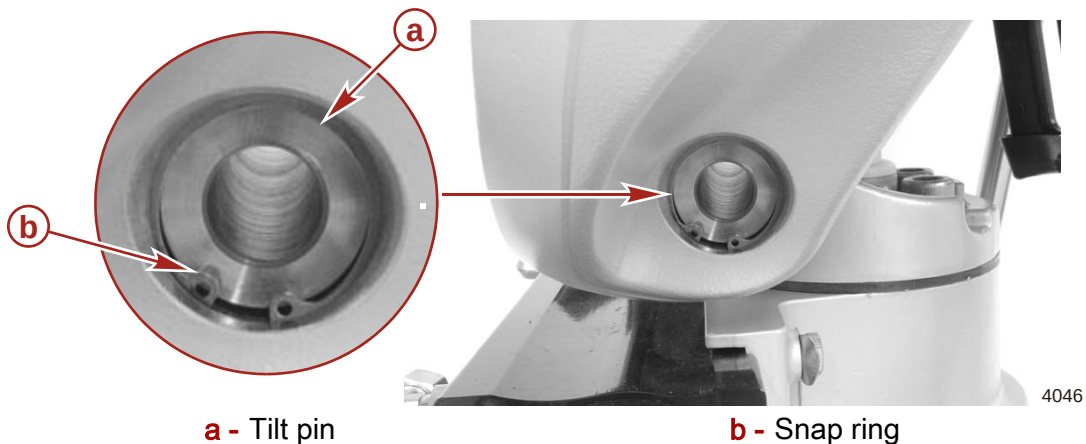
Pedestal

TRIM CYLINDER ROD ENDS

Detach the power trim cylinder rod ends from the mount cradle. Refer to **Section 5C - Power Trim System**.

TILT PIN

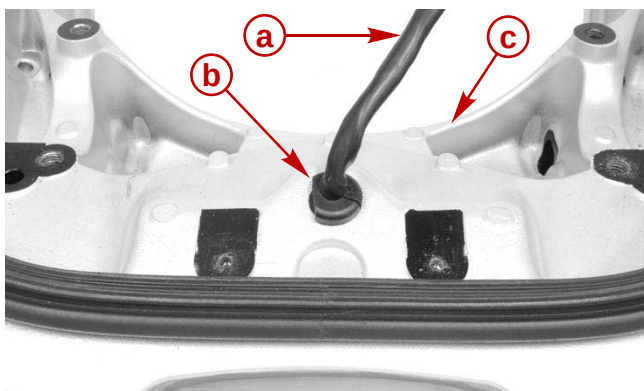
1. Remove snap ring on port end of tilt pin.



a - Tilt pin

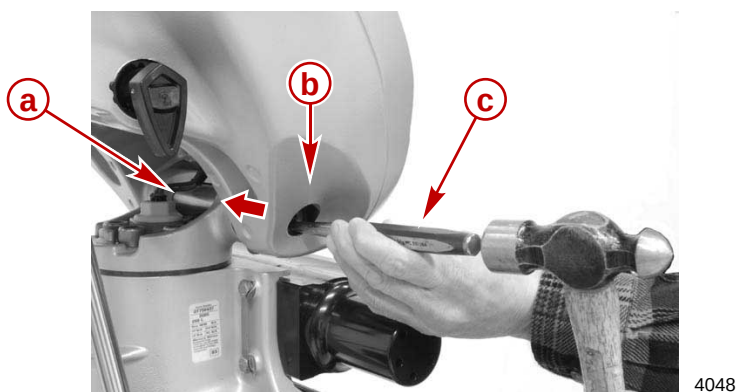
b - Snap ring

2. Remove power trim harness wire and grommet from mount cradle.



a - Power trim harness wire
b - Power trim grommet
c - Mount cradle

3. Securely hold mount cradle. Using a drift pin, remove tilt pin from starboard side of mount cradle.

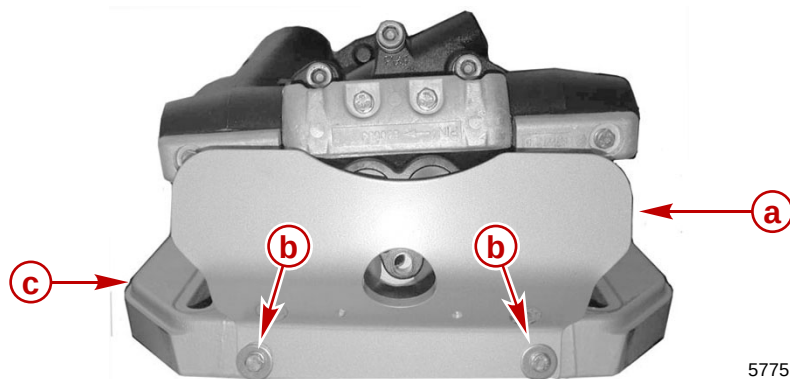


a - Tilt pin
b - Starboard side of mount cradle
c - Drift pin

4. Remove mount cradle from pedestal and trim rods.

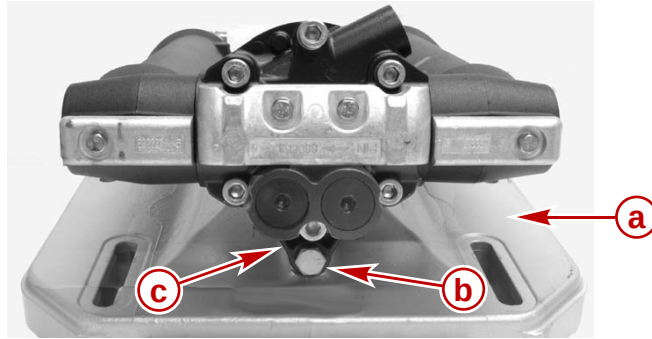
POWER TRIM SYSTEM REMOVAL

1. Remove 2 screws and washers securing the splash to the pedestal. Remove splash plate from pedestal.



a - Splash plate
b - Splash plate mounting screw and washer
c - Pedestal

2. Support the power trim system assembly by installing a 10 mm screw in the power trim manifold and pedestal.

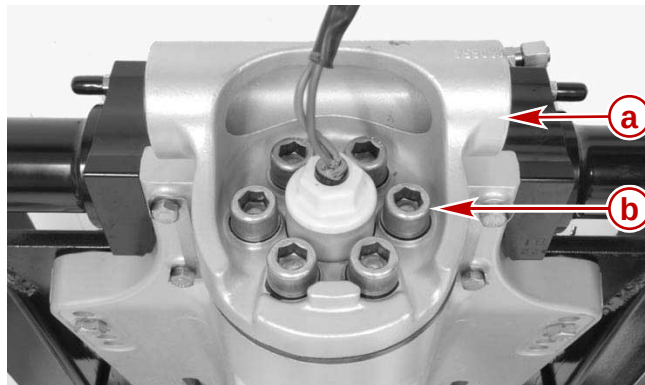


4050

a - Pedestal
b - 10 mm screw

c - Power trim manifold

3. Remove 6 screws attaching steering head to steering tube inside of the pedestal.

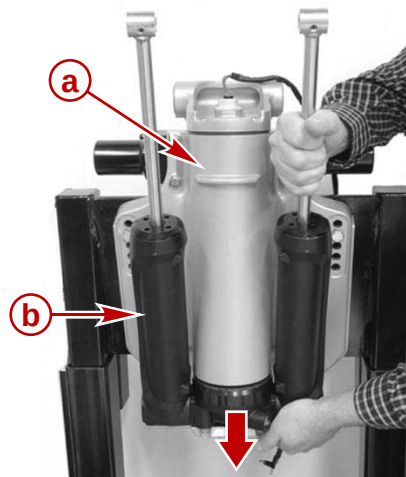


4051

a - Steering head

b - Attaching screws (12 mm internal hex)

4. Securely hold the power trim system assembly while removing the 10 mm screw from the power trim manifold. Remove the power trim system assembly.



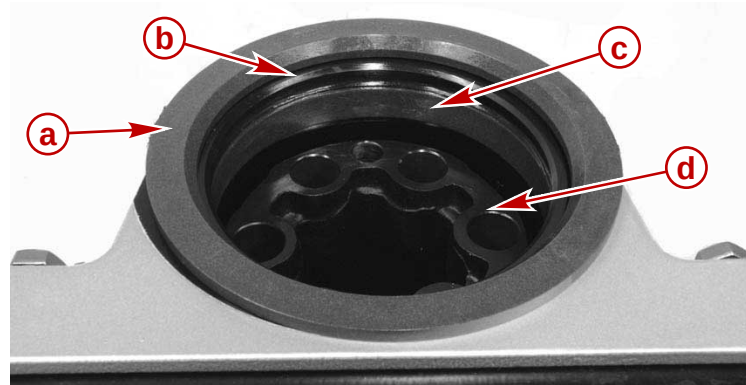
4052

a - Pedestal

b - Power trim system assembly

BEARINGS AND SEALS

1. Remove the top outer bearing from pedestal.

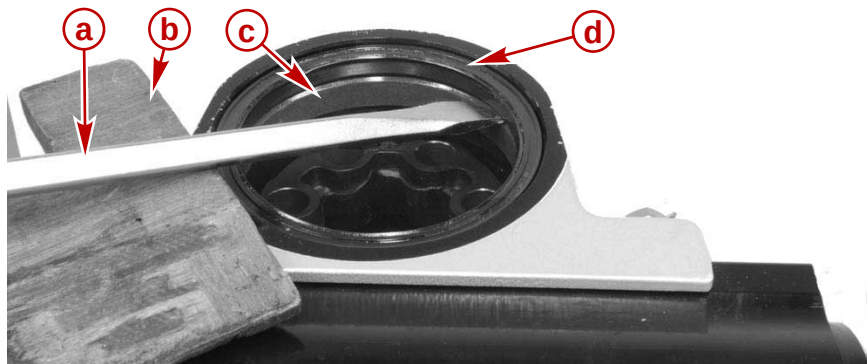


4055

a - Top upper bearing
b - Seal

c - Top inner bearing
d - Steering arm

2. Place a wooden block on top of the pedestal to protect it during seal removal. Use a flat blade screwdriver to remove the seal and bottom upper bearing inside the pedestal.
3. Remove the lower bearings and seal.

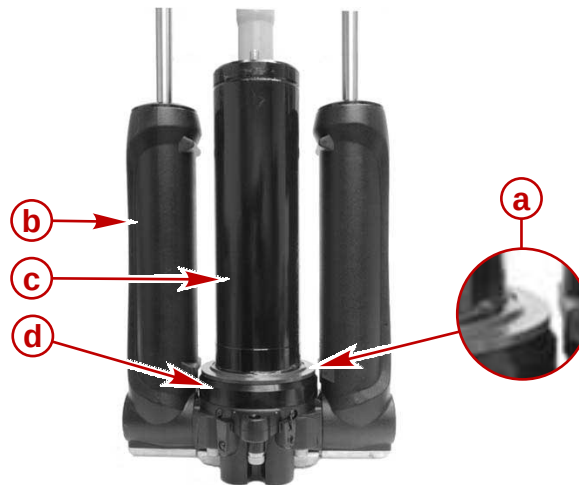


4053

a - Flat blade screwdriver
b - Wooden block

c - Top inner bearing
d - Seal

4. Remove bottom lower bearing from power trim steering tube.



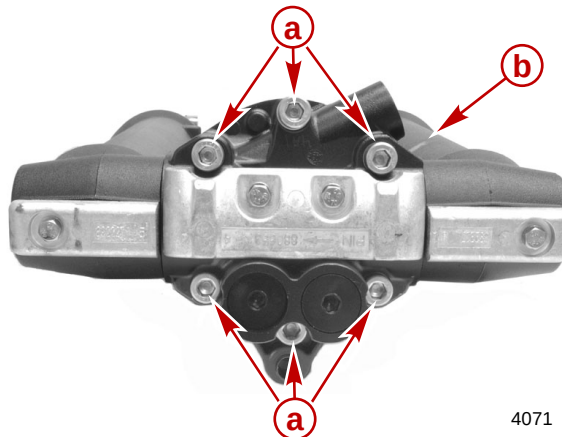
4070

- | | |
|---------------------------------|--------------------------------|
| a - Bottom outer bearing | c - Steering tube |
| b - Power trim cylinder | d - Power trim manifold |

5. Remove bottom seal using the same procedure as on the top seal.
6. Remove bottom inner bearing.

STEERING TUBE

1. Remove the 6 screws attaching the steering tube to the power trim system assembly.



4071

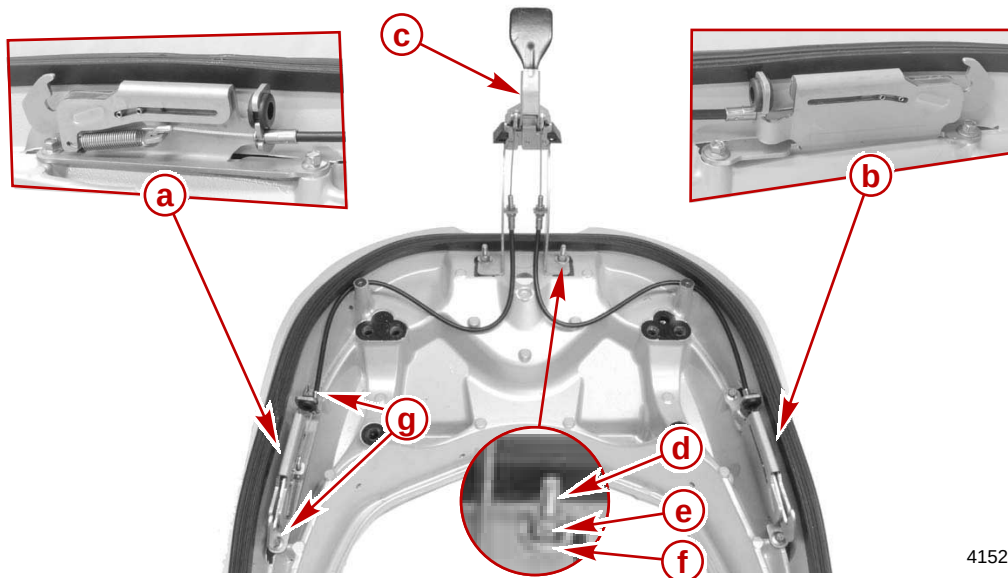
- | | |
|--|--------------------------------|
| a - Mounting screws (8 mm internal hex) | b - Power trim manifold |
|--|--------------------------------|

2. Remove steering tube from power trim system assembly.

Mount Cradle

COWL LATCHES

Remove front and side latches.



- a** - Port side latch
- b** - Starboard side latch
- c** - Front and side latch
- d** - Stud (2)

- e** - Nut (2)
- f** - Washer (2)
- g** - Mounting screws (4)

SEAL

Remove mount cradle seal from mount cradle.

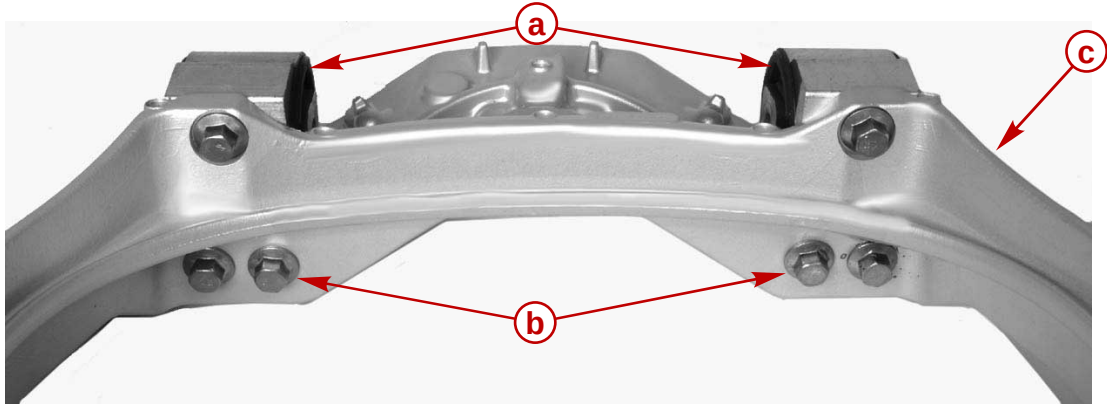


- a** - Mount cradle

- b** - Seal

REAR MOTOR MOUNTS

Remove 3 screws securing each rear motor mount.



4137

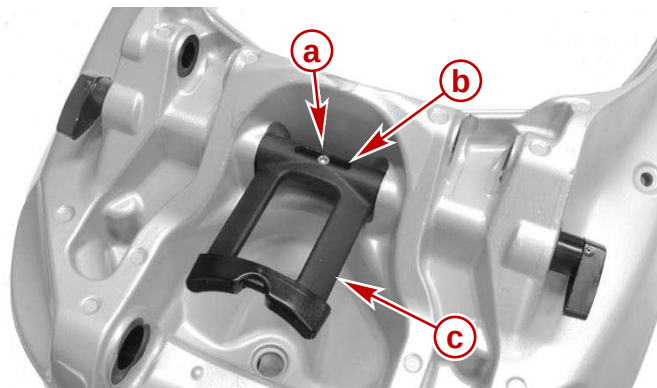
a - Rear motor mounts (2)

c - Mount cradle

b - Mounting screws (6)

TILT LOCK

1. Remove screw from tilt lock bracket and tilt lock shaft.



4106

a - Tilt lock bracket screw (T27 Torx)

c - Tilt lock bracket

b - Tilt lock shaft

2. Using a drift pin and hammer, remove roll pin from tilt lock lever



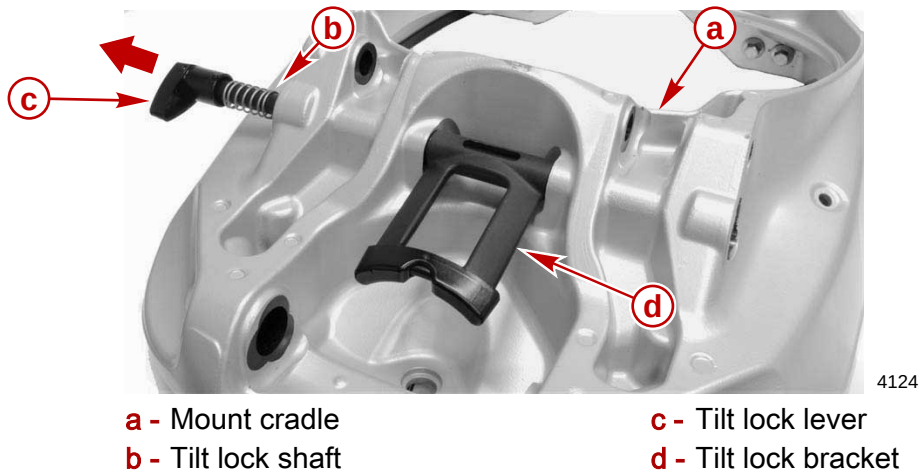
4123

a - Tilt lock lever with roll pin

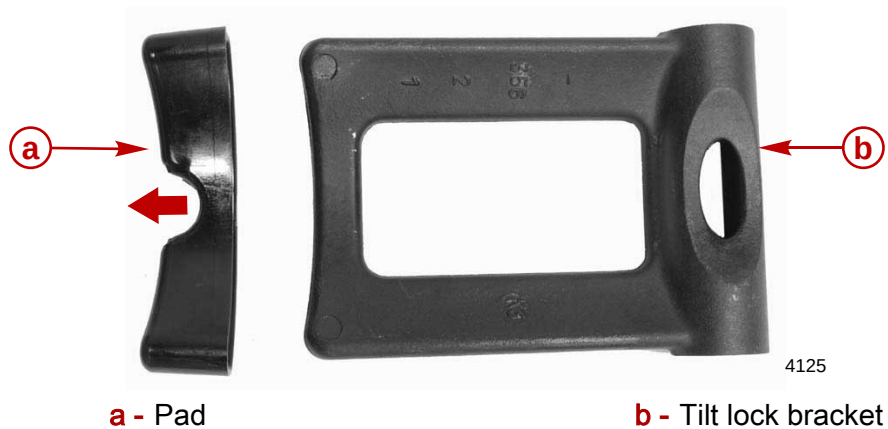
b - Drift pin

3. Remove tilt lock lever and spring.
4. Slide tilt lock shaft out of bore from opposite side of cradle mount.

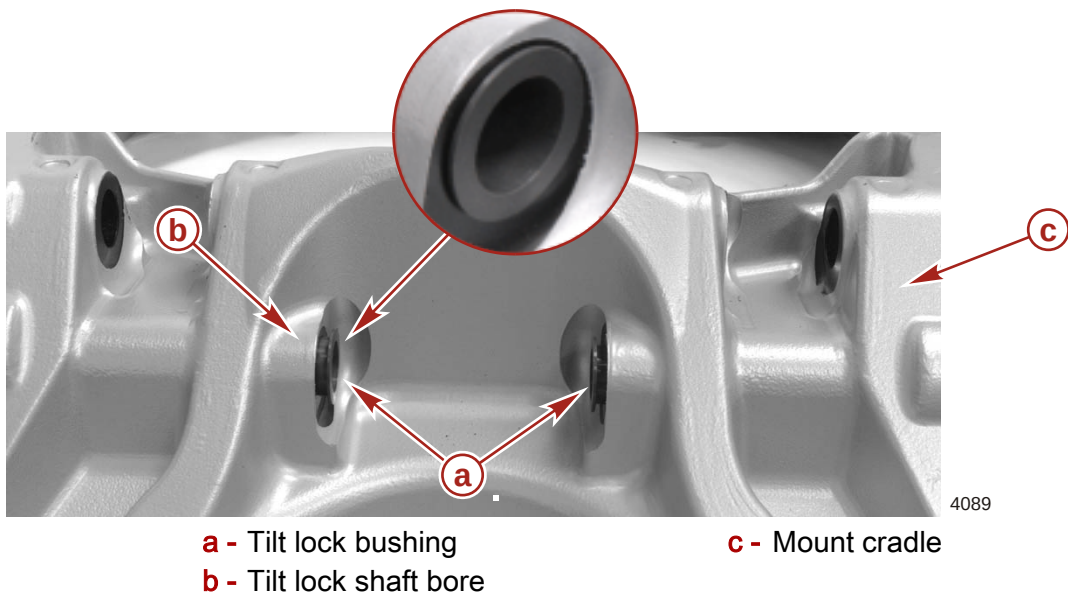
5. Remove tilt lock bracket.



6. Remove pad from tilt lock bracket.



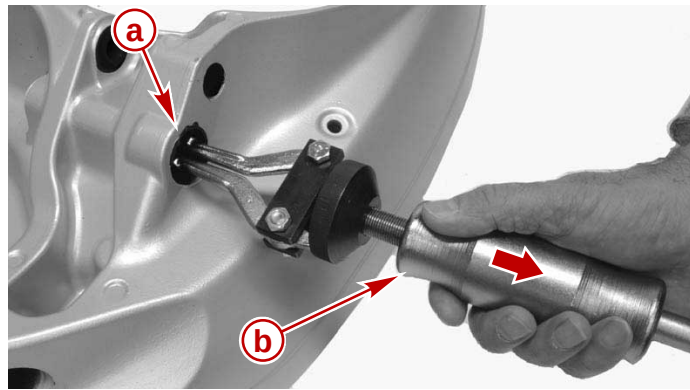
7. Remove 2 bearings from each tilt lock shaft bore.



8. Use slide hammer puller to remove tilt lock clutch from port and starboard side of mount cradle.

Slide Hammer Puller

91-34569A1

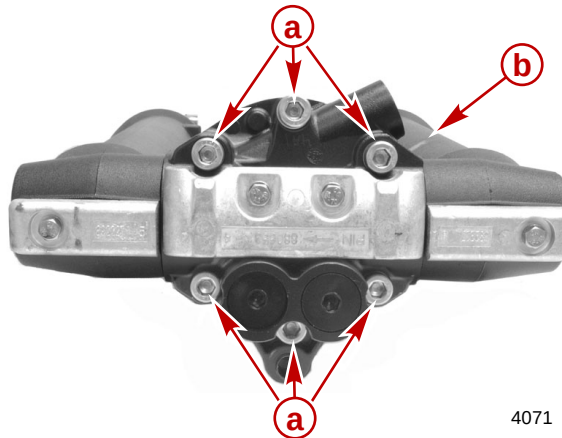
**a** - Tilt lock clutch**b** - Slide hammer

Mid-Section Reassembly

Pedestal

STEERING TUBE

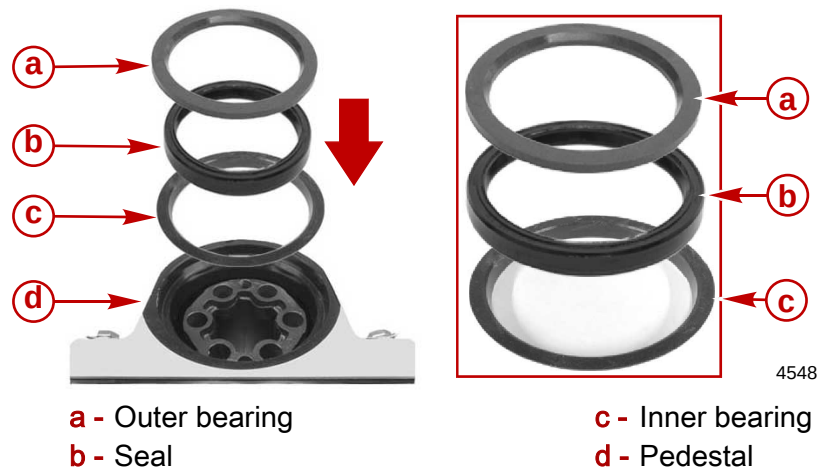
1. Attach the steering tube to the power trim system assembly.
2. Install the 6 screws attaching the steering tube to the power trim system assembly.

**a** - Mounting screws (8 mm internal hex)**b** - Power trim manifold

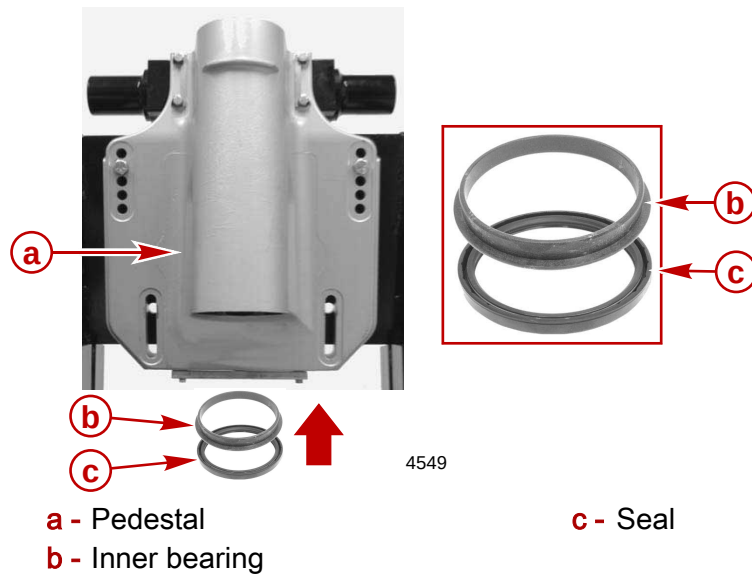
BEARINGS AND SEALS

1. Install inner bearing into top of pedestal.
2. Press seal with spring side down into top of pedestal.

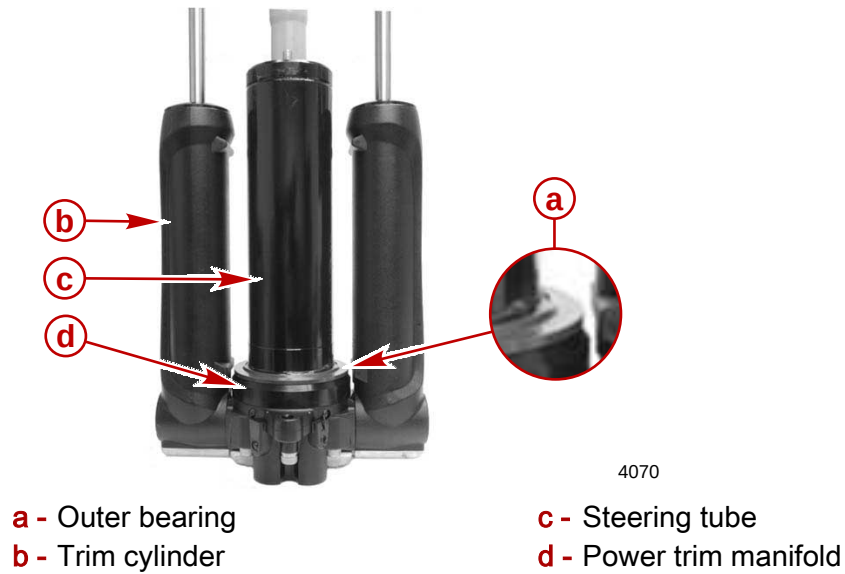
3. Install outer bearing on top of pedestal.



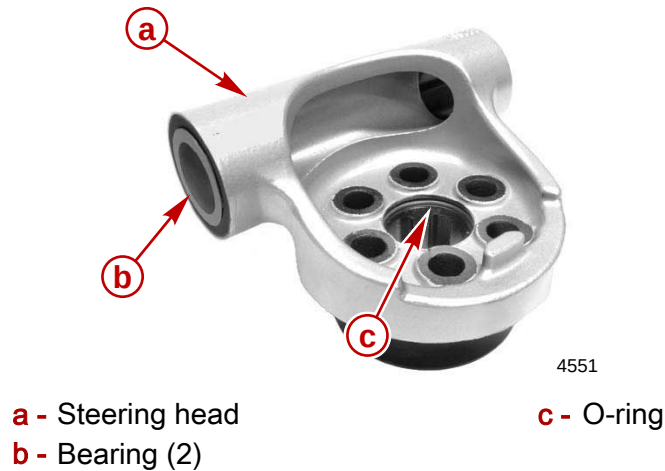
4. Install inner bearing into bottom of pedestal.
5. Press seal with spring side up into bottom of pedestal.



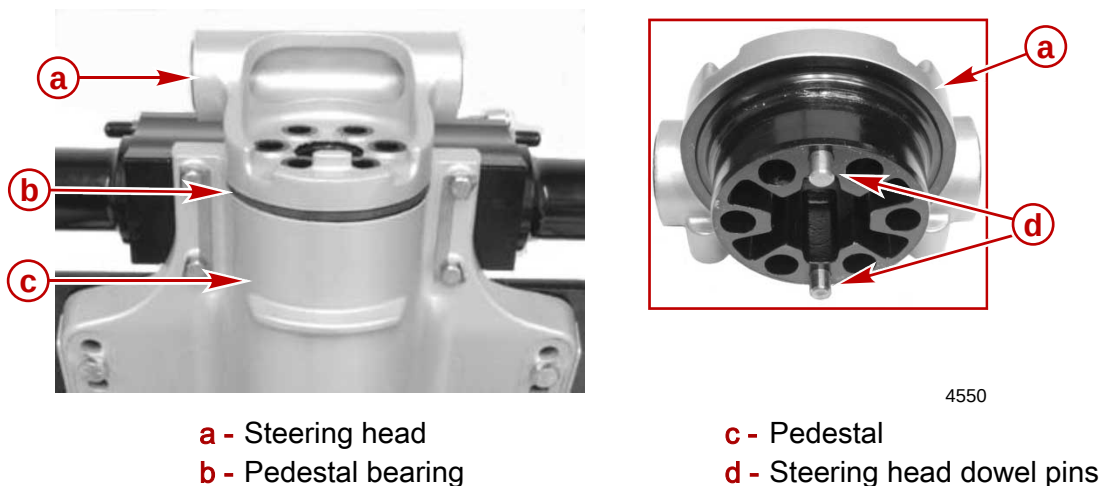
6. Install lower outer bearing over steering tube on power trim manifold.



7. Remove and replace 2 bushings and O-ring in steering head.



8. Install steering head in pedestal. Insert dowel pins of steering head into holes of steering arm.



-

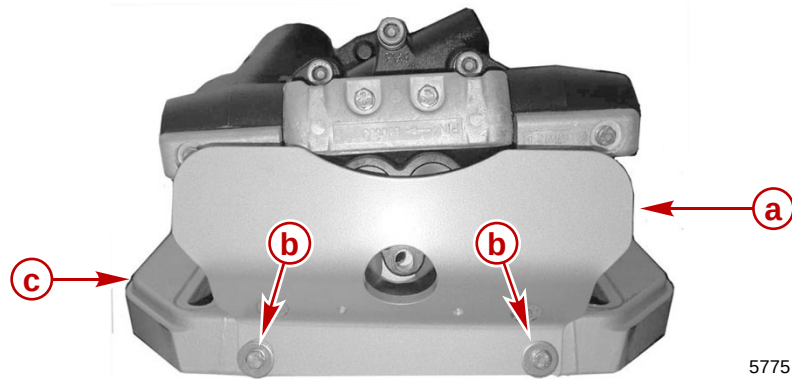
c - Power trim unit

-

b - Steering head screws (12 mm internal hex) (M14 x 105)

Description	Nm	lb. in.	lb. ft.
Steering head screws (6)	108.5		80

- Attach splash plate to pedestal. Secure with 2 screws and washers. Tighten to specified torque.



a - Splash plate

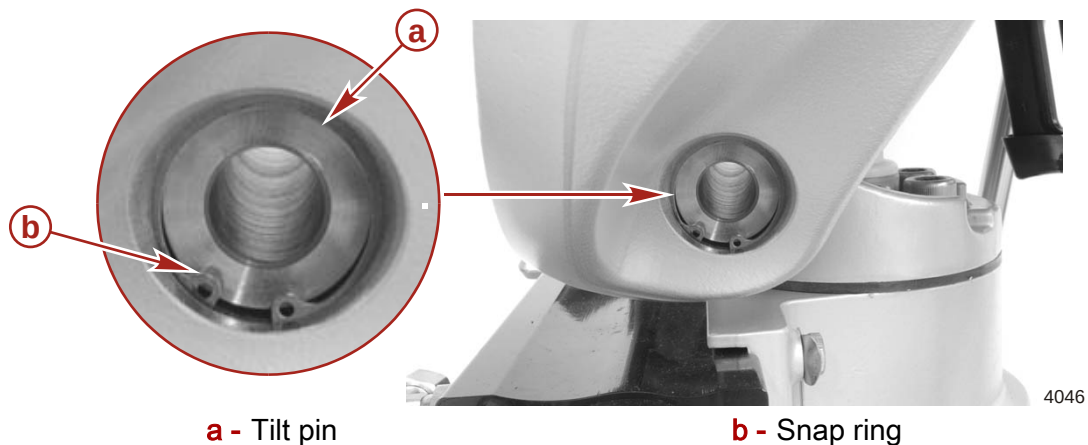
c - Pedestal

b - Splash plate mounting screw and washer

Description	Nm	lb. in.	lb. ft.
Splash plate mounting screw	14	123	

MOUNT CRADLE TILT PIN

- Align mount cradle pivot bore to steering head.
- Insert tilt pin from port side of mount cradle through steering head.
- Install internal snap ring on port side of mount cradle.



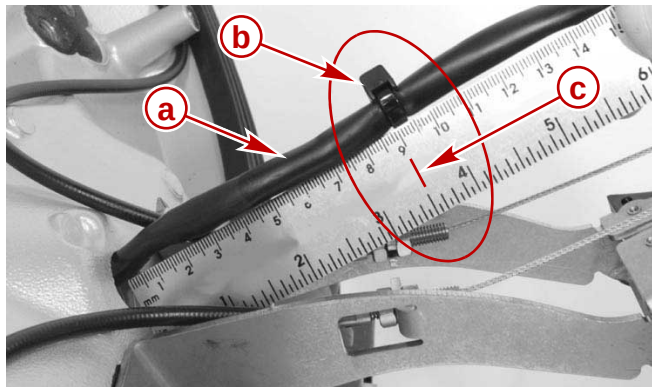
a - Tilt pin

b - Snap ring

POWER TRIM HARNESS

- Route power trim harness through hole in mount cradle.

2. Attach a cable tie on the harness a distance of 185 mm (7.25 in.) from the reservoir fill cap. With the mount cradle attached, place the cable tie 90 mm (3.5 in.) from the cradle top surface when trimmed fully up.



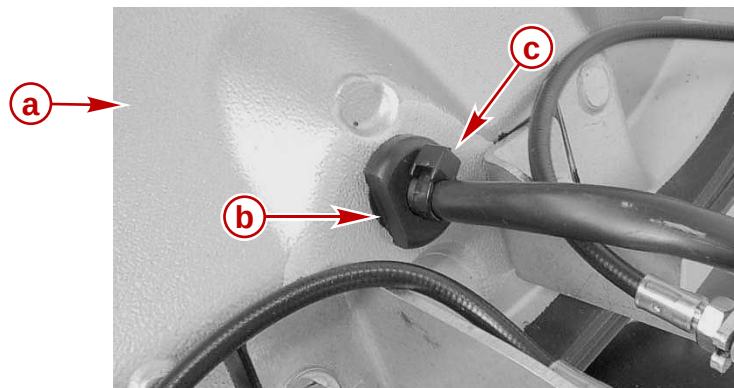
4594

a - Power trim harness

c - Measured distance

b - Cable tie

3. Place the power trim grommet on the harness below the cable tie.
4. Push the grommet and harness in the mount cradle. As the grommet is pushed in, rotate the grommet so the flat faces either side of the engine when installed.



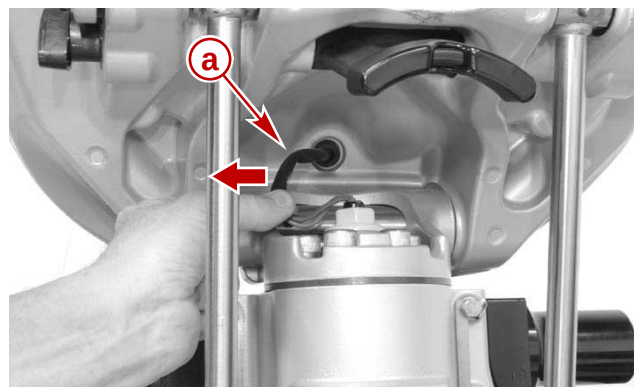
4595

a - Mount cradle

c - Cable tie

b - Grommet

5. To ensure that the harness will coil when the mount cradle is trimmed down, gently pull on the harness to check that it is off-center.



4596

a - Power trim harness

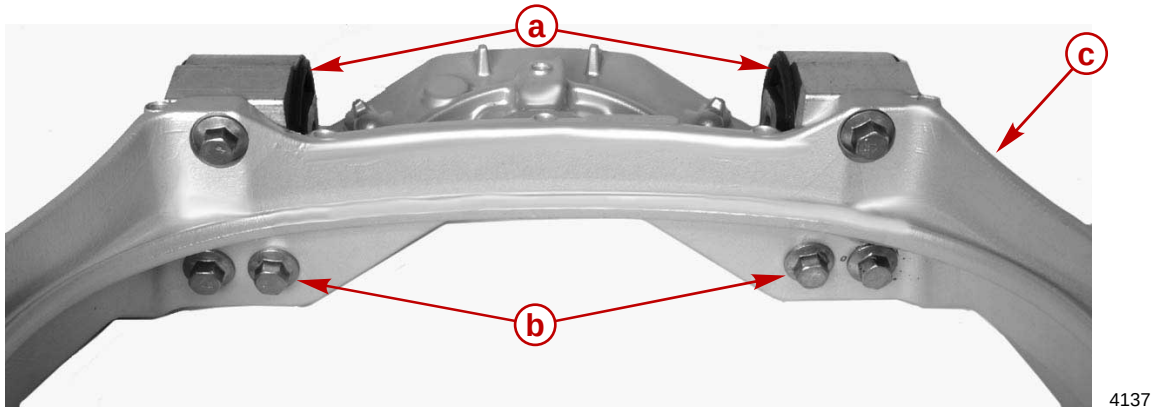
TRIM CYLINDER ROD ENDS

Assemble trim cylinder rod ends to mount cradle. Refer to **Section 5C - Power Trim System**.

Mount Cradle

REAR MOTOR MOUNTS

Apply Loctite Threadlocker 242 to rear motor mount screw threads. Install 3 screws in each rear motor mount and attach motor mounts to mount cradle. Tighten screws to specified torque.



a - Rear motor mounts (2)

c - Mount cradle

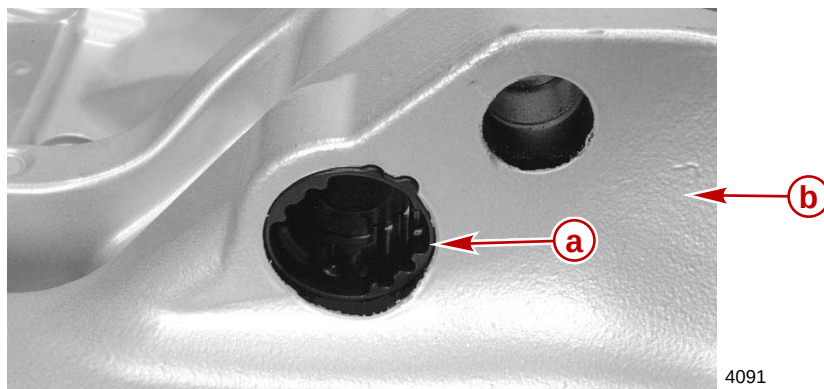
b - Rear motor mount screws (6)

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Rear motor mount screws	92-809821

Description	Nm	lb. in.	lb. ft.
Rear motor mount attaching screws	125		92.2

TILT LOCK

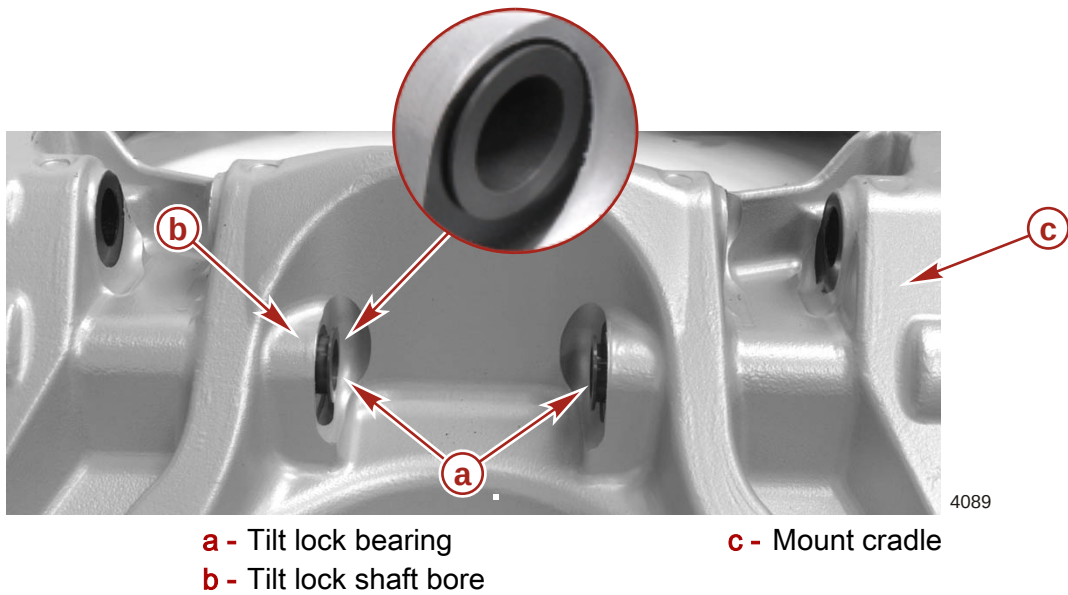
1. Install tilt lock clutch in port and starboard side of mount cradle.



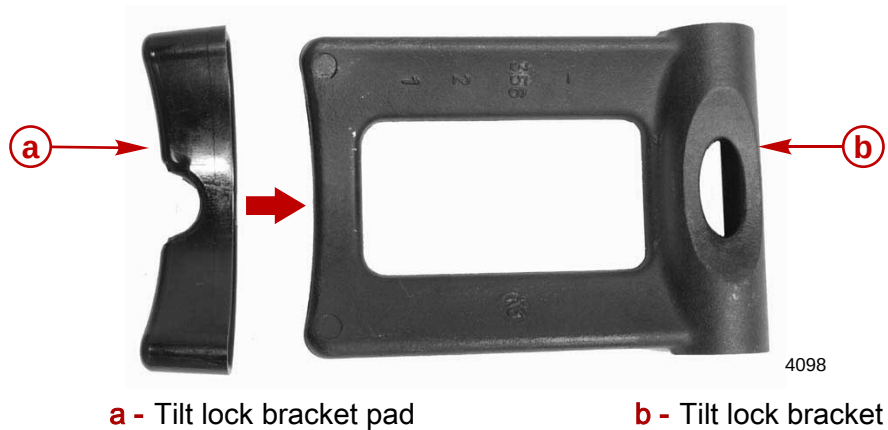
a - Tilt lock clutch

b - Mount cradle

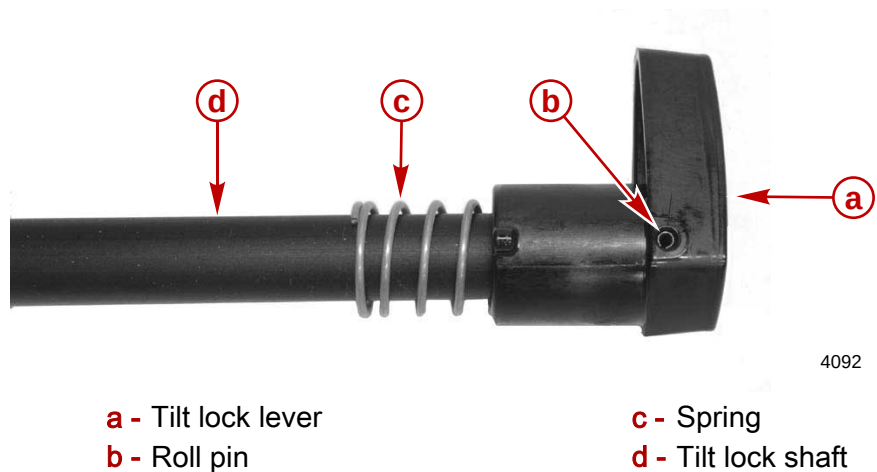
2. Install 2 bearings in tilt lock shaft bore.



3. Install pad onto tilt lock bracket.

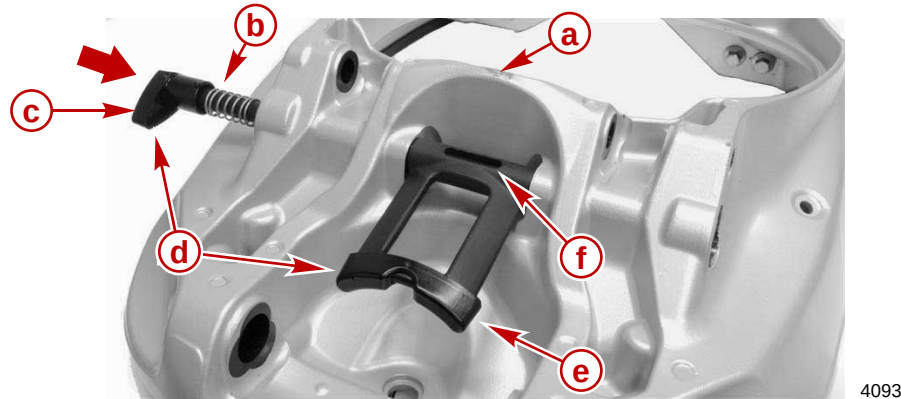


4. Assemble tilt lock lever on shaft. Install roll pin.
5. Install spring on tilt lock shaft.



6. Slide tilt lock shaft with spring partially into bore.

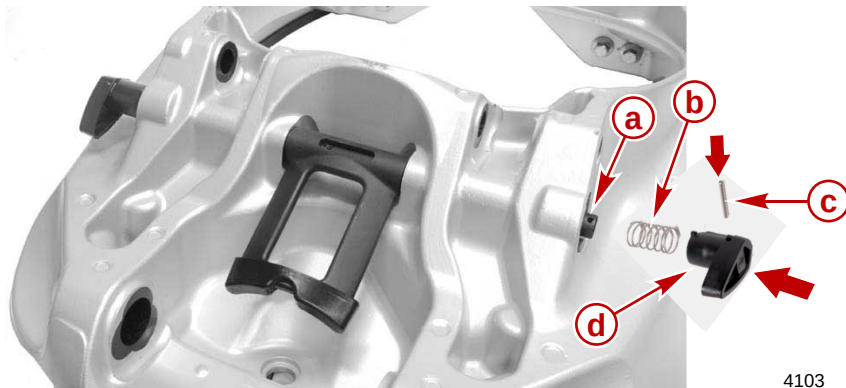
7. Align tilt lock lever with tilt lock bracket.
8. Slide tilt lock shaft through bracket into opposite bore.



a - Mount cradle
b - Tilt lock shaft
c - Tilt lock lever

d - Lever and bracket aligned
e - Tilt lock bracket pad
f - Tilt lock bracket

9. Assemble tilt lock lever and spring and install on tilt lock shaft. Secure with roll pin.

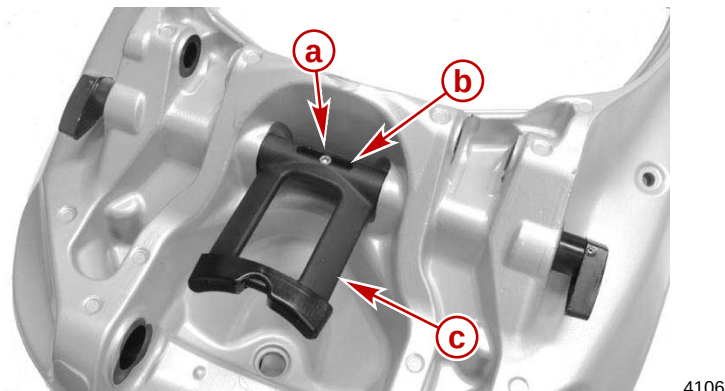


a - Tilt lock shaft
b - Spring

c - Roll pin
d - Tilt lock lever

10. Apply Loctite 242 Threadlocker to tilt lock bracket screw.
11. Align hole in tilt lock bracket with threaded hole in tilt lock shaft.

12. Install screw through tilt lock bracket into tilt lock shaft. Tighten screw to specified torque.



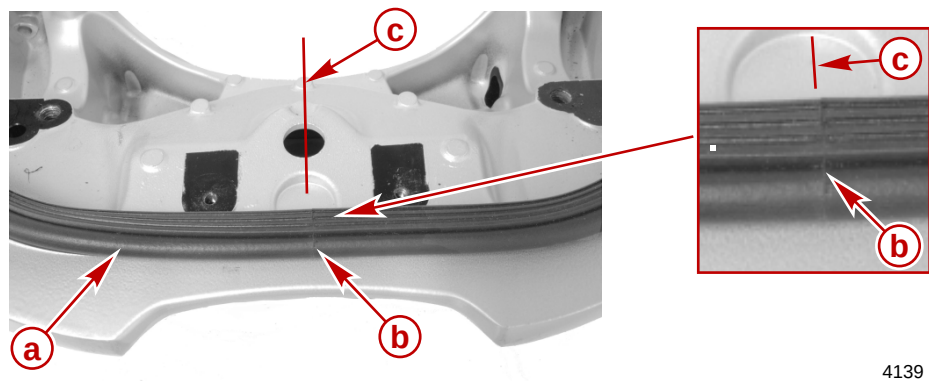
- a** - Tilt lock bracket screw (T27 Torx)
(M5 x 10)
- b** - Tilt lock shaft
- c** - Tilt lock bracket

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Tilt lock bracket screw	92-809821

Description	Nm	lb. in.	lb. ft.
Tilt lock bracket screw	4	35	

SEAL

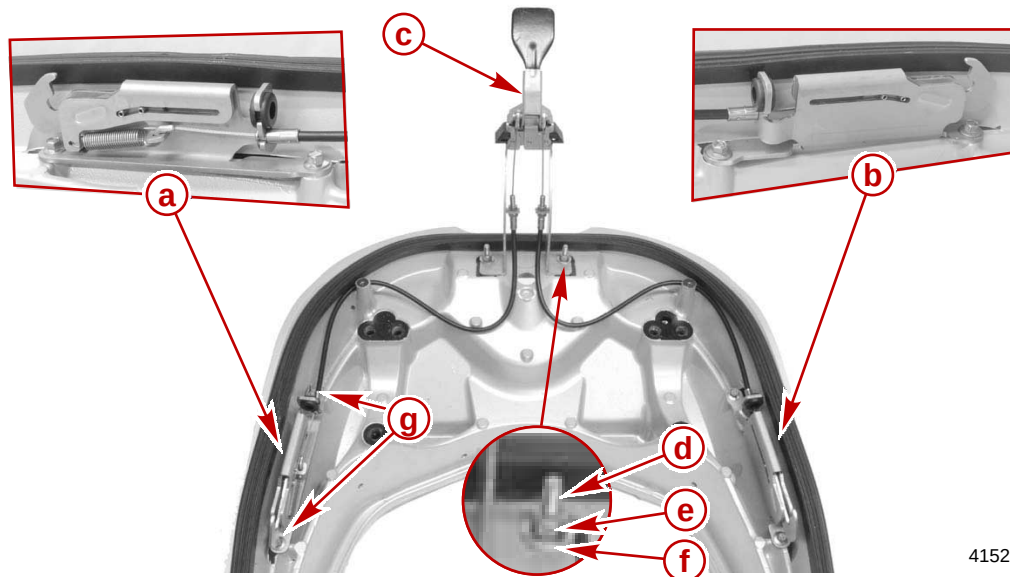
1. Install upper mount cradle seal on mount cradle. Position the seal at the rear of the mount cradle with the notch of the seal aligned with the centerline of the mount cradle.
2. Press the seal down on the mount cradle and continue around the mount cradle until the seal is fully seated.



- a** - Seal
- b** - Notch on seal aligned with mount cradle centerline
- c** - Mount cradle centerline

COWL LATCHES

Install front and side latches.



4152

- a** - Port side latch
- b** - Starboard side latch
- c** - Front and side latch
- d** - Stud (2)

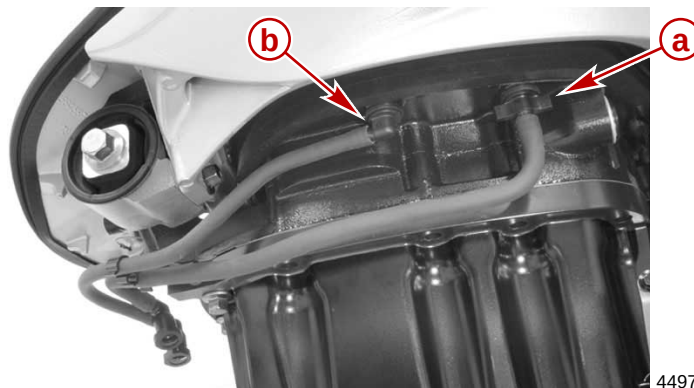
- e** - Nut (2)
- f** - Washer (2)
- g** - Mounting screws (2 each side)

ADAPTER PLATE

For adapter plate installation, refer to **Section 5B - Adapter Plate Reassembly**.

Hoses and Harnesses

1. Assemble the FSM fuel inlet hose and vent hose to the adapter plate on starboard side. Install hose connector from the bottom side of adapter plate. Align connector tab with slot in the adapter plate, then rotate clockwise to lock in position.

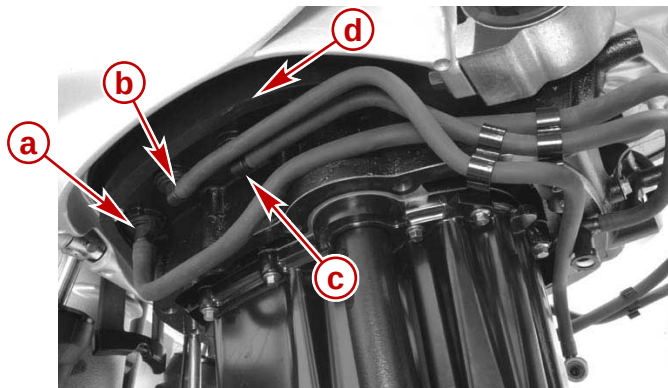


4497

- a** - FSM fuel inlet hose (10 mm red tab)

- b** - Vent hose (0.375 in. blue tab)

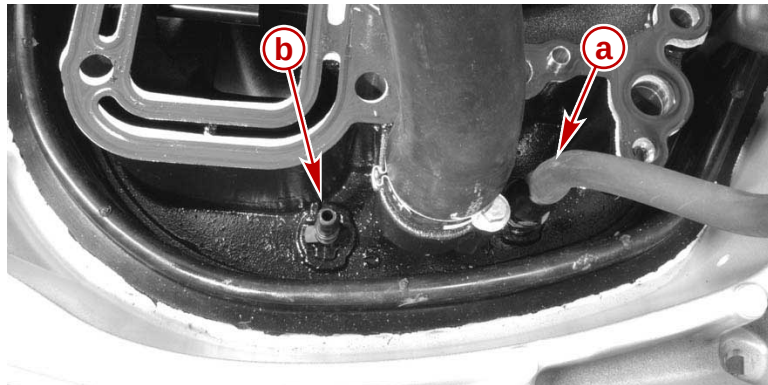
2. Assemble the FSM outlet hose, FSM water inlet hose, and the manifold hose to the adapter plate on port side. Install hose connector from the bottom side of adapter plate. Align connector tab with slot in the adapter plate, then rotate clockwise to lock in position.



4215

- | | |
|---|---|
| a - FSM high outlet hose (10 mm red tab) | c - Manifold reference hose (8 mm white tab) |
| b - FSM water cooling inlet hose (8 mm blue tab) | d - Adapter plate |

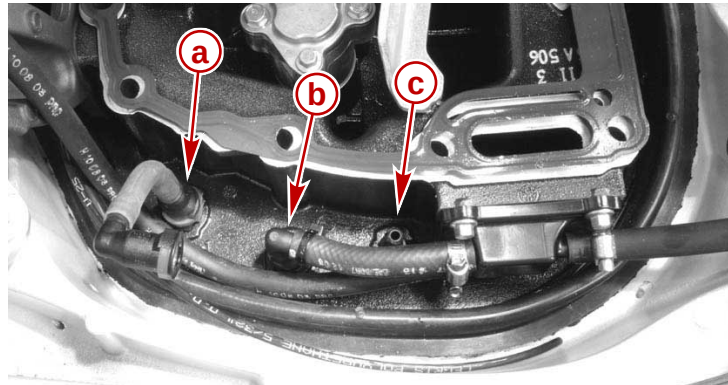
3. Position and assemble 2 hose clips to port hoses and 1 clip to starboard hoses.
4. Connect the FSM fuel inlet hose on top starboard side of adapter plate. Push the colored lock tab on the hose end down on the connector to install.



4496

- | | |
|--|--------------------------------|
| a - FSM fuel inlet hose (10 mm red tab) | b - Vent hose connector |
|--|--------------------------------|

5. Connect the FSM outlet hose and FSM water inlet hose on top port side of adapter plate. Push the colored lock tab on the hose end down on the connector to install.

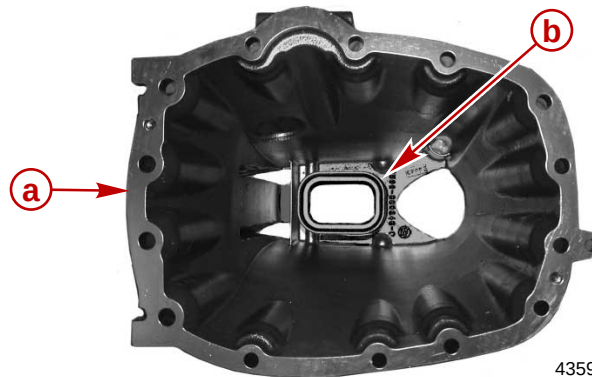


4216

- a** - FSM outlet hose (10 mm red tab)
- b** - FSM water inlet hose (8 mm blue tab)
- c** - Manifold hose connector

Driveshaft Housing

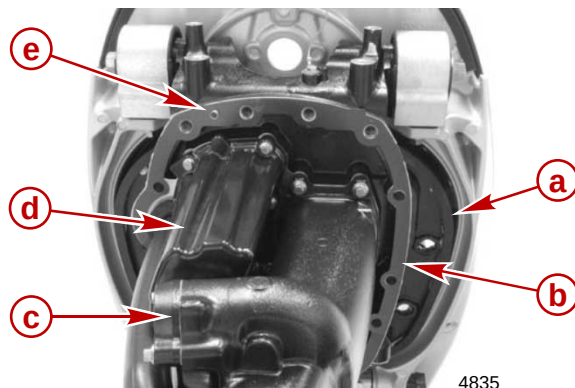
1. Install new exhaust tube seal in groove in bottom of driveshaft housing.



4359

- a** - Driveshaft housing
- b** - Exhaust tube seal

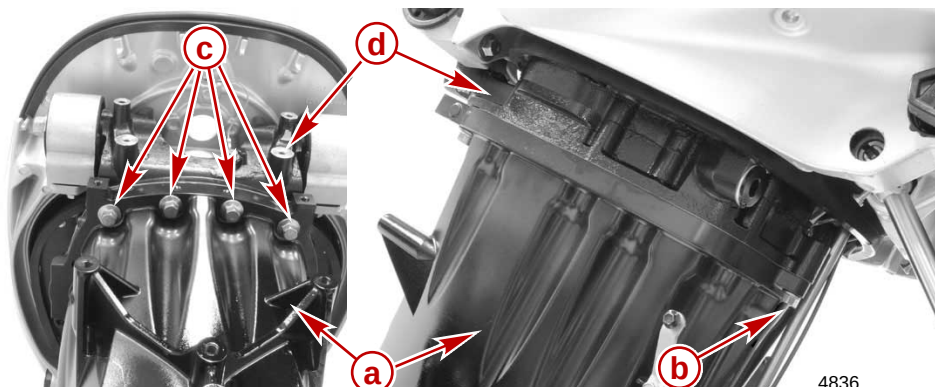
2. Clean mating surfaces of adapter plate and driveshaft housing.
3. Place new gasket over dowel pins on adapter plate.



4835

- a** - Adapter plate
- b** - Driveshaft housing gasket
- c** - Exhaust tube
- d** - Oil sump
- e** - Dowel pin (1 of 2)

4. Apply Loctite 271 Threadlocker to the four M12 mounting screw threads.
5. Apply Loctite 242 Threadlocker to the M8 mounting screw threads.
6. Assemble driveshaft housing to adapter plate with 4 screws in rear of housing and 1 in front. Tighten screws to specified torque.

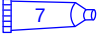


a - Driveshaft housing

b - Driveshaft housing mounting screw (1) M8 x 30

c - Driveshaft housing mounting screw (4) M12 x 45

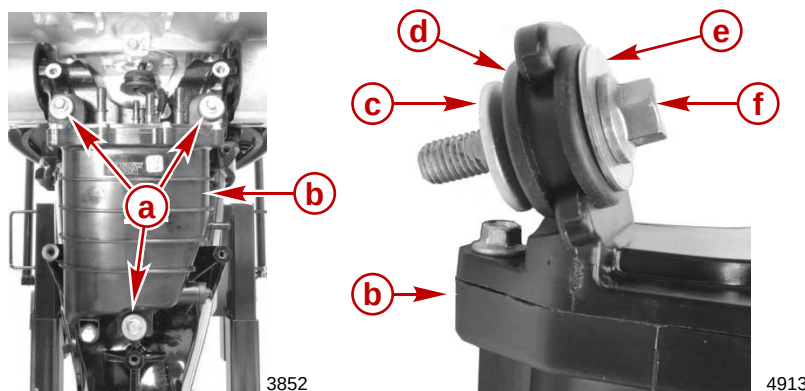
d - Adapter plate

Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	M12 driveshaft housing mounting screws	92-809819
 66	Loctite 242 Threadlocker	M8 driveshaft housing screw	92-809821

Description	Nm	lb. in.	lb. ft.
Driveshaft housing mounting screws (M12 x 45)	48		35.4
Driveshaft housing mounting screw (M8 x 30)	24		17.7

Fuel System Module (FSM)

1. Apply Loctite 242 to 3 fuel system module mounting screw threads.
2. Route water cooling inlet hose to starboard side of driveshaft housing (behind FSM)
3. Loosely attach the fuel system module to the driveshaft housing with 3 screws, washers grommets and bushings.



a - Fuel system module mounting hardware

b - Fuel system module

c - Bushing (3)

d - Grommet (3)

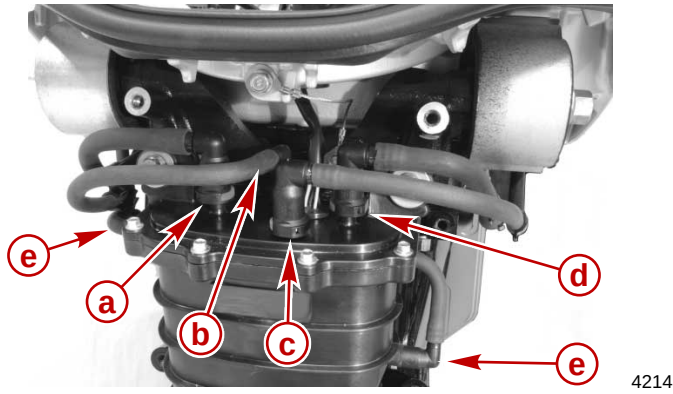
e - Washer (3)

f - Mounting screw (3) M8 x 35

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Fuel system module mounting screws	92-809821

4. Connect the fuel out line, manifold reference line, fuel in line, vent canister line and the fuel cooler line.

NOTE: The fuel lines at the Fuel System Module are pre-formed and only fit on the correct FSM port.

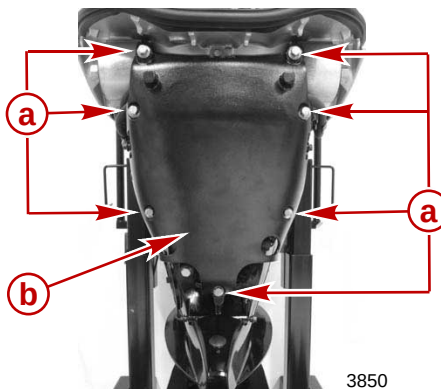


- a** - High pressure outlet (10 mm red tab)
- b** - Manifold reference to fuel pressure regulator (8 mm white tab)
- c** - Vent to vent canister switch (0.375 in. blue tab)
- d** - FSM fuel inlet from fuel filter/water separator (10 mm red tab)
- e** - Water cooling inlet hose (8 mm blue tab)

5. Tighten the 3 FSM mounting screws to specified torque.

Description	Nm	lb. in.	lb. ft.
Fuel system module mounting screws	24		17.7

6. Apply Loctite 242 to seven fuel system module shroud mounting screw threads.
7. Install 7 screws securing the fuel system module shroud to the driveshaft housing. Tighten screws to specified torque.

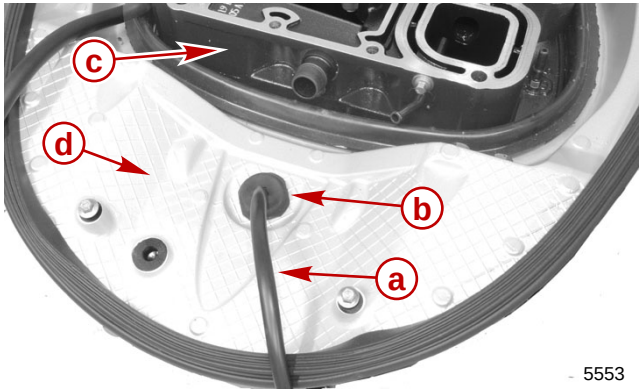


- a** - Fuel system module shroud mounting screws (M8)
- b** - Fuel system module shroud mounting screws (M8)

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Shroud mounting screws	92-809821

Description	Nm	lb. in.	lb. ft.
Fuel system module shroud mounting screws	24		17.7

8. Install the fuel system module harness grommet in the adapter plate.



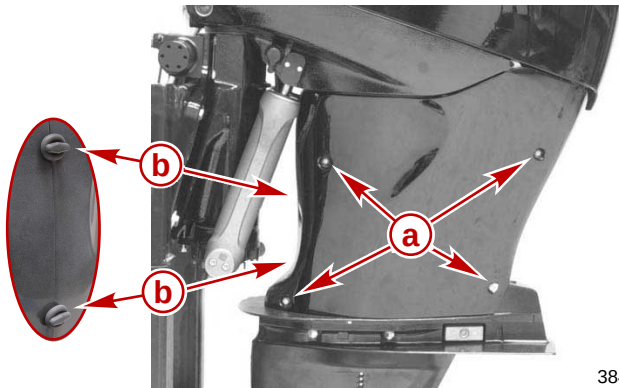
- a** - Fuel system module harness

b - Fuel system module harness grommet
- c** - Adapter plate

d - Mount cradle

Completing Mid-Section Reassembly

1. Assemble gearcase to driveshaft housing. Refer to **Section 6 - Gearcase Installation**.
2. Assemble engine to mid-section. Refer to **4A - Dressed Powerhead Removal/Installation**.
3. Install port chap to driveshaft housing. Secure with screws (4 or 6 for XXL shaft). Tighten screws to specified torque.
4. Install starboard chap to driveshaft housing. Secure with screws (4 or 6 for XXL shaft). Tighten screws to specified torque.
5. Attach two O-rings securing the front tabs on the port and starboard chaps.



- a** - Chap mounting screws (M6 special)
- b** - O-ring and tab

Description	Nm	lb. in.	lb. ft.
Chap mounting screws	6	53	

Mid-Section

Section 5B - Adapter Plate

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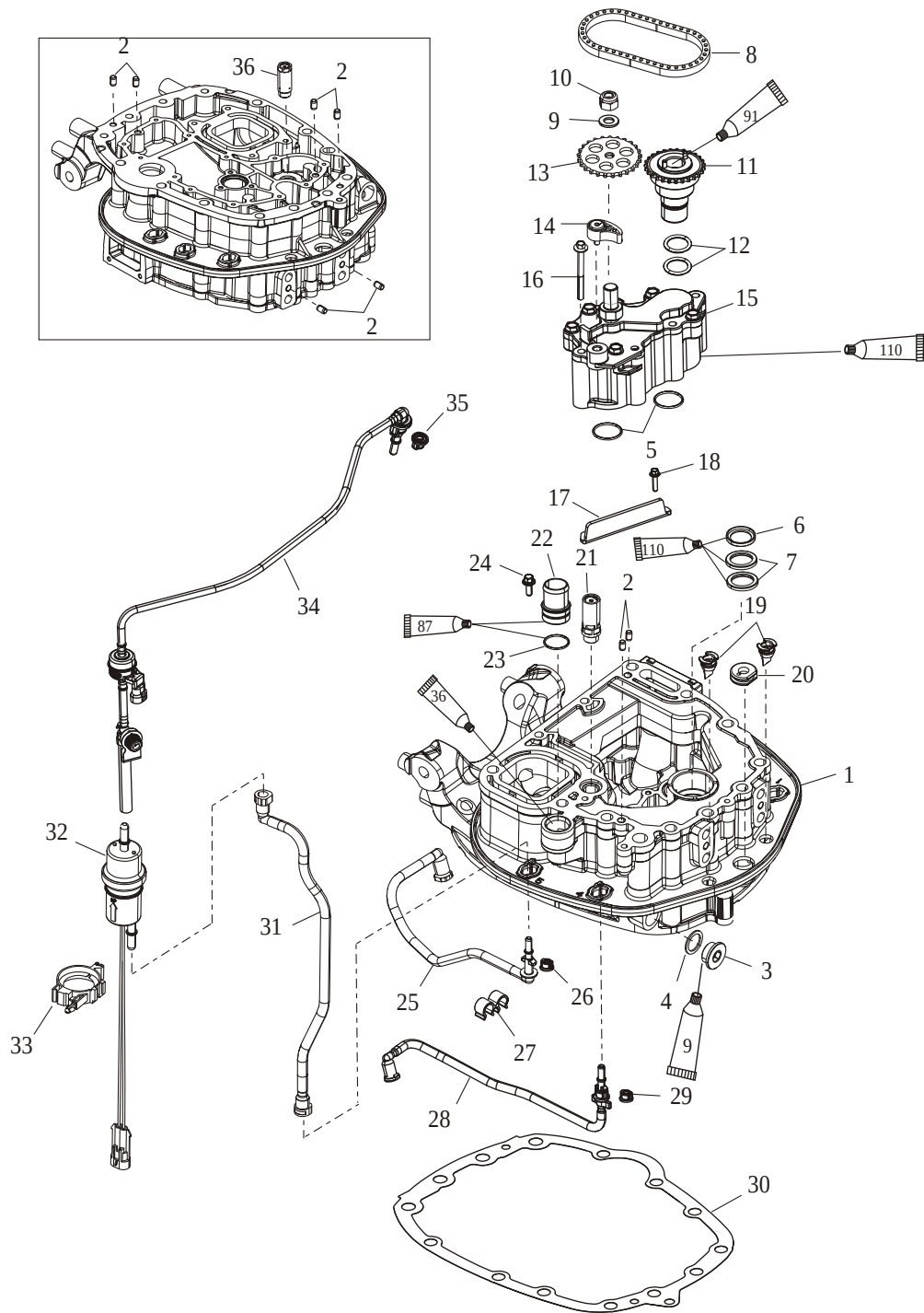
**5
B**

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	Front motor mount screws	92-809819
		Rear motor mount screws	
 36	P80 Rubber Lubricant	Installed dump fitting	Obtain Locally
		O-rings	
 66	Loctite 242 Threadlocker	Idle relief fitting mounting screws and evaporative cooling fitting mounting screws	92-809821
		Water strainer mounting screws	
		Dump fitting mounting screws	
		Front motor mount screws	
		Oil pickup tube screws	
		Oil sump mounting screws	
 87	High Performance Gear Lubricant	Exhaust tube mounting screws	92-802854A1
		Dump fitting and O-ring	
 91	Engine Coupler Spline Grease	Oil pump driveshaft	92-802869A1
 110	4 Stroke 10W30 Outboard Oil	Oil seals	92-802833A1
		Water seals	
		Cooling jet check valve and dump fitting O-rings	
 113	Loctite Moly Paste (Molybdenum Disulfide Grease)	Underside of flange head	Obtain Locally
 137	Three Bond Adhesive TB-1530	Adapter plate seal	Obtain Locally

Notes:

Oil Pump/Adapter Plate-Upper Components



2400

Oil Pump/Adapter Plate-Upper Components

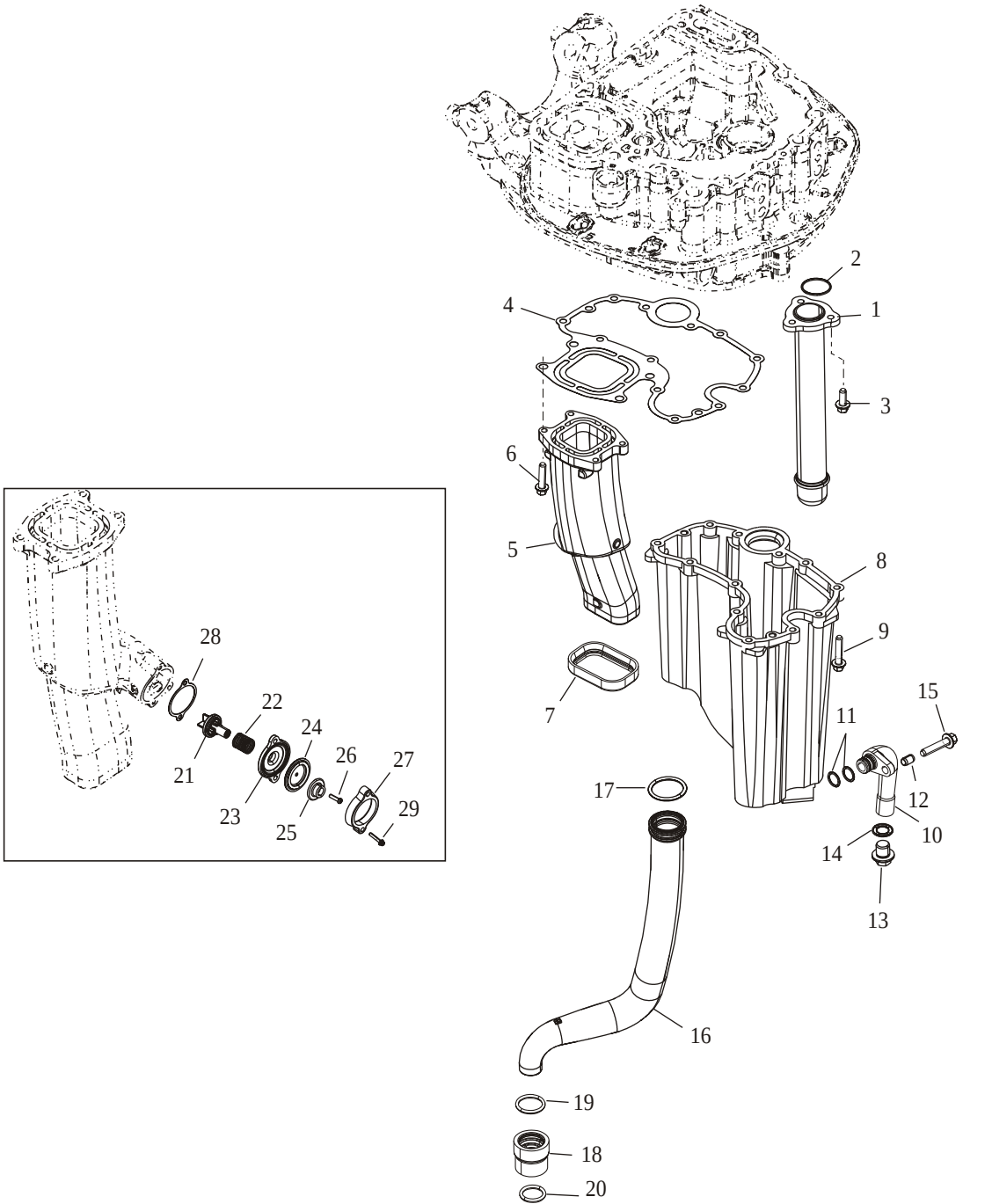
Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Adapter plate			
2	8	Dowel pin			
3	1	Plug	50		37
4	1	Washer			
5	2	O-ring			
6	1	Oil seal			
7	2	Seal - Water			
8	1	Chain - Oil pump drive			
9	1	Washer			
10	1	Nut	80		59
11	1	Driveshaft - Oil pump			
12	1	O-ring			
13	1	Sprocket - Driven			
14	1	Tensioner assembly - Oil pump drive			
15	1	Oil pump assembly			
16	5	Screw	10	88	
17	1	Oil deflector			
18	2	Screw (M6 x 16)	10	88	
19	2	Cowl drain			
20	1	Grommet			
21	1	Check valve assembly	40		29.5
22	1	Fitting - Dump			
23	1	O-ring			
24	1	Screw (M6 x 12)	6	53	
25	1	Hose - Vent (Lower)			
26	1	Grommet			
27	1	Clip			
28	1	Hose - Fuel into Fuel Supply Module			
29	1	Grommet			
30	1	Gasket			
31	1	Hose - Fuel (Vent)			
32	1	Vent canister			
33	1	Clip			
34	1	Fuel line purge valve assembly			
35	1	Grommet			
36	1	Pressure relief valve - Oil pump	40		29.5

Tube Ref No.	Description	Where Used	Part No.
 36	P80 Rubber Lubricant	Installed dump fitting	Obtain Locally

Tube Ref No.	Description	Where Used	Part No.
 87	High Performance Gear Lubricant	Dump fitting and O-ring	92-802854A1
 91	Engine Coupler Spline Grease	Oil pump driveshaft	92-802869A1
 110	4 Stroke 10W30 Outboard Oil	Oil seals	92-802833A1

Notes:

Adapter Plate-Lower Components

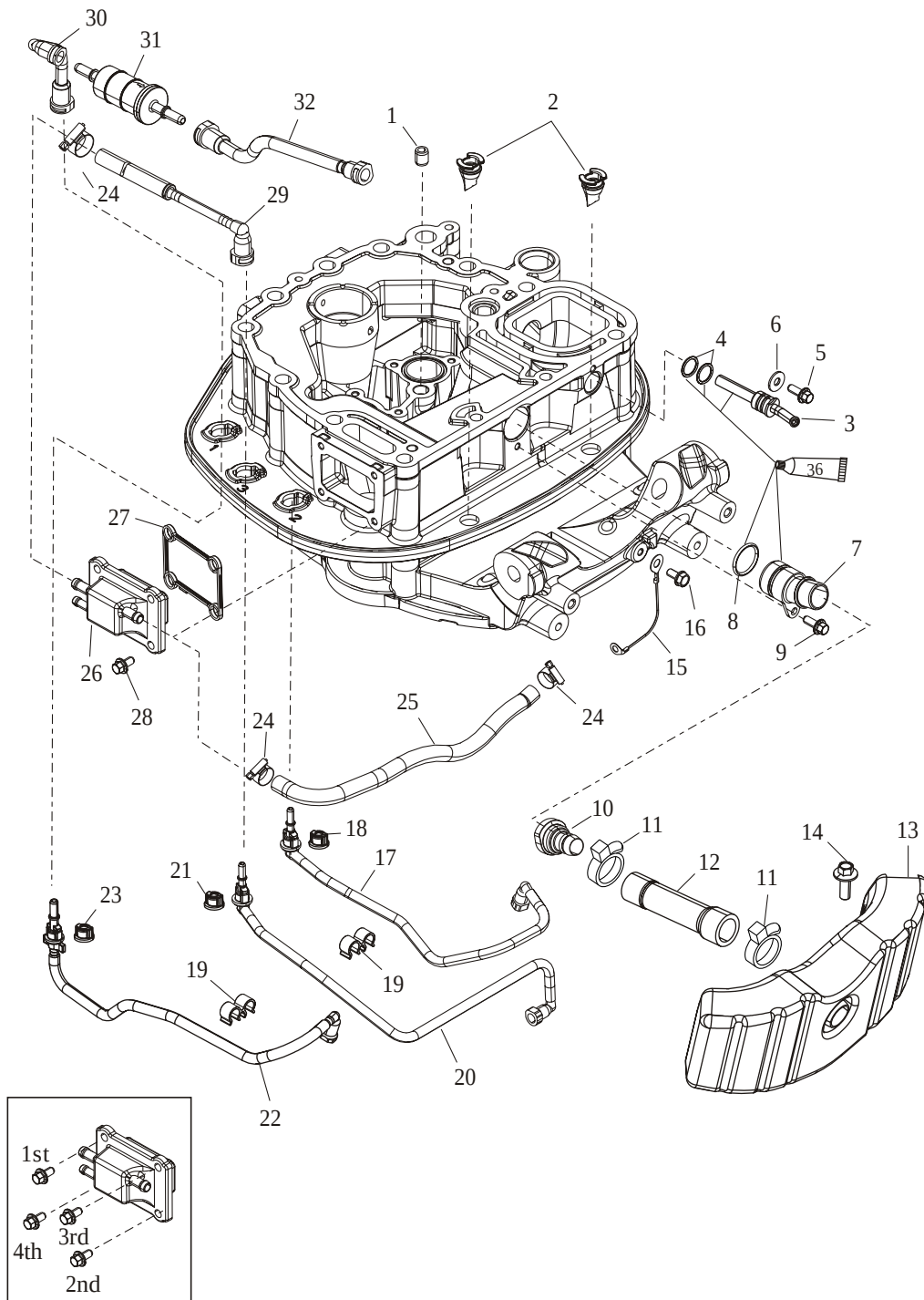


2401

Adapter Plate-Lower Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Oil pickup			
2	1	O-ring			
3	3	Screw	10	88	
4	1	Gasket - Oil sump			
5	1	Exhaust tube			
6	4	Bolt (M8 x 35)	34		25
7	1	Seal - Exhaust tube			
8	1	Oil sump			
9	12	Screw	15	133	
10	1	Tube - Oil drain			
11	2	O-ring			
12	1	Dowel pin			
13	1	Oil drain plug			
14	1	Seal - Drain plug			
15	1	Screw	10	88	
16	1	Water tube			
17	1	O-ring			
18	1	Coupling			
19	1	O-ring			
20	1	O-ring			
21	1	Poppet assembly			
22	1	Spring			
23	1	Retainer			
24	1	Diaphragm			
25	1	Washer			
26	1	Screw (10-16 x 0.750 in.)			
27	1	Cover - Poppet			
28	1	Gasket - Poppet			
29	2	Screw		44	5

Adapter Plate Hose Routings Components



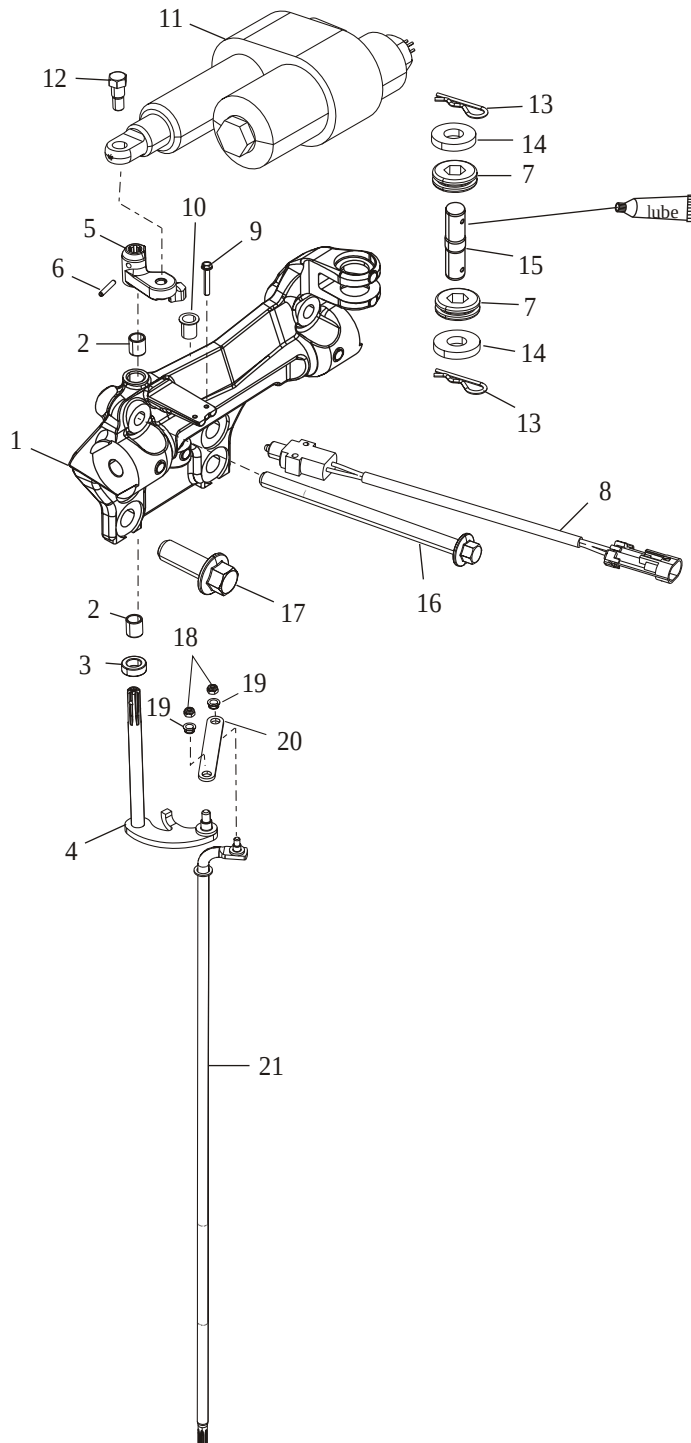
2399

Adapter Plate Hose Routings Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Dowel pin (12 mm)			
2	2	Cowl drain			
3	1	Fitting			
4	2	O-ring			
5	1	Screw	6	53	
6	1	Washer			
7	1	Fitting			
8	1	O-ring			
9	1	Screw	6	53	
10	1	Fitting			
11	1	Cable tie (8 in.)			
12	1	Hose - Idle exhaust			
13	1	Exhaust plenum			
14	2	Screw (M6 x 16)	6	53	
15	1	Cable			
16	1	Screw (M6 x 13)	8	71	
17	1	Hose - Manifold reference (Lower)			
18	1	Grommet			
19	2	Clip			
20	1	Hose - Water in (Lower)			
21	1	Grommet			
22	1	Hose - FSM (Out)			
23	1	Grommet			
24	3	Clamp			
25	1	Tubing (21 in.)			
26	1	Manifold housing			
27	1	Seal			
28	4	Screw (M6 x 16)	Hand start and drive 1st screw snug. Drive remaining 3 screws in "X" pattern sequence to 6 Nm (53 lb. in.). Return to 1st screw and drive to torque.		
29	1	Hose - Water in (Upper)			
30	1	Hose - High pressure filter (PRE)			
31	1	Hose - High pressure			
32	1	Hose - High pressure filter - To fuel rail (POST)			

Tube Ref No.	Description	Where Used	Part No.
 36	P80 Rubber Lubricant	O-rings	Obtain Locally

Upper Shift Components



2397

Upper Shift Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Bracket			
2	2	Bushing			
3	1	Spacer			
4	1	Shift shaft - Bellcrank			
5	1	Bellcrank - Upper			
6	1	Roll pin			
7	2	Grommet			
8	1	Switch			
9	2	Screw	2.3	20	
10	1	Bushing			
11	1	Shift actuator			
12	1	Screw	20		14.7
13	2	Cotter pin			
14	2	Washer			
15	1	Pin - Pivot			
16	2	Screw (M10 x 155)	40		29.5
			Plus 45 degree turn		
17	4	Screw (M14)	185		136.4
18	2	Nut (M6)	6	53	
19	2	Bushing			
20	1	Shift shaft link			
21	1	Shift shaft			

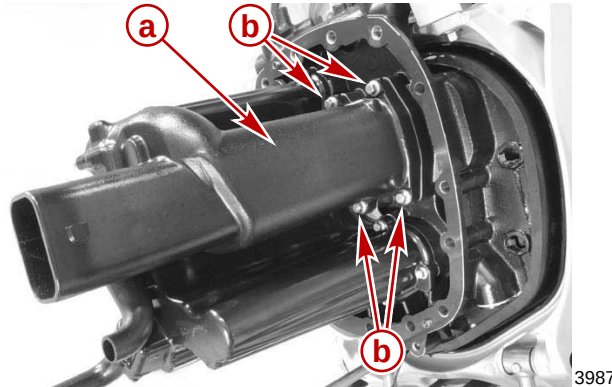
Adapter Plate Disassembly

Preparing Outboard for Adapter Plate Disassembly

1. Remove powerhead. Refer to **Section 4A - Dressed Powerhead Removal/Installation**.
2. Remove driveshaft housing. Refer to **Section 5A - Mid Section Disassembly**.

Exhaust Tube and Oil Sump

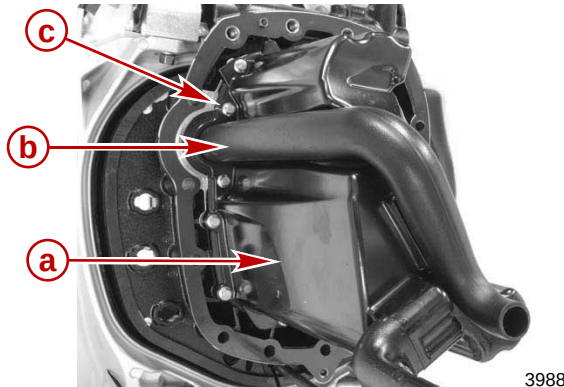
1. Tilt outboard to up position. Engage tilt lock.
2. Remove 4 screws securing exhaust tube to adapter plate. Remove exhaust tube.



a - Exhaust tube

b - Exhaust tube mounting screw

3. Remove 12 screws securing oil sump to adapter plate. Remove oil sump.



a - Oil sump

b - Water pickup tube

c - Oil sump mounting screws (12)

ADAPTER PLATE

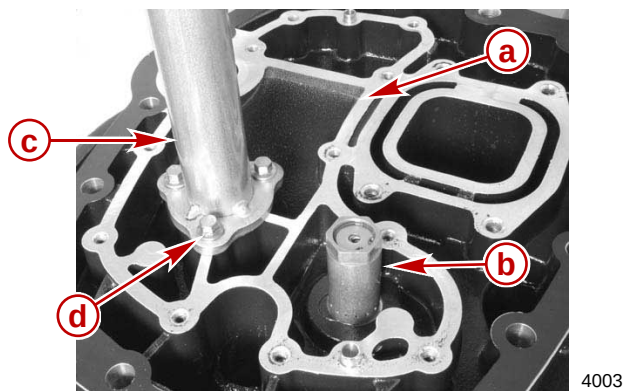
For removal of the adapter plate, refer to **Removing from Mount Cradle** in this section.

Lower Components and Cooling Jet Check Valve

1. Tilt outboard to up position. Engage tilt lock.
2. Remove oil pump pressure relief valve.

IMPORTANT: Only use a socket or box end wrench to remove and install valve. Using an open end wrench may damage the valve.

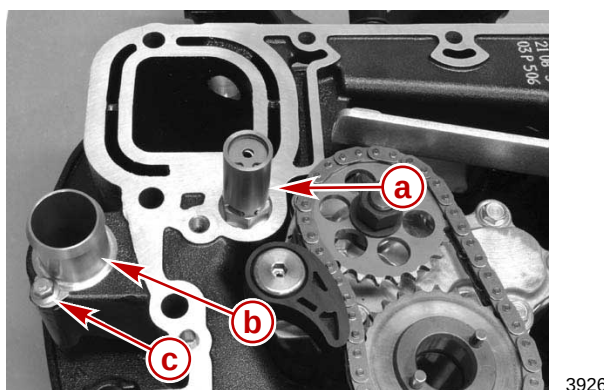
3. Remove 3 screws securing oil pickup tube. Remove oil pickup tube.



- a - Adapter plate
b - Pressure relief valve
c - Oil pickup tube
d - Screw (3)

4. Disengage tilt lock. Trim outboard down.
5. Remove cooling jet check valve from adapter plate.

IMPORTANT: Only use a socket or box end wrench to remove and install valve. Using an open end wrench may damage the valve.



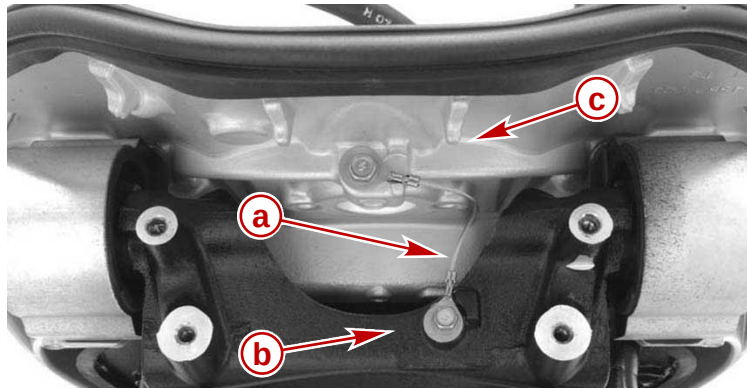
- a - Cooling jet check valve
b - Dump fitting
c - Dump fitting mounting screw

6. Thoroughly clean adapter plate cavities and passages.
7. Clean both upper and lower adapter plate surfaces. Remove old gasket material from surfaces.

NOTE: If outboard is disassembled due to powerhead removal, inspect and thoroughly clean adaptor plate surfaces and internal passages. It is not necessary to remove the adaptor plate from the mount cradle.

Removing from Mount Cradle

1. Remove ground strap from adapter plate.

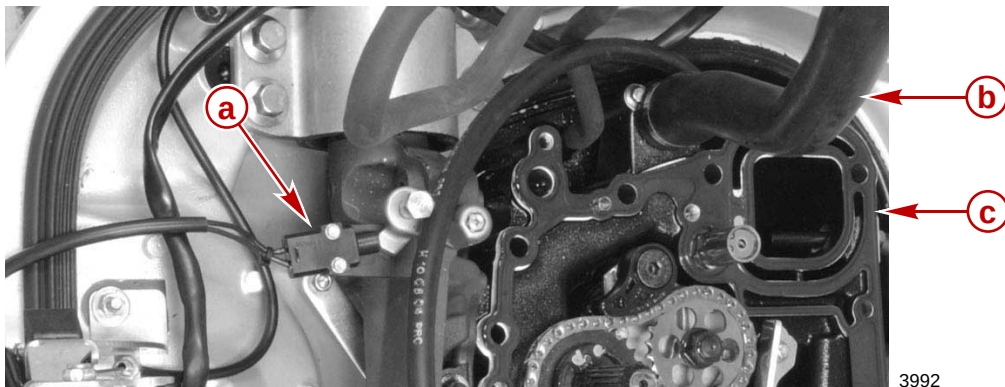


3991

a - Ground strap
b - Adapter plate

c - Mount cradle

2. Remove neutral start switch from front bracket, and dump hose and gasket from adapter plate.

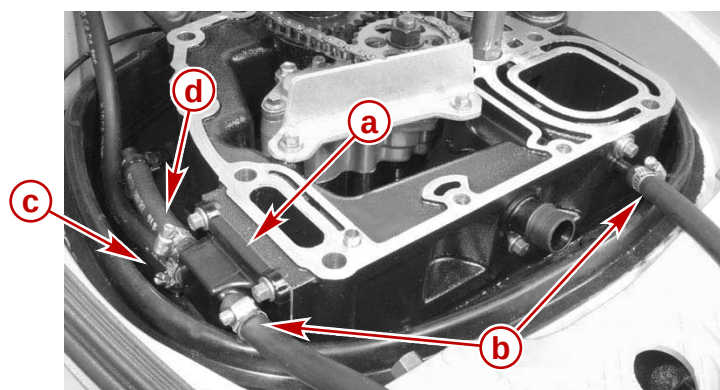


3992

a - Neutral start switch
b - Dump hose

c - Gasket

3. Remove water hoses from water strainer and adapter plate.



3994

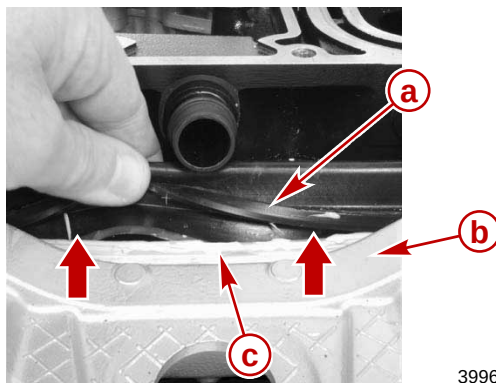
a - Water strainer
b - Hose - Evaporative cooling water supply

c - Hose - Tell tale
d - Hose - FSM cooling water supply (blue tab)

4. Break loose the adapter plate to mount cradle rubber seal. The rubber seal is glued in place with a silicone type adhesive. Start at rear and work around adapter plate until seal is completely loose from the mount cradle.

IMPORTANT: Do not damage or remove paint from either surface when removing seal.

NOTE: It may be necessary to use a pry bar to loosen the adapter plate seal or in extreme cases it may be necessary to cut the seal to remove. Carefully remove all adhesive and seal material from the adapter plate and mount cradle.



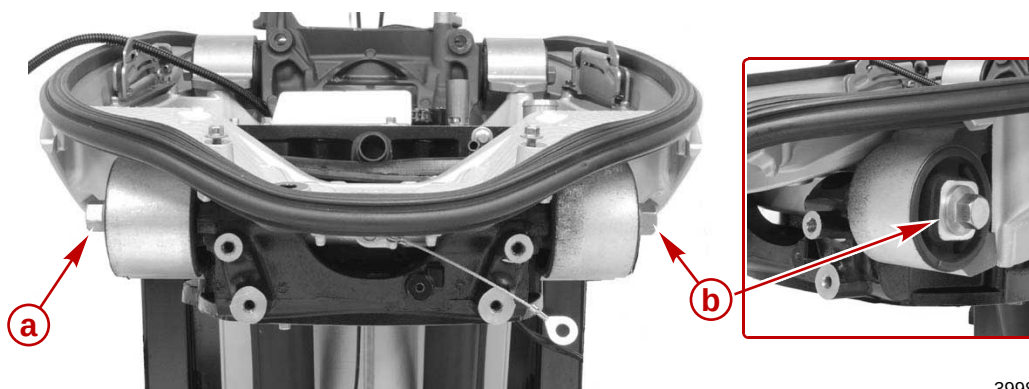
3996

a - Seal

b - Mount cradle

c - Adhesive sealant

5. Remove the screw attaching the port and starboard rear motor mounts to adapter plate.

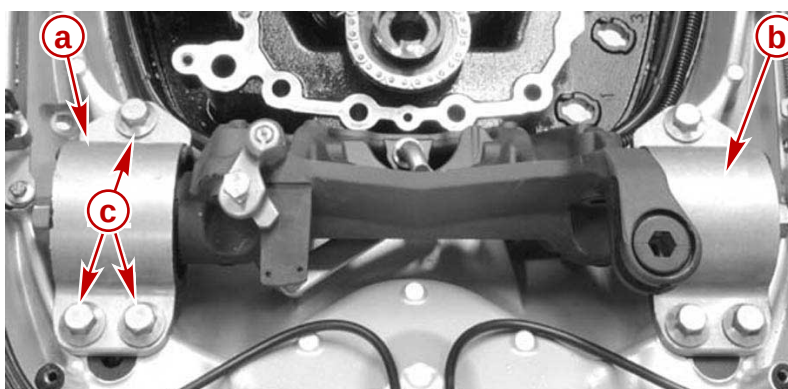


3998

a - Port rear motor mount screw

b - Starboard rear motor mount screw

6. Remove 6 screws securing the front motor mount to the bracket.



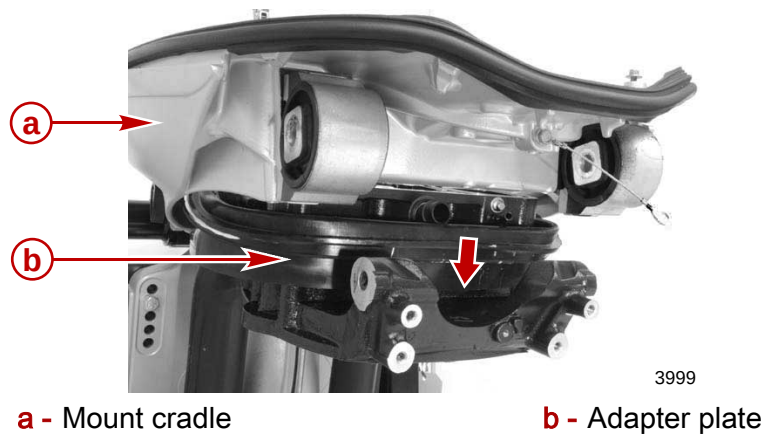
3997

a - Starboard front motor mount

b - Port front motor mount

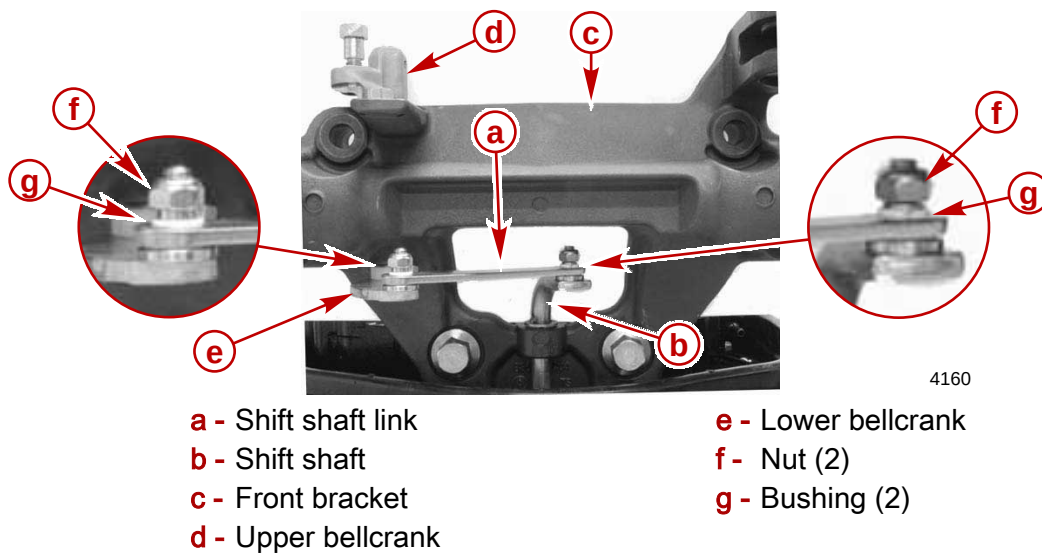
c - Mounting screws (3 each)

7. Remove adapter plate by pivoting adapter plate down through opening in mount cradle.



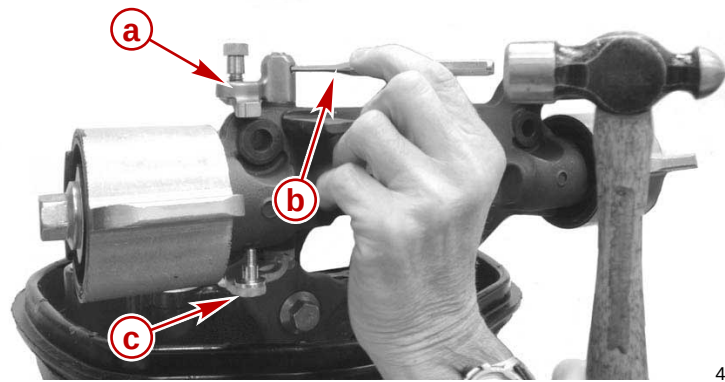
Front Bracket Disassembly

1. Remove nuts from shift shaft and lower bellcrank.
2. Remove shift shaft link.
3. Remove shift shaft.
4. Inspect bushings for wear or damage.



5. Using a drift punch, remove roll pin from upper bellcrank.

6. Remove upper and lower bellcrank from front bracket.

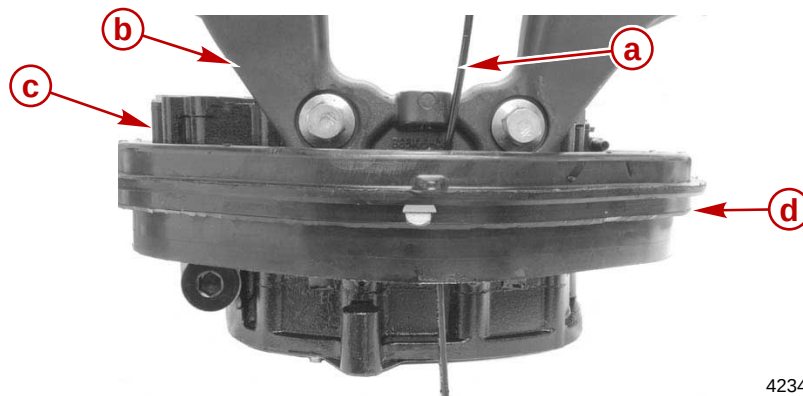


4274

a - Upper bellcrank
b - Drift punch

c - Lower bellcrank

7. Remove speedometer tube.
8. Remove seal.

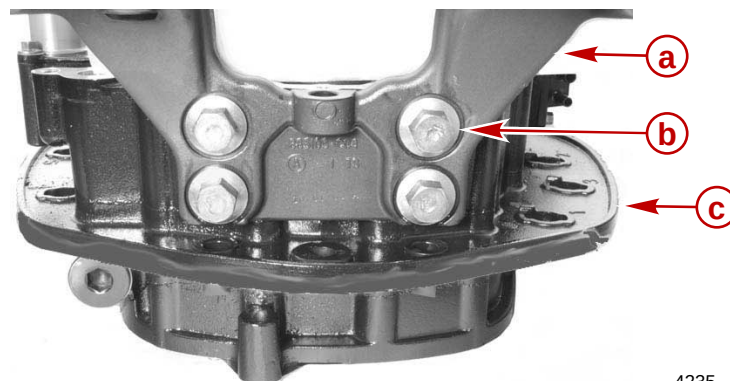


4234

a - Speedometer tube
b - front bracket

c - Adapter plate
d - Seal

9. Remove 4 screws securing front motor mounts to adapter plate.

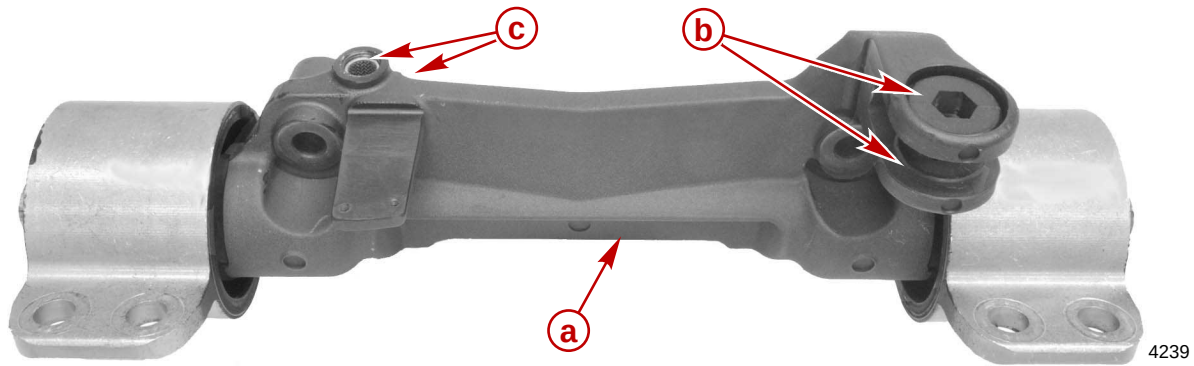


4235

a - Front motor mount
b - Mounting screw (4)

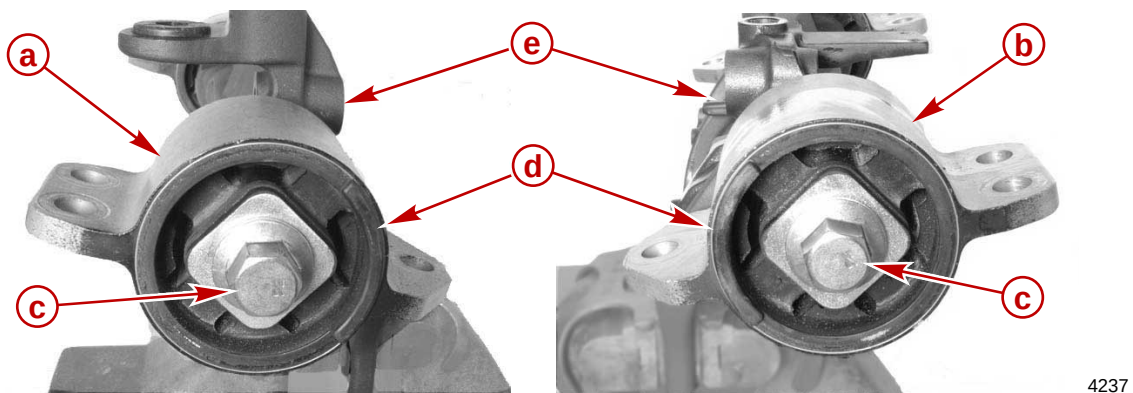
c - Adapter plate

10. Inspect pivot pin grommets and bellcrank bushings for wear or damage. Replace if required.



- a** - Front bracket
b - Pivot pin grommets (2)
c - Bellcrank bushings (2)

11. Remove screw attaching port front motor mount to bracket. Remove port front motor mount.
12. Remove screw attaching starboard front motor mount to bracket. Remove starboard front motor mount.

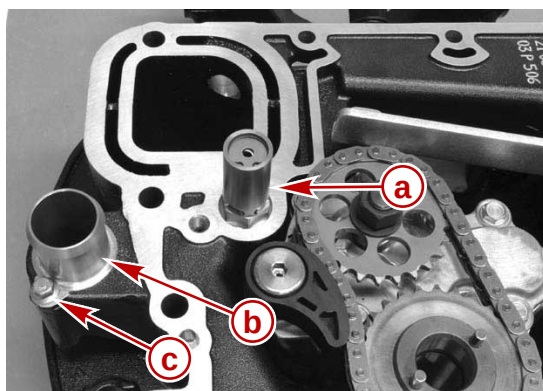


- a** - Port front motor mount
b - Starboard front motor mount
c - Mounting screw
d - Notch on motor mounts
e - Front bracket

Upper Components

1. Remove cooling jet check valve from adapter plate.
IMPORTANT: Only use a socket or box end wrench to remove and install valve. Using an open end wrench may damage the valve.

2. Remove dump fitting from adapter plate.

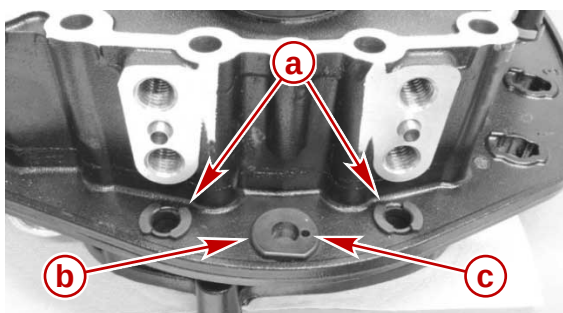


3926

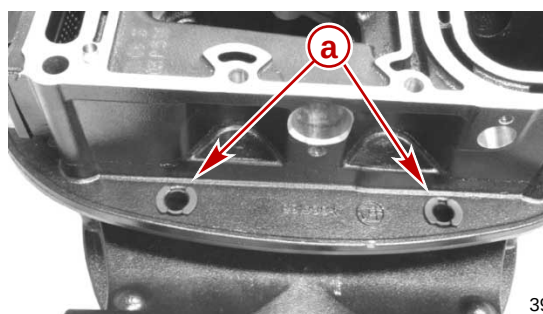
a - Cooling jet check valve
b - Dump fitting

c - Dump fitting mounting screw

3. Remove 4 cowl drain check valves from adapter plate.
4. Remove upper shift shaft grommet from adapter plate.



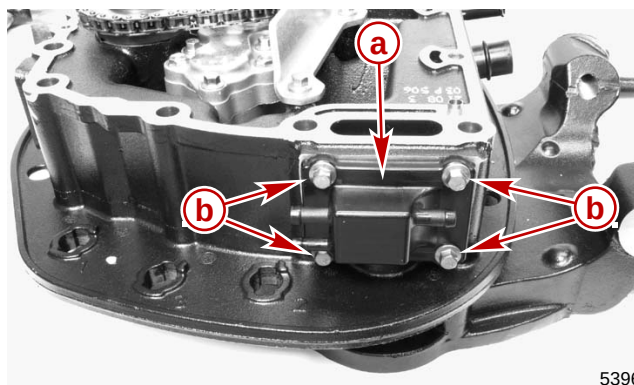
a - Cowl drain check valves
b - Shift shaft grommet



3923

c - Speedometer tube hole

5. Remove water strainer with seal and 4 mounting screws.



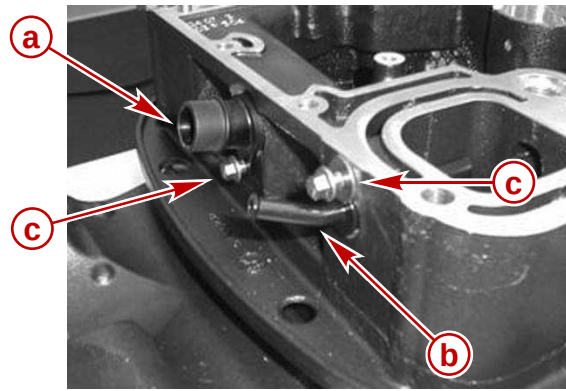
5396

a - Water strainer

b - Water strainer mounting screws

6. Remove screw and washer securing evaporative cooling fitting. Remove evaporative cooling fitting.

7. Remove screw securing idle relief fitting. Remove idle relief fitting.



3916

a - Idle relief fitting

c - Mounting hardware

b - Evaporative cooling fitting

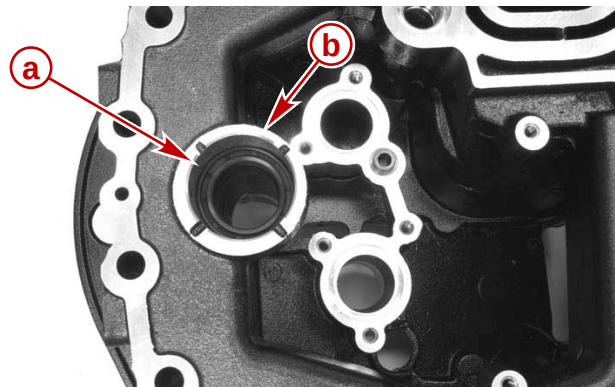
8. Clean adapter plate surfaces. Be careful not to damage gasket surfaces when cleaning.

Oil Pump

Remove oil pump. Refer to 4C - Oil Pump Removal.

Driveshaft Seals

1. Remove the 3 driveshaft seals in the oil pump drive gear hub cavity.



4275

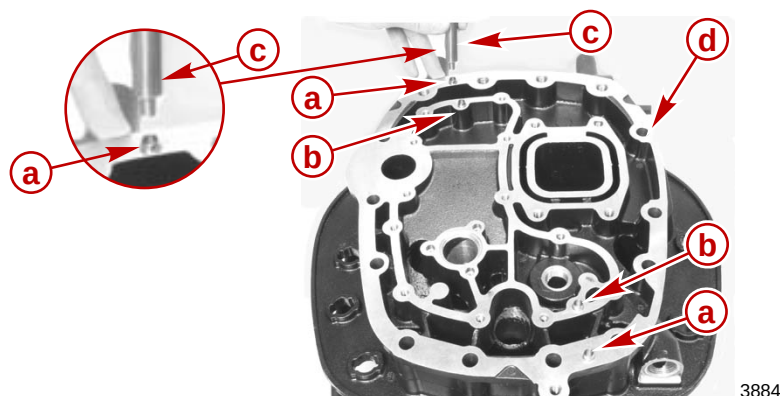
a - Driveshaft seals (3)

b - Oil pump drive gear hub cavity

Adapter Plate Reassembly

Dowel Pins and Plugs

1. Install 2 oil sump and 2 driveshaft housing dowel pins in bottom side of adapter plate.



a - Driveshaft housing dowel pin

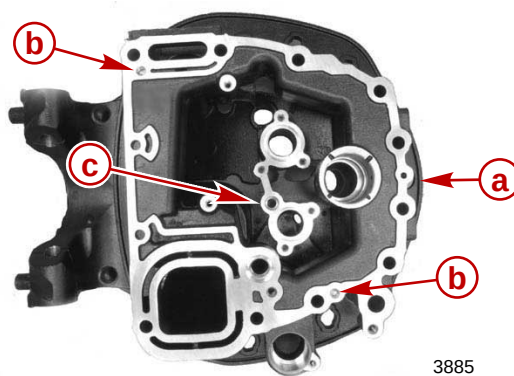
b - Oil sump housing dowel pin

c - Dowel pin installation tool

d - Bottom side of adapter plate

2. Assemble 2 powerhead to adapter plate dowel pins to the top side.
3. Install oil pump dowel pin until it bottoms in bore. Measure exposed length of dowel pin to ensure it is installed to correct depth.

Dowel Pin	
Maximum exposed height	6.0 mm (0.236 in.)

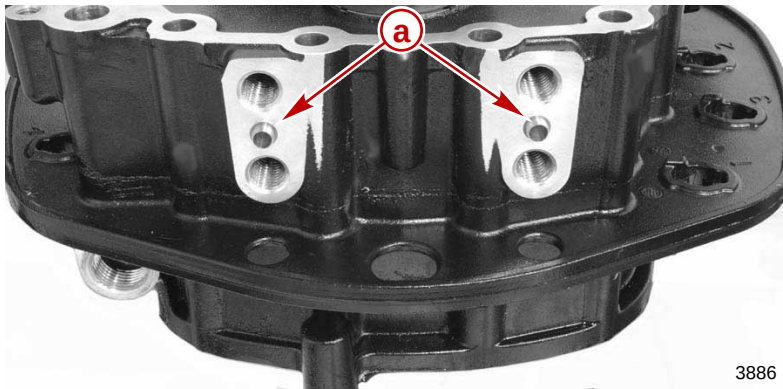


a - Top side of adapter plate

b - Engine block dowel pin

c - Oil pump dowel pin

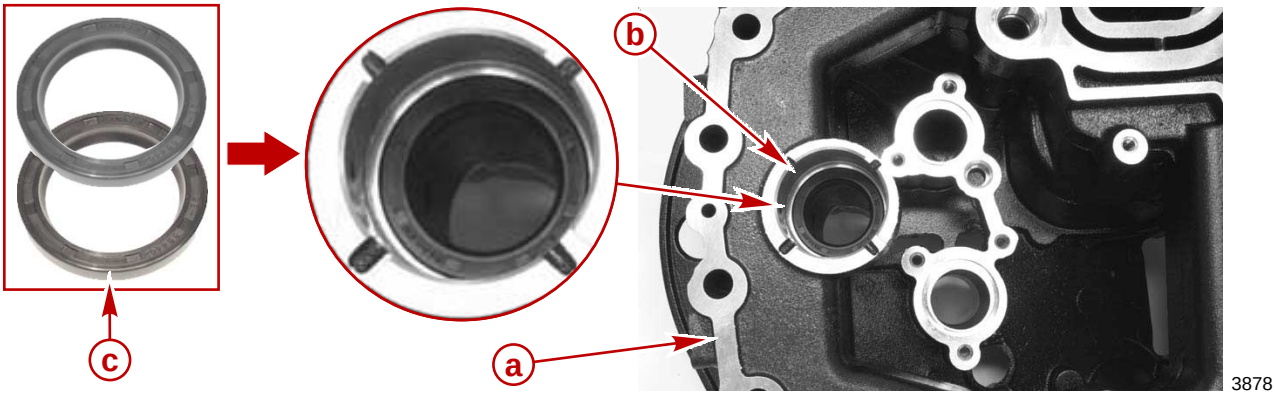
4. Assemble 2 front mount bracket dowel pins.



a - Front mount bracket dowel pin

Driveshaft Seals

1. Lubricate 2 water seals with 4 Stroke Outboard Oil. Install 2 water seals, spring side down, in oil pump drive gear hub bore. Press seals into bore until seated.

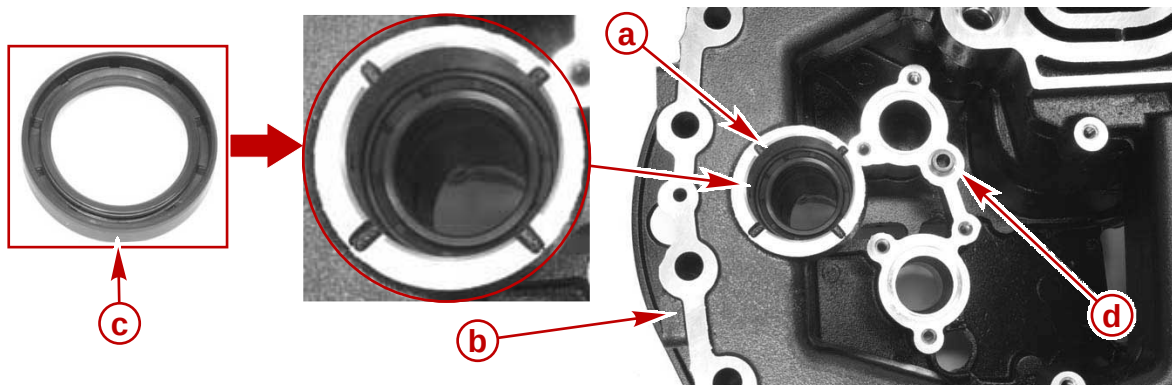


a - Adapter plate
b - Oil pump drive gear hub cavity

c - Water seals, spring side down

Tube Ref No.	Description	Where Used	Part No.
 110 	4 Stroke 10W30 Outboard Oil	Water seals	92-802833A1

- Lubricate oil seal with 4 Stroke Outboard Oil. Install oil seal, spring side up, in the oil pump drive gear hub cavity. Press seal into bore until it reaches the top ridge.



3880

a - Oil pump drive gear hub cavity
b - Adapter plate

c - Oil seal, spring side up
d - Oil pump dowel pin

Tube Ref No.	Description	Where Used	Part No.
 110	4 Stroke 10W30 Outboard Oil	Oil seals	92-802833A1

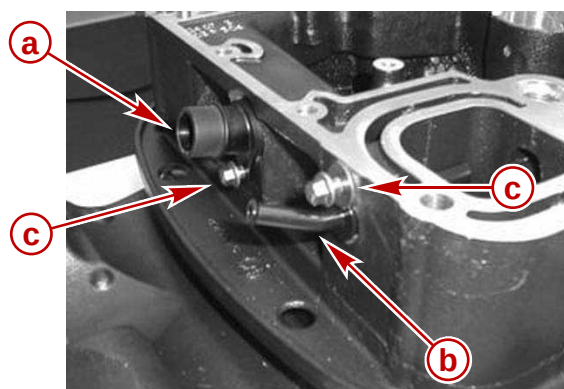
Oil Pump

Install oil pump. Refer to **4C - Oil Pump Installation**.

Upper Components

NOTE: Lightly lubricate O-rings and grommets before installation.

- Install evaporative cooling fitting with O-ring, washer and screw. Apply Loctite 242 Threadlocker to screw threads. Tighten screw to specified torque.
- Install idle relief fitting with O-ring and screw. Apply Loctite 242 Threadlocker to screw threads. Tighten screw to specified torque.



3916

a - Idle relief fitting
b - Evaporative cooling fitting

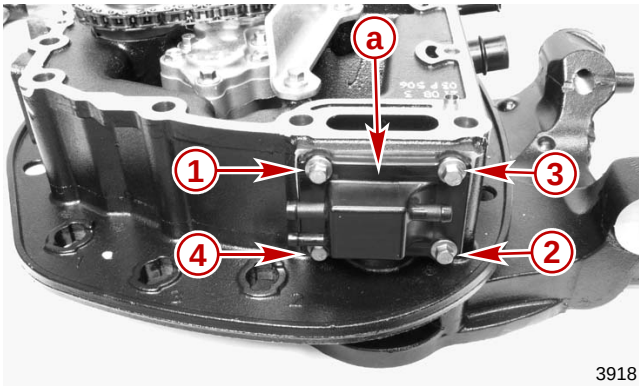
c - Mounting hardware

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Idle relief fitting mounting screws and evaporative cooling fitting mounting screws	92-809821

Description	Nm	lb. in.	lb. ft.
Evaporative cooling fitting screw	6	53	

Description	Nm	lb. in.	lb. ft.
Idle relief fitting screw	6	53	

3. Install water strainer with seal and 4 screws. Apply Loctite 242 Threadlocker to screw threads. Tighten in sequence to specified torque.

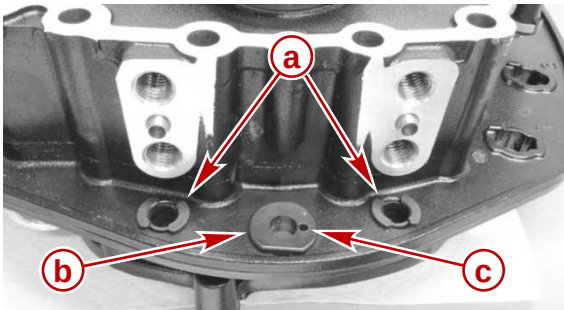


a - Water strainer

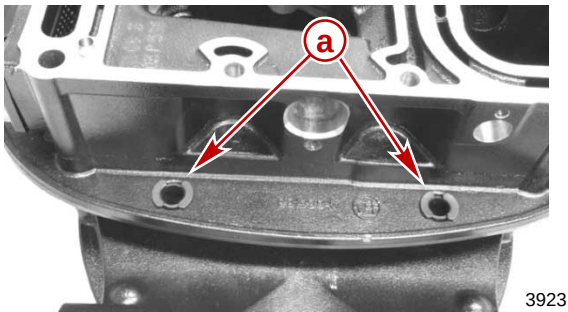
Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Water strainer mounting screws	92-809821

Description	Nm	lb. in.	lb. ft.
Water strainer screw - Drive 1st screw snug. Drive remaining 3 screws in specified pattern sequence to specified torque. Return to 1st screw and drive to specified torque.	6	53	

4. Install 4 cowl drain check valves into adapter plate.
5. Install upper shift shaft grommet into adapter plate.



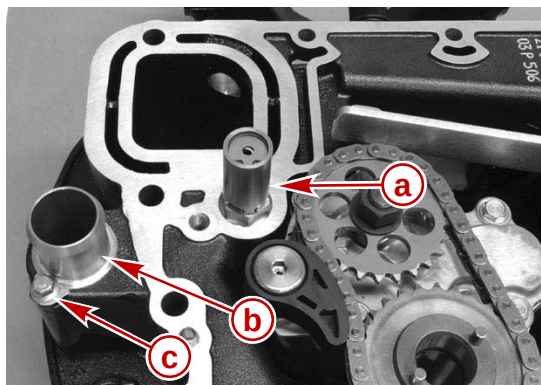
a - Cowl drain check valves
b - Shift shaft grommet



c - Speedometer tube hole

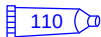
6. Install cooling jet check valve with lubricated O-ring into adapter plate.
IMPORTANT: Only use a socket or box end wrench to remove and install valve. Using an open end wrench may damage the valve.

7. Install dump fitting with lubricated O-ring and screw into adapter plate. Apply Loctite 242 Threadlocker to screw threads. Tighten screw to specified torque.



a - Cooling jet check valve
b - Dump fitting

c - Dump fitting mounting screw

Tube Ref No.	Description	Where Used	Part No.
 110	4 Stroke 10W30 Outboard Oil	Cooling jet check valve and dump fitting O-rings	92-802833A1
 66	Loctite 242 Threadlocker	Dump fitting mounting screws	92-809821

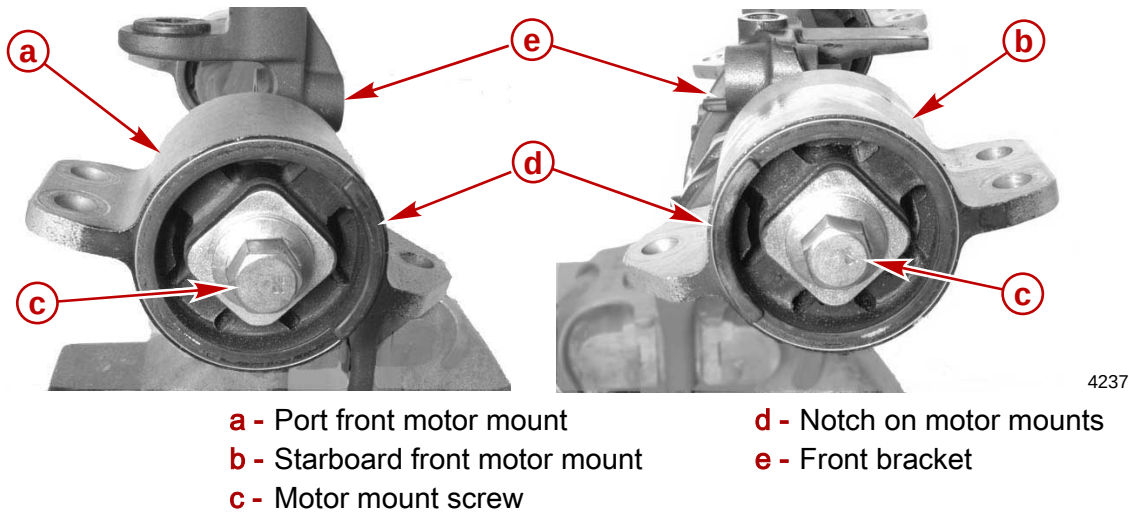
Description	Nm	lb. in.	lb. ft.
Cooling jet check valve	40		29.5
Dump fitting mounting screw	6	53	

Front Bracket Reassembly

MOTOR MOUNTS

1. Clean threads and flat surface of the front bracket.
2. Place port motor mount on front bracket with notch facing towards aft. Place a small amount of Loctite 271 Threadlocker on mounting screw threads. Install screw attaching port front motor mount to bracket. Tighten mounting screw to specified torque.

3. Place port motor mount on front bracket with notch facing towards aft. Place a small amount of Loctite 271 Threadlocker on motor mount screw threads. Install screw attaching starboard front motor mount to bracket. Tighten motor mount screw to specified torque.

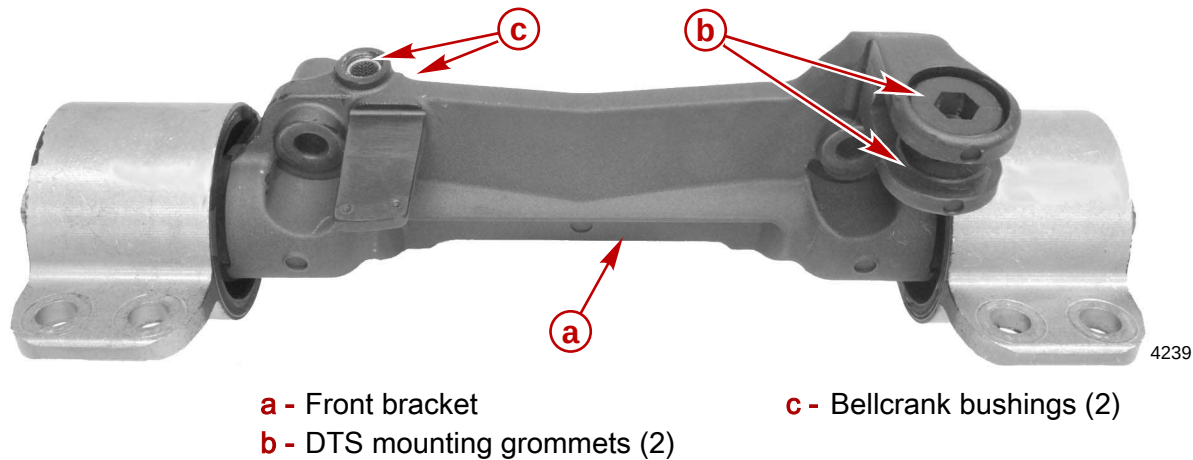


Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	Front motor mount screws	92-809819

Description	Nm	lb. in.	lb. ft.
Front motor mount screw	225		166

GROMMETS AND BUSHINGS

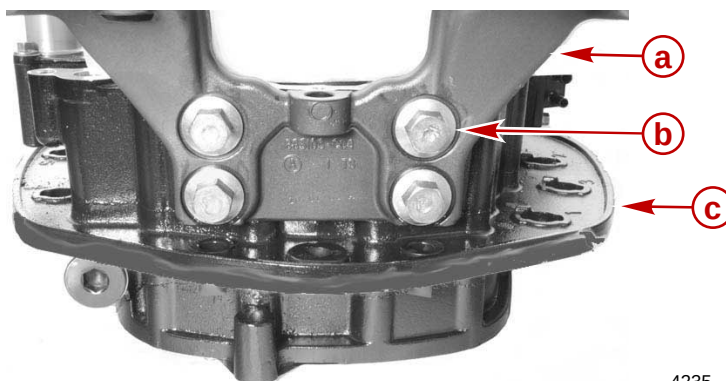
Inspect DTS mounting grommets and bellcrank bushings for wear or damage. Replace if required.



MOUNTING

1. Clean old adhesive from adapter plate flange.

2. Apply Small amount of Loctite 242 Threadlocker to screw threads. Install 4 mounting screws attaching the front motor mounts to adapter plate. Tighten mounting screws to specified torque.



a - Front bracket

b - Mounting screw (4)

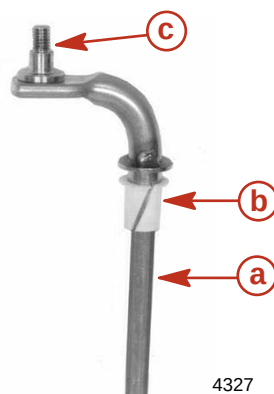
c - Adapter plate flange

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Front motor mount screws	92-809821

Description	Nm	lb. in.	lb. ft.
Front bracket mounting screws	185		136.4

SHIFT COMPONENTS

1. Install bushing on shift shaft. Install shift shaft down through support and grommet in front bracket.

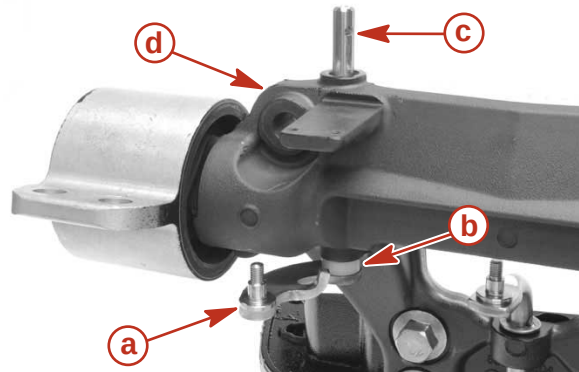


a - Shift shaft

b - Bushing

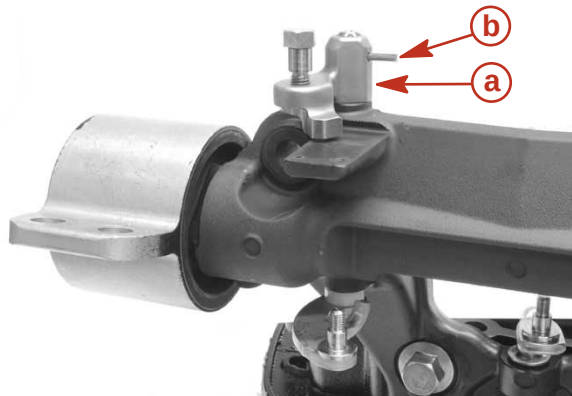
c - Link stud

2. Install bushing on lower bellcrank shaft. Install lower bellcrank up through bore in front bracket.



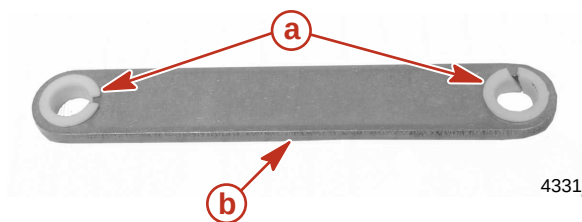
- a** - Lower bellcrank
b - Lower bellcrank bushing
c - Lower bellcrank shaft
d - Front bracket

3. Install upper bellcrank. Align splines so the hole in the lower bellcrank shaft and the hole in the upper bellcrank are in line. Ensure upper and lower bellcranks are positioned as shown. Install roll pin through upper bellcrank.



- a** - Upper bellcrank
b - Roll pin

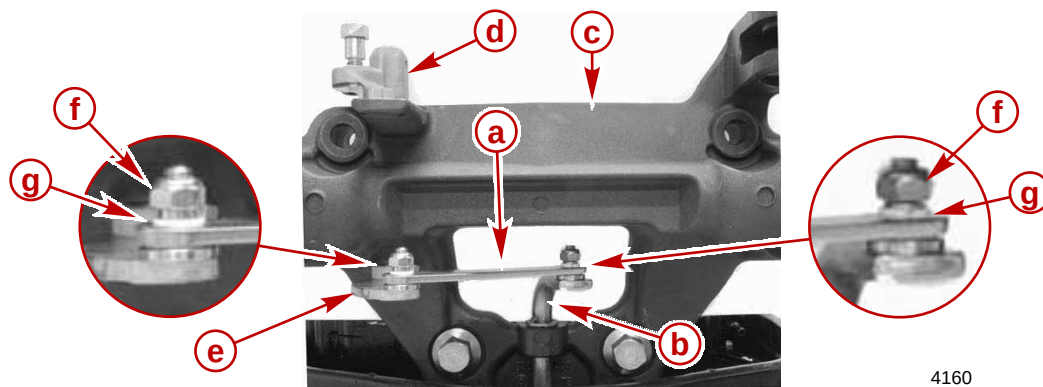
4. Install bushings in shift shaft link.



- a** - Link bushings (2)
b - Link

5. Install shift shaft link on shift shaft and lower bellcrank studs.

6. Install nut on each lower bellcrank stud and shift shaft stud. Tighten nut to specified torque.

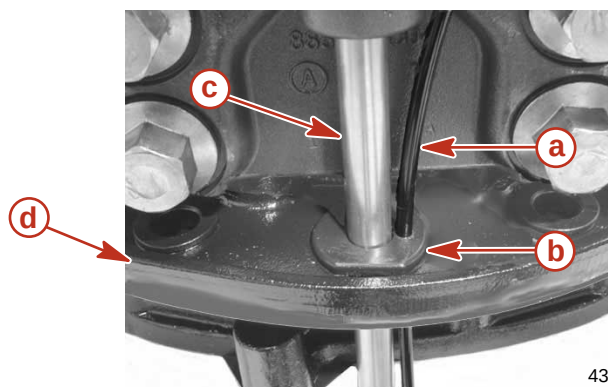


a - Shift shaft link
b - Shift shaft
c - Front bracket
d - Upper bellcrank

e - Lower bellcrank
f - Nut
g - Bushing

Description	Nm	lb. in.	lb. ft.
Shift shaft link nut	6	53	

7. Install speedometer tube through small hole in shift shaft grommet.



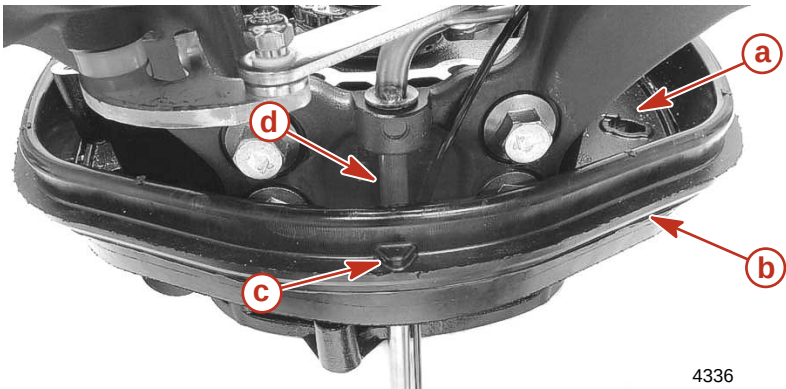
a - Speedometer tube
b - Shift shaft grommet

c - Shift shaft
d - Adapter plate

Adapter Plate to Mount Cradle Seal

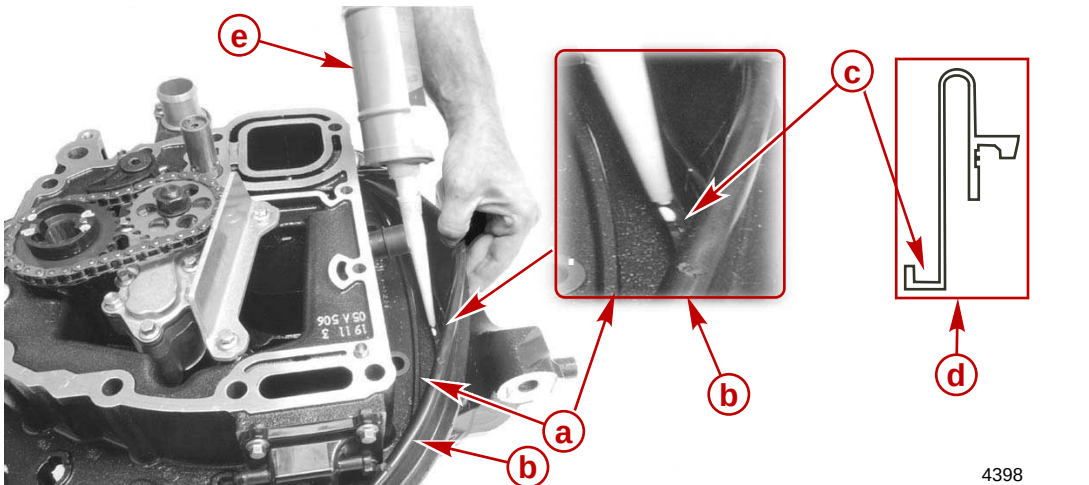
1. Remove old sealant from edge of adapter plate flange.
2. Slip seal over adapter plate.
3. Align triangular marker on seal with shift shaft.

4. Pull adapter plate seal up to bottom side of adapter plate flange.



- a - Adapter plate flange
b - Seal
c - Triangular marker
d - Shift shaft

5. Pull seal away from adapter plate to expose bottom lip of seal. Apply a 6 mm (0.250 in.) wide continuous bead of sealant on the bottom lip of the adapter plate seal.
IMPORTANT: Ensure that there are no gaps in the sealant bead.



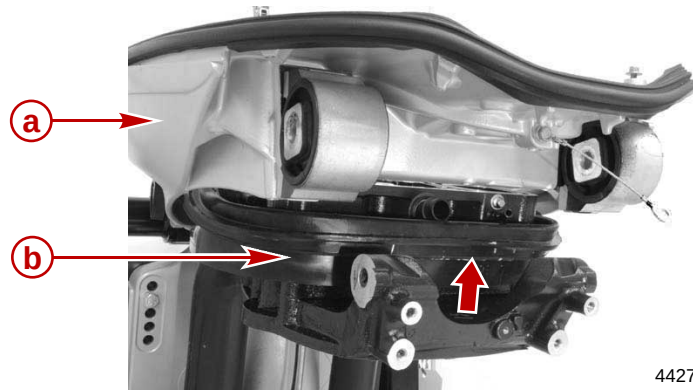
- a - Adapter plate flange
b - Adapter plate seal
c - Bottom lip of adapter plate seal - apply adhesive to this surface
d - Cross section view of seal
e - Caulk tube

Tube Ref No.	Description	Where Used	Part No.
 137	Three Bond Adhesive TB-1530	Adapter plate seal	Obtain Locally

6. Press seal to adapter plate flange to ensure that a good bond develops between the seal and adaptor plate. Allow sealant to cure for approximately 5 minutes.

Installing in Mount Cradle

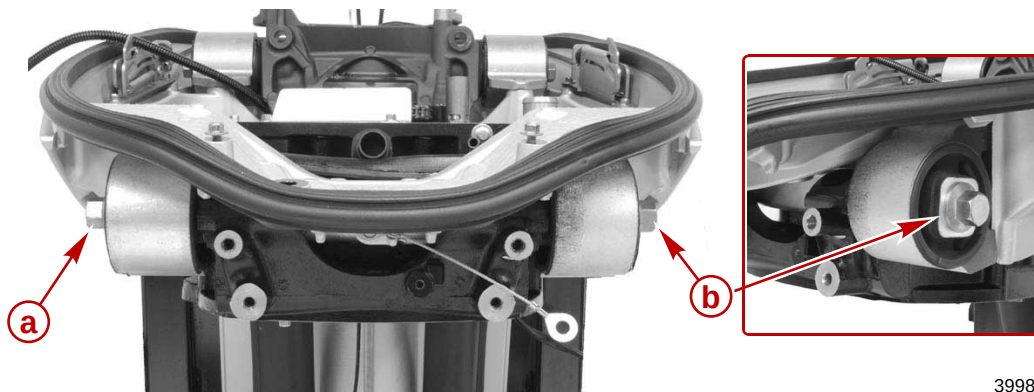
1. Install adapter plate with seal into mount cradle by pivoting adapter plate up through opening in mount cradle.



a - Mount cradle

b - Adapter plate

2. Apply Loctite 271 Threadlocker to rear motor mount screw threads. Apply molybdenum disulfide grease to underside of flange head. Assemble the port and starboard rear motor mounts to adapter plate. Tighten screws to specified torque.



a - Port rear motor mount screw

b - Starboard rear motor mount screw

Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	Rear motor mount screws	92-809819
 113	Loctite Moly Paste (Molybdenum Disulfide Grease)	Underside of flange head	Obtain Locally

Description	Nm	lb. in.	lb. ft.
Rear motor mount screws (M16)	270		199

-

c - Mounting screws (3 each)

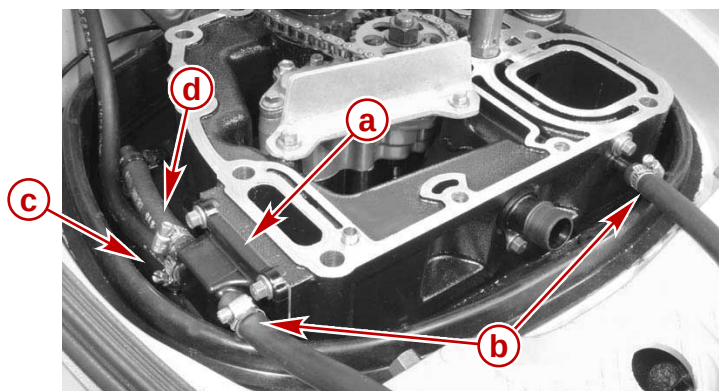
Description	Nm	lb. in.	lb. ft.
Front motor mount screws	125		92

-
- 4426

c - Adapter plate seal

90-896580500 JULY 2004

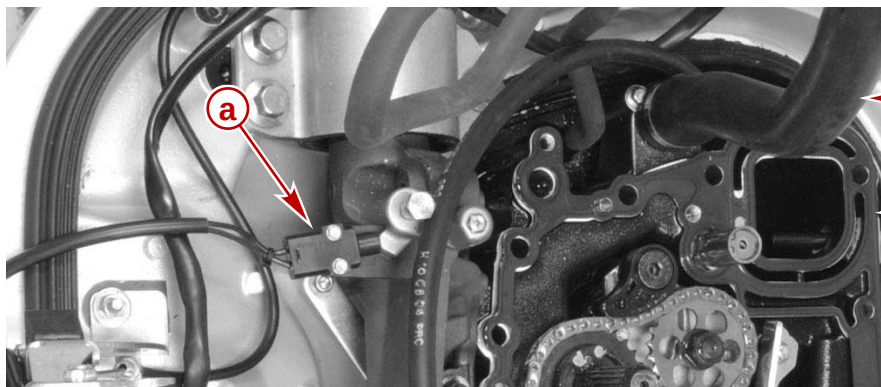
5. Install water hoses to water strainer and adapter plate. Tighten hose clamps.



3994

- a** - Water strainer
b - Hose - Evaporative cooling water supply
c - Hose - Tell tale water supply
d - Hose - FSM cooling water supply (blue tab)

6. Install neutral start switch to front mount bracket. Install dump hose and gasket to adapter plate.

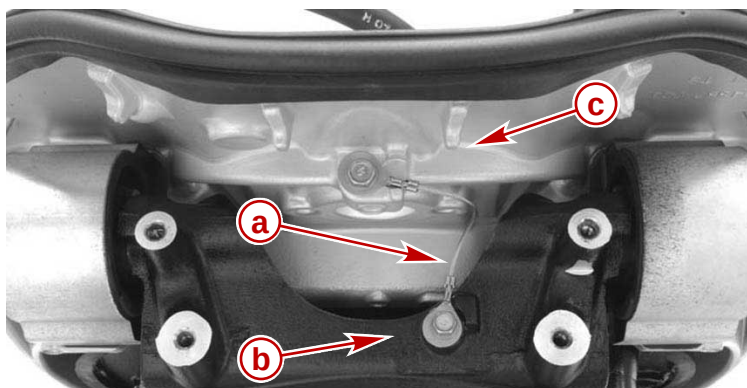


3992

- a** - Neutral start switch
b - Dump hose
c - Gasket

Description	Nm	lb. in.	lb. ft.
Neutral start switch screws (M3 x 20)	2.3	20	

7. Install ground strap to adapter plate. Tighten screw to specified torque.



3991

- a** - Ground strap
b - Adapter plate
c - Mount cradle (rear)

Description	Nm	lb. in.	lb. ft.
Ground strap screw (M6 x 13)	8	71	

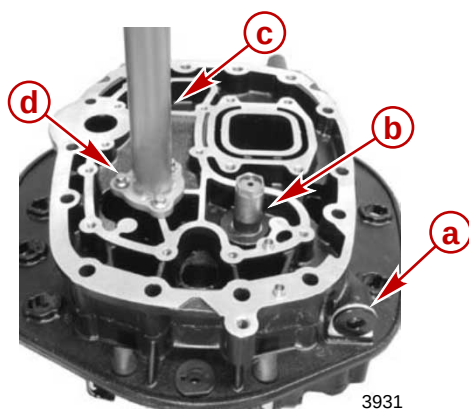
Lower Components

NOTE: Lightly lubricate O-rings and grommets before installation.

NOTE: Before installing adapter plate components, thoroughly clean mounting and gasket surfaces.

1. Install oil galley plug with washer in front of adapter plate. Tighten plug to specified torque.
2. Apply Loctite 242 to threads of the oil pickup tube screws. Assemble O-ring to oil pickup tube. Install oil pickup tube with O-ring and 3 screws. Tighten screws to specified torque.
3. Install oil pump check valve into adapter plate.

IMPORTANT: Only use a socket or box end wrench to remove and install valve. Using an open end wrench may damage the valve.



a - Oil galley plug

b - Oil pump check valve

c - Oil pick up tube

d - Oil pick up tube screws (3) (M6 x 25)

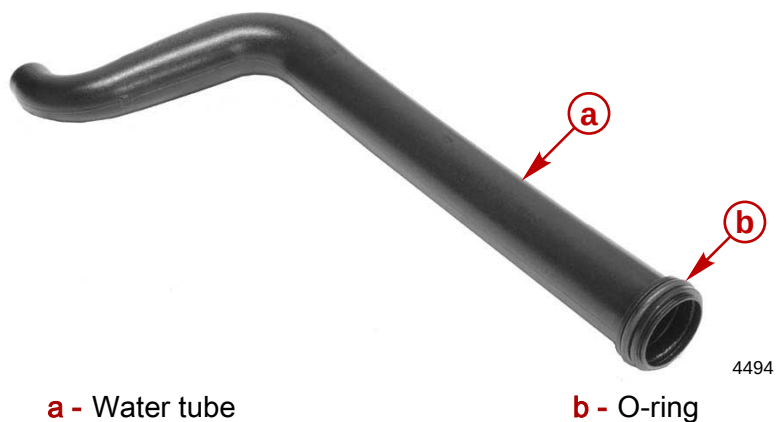
Description	Nm	lb. in.	lb. ft.
Oil galley plug	55		40.5
Oil pick up tube screws (M6 x 25)	10	88	
Oil pump check valve	40		29.5

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Oil pickup tube screws	92-809821

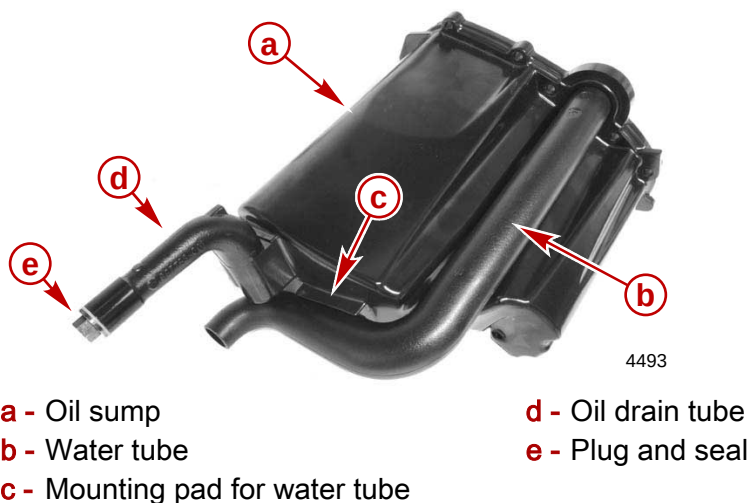
Exhaust Tube/Oil Sump

NOTE: Lightly lubricate O-rings and grommets before installation.

1. Install O-ring to water tube.



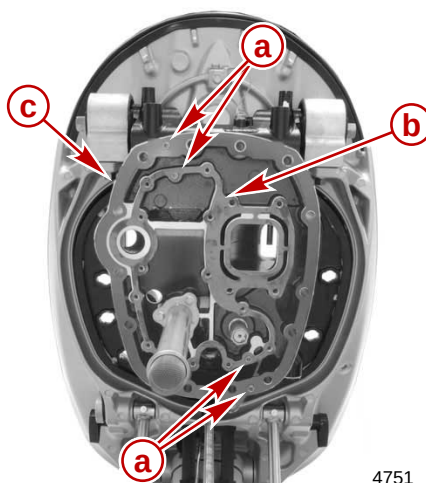
2. Assemble water tube through opening in oil sump and ensure that it locks into the mounting pad on the bottom of the sump.
3. Install drain plug and seal washer into into drain tube.



Description	Nm	lb. in.	lb. ft.
Oil drain plug	9.9	88	

4. Clean gasket surface of the adapter plate and oil sump.

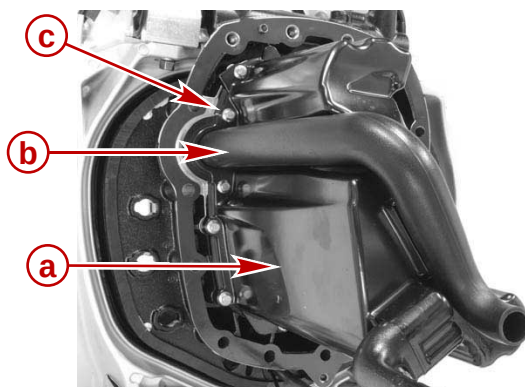
5. Install oil sump gasket over dowel pins in adapter plate.



4751

- a** - Dowel pins
b - Oil sump gasket
c - Driveshaft housing gasket

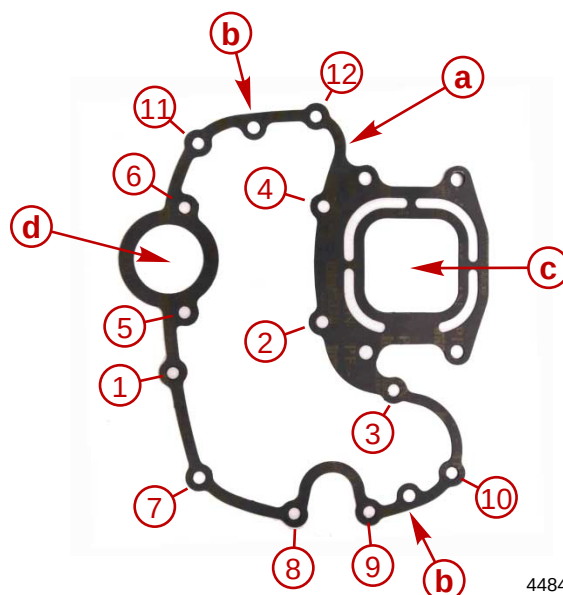
6. Assemble oil sump to adapter plate with 12 screws.



3988

- a** - Oil sump
b - Water tube
c - Mounting screws (12)

7. Tighten screws in sequence to specified torque.



a - Oil sump pattern

b - Dowel pin location (2)

c - Exhaust tube location

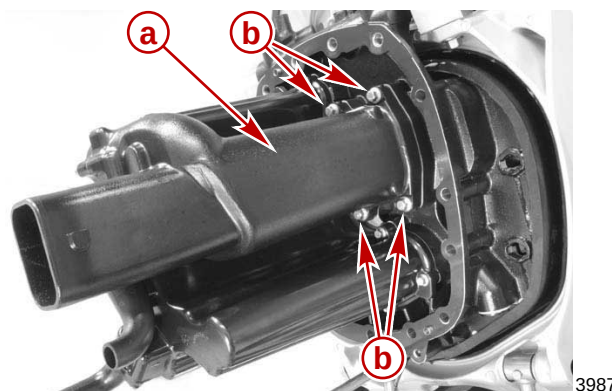
d - Water tube location

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Oil sump mounting screws	92-809821

Description	Nm	lb. in.	lb. ft.
Oil sump mounting screws (M6 x 20)	10	88.5	

8. Clean gasket surface of the exhaust tube.

9. Assemble exhaust tube to adapter plate with (4) screws. Tighten mounting screws to specified torque.



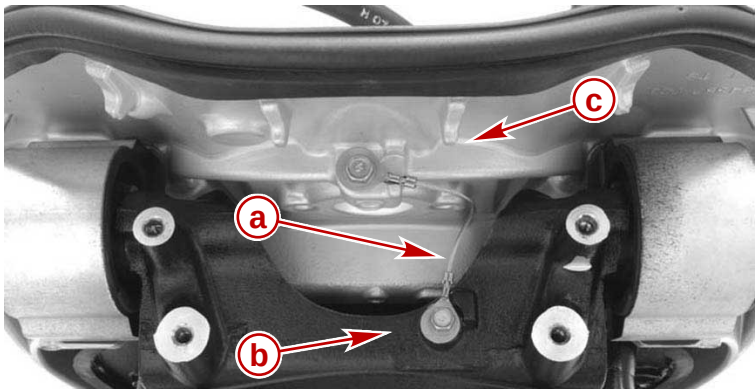
a - Exhaust tube

b - Mounting screws

Tube Ref No.	Description	Where Used	Part No.
 66	Loctite 242 Threadlocker	Exhaust tube mounting screws	92-809821

Description	Nm	lb. in.	lb. ft.
Exhaust tube mounting screws (M8 x 35)	34		25

10. Assemble ground wire between adapter plate and cradle with (2) screws.



a - Ground strap
b - Adapter plate
c - Mount cradle (rear)

Description	Nm	lb. in.	lb. ft.
Ground screws (M6 x 13)	8	71	

Completing Outboard Adapter Plate Reassembly

- 1. Install driveshaft housing to adapter plate. Refer to **Section 5A - Pedestal/Mount Cradle and Driveshaft Housing**.
- 2. Install powerhead. Refer to **Section 4A - Dressed Powerhead Removal/Installation**.

Mid-Section

Section 5C - Power Trim

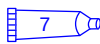
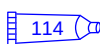
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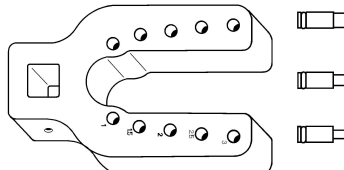
Power Trim Specifications

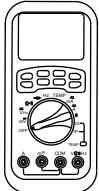
Power Trim Specifications	
Trim up circuit pressure, maximum	18,270 - 28,960 kPa (2650 - 4200 psi)
Trim down circuit pressure	1255 - 2765 kPa (182 - 401 psi)
System fluid	Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) (Type Dexron III)

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	Power trim sensor bolts	92-809819
 114	Power Trim and Steering Fluid	Manual release valve O-rings and power trim system fluid	92-802880A1
		Memory piston O-ring	
		Rod seal, rod wiper, bushing and O-ring	
		Shock piston O-ring	
		Manifold bushings and O-rings	
		Pivot pin and trim cylinder O-rings	
		Manifold O-rings and pivot pin	

Special Tools - Power Trim

Spanner Wrench  ob00735	91-821709T Removes the trim cylinder end cap on all trim cylinders. Uses interchangeable pin sets: 91-811907 Large pin set 5.97 mm (0.235 in.), 91-811908 Medium pin set 4.57 mm (0.180 in.), 91-811909 Small pin set 3.81 mm (0.150 in.)
Power Trim Test Gauge Kit  3753	91-52915A6 Tests circuit pressures for various trim pumps.
Power Trim Adapter Fitting  4415	91-822778004 Replaces power trim manual release valve when testing power trim circuits.

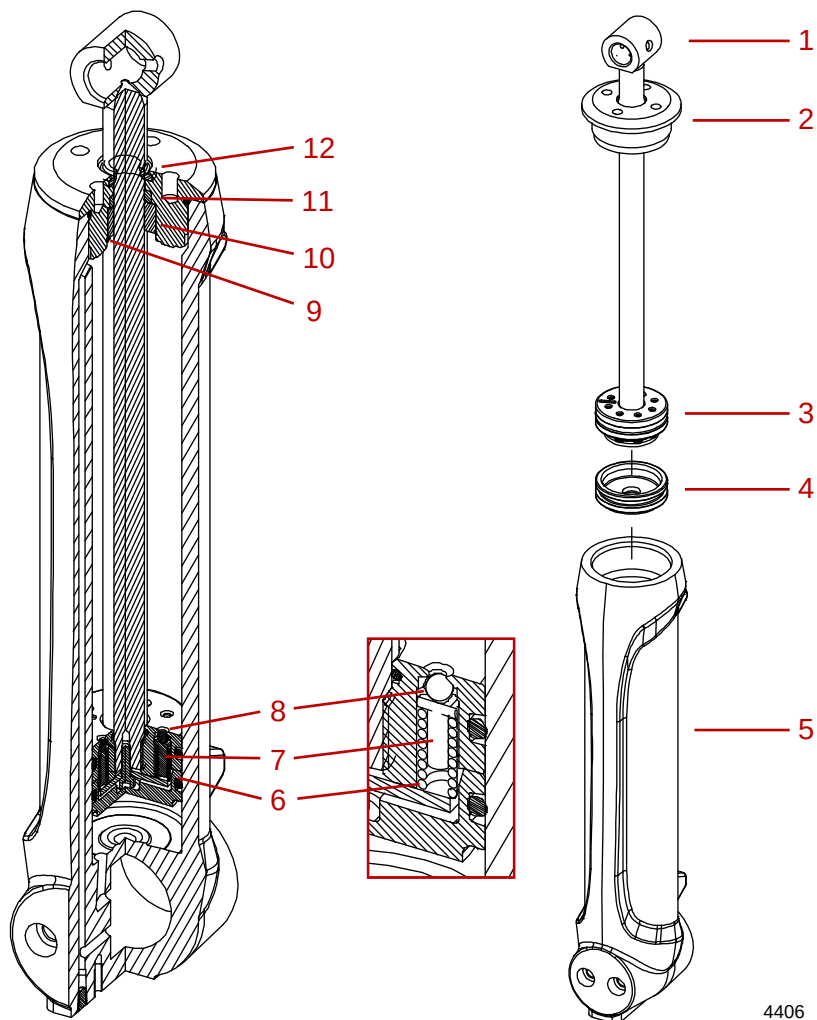
DMT 2000 Digital Multimeter	91-854009A1
 mc29	Measures RPM, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.
DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.
Slide Hammer Puller	91-34569A1
 ob01617	Removes trim cylinder pivot pin from mount cradle.
Breakout Box	SPX P/N MM-46225
 5974	Connects to Propulsion Control Module (PCM) to test engine circuits and components without probing wires. May be used with Computer Diagnostic System (CDS).



Power Trim System Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	4	Screw	26		19.2
2	2	Trim cylinder assembly			
3	2	O-ring - Trim cylinder			
4	2	Bearing			
5	1	Pressure operated check manifold assembly			
6	4	O-ring - Tilt pin			
7	1	Tilt pin			
8	1	O-ring - Steering tube			
9	1	O-ring - Reservoir			
10	1	Filter			
11	2	O-ring - Filter			
12	2	O-ring - Pump to manifold			
13	1	Pump assembly			
14	1	Coupling			
15	2	Screw - 10-32 UNF X 3 in.	8	70	
16	2	Screw - 1/4-20 X 0.625 in.	8.5	75	
17	1	Electric motor			
18	1	Locking ring			
19	1	Clip			
20	1	Reservoir			
21	1	Cap			
22	1	Pin			
23	1	Reservoir neck			
24	1	O-ring			
25	3	O-ring			

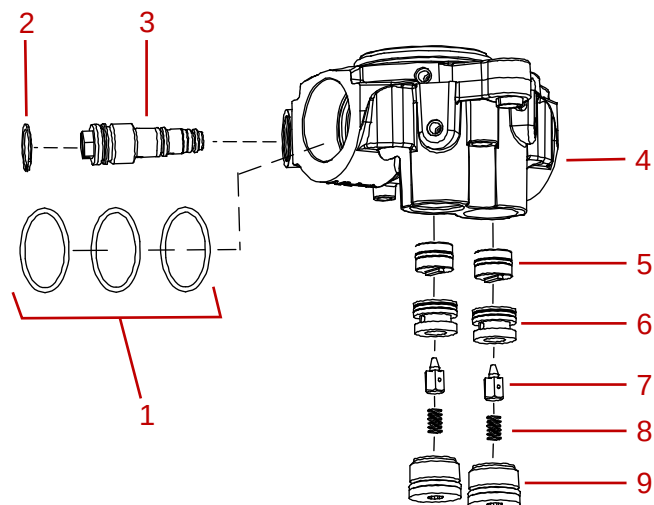
Power Trim Cylinder Components



4406

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Cylinder rod			
2	1	End cap assembly	61		45
3	1	Shock piston assembly	122		90
4	1	Memory piston with O-ring			
5	1	Cylinder tube			
6	7	Check ball spring			
7	7	Check ball guide			
8	7	Check ball			
9	1	End cap snap ring			
10	1	End cap bushing			
11	1	End cap rod seal			
12	1	End cap rod wiper			

Pressure Operated Check Manifold Components

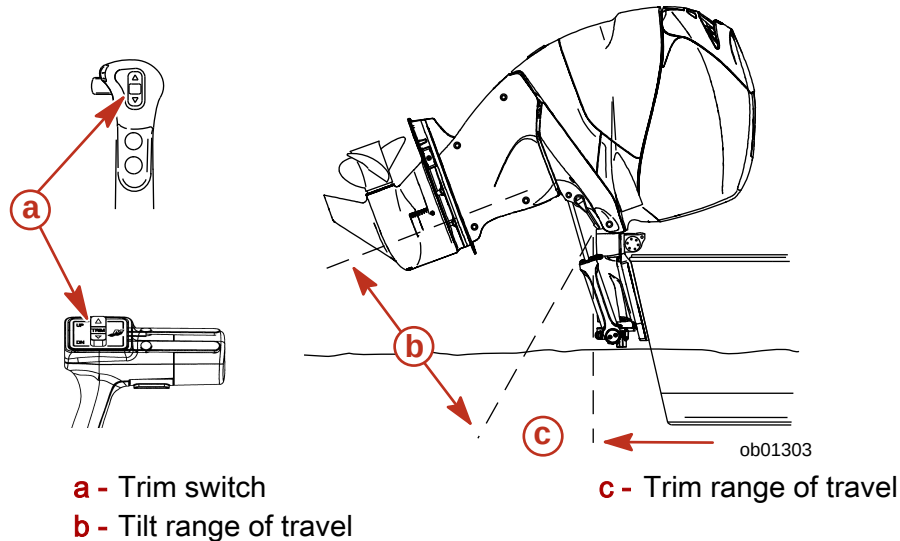


4405

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	3	O-ring			
2	1	Snap ring			
3	1	Manual release valve with O-rings			
4	1	Manifold			
5	2	Shuttle spool with O-ring			
6	2	Check seat with O-ring			
7	2	Hex poppet			
8	2	Spring			
9	2	Retainer plug	40.7		30

Power Trim and Tilt

The outboard has a trim/tilt control called power trim. This enables the operator to easily adjust the position of the outboard by pressing the trim switch. Moving the outboard in closer to the boat transom is called trimming in or trimming down. Moving the outboard further away from the boat transom is called trimming out or trimming up. The term trim generally refers to the adjustment of the outboard within the first 20° range of travel. This is the range used while operating the boat on plane. The term tilt is generally used when referring to adjusting the outboard further up out of the water. With the engine not running and the key switch in the "ON" position, the outboard can be tilted out of the water. At low idle speed (2000 RPM and below), the outboard can also be tilted up past the trim range to permit shallow water operation.



Power Trim Operation

With most boats, operating around the middle of the trim range will give satisfactory results. However, to take full advantage of the trimming capability there may be times when you choose to trim the outboard all the way in or out. Along with an improvement in some performance aspects comes a greater responsibility for the operator, this being an awareness of some potential control hazards.

Consider the following lists carefully:

1. Trimming In or Down Can:

- Lower the bow.
- Result in quicker planing off, especially with a heavy load or a stern heavy boat.
- Generally improve the ride in choppy water.
- In excess can lower the bow of some boats to a point where they begin to plow with their bow in the water while on plane. This can result in an unexpected turn in either direction (called bow steering or over-steering) if any turn is attempted, or if a significant wave is encountered.

⚠ WARNING

Avoid possible serious injury or death. Adjust outboard to an intermediate trim position as soon as boat is on plane to avoid possible ejection due to boat spin out. Do not attempt to turn boat when on plane if outboard is trimmed extremely in or down and there is a pull on the steering wheel.

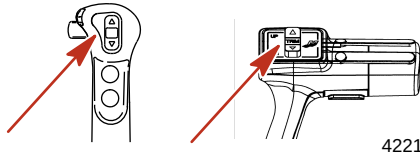
2. Trimming Out or Up can:
 - Lift the bow higher out of the water.
 - Generally increase top speed.
 - Increase clearance over submerged objects or a shallow bottom.
 - In excess can cause boat porpoising (bouncing) or propeller ventilation.
 - Cause engine overheating if any cooling water intake holes are above the water line.

Tilting To Full Up Position

TILT AT HELM

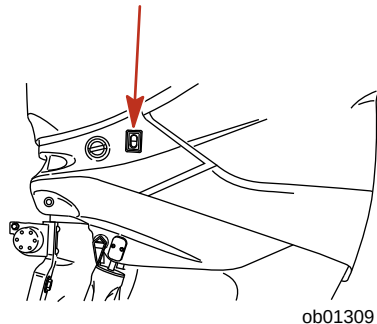
IMPORTANT: Turning key to the "START" position while the engine is running will result in engine shut down, while leaving the DTS system active. This will allow the use of the power trim/tilt from the remote control handle.

1. Shut off engine by:
 - a. Turning the key to the "START" position, then releasing it to the "ON" position.
 - b. Turning the key to "OFF" position and returning it to the "ON" position.
2. Press the trim/tilt switch to the up position. The outboard will tilt up until the switch is released or it reaches its maximum tilt position.



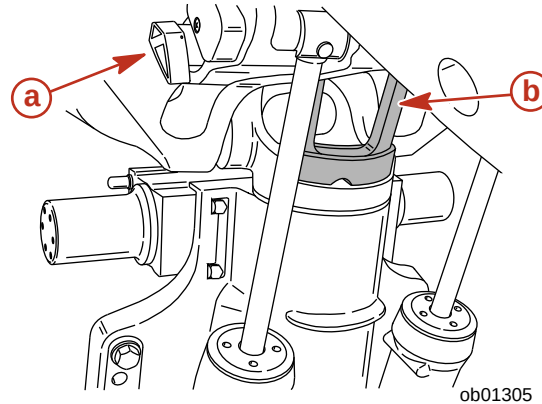
TILT AT ENGINE

The cowl mounted auxiliary tilt switch can be used to tilt the outboard with the key switch in the "OFF" position.



1. Rotate the tilt support lever down.
2. Lower outboard until tilt support bracket rests on the pedestal.

3. Disengage the tilt support bracket, by raising the outboard up and rotating the tilt support lever up. Lower the outboard.



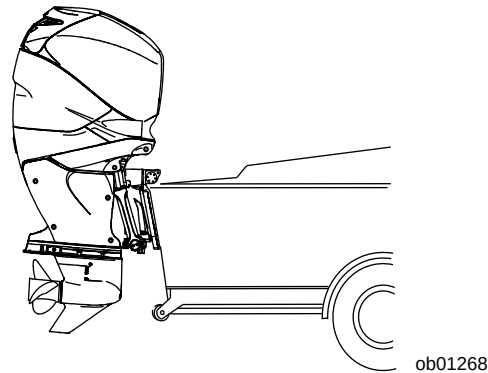
a - Tilt support lever

b - Tilt support bracket

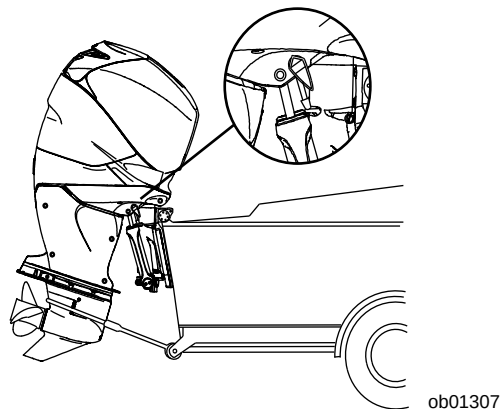
Trailing Boat/Outboard

When transporting the boat on a trailer, the outboard should be positioned and/or supported in one of the following ways:

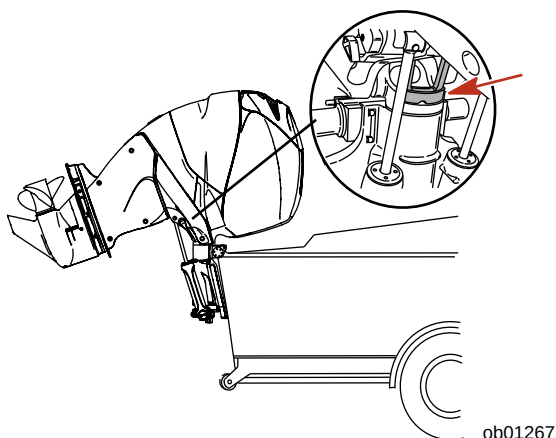
1. If the boat trailer provides sufficient ground clearance, the outboard may be tilted down to the vertical operating position with no additional support required.



2. If additional ground clearance is required, the outboard should be tilted up and supported using the outboard's tilt support bracket (trailing position) and/or an accessory transom support device.



3. For maximum ground clearance, the outboard can be tilted to the full tilt position and supported using the outboards tilt support bracket and/or an accessory transom support device.



ob01267

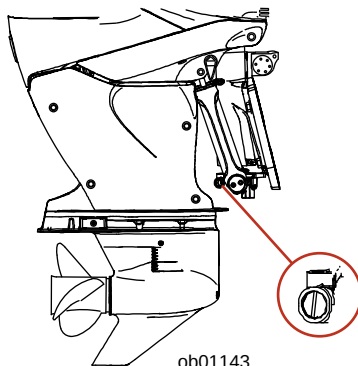
Additional clearance may be required for railroad crossings, driveways and trailer bouncing. Refer to your local dealer for recommendations.

IMPORTANT: Do not rely on the power trim/tilt system to maintain proper ground clearance for trailering. The power trim/tilt system is not intended to support the outboard for trailering.

Shift the outboard to forward gear. This prevents the propeller from spinning freely when boat is trailered.

Manual Tilting

If the outboard cannot be tilted using the power trim/tilt switch, the outboard can be manually tilted.



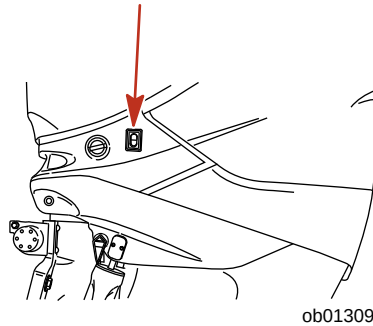
ob01143

NOTE: The manual tilt release valve must be tightened before operating the outboard to prevent the outboard from tilting up during reverse operation.

1. Turn out the manual tilt release valve 3 turns counterclockwise. This allows manual tilting of the outboard. Tilt the outboard to the desired position and tighten the manual tilt release valve.

Auxiliary Tilt Switch

The auxiliary tilt switch can be used to tilt the outboard up or down using the power trim system.



Shallow Water Operation

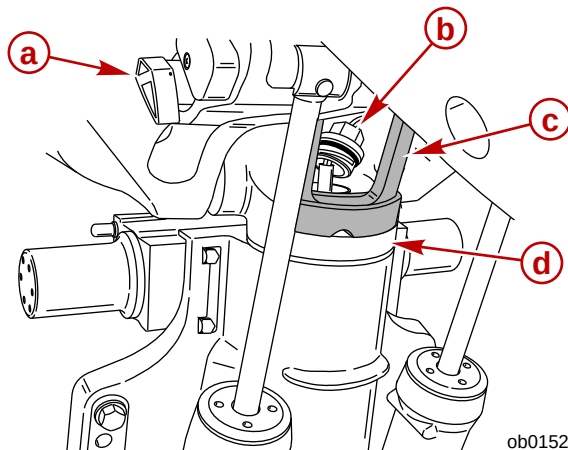
When operating your boat in shallow water, you can tilt the outboard beyond the maximum trim range to prevent hitting bottom.

1. Reduce engine speed below 2000 RPM.
2. Tilt outboard up. Make sure all the water intake holes stay submerged at all times.
3. Operate the engine at slow speed only. With the outboard tilted past 20° trim limit, the warning horn will sound and engine speed will be automatically limited to approximately 2000 RPM. The outboard must be tilted (trimmed) down below the maximum trim range to allow operation above 2000 RPM.

Check Fluid and Purge the Power Trim System

Checking Power Trim Fluid

1. Tilt outboard to the full up position.
2. Rotate the tilt support bracket down.
3. Lower outboard until tilt support bracket rests on pedestal.
4. Remove the power trim fill cap. The fill cap only requires 1/4 turn to remove.



a - Tilt support lever
b - Power trim fill cap

c - Tilt support bracket
d - Pedestal

5. The fluid level should be approximately 25 mm (1 in.) from the top of the fill neck. Add Quicksilver or Mercury Precision Lubricants Power Trim & Steering Fluid. If not available, use automotive automatic transmission fluid (ATF).

6. Reinstall the power trim fill cap. Tighten fill cap 1/4 turn. Cap will snap in place. Do not tighten beyond this point.

Purging Power Trim System

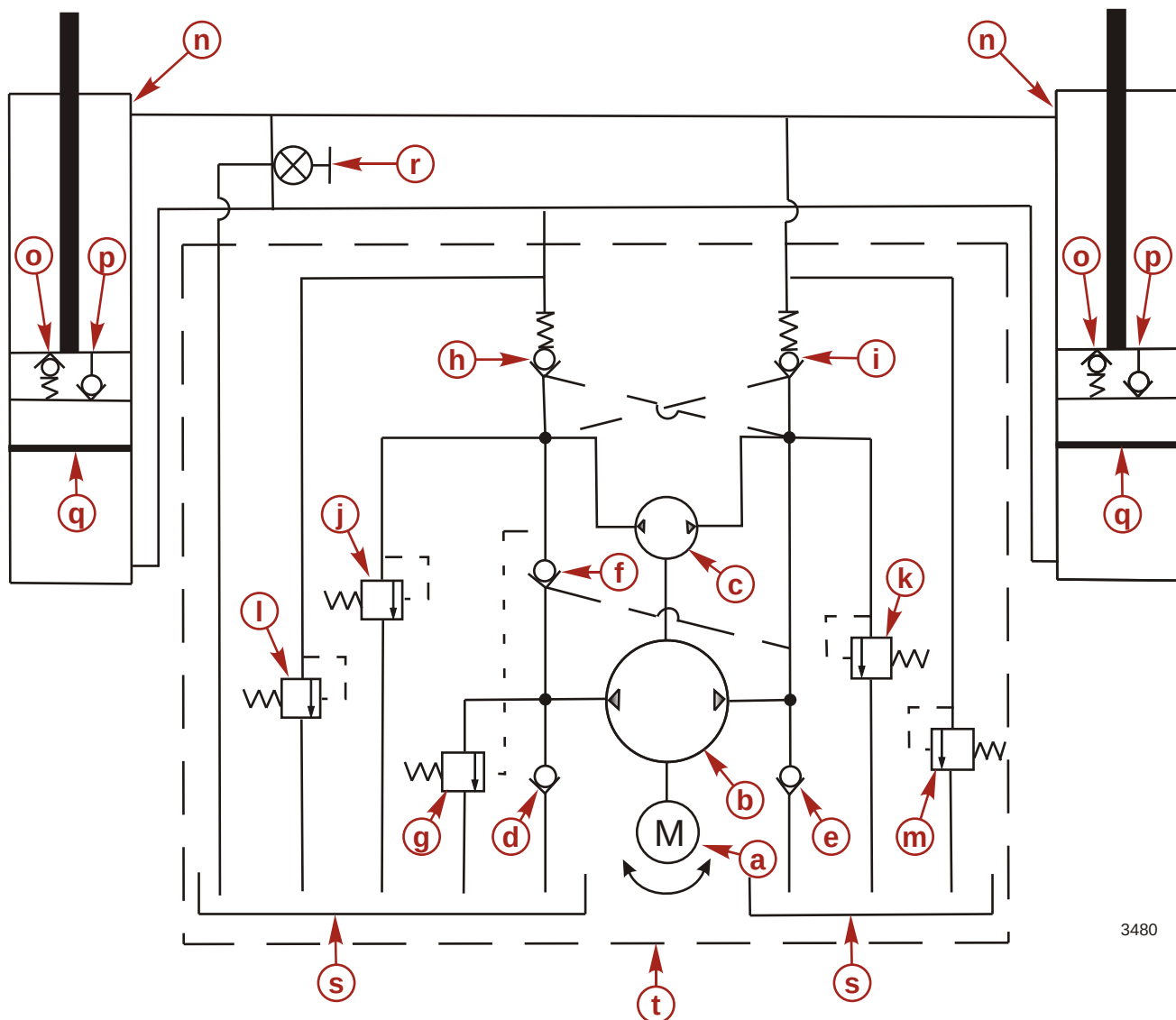
IMPORTANT: The fill cap with O-ring must be tightened securely before operating the power trim system.

IMPORTANT: Operate the power trim system in short spurts until the hydraulic pump is primed and the trim cylinders move.

- Cycle the outboard through the entire trim/tilt range 4 times.
- To check for presence of air in the system, extend cylinders slightly and push down on outboard. If the trim rams retract more than 3 mm (0.125 in.), air is present. Cycle trim system again and repeat this step.
- Check fluid level. Refer to **Checking Power Trim Fluid**.

Theory of Operation

Power Trim Hydraulic Diagram



3480

- | | |
|--|---|
| a - Electric motor | k - Down circuit relief valve
1255 - 2765 kPa (182 - 401 psi) |
| b - Large displacement pump | l - Up circuit thermal relief valve |
| c - Small displacement pump | m - Down circuit thermal relief valve |
| d - Trim down inlet check valve | n - Trim cylinder |
| e - Trim up inlet check valve | o - Impact relief valve |
| f - Unloading circuit check valve | p - Return check valve |
| g - Unloading valve | q - Memory piston |
| h - Trim up pressure operated check valve | r - Manual release valve |
| i - Trim down pressure operated check valve | s - Reservoir |
| j - Up circuit relief valve 23,440 kPa (3400 psi) nominal | t - Power unit |

Operation

The power trim system consists of an integral two stage pump, manifold, reservoir, and two trim cylinders. A two stage pump is used to increase cylinder extend speed during tilt operation. When the outboard is trimmed up at idle or slow running speed, the fluid output of both pumps are used to extend the trim cylinders. The combined output of the two pumps extend the cylinders at the same rate as one pump of the same displacement. When the pressure required to raise the outboard motor increases, the unloading valve diverts the large pump's flow back to the reservoir and the output of the small pump continues to extend the trim cylinders at a higher pressure. Using the small pump flow at high pressure requires less power than using a larger single pump. A high pressure relief valve limits the pressure to 18,270 - 28,960 kPa (2650 - 4200 psi) in the up circuit. The system is protected from thermal expansion of trapped oil in the trim cylinders by two thermal relief valves, one for the up circuit and one for the down circuit.

TRIM CIRCUIT - UP

When the up circuit is activated, the electric motor rotates the two stage hydraulic pump. As the pump gears rotate, fluid is drawn through a check valve and into the inlet passages of the two pumps. The large pump's flow passes through a check valve and combines with the small pump's flow. The combined flow then passes through a pressure operated check valve in the manifold and to the bottom of the trim cylinders. The fluid pushes the pistons out, trimming the engine up. When the pressure required to raise the outboard motor increases, a check valve and unloading valve divert the large pump's flow back to the reservoir and the output of the small pump continues to extend the cylinders. Oil, from the top side of the cylinder, returns through a passage in the cylinder wall into the manifold to the inlet side of each pump. When the engine is not running, the outboard may be tilted to the full up position by activating the cowl trim switch. In this mode, as the trim cylinders extend to their limit, up pressure increases to 18,270 - 28,960 kPa (2650 - 4200 psi) and opens the up pressure relief valve. When the engine is running above 2000 RPM, trim angle is limited to 20 degrees by the trim angle sensor and the PCM.

TRIM CIRCUIT - DOWN

When the down circuit is activated, the electric motor rotates in the opposite direction. As the pump gears rotate, fluid is drawn through a check valve and into the inlet passages of the two pumps. The large pump and small pump flow is combined and passes through a pilot operated check valve and to the top of the trim cylinders. The fluid pushes the pistons down and trims the engine down. Oil, from the bottom side of the cylinder, returns through the manifold to the inlet side of each pump. As the trim cylinders retract fully, down pressure increases to 1255 - 2765 kPa (182 - 401 psi) and opens the down pressure relief valve.

TRAIL OVER SYSTEM

Should the outboard motor strike a submerged object while in forward motion, hydraulic pressure on the top side of the cylinder will increase to cause the impact relief valve in the trim cylinders to open. This allows the lower unit to trail over the obstruction. The fluid in the top side of the cylinder opens the impact relief valve and flows into the cavity between the memory piston and the cylinder piston. When the lower unit clears the submerged object, the thrust of the engine forces the engine back down. As the cylinder piston is lowered, fluid trapped between the memory piston and the cylinder piston escapes through a return check valve. Fluid below the memory piston is trapped in place, therefore stopping the cylinder piston and returning the trim position to its previous position.

Troubleshooting the Power Trim System

Preliminary

Determine if problem is hydraulic or electrical related. Most often, if the electric motor operates, the problem is in the hydraulic system. If the electric motor does not operate, the problem is in the electrical system.

IMPORTANT: Operate power trim system after each check to see if the problem is corrected. If problem has not been corrected proceed with the next check.

1. Check that the manual release valve is tightened fully (clockwise).
2. Check trim pump fluid level in full up position. Fill if necessary. Refer to Check Fluid and Purge the Power Trim System in this section.
3. Check for external leakage in the power trim system. Replace/repair defective component if leak is found. Maximum acceptable power trim cylinder leak down is 25 mm (1 in.) within a 24 hour period.

Hydraulic System Troubleshooting

CONDITION/PROBLEM

Condition of Trim System	Problem
Trim motor runs; trim system does not move up or down	1, 2, 5, 7, 10
Does not trim full down. Up trim OK	2, 3, 4, 6, 7
Does not trim full up. Down trim OK	1, 4, 6, 7
Partial or jerky down/up	1, 3, 6
Thump noise when shifting	2, 3, 5
Does not trim under load	2, 5, 8, 9, 10, 12
Does not hold trim position under load	4, 5, 6, 7
Trail out when backing off from high speed	3, 4
Leaks down and does not hold trim	4, 5, 6, 7
Trim motor working hard and trims slow up and down	8, 9
Trims up very slow	1, 2, 8, 9
Starts to trim up from full down position when the down trim button is depressed	3, 4
Trim position will not hold in reverse	2, 3, 4, 5, 13

PROBLEM/SOLUTION

No.	Problem	Solution
1.	Low fluid level	Add Power Trim and Stering Fluid or ATF (Type Dexron III).
2.	Defective hydraulic pump	Pressure test pump. Refer to Testing Power Trim System following.
3.	Trim cylinder shock piston ball not seated	Inspect ball seat for nicks or contamination.
4.	Trim cylinder piston or memory piston O-rings leaking or cut	Inspect O-rings for cuts or abrasion.
5.	Manual release valve leaking (check condition of O-rings) (valve not fully closed)	Ensure that valve is fully closed. Inspect O-rings.
6.	Thermal relief valve not seated	Inspect seat for debris and damage.
7.	Debris in system	Inspect for debris. Refill system with clean fluid.
8.	Battery low	Check battery.
9.	Electric motor defective	Refer to Electrical System Troubleshooting .

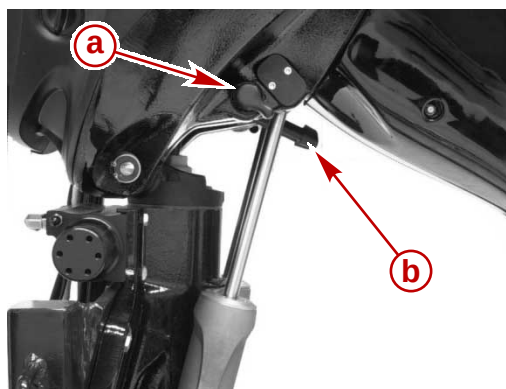
No.	Problem	Solution
10.	Broken motor/pump driveshaft	Inspect for damage.
11.	Air pocket under pump	Purge system. Refer to Purging the Power Trim System preceding.
12.	Defective up relief valve	Replace power trim pump assembly.
13.	Defective down relief valve	Replace power trim pump assembly.

Testing Power Trim System

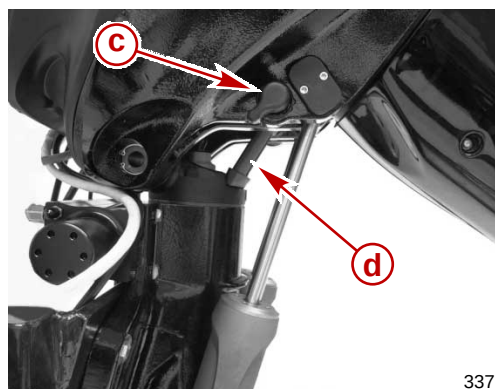
INSTALL TEST GAUGE ADAPTER FITTING FOR UP PRESSURE TEST

IMPORTANT: Tilt the outboard to the full up position and engage the tilt lock lever before checking fluid level. System is pressurized. Completely extend the trim cylinders to depressurize the system.

1. Trim engine up and engage tilt lock lever.
2. Momentarily actuate the trim switch in opposite direction from last operation to relieve pressure in system.



a - Tilt lock lever disengaged
b - Tilt lock bracket disengaged



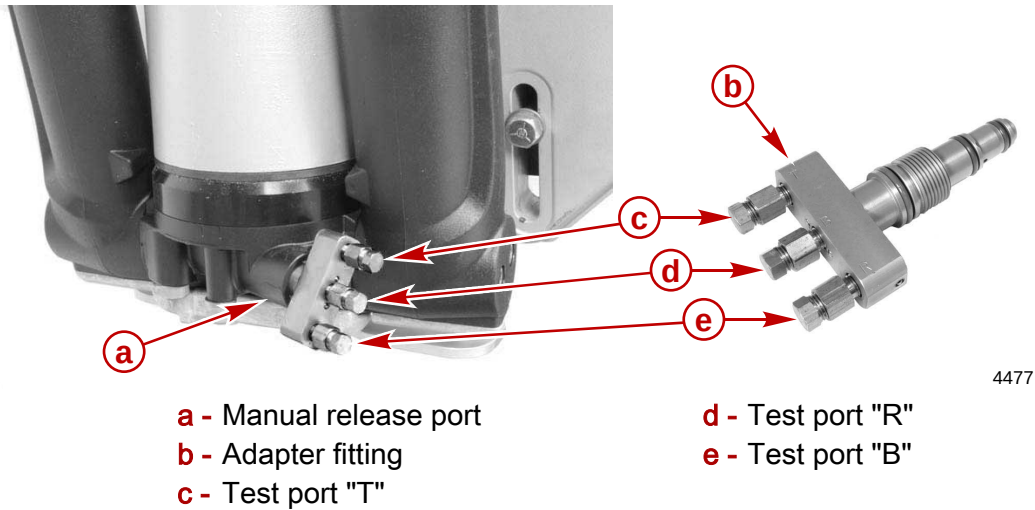
c - Tilt lock lever engaged
d - Tilt lock bracket engaged

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3. Check for external leaks.
4. Slowly remove reservoir cap to relieve pressure.
5. Remove snap ring securing manual release valve and remove manual release valve.

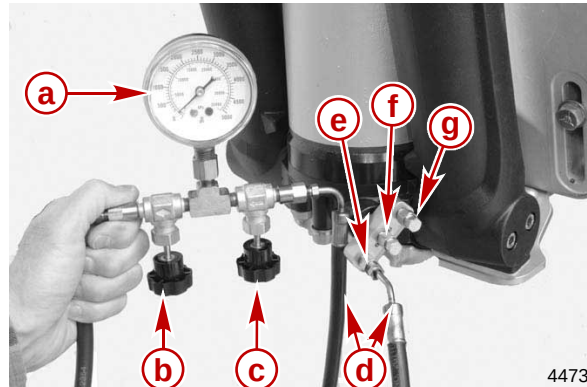
NOTE: A small amount of fluid may drip from the manual release port. Place a container under the trim assembly to collect any leakage.

6. Install power trim adapter fitting in manual release port.



Power Trim Adapter Fitting	91-822778004
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7. Thread hose at valve "c" from Test Gauge Kit into adapter test port "B".



Power Trim Test Gauge Kit	91-52915A6
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8. Check power trim fluid level. If necessary, add fluid to bring level to 25 mm (1 in.) below top of reservoir neck.
9. Reinstall reservoir cap.

IMPORTANT: Reservoir cap must be installed to ensure accurate test results.

UP PRESSURE CIRCUIT TEST

1. Ensure all fittings are tight prior to testing.
2. Trim engine up slightly and disengage tilt lock lever.
3. Open valve "c" on power trim test gauge.
4. Run trim down.
5. Run trim up. Hold and observe pressure for a few seconds. Release trim button.

Up Pressure Relief Valve Specification	
Pressure	18,270 - 28,960 kPa 2650 - 4200 psi
Current draw	130 amp maximum

NOTE: If pressure is out of specification, the pump or up pressure relief valve is defective. Replace trim pump assembly. Refer to **Power Unit Disassembly/Reassembly** for instructions.

NOTE: If testing the down circuit pressure, proceed to **Down Pressure Pump Test**.

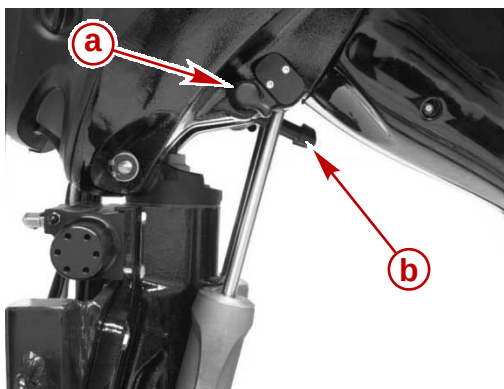
6. Run trim down to release pressure.
7. Place outboard in full up position and engage tilt lock lever.
8. Momentarily actuate the trim switch in opposite direction from last operation to relieve pressure in system.
9. Momentarily open reservoir cap to relieve pressure, then retighten cap.
10. Remove test gauge hose and adapter fitting.
11. Install manual release valve and snap ring. Ensure snap ring is fully seated in groove.
12. Check power trim fluid level.
13. Reinstall reservoir cap.

INSTALL TEST GAUGE ADAPTER FITTING FOR DOWN PRESSURE TEST

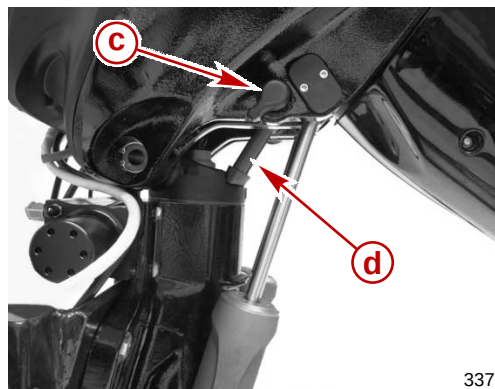
If the power trim adapter fitting is installed from previous test, proceed to step 7.

IMPORTANT: Tilt the outboard to the full up position and engage the tilt lock lever before checking fluid level. System is pressurized. Completely extend the trim cylinders to depressurize the system.

1. Trim engine up and engage tilt lock lever.
2. Momentarily actuate the trim switch in opposite direction from last operation to relieve pressure in system.



a - Tilt lock lever disengaged
b - Tilt lock bracket disengaged

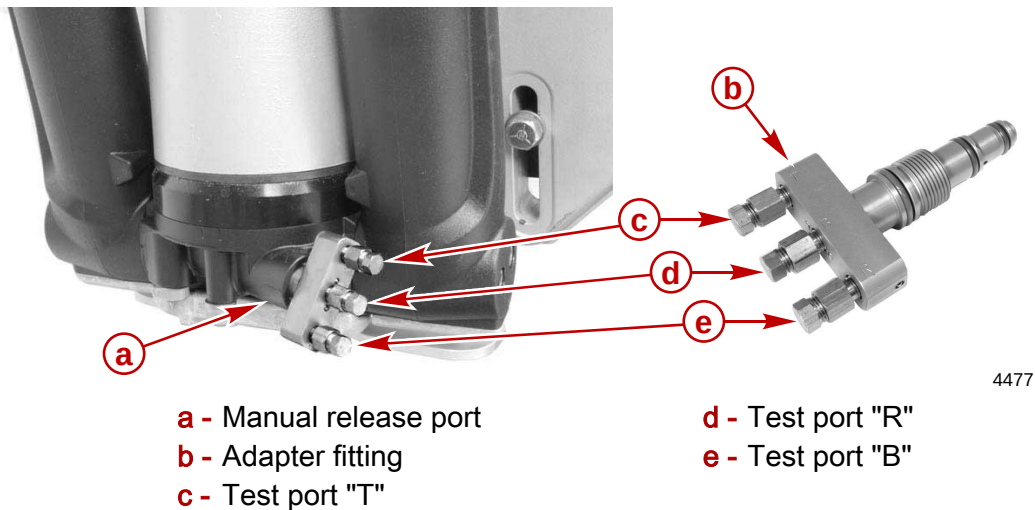


c - Tilt lock lever engaged
d - Tilt lock bracket engaged

3. Check for external leaks.
4. Slowly remove reservoir cap to relieve pressure.
5. Remove snap ring securing manual release valve and remove manual release valve.

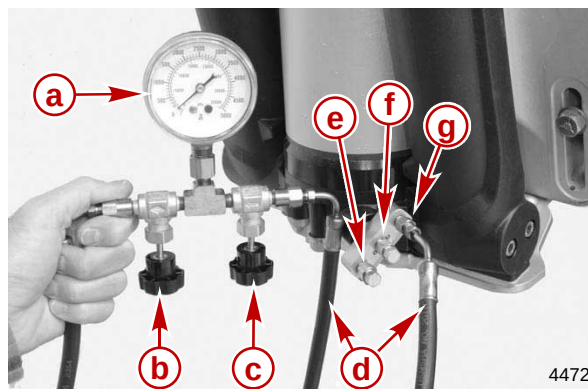
NOTE: A small amount of fluid may drip from the manual release port. Place a container under the trim assembly to collect any leakage.

6. Install power trim adapter fitting in manual release port.



Power Trim Adapter Fitting	91-822778004
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7. Ensure Test Port "B" and "R" are plugged.
8. Thread hose at valve "c" from Test Gauge Kit into adapter test port "T".



Power Trim Test Gauge Kit	91-52915A6
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9. Check power trim fluid level. If necessary, add fluid to bring level to 25 mm (1 in.) below top of reservoir neck.
10. Reinstall reservoir cap.

IMPORTANT: Reservoir cap must be installed to ensure accurate test results.

DOWN PRESSURE CIRCUIT TEST

1. Ensure all fittings are tight prior to testing.
2. Trim engine up slightly and disengage tilt lock lever.
3. Open valve "c" on power trim test gauge.
4. Cycle trim down and up.
5. Run trim down. Hold and observe pressure for a few seconds. Release trim button.

Down Pressure Relief Valve Specification	
Pressure	1255 - 2765 kPa 182 - 401 psi
Current draw	90 amp maximum

NOTE: If pressure is out of specification, the pump or down pressure relief valve is defective. Replace trim pump assembly. Refer to **Power Unit Disassembly/Reassembly** for instructions.

6. Run trim down to release pressure.
7. Place outboard in full up position and engage tilt lock lever.
8. Momentarily actuate the trim switch in opposite direction from last operation to relieve pressure in system.
9. Slowly remove reservoir cap to relieve pressure.
10. Remove test gauge hose and adapter fitting.
11. Install manual release valve and snap ring. Ensure snap ring is fully seated in groove.
12. Check power trim fluid level. If necessary, add fluid to bring level to 25 mm (1 in.) below top of reservoir neck.
13. Reinstall reservoir cap.

Electrical System Troubleshooting

GENERAL CHECKS

Before troubleshooting the power trim electrical system, check the following:

- Disconnected wires
- Connections are tight and corrosion free
- Plug-in connections are fully engaged
- Battery is fully charged

CONDITION/PROBLEM

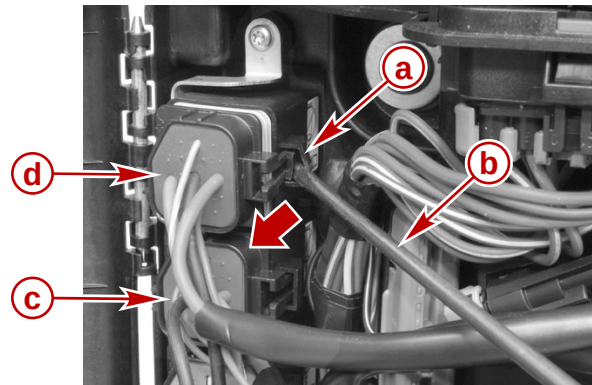
Condition of Trim System	Problem No.
Trim motor does not run when trim button is depressed	1, 2, 4, 5, 6, 8
Trim system trims opposite of buttons	3
Cowl mounted trim buttons do not activate trim system	2, 4, 5, 6

PROBLEM/SOLUTION

No.	Problem	Solution
1.	Battery low or discharged	Check battery.
2.	Open circuit in trim wiring	Check for an open connection.
3.	Wiring reversed in remote control, cowl switch or trim leads	Verify connections.
4.	Wire harness corroded through	Replace wire harness.
5.	Internal motor problem (brushes, shorted armature)	Check for open connection. Replace motor.
6.	Trim switch failure	Replace switch.
7.	Relay not operating	Verify relays are functioning correctly. Check voltage at trim bullets.

POWER TRIM RELAY TEST PROCEDURE

NOTE: To remove the power trim relays, insert a flat blade screwdriver in the relay lock tab. Gently twist the blade and pry the relay loose. Pull the relay out. Do not pull with the wires.



a - Lock tab

b - Flat blade screwdriver

c - Down trim relay

d - Up trim relay

The trim motor relay system used on permanent magnet trim systems connect each of the two wires from the trim motor to either ground or positive in order to allow the motor to run in both directions.

If the motor will not run in the up direction, it may be either the up relay is not making contact to 12 volts or the down relay is not making contact to ground. The opposite is true if the system will not run down. When the system is not energized, both relays should connect the heavy motor leads to ground.

To test which relay is faulty if the trim system does not operate in one direction:

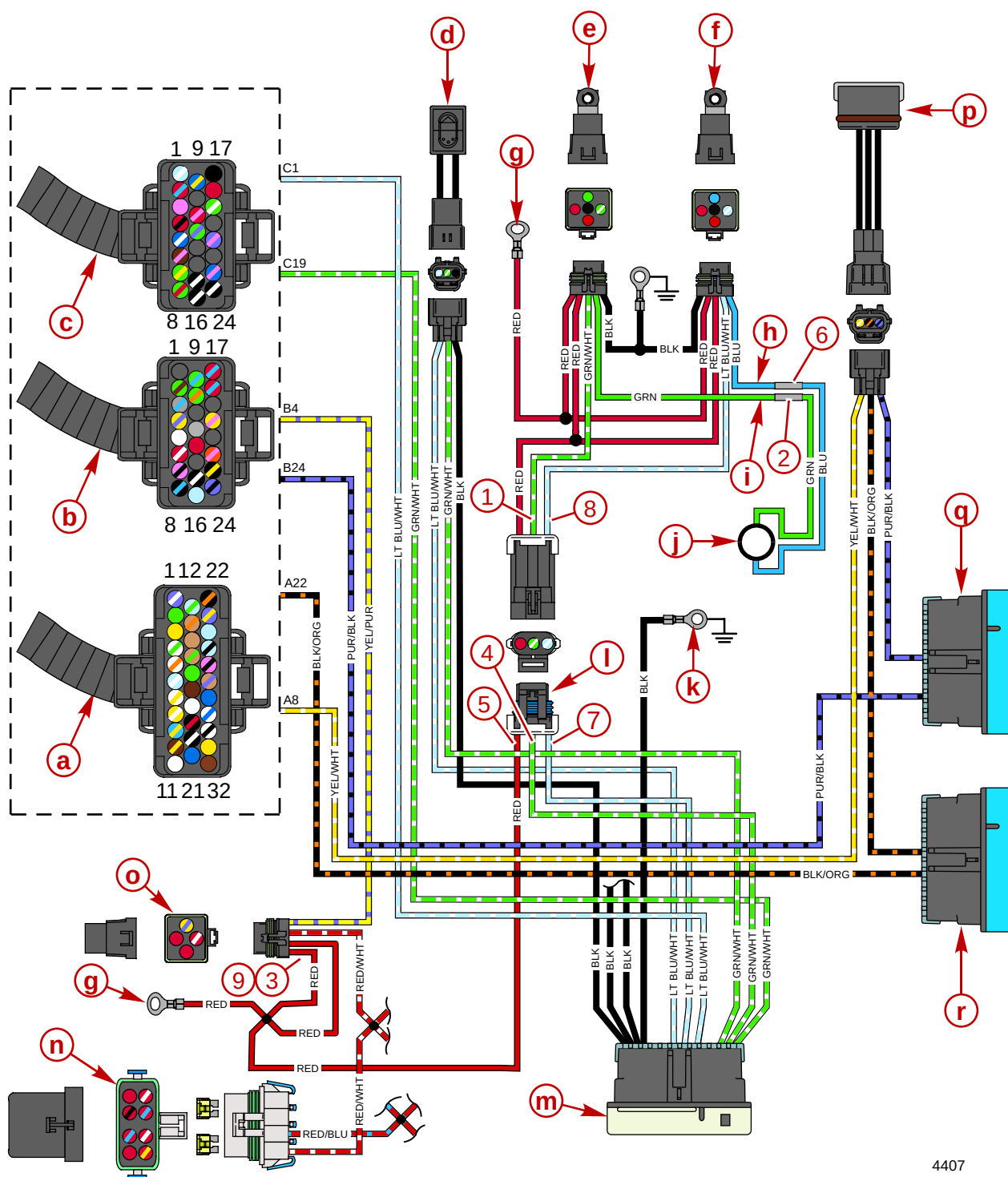
1. Disconnect the heavy gauge pump wires from the trim control relay.
2. Check for continuity between the heavy leads from the trim relays to ground.

Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Green	Ground	Full continuity (R x 1)	< 20 Ω
Blue	Ground	Full continuity (R x 1)	< 20 Ω

3. Replace the relay that does not have continuity.
4. Connect a voltmeter to the heavy blue lead and to ground. You should have 12 volts on the blue lead when the up switch is pushed. You should also have 12 volts on the green lead when the down switch is pushed. Replace the relay that does not switch the lead to positive.

Notes:

POWER TRIM ELECTRICAL CIRCUIT



4407

- a** - PCM connector A
- b** - PCM connector B
- c** - PCM connector C
- d** - Cowl tilt switch
- e** - Down relay
- f** - Up relay
- g** - +12 v power
- h** - Up lead at motor
- i** - Down lead at motor
- j** - Power trim motor
- k** - -12 v ground
- l** - Power trim harness connector
- m** - Splice saver SP1
- n** - Fuse holder
- o** - Main power relay
- p** - Trim position sensor
- q** - Splice saver SP6
- r** - Splice saver SP5

TROUBLESHOOTING THE DOWN CIRCUIT

Refer to the preceding wiring diagrams for connection points when troubleshooting the electrical systems. Connection points are specified by number.

Step	Test Procedure	Test Result
Step 1: Check for battery voltage at Point 1.	☐ Disconnect down relay. ☐ Connect voltmeter black lead to Point 1 and red lead to battery positive. ☐ Depress the down trim button.	Battery voltage measured: - Reconnect down trim relay. - Go to Step 2. No battery voltage measured: - Go to Step 3.
Step 2: Check for battery voltage at Point 3.	☐ Connect voltmeter red lead to Point 3 and black lead to ground.	Battery voltage measured: - Go to Step 5. No battery voltage measured: - There is an open circuit between Point 3 and positive (+) battery terminal. - Check for loose or corroded connections. - Check wires for open.
Step 3: Check for battery voltage at Point 4.	☐ Disconnect 3 pin connector ☐ Connect voltmeter black lead to Point 4 and red lead to battery positive. ☐ Depress the down trim button.	Battery voltage measured: - Wire is open between Points 4 and 1. No battery voltage measured: - Reconnect 3 pin connector. - Go to Step 4.
Step 4: Check for battery voltage at Point 5.	☐ Connect voltmeter red lead to Point 5 and black lead to ground.	Battery voltage measured: - Trim switch is faulty. No battery voltage measured: - Check for loose or corroded wire at Point 5. - Open circuit in wire supplying current to Point 5.
Step 5: Check for battery voltage at Point 2.	☐ Connect voltmeter red lead to Point 2 (female bullet connector) and black lead to ground. ☐ Depress the down trim button.	Battery voltage measured: - Go to Step 6. No battery voltage measured: - Relay is defective.
Step 6: Check Up relay.	☐ Test up relay. Refer to Power Trim Relay Test preceding.	Relay is good: - Pump motor wiring is defective. - Pump motor is defective. Relay is faulty: - Replace relay.

TROUBLESHOOTING THE UP CIRCUIT

NOTE: Refer to the preceding wiring diagrams for connection points when troubleshooting the electrical systems. Connection points are specified by number.

Step	Test Procedure	Test Result
Step 1: Check for battery voltage at Point 8.	☐ Disconnect up relay. ☐ Connect voltmeter black lead to Point 8 and red lead to battery positive. ☐ Depress the up trim button.	Battery voltage measured: - Reconnect up trim relay. - Go to Step 2. No battery voltage measured: - Go to Step 3.

Step	Test Procedure	Test Result
Step 2: Check for battery voltage at Point 9.	☐ Connect voltmeter red lead to Point 9 and black lead to ground.	Battery voltage measured: - Go to Step 5. No battery voltage measured: - There is an open circuit between Point 9 and positive (+) battery terminal. - Check for loose or corroded connections. - Check wires for open.
Step 3: Check for battery voltage at Point 7.	☐ Connect voltmeter black lead to Point 7 and red lead to battery positive. ☐ Depress the up trim button.	Battery voltage measured: - Wire is open between Points 7 and 8. No battery voltage measured: - Reconnect 3 pin connector. - Go to Step 4.
Step 4: Check for battery voltage at Point 5.	☐ Connect voltmeter red lead to Point 5 and black lead to ground.	Battery voltage measured: - Trim switch is faulty. No battery voltage measured: - Check for loose or corroded wire at Point 5. - Open circuit in wire supplying current to Point 5.
Step 5: Check for battery voltage at Point 6.	☐ Connect voltmeter red lead to Point 6 and black lead to ground. Depress the up trim button.	Battery voltage measured: - Go to Step 6. No battery voltage measured: - Relay is defective.
Step 6: Check Up relay.	☐ Test Down relay. Refer to Power Trim Relay Test preceding.	Relay is good: - Pump motor wiring is defective. - Pump motor is defective. Relay is faulty: - Replace relay.

TROUBLESHOOTING THE DOWN AND UP CIRCUITS (ALL CIRCUITS INOPERATIVE)

NOTE: Refer to the preceding wiring diagrams for connection points when troubleshooting the electrical systems. Connection points are specified by number.

Step	Test Procedure	Test Result
Step 1: Check fuse.	☐ Visually inspect power trim motor fuse.	Fuse blown: - Correct problem that caused to blow, and - Replace fuse Fuse not blown: - Go to Step 2.
Step 2: Check battery voltage.	☐ Connect voltmeter red lead to Point 3 and black lead to ground.	No battery voltage: - Check battery leads for poor connections or open circuit. - Check battery charge. Battery voltage measured: - Go to Step 3.

Step	Test Procedure	Test Result
Step 3: Up trim switch.	☐ Connect voltmeter black lead to Point 1 and red lead to battery positive. ☐ Depress up trim button.	No battery voltage: - Go to Step 4. Battery voltage measured: - Check black ground wires for connection or poor ground at Point 10. - Pump motor is faulty.
Step 4: Open circuits	☐ Connect voltmeter red lead to Point 5 and black lead to ground.	No voltage measured: - Go to Step 5. Battery voltage measured: - Trim switch is faulty or - Open circuit in wires (grn/wht or blu/wht) between trim buttons and trim pump motor. - Check - Trim switch. - All trim harness connections for loose or corroded connections. - Pinched or severed wires.
Step 5: Check voltage.	Check that voltage is being supplied to control by performing the following checks: ☐ Do not start engine. ☐ Turn ignition switch to "RUN" position. ☐ Check for voltage at any instrument using a voltmeter.	No voltage measured: - Red wire is open between Point 3 and red terminal on back of ignition switch. - Check for loose or corroded connections - Check for open in wire. Battery voltage measured: - There is an open circuit between Point 5 and red terminal on back of ignition switch.

TRIM POSITION SENSOR

The trim position sensor is located on the port side of the cradle mount. It supplies the Propulsion Control Module (PCM) with trim position information. The trim position sensor and PCM limit the trim angle when engine speed is greater than 2000 rpm and limits the tilt angle for trailering. The PCM will generate and store a failure code when the Trim Position Sensor (TPS) fails, but it will not sound an alarm horn.

The trim sensor only effects trim functions controlled by the helm trim switch. The trim system will function with the cowl tilt switch and will operate regardless of the position being reported by the trim position sensor. This means that there are no trim or trailer limits when using the cowl tilt switch. The engine will trim as long as the tilt switch is depressed or until the mechanical stop is reached.

1. The following are some of the problems encountered with a faulty trim position sensor:

- Engine speed limited to 2000 rpm
- Engine will trim higher than the set trim limit at speeds above 2000 rpm
- Engine trims past the maximum trailer limits
- Engine trims normally, but there are no trailer limits

NOTE: If an operator tries to set trim limits with a faulty trim position sensor without noticing that the sender output is not changing, and sets the trim and trailer limits to the same point, the trim system will not function. The PCM needs to be reprogrammed or replaced.

TROUBLESHOOTING THE TRIM POSITION CIRCUIT

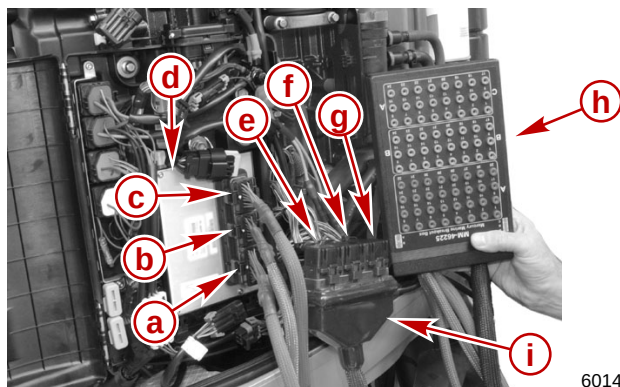
Breakout Box		SPX p/n MM-46225
Step	Test Procedure	Test Result
Step 1: Check trim position sensor using trim gauge.	☐ Turn key to "ON" position. ☐ Trim engine up and down. ☐ Observe trim position gauge on instrument panel.	Trim position gauge varies with engine trim position: - Trim position sensor is good. - Go to Step 2. Trim position gauge does not vary with engine trim position: - Go to Step 2.
Step 2: Check trim position sensor using DDT.	☐ Turn key to "OFF" position. ☐ Connect digital diagnostic tool (DDT) to engine. ☐ Turn key to "ON" position. ☐ Observe trim position sensor counts on DDT. ☐ Trim engine up and down.	Count increases as engine trims up and decreases as engine trims down: - Trim position sensor is good. Count does not vary with engine trim position: - Go to Step 3.
Step 3: Check PCM harness for open or short circuit.	☐ Turn key to "OFF" position. ☐ Disconnect digital diagnostic tool (DDT) from engine. ☐ Connect breakout box, SPX p/n MM-46225, black lead to PCM harness connectors. Do not connect red, green or blue leads to PCM. Refer to Breakout Box Connections following. ☐ Disconnect trim position sensor harness connectors. Refer to Trim Position Sensor Location following. ☐ Check resistance from breakout box pin to trim position sensor harness connector (PCM harness side). ☐ Pin B24 to pur/blk ☐ Pin A22 to blk/orn ☐ Pin A8 to yel/wht	Resistance measured is less than 0.8 ohms: - Go to step 4. Resistance measured is greater than 0.8 ohms: - PCM harness may be faulty.
Step 4: Check transducer voltage.	☐ Turn key to "OFF" position. ☐ Connect trim position sensor harness connectors. ☐ Connect red, green and blue breakout box leads to PCM. ☐ Turn key to "ON" position. ☐ Check transducer power between pin A22 and A23 of breakout box.	Voltage measured is 5 ± 0.1 VDC: - Go to Step 5. Voltage measured is out of specified range: - Go to Step 6.
Step 5: Check trim position sensor output voltage.	☐ Turn key to "ON" position. ☐ Check trim position sensor voltage output between pin A22 and A8 of breakout box. ☐ Trim outboard from full in to full out.	Voltage measured varies between a minimum of 0.5 VDC and a maximum of 4.5 VDC: - Trim position sensor is good. Voltage measured is out of specified range: - Go to Step 6.

Step	Test Procedure	Test Result
Step 6: Check trim position sensor resistance.	☐ Turn key to "OFF" position. ☐ Disconnect red, green and blue breakout box leads from PCM. ☐ Check trim position sensor resistance. Refer to chart following for specifications.	Resistance measured is within specification in Table: - Go to Step 7. Resistance measured is not within specification in Table: - Trim position sensor is faulty. - Go to Step 7.
Step 7: Check resistance sensor signal pin and ground in PCM.	☐ Disconnect PCM harness leads from breakout box black lead. ☐ Connect red, green and blue breakout box leads to PCM. ☐ Check resistance between pin A8 and B24 of breakout box.	Resistance measured is 215.6 k Ω to 224.4 k Ω . - Replace trim position sensor. Open or short measured: - Replace PCM.

TRIM POSITION SENOR RESISTANCE TABLE

Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Breakout Box Pin B24	Breakout Box Pin A22	Ω	6000
Breakout Box Pin B24	Breakout Box Pin A8	Ω	168
Breakout Box Pin A22	Breakout Box Pin A8	Ω	6000

BREAKOUT BOX CONNECTIONS



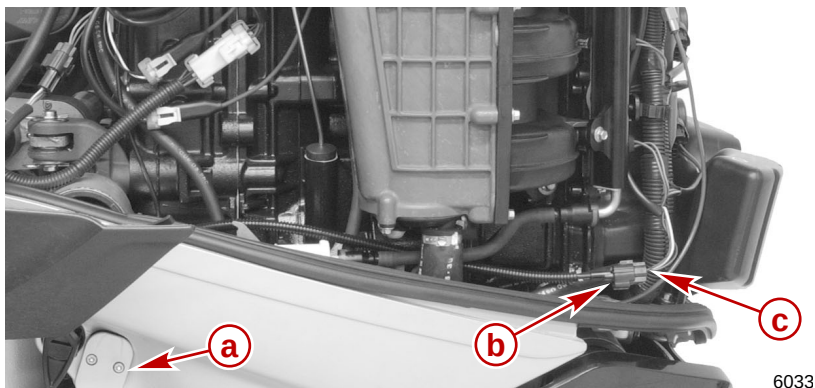
- a** - "A" connector - Red lead
b - "B" connector - Green lead
c - "C" connector - Blue lead
d - PCM
e - "C" connector

- f** - "B" connector
g - "A" connector
h - Breakout box
i - Main connector - Black lead

Breakout Box	SPX p/n MM-46225
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TRIM POSITION SENSOR LOCATION

Disconnect trim position sensor connector from the PCM harness connector.



Port side view

a - Trim position sensor

b - Trim position sensor connector

c - Trim position sensor PCM harness connector

General Service Recommendations

There may be more than one way to disassemble or reassemble a particular part, therefore, it is recommended that the entire procedure be read prior to repair.

IMPORTANT: Read the following before attempting any repairs.

In many cases, disassembly of a sub-assembly may not be necessary, until cleaning and inspection reveals that disassembly is required for replacement of one or more components.

The power trim system may be disassembled in 3 sub-assemblies (power unit, trim cylinders, and manifold pressure operated check) or as a complete assembly. This service manual section is structured for the disassembly and reassembly of any one of the sub-assemblies without the disassembly of another sub-assembly. If complete disassembly of the system is required for cleaning or inspection, start with the removal of the system from the outboard, then proceed to the **Power Unit Disassembly, Trim Cylinder Disassembly**, and then **Manifold Pressure Operated Check Disassembly**.

Service procedure order in this section is a normal disassembly/reassembly sequence. It is suggested that the sequence be followed without deviation to ensure proper repairs. When performing partial repairs, follow the instructions to the point where the desired component can be replaced, then proceed to reassembly and installation of that component in the reassembly part of this section. Use the **Table of Contents** (on back of section divider) to find correct page number.

Threaded parts are right hand (RH), unless otherwise indicated.

When holding, pressing or driving is required, use soft metal vise jaw protectors or wood for protection of parts. Use a suitable mandrel (one that will contact only the bearing race) when pressing or driving bearings.

Whenever compressed air is used to dry a part, verify that no water is present in air line.

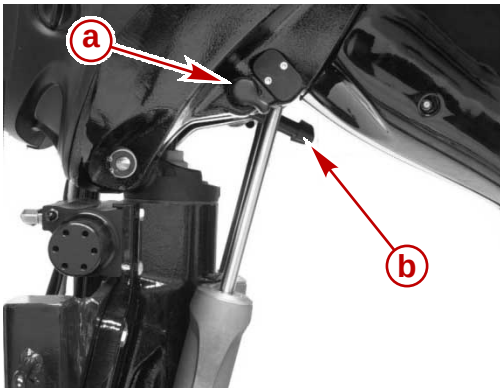
Seals

As a normal procedure, all O-rings and oil seals should be replaced without regard to appearance. When using Loctite on seals or threads, surfaces must be clean and dry. To ease installation, apply Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) (Type Dexron III) on all O-rings. To prevent wear, apply 2-4-C with Teflon on I.D. of oil seals.

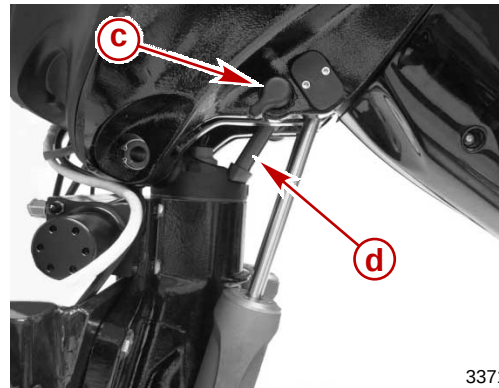
Power Trim System

Power Trim System Removal

1. Trim engine up and engage tilt lock lever. Momentarily actuate the trim switch in opposite direction from last operation to relieve pressure in system.



a - Tilt lock lever disengaged
b - Tilt lock bracket disengaged



c - Tilt lock lever engaged
d - Tilt lock bracket engaged

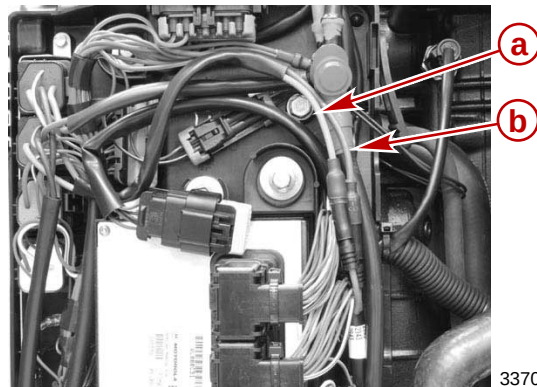
3371

POWER TRIM HARNESS

1. Disconnect trim motor harness (blue and green) bullet connectors located in the electrical box.
2. Remove power trim harness grommet from mount cradle and remove grommet from harness.

NOTE: Tape a fish wire to the power trim leads before removing. The wire will be used during installation the pull the power trim leads through the cowl area.

3. Pull power trim motor harness through grommet in cradle mount.



a - Green wire

b - Blue wire

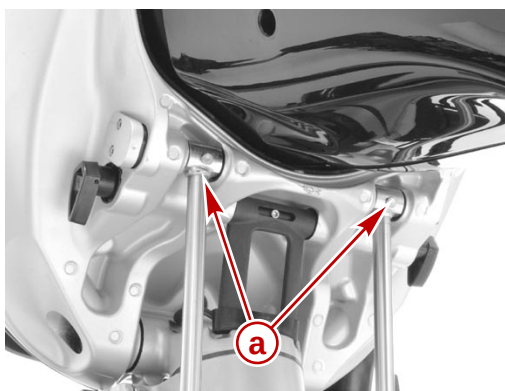
3370

4. Remove wire from power trim leads. Leave wire in place for installation.

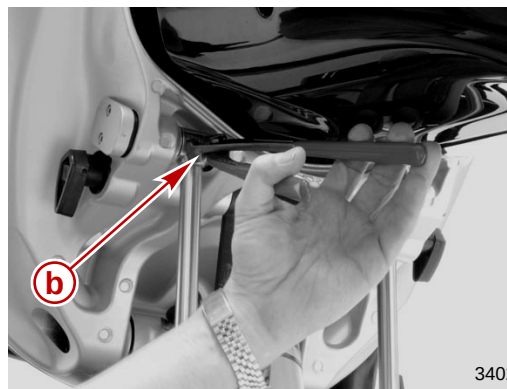
TRIM CYLINDER ROD ENDS

1. Use Oetike® crimp tool pliers to remove 2 trilobe cross pins from upper pivot pins.

NOTE: The lower chap may be removed to aid in cross pin removal.



a - Trilobe pin



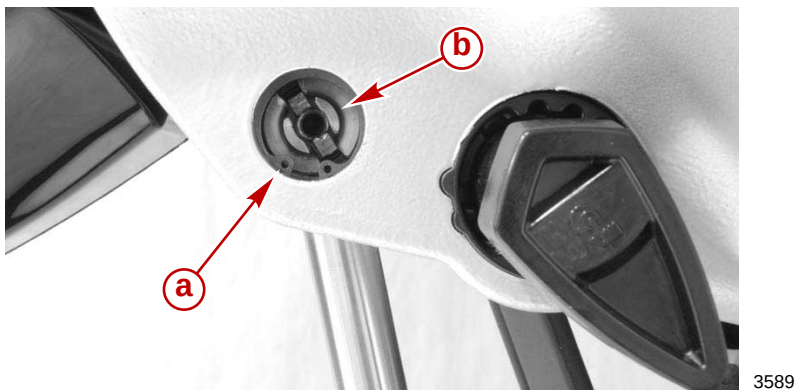
b - Oetike® Pliers

2. Remove 2 screws securing trim sensor (T27 Torx bit). Use screws to remove sensor from mount cradle.



a - Trim sensor

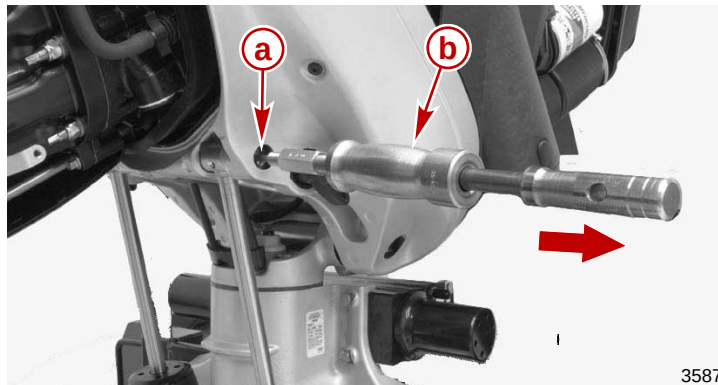
3. Remove snap ring from starboard and port pivot pins.



a - Starboard pivot pin

b - Snap ring

4. Thread slide hammer puller or 6 mm screw into starboard pivot pin and pull pin out. Thread puller or 6 mm screw into port pivot pin and pull pin out.



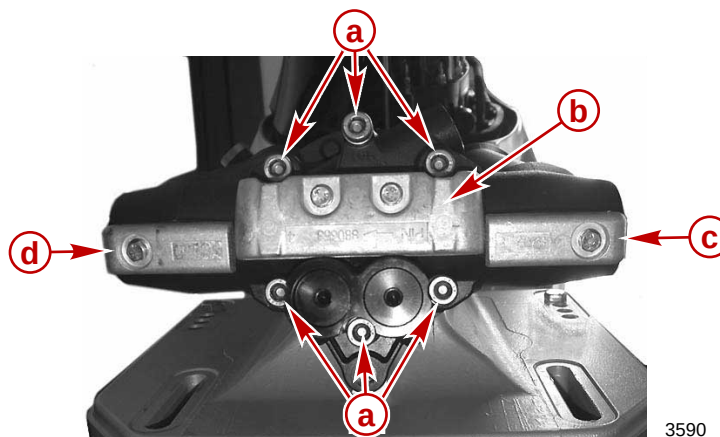
a - Pivot pin

b - Slide hammer puller

Slide Hammer Puller	91-34569A1
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POWER TRIM UNIT

1. Remove five of the six mounting screws from bottom of the power trim assembly. Leave one screw in place to prevent the power trim unit from falling.



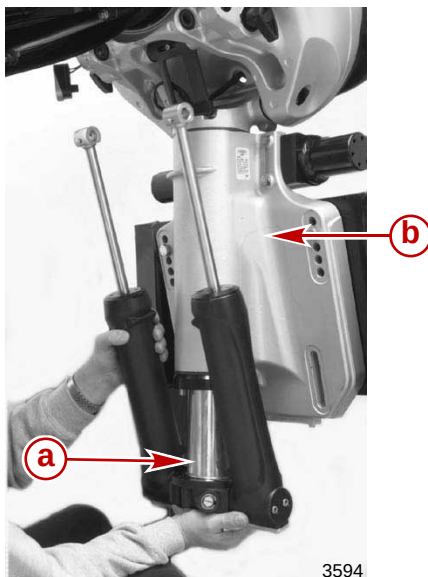
a - Power trim mounting screws

b - Power trim assembly

c - Starboard trim cylinder

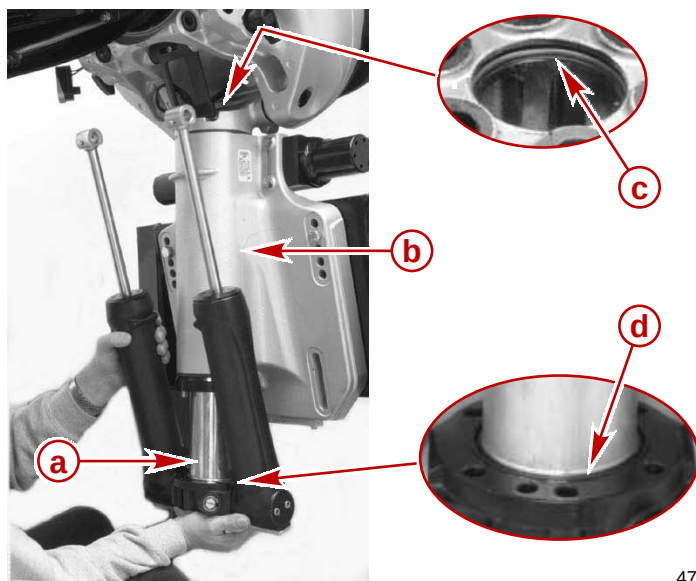
d - Port trim cylinder

2. Support the power trim unit while removing the remaining screw. Remove power trim unit from pedestal.

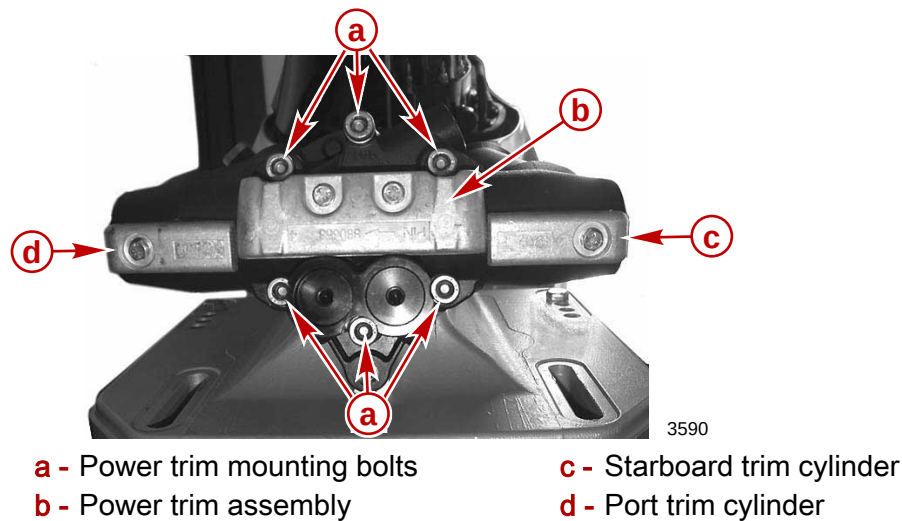
**a** - Power trim assembly**b** - Pedestal

Power Trim System Installation

1. Re-tape the power trim harness to the fish wire used for removal. Pull the fish wire up through the pedestal and the hole in mount cradle.
2. Ensure that the O-ring is in place in the steering head.
3. Ensure that steering tube O-ring is in place on the manifold base.
4. Install power trim assembly into pedestal.

**a** - Power trim assembly
b - Pedestal**c** - Steering head O-ring
d - Steering tube O-ring

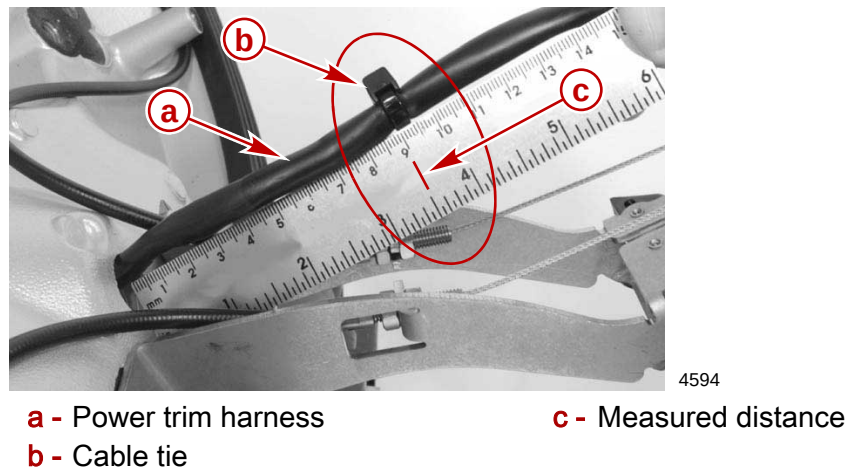
5. Install 6 bolts in bottom of the power trim assembly. Tighten to specified torque.



Description	Nm	lb. in.	lb. ft.
Power trim assembly mounting bolts	47.5		35

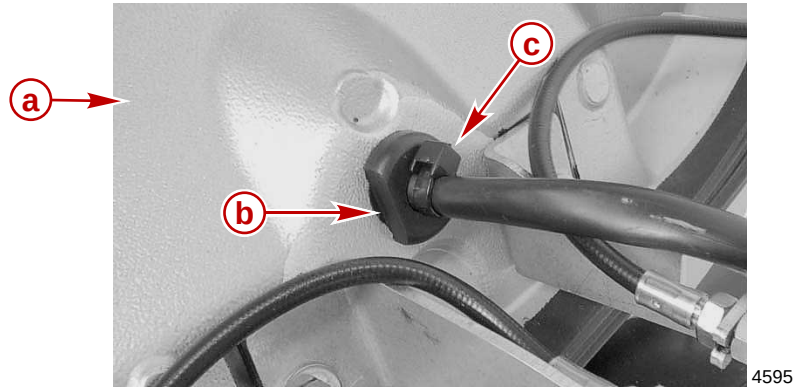
POWER TRIM HARNESS

1. Continue pulling the fish wire to route power trim motor harness up through hole in mount cradle to bullet connectors in electrical component box. Remove fish wire from harness.
2. Attach a cable tie on the harness a distance of 18.5 cm (7.25 in.) from the reservoir fill cap. With the mount cradle attached, place the cable tie 9.0 cm (3.5 in.) from the cradle top surface when trimmed fully up.



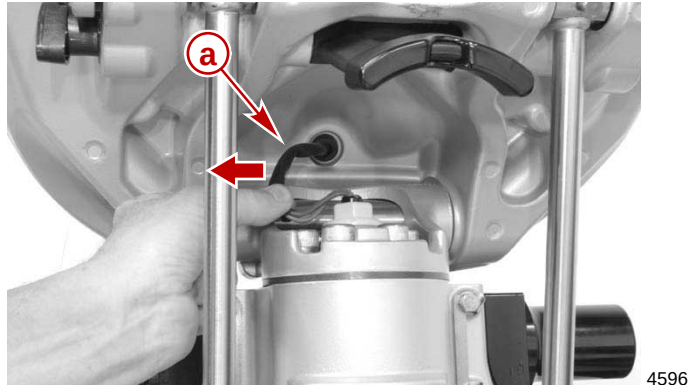
3. Place the power trim grommet on the harness below the cable tie.

4. Push the grommet and harness in the mount cradle. As the grommet is pushed in, rotate the grommet so the flat edge faces either side of the engine when installed.



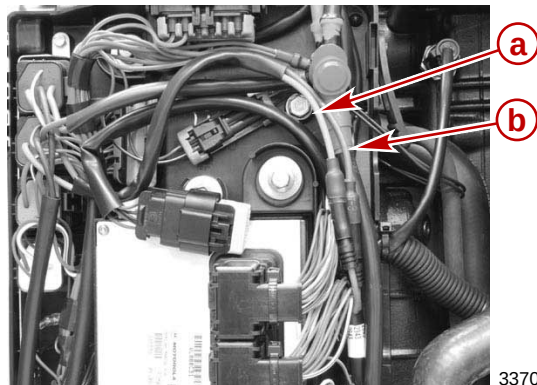
a - Mount cradle
b - Grommet - flat edge facing side of engine
c - Cable tie

5. To ensure that the harness will coil when the mount cradle is trimmed down, gently pull on the harness to check that it is off-center.



a - Power trim harness pulled towards side of engine

6. Connect trim motor harness (blue and green) bullet connectors.

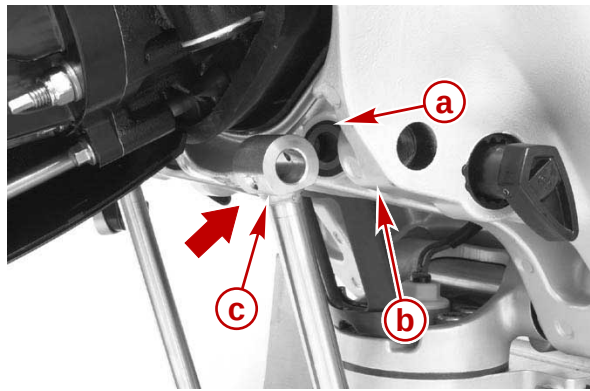


a - Green wire
b - Blue wire

TRIM CYLINDER ROD ENDS

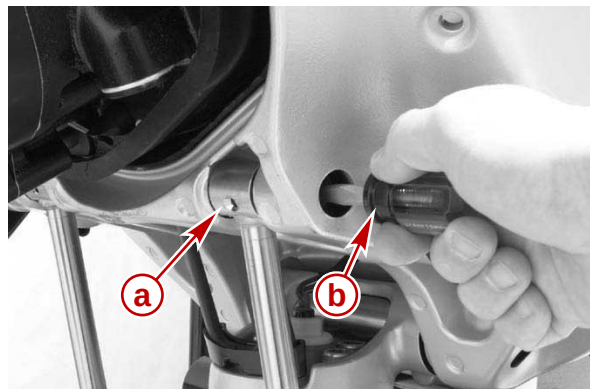
1. Ensure that the 4 rod end bearings are in place in the mount cradle lugs.

2. Position port and starboard trim cylinder rod ends into mount cradle.



a - Trim cylinder rod end bearing (4) **c** - Trim cylinder rod end
b - Mount cradle lug

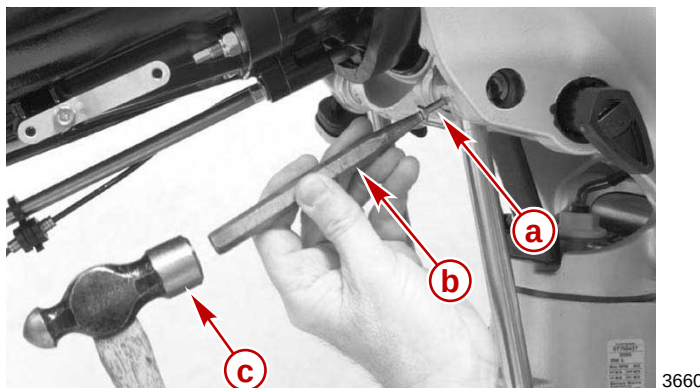
3. Install port and starboard pivot pins.
4. Using screwdriver, align hole in pivot pin with the hole in the trim cylinder rod end.



a - Trim cylinder rod end **b** - Screwdriver

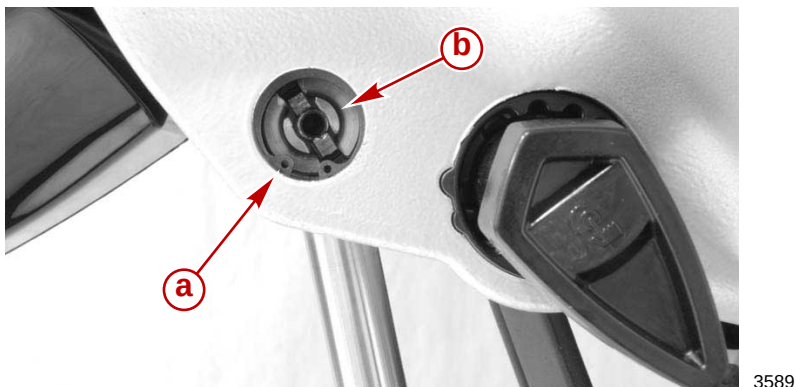
5. Using a brass drift or soft metal hammer, install new trilobe pins fully into trim cylinder rod ends and upper pivot pins.

NOTE: Do not use a steel drift punch to install trilobe cross pins. It may cause corrosion to develop on the pins.



a - Trilobe pin **c** - Hammer
b - Brass drift punch

6. Install snap ring on each pivot pin. Ensure that snap ring is fully seated in snap ring groove.



a - Starboard pivot pin

b - Snap ring

7. Install trim sensor in port mount cradle. Align tang on sensor with slot in pivot pin.
8. Apply Loctite 271 Threadlocker to sensor bolts. Tighten sensor bolts to specified torque.



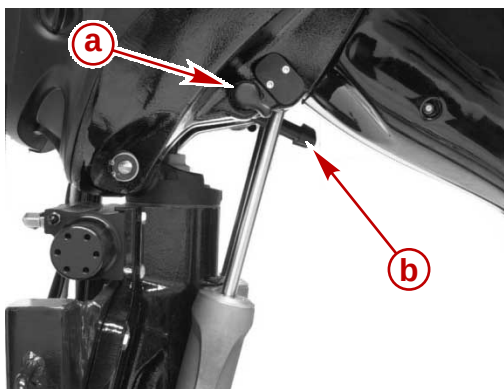
a - Trim sensor

Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	Power trim sensor bolts	92-809819

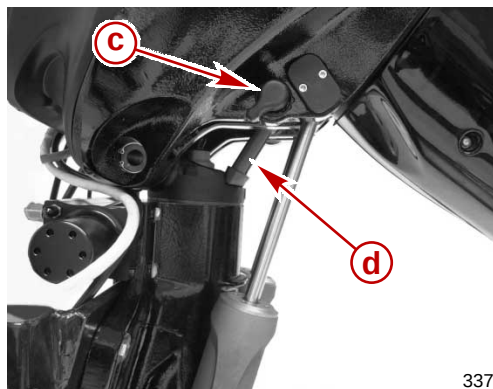
Description	Nm	lb. in.	lb. ft.
Power trim sensor bolts	4	35	

9. Install lower chaps if removed during disassembly.

10. Trim engine up slightly and disengage tilt lock lever.



a - Tilt lock lever disengaged
b - Tilt lock bracket disengaged



3371

c - Tilt lock lever engaged
d - Tilt lock bracket engaged

11. Trim outboard down.

PURGING THE POWER TRIM SYSTEM

Purge air from the power trim system. Refer to **Check Fluid and Purge the Power Trim System**.

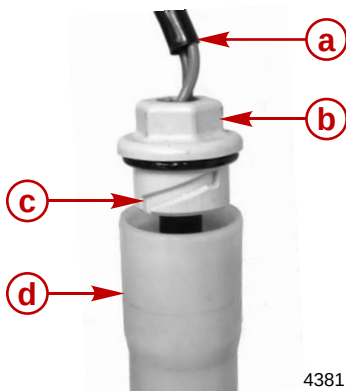
Power Unit

Power Unit Disassembly

Remove power trim system from outboard. Refer to **Power Trim System Removal**.

DRAINING THE SYSTEM

1. Remove reservoir cap from reservoir neck. The reservoir cap only requires 1/4 turn to remove.

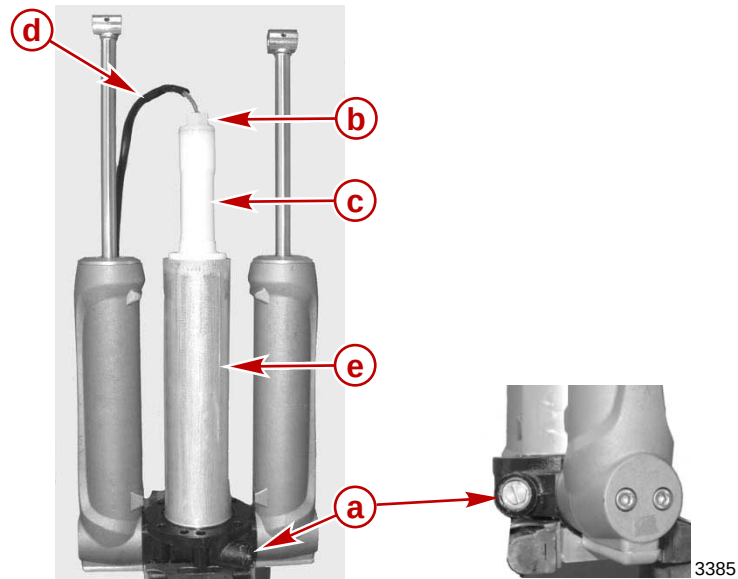


4381

a - Power trim harness
b - Reservoir cap
c - Quarter turn channel
d - Reservoir neck

2. Remove reservoir cap from harness.
3. Drain fluid from reservoir.

4. Remove snap ring and manual release valve. Allow additional fluid to drain from internal components.

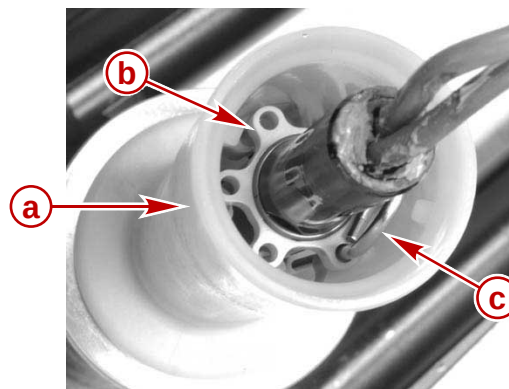


a - Manual release valve
b - Reservoir cap
c - Reservoir neck

d - Power trim motor harness
e - Reservoir

RESERVOIR

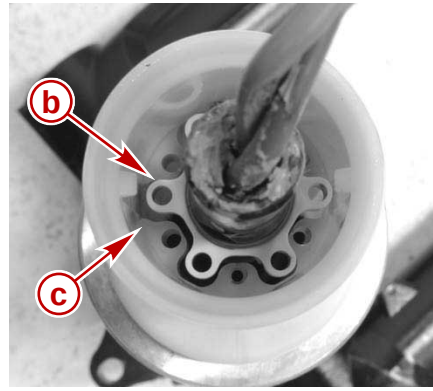
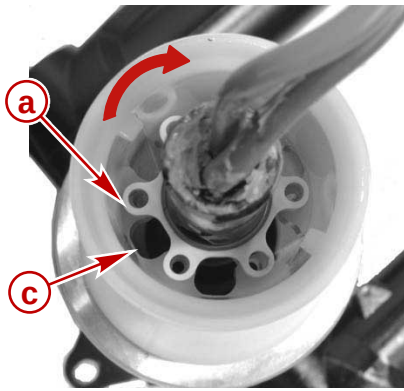
1. Remove locking pin from reservoir neck.



a - Filler neck
b - Retaining ring

c - Retaining pin

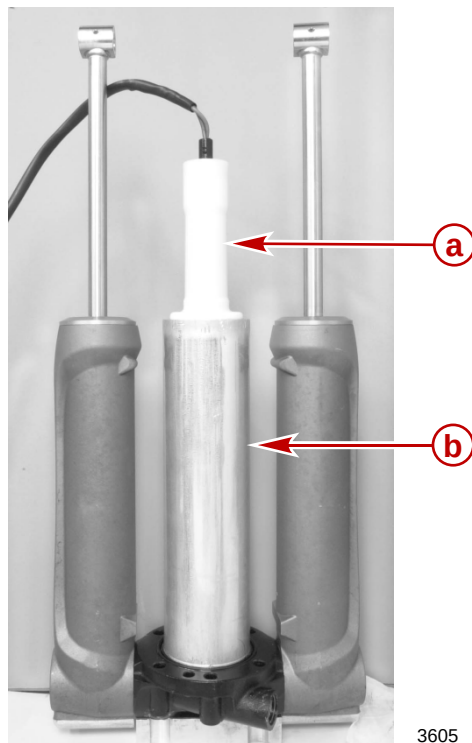
2. Rotate reservoir neck to align slots in reservoir neck to match outline of locking ring.



3598

- a** - Locking ring in locked position - not aligned with slots in reservoir neck
- b** - Locking ring aligned with slots in reservoir neck
- c** - Reservoir neck

3. Remove reservoir neck. It may be necessary to wiggle the reservoir neck to break the seal.
4. Remove aluminum reservoir.

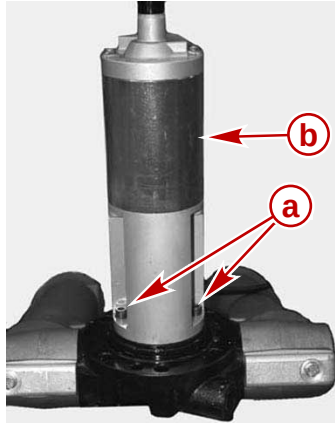


3605

a - Reservoir neck

b - Aluminum reservoir

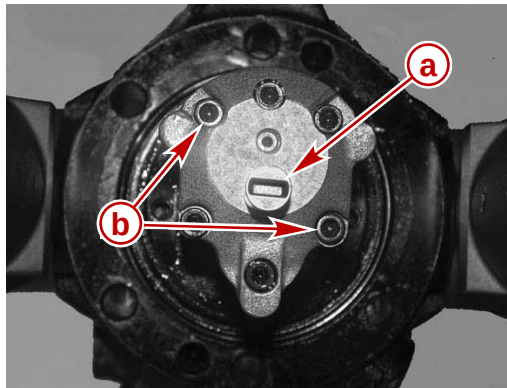
5. Remove two motor mounting screws securing trim motor assembly. Remove trim motor.



a - Motor mounting screws (4.5 mm internal hex) **b** - Trim motor

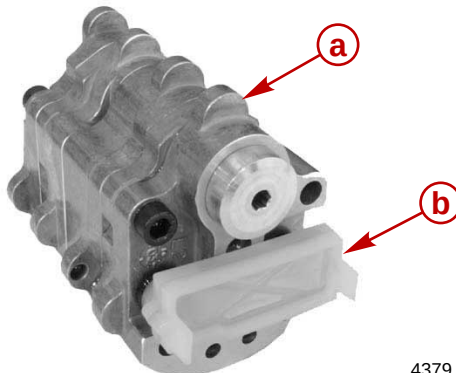
PUMP AND FILTER

1. Remove motor/pump coupling. Remove two trim pump mounting screws securing pump and remove pump.



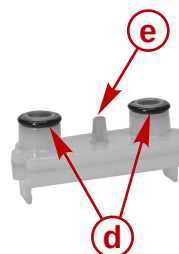
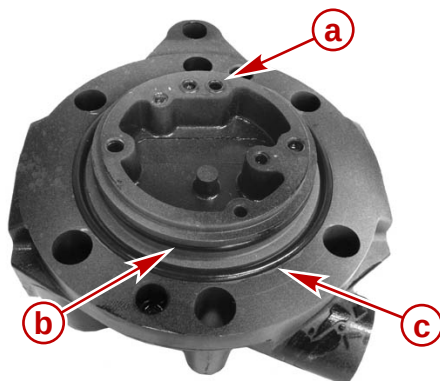
a - Motor/pump coupling **b** - Trim pump mounting screws (4.0 mm internal hex)

2. Remove filter assembly from power trim pump.



a - Power trim pump **b** - Pump filter

3. Remove and discard O-rings from filter and manifold. Use new O-rings when assembling the power trim components.



3611

- | | |
|--|--|
| a - Pump port O-rings | d - Pump filter O-rings |
| b - Reservoir base O-ring on diameter | e - Guide post for installation |
| c - Steering tube O-ring on face | |

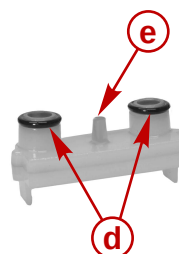
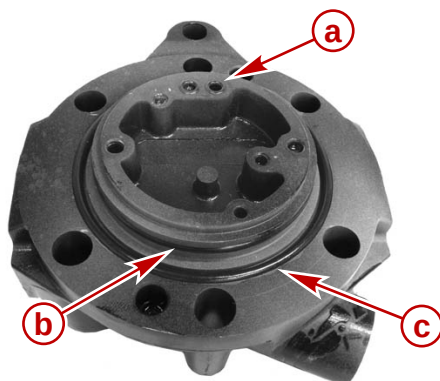
4. Inspect manifold and components for wear and contamination. Clean components if contamination is found.

Power Unit Reassembly

NOTE: Replace all O-rings with new O-rings when reassembling the power unit. Lubricate O-rings with clean Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) (Type Dexron III) prior to installation.

PUMP AND FILTER

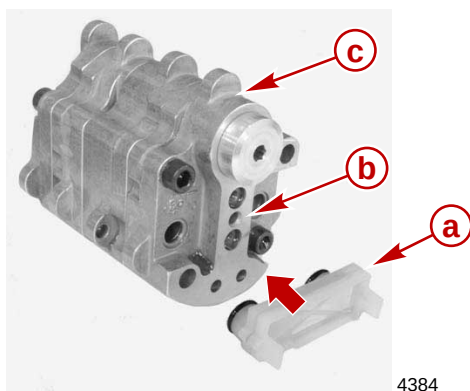
1. Install lubricated O-rings on manifold base. Install lubricated O-rings on pump filter.



3611

- | | |
|--|--|
| a - Pump port O-rings | d - Pump filter O-rings |
| b - Reservoir base O-ring on diameter | e - Guide post for installation |
| c - Steering tube O-ring on face | |

2. Install filter on power trim pump. Insert guide post on filter into hole in pump base.



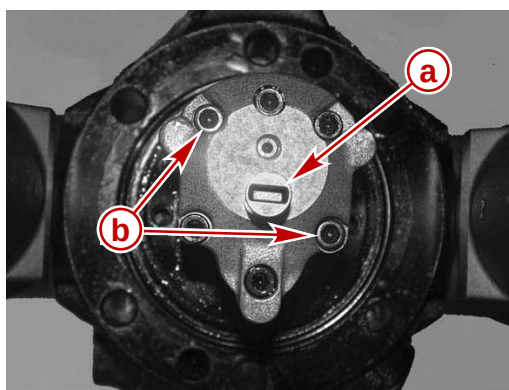
a - Pump filter

b - Hole in pump base for filter installation

c - Power trim pump

3. Install pump assembly onto manifold. Secure with two trim pump mounting screws. Tighten to specified torque.
4. Place motor/pump coupler on the trim pump input shaft.

NOTE: Coupler ends have different size slots. The small slot installs on pump shaft.



a - Motor/pump coupler

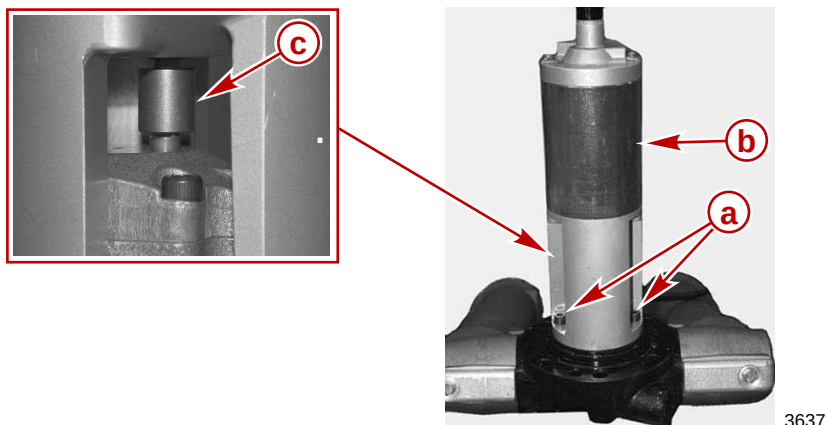
b - Trim pump mounting screws (4 mm internal hex)

Description	Nm	lb. in.	lb. ft.
Trim pump mounting screws	8	70	

TRIM MOTOR

1. Place trim motor on the trim pump and manifold while aligning the tang on the motor shaft with the slot in the coupler.
2. Rotate coupler by hand to ensure proper installation of coupler.

- Secure the power trim motor with two motor mounting screws. Tighten screws to specified torque.

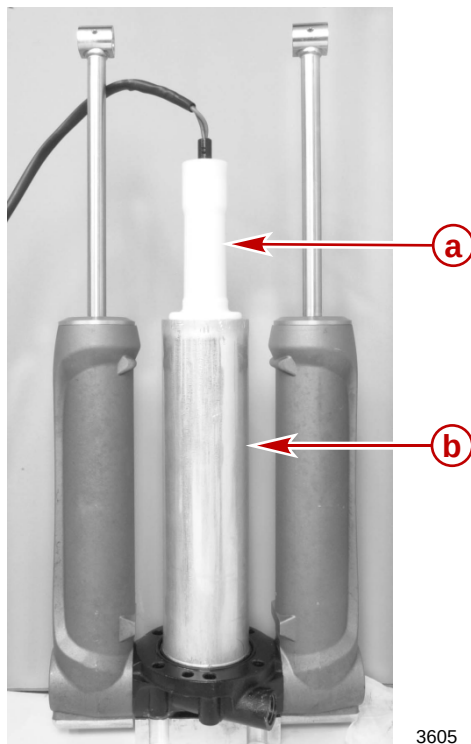


- a** - Motor mounting screws (4.5 mm internal hex) **c** - Motor/pump coupler
- b** - Trim motor

Description	Nm	lb. in.	lb. ft.
Motor mounting screws	8.5	75	

RESERVOIR

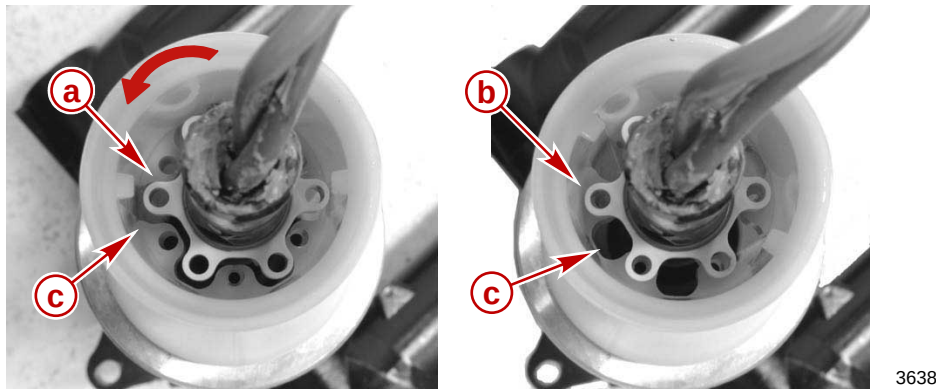
- Assemble reservoir neck to reservoir canister. Ensure reservoir neck is fully seated on reservoir.
- Route electric motor harness through reservoir.



- a** - Reservoir neck **b** - Reservoir

- Align reservoir neck with locking ring and seat reservoir onto manifold base.

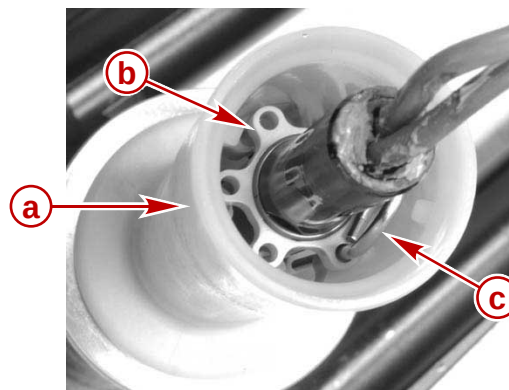
4. Rotate reservoir neck to align locking pin hole with hole in reservoir neck.



- a** - Locking ring aligned with assembly slot in reservoir neck
b - Locking ring in locked position
c - Reservoir neck

5. Install locking pin through locking ring and reservoir neck.

IMPORTANT: Recheck engagement of locking pin, locking ring and reservoir neck. Improper assembly of components may result in loss of system fluid.

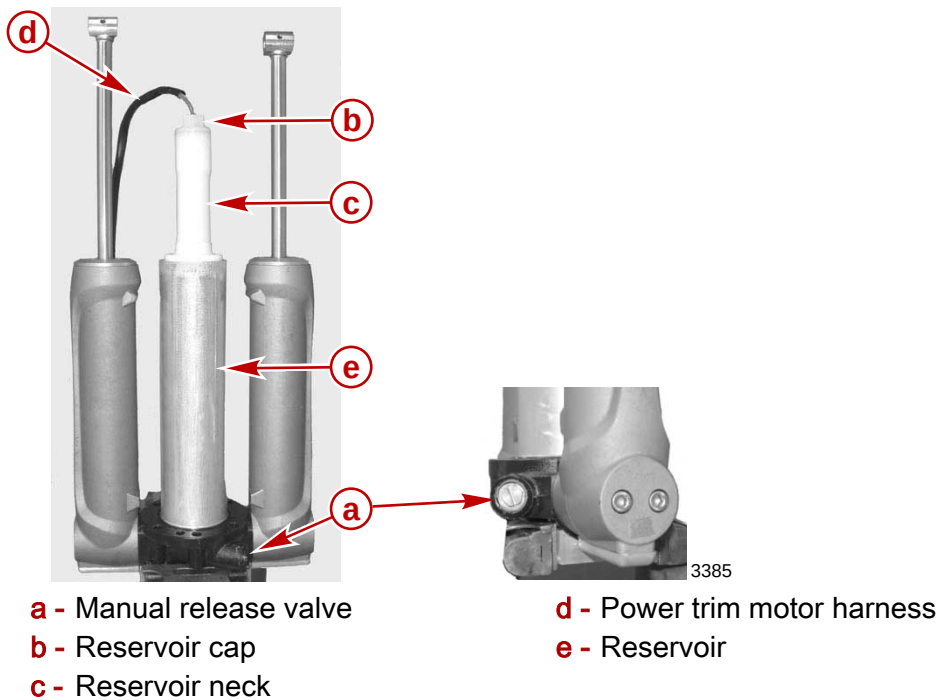


- a** - Reservoir neck
b - Locking ring
c - Locking pin

FILLING AND PURGING SYSTEM

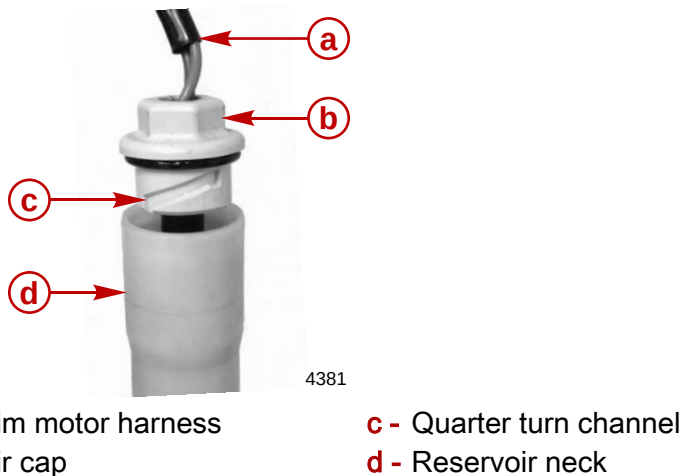
1. Install new lubricated O-rings on manual release valve.
2. Install manual relief valve in manifold.
3. Install snap ring securing manual release valve. Verify snap ring is fully seated in groove.
4. Close manual release valve.
5. Fill reservoir through reservoir neck to 25 mm (1 in.) from top of reservoir neck. Use Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) (Type Dexron III).

6. Route electric motor harness through reservoir neck cap.



Tube Ref No.	Description	Where Used	Part No.
 114	Power Trim and Steering Fluid	Manual release valve O-rings and power trim system fluid	92-802880A1

7. Tighten reservoir cap 1/4 turn. Cap will snap in place. Do not tighten beyond this point.



8. Connect trim motor harness (blue and green) bullet connectors to a 12 volt power supply.
9. Operate trim system, cycle trim rams up and down several times to remove air.
10. Check for leaks.
11. Check fluid level. Add fluid if necessary to bring fluid to 25 mm (1 in.) from top of reservoir neck. Install reservoir cap.
12. Install power trim system in outboard. Refer to **Power Trim System Installation** for instructions.

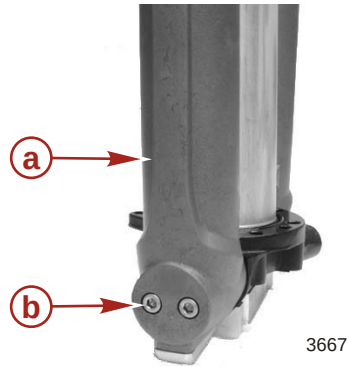
Trim Cylinder and Pivot Pin

Trim Cylinder and Pivot Pin Removal

1. Remove power trim system from outboard. Refer to **Power Trim System Removal** preceding.
2. Drain fluid from the power trim system. Refer to **Power Unit Disassembly** preceding.

DISASSEMBLY

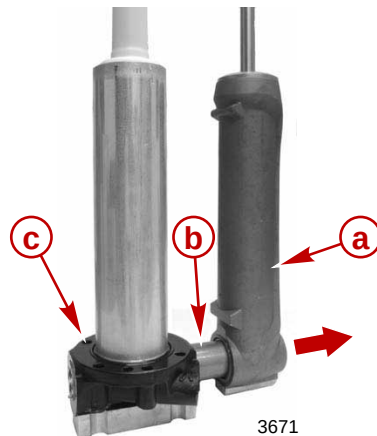
1. Remove two 6 mm internal hex mounting screws securing port trim cylinder to pivot pin.



a - Port trim cylinder

b - Internal hex mounting screws

2. Remove port trim cylinder assembly from pivot pin.
3. Remove pivot pin and starboard trim cylinder from manifold.



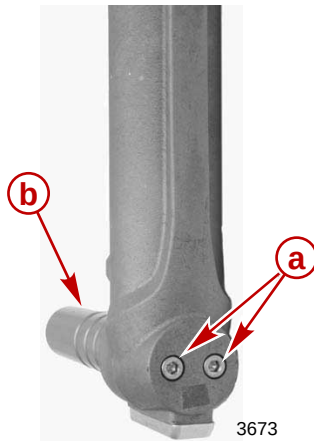
a - Starboard trim cylinder

c - Manifold

b - Pivot pin

4. Remove two 6 mm internal hex mounting screws securing starboard trim cylinder to pivot pin.

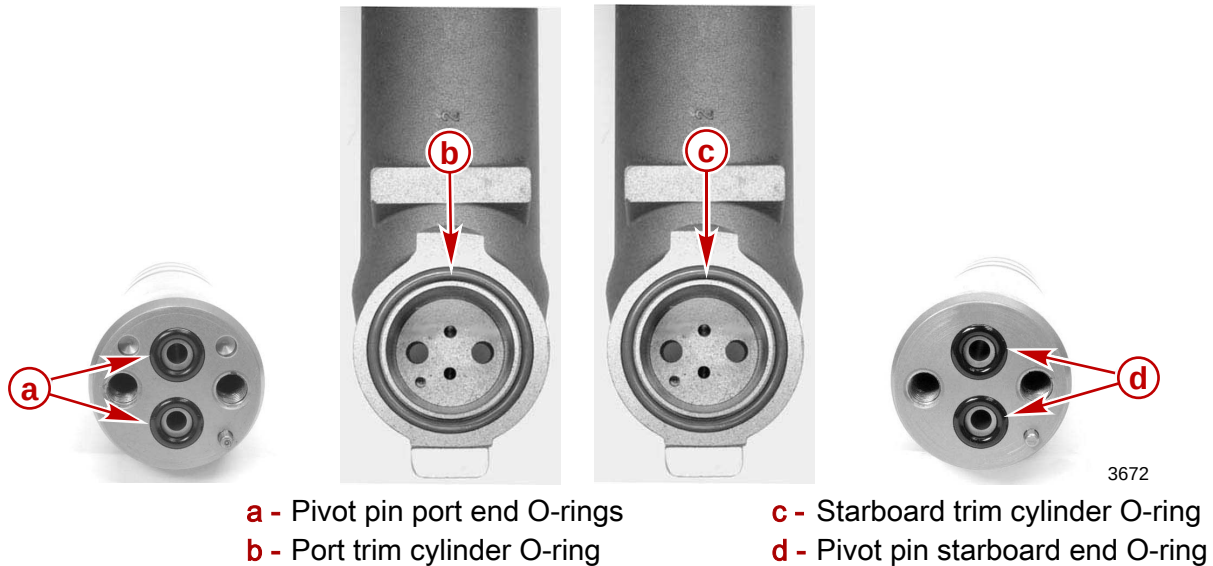
5. Remove starboard trim cylinder assembly from pivot pin.



a - Internal hex mounting screws

b - Pivot pin

6. Remove and discard O-rings from pivot pin and trim cylinders.



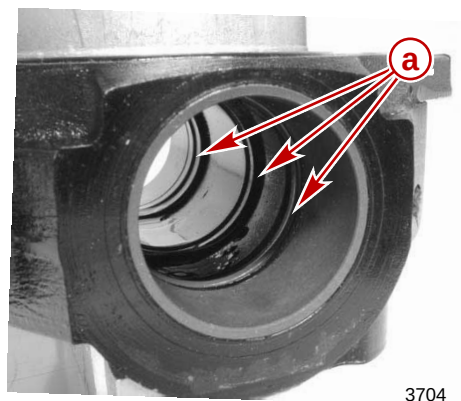
a - Pivot pin port end O-rings

b - Port trim cylinder O-ring

c - Starboard trim cylinder O-ring

d - Pivot pin starboard end O-ring

7. Remove and discard internal O-rings from the pivot pin bore in the manifold.



a - Manifold O-rings (3)

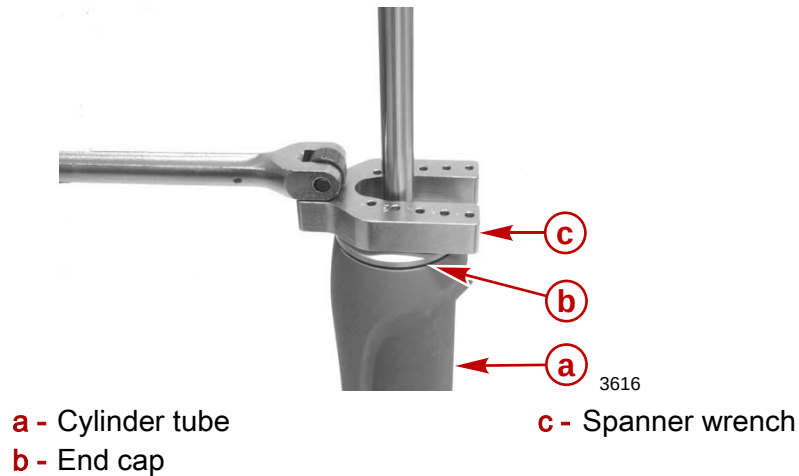
8. Inspect pivot pin for wear.

Trim Cylinder Disassembly

CYLINDER ROD

1. Remove end cap from trim cylinder using spanner wrench.

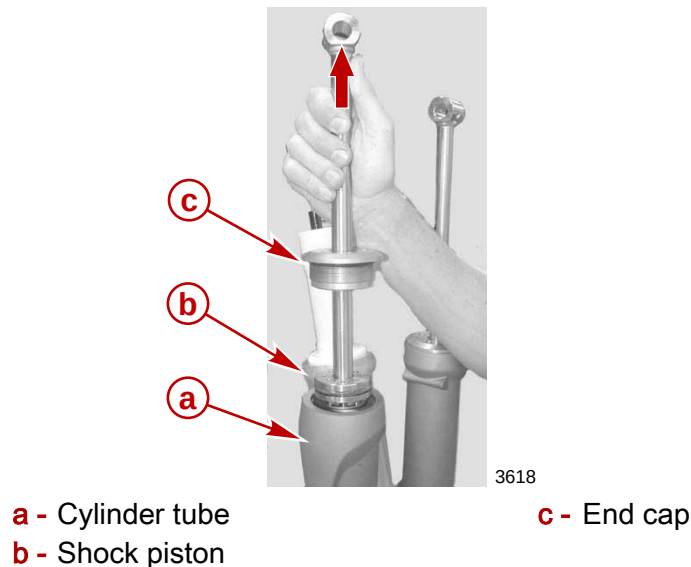
NOTE: Use the 4.57 mm (0.180 in.) diameter pins in the 1.5 in. span position.



Spanner Wrench	91-821709T
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2. Remove cylinder rod and shock piston from cylinder tube.

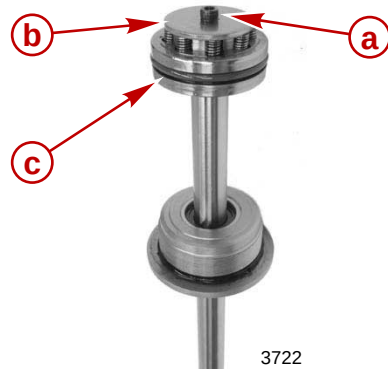
NOTE: Use a suitable tool (drift punch) to open one of the check valves in the shock piston to break the cylinder suction and ease piston removal.



SHOCK PISTON

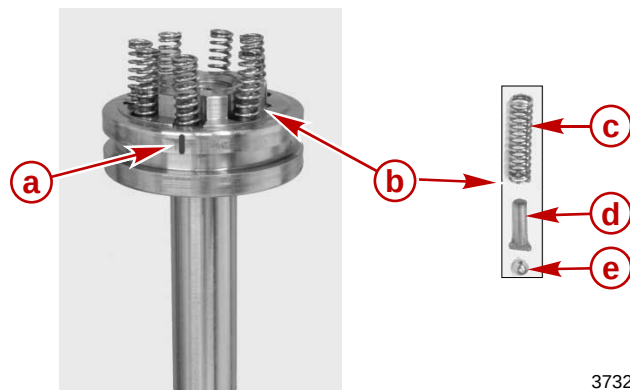
1. Remove and discard O-ring from shock piston.

2. Remove 4 mm internal hex screw securing retaining plate from cylinder rod piston.



- a** - 4 mm internal hex screw
b - Retaining plate
c - O-ring

3. Mark check ball cavity with marker. This is number 1 cavity. Moving in a clockwise direction, the remaining check components are numbered 2 through 7.
4. Remove check ball components from first shock piston cavity. Keep components from each cavity separate from each other and numbered from 1 through 7. Proceed in a clockwise pattern to remove remaining check ball components from each cavity.

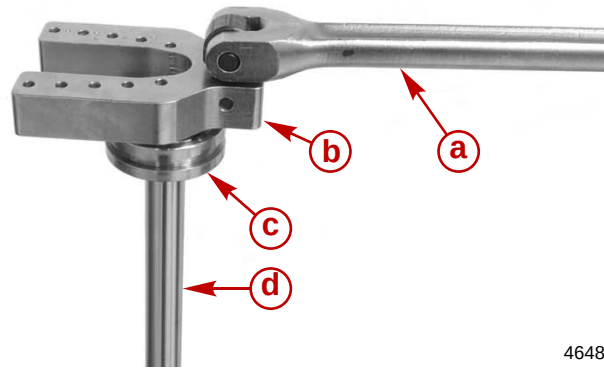


- a** - Mark for number 1 cavity
b - Check ball components
c - Spring
d - Spring guide
e - Ball

5. Place cylinder rod in a soft jawed vise.
6. Loosen shock piston using spanner wrench.

NOTE: Use the large diameter pins, 5.97 mm (0.235 in.), in the 1 in. span position. Pins should be partially pulled out of the spanner to extend approximately 9.5 mm (0.375 in.).

7. Remove piston from rod.



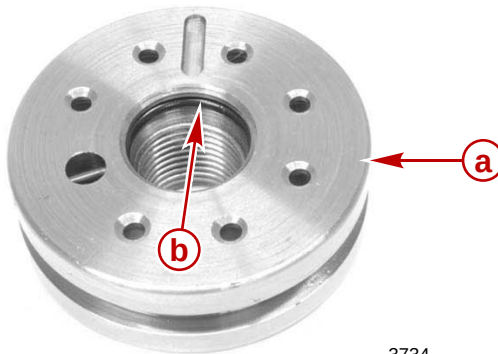
4648

a - Breaker bar
b - Spanner wrench

c - Memory piston
d - Cylinder rod

Spanner Wrench	91-821709T
----------------	------------

8. Inspect check valve cavity and components for contamination. Clean components if contamination is found.
9. Remove inner O-ring from shock piston.



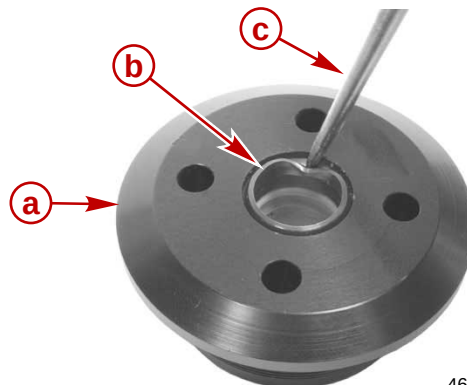
3734

a - Shock piston

b - O-ring

END CAP

1. Remove cylinder end cap from cylinder rod.
2. Inspect end cap. If cylinder rod wiper has failed to keep rod clean, remove wiper.

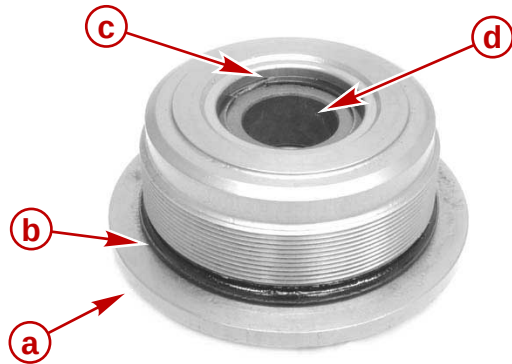


4695

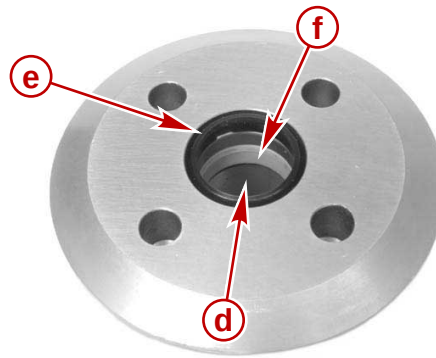
a - Cylinder end cap
b - Cylinder rod wiper

c - Pick tool

3. Place end cap on clean surface.
4. Remove snap ring from end cap.
5. Remove and discard O-ring.



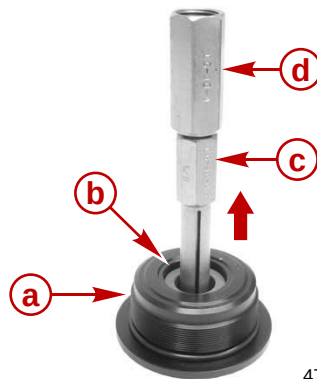
- a** - Cylinder end cap
b - O-ring
c - Snap ring



- d** - Cylinder rod wiper
e - Rod seal
f - Bushing

3735

6. Using collet and expanding rod, remove and discard bushing and rod seal.



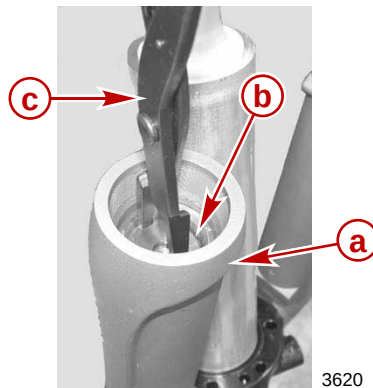
- a** - Trim cylinder end cap
b - Bushing and seal

4706

- c** - Collet (CG-40-A6)
d - Expanding rod (CG-40-4)

MEMORY PISTON

1. Using lock ring pliers, remove memory piston from cylinder tube.



3620

- a** - Cylinder tube
b - Memory piston

- c** - Lock ring pliers

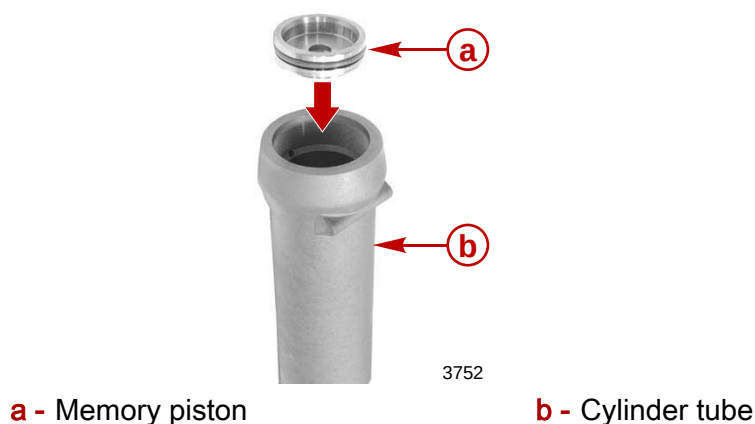
2. Remove and discard O-ring from memory piston.
3. Inspect components for wear and damage. Replace as required.

Trim Cylinder Reassembly

NOTE: Replace all O-rings with new O-rings when reassembling the trim cylinders and pivot pin. Lubricate O-rings with clean Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) (Type Dexron III) prior to installation.

MEMORY PISTON

1. Install new lubricated O-ring on memory piston.
2. Install memory piston into cylinder tube.



Tube Ref No.	Description	Where Used	Part No.
 114	Power Trim and Steering Fluid	Memory piston O-ring	92-802880A1

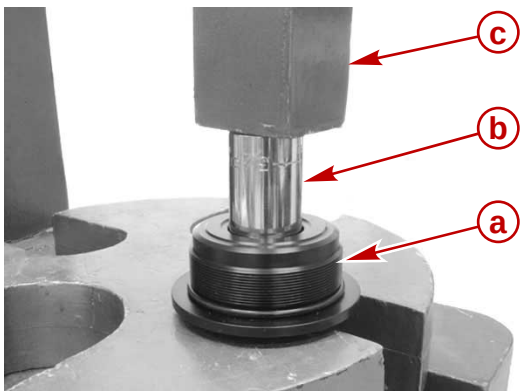
END CAP

1. Install lubricated O-ring on end cap.



2. With O-ring facing up, install rod seal in trim cylinder end cap using arbor press and seal driver.
3. Using seal driver, install trim cylinder end cap bushing.

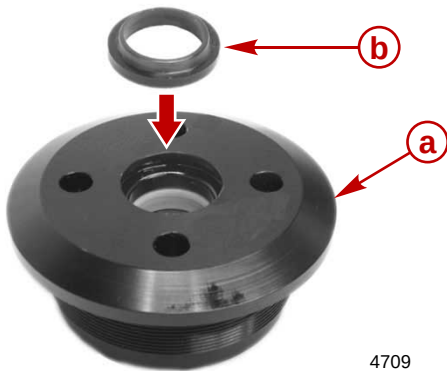
4. Install snap ring.



4708

- a - Trim cylinder end cap
- b - Seal driver
- c - Seal driver

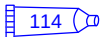
5. Install cylinder rod wiper.



4709

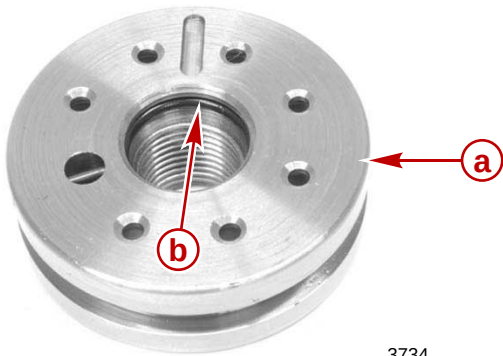
- a - Trim cylinder end cap
- b - Cylinder rod wiper

6. Lubricate rod seal, rod wiper, bushing, threads of end cap and O-ring. Install end cap on cylinder rod.

Tube Ref No.	Description	Where Used	Part No.
 114	Power Trim and Steering Fluid	Rod seal, rod wiper, bushing and O-ring	92-802880A1

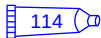
SHOCK PISTON AND CYLINDER ROD

1. Install new lubricated inner O-ring in shock piston.



3734

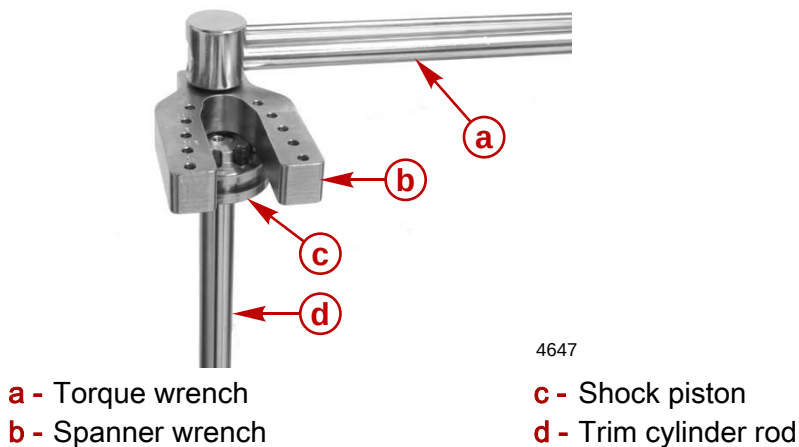
- a - Shock piston
- b - O-ring

Tube Ref No.	Description	Where Used	Part No.
 114	Power Trim and Steering Fluid	Shock piston O-ring	92-802880A1

2. Thread shock piston on cylinder rod. Tighten shock piston to specified torque.

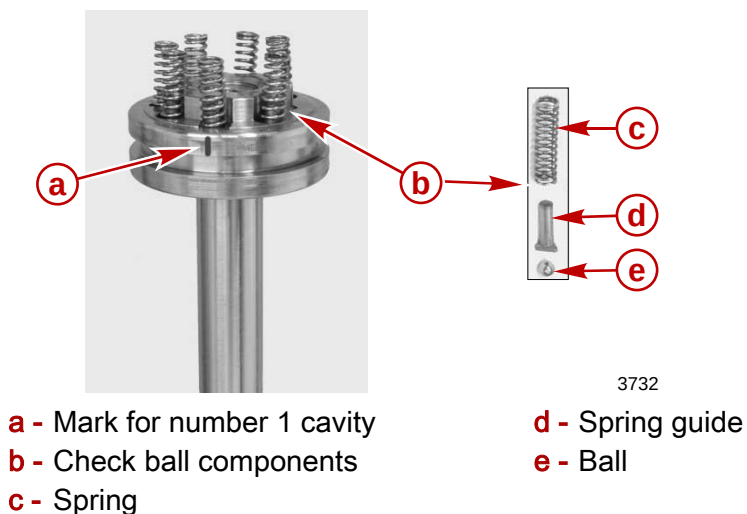
NOTE: Assemble torque wrench and spanner wrench 90 degrees to each other to obtain the most accurate torque reading.

NOTE: Use the large diameter pins, 5.97 mm (0.235 in.), in the 1 in. span position. Pins should be partially pulled out of the spanner to extend approximately 9.5 mm (0.375 in.).



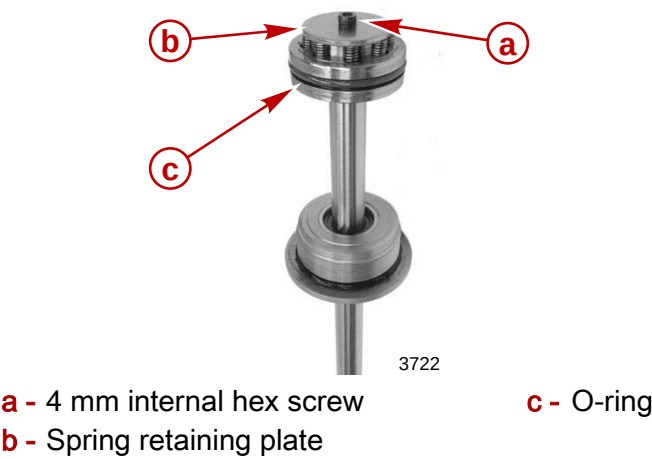
Spanner Wrench	91-821709T		
Description	Nm	lb. in.	lb. ft.
Shock piston	122		90

3. Install retained check ball components in respective cavity. Install number 1 set of spring, spring guide and ball into cavity 1. Repeat in same order as disassembled for sets 2 through 7.



4. Secure check ball spring retaining plate with 4 mm internal hex screw. Tighten to specified torque.

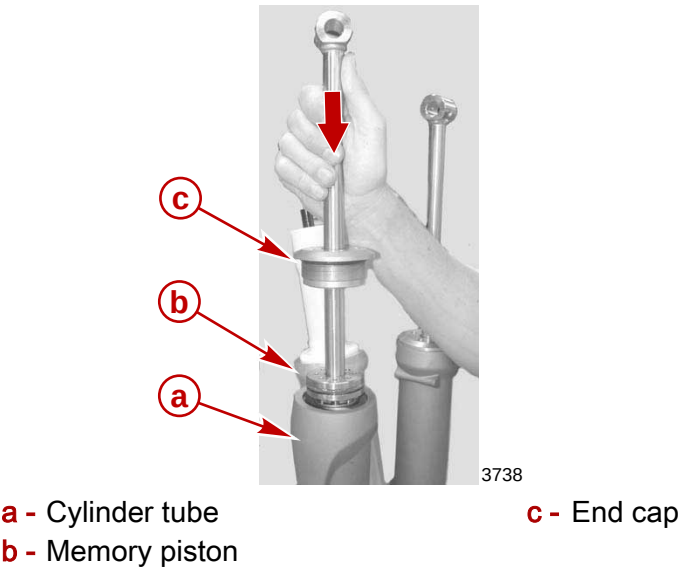
5. Install new lubricated O-ring on shock piston.



Tube Ref No.	Description	Where Used	Part No.
 114	Power Trim and Steering Fluid	Shock piston O-ring	92-802880A1

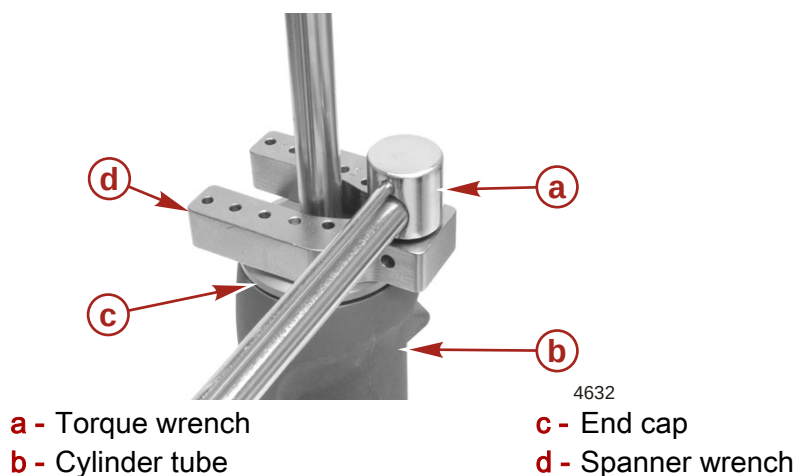
Description	Nm	lb. in.	lb. ft.
Spring retaining plate screw	6.8	60	

6. Install assembled cylinder rod into cylinder tube.



7. Thread end cap into cylinder tube. Tighten end cap to specified torque.
NOTE: Assemble torque wrench and spanner wrench 90 degrees to each other to obtain the most accurate torque reading.

NOTE: Use the 4.57 mm (0.180 in.) diameter pins in the 1.5 in. span position.

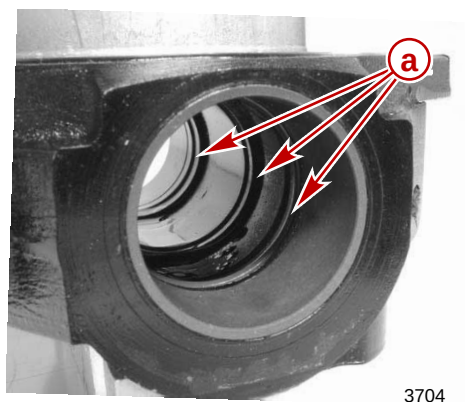


Spanner Wrench	91-821709T		
Description	Nm	lb. in.	lb. ft.
Cylinder end cap	61		45

Trim Cylinder and Pivot Pin Installation

NOTE: Replace all O-rings with new O-rings when reassembling the trim cylinders and pivot pin. Lubricate O-rings with clean Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) (Type Dexron III) prior to installation.

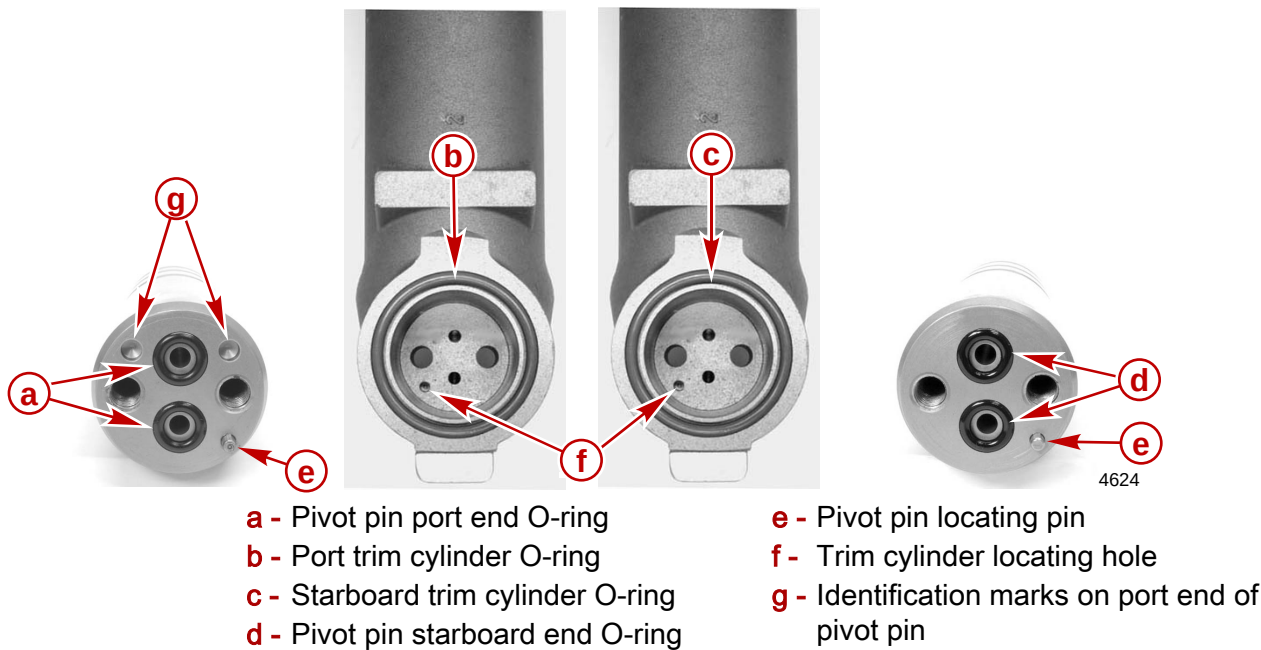
1. Lubricate O-rings and wear bushings inside of manifold.
2. Install lubricated O-rings in the pivot pin bore in the manifold.



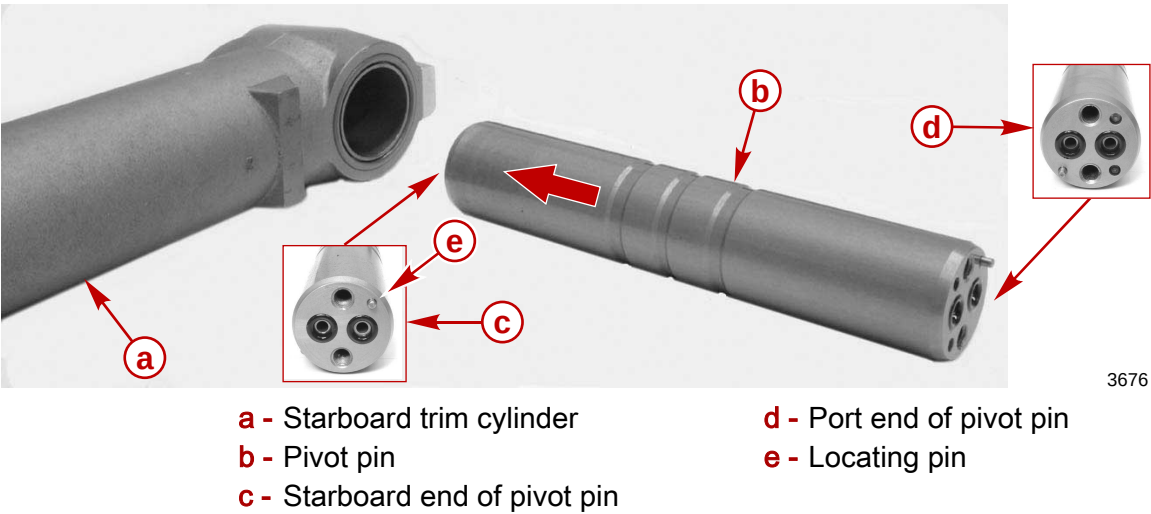
a - Manifold O-rings (3)

Tube Ref No.	Description	Where Used	Part No.
 114	Power Trim and Steering Fluid	Manifold bushings and O-rings	92-802880A1

3. Install lubricated O-rings on pivot pin and trim cylinders.

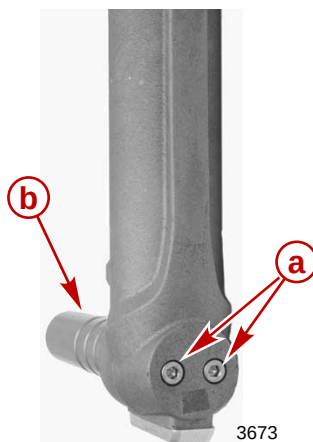


4. Install starboard end of pivot pin into starboard trim cylinder. Ensure that locating pin on end of pivot pin engages hole in trim cylinder.



Tube Ref No.	Description	Where Used	Part No.
 114	Power Trim and Steering Fluid	Pivot pin and trim cylinder O-rings	92-802880A1

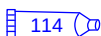
5. Secure starboard trim cylinder to pivot pin with two 6 mm internal hex screws. Tighten screws to specified torque.



a - Starboard trim cylinder mounting screws **b** - Pivot pin

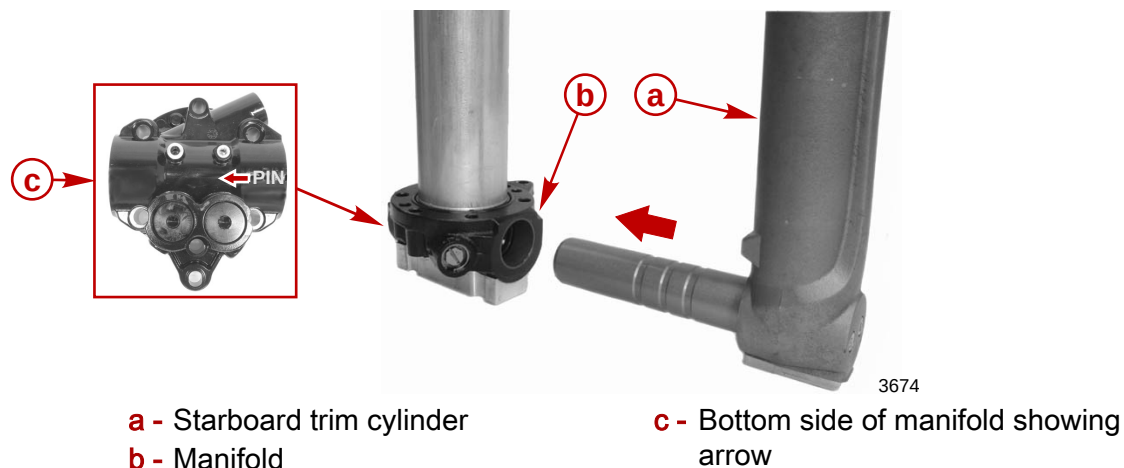
Description	Nm	lb. in.	lb. ft.
Internal hex mounting screws	26		19.2

6. Lubricate O-ring in pivot pin bore in manifold and pivot pin.

Tube Ref No.	Description	Where Used	Part No.
 114	Power Trim and Steering Fluid	Manifold O-rings and pivot pin	92-802880A1

7. Ensure that 3 O-rings are installed in the manifold pivot pin bore.
 8. Install pivot pin and starboard trim cylinder into starboard end of manifold.

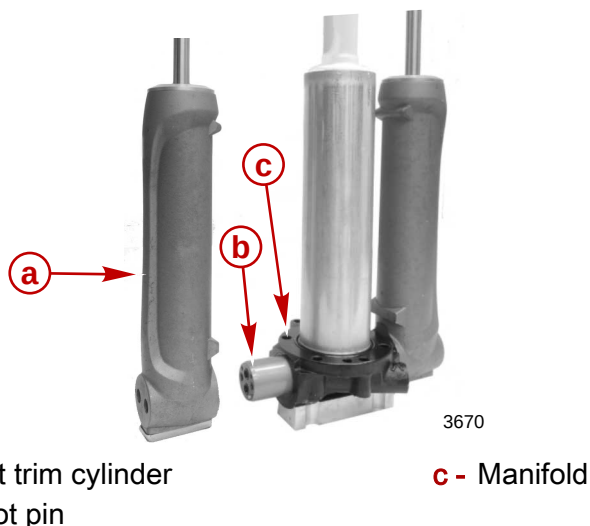
NOTE: Manifold has an arrow indicating direction of pivot pin insertion.



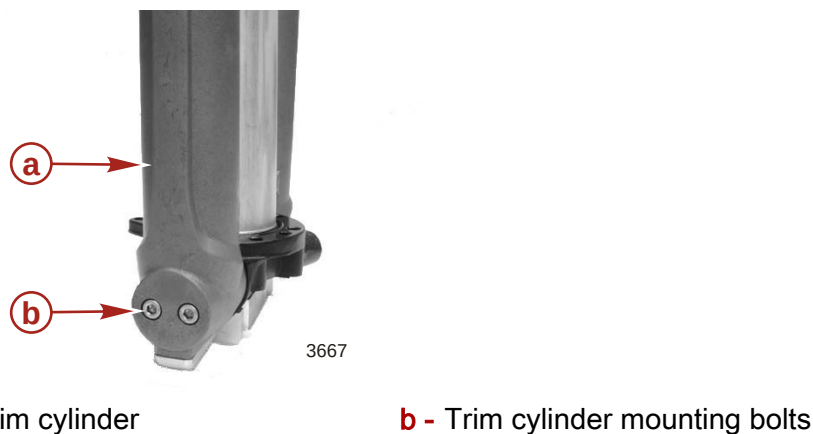
a - Starboard trim cylinder
b - Manifold

c - Bottom side of manifold showing arrow

9. Install port trim cylinder assembly to pivot pin. Ensure that 2 O-rings are in place on port end of pivot pin. Ensure that small pin on end of pivot pin engages hole in trim cylinder.



10. Secure port trim cylinder to pivot pin with two 6 mm internal hex bolts. Tighten bolts to specified torque.



Description	Nm	lb. in.	lb. ft.
Trim cylinder mounting bolt	26		19.2

11. Fill power trim system with Power Trim and Steering Fluid or Dexron III Automatic Transmission Fluid. Refer to **Power Unit Reassembly, Filling and Purging System** for instructions.

SYSTEM INSTALLATION

Install power trim system in outboard. Refer to **Power Trim System Installation** for instructions.

Pressure Operated Check Manifold

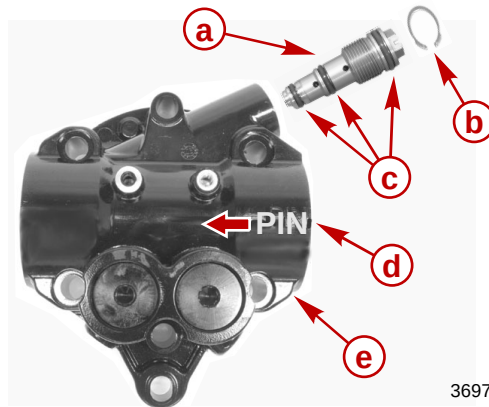
Manifold Disassembly

REMOVING AND DRAINING THE POWER TRIM SYSTEM

1. Remove power trim system from outboard. Refer to **Power Trim System Removal**.
2. Drain fluid from the power trim system. Refer to **Power Unit Disassembly**.

MANUAL RELEASE VALVE

1. Remove manual release snap ring from manifold.
2. Remove manual release valve from manifold.
3. Discard 3 O-rings from manual release valve.



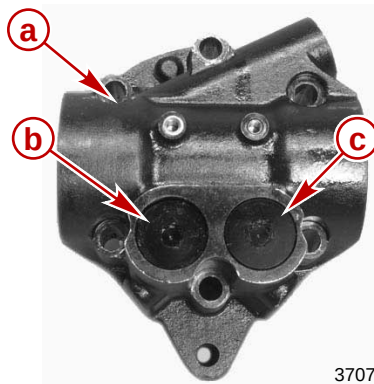
a - Manual release valve
b - Snap ring
c - O-rings

d - Pivot pin insertion direction
e - Manifold

4. Inspect components for wear and contamination. Replace if required.

PRESSURE OPERATED CHECK VALVE

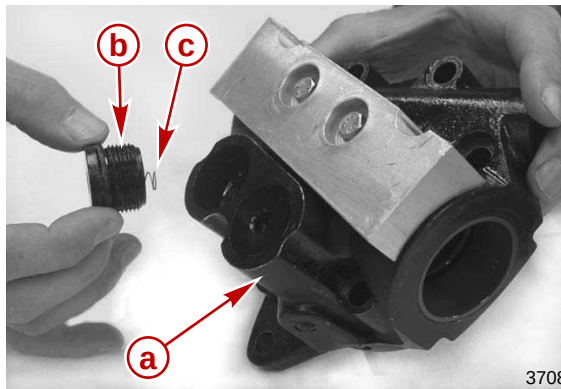
1. Remove plugs (5/16 in. internal hex) from pressure operated check valve manifold.



a - Manifold
b - Plug - trim up check valve assembly

c - Plug - trim down check valve assembly

2. Remove plug and spring.

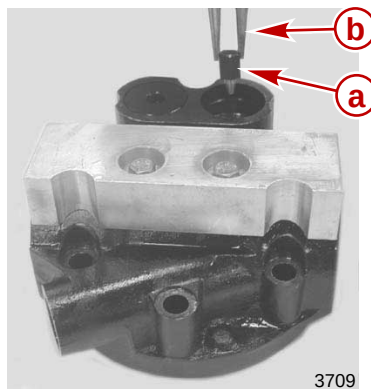


a - Manifold

b - Plug

c - Spring

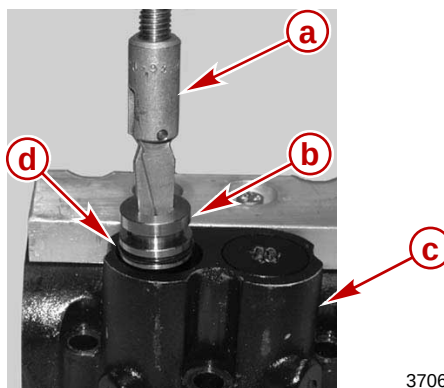
3. Using a needle nose pliers, remove poppet.



a - Poppet

b - Needle nose pliers

4. Remove the hex check seat. Remove and discard O-ring.



a - Check seat removal tool (Snap-On
p/n CJ-93-4)

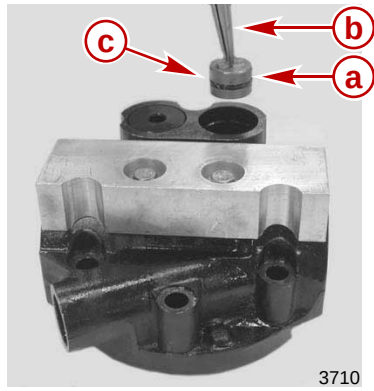
b - Check valve

3706

c - Manifold

d - O-ring

5. Remove shuttle spool from manifold. Remove and discard O-ring.



a - Shuttle spool
b - Needle nose pliers

c - O-ring

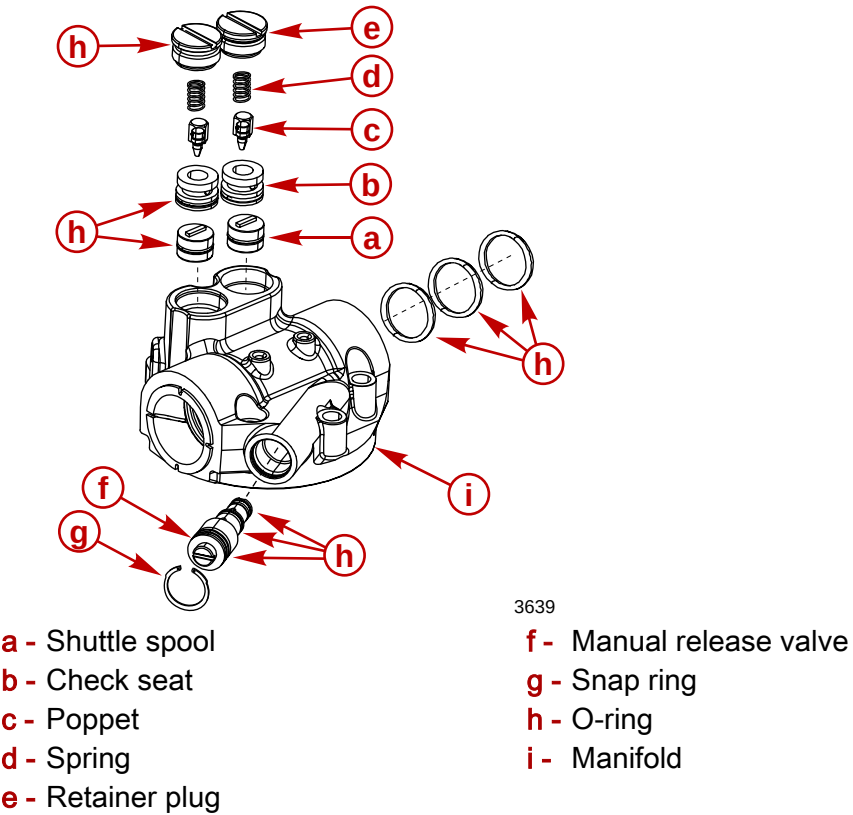
6. Inspect components for wear and contamination. Replace if required.

Manifold Reassembly

NOTE: Replace all O-rings with new O-rings when reassembling the manifold pressure operated check components. Lubricate O-rings with clean Power Trim and Steering Fluid or Automatic Transmission Fluid (ATF) (Type Dexron III) prior to installation.

1. Place lubricated shuttle spool in each pressure operated check cavity.
2. Position shuttle spool into place with needle nose pliers.
3. Place lubricated check seat in each cavity.
4. Press check seats into place using Snap-On check seat tool (CJ-93-4).
5. Place poppet in each cavity.
6. Dip end of each spring into petroleum jelly and place in counterbore of retainer plug.
7. Install retainer plug and spring in each cavity.

8. Tighten retainer plug to specified torque.



Description	Nm	lb. in.	lb. ft.
Retainer plug	40.7		30

9. Fill power trim system with Power Trim and Steering Fluid or Dexron III Automatic Transmission Fluid. Refer to **Power Unit Reassembly, Filling and Purging System** for instructions.

SYSTEM INSTALLATION

Install power trim system in outboard. Refer to **Power Trim System Installation** for instructions.

Lower Unit

Section 6A - Right Hand Rotation

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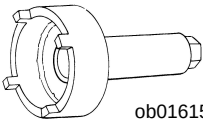
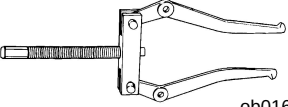
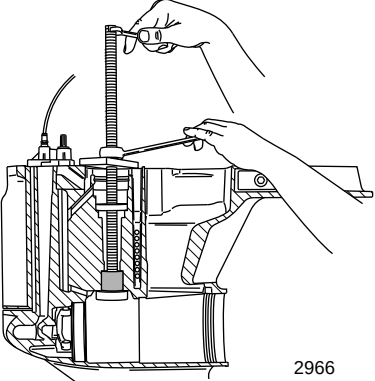
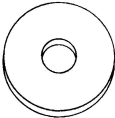
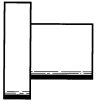
Gear Housing Specifications (Standard Rotation)

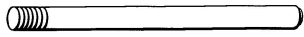
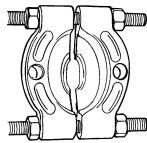
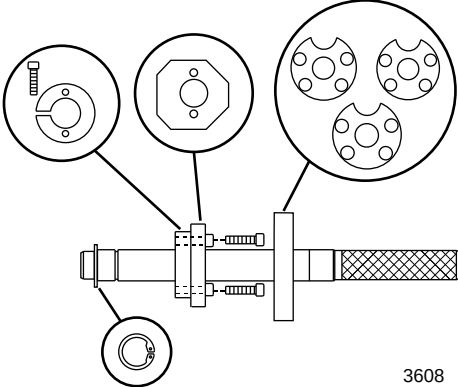
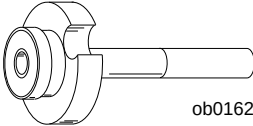
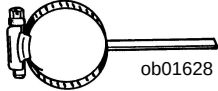
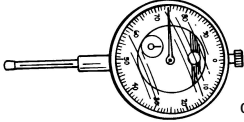
Gear Housing Specifications (Standard Rotation)	
Gear Ratio	1.85:1 (13/24 Teeth)
Gearcase Capacity	970 ml (32.8 fl.oz.)
Gear Lubricant Type	Premium Gear Lubricant
Pinion Height	0.635 mm (0.025 in.)
Forward Gear Backlash	0.482 - 0.660 mm (0.019 - 0.026 in.)
Reverse Gear Backlash	1.27 - 1.47 mm (0.050 - 0.058 in.)
Water Pressure @ RPM	55 - 68.9 kPa (8 - 10 psi)
Gear Housing Pressure (without gear lubricant, 5 minutes without leakage)	103.4 kPa (15 psi)

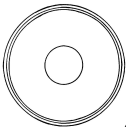
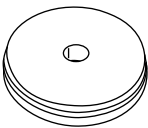
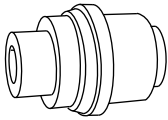
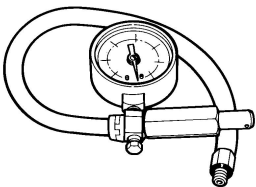
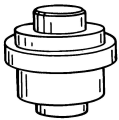
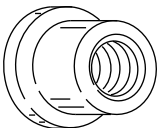
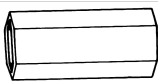
Lubricant, Sealant, Adhesives

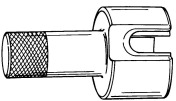
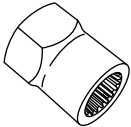
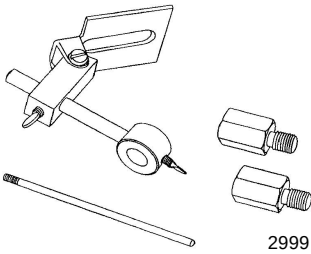
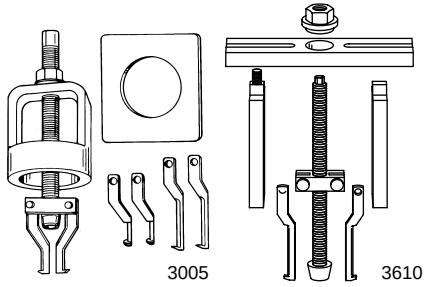
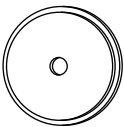
Tube Ref No.	Description	Where Used	Part No.
	Loctite 271 Threadlocker	Pinion gear nut threads	92-809819
		Threads of pinion nut	
	Perfect Seal	Speedometer connector threads	92-34227-1
	Premium Gear Lubricant	Tapered bearing race bore	92-802846A1
		Bearing bore in carrier	
		Inside diameter of driveshaft tapered bearing	
		Inside diameter of forward gear	
		Pinion bearing bore	
		Forward gear bearing cup bore	
		Outside diameter of pinion bearing	
	2-4-C Marine Lubricant with Teflon	Gear housing	92-802859A1
		Oil seal lips and between oil seals	
		Oil seal lips and between oil seals	
		Bearing carrier O-ring	
		Seat of shift shaft bushing O-ring diameter and lip of oil seal	
		O-ring	
		Pinion needle bearings	
		Retainer threads	
		Bearing carrier retainer nut threads and corresponding gear housing threads, bearing carrier O-ring, upper driveshaft bearing retainer threads	
		Carrier O-ring, forward and aft outer diameters of bearing carrier, gearcase area where carrier will seat, space between carrier seals	
		Bearing carrier retainer nut threads and corresponding gear housing threads	
		Oil seal carrier seal lips, space between oil seals and O-ring	
		Flat surface of the impeller key	
		Inside of water pump cover	
		Driveshaft splines; shift shaft splines	
	Loctite 380	Outer diameter of oil seals	Obtain Locally
		Outer diameter of bearing carrier oil seal	

Special Tools - Standard Rotation Gearcase

Bearing Carrier Retainer Nut Wrench	91-61069T
 ob01615	Installs and removes the bearing carrier retainer nuts.
Puller Jaws Assembly Puller Bolt	91-46086A1 91-85716
 ob01616	Removes bearing carrier and bearing races.
Slide Hammer Puller	91-34569A1
 ob01617	Removes bearings and bearing races.
Bearing Removal and Installation Kit	91-31229A7
 2966	Installs and removes the bearings in all gearcases. 91-31229A7 tool assembly includes the following components: 11-24156 Hex Nut 12-34961 Washer 91-15755T Bearing Carrier 91-29310 Plate 91-29610 Pilot Plate 91-30366T1 Mandrel 91-31229 Puller Shaft 91-32325T Driver Head 91-32336 Driver Needle Bearing 91-36379 Puller/Head Gear 91-36569T Driver Head 91-36571T Pilot Washer 91-37292 Roller Bearing 91-37311 Driver Head 91-37312 -Driver Head 91-37323 Driver Head Rod 91-37324 Pilot Washer 91-38628T Puller/Driver Head 91-52393 Driver Needle Bearing 91-52394 Head Pull Rod
Pilot Washer	91-36571T
 ob01619	Used in pinion gear and pinion bearing installation.
Puller/Driver Head	91-38628
 ob01622	Used in pinion gear and pinion bearing installation.

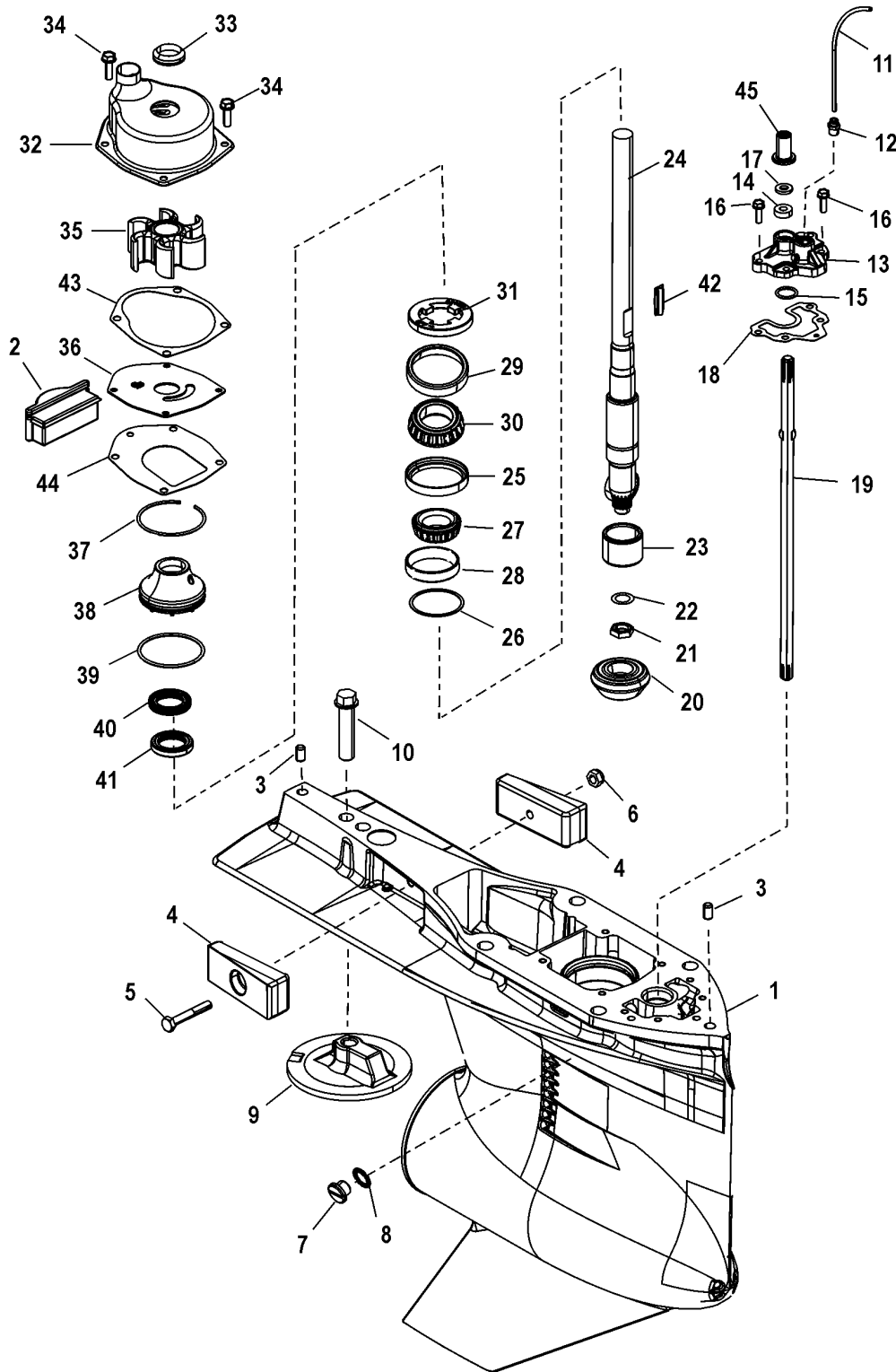
Driver Rod	91-37323
 ob01623	Used in pinion gear and pinion bearing installation.
Universal Puller Plate	91-37241
 ob01624	Removes bearings from gears and the driveshaft.
Pinion Gear Locating Tool	91-12349A05
 3608	Measures pinion gear height.
Pinion Gear Locating Tool	91-56048001
 ob01627	Measures pinion gear height.
Backlash Indicator Rod	91-78473 for (1.86:1 ratio)
 ob01628	Used to check gear backlash
Dial Indicator	91-58222A1
 ob01629	Measures gear backlash and pinion gear location.
Driveshaft Bearing Retainer Wrench	91-43506T
 ob01630	Removes and installs the threaded bearing retainer.

Dial Indicator Holding Tool	91-89897
 ob01631	Secures the dial indicator to gear housing when checking backlash.
Bearing Cup Driver	91-885592T
 ob01625	Installs reverse gear bearing cup.
Seal Driver Guide	91-889845
 ob01670	Aids in the installation of bearing carrier seals.
Bearing Cup Driver/Oil Seal Installer Tool	91-888414T
 6229	Installs bearing carrier cup and seals.
Leakage Tester Kit	FT8950
 ob01632	Checks gear housing for leakage prior to filling with gear lubricant.
Oil Seal Driver	91-889844T
 ob01633	Installs seals in driveshaft seal carrier.
Driver Head	91-36569T
 ob01634	Used in pinion gear and bearing installation.
Propeller Shaft Adapter	91-61077
 ob01635	Used to hold propeller shaft

Pinion Nut Wrench	91-61067003
 ob01639	Holds the pinion nut when removing the pinion gear and driveshaft.
Driveshaft Holding Tool	91-889958T
 ob01206	Holds driveshaft during pinion nut removal on the Verado models.
Dial Indicator Adaptor	91-83155
 2999	Attaches the dial indicator to the gearcase when checking backlash.
Bearing Puller Assembly	91-83165T
 3005 3610	Removes bearings, races and bearing carriers
Guide Plate	91-816243
 4481	Centers the rod used to drive in the forward gear bearing on a standard rotation gearcase, and the reverse gear bearing on a counter rotation gearcase.
Oil Drain Funnel	91-892866A01
 4993	Diverts draining engine oil from contacting the anti-splash and anti-cavitation plates.

Notes:

Gear Housing (Driveshaft)



2380

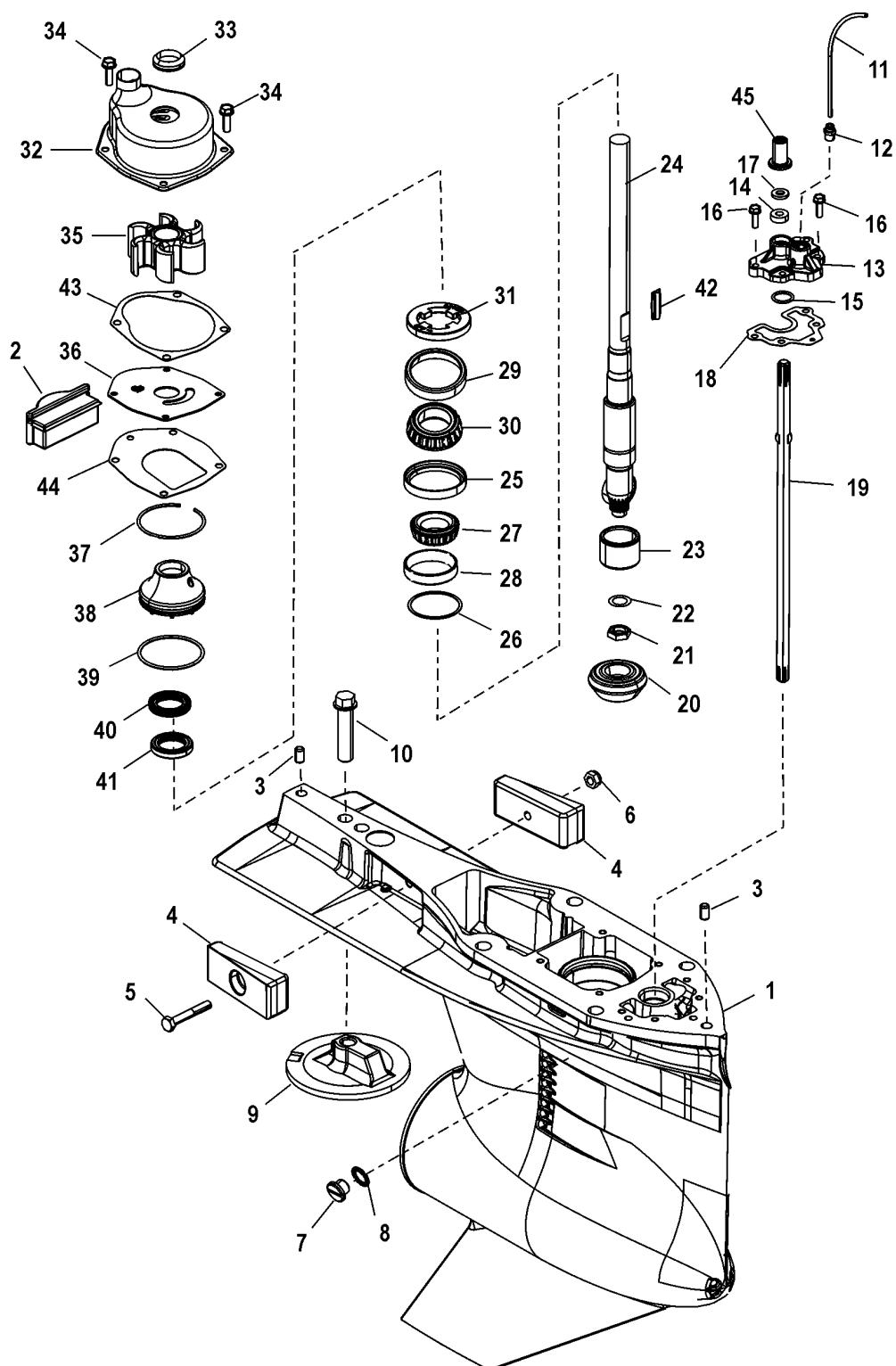
Gear Housing (Driveshaft)

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Gear housing			
2	1	Filler block			
3	2	Dowl pin			
4	2	Anode			
5	1	Screw (M6 X 40)			
6	1	Nut			
7	1	Screw	6.7	60	
8	1	Seal			
9	1	Anodic plate			
10	1	Screw (0.437-14 x 1-3/4 in)	54		40
11	1	Hose 17.7 cm (7 in.) (Long)			
		Hose 30.5 cm (12 in.) (X-long)			
		Hose 43.2 cm (17 in.) (XX-Long)			
12	1	Fitting	2.8	25	
13	1	Cover assembly			
14	1	Oil seal			
15	1	O-ring			
16	4	Screw (M6 x 20)	6.7	60	
17	1	Washer			
18	1	Gasket			
19	1	Shift shaft - Lower			
20	1	Pinion gear (13 Teeth)			
21	1	Nut (5/8-18)	101		75
22	1	Washer			
23	1	Roller bearing			
24	1	Driveshaft (Long)			
		Driveshaft (X-Long)			
		Driveshaft (XX-Long)			
25	1	Shim/Bearing assembly			
26	AR	Shim (0.002 through 0.050)			
27	1	Roller bearing assembly			
28	1	Cup			
29	1	Roller bearing assembly			
30	1	Cup			
31	1	Retainer	135.5		100
32	1	Housing - Water pump			
33	1	Face seal			
34	4	Screw (M6 x 20)	6.7	60	
35	1	Impeller			
36	1	Face plate			

Right Hand Rotation

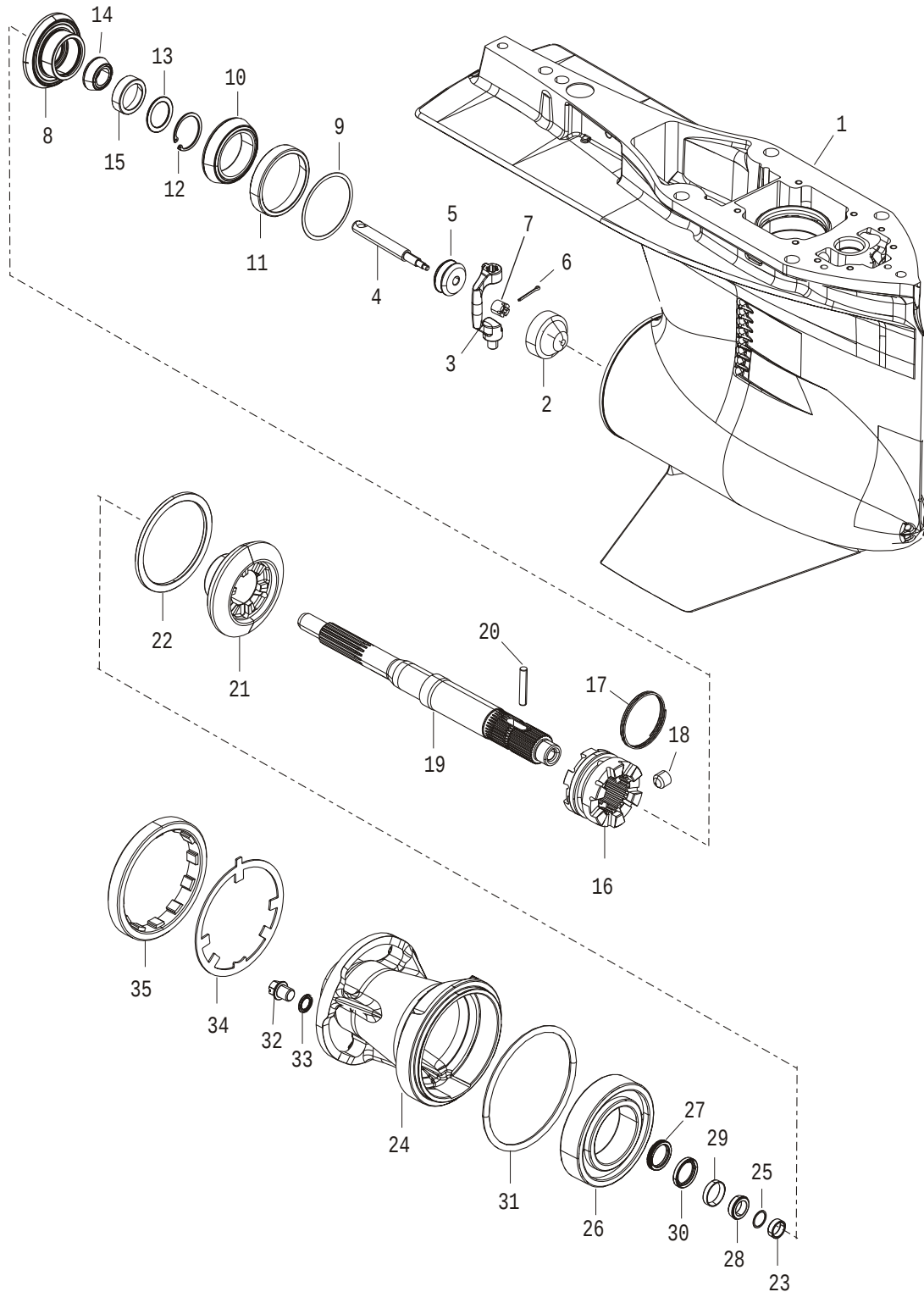
Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
37	1	Retaining ring			
38	1	Oil seal carrier			
39	1	O-ring			
40	1	Oil seal			
41	1	Oil seal			
42	1	Key			
43	1	Gasket			
44	1	Gasket			
45	1	Coupling			

Gear Housing (Driveshaft)



2380

Gear Housing (Prop Shaft) (Standard Rotation)



2388

Gear Housing (Prop Shaft) (Standard Rotation)

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Gear housing			
2	1	Plug	135		100
3	1	Crank - shifter			
4	1	Shaft - shift spool			
5	1	Spool			
6	1	Cotter pin			
7	1	Sleeve - adjusting			
8	1	Forward gear			
9	AR	Shim (0.002 through 0.050 in.)			
10	1	Roller bearing			
11	1	Cup			
12	1	Retaining ring			
13	1	Thrust washer			
14	1	Roller bearing assembly			
15	1	Cup			
16	1	Clutch			
17	1	Spring			
18	1	Detent pin			
19	1	Prop shaft			
20	1	Cross pin			
21	1	Reverse gear			
22	1	Thrust ring			
23	1	Spacer			
24	1	Bearing carrier			
25	AR	Shim (0.002 through 0.070 in.)			
26	1	Ball bearing			
27	1	Oil seal			
28	1	Roller bearing			
29	1	Cup			
30	1	Oil seal			
31	1	O-ring			
32	1	Screw	8.5	60	
33	1	Seal			
34	1	Keyed washer			
35	1	Retainer - bearing	285 ^{1.}		210 ^{1.}

1. Torque retainer to 135.5 Nm (100 lb. ft.) then check rolling torque on propeller shaft. If torque is within specification, torque retainer to 285 Nm (210 lb. ft.)

General Service Recommendations

There may be more than one way to disassemble or reassemble a particular part, therefore, it is recommended that the entire procedure be read prior to repair.

IMPORTANT: Read the following before attempting any repairs.

In many cases, disassembly of a sub-assembly may not be necessary, until cleaning and inspection reveals that disassembly is required for replacement of one or more components.

Service procedure order in this section is a normal disassembly/reassembly sequence. It is suggested that the sequence be followed without deviation to assure proper repairs. When performing partial repairs, follow the instructions to the point where the desired component can be replaced, then proceed to reassembly and installation of that component in the reassembly part of this section. Use the **Table of Contents** (on back of section divider) to find correct page number.

Threaded parts are right hand (RH), unless otherwise indicated.

When holding, pressing or driving is required, use soft metal vise jaw protectors or wood for protection of parts. Use a suitable mandrel (one that will contact only the bearing race) when pressing or driving bearings.

Whenever compressed air is used to dry a part, verify that no water is present in air line.

Bearings

Upon disassembly of gear housing, all bearings must be cleaned and inspected. Clean bearings with solvent and dry with compressed air. Air should be directed at the bearing so that it passes through the bearing. Do not spin bearing with compressed air, as this may cause bearing to score from lack of lubrication. After cleaning, lubricate bearings with Premium Gear Lubricant. Do not lubricate tapered bearing cups until after inspection.

Inspect all bearings for roughness, catches and bearing race side wear. Work inner bearing race in and out, while holding outer race, to check for side wear.

When inspecting tapered bearings, determine condition of rollers and inner bearing race by inspecting bearing cup for pitting, scoring, grooves, uneven wear, imbedded particles and/or discoloration from overheating. Always replace tapered bearing and race as a set. Inspect gear housing for bearing races that have spun in their respective bores. If race has spun, gear housing must be replaced.

Roller bearing condition is determined by inspecting the bearing surface of the shaft that the roller bearing supports. Check shaft surface for pitting, scoring, grooving, imbedded particles, uneven wear and/or discoloration from overheating. The shaft and bearing must be replaced, if the conditions described are found.

Shims

Keep a record of all shim amounts and location during disassembly to aid in reassembly. Be sure to follow shimming instructions during reassembly, as gears must be installed to correct depth and have the correct amount of backlash to avoid noisy operation and premature gear failure.

Seals

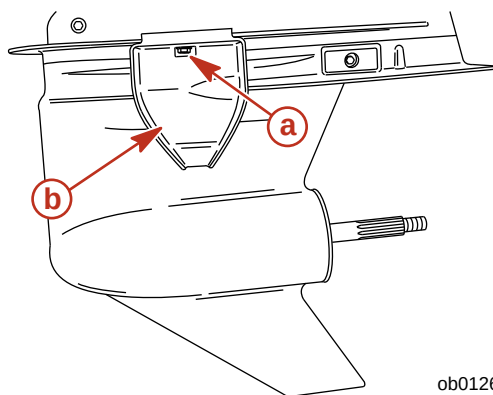
As a normal procedure, all O-rings and oil seals should be replaced without regard to appearance. To prevent leakage around oil seals, apply Loctite 271 to outer diameter of all metal case oil seals. When using Loctite on seals or threads, surfaces must be clean and dry. To ease installation, apply 2-4-C with Teflon on all O-rings. To prevent wear, apply 2-4-C with Teflon on I.D. of oil seals.

Gearcase Removal

⚠ WARNING

To prevent accidental engine starting, remove battery cables from battery before removing or installing gear housing.

1. Verify position of shift switch. Gearcase must be in same position when reinstalling gearcase to driveshaft housing.
2. Drain engine oil pan of oil. Failure to drain oil prior to removing gearcase will result in approximately 0.9463 liter (1 qt.) of oil leakage when gearcase is removed.



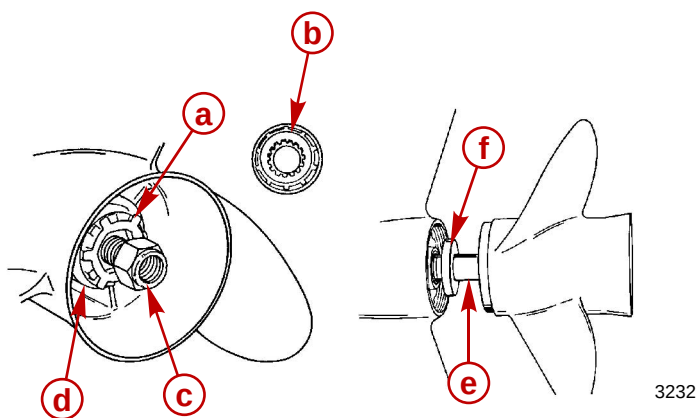
ob01264

a - Drain plug/seal washer

b - Oil drain funnel

Oil Drain Funnel	91-892866A01
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3. Tilt outboard to trailer full up position and engage tilt lock lever.
4. Bend tabs of propeller tab washer away from thrust hub (rear), then remove propeller locknut, tab washer, thrust hub (rear), propeller and thrust hub (forward) from propeller shaft.



a - Tab washer

b - Continuity washer (if equipped)

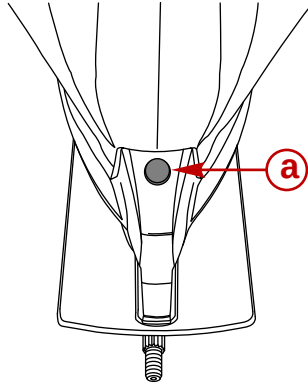
c - Propeller nut

d - Thrust hub (rear)

e - Propeller shaft

f - Thrust hub (forward)

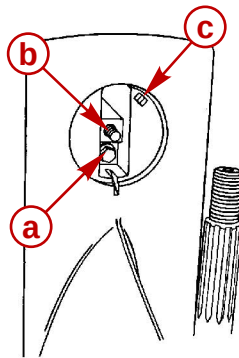
5. Remove rubber plug at rear edge of driveshaft housing. Remove bolt (13 mm) that secures anodic plate and remove plate from gear housing.



ob01533

a - Rubber plug

6. Once plate is removed, remove bolt (14 mm) from inside of cavity.



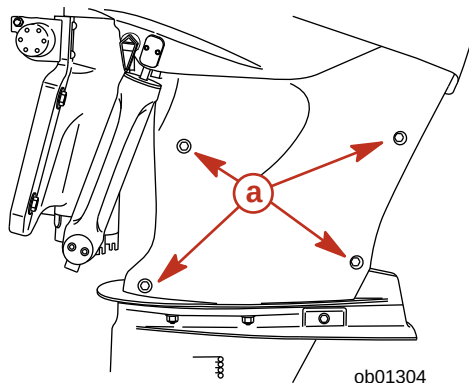
3233

a - Screw (inside cavity)

c - Ribs

b - Screw (secures anodic plate)

7. Remove screws (4 or 6 for XXL shaft) securing port chap to driveshaft housing and remove chap.

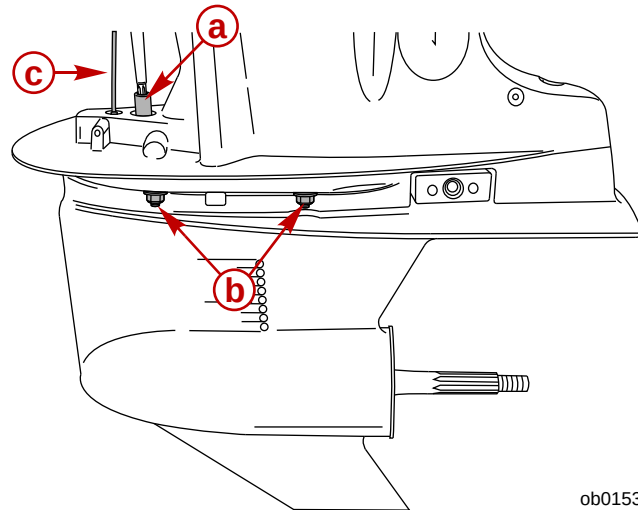


ob01304

a - Driveshaft housing chap screws (4 or 6 for XXL shaft)

8. While pressing in on speedometer hose junction, pull out on hose to disconnect.
9. Loosen the side mounting locknuts. Do not attempt to remove one nut before opposite side is loosened sufficiently, or gear housing could be damaged

10. Pull gear housing away from driveshaft housing as far as the loosened nuts (in Step 8) will allow, then remove loosened nuts. Do not allow gear housing to fall, as it now is free.



ob01535

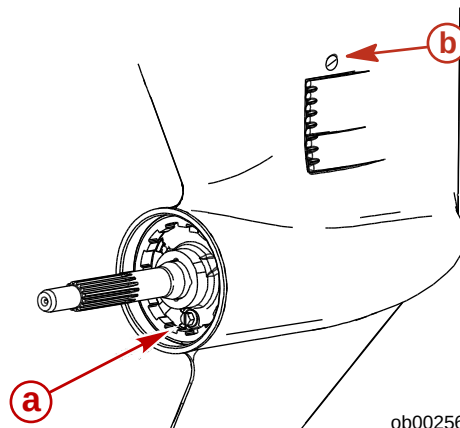
a - Shift shaft coupler**b** - Nuts and washers (2 each side)**c** - Speedometer hose

11. Pull gear housing from driveshaft housing.

Gearcase Serviceability Inspection

Draining and Inspecting Gear Housing Lubricant

1. Place gear housing in a suitable holding fixture or vise with the driveshaft in a vertical position.
2. Position a clean drain pan under gear housing and remove fill and vent screws from gear housing with a 10 mm socket or slot screw driver.



ob00256

a - Fill screw**b** - Vent screw

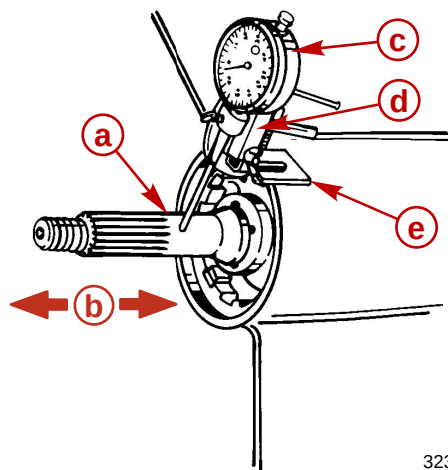
3. Inspect gear lubricant for metal particles. Presence of a small amount of fine metal particles (resembling powder) indicates normal wear. Presence of larger particles (or a large quantity of fine particles) indicates need for gear housing disassembly, and component inspection.
4. Note the color of gear lubricant. White or cream color indicates presence of water in lubricant. Check drain pan for water separation from lubricant. Presence of water in gear lubricant indicates the need for disassembly, and inspection of oil seals, seal surfaces, O-rings and gear housing components.

NOTE: Gear lubricant drained from a recently run gearcase will be a light chocolate brown in color due to agitation/aeration. Oil which is stabilized will be a clear yellow brown in color.

Propeller Shaft Inspection

Check for a bent propeller shaft as follows:

1. Rotate the propeller shaft while observing the dial indicator. If the deflection is more than 0.23 mm (0.009 in.), a bent propeller shaft is indicated.
2. Check for propeller shaft endplay. There should be no endplay. If endplay exists, excessive wear has occurred and gearcase must be disassembled for inspection.



3234

a - Propeller shaft runout
b - Propeller shaft endplay
c - Dial Indicator

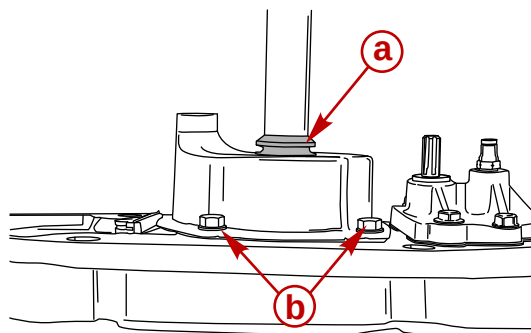
d - Dial Indicator Holding Tool
e - Dial Indicator Adapter

Dial Indicator	91-58222A1
Dial Indicator Adapter	91-83155
Dial Indicator Holding Tool	91-89897

Water Pump

Removal And Disassembly

1. Remove the water seal and water pump screws.

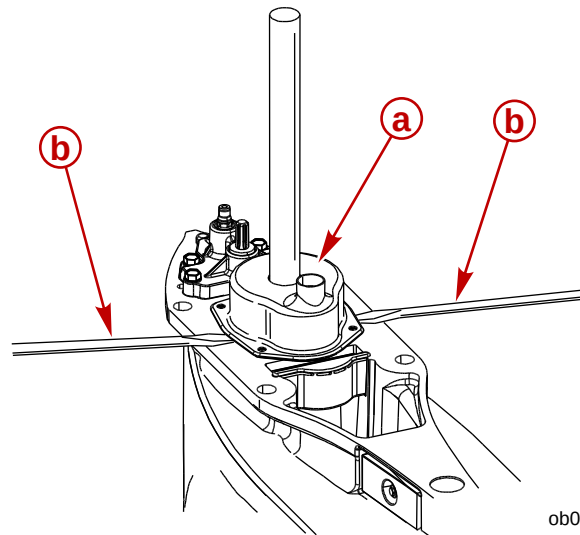


ob01614

a - Water seal

b - Screws (2 each side)

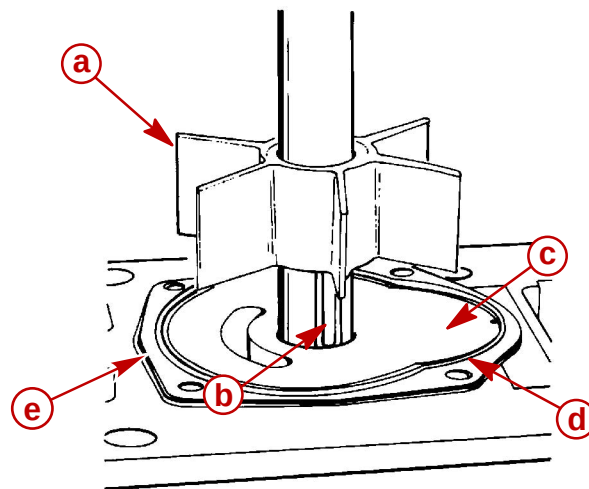
- Carefully slide the water pump straight up off of the driveshaft. It may be necessary to encourage the water pump up by gently prying up on its mounting flanges with screwdrivers.



ob00258

a - Water pump body**b** - Screwdrivers

- Remove the impeller, impeller key, face plate, pump cover gasket and pump base gasket.



4512

a - Impeller**b** - Key**c** - Face plate**d** - Pump cover gasket (gray bead faces up)**e** - Pump cover base gasket

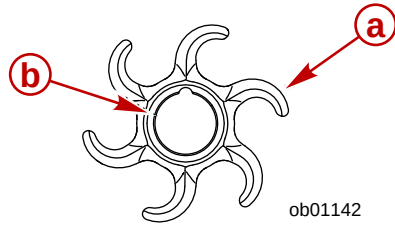
Cleaning and Inspection

NOTE: With the gearcase removed, inspect the water tube coupling assembly inside the driveshaft housing for wear or damage. If necessary replace the worn or damaged components as required.

IMPORTANT: The circular groove formed by the impeller sealing bead should be disregarded when inspecting liner and plate. The depth of the groove will not affect water pump output.

- Inspect face plate and water pump liner for grooves and/or rough surfaces.
- Inspect impeller side seal surfaces and ends of impeller blades for cracks, tears and wear. Replace impeller if any of these conditions are found.

3. Inspect impeller bonding to impeller hub.



a - Impeller

b - Hub

4. Inspect impeller for glazed or melted appearance (caused by operation without sufficient water supply). Replace impeller if any of these conditions exist.

IMPORTANT: When completing gear housing repairs that require removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary, however, to re-use impeller, do not install in reverse to original rotation, or premature impeller failure will occur.

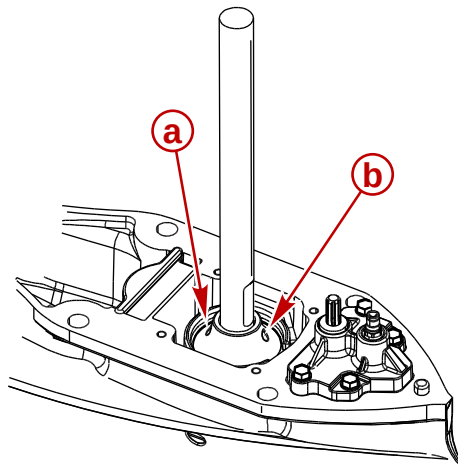
IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

Oil Seal Carrier Assembly

Removal

NOTE: Pushing down on the seal carrier may aid in the removal of the retaining ring above the seal carrier.

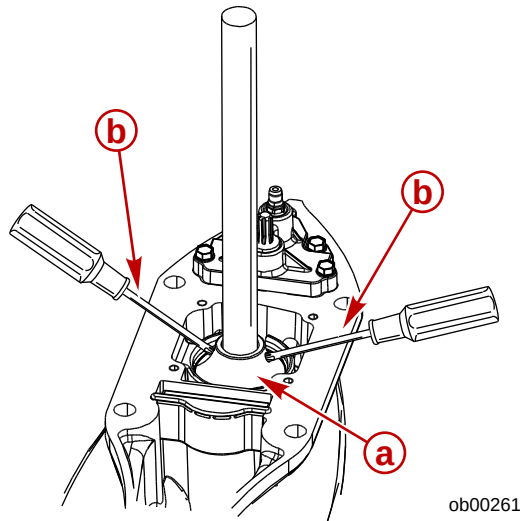
1. While pushing down on seal carrier, use a flat tip screwdriver to aid in removal of retaining ring above oil seal carrier.



a - Retaining ring

b - Seal carrier

2. Remove the oil seal carrier from the gear housing. It may be necessary to gently pry up on it with two screwdrivers.



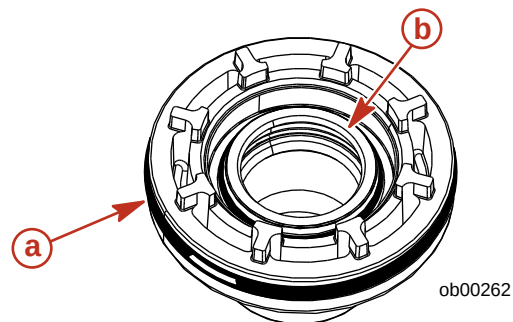
a - Oil seal carrier

b - Screwdrivers

Disassembly

NOTE: Complete the instructions in this section only if the assembly components have been found to be defective and are in need of repair or replacement.

1. Remove the O-ring.

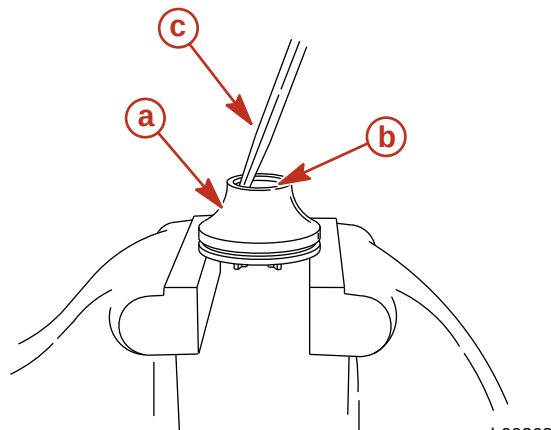


a - O-ring

b - Oil seals (2)

IMPORTANT: Use caution when removing carrier oil seals to avoid nicking or scratching the plastic surface the seals contact in the carrier as water leakage into gearcase could result.

2. Remove oil seals with screwdriver or punch.



a - Oil seal carrier

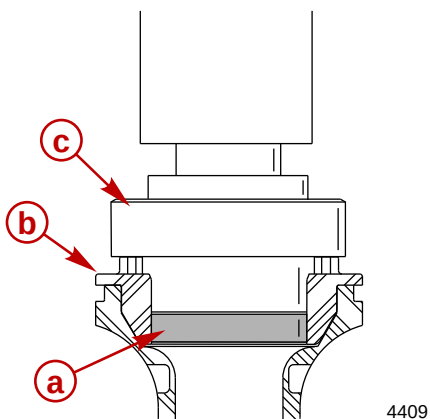
b - Oil seals

c - Screwdriver

Reassembly

The oil seals in the carrier assembly are the same diameter. The bottom (first) seal lip faces down; the top (second) seal lip faces up. Apply 2-4-C with Teflon to seal lips and between seals. Apply Loctite 380 to outer diameter of both seals.

1. Press first seal into carrier with Oil Seal Driver using long side of seal driver.



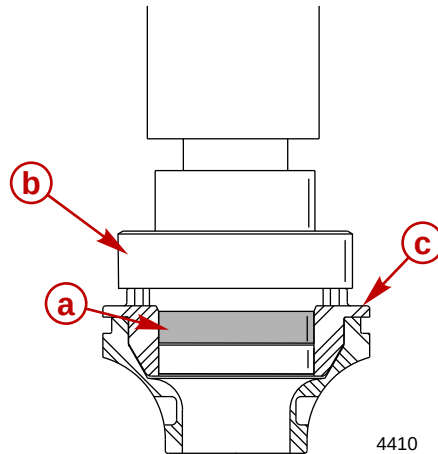
a - First seal installed (lip faces away from driver)

b - Seal carrier

c - Oil Seal Driver

Oil Seal Driver	91-889844T
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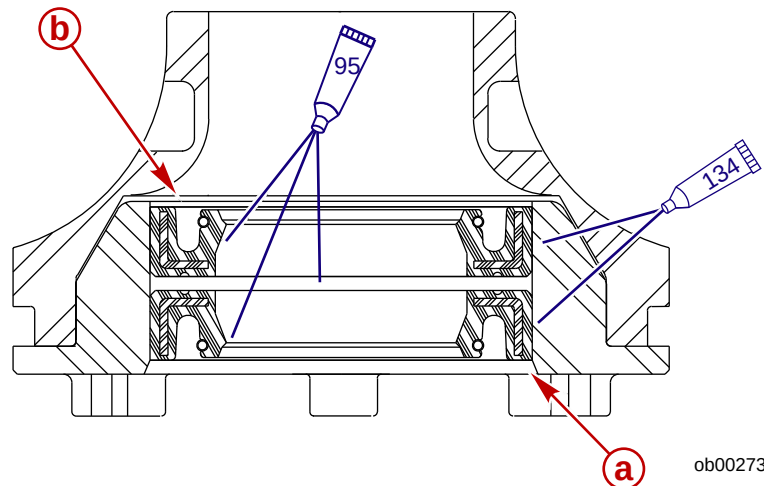
- Reverse seal driver and using short side of driver, press second seal in until seal driver is flush with carrier surface.



- a** - Second seal installed (lip faces towards driver)
b - Oil Seal Driver
c - Seal carrier

Oil Seal Driver	91-889844T
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- Apply 2-4-C with Teflon to seal lips.



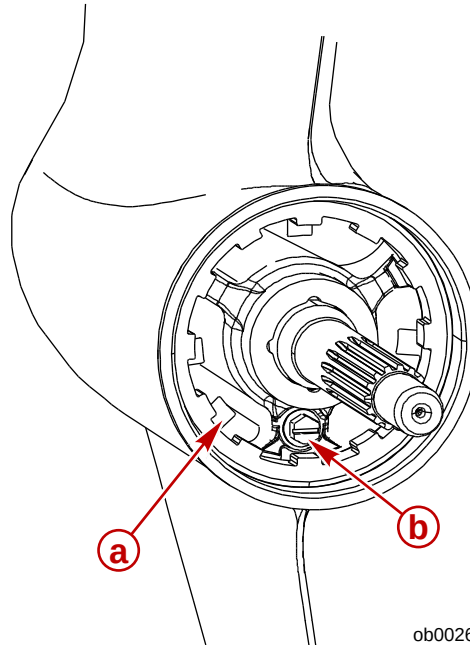
- a** - Second seal installed (lip faces down)
b - First seal installed (lip faces up)

Tube Ref No.	Description	Where Used	Part No.
	2-4-C Marine Lubricant with Teflon	Oil seal lips and between oil seals	92-802859A1
	Loctite 380	Outer diameter of oil seals	Obtain Locally

Bearing Carrier and Propeller Shaft

- Straighten any lock tabs on the tab washer.

NOTE: Drain plug in bearing carrier must be removed before using Bearing Carrier Retainer Nut Wrench to remove bearing carrier retainer.



a - Tab

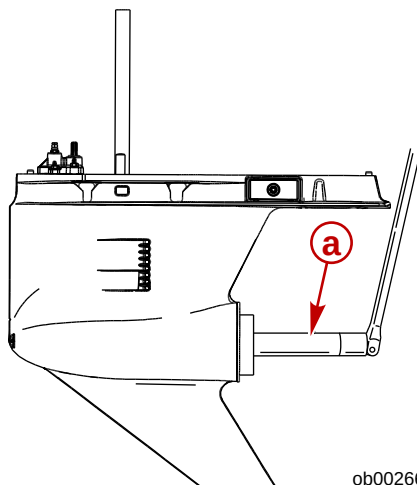
b - Drain plug

2. Remove the bearing carrier retainer following step "a" or "b" as follows:

⚠ CAUTION

Do not drill into the gear housing retainer threads when using the following procedure for removing the retainer.

- a. Remove bearing carrier retainer turning retainer counterclockwise using Bearing Carrier Retainer Nut Wrench.

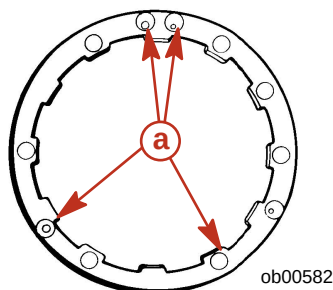


a - Bearing Carrier Retainer Nut Wrench

Bearing Carrier Retainer Nut Wrench

91-61069T

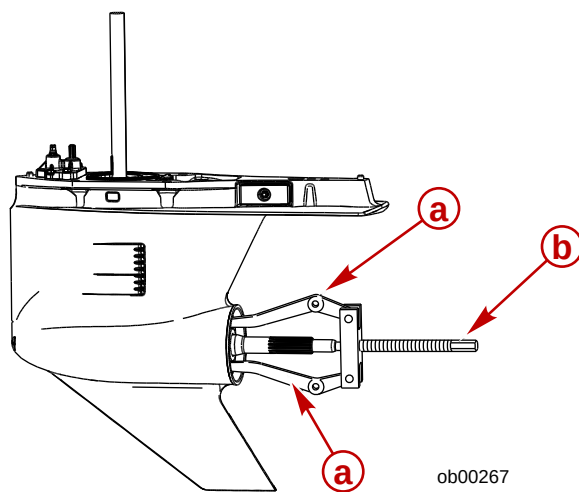
- b. If the retainer is corroded in place, drill four holes in the retainer and fracture the retainer with a chisel. Pry the remaining segments out.



a - Drilled holes

- c. Remove tab washer.
3. Pull the bearing carrier from the gear housing by pulling on the outer ring of the bearing carrier. Position puller jaws close to bosses in carrier.

NOTE: If the bearing carrier is seized in the gear housing, it may be necessary to use heat to loosen the carrier.



a - Puller Jaws

b - Puller Bolt

Puller Jaws Assembly	91-46086A1
Puller Bolt	91-85716

Cleaning/Inspection

IMPORTANT: It is recommended that all seals and O-rings be replaced (as a normal repair procedure) to assure effective repair.

1. Clean bearing carrier with solvent and dry with compressed air.

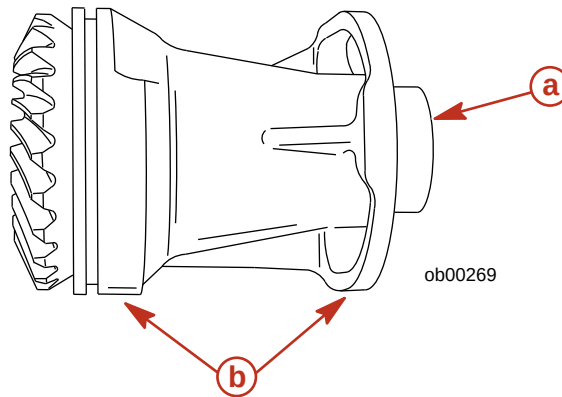
⚠ WARNING

Avoid serious injury or death. Do not allow the bearings to spin when drying them with compressed air. The bearings can explode, even if they are spun at very slow speeds.

⚠ CAUTION

Do not spin bearings dry with compressed air, as this could cause bearing to score.

2. Inspect the bearing carrier for signs of excessive corrosion especially in the area where the bearing carrier touches the gear housing. If excessive corrosion is evident replace the carrier.



a - Bearing carrier

b - Inspect for corrosion

3. The propeller shaft utilizes a tapered roller bearing and cup for shaft support just forward of the bearing carrier seals. The reverse gear and bearing assembly must be removed from the bearing carrier to gain access to the propeller shaft tapered bearing for inspection.
4. Inspect reverse gear to pinion gear wear pattern (should be even and smooth). If not, replace reverse gear, pinion gear and forward gear.
5. Check clutch jaws on reverse gear for damage. Replace reverse gear, if damage is found on clutch jaws.
6. Apply light oil to reverse gear bearing. Rotate reverse gear bearing while checking bearing for rough spots and/or catches. Push in and pull out on reverse gear to check for bearing side wear. Replace bearing if any of the listed conditions exist.

Disassembly

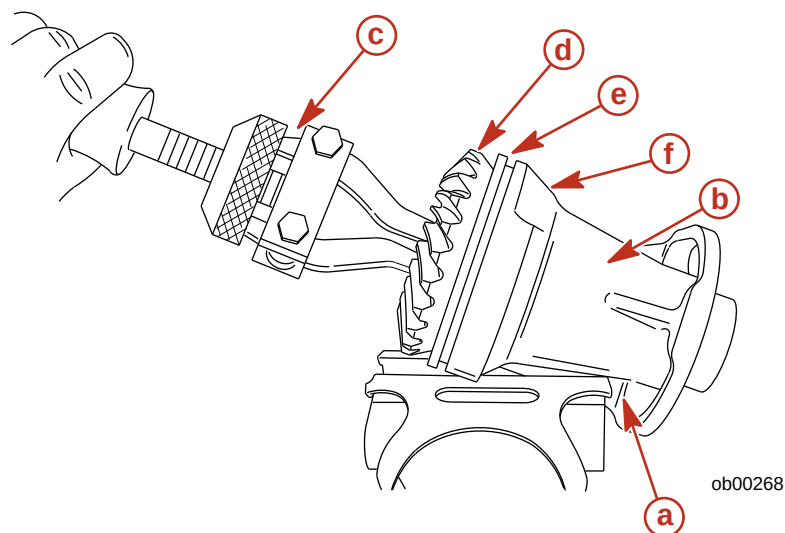
1. Remove and discard O-ring from between bearing carrier and thrust washer.

⚠ CAUTION

Clamp onto the reinforcing rib of the bearing carrier ONLY, or damage to the carrier may result.

2. Place the bearing carrier in a vise, clamping on the reinforcing rib.

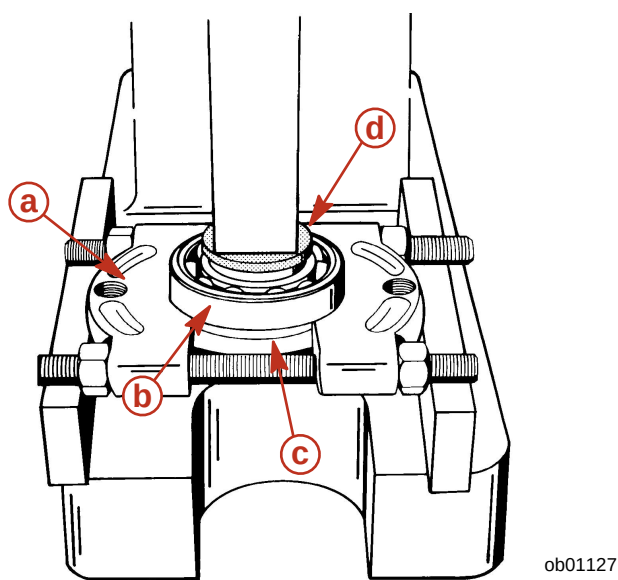
3. Remove the reverse gear, thrust ring, and bearing as an assembly, using a slide hammer puller.



- | | |
|-------------------------------------|---|
| a - Bearing carrier reinforcing rib | d - Reverse gear |
| b - Bearing carrier | e - Thrust hub |
| c - Slide Hammer Puller | f - Bearing (not seen) - located inside carrier |

Slide Hammer Puller	91-34569A1
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4. Remove thrust washer from reverse gear assembly.
5. Using a suitable mandrel and the universal puller plate to support the bearing, press the bearing from the reverse gear as shown.



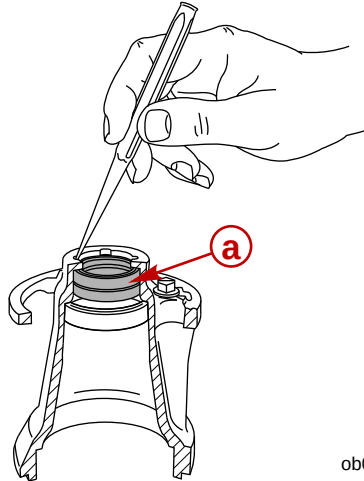
- | | |
|----------------------------|-------------|
| a - Universal Puller Plate | c - Gear |
| b - Bearing | d - Mandrel |

Universal Puller Plate	91-37241
------------------------	----------

- a. Inspect the gear, and thrust washer for excessive wear, cracks, or damage. Replace the appropriate components if any of these conditions are found.

NOTE: *Inspect the aft propeller shaft tapered roller bearing for pits, scoring, discoloration or excessive looseness. Replace bearing and bearing race inside of carrier if these conditions exists.*

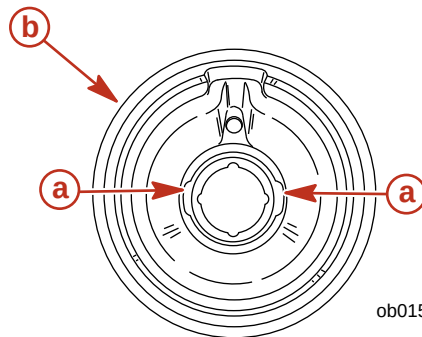
6. Perform the following step "a" or "b" as necessary.
 - a. **If replacing the seals only:** Remove the oil seals with a suitable punch, being careful not to damage the bore of the bearing carrier. Discard both of the seals.



ob01548

a - Seals

- b. **If replacing the tapered roller bearing and seals:** Remove the seals with a punch as noted above. There are slots cast into the carrier to aid in the removal of the bearing race with puller jaws.

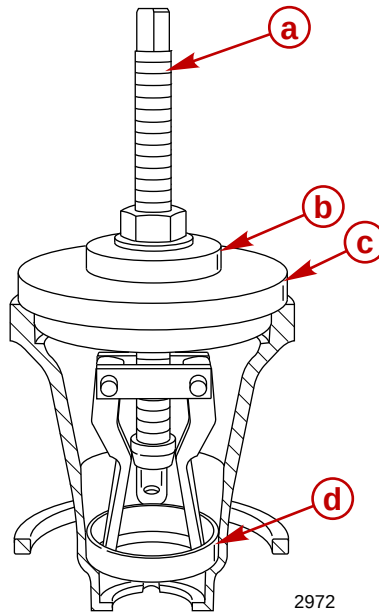


ob01555

a - Slots

b - Bearing carrier

- c. Remove the tapered bearing race from the carrier using Bearing Puller Assembly, Pilot Washer, and Seal Driver Guide. Discard the bearing, race and both seals.



a - Bearing Puller Assembly
b - Pilot Washer

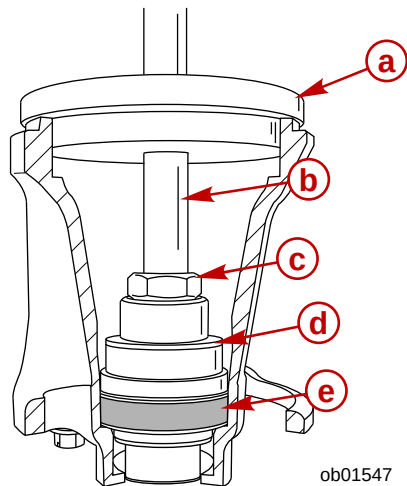
c - Seal Driver Guide
d - Race

Bearing Puller Assembly	91-83165T
Pilot Washer	91-36571T
Seal Driver Guide	91-889845

Reassembly

1. Clean all of the components with a suitable solvent and dry the parts thoroughly using compressed air.
2. Lubricate the bore that the tapered bearing race is pressed into with Premium Gear Lubricant.
3. Assemble the bearing race onto the driver.

4. Press the bearing race into the bearing carrier until the race bottoms out in the bearing carrier.



- a** - Seal Driver Guide

b - Driver Rod

c - Nut
- d** - Bearing Cup Driver/Oil Seal Installer

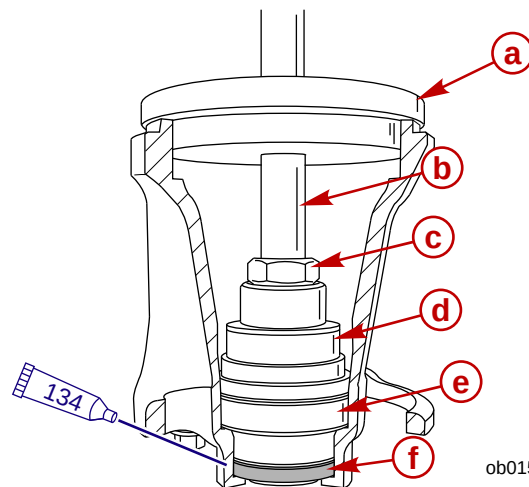
e - Tapered bearing race

Seal Driver Guide	91-889845
Bearing Removal and Installation Kit	91-31229A7
Bearing Cup Driver/Oil Seal Installer	91-888414T

Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Tapered bearing race bore	92-802846A1

5. Thoroughly clean the bore in which the first seal is to be pressed.
6. Assemble the first seal (with the lips of the seal facing away from the driver shoulder) onto the long end of the oil seal driver.
7. Apply Loctite 380 to outer diameter of seal.

8. Press on the oil seal driver until the driver bottoms on the bearing race.

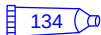


ob01545

a - Seal Driver Guide
b - Driver Rod
c - Nut

d - Bearing Cup Driver/Oil Seal Installer
e - Bearing race
f - Oil seal (first)

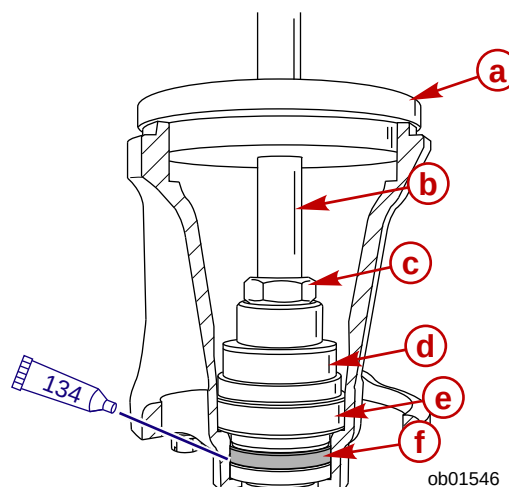
Seal Driver Guide	91-889845
Bearing Removal and Installation Kit	91-31229A7
Bearing Cup Driver/Oil Seal Installer	91-888414T

Tube Ref No.	Description	Where Used	Part No.
 134	Loctite 380	Outer diameter of bearing carrier oil seal	Obtain Locally

9. Assemble the second seal (with the lips of the seal facing the driver shoulder) onto the short end of the driver seal.

10. Apply Loctite 380 to outer diameter of seal.

11. Press the oil seal with the driver until the driver bottoms out on the bearing race.



ob01546

a - Seal Driver Guide
b - Driver Rod
c - Nut

d - Bearing Cup Driver/Oil Seal Installer
e - Bearing race
f - Oil seal (second)

Seal Driver Guide	91-889845
Bearing Removal and Installation Kit	91-31229A7
Bearing Cup Driver/Oil Seal Installer	91-888414T

Tube Ref No.	Description	Where Used	Part No.
 134	Loctite 380	Outer diameter of oil seals	Obtain Locally

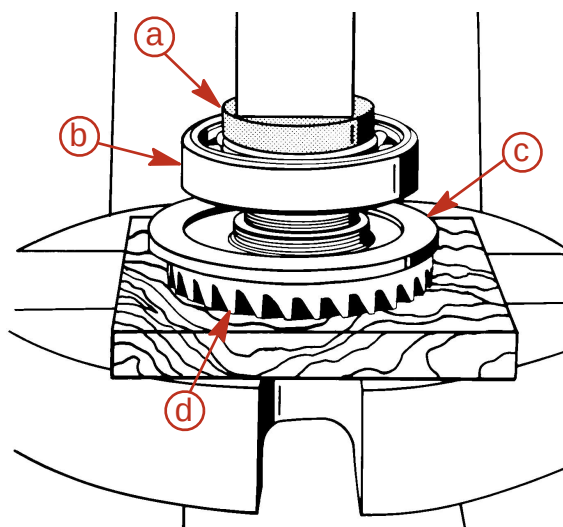
12. Lubricate the seal lips and fill the area between the seals with 2-4-C with Teflon.

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Oil seal lips and between oil seals	92-802859A1

13. Install propeller shaft tapered roller bearing into carrier bearing race.

NOTE: Reverse gear bearing is not fully seated until reverse gear/bearing assembly is pressed into the bearing carrier.

14. Install the thrust washer and a new ball bearing onto the reverse gear. Press on the inner race of the ball bearing using the pilot washer until the pilot washer bottoms out on the gear.



a - Pilot Washer
b - Ball bearing

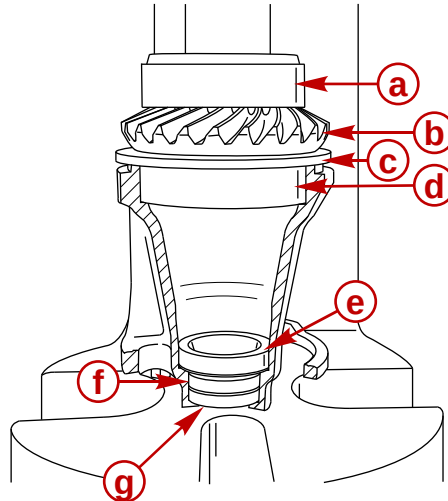
c - Thrust washer
d - Reverse gear

Pilot Washer	91-36571T
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15. Lubricate the bore that the bearing is pressed into with Premium Gear Lubricant.

Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Bearing bore in carrier	92-802846A1

16. Press the reverse gear assembly into the bearing carrier until the bearing bottoms out in carrier.



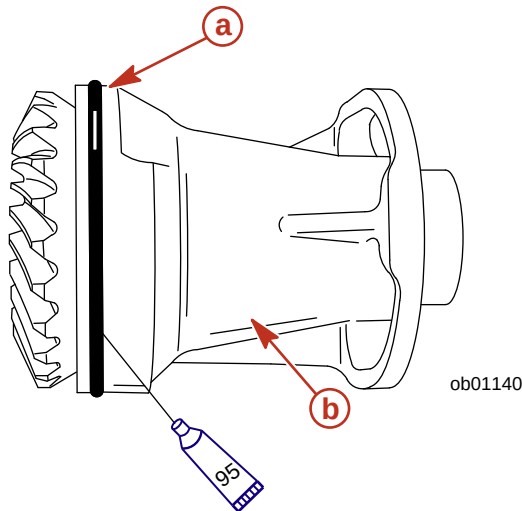
ob01542

a - Bearing Cup Driver
b - Reverse gear
c - Thrust washer
d - Ball bearing

e - Tapered bearing
f - Seal
g - Seal

Bearing Cup Driver	91-885592T
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17. Lubricate the O-ring with 2-4-C with Teflon and install the O-ring onto the bearing carrier.



ob01140

a - O-ring

b - Bearing carrier

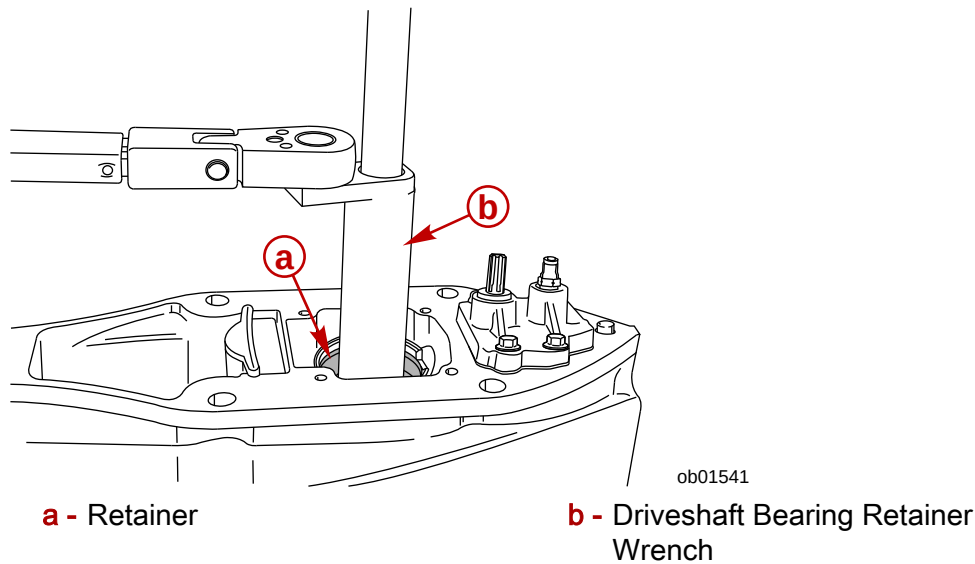
Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Bearing carrier O-ring	92-802859A1

Driveshaft Assembly

Removal

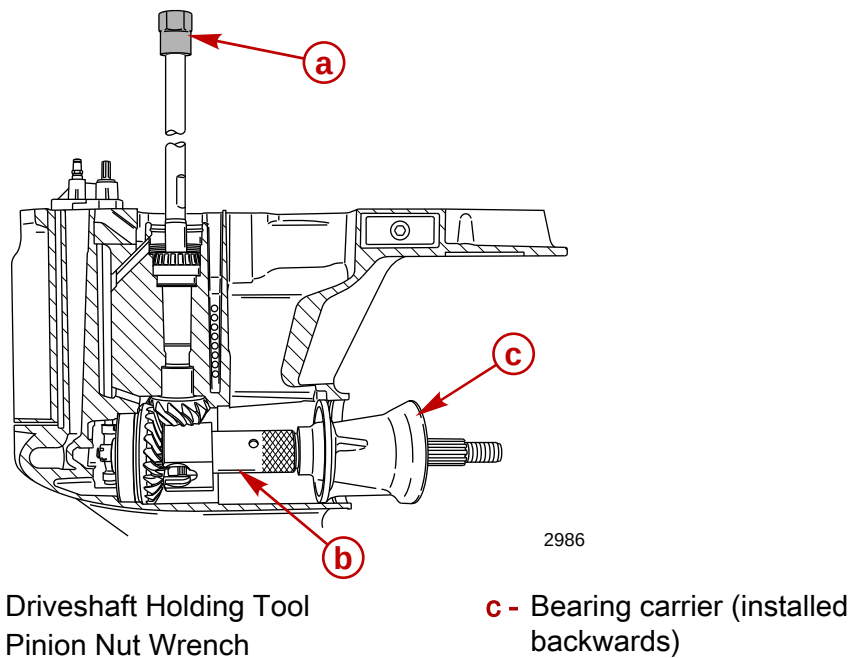
1. Remove the driveshaft pinion nut as follows:

- a. Remove the upper driveshaft tapered bearing retainer.



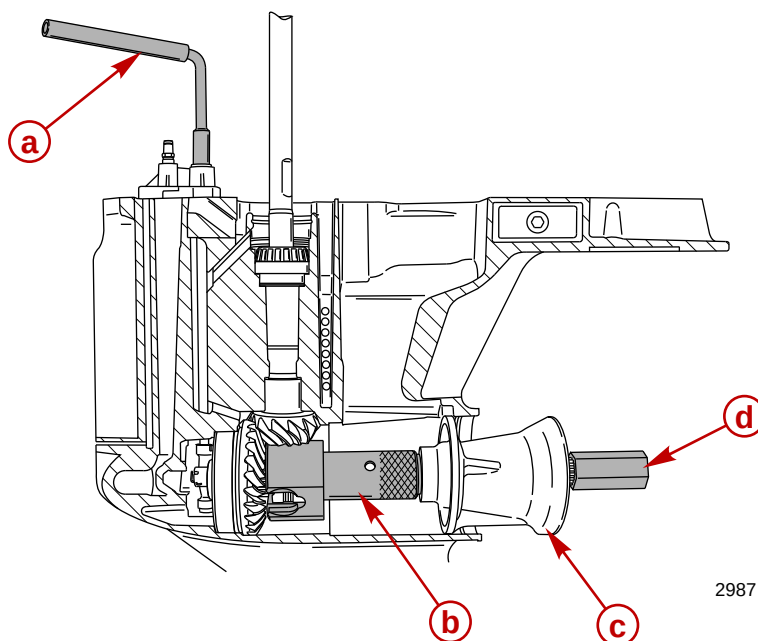
Driveshaft Bearing Retainer Wrench	91-43506T
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- b. Place the Driveshaft Holding Tool onto the driveshaft.
- c. Insert the Pinion Nut Wrench with the MC1 slot facing the pinion gear into the gear housing. It may be necessary to slightly lift and rotate the driveshaft to align the pinion gear nut into the Pinion Nut Wrench slot.
- d. Install the bearing carrier into the gear housing backwards to support the prop shaft and to keep the Pinion Nut Wrench aligned.
- e. Using the Driveshaft Holding Tool, loosen the pinion nut by rotating the driveshaft counterclockwise.



Driveshaft Holding Tool	91-889958T
Pinion Nut Wrench	91-61067003

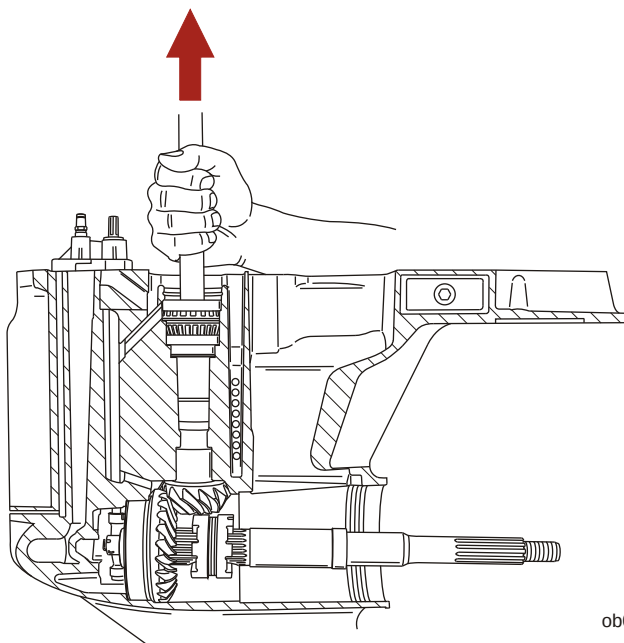
- f. If the driveshaft is broken, place Propeller Shaft Adaptor onto the propeller shaft splines, hold shift shaft in forward gear and loosen the pinion nut by rotating prop shaft counterclockwise to turn gears, thus loosening the pinion nut.



- a** - Shift Shaft Tool (fabricate from old shift shaft) **c** - Bearing carrier (installed backwards)
b - Pinion Nut Wrench **d** - Propeller Shaft Adaptor

Pinion Nut Wrench	91-61067003
Propeller Shaft Adaptor	91-61077

- g. Completely unscrew the pinion nut by rotating the driveshaft (or the propeller shaft) in a counterclockwise direction.
h. Remove all tools.
2. Remove the driveshaft and all components by pulling the driveshaft straight out of the gear housing as shown.

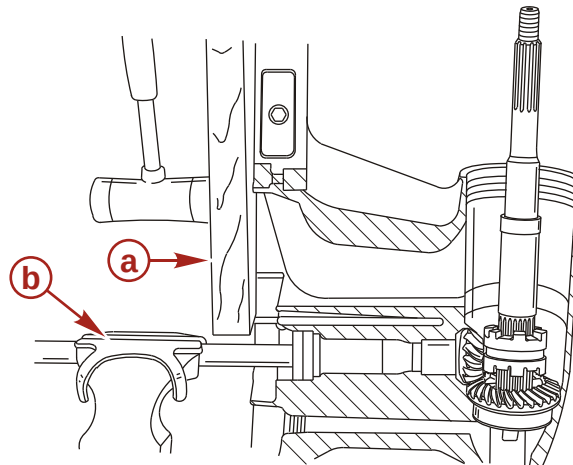


IMPORTANT: The pinion bearing rollers are free to fall out of the pinion bearing once the driveshaft is removed. Be careful not to loose the 18 rollers.

NOTE: If pinion gear is seized onto the driveshaft, place gearcase in vise using soft jaw vise covers. Place a block of wood on gear housing mating surface. Use a mallet and carefully tap gear housing away from driveshaft.

⚠ CAUTION

To prevent possible impact damage to the gear housing, do not strike the gear housing directly with the mallet. Striking a gear housing directly with a mallet or dropping the gear housing could distort the gear housing. Distortion damage may result in gear housing failure.

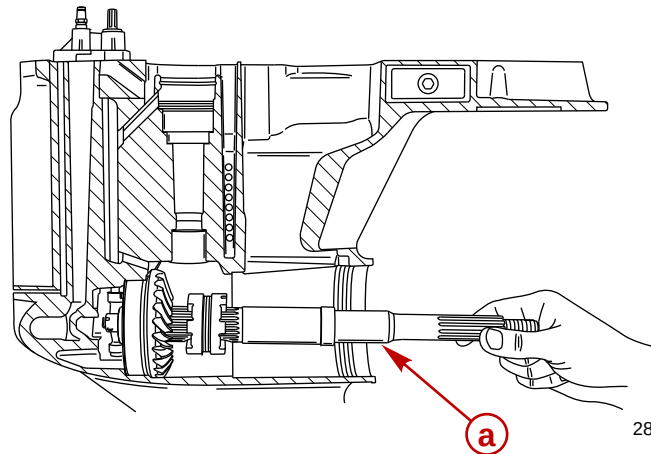


ob01432

a - Wood block

b - Driveshaft in soft jaw vise

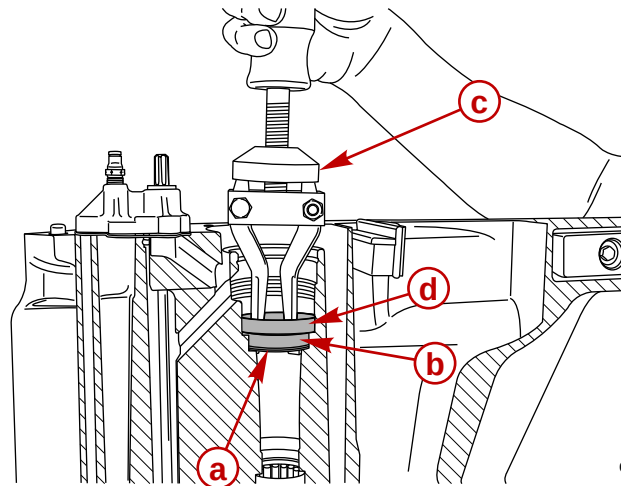
3. Move the prop shaft downward to retrieve the pinion gear, washer and nut from inside the gear housing.
4. Raise the propeller shaft back up until it is centered in the gear housing and then move the prop shaft to the starboard side of the housing.



2849

a - Propeller shaft

- Remove lower driveshaft bearing cup and shims using Slide Hammer Puller (retain shims for re-installation).



ob01426

a - Shims**b** - Bearing race**c** - Slide Hammer Puller**d** - Driveshaft bearing cup

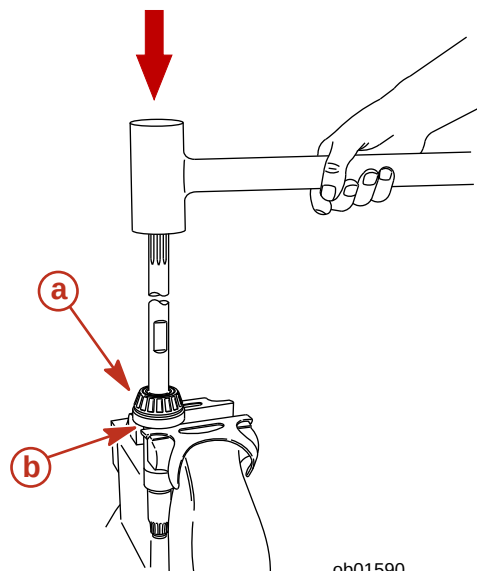
Slide Hammer Puller

91-34569A1

Disassembly

NOTE: Do not remove upper and lower tapered roller bearings from driveshaft unless replacement is indicated. Bearings cannot be reused after removal from driveshaft.

- Both upper and lower tapered roller bearings can be removed from the driveshaft in one operation. Using the bottom bearing cup removed from the gearcase, place the cup on top of a vise leaving the vise jaws open enough to allow the driveshaft to slide through.
- Place the driveshaft through the cup and vise until the bottom bearing is resting in the cup. While holding the driveshaft, tap on the top of the shaft with a dead blow hammer until the bearings are free. Do not drop the shaft when performing this operation.

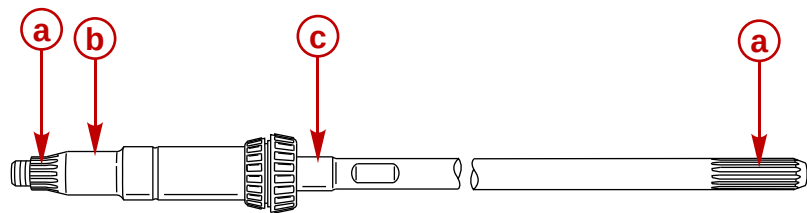


ob01590

a - Lower bearing cup removed from gearcase**b** - Driveshaft with both upper and lower bearings

Inspection

1. Clean all parts with a suitable solvent and dry the parts thoroughly using compressed air, being careful not to spin the bearings.
2. The condition of the upper and lower driveshaft bearing cups is an indication of the condition of each of the tapered roller bearings on the driveshaft. Replace the bearing and bearing cup if the cup is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.
3. Inspect the bearing surface on the driveshaft where the needles of the lower pinion bearing roll. Replace the pinion bearing and the driveshaft if the shaft is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.
4. Inspect the splines at both ends of the driveshaft for a worn or twisted condition. Replace the driveshaft if either condition exists.
5. Inspect driveshaft for grooves where water pump base oil seals contact shaft. Replace driveshaft if grooves are found.



ob01430

a - Splines

b - Pinion bearing surface

c - Seal surface

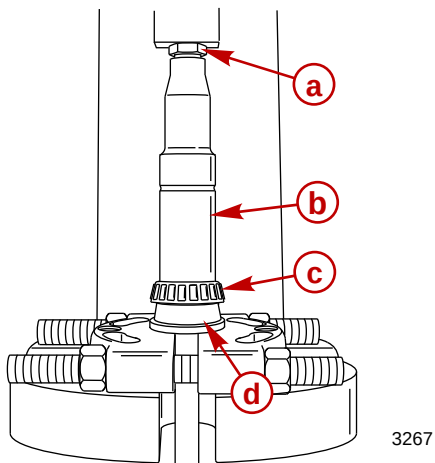
6. Inspect the pinion gear for pitting, chipped or broken teeth, hairline fractures, and excessive or uneven wear. Replace the pinion gear and the forward gear as a set if any defects are found.

Reassembly

NOTE: Complete the instructions in this section only if the components have been disassembled.

1. Apply a light coat of Premium Gear Lubricant on I.D. of driveshaft tapered bearing.
2. Assemble a new lower tapered roller bearing to the driveshaft, with the small O.D. of the bearing facing the pinion gear end of the driveshaft.
3. Thread a used pinion nut onto end of driveshaft. Leave approximately 2 mm (1/16 in.) of nut threads exposed. Driveshaft threads must not extend beyond nut or thread damage could result while pressing.

4. Press the tapered roller bearing onto the driveshaft using the Universal Puller Plate and a suitable mandrel, (an old tapered roller bearing inner race).



a - Pinion nut
b - Driveshaft

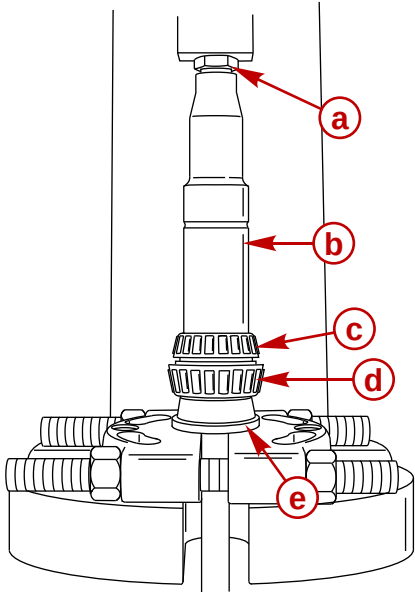
c - Lower driveshaft tapered bearing
d - Old tapered roller bearing inner race

Universal Puller Plate	91-37241
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Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Inside diameter of driveshaft tapered bearing	92-802846A1

5. Apply a light coat of Premium Gear Lubricant on I.D. of driveshaft tapered bearing.
6. Assemble a new upper tapered roller bearing to the driveshaft with the large O.D. of the bearing facing the pinion gear end of the driveshaft.
7. Thread a used pinion nut onto end of driveshaft. Leave approximately 2 mm (1/16 in.) of nut threads exposed. Driveshaft threads must not extend beyond nut or thread damage could result while pressing.

8. Press the tapered roller bearing onto the driveshaft using the Universal Puller Plate and a suitable mandrel, (an old tapered roller bearing inner race).



ob01455

- a** - Pinion nut

b - Driveshaft

c - Lower driveshaft tapered bearing
- d** - Upper driveshaft tapered bearing

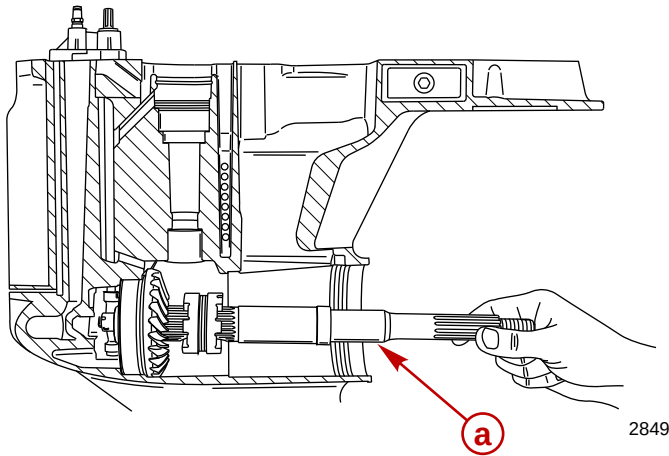
e - Old tapered roller bearing inner race

Universal Puller Plate			91-37241
Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Inside diameter of driveshaft tapered bearing	92-802846A1

Propeller Shaft Assembly and Forward Gear Bearing Cup

Removal

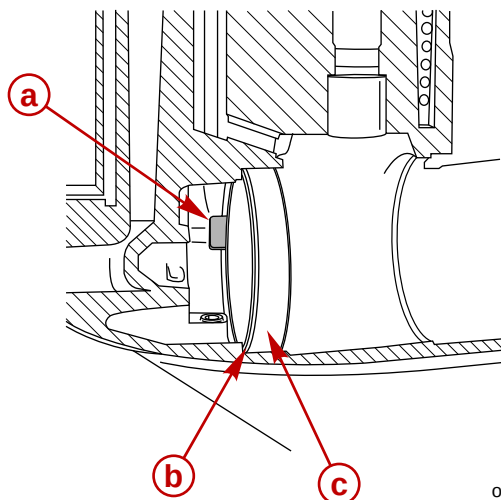
1. Tilt the propeller shaft to the starboard side of the gear housing and remove the shaft.



2849

- a** - Propeller shaft

2. Two notches are provided in the gear housing just forward of the forward gear bearing cup, to position puller jaws for easier removal of the bearing cup and shims.

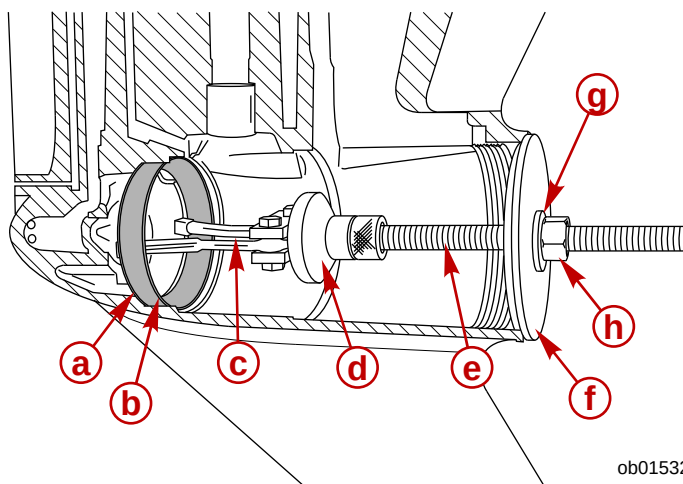


ob01002

a - Notches
b - Shims

c - Forward gear bearing cup

3. Remove forward gear bearing cup and shims. Measure and make note of the shim thickness. If shims are not damaged, they may be reused.



ob01532

a - Shims
b - Bearing cup
c - Jaws (from Slide Hammer Puller Kit)
d - Puller Head (from Slide Hammer Puller Kit)

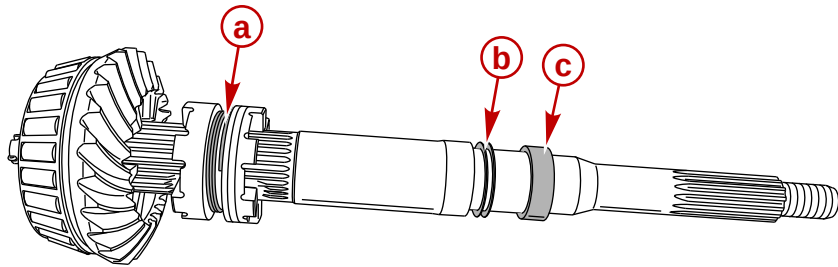
e - Puller Shaft
f - Guide Plate
g - Washer
h - Nut

Slide Hammer Puller Kit	91-34569A1
Bearing Removal and Installation Kit	91-31229A7
Guide Plate	91-816243

Component Disassembly

NOTE: When accomplishing the next step, all of the parts are free to come apart. Work closely over a work bench to ensure that the parts are not dropped or damaged and to avoid personal injury.

1. Remove propeller shaft preload spacer and shims.
2. Remove the spring around the clutch being careful not to over-stretch it during removal. If the spring does not coil back to its normal position once it has been removed, it must be replaced.

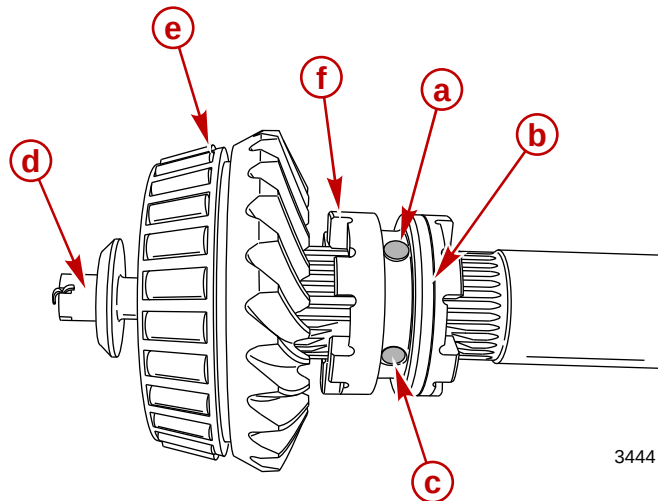


3443

a - Spring
b - Shims

c - Preload spacer

3. Remove detent pin.
4. Remove the cross pin that goes through the clutch.
5. Remove the remainder of the components.



3444

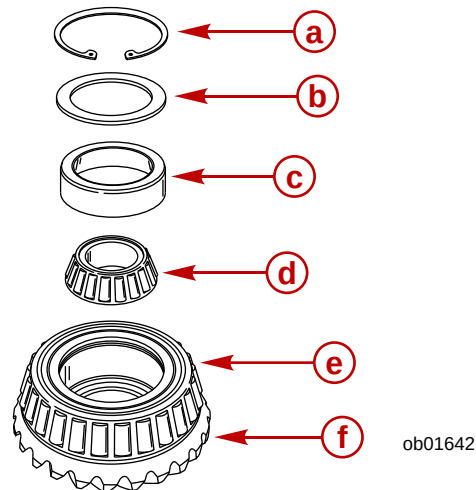
a - Detent pin
b - Clutch band (faces toward reverse gear)
c - Cross pin

d - Spool and actuating shaft assembly
e - Forward gear assembly
f - Clutch

Inspection

1. Clean all the parts with a suitable solvent and dry the parts thoroughly using compressed air, being careful not to spin bearings.
2. Inspect the sliding clutch jaws for damage. Jaws must not be chipped or rounded off. Replace the clutch if they are.

3. The propeller shaft utilizes two tapered roller bearing and cup assemblies for propeller shaft support. One tapered bearing is just forward of the bearing carrier seals. The reverse gear assembly must be removed from the bearing carrier to gain access to this bearing for inspection. The other tapered bearing is located inside the forward gear assembly. The forward gear assembly must be removed from the propeller shaft and a snap ring retainer and flat washer removed from the forward gear assembly to gain access to this tapered bearing for inspection.



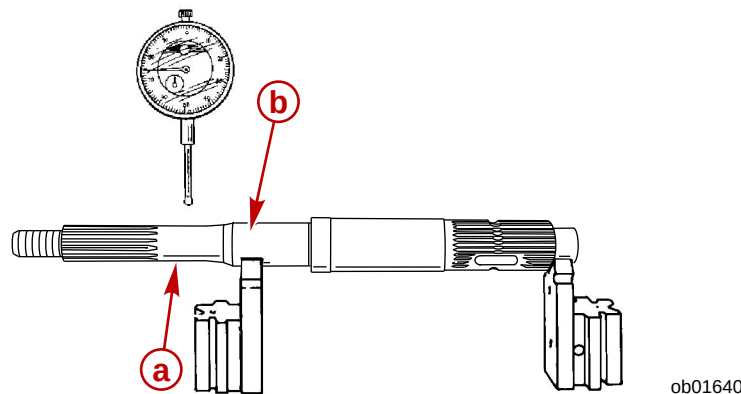
ob01642

- | | |
|---------------------------------|---------------------------------|
| a - Snap ring | d - Tapered bearing |
| b - Flat washer | e - Forward gear bearing |
| c - Tapered bearing race | f - Forward gear |

NOTE: Forward gear bearing should not be removed from forward gear unless replacement is necessary. Bearing is not reuseable if bearing is removed.

4. Inspect the propeller shaft splines at both ends for a broken, worn, or twisted condition. Replace the propeller shaft if any of these conditions exists.
5. Inspect the surface of the propeller shaft where the bearing carrier seal lips contact the shaft. If the oil seals have made grooves, replace the propeller shaft and oil seals.
6. Inspect the propeller shaft for a bent condition using v-blocks and a dial indicator.
 - a. Position the propeller shaft bearing surfaces on v-blocks.
 - b. Adjust the height of V-blocks to level the propeller shaft.
 - c. Position the dial indicator tip just forward of the propeller shaft splines.
7. Rotate the propeller shaft and observe the dial indicator movement, If the indicator in the dial moves more than 0.23 mm (0.009 in.), replace the propeller shaft.

8. Inspect bearing carrier seal surface area on propeller shaft for grooves. If grooves are present, propeller shaft must be replaced.



a - Check movement with Dial Indicator here

b - Seal surface area

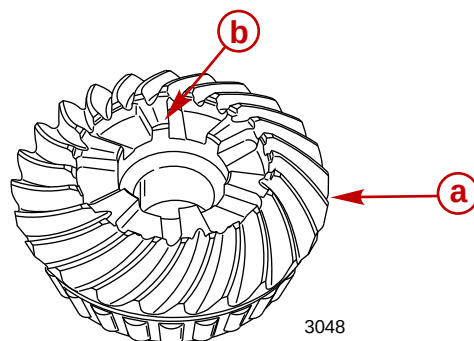
Dial Indicator

91-58222A1

Forward Gear Assembly

Component Inspection

1. Clean the forward gear assembly and the forward gear bearing cup with a suitable solvent and dry with compressed air. Be careful not to spin the bearings.
2. Inspect the gear for pitting, chipped or broken teeth, hairline fractures, and excessive or uneven wear. Replace the forward gear and the pinion gear as a set if any defects are found.
3. Inspect the clutch jaws of the gear for damage. The surfaces must not be chipped or rounded off. Replace both the forward and pinion gear as a set if any of these conditions exist.



a - Forward gear teeth

b - Clutch jaws

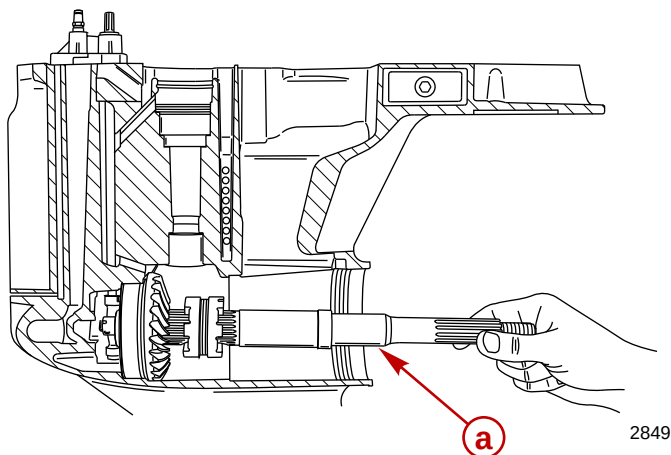
4. Inspect the propeller shaft tapered roller bearing on the inside of the forward gear and its respective bearing cup. If either the bearing or the bearing cup surface is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles, remove and replace the tapered roller bearing assembly in the forward gear.

5. Inspect the tapered roller bearing pressed onto the forward gear and the bearing surface on the forward gear bearing cup. If either the roller bearing or the bearing surface of the forward gear bearing cup is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles, replace the forward gear bearing cup and remove and replace the tapered roller bearing as outlined in the next section.

Disassembly

NOTE: Forward gear and propeller shaft assembly can only be removed from gear housing after driveshaft and pinion gear have been removed.

1. Tilt the propeller shaft to the starboard side of gear housing and remove the propeller shaft and gear assembly.

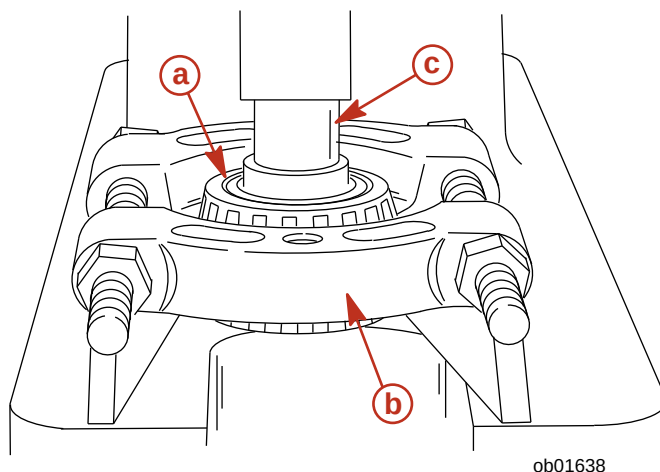


a - Propeller shaft

IMPORTANT: Do not remove pressed on tapered roller bearing from forward gear unless replacement of bearing is required. Bearing cannot be reused after it has been removed.

2. If inspection determines that replacement of forward gear tapered bearing is required, separate gear from bearing as follows:
 - a. Press Universal Puller Plate between forward gear and tapered bearing.
 - b. Place assembly on press and press gear out of bearing with suitable mandrel.

NOTE: Tapered bearing and race must be replaced as a set.



a - Forward gear bearing
b - Universal Puller Plate

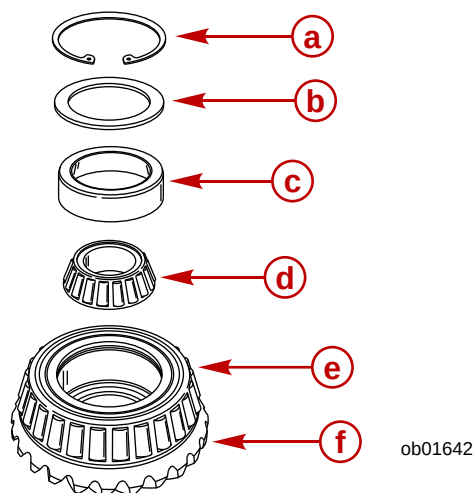
c - Mandrel

3. If inspection determines that replacement of propeller shaft tapered roller bearing is required, remove bearing as follows:

- a. Clamp forward gear in a soft jaw vise securely.

IMPORTANT: Use suitable eye protection when removing or installing snap ring.

- b. Use snap ring pliers to remove snap ring. Push tapered roller bearing assembly out of inside of forward gear.



a - Snap ring

b - Flat washer

c - Tapered bearing race

d - Tapered bearing

e - Forward gear bearing

f - Forward gear

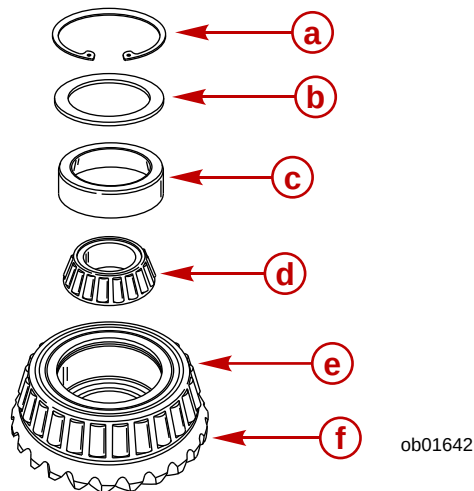
Reassembly

NOTE: Complete the instructions in this section only if the assembly components have been disassembled and repaired or replaced.

1. Apply Premium Gear Lubricant to I.D. of forward gear. Push tapered roller bearing assembly into forward gear until bearing seats.

IMPORTANT: Use suitable eye protection when removing or installing snap ring.

2. Install snap ring into groove of forward gear to secure tapered roller bearing assembly.



ob01642

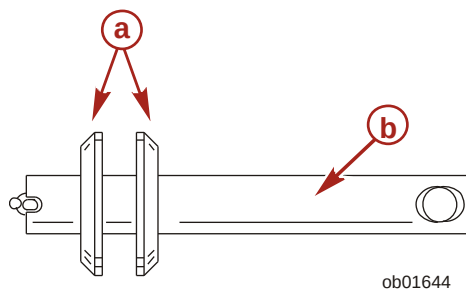
- | | |
|---------------------------------|---------------------------------|
| a - Snap ring | d - Tapered bearing |
| b - Flat washer | e - Forward gear bearing |
| c - Tapered bearing race | f - Forward gear |

Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Inside diameter of forward gear	92-802846A1

Shift Spool Assembly

Inspection

1. Clean the assembly with a suitable solvent and dry the parts using compressed air.
2. Inspect the shift spool assembly for damage. Small nicks and burrs may be smoothed. If any parts are damaged or worn excessively, it will be necessary to replace the complete shift spool assembly. Individual parts are not available for the assembly.
3. Inspect the shift spool for wear in the area where the shift crank comes into contact.

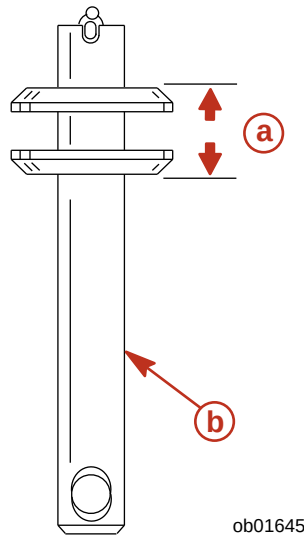


ob01644

- | | |
|-------------------------|---------------------------------------|
| a - Contact area | b - Non-ratcheting shift spool |
|-------------------------|---------------------------------------|

4. Inspect to ensure that the spool spins freely (it may be helpful to lightly tap the castle nut end of the shift spool against a firm surface to align the internal parts).

5. Inspect to ensure that the spool has end play. This end play may be achieved by turning the castle nut clockwise down until it is snug and then backing off the nut counterclockwise to the first cotter pin slot.



a - End play

b - Shift spool

Shift Spool	
End Play	0.05 mm - 0.25 mm (0.002 - 0.010 in.)

Disassembly

NOTE: If the spool spins freely and has the proper clearance, it will not be necessary to disassemble and reassemble the spool. If the spool does not function properly, proceed with the following disassembly procedures.

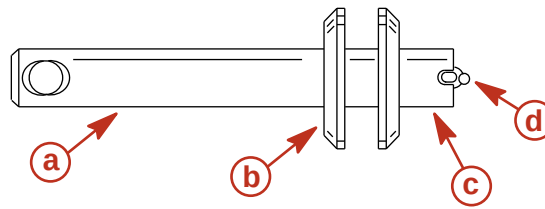
NOTE: Disassembly of the shift spool is for cleaning and inspection of the internal parts due to an improperly functioning shift spool assembly or debris in the gear housing and/or shift spool assembly. Individual components for the shift spool are not available as replacement parts. If the shift spool does not function properly and the following cleaning and adjustment procedures do not correct the problem, it will be necessary to order a new shift spool assembly.

1. Remove and discard the cotter pin.
2. Remove the castle nut and spool.

Reassembly

1. Place the shift spool onto the shift spool shaft.
2. Screw the castle nut down until it touches the spool and a slight resistance is felt.
3. Loosen the castle nut until the cotter pin slot of the nut is aligned with the hole in the shaft. If, when the castle nut is screwed down, the cotter pin slot is already aligned at the hole in the shaft, back the castle nut off until the next available slot in the nut is aligned with the hole in the shaft.
4. Insert a new cotter pin and bend ends of the cotter pin in opposite directions.

5. Verify the spool has end play. If it does not, readjust the castle nut again.



ob01646

a - Shift shaft
b - Spool

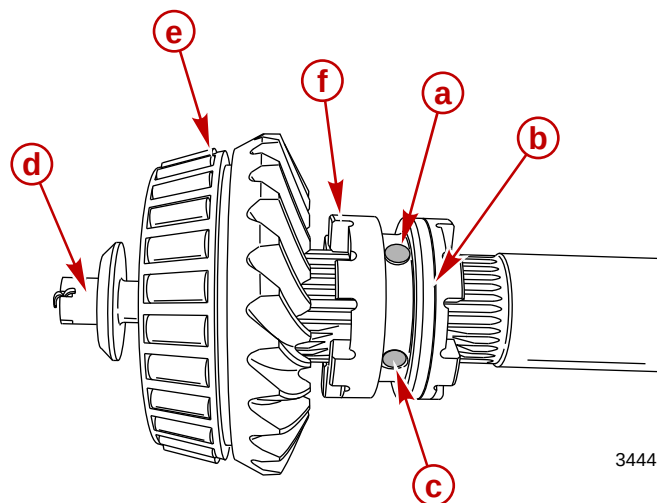
c - Castle nut
d - Cotter pin

Shift Spool	
End Play	0.05 mm - 0.25 mm (0.002 - 0.010 in.)

6. If this adjustment did not produce the desired results it will be necessary to disassemble, clean, and reassemble the shift spool assembly. If the spool assembly has already been disassembled and cleaned it will be necessary to replace the shift spool assembly.

Propeller Shaft Reassembly

1. Install the sliding clutch (with band on clutch facing aft) onto the propeller shaft. Align cross pin holes in the clutch with the slot in the propeller shaft.
2. Assemble the forward gear assembly to the propeller shaft.
3. Assemble the shift spool assembly to the propeller shaft making sure the cross pin hole of the shift spool shaft is aligned with the clutch.
4. Assemble the cross pin through the sliding clutch, through the propeller shaft and through the shift spool shaft hole.
5. Install detent pin in third hole in clutch.

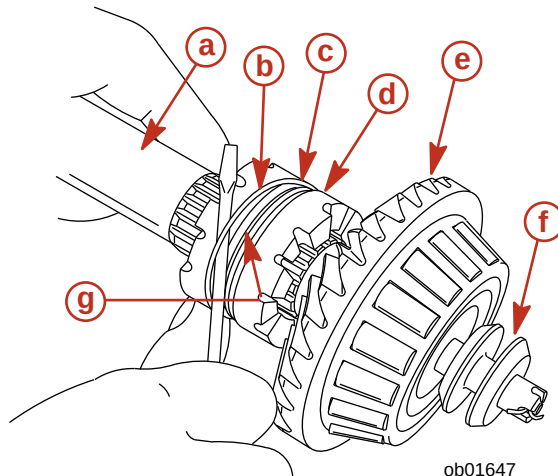


3444

a - Detent pin
b - Clutch band (faces aft)
c - Cross pin

d - Shift spool and actuating shaft assembly
e - Forward gear assembly
f - Clutch

6. Assemble the cross pin retaining spring over the propeller end of the propeller shaft and wind it around the clutch over the cross pin hole. Be careful not to distort the spring while assembling it. **Verify the spring is wound on so that it does not cross over on itself and that it lies flat against the clutch once it is assembled.** If it does not lie flat against the clutch, a new spring must be installed.



ob01647

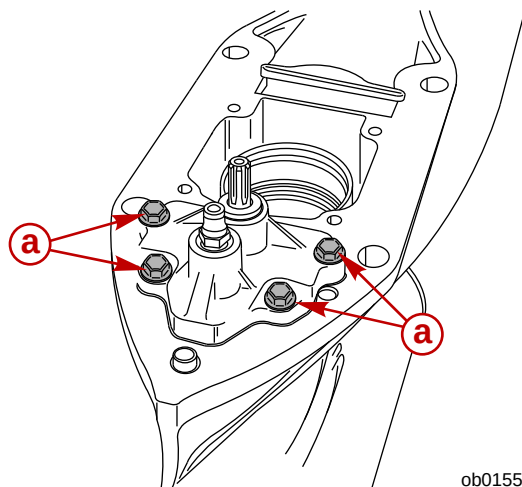
- | | |
|---------------------------------------|---|
| a - Propeller shaft | e - Forward gear assembly |
| b - Cross pin retaining spring | f - Spool and actuating shaft assembly |
| c - Cross pin (hidden) | g - Detent pin (hidden) |
| d - Sliding clutch | |

Shift Shaft Assembly

Removal

NOTE: It is possible to remove and service the shift shaft assembly (but not the shift crank inside the gearcase) without removing any of the internal components of the gear housing.

1. Remove the shift shaft bushing screws. Remove the shift shaft and bushing by pulling both straight out of gear housing.

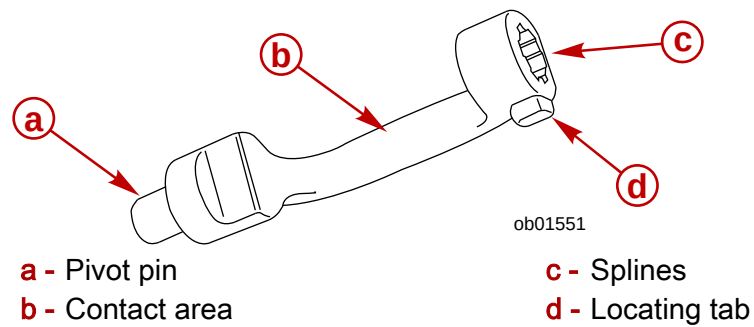


ob01552

- a** - Shift shaft bushing screws

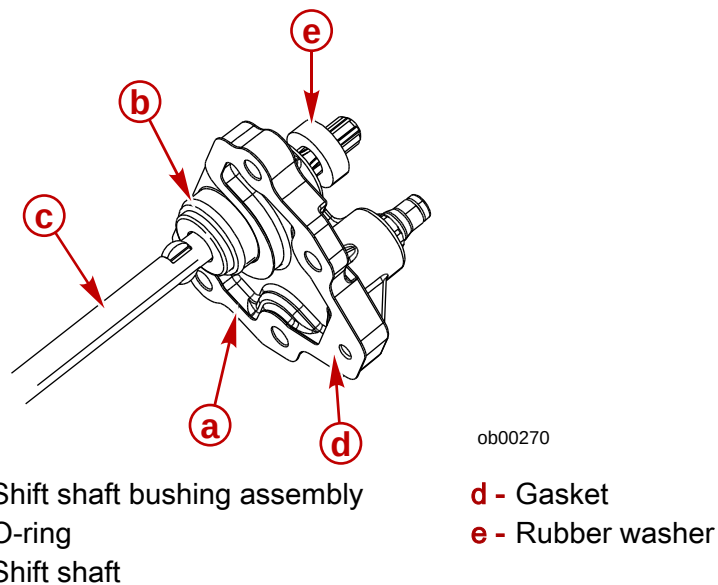
2. Remove the shift crank from the inside of the gear housing. Clean it with a suitable solvent and dry it thoroughly. Inspect it for wear in the areas that contact the shift spool and inspect the splines and the pivot pin for damage or wear.

NOTE: The shift crank has a locating tab. On right hand rotation gearcases, the tab faces toward the forward gear bearing assembly. On left hand rotation gearcases, the tab faces away from the reverse gear bearing assembly.



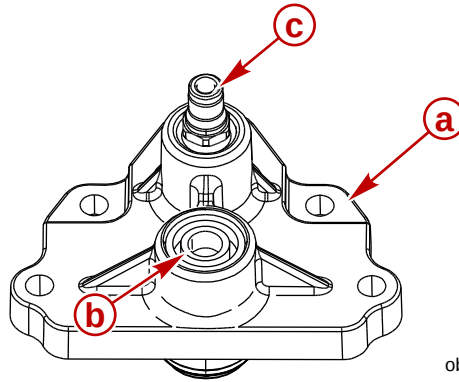
Disassembly and Inspection

1. Remove the coupler from the shift shaft. Slide the bushing assembly off the shift shaft.



2. Clean all components with a suitable solvent and dry thoroughly with compressed air.
 - a. Inspect the shift shaft bushing for cracking, damage, or excessive wear.
 - b. Inspect the oil seal inside the bushing, the sleeve, and the O-rings on the outside of the bushing for damage or excessive wear.
 - c. Inspect the speedometer connector for damage or blockage.
 - d. Inspect the speedometer passage through the shift shaft bushing for debris.

NOTE: If any of these conditions exist, replace the appropriate components.



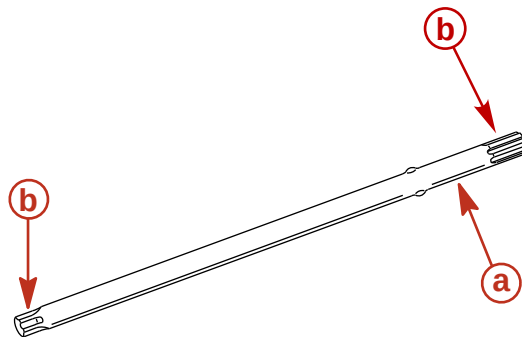
ob00271

a - Shift shaft bushing

c - Speedometer tube connector

b - Oil seal (seal is replaceable)

3. Inspect the shift shaft splines and oil seal surface for corrosion and/or excessive wear. Replace the shift shaft if either if these conditions are found.



ob01648

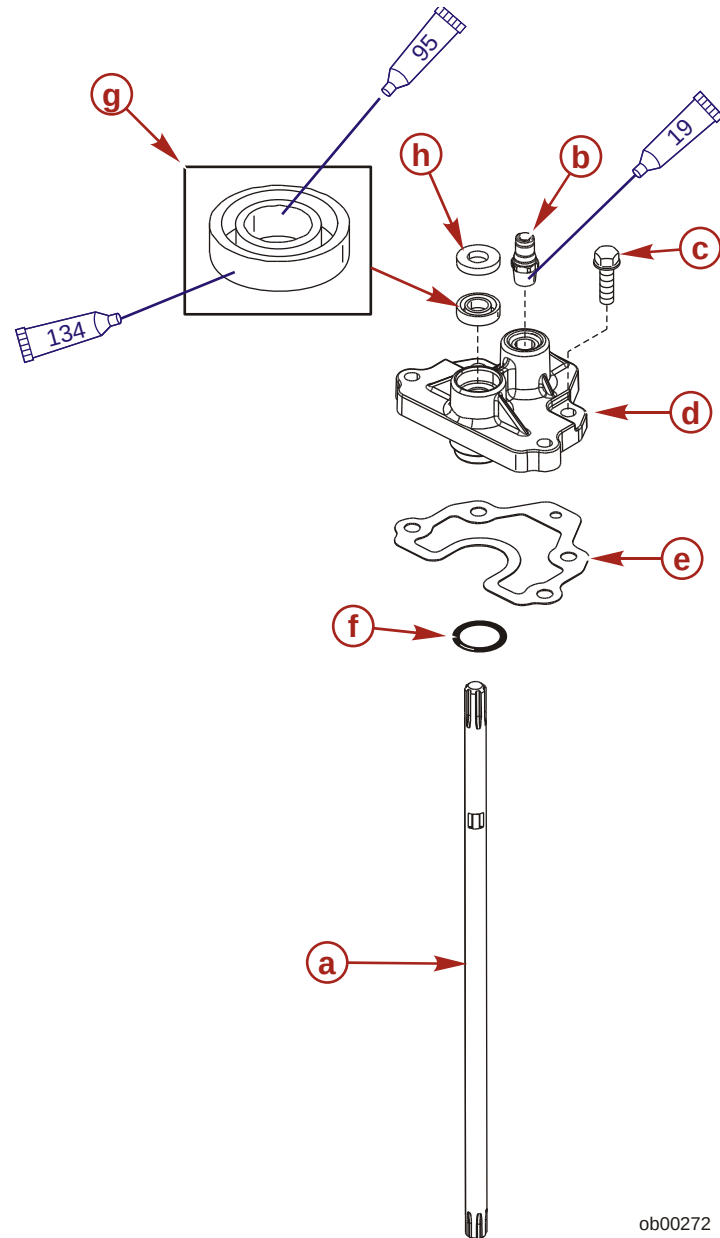
a - Oil seal surface

b - Splines

Reassembly

1. Lightly lubricate the seat of the O-ring diameter on the bushing and the lip of the oil seal with 2-4-C with Teflon.
2. Apply Loctite 380 to the outside diameter of the oil seal. Wipe off any excess Loctite.
3. If the speedometer connector was removed and/or replaced, lightly coat the threads of the connector with Perfect Seal. Assemble the speedometer connector to the bushing and torque the connector to specification.

4. Assemble all components as shown below. Be sure to position O-ring onto bushing before installing bushing into gear housing.



ob00272

- a** - Shift shaft
b - Speedometer hose connector
c - Screws
d - Bushing assembly
e - Gasket
f - O-ring
g - Seal (lip faces up)
h - Rubber washer

Tube Ref No.	Description	Where Used	Part No.
 19	Perfect Seal	Speedometer connector threads	92-34227-1
 95	2-4-C Marine Lubricant with Teflon	Seat of shift shaft bushing O-ring diameter and lip of oil seal	92-802859A1
 134	Loctite 380	Outer diameter of oil seals	Obtain Locally

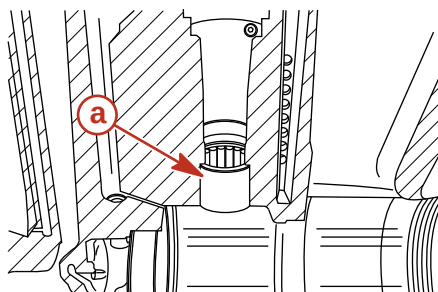
Description	Nm	lb. in.	lb. ft
Speedometer connector	2.8	25	
Bushing assembly screws (M6 x 20) (4 each)	7	60	

Pinion Bearing Removal

NOTE: Inspect the bearing surface on the driveshaft where the needles of the lower pinion bearing roll. The condition of the driveshaft at this location gives an indication of the condition of the needle bearing. Replace lower pinion bearing (needles and race as a set) if the driveshaft is pitted, grooved scored, worn unevenly, discolored from overheating, or has embedded particles.

IMPORTANT: All the needle bearings (18) must be in place inside bearing race while driving the pinion bearing from the gear housing. It is recommended that the cardboard tube provided with a new pinion bearing be used to keep the bearings in place while driving out the old pinion bearing.

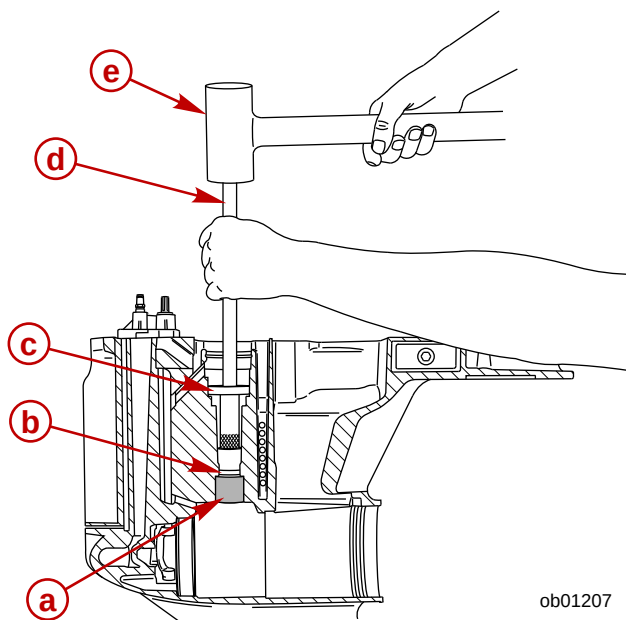
IMPORTANT: Do not reuse the bearing (race or rollers) once it has been removed.



ob01538

a - Pinion bearing

Remove and discard the pinion bearing (race and rollers) using tools as shown.



ob01207

a - Pinion bearing
b - Driver Head
c - Pilot Washer

d - Driver Rod
e - Dead blow hammer

Driver Head	91-36569T
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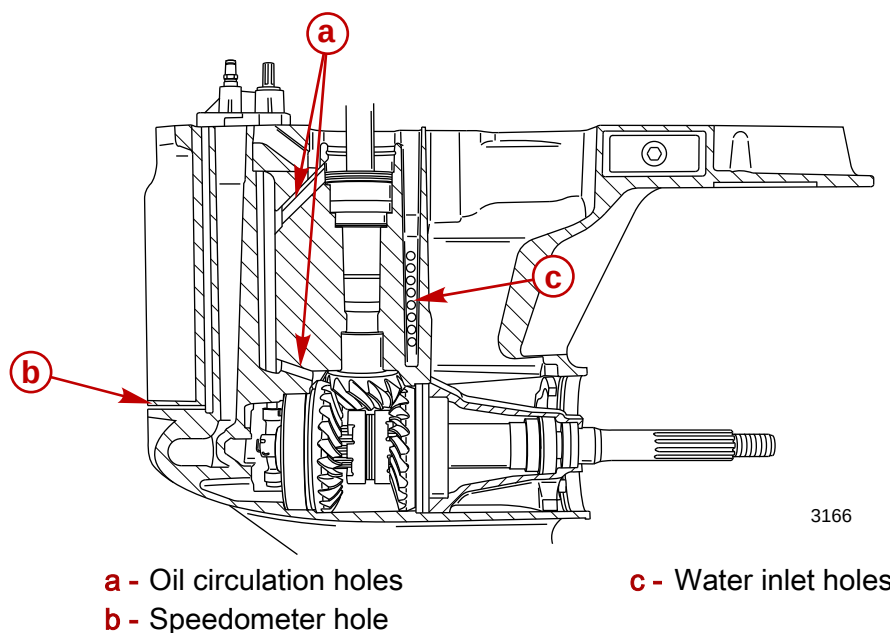
Pilot Washer	91-36571
Driver Rod	91-37323

Gear Housing Inspection

1. Clean the gear housing thoroughly with a suitable solvent and a hard bristle brush. Dry the gear housing thoroughly using compressed air. Ensure that all sealants, locking agents and debris are removed.
2. Verify the 2 oil circulation holes in the driveshaft bore and the shift shaft hole are clear and free of debris.
3. Inspect the gear housing for excessive corrosion, impact or any other damage. Excessive damage and/or corrosion requires replacement of the gear housing.
4. Inspect the bearing carrier retainer threads in the gear housing for corrosion and/or stripped threads. Damage or corrosion to the threads requires replacement of the gear housing.

NOTE: The upper driveshaft bearing cup is a slip fit within the driveshaft bore and may show signs of movement. All other bearing cups are press fit and should not show any signs of movement.

5. Inspect bearing race/cup contact areas for evidence of bearing cup spinning. Check that bearing cups are not loose in bearing bores. A press fit type bearing bore in which the race/cup is loose will require replacement of the gear housing.
6. Inspect for blockage in water inlet holes and the speedometer hole, clean as necessary. Be careful not to enlarge the speedometer hole as this could cause erroneous speedometer readings.

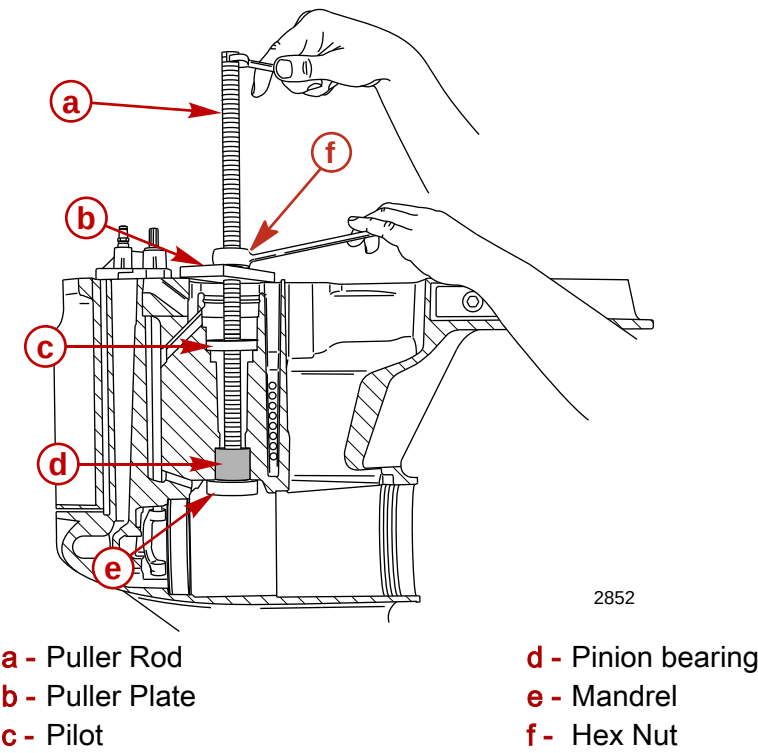


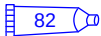
7. Verify that the locating pins are in place in the gear housing and that the corresponding holes in the driveshaft housing are not elongated. The driveshaft may break if the housings are not aligned properly due to missing locating pins or elongated holes.

Pinion Bearing Installation

IMPORTANT: Install only a new pinion bearing. Do not reinstall a pinion bearing that has been previously removed from a gear housing.

- 1. Lubricate the bore into which the pinion bearing is to be installed with Premium Gear Lubricant.
- 2. Position the new pinion bearing (with the cardboard shipping sleeve in place) onto the driver head, with the lettered and numbered side of the bearing oriented upward.
- 3. Insert the driver with the bearing assembly, into position (by way of the propeller shaft bore) at the driveshaft bore as shown.
- 4. Install the bearing by screwing down the nut until the bearing is fully seated against the bore shoulder.



Bearing Removal and Installation Kit			91-31229A7
Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Pinion bearing bore	92-802846A1

Forward Bearing Cup

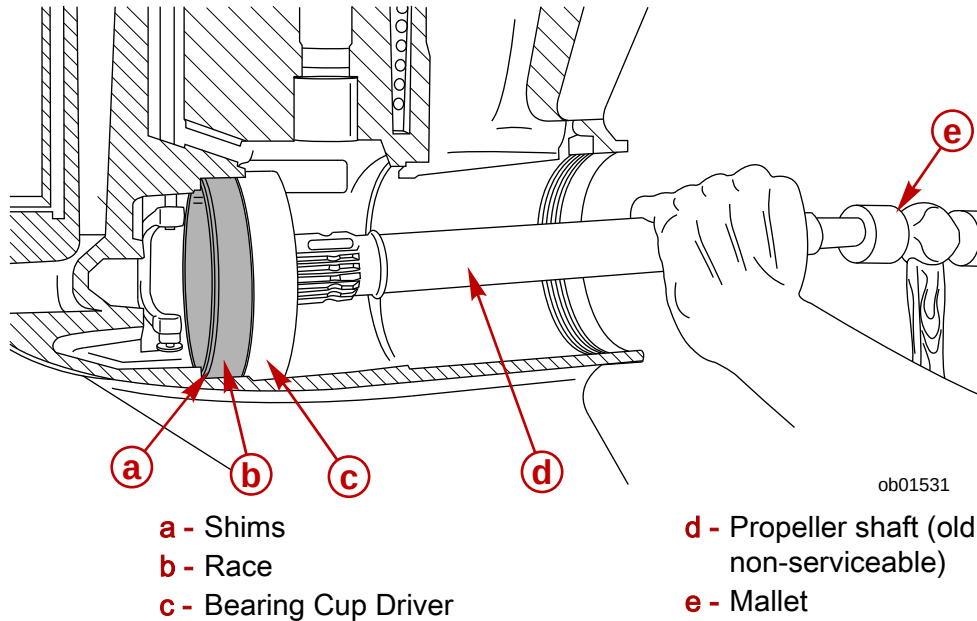
Installation

Forward Gear	
Backlash	0.43 mm to 0.71 mm (0.017 in. to 0.028 in.)

NOTE: If the forward gear, forward gear bearing and cup, or gear housing were not replaced, install the same quantity of shims that were taken out when cup was removed. If the forward gear, forward gear bearing/cup, or gear housing were replaced, install 0.76 mm (0.030 in.) of shims.

- 1. Lubricate the bore into which the forward gear bearing cup is to be installed with Premium Gear Lubricant.
- 2. Place the shim into forward bore of gear housing.
- 3. Press the bearing cup into the gear housing using the installation tool as follows:

IMPORTANT: Verify that the bearing cup is positioned as straight as possible to avoid cocking it in the bore while pressing it in.



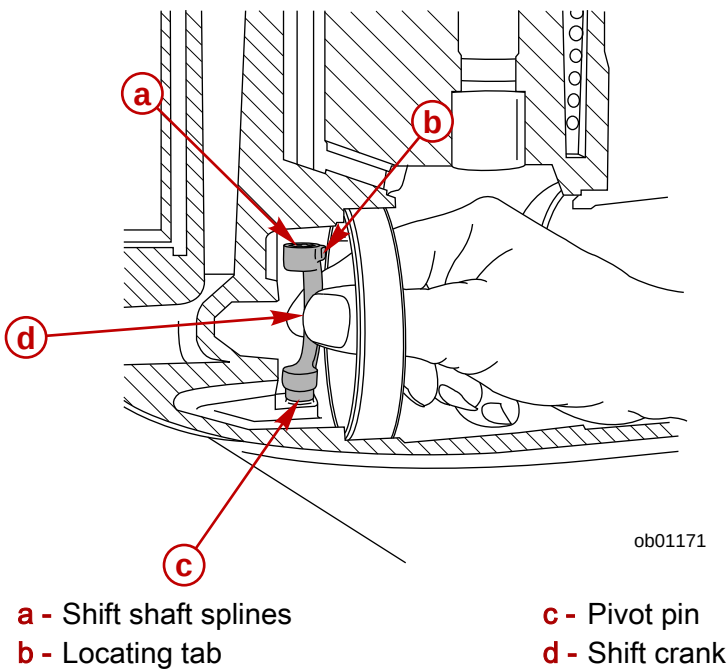
Bearing Cup Driver	91-885592T
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Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Forward gear bearing cup bore	92-802846A1

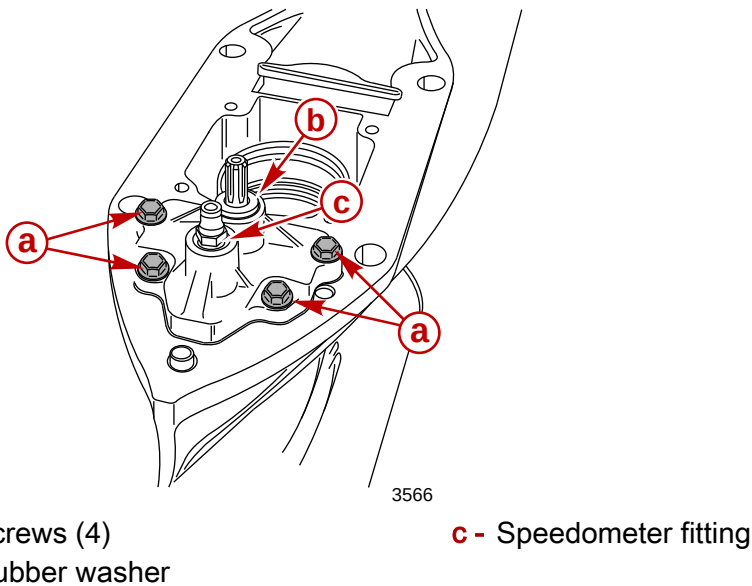
Shift Shaft Installation

1. Place the shift crank into the pivot pin hole in the forward section of the gear housing. Ensure that the shift crank faces towards the right (starboard) side of the gear housing.

NOTE: The shift crank has a locating tab. On right hand rotation gearcases, the locating tab faces toward the forward gear bearing assembly. On left hand rotation gearcases, the locating tab faces away from the reverse gear bearing assembly.



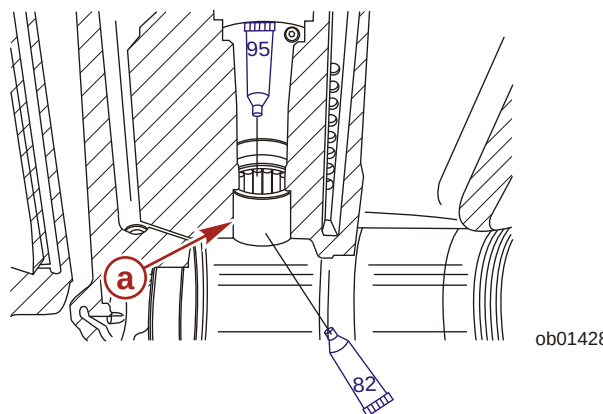
- 2. Install the shift shaft assembly into the gear housing as shown. Engage the splined end of the shift shaft with the shift crank. Verify O-ring is positioned properly and lubricated with 2-4-C with Teflon. Secure shift shaft bushing with four screws. Torque screws and speedometer fitting to specification.
- 3. Install rubber washer onto shift shaft.



Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	O-ring	92-802859A1

Description	Nm	lb. in.	lb. ft.
Shift shaft bushing screws (M6 X 20)	7	60	
Speedometer fitting	2.8	25	

NOTE: If the pinion bearing needle bearings have fallen out, install 18 needles into needle bearing outer race. Use 2-4-C with Teflon, to help hold needles in place.



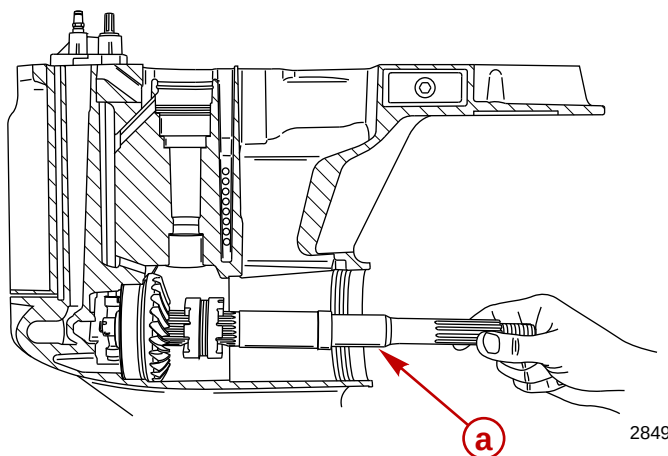
a - Pinion bearing

Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Outside diameter of pinion bearing	92-802846A1
 95	2-4-C Marine Lubricant with Teflon	Pinion needle bearings	92-802859A1

Propeller Shaft Installation

NOTE: The shift/clutch assembly should be in the neutral detent position when installing the propeller shaft.

1. To allow for the engagement of the shift spool with the shift crank, tilt the propeller end of the propeller shaft assembly to the right (starboard) side of gear housing and hold the shift shaft in neutral while installing shaft.



a - Propeller shaft

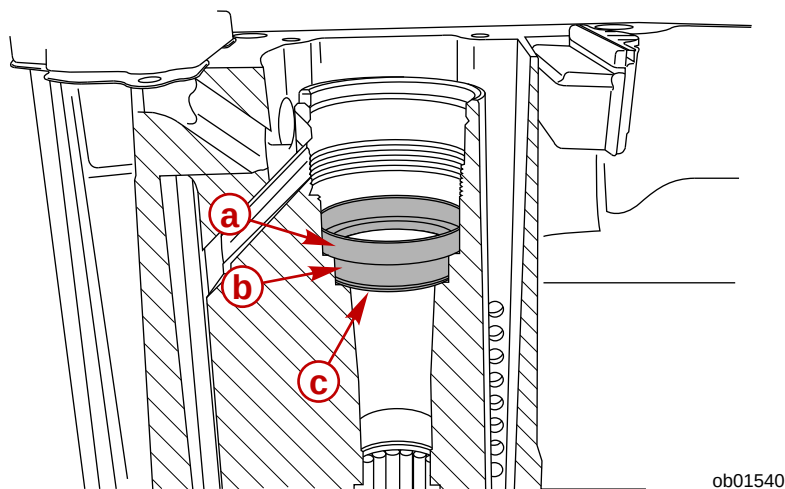
2. Operate the shift shaft to ensure that it has been properly installed. The sliding clutch should move forward when the shift shaft is turned counterclockwise, and should move aft when the shift shaft is turned clockwise.

Driveshaft and Pinion Gear Installation

NOTE: If the original shims were not retained or if pinion gear, driveshaft, driveshaft upper tapered roller bearing and cup, or gear housing were replaced, start off by installing a 0.508 mm (0.020 in.) shim, for the lower tapered roller bearing.

NOTE: If the original shims were retained (or measurement known) and none of the above listed parts were replaced, reinstall the same shims or same amount of shims.

1. Place the lower tapered bearing shims into the driveshaft housing bore.
2. Install lower tapered bearing race into the driveshaft housing bore.
3. Install spacer (flanged end faces down).



a - Spacer

b - Tapered bearing race

c - Shims

4. Apply Loctite 271 to the threads of the pinion gear nut and place the pinion gear nut into the MR slot of the pinion nut adapter.

Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	Pinion gear nut threads	92-809819

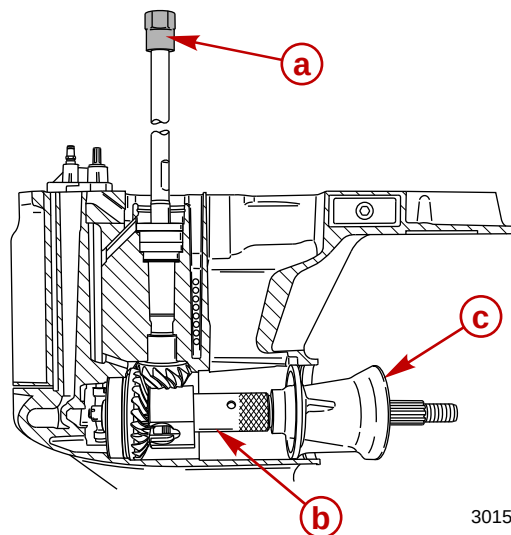
NOTE: Install the pinion gear nut with the flat side of the nut away from the pinion gear.

NOTE: For ease of installation, glue the washer to the pinion gear, using 3M Adhesive, or Bellows Adhesive, or equivalent.

NOTE: If the backlash may have to be changed, it is recommended that Loctite 271 not be applied to the pinion nut until the backlash setting is finalized. Do not reuse the old pinion nut. Install a new pinion nut after backlash is finalized.

5. Place the pinion gear and washer into the gear housing.
6. With the propeller shaft horizontal, insert the pinion nut holding tool (with the nut) into the gear housing.
7. Insert the driveshaft into the gear housing driveshaft bore. It may be necessary to rotate the driveshaft to engage the driveshaft splines into the pinion gear splines.
8. Start the pinion nut onto the driveshaft threads by rotating the driveshaft until the nut is snug.
9. Install the bearing carrier into the gear housing backwards to hold the propeller shaft and the pinion nut holding tool in position.

10. Torque the pinion nut to specification by turning the driveshaft using the driveshaft holding tool and torque wrench.



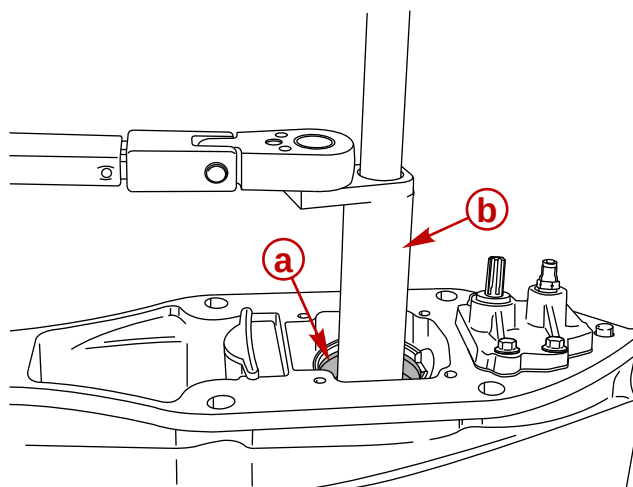
a - Driveshaft Holding Tool
b - Pinion Nut Wrench

c - Bearing carrier (installed backwards)

Driveshaft Holding Tool	91-889958T
Pinion Nut Wrench	91-61067003

Description	Nm	lb. in.	lb. ft.
Pinion Nut	101.7		75

11. Install the upper driveshaft tapered roller bearing cup. Apply 2-4-C with Teflon to the retainer threads and install the retainer. Torque retainer to specification.



a - Retainer

b - Driveshaft Bearing Retainer Wrench

Driveshaft Bearing Retainer Wrench	91-43506T
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Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Retainer threads	92-802859A1

Description	Nm	lb. in.	lb. ft.
Retainer	135.5		100

12. Remove the bearing carrier, Pinion Nut Wrench and Driveshaft Bearing Retainer Wrench.

NOTE: Units correctly assembled to this point would show a driveshaft rolling torque of 0.2 - 0.9 Nm (2 - 8 lb. in.).

Pinion Gear Height

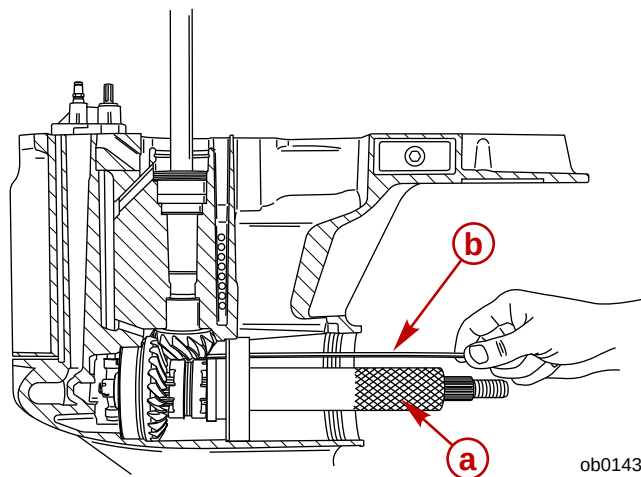
Checking and Adjusting Using Pinion Gear Locating Tool 91-56048001

NOTE: The prop shaft and forward gear can be installed when checking pinion height if Pinion Gear Locating Tool (91-56048001) is used.

1. Place the Pinion Gear Locating Tool into the gear housing aligning window in tool with pinion gear.

NOTE: Take the following measurements at 3 locations, rotating the driveshaft 120 degrees between each reading.

2. Insert the thickest feeler gauge that fits snugly between one tooth of the pinion gear and the high point of the shimming tool.



ob01433

a - Pinion Gear Locating Tool

b - Feeler gauge

Pinion Gear Locating Tool	91-56048001
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3. Rotate the driveshaft 120 degrees in a clockwise direction and take another reading.
4. Repeat this process until 3 readings have been taken.
5. Add the 3 readings together and divide the sum by 3 to get the average pinion gear height. Make note of this average measurement.

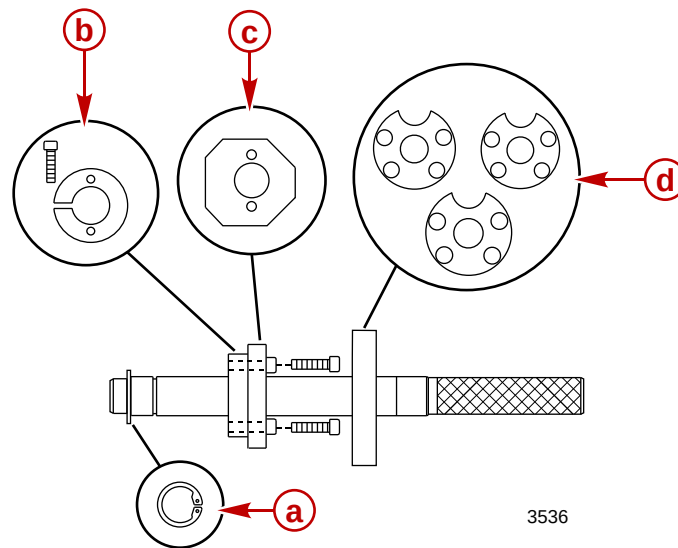
Pinion Gear	
Height	0.64 mm (0.025 in.)

6. If the average pinion gear height is not correct, add shims (to increase pinion height) or subtract shims (to lower pinion height) beneath the lower driveshaft tapered bearing race.
7. Reinstall removed components and retorque retainer to specifications.

Description	Nm	lb.in.	lb.ft
Retainer	135.5		100

8. Rotate the driveshaft at least 3 full turns in a clockwise direction. Recheck the pinion gear height. If pinion height is not within specification, adjust shim thickness and recheck. Repeat this process until the average pinion height is within specification.

Checking and Adjusting using Pinion Gear Locating Tool 91-12349A05



a - Retaining ring - relocate to first groove for 2.6 Liter gearcase

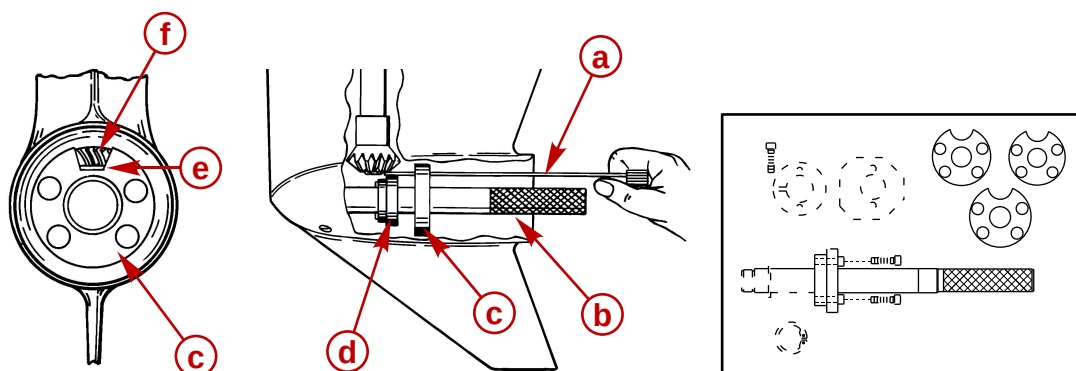
b - Split collar

c - Gaging block - use flat #4 for 2.6 Liter gearcase

d - Locating disc - use disc #2 for 2.6 Liter gearcase

NOTE: The forward gear assembly must be installed when using Pinion Gear Locating Tool 91-12349A05.

1. Install retaining ring on pinion height tool into first groove of arbor.
2. Using Disc #2 and Flat #4, install Pinion Gear Locating Tool into gearcase.



a - Feeler gauge

b - Pinion Gear Locating Tool

c - Disc #2

d - Flat #4

e - 0.64 mm (0.025 in.)

f - Pinion gear

Pinion Gear Locating Tool

91-12349A05

NOTE: Take the following measurements at three locations, rotating the driveshaft 120 degrees between each reading (always rotate the driveshaft in a clockwise direction).

3. Insert the thickest feeler gauge that fits snugly between one tooth of the pinion gear and high point of the shimming tool.
4. Rotate the driveshaft 120 degrees in a clockwise direction and take another reading.
5. Repeat this process until three readings have been taken.
6. Add the three readings together and divide the sum by three to get the average pinion gear height. Make note of this average measurement.

Pinion Gear	
Height	0.64 mm (0.025 in.).

7. If the average pinion gear height is not correct, add or subtract shims beneath the lower driveshaft tapered bearing race.
8. Reinstall removed components and retorquer retainer to specifications.

Description	Nm	lb.in.	lb.ft
Retainer	135.5		100

9. Rotate the driveshaft at least 3 full turns in a clockwise direction. Recheck the pinion gear height. If pinion height is not within specification, adjust shim thickness and recheck. Repeat this process until the average pinion height is within specification.

Forward Gear Backlash

Forward Gear	
Backlash	0.457 mm to 0.685 mm (0.018 in. - 0.027 in.)

NOTE: If backlash has already been checked and it was determined that it needs to be adjusted, (see Checking Forward Gear Backlash), adding or subtracting 0.03 mm (0.001 in.) shims will change the gear backlash by the same amount.

Example 1 (if backlash is too high)	
If forward backlash checks:	1.02 mm (0.040 in.)
(Subtract):	0.56 mm (0.022 in.)
Add this quantity of shims:	0.46 mm (0.018 in.)
Provides backlash of:	0.56 mm (0.022 in.)

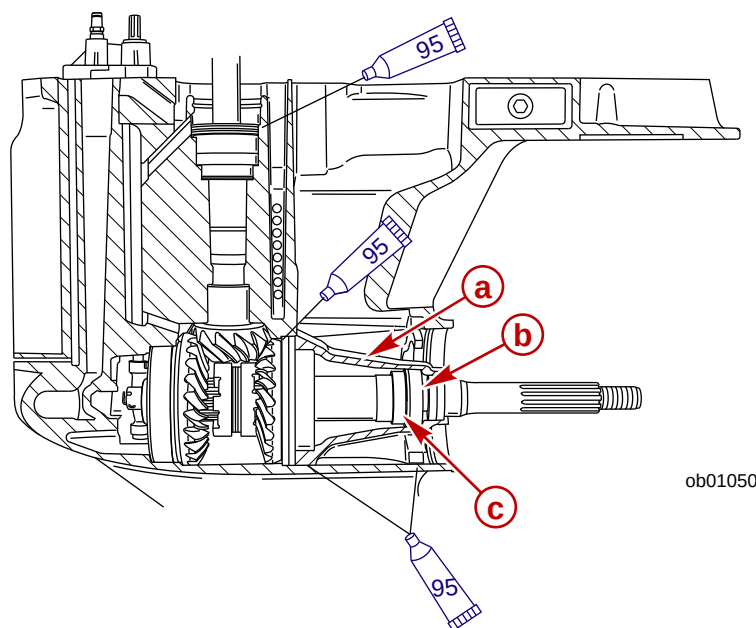
Example 2 (if backlash is too low)	
Backlash checks:	0.25 mm (0.010 in.)
Subtract this quantity of shims:	0.31 mm (0.012 in.)
Provides backlash of:	0.56 mm (0.022 in.)

1. Install propeller shaft preload spacer onto propeller shaft.

NOTE: Propeller shaft preload shims will be installed when checking propeller shaft preload, following.

2. Place the bearing carrier assembly into the gear housing being careful to align the rear propeller shaft bearing with the propeller shaft. It may be necessary to turn the driveshaft to align the teeth of the pinion and reverse gears.

3. Fill the bearing carrier retainer nut threads and corresponding gear housing threads with 2-4-C with Teflon. Start the retainer into the gear housing threads and screw it down fully by hand.

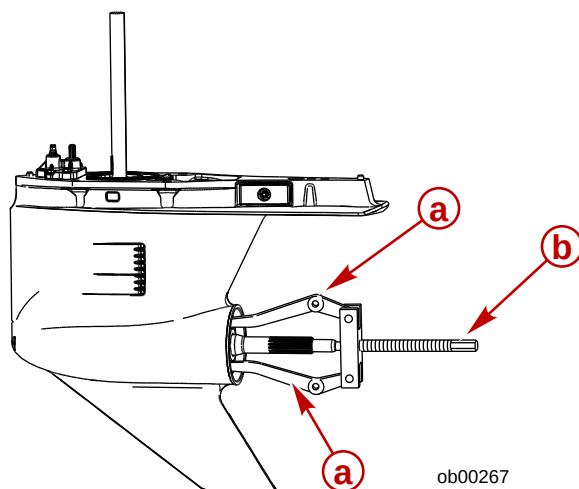


a - Bearing carrier assembly
b - Propeller shaft bearing

c - Preload spacer

Tube Ref No.	Description	Where Used	Part No.
	2-4-C Marine Lubricant with Teflon	Bearing carrier retainer nut threads and corresponding gear housing threads, bearing carrier O-ring, upper driveshaft bearing retainer threads	92-802859A1

4. Apply forward pressure to propeller shaft as follows:
- Attach Puller Jaws Assembly onto bearing carrier bosses and propeller shaft.
 - Torque the puller bolt to specification. Rotate driveshaft three full turns clockwise and retorque the bolt to specification.

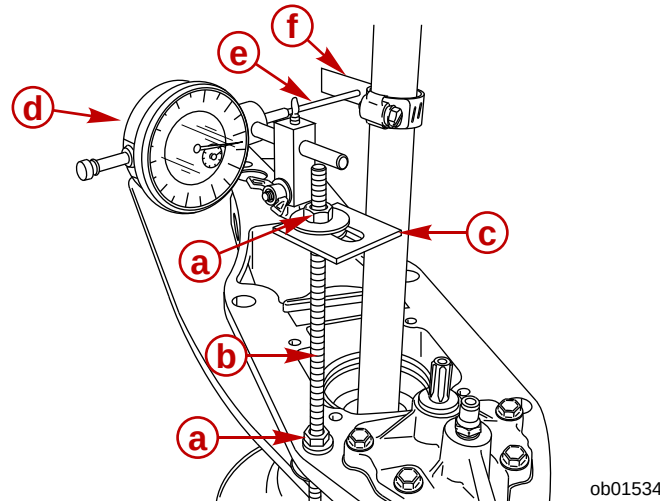


a - Puller Jaws Assembly

b - Puller Bolt

Puller Jaws Assembly	91-46086A1		
Puller Bolt	91-85716		
Description	Nm	lb.in.	lb.ft
Propeller shaft torque	5.5	50	

5. Install a dial indicator and align the dial indicator pointer so that it is perpendicular to and touching the I mark on the dial indicator tool. Tighten the indicator tool onto the driveshaft and rotate the driveshaft so that the needle in the dial makes at least one full revolution and comes to "0" on the dial indicator scale.



- a - Nuts (4) (obtain locally)
b - Threaded rod - 9.5 mm (3/8 in.)
obtain locally
c - Dial Indicator Holding Tool
d - Dial Indicator
e - Indicator Pointer
f - Backlash Indicator Rod

Dial Indicator Holding Tool	91-83155
Dial Indicator	91-58222A1
Backlash Indicator Rod	91-78473

6. Take the backlash readings by lightly turning the driveshaft back and forth, (no movement should be noticed at the propeller shaft).
 - a. Observe the dial indicator and record the reading.
 - b. Loosen the indicator tool and rotate the driveshaft 90 degrees in a clockwise direction.
 - c. Repeat step 2 above and take and record another reading. Repeat step 3 until a total of 4 backlash readings have been taken.
7. Add the four readings together and divide the sum by four. This is your average backlash.

Forward Gear	
Average Backlash	0.457 mm - 0.685 mm (0.018 in. - 0.027 in.)

8. If backlash is less than the specified minimum, remove shims from in front of forward gear bearing race to obtain correct backlash. When reinstalling pinion nut, apply Loctite 271 to threads of nut.
9. If backlash is more than the specified maximum, add shims in front of forward gear bearing race to obtain correct backlash. When reinstalling pinion nut, apply Loctite 271 to threads of nut.

Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	Threads of pinion nut	92-809819

NOTE: By adding or subtracting 0.025 mm (0.001 in) shim, the backlash will change approximately 0.025 mm (0.001 in).

10. Remove bearing carrier removal tool and puller bolt.

Reverse Gear Backlash

Reverse Gear	
Backlash	1.27 mm to 1.47 mm (0.050 in. to 0.058 in.)

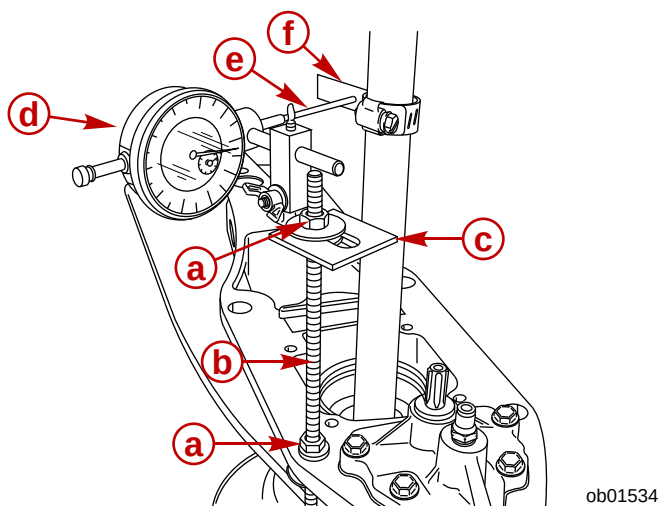
Although reverse gear backlash is not adjustable, it may be checked as follows:

NOTE: Pinion height must be set before checking reverse gear backlash.

NOTE: Torque bearing carrier retainer nut to specification.

Description	Nm	lb. in.	lb. ft.
Bearing carrier retainer nut	285		210

1. Apply backward pressure on the propeller shaft by holding shift crank against reverse gear.
2. Install a dial indicator and align the dial indicator pointer so that it is perpendicular to and touching the I mark on the dial indicator tool. Tighten the indicator tool onto the driveshaft and rotate the driveshaft so that the needle in the dial makes at least one full revolution and comes to "0" on the dial indicator scale.



- a** - Nuts (4) (obtain locally)
b - Threaded rod - 9.5 mm (3/8 in.)
 obtain locally
c - Dial Indicator Holding Tool

- d** - Dial Indicator
e - Indicator pointer
f - Backlash Indicator Rod

Dial Indicator Holding Tool	91-83155
Dial Indicator	91-58222A1
Backlash Indicator Rod	91-78473

3. Take the backlash readings by lightly turning the driveshaft back and forth, so as to feel the backlash between the gears, (no movement should be noticed at the propeller shaft).

- a. Observe the dial indicator and record the reading.
- b. Loosen the indicator tool and rotate the driveshaft 90 degrees in a clockwise direction.
- c. Repeat step 2 above and take and record another reading. Repeat step 3 until a total of 4 backlash readings have been taken.
4. Add the four readings together and divide the sum by four. This is your average backlash. If backlash is not as indicated, gearcase is not properly assembled or parts are excessively worn and must be replaced before returning gearcase to service.

Reverse Gear	
Average Backlash	1.27 mm - 1.47 mm (0.050 in. - 0.058 in.)

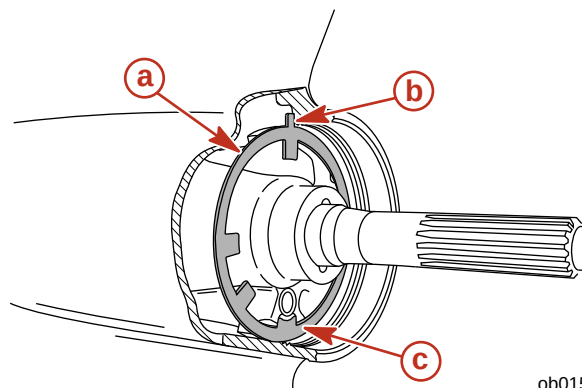
5. Remove the backlash indicator tool. Remove the dial indicator and all its mounting components.

Propeller Shaft Bearing Preload

NOTE: All gear housing components must be installed and correctly shimmed before checking propeller shaft bearing preload. Propeller shaft tapered roller bearing must be properly seated in race during installation. Driveshaft retainer should be torqued to specification.

Description	Nm	lb. in.	lb. ft.
Driveshaft retainer	135		100

1. Remove bearing carrier.
2. Slide preload spacer off propeller shaft.
3. Install (retained) propeller shaft preload shims onto propeller shaft. If shims were lost, start with 0.9 mm (0.035 in.) shim thickness.
4. Reinstall preload spacer onto propeller shaft.
5. Reinstall bearing carrier, aligning rear propeller shaft bearing with propeller shaft. It may be necessary to turn the driveshaft to align the teeth of the pinion with reverse gear.
6. Insert the small rectangular tab of the tab washer into its corresponding slot in the gearcase at the 12 o'clock position above the bearing carrier while aligning the u-shaped tab of the tab washer with its corresponding slot below the lubricant fill screw in the bearing carrier.



a - Tab washer
b - Rectangular tab

c - U-shaped tab

7. With gear housing in neutral, torque bearing carrier retainer nut to initial specification.

8. Rotate propeller shaft several times to seat propeller shaft tapered roller bearings in their races.
9. Torque bearing carrier retainer nut to final specification.

Description		Nm	lb. in.	lb. ft.
Bearing carrier retainer nut	First	135		100
	Final	284		210

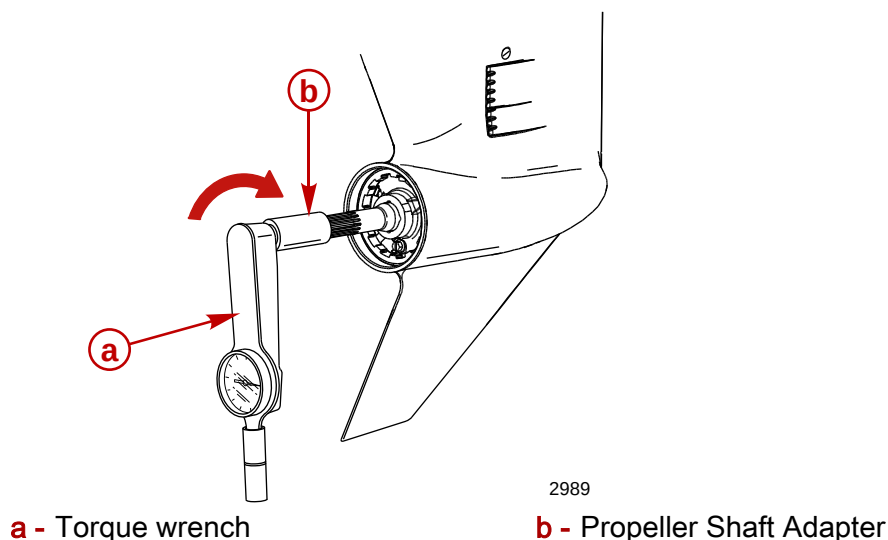
10. Install Propeller Shaft Adapter and using a torque wrench, rotate propeller shaft in the direction of normal rotation with a slow steady motion.

11. Verify rolling torque is within specification for new or used bearings.

Description	Nm	lb. in.	lb. ft.
Bearing rolling torque (new bearings)	1.1 - 1.8	10 - 16	
Bearing rolling torque (used bearings)	0.45 - 1.1	4 - 10	

NOTE: Preload will change approximately 0.056 Nm (1/2 lb. in.) of rolling torque per 0.025 mm (0.001 in.) of shim change.

12. If rolling torque is too high, remove shims from propeller shaft ahead of tapered bearing/spacer in bearing carrier. If torque is too low, add shims.



Propeller Shaft Adapter	91-61077
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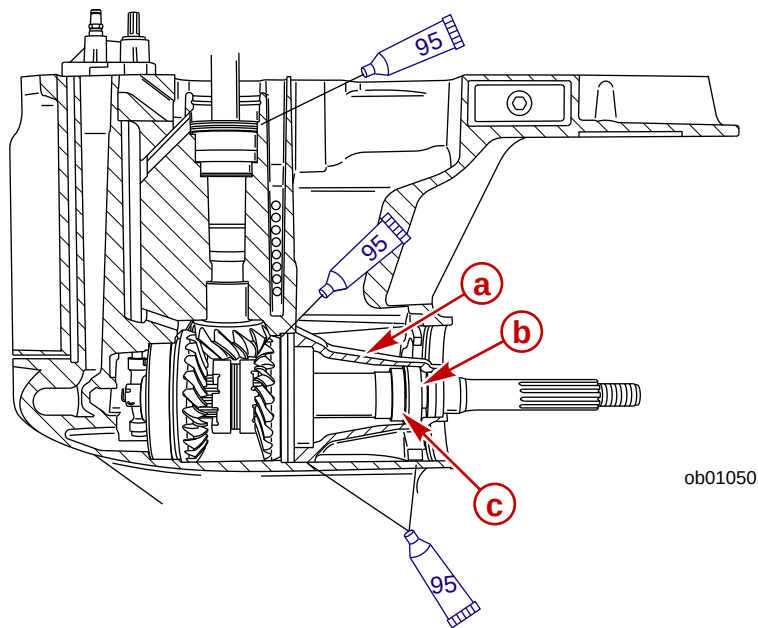
NOTE: If shims are changed, torque bearing carrier to initial specification. Rotate propeller shaft several times to seat propeller shaft tapered bearing. Re-torque retainer nut to final specification. Use torque wrench to check rolling torque. Repeat this procedure each time shims are changed.

Description		Nm	lb. in.	lb. ft.
Bearing carrier	First	135		100
	Final	284		210

Bearing Carrier Final Installation

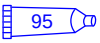
1. Remove the bearing carrier and lubricate the following as specified:
 - a. Lubricate the carrier O-ring with 2-4-C with Teflon.

- b. Lubricate both the forward and aft outer diameters of the bearing carrier and gearcase area where carrier will seat with 2-4-C with Teflon.
- c. Fill the space between the carrier oil seals with 2-4-C with Teflon.



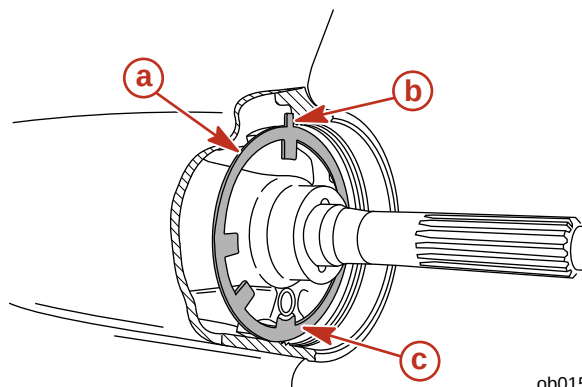
a - Bearing carrier
b - Propeller shaft bearing

c - Preload spacer

Tube Ref No.	Description	Where Used	Part No.
	2-4-C Marine Lubricant with Teflon	Carrier O-ring, forward and aft outer diameters of bearing carrier, gearcase area where carrier will seat, space between carrier seals	92-802859A1

2. Place the bearing carrier assembly into the gear housing, being careful to align rear propeller shaft bearing. It may be necessary to turn the driveshaft to align the teeth of the pinion and the reverse gears.
3. Lubricant fill screw in bearing carrier should be located at the 6 o'clock position.

4. Insert the small rectangular tab of the tab washer into its corresponding slot in the gearcase at 12 o'clock position above the bearing carrier while aligning the u-shaped tab of the tab washer with its corresponding slot below the lubricant fill screw in the bearing carrier.



ob01554

a - Tab washer
b - Rectangular tab

c - U-shaped tab

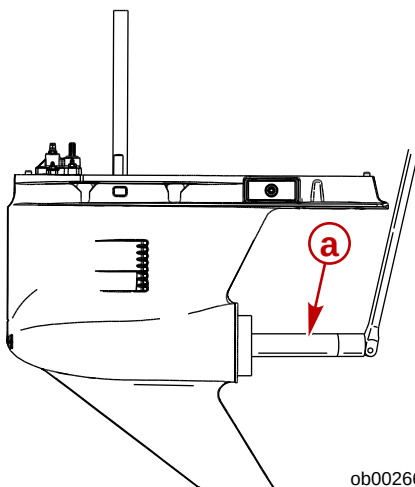
5. Fill the bearing carrier retainer nut threads and corresponding gear housing threads with 2-4-C with Teflon. Start the retainer into the gear housing threads and screw it down fully by hand.

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Bearing carrier retainer nut threads and corresponding gear housing threads	92-802859A1

IMPORTANT: Before torquing bearing carrier retainer, gearcase must be bolted to driveshaft housing or securely fastened in a gearcase holding fixture to avoid possible damage to gear housing.

NOTE: Torque retainer nut to initial specification first. Rotate propeller shaft several times to seat tapered roller bearings. Retainer nut can then be torqued to final specification.

6. Torque the bearing carrier retainer to specification. If one tab does not align up in space between two of the notches, continue to tighten retainer until alignment is achieved. Do not loosen retainer to achieve alignment.



ob00266

a - Bearing Carrier Retainer Nut Wrench

Bearing Carrier Retainer Nut Wrench		91-61069T		
Description		Nm	lb. in.	lb. ft.
Bearing carrier retainer nut	First	135.5		100
	Final	285		210

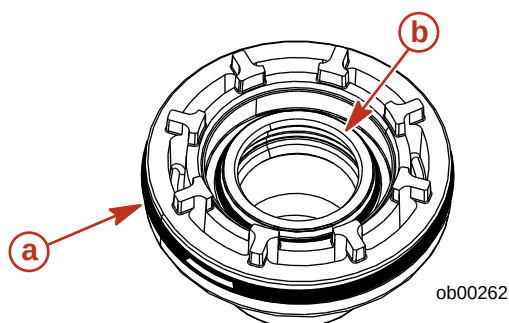
- Bend one tab aft (outward) into a space between two of the notches of the retainer. Bend all the remaining tabs forward (inward).

Oil Seal Carrier Installation

NOTE: Oil seal carrier maybe lightly tapped into position by sliding Driveshaft Bearing Retainer Wrench over the driveshaft.

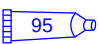
Driveshaft Bearing Retainer Wrench	91-43506T
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- Lubricate the oil seal carrier oil seal lips, space between seals and O-ring with 2-4-C with Teflon and install the oil seal carrier over the driveshaft and into the gearcase.

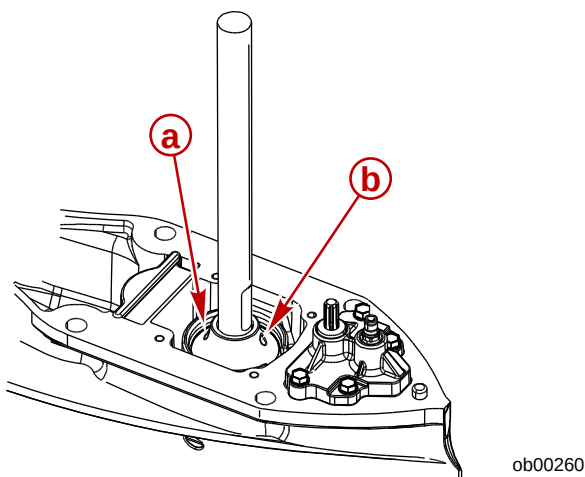


a - O-ring

b - Oil seal lips

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Oil seal carrier seal lips, space between oil seals and O-ring	92-802859A1

- Reinstall retaining ring above oil seal carrier.



a - Retaining ring

b - Oil seal carrier

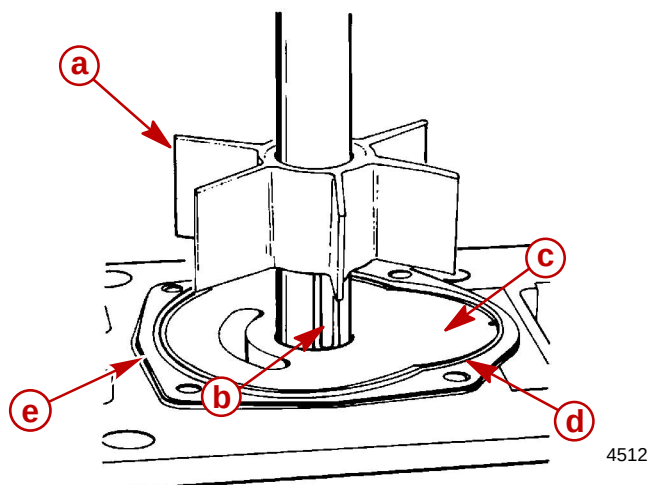
Water Pump Installation

- Install water pump base gasket.

2. Install water pump face plate.
3. Install water pump cover gasket.
4. Place a small amount of 2-4-C with Teflon on the flat surface of the impeller key and install the key onto the driveshaft keyway.

IMPORTANT: When using an impeller whose blades have taken a set, face the curl of the blades in a counterclockwise direction. Do not install the impeller with its blades oriented in a reversed direction from original rotation, or premature impeller failure will occur.

5. Assemble the water pump impeller onto the driveshaft and down over the key.

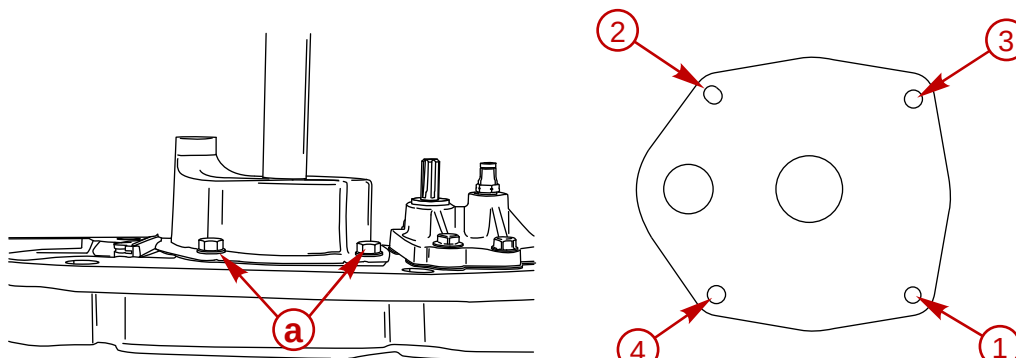


a - Impeller
b - Key
c - Face plate

d - Pump cover gasket (gray seal bead faces up)
e - Pump base gasket

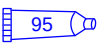
Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Flat surface of the impeller key	92-802859A1

6. Apply a light coat of 2-4-C with Teflon to the inside of the pump cover. Rotate the driveshaft in a clockwise direction, while pushing down on the water pump cover to ease the water pump cover over the impeller blades.
7. Hand start starboard front fastener first into the water pump assembly. Install the remaining 3 fasteners. Run all fasteners down and torque in sequence to specification.



a - Water pump cover screws (4)

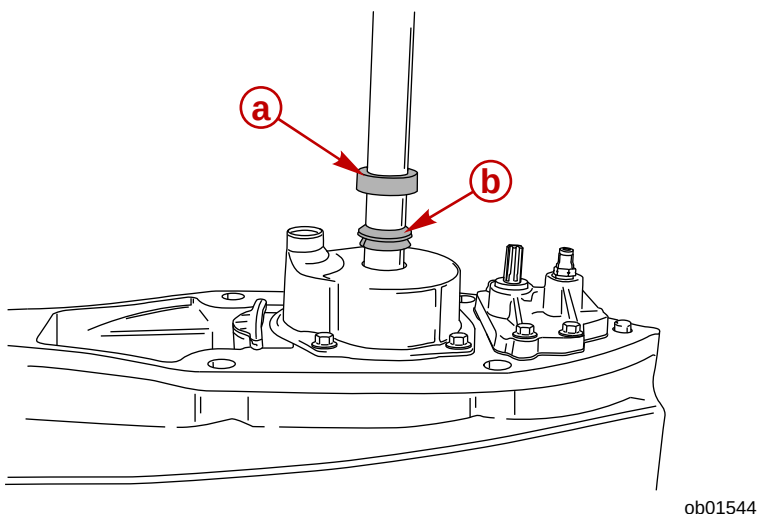
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Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Inside of water pump cover	92-802859A1

Description	Nm	lb. in.	lb. ft.
Water pump cover screws (4)	7	60	

IMPORTANT: If seal installed above pump housing is not at the proper height, air will be drawn into the pump resulting in overheating of the engine.

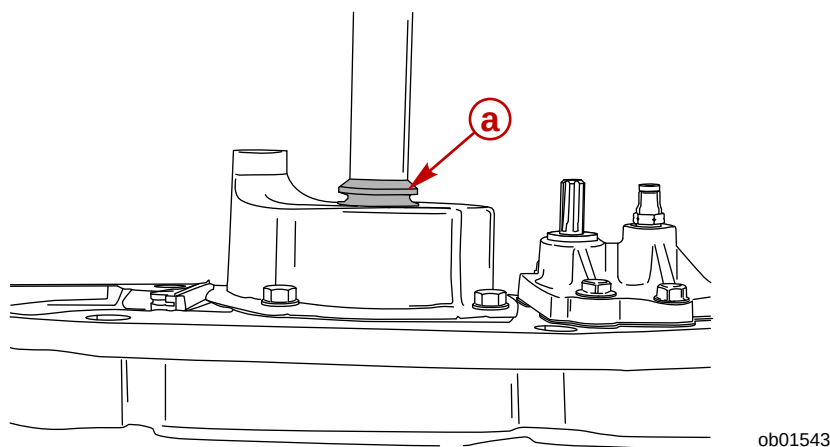
8. Using tool provided in Seal Kit or Water Pump Kit, press seal down over driveshaft (do not grease driveshaft) until tool seats against pump housing.



a - Tool

b - Seal

NOTE: If tool is not available, lightly press seal against housing until specified height is obtained.



a - Seal

Water Pump Cover	
Seal Height	8.9 mm $\pm$ 0.76 mm (0.350 in. $\pm$ 0.030 in.)

Gear Lubricant Filling Instructions

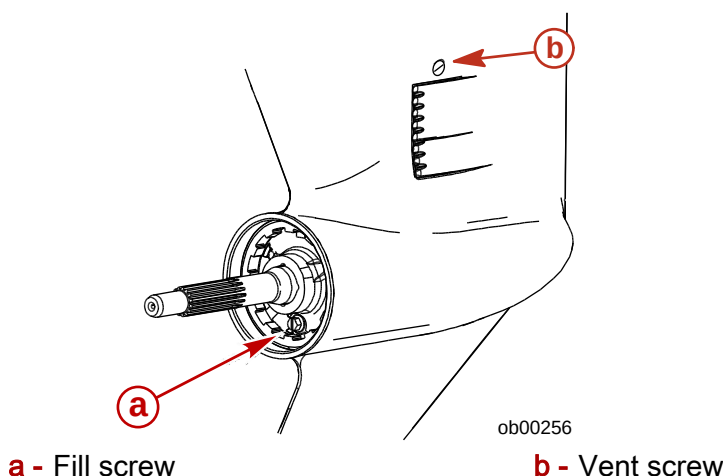
1. Inspect fill and vent sealing washers for cuts or abrasions. Replace washers if necessary.

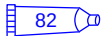
IMPORTANT: Never apply lubricant to gear housing without first removing vent screw, or gear housing cannot be filled because of trapped air. Fill gear housing only when housing is in a vertical position.

2. Slowly fill housing through fill hole with Premium Gear Lubricant until lubricant flows out of vent hole and no air bubbles are visible.
3. Install vent screw into vent hole.

IMPORTANT: Do not lose more than 30cc (1 fl. oz.) of gear lubricant while reinstalling fill screw.

4. Remove grease tube (or hose) from fill hole and quickly install fill screw into fill hole. Torque fill and vent screws to specification.



Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Gear housing	92-802846A1

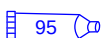
Description	Nm	lb. in.	lb. ft.
Fill and vent screws	6.8	60	

Installing Gear Housing to Driveshaft Housing

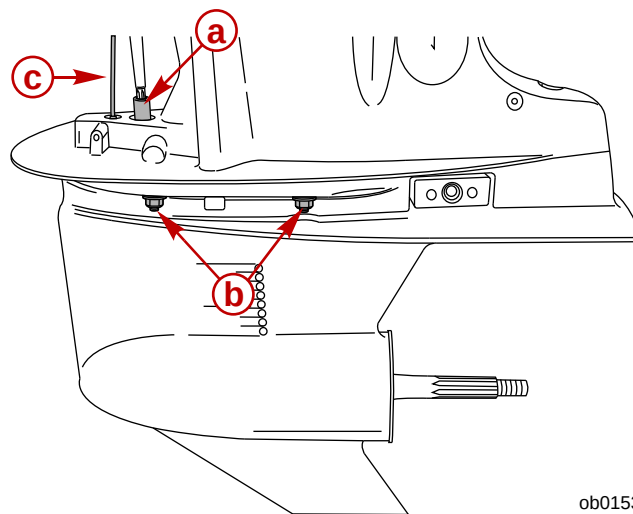
⚠ WARNING

To prevent accidental engine starting, remove and isolate spark plug leads from spark plugs before removing or installing gear housing.

1. Tilt engine to full up position and engage the tilt lock lever.
2. Apply a light coat of 2-4-C with Teflon onto driveshaft splines.
3. Apply a light coat of 2-4-C with Teflon onto shift shaft splines. Do not allow lubricant on top of shift shaft.

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Driveshaft splines; shift shaft splines	92-802859A1

4. Insert anodic plate bolt into hole in rear of gear housing to driveshaft housing machined surface.
5. Verify neutral position switch is in the neutral position. Verify that the gearcase is in the neutral position.
6. Position gear housing so that the driveshaft is protruding into driveshaft housing. If, while performing Step 7, the driveshaft splines will not align with crankshaft splines, lower the gearcase and turn the driveshaft slightly in a clockwise direction. Repeat as required until driveshaft splines match with crankshaft splines.
7. Move gear housing up toward driveshaft housing while aligning shift shaft splines with shift shaft coupler and water tube outlet on water pump cover with water tube coupler (in driveshaft housing).
8. Place flat washers onto studs (located on either side of driveshaft housing). Start a nut on these studs and tighten finger-tight.
9. Insert speedometer tube into speedometer tube coupler.

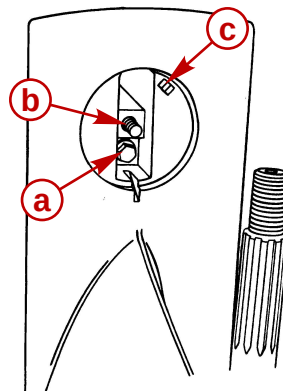


ob01535

- a** - Shift shaft coupler
b - Nuts and flat washers (2 each side)

- c** - Speedometer tube

10. Start screw at rear of gear housing inside trim tab recess. Do not tighten screw at this time.



ob01286

- a** - Screw
b - Anodic plate attaching bolt

- c** - Ribs (align carefully with anodic plate)

IMPORTANT: Do not force gearcase up into place with attaching nuts.

11. Evenly tighten two nuts which were started in Step 8. Torque to specification.

Description	Nm	lb. in.	lb. ft.
Nuts (2 each side)	75		55

12. After two nuts (located on either side of driveshaft housing) are tightened, check shift operation as follows:

- Turn ignition switch to the "ON" position and move remote control to forward gear position; propeller shaft should rotate clockwise and then lock (no ratcheting motion).
- Move remote control into neutral position. Propeller shaft should rotate freely clockwise/counterclockwise.
- Move remote control into reverse gear position; propeller shaft should rotate counterclockwise and then lock (no ratcheting motion).

IMPORTANT: If shifting operation is not as described, preceding, the gear housing must be removed and the cause corrected.

13. Install remaining washers and nuts onto drive shaft studs and torque to specification.

Description	Nm	lb. in.	lb. ft.
Gearcase attaching nut (2 each side)	75		55

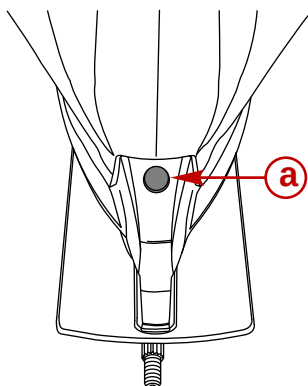
14. Torque screw (started in Step 10) to specification.

Description	Nm	lb. in.	lb. ft.
Screw (M12 x 35)	75		55

15. Position trim tab or anodic plate in gear housing. Align grooves of trim tab with ribs in trim tab pocket. Adjust to position in which it had previously been installed, and while holding trim tab, torque screw to specification

Description	Nm	lb. in.	lb. ft.
Screw (0.437 - 14 x 1 - 3/4 in.)	54		40

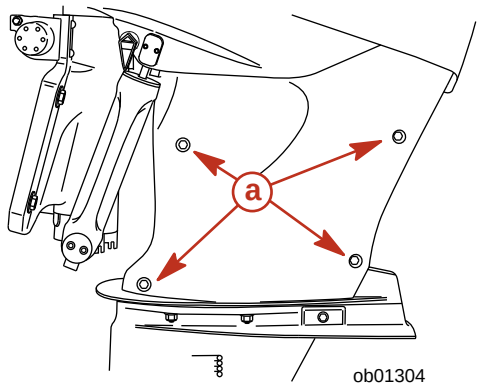
16. Install plastic cap into trim tab bolt opening at rear edge of driveshaft housing.



ob01533

a - Cap

17. Reinstall the port driveshaft housing chap. Torque screws to specification.



a - Screws (4) or (6) for XXL shaft

Description	Nm	lb. in.	lb. ft.
Driveshaft housing chap screws (4 or 6 each side)	6	53	

Lower Unit

Section 6B - Left Hand Rotation

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		6B-77

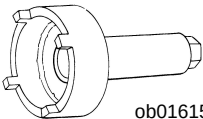
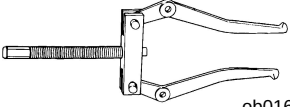
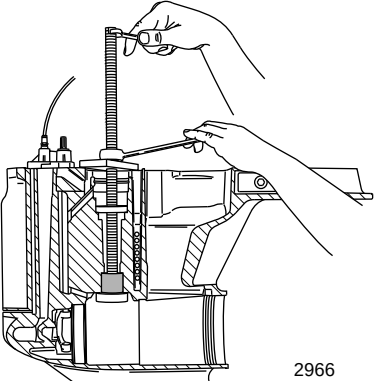
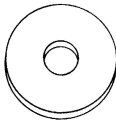
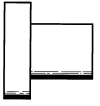
Gear Housing Specifications (Counter Rotation)

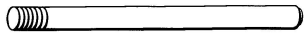
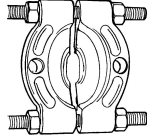
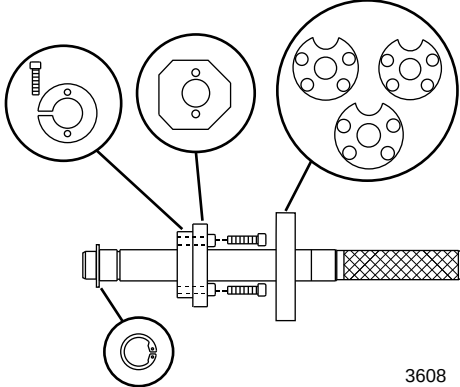
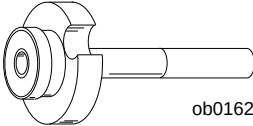
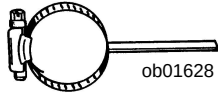
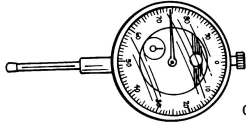
Gear Housing Specifications (Counter Rotation)	
Gear Ratio	1.85:1 (13/24 Teeth)
Gearcase Capacity	970 ml (32.8 fl.oz.)
Gear Lubricant Type	Premium Gear Lubricant
Pinion Height	0.635 mm (0.025 in.)
Forward Gear Backlash	0.482 - 0.660 mm (0.019 - 0.026 in.)
Reverse Gear Backlash	1.27 - 1.47 mm (0.050 - 0.058 in.)
Water Pressure @ RPM	55 - 68.9 kPa (8 - 10 psi)
Gear Housing Pressure (without gear lubricant, 5 minutes without leakage)	103.4 kPa (15 psi)

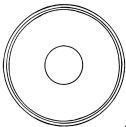
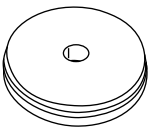
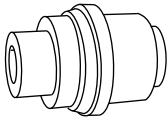
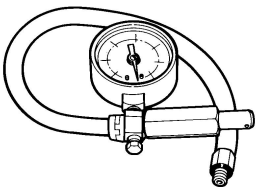
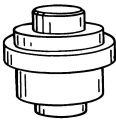
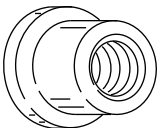
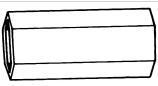
Lubricant, Sealant, Adhesives

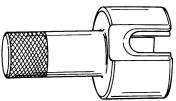
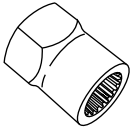
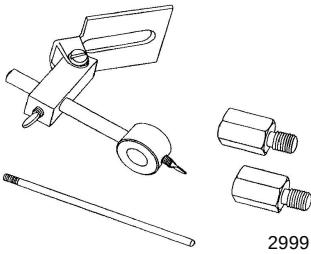
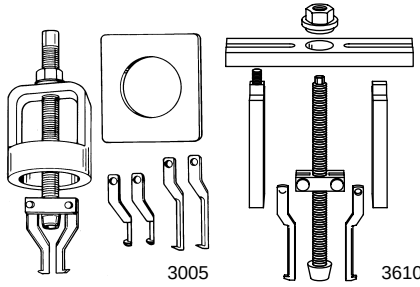
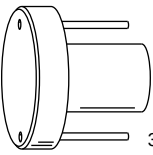
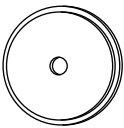
Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	Pinion gear nut threads	92-809819
 19	Perfect Seal	Speedometer connector threads	92-34227-1
 82	Premium Gear Lubricant	Bore that roller bearing is pressed into Inside diameter of driveshaft tapered bearings Outside diameter of reverse gear Pinion bearing bore Reverse gear bearing cup bore Outside diameter of pinion bearing Gear housing	92-802846A1
 95	2-4-C Marine Lubricant with Teflon	Oil seal lips and between oil seals Bore that roller bearing is pressed into Bearing Carrier O-ring Seat of shift shaft bushing O-ring diameter and lip of oil seal Hold pinion needle bearings in place Retainer threads Bearing carrier retainer threads, corresponding gear housing threads and upper driveshaft bearing retainer threads Carrier O-ring, forward and aft outer diameters of bearing carrier, gearcase area where carrier will seat, space between carrier seals Bearing carrier retainer nut threads and corresponding gear housing threads Oil seal carrier seal lips, space between oil seals and O-ring Flat surface of the impeller key Inside of water pump cover Driveshaft splines; shift shaft splines	92-802859A1
 134	Loctite 380	Outer diameter of oil seals Outer diameter of oil seal	Obtain Locally

Special Tools - Counter Rotation Gearcase

Bearing Carrier Retainer Nut Wrench	91-61069T
 ob01615	Installs and removes the bearing carrier retainer nuts.
Puller Jaws Assembly Puller Bolt	91-46086A1 91-85716
 ob01616	Removes bearing carrier and bearing races.
Slide Hammer Puller	91-34569A1
 ob01617	Removes bearings and bearing races.
Bearing Removal and Installation Kit	91-31229A7
 2966	Installs and removes the bearings in all gearcases. 91-31229A7 tool assembly includes the following components: 11-24156 Hex Nut 12-34961 Washer 91-15755T Bearing Carrier 91-29310 Plate 91-29610 Pilot Plate 91-30366T1 Mandrel 91-31229 Puller Shaft 91-32325T Driver Head 91-32336 Driver Needle Bearing 91-36379 Puller/Head Gear 91-36569T Driver Head 91-36571T Pilot Washer 91-37292 Roller Bearing 91-37311 Driver Head 91-37312 -Driver Head 91-37323 Driver Head Rod 91-37324 Pilot Washer 91-38628T Puller/Driver Head 91-52393 Driver Needle Bearing 91-52394 Head Pull Rod
Pilot Washer	91-36571T
 ob01619	Used in pinion gear and pinion bearing installation.
Puller/Driver Head	91-38628
 ob01622	Used in pinion gear and pinion bearing installation.

Driver Rod	91-37323
 ob01623	Used in pinion gear and pinion bearing installation.
Universal Puller Plate	91-37241
 ob01624	Removes bearings from gears and the driveshaft.
Pinion Gear Locating Tool	91-12349A05
 3608	Measures pinion gear height.
Pinion Gear Locating Tool	91-56048001
 ob01627	Measures pinion gear height.
Backlash Indicator Rod	91-78473
 ob01628	Checks the gear backlash on the 1.86:1 ratio gear housings.
Dial Indicator	91-58222A1
 ob01629	Measures gear backlash and pinion gear location.
Driveshaft Bearing Retainer Wrench	91-43506T
 ob01630	Removes and installs the threaded bearing retainer.

Dial Indicator Holding Tool	91-89897
 ob01631	Secures the dial indicator to gear housing when checking backlash.
Bearing Cup Driver	91-885592T
 ob01625	Installs reverse gear bearing cup.
Seal Driver Guide	91-889845
 ob01670	Aids in the installation of bearing carrier seals.
Bearing Cup Driver/Oil Seal Installer Tool	91-888414T
 6229	Installs bearing carrier cup and seals.
Leakage Tester Kit	FT8950
 ob01632	Checks gear housing for leakage prior to filling with gear lubricant.
Oil Seal Driver	91-889844T
 ob01633	Installs seals in driveshaft seal carrier.
Driver Head	91-36569T
 ob01634	Used in pinion gear and bearing installation.
Propeller Shaft Adapter	91-61077
 ob01635	Provides a wrench surface to turn the propeller shaft.

Pinion Nut Wrench	91-61067003
 ob01639	Holds the pinion nut when removing the pinion gear and driveshaft.
Driveshaft Holding Tool	91-889958T
 ob01206	Holds driveshaft during pinion nut removal on the Verado models.
Dial Indicator Adaptor	91-83155
 2999	Attaches the dial indicator to the gearcase when checking backlash.
Bearing Puller Assembly	91-83165T
 3005 3610	Removes bearings, bearing carriers, and bearing races.
Bearing Removal Tool	91-816245
 3655	Removes forward gear bearing in bearing adaptor.
Guide Plate	91-816243
 4481	Centers the rod used to drive in the forward gear bearing on a standard rotation gearcase, and the reverse gear bearing on a counter rotation gearcase.
Oil Drain Funnel	91-892866A01
 4993	Diverts draining engine oil from contacting the anti-splash and anti-cavitation plates.

Notes:



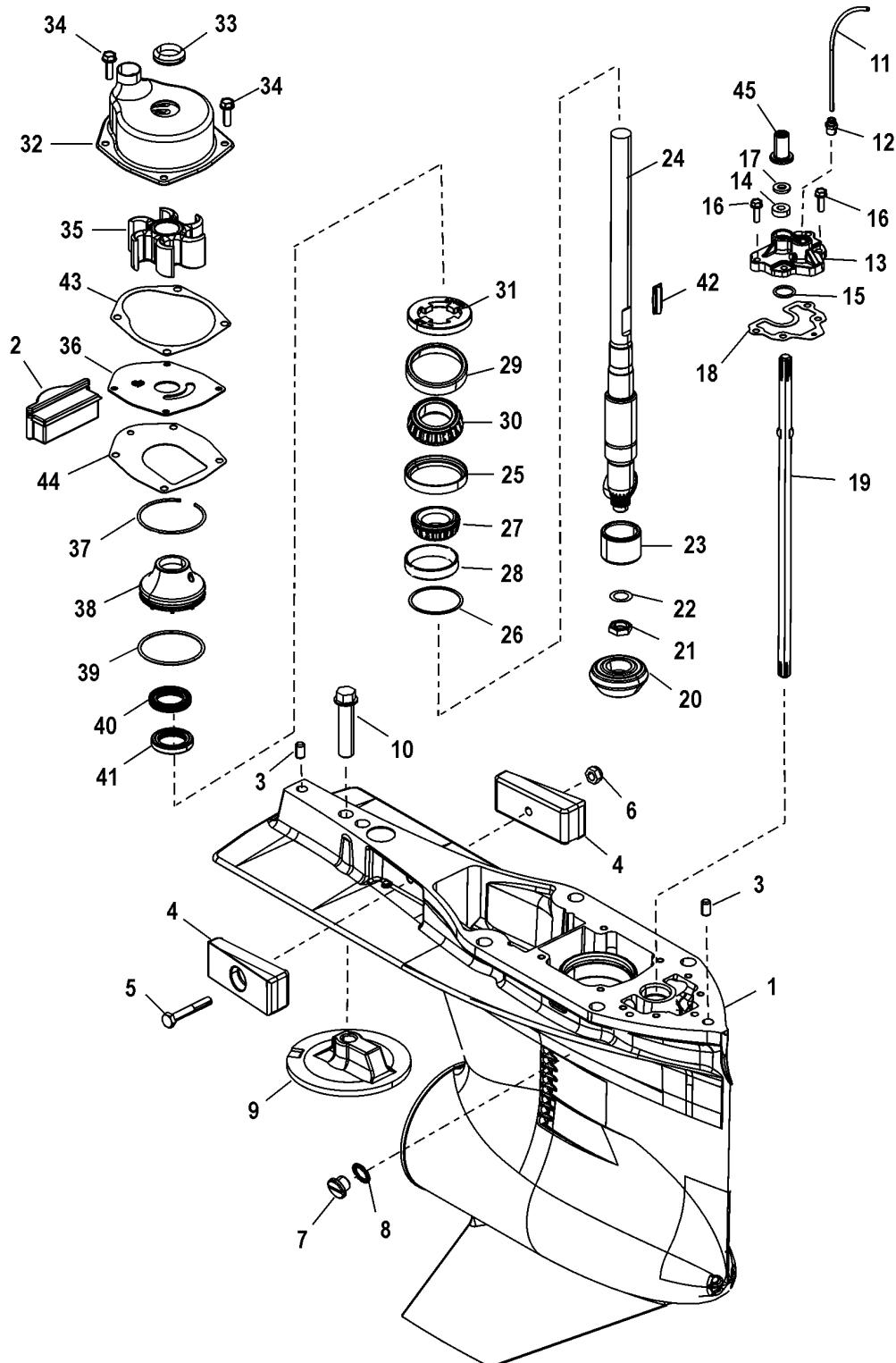
Gear Housing (Driveshaft)

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Gear housing			
2	1	Filler block			
3	2	Dowl pin			
4	2	Anode			
5	1	Screw (M6 X 40)			
6	1	Nut			
7	1	Screw	6.7	60	
8	1	Seal			
9	1	Anodic plate			
10	1	Screw (0.437-14 x 1-3/4 in)	54		40
11	1	Hose 17.7 cm (7 in.) (Long)			
		Hose 30.5 cm (12 in.) (X-long)			
		Hose 43.2 cm (17 in.) (XX-Long)			
12	1	Fitting	2.8	25	
13	1	Cover assembly			
14	1	Oil seal			
15	1	O-ring			
16	4	Screw (M6 x 20)	6.7	60	
17	1	Washer			
18	1	Gasket			
19	1	Shift shaft - Lower			
20	1	Pinion gear (13 Teeth)			
21	1	Nut (5/8-18)	101		75
22	1	Washer			
23	1	Roller bearing			
24	1	Driveshaft (Long)			
		Driveshaft (X-Long)			
		Driveshaft (XX-Long)			
25	1	Shim/Bearing assembly			
26	AR	Shim (0.002 through 0.050)			
27	1	Roller bearing assembly			
28	1	Cup			
29	1	Roller bearing assembly			
30	1	Cup			
31	1	Retainer	135.5		100
32	1	Housing - Water pump			
33	1	Face seal			
34	4	Screw (M6 x 20)	6.7	60	
35	1	Impeller			
36	1	Face plate			

Left Hand Rotation

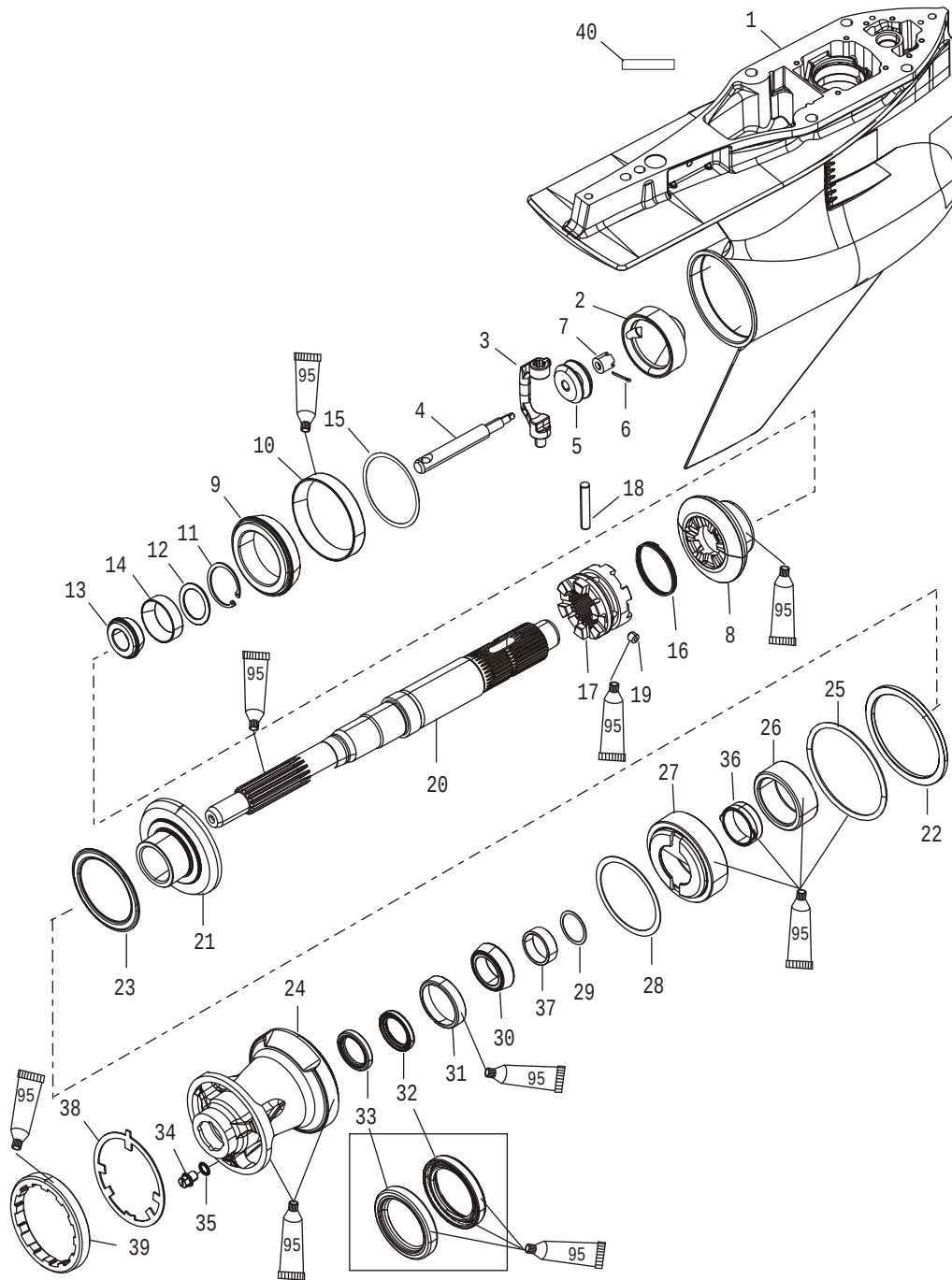
Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
37	1	Retaining ring			
38	1	Oil seal carrier			
39	1	O-ring			
40	1	Oil seal			
41	1	Oil seal			
42	1	Key			
43	1	Gasket			
44	1	Gasket			
45	1	Coupling			

Gear Housing (Driveshaft)



2380

Gear Housing (Prop Shaft) (Counter Rotation)



2467

Gear Housing (Prop Shaft) (Counter Rotation)

Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	1	Gear housing			
2	1	Plug	135		100
3	1	Crank - Shifter			
4	1	Shaft - Shift spool			
5	1	Spool			
6	1	Cotter pin			
7	1	Sleeve adjusting			
8	1	Reverse gear			
9	1	Roller bearing			
10	1	Cup			
11	1	Retaining ring			
12	1	Thrust washer			
13	1	Roller bearing assembly			
14	1	Cup			
15	AR	Shim (0.002 through 0.050 in.)			
16	1	Spring			
17	1	Clutch			
18	1	Cross pin			
19	1	Detent pin			
20	1	Prop shaft			
21	1	Forward gear			
22	1	Thrust ring			
23	1	Thrust bearing			
24	1	Bearing carrier			
25	1	O-ring			
26	1	Needle roller bearing			
27	1	Bearing adapter			
28	AR	Shim (0.002 through 0.045 in.)			
29	AR	Shim (0.030 through 0.070 in.)			
30	1	Roller bearing assembly			
31	1	Cup			
32	1	Oil seal			
33	1	Oil seal			
34	1	Screw	6.8	60	
35	1	Seal			
36	1	Adapter			
37	1	Spacer			
38	1	Keyed washer			
39	1	Retainer			
40	1	Decal - Counter rotation			

General Service Recommendations

There may be more than one way to disassemble or reassemble a particular part, therefore, it is recommended that the entire procedure be read prior to repair.

IMPORTANT: Read the following before attempting any repairs.

In many cases, disassembly of a sub-assembly may not be necessary, until cleaning and inspection reveals that disassembly is required for replacement of one or more components.

Service procedure order in this section is a normal disassembly/reassembly sequence. It is suggested that the sequence be followed without deviation to assure proper repairs. When performing partial repairs, follow the instructions to the point where the desired component can be replaced, then proceed to reassembly and installation of that component in the reassembly part of this section. Use the **Table of Contents** (on back of section divider) to find correct page number.

Threaded parts are right hand (RH), unless otherwise indicated.

When holding, pressing or driving is required, use soft metal vise jaw protectors or wood for protection of parts. Use a suitable mandrel (one that will contact only the bearing race) when pressing or driving bearings.

Whenever compressed air is used to dry a part, verify that no water is present in air line.

Bearings

Upon disassembly of gear housing, all bearings must be cleaned and inspected. Clean bearings with solvent and dry with compressed air. Air should be directed at the bearing so that it passes through the bearing. Do not spin bearing with compressed air, as this may cause bearing to score from lack of lubrication. After cleaning, lubricate bearings with Premium Gear Lubricant. Do not lubricate tapered bearing cups until after inspection.

Inspect all bearings for roughness, catches and bearing race side wear. Work inner bearing race in and out, while holding outer race, to check for side wear.

When inspecting tapered bearings, determine condition of rollers and inner bearing race by inspecting bearing cup for pitting, scoring, grooves, uneven wear, imbedded particles and/or discoloration from overheating. Always replace tapered bearing and race as a set. Inspect gear housing for bearing races that have spun in their respective bores. If race has spun, gear housing must be replaced.

Roller bearing condition is determined by inspecting the bearing surface of the shaft that the roller bearing supports. Check shaft surface for pitting, scoring, grooving, imbedded particles, uneven wear and/or discoloration from overheating. The shaft and bearing must be replaced, if the conditions described are found.

Shims

Keep a record of all shim amounts and location during disassembly to aid in reassembly. Be sure to follow shimming instructions during reassembly, as gears must be installed to correct depth and have the correct amount of backlash to avoid noisy operation and premature gear failure.

Seals

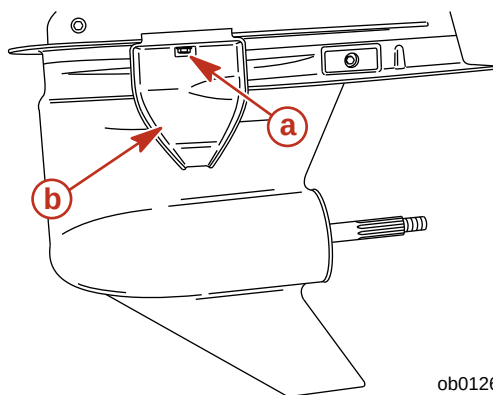
As a normal procedure, all O-rings and oil seals should be replaced without regard to appearance. To prevent leakage around oil seals, apply Loctite 271 to outer diameter of all metal case oil seals. When using Loctite on seals or threads, surfaces must be clean and dry. To ease installation, apply 2-4-C with Teflon on all O-rings. To prevent wear, apply 2-4-C with Teflon on I.D. of oil seals.

Gearcase Removal

⚠ WARNING

To prevent accidental engine starting, remove battery cables from battery before removing or installing gear housing.

1. Verify position of shift switch. Gearcase must be in same position when reinstalling gearcase to driveshaft housing.
2. Drain engine oil pan of oil. Failure to drain oil prior to removing gearcase will result in approximately 0.9463 liter (1 qt.) of oil leakage when gearcase is removed.



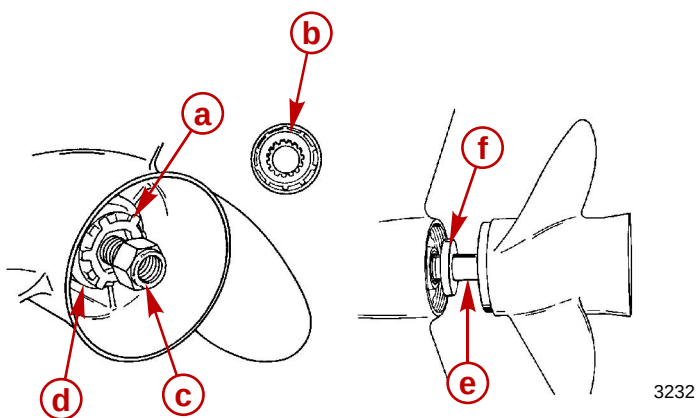
ob01264

a - Drain plug/seal washer

b - Oil drain funnel

Oil Drain Funnel	91-892866A01
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3. Tilt outboard to trailer full up position and engage tilt lock lever.
4. Bend tabs of propeller tab washer away from thrust hub (rear), then remove propeller locknut, tab washer, thrust hub (rear), propeller and thrust hub (forward) from propeller shaft.



a - Tab washer

b - Continuity washer (if equipped)

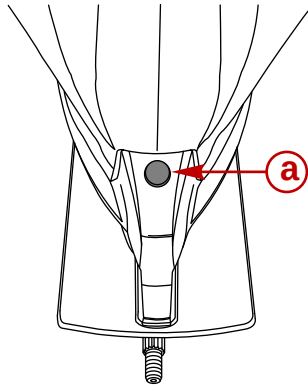
c - Propeller nut

d - Thrust hub (rear)

e - Propeller shaft

f - Thrust hub (forward)

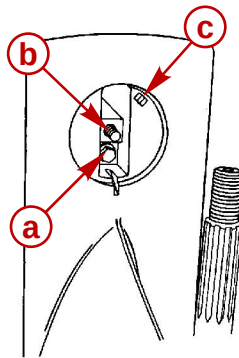
5. Remove rubber plug at rear edge of driveshaft housing. Remove bolt (13 mm) that secures anodic plate and remove plate from gear housing.



ob01533

a - Rubber plug

6. Once plate is removed, remove bolt (14 mm) from inside of cavity.



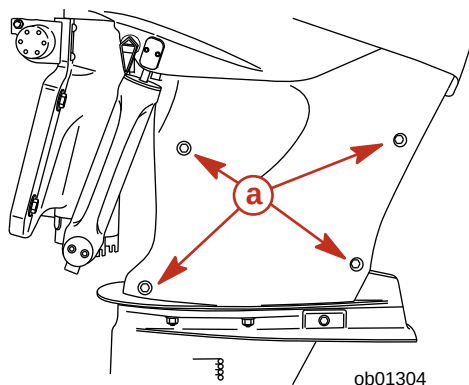
3233

a - Screw (inside cavity)

c - Ribs

b - Screw (secures anodic plate)

7. Remove screws (4 or 6 for XXL shaft) securing port chap to driveshaft housing and remove chap.

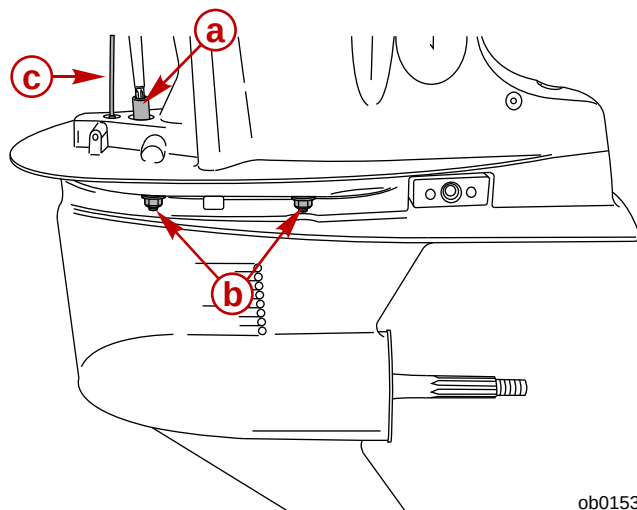


ob01304

a - Driveshaft housing chap screws (4 or 6 for XXL shaft)

8. While pressing in on speedometer hose junction, pull out on hose to disconnect.
9. Loosen the side mounting locknuts. Do not attempt to remove one nut before opposite side is loosened sufficiently, or gear housing could be damaged

10. Pull gear housing away from driveshaft housing as far as the loosened nuts (in Step 8) will allow, then remove loosened nuts. Do not allow gear housing to fall, as it now is free.



ob01535

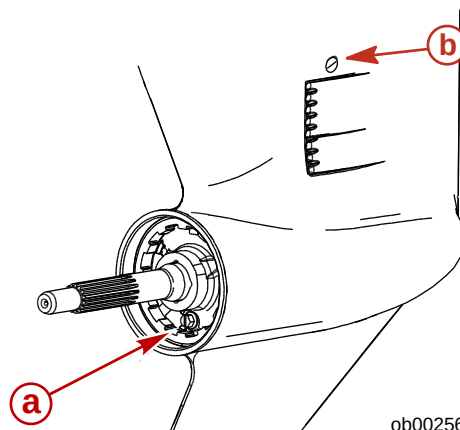
a - Shift shaft coupler**b** - Nuts and washers (2 each side)**c** - Speedometer hose

11. Pull gear housing from driveshaft housing.

Gearcase Serviceability Inspection

Draining and Inspecting Gear Housing Lubricant

1. Place gear housing in a suitable holding fixture or vise with the driveshaft in a vertical position.
2. Position a clean drain pan under gear housing and remove fill and vent screws from gear housing with a 10 mm socket or slot screw driver.



ob00256

a - Fill screw**b** - Vent screw

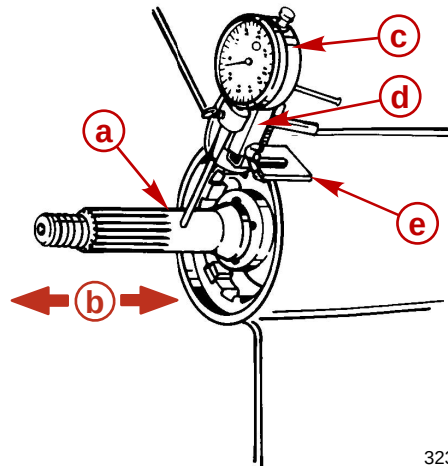
3. Inspect gear lubricant for metal particles. Presence of a small amount of fine metal particles (resembling powder) indicates normal wear. Presence of larger particles (or a large quantity of fine particles) indicates need for gear housing disassembly, and component inspection.
4. Note the color of gear lubricant. White or cream color indicates presence of water in lubricant. Check drain pan for water separation from lubricant. Presence of water in gear lubricant indicates the need for disassembly, and inspection of oil seals, seal surfaces, O-rings and gear housing components.

NOTE: Gear lubricant drained from a recently run gearcase will be a light chocolate brown in color due to agitation/aeration. Oil which is stabilized will be a clear yellow brown in color.

Propeller Shaft Inspection

Check for a bent propeller shaft as follows:

1. Rotate the propeller shaft while observing the dial indicator. If the deflection is more than 0.23 mm (0.009 in.), a bent propeller shaft is indicated.
2. Check for propeller shaft endplay. There should be no endplay. If endplay exists, excessive wear has occurred and gearcase must be disassembled for inspection.



3234

a - Propeller shaft runout
b - Propeller shaft endplay
c - Dial Indicator

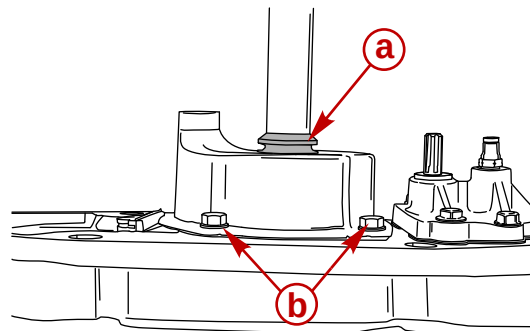
d - Dial Indicator Holding Tool
e - Dial Indicator Adapter

Dial Indicator	91-58222A1
Dial Indicator Adapter	91-83155
Dial Indicator Holding Tool	91-89897

Water Pump

Removal And Disassembly

1. Remove the water seal and water pump screws.

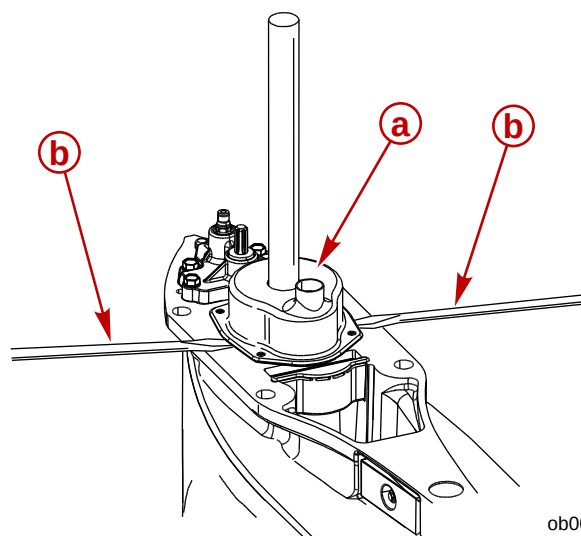


ob01614

a - Water seal

b - Screws (2 each side)

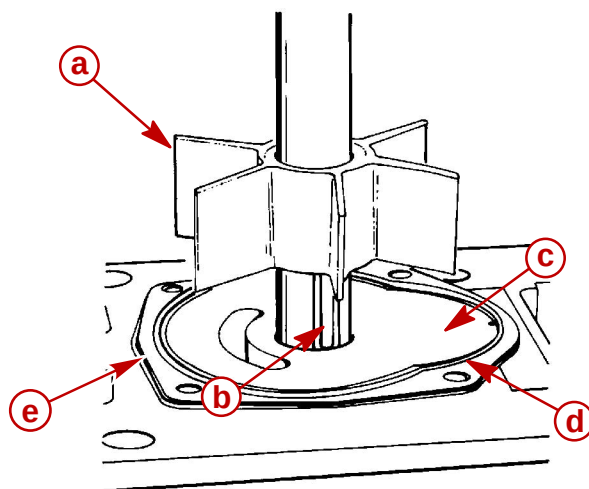
- Carefully slide the water pump straight up off of the driveshaft. It may be necessary to encourage the water pump up by gently prying up on its mounting flanges with screwdrivers.



ob00258

a - Water pump body**b** - Screwdrivers

- Remove the impeller, impeller key, face plate, pump cover gasket and pump base gasket.



4512

a - Impeller**b** - Key**c** - Face plate**d** - Pump cover gasket (gray bead faces up)**e** - Pump cover base gasket

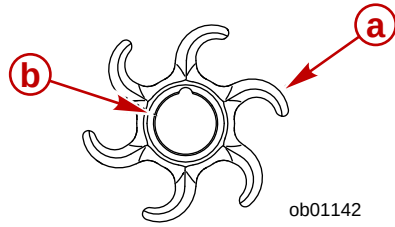
Cleaning and Inspection

NOTE: With the gearcase removed, inspect the water tube coupling assembly inside the driveshaft housing for wear or damage. If necessary replace the worn or damaged components as required.

IMPORTANT: The circular groove formed by the impeller sealing bead should be disregarded when inspecting liner and plate. The depth of the groove will not affect water pump output.

- Inspect face plate and water pump liner for grooves and/or rough surfaces.
- Inspect impeller side seal surfaces and ends of impeller blades for cracks, tears and wear. Replace impeller if any of these conditions are found.

3. Inspect impeller bonding to impeller hub.



a - Impeller

b - Hub

4. Inspect impeller for glazed or melted appearance (caused by operation without sufficient water supply). Replace impeller if any of these conditions exist.

IMPORTANT: When completing gear housing repairs that require removal of water pump impeller, it is recommended that the impeller be replaced. If it is necessary, however, to re-use impeller, do not install in reverse to original rotation, or premature impeller failure will occur.

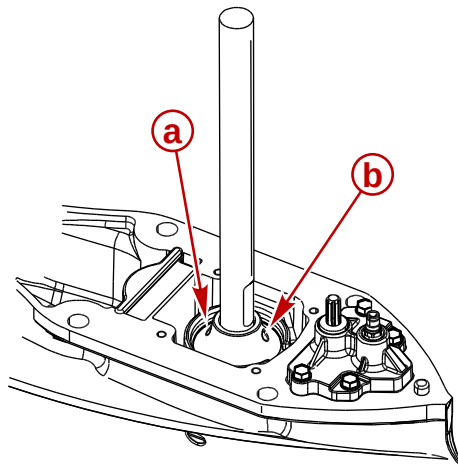
IMPORTANT: It is recommended that all seals and gaskets be replaced (as a normal repair procedure) to assure effective repair.

Oil Seal Carrier Assembly

Removal

NOTE: Pushing down on the seal carrier may aid in the removal of the retaining ring above the seal carrier.

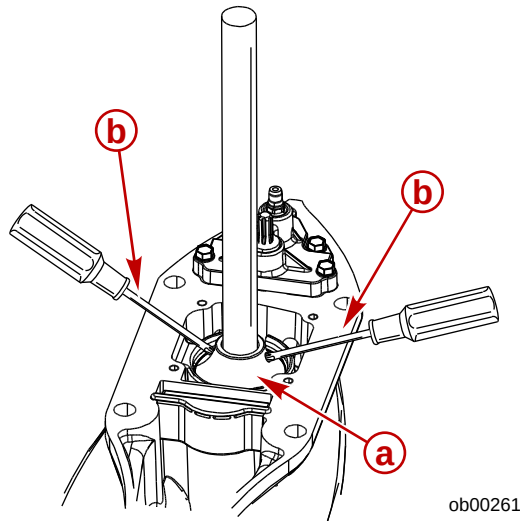
1. While pushing down on seal carrier, use a flat tip screwdriver to aid in removal of retaining ring above oil seal carrier.



a - Retaining ring

b - Seal carrier

2. Remove the oil seal carrier from the gear housing. It may be necessary to gently pry up on it with two screwdrivers.



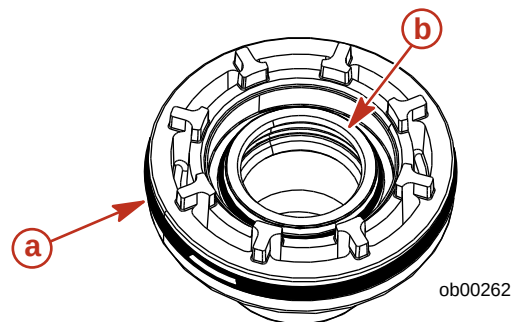
a - Oil seal carrier

b - Screwdrivers

Disassembly

NOTE: Complete the instructions in this section only if the assembly components have been found to be defective and are in need of repair or replacement.

1. Remove the O-ring.

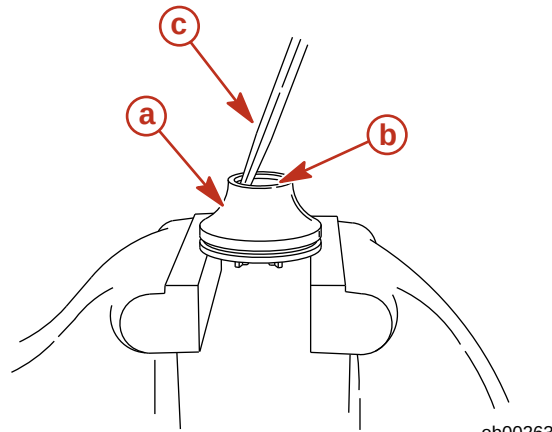


a - O-ring

b - Oil seals (2)

IMPORTANT: Use caution when removing carrier oil seals to avoid nicking or scratching the plastic surface the seals contact in the carrier as water leakage into gearcase could result.

2. Remove oil seals with screwdriver or punch.



ob00263

a - Oil seal carrier

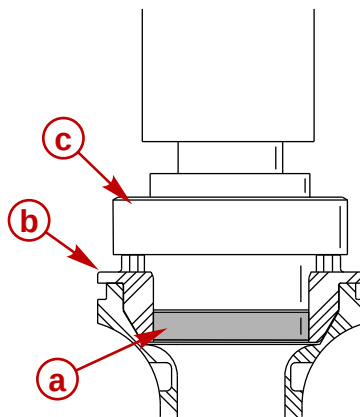
b - Oil seals

c - Screwdriver

Reassembly

The oil seals in the carrier assembly are the same diameter. The bottom (first) seal lip faces down; the top (second) seal lip faces up. Apply 2-4-C with Teflon to seal lips and between seals. Apply Loctite 380 to outer diameter of both seals.

1. Press first seal into carrier with Oil Seal Driver using long side of seal driver.



4409

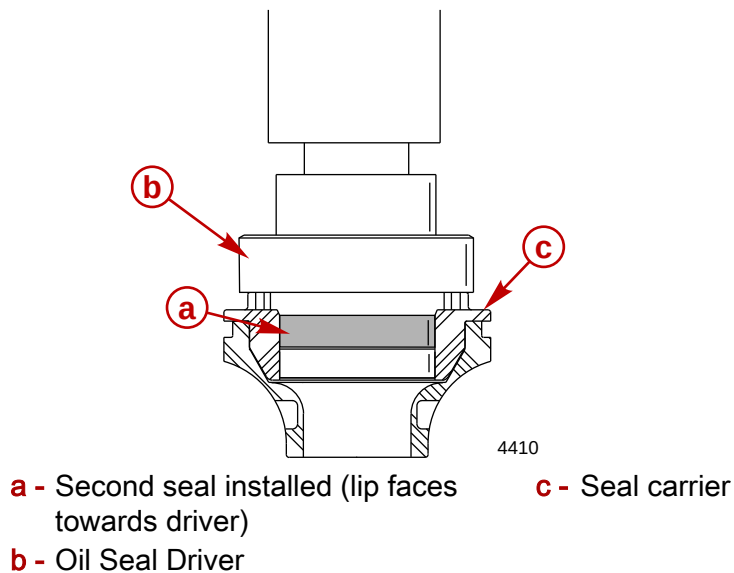
a - First seal installed (lip faces away from driver)

b - Seal carrier

c - Oil Seal Driver

Oil Seal Driver	91-889844T
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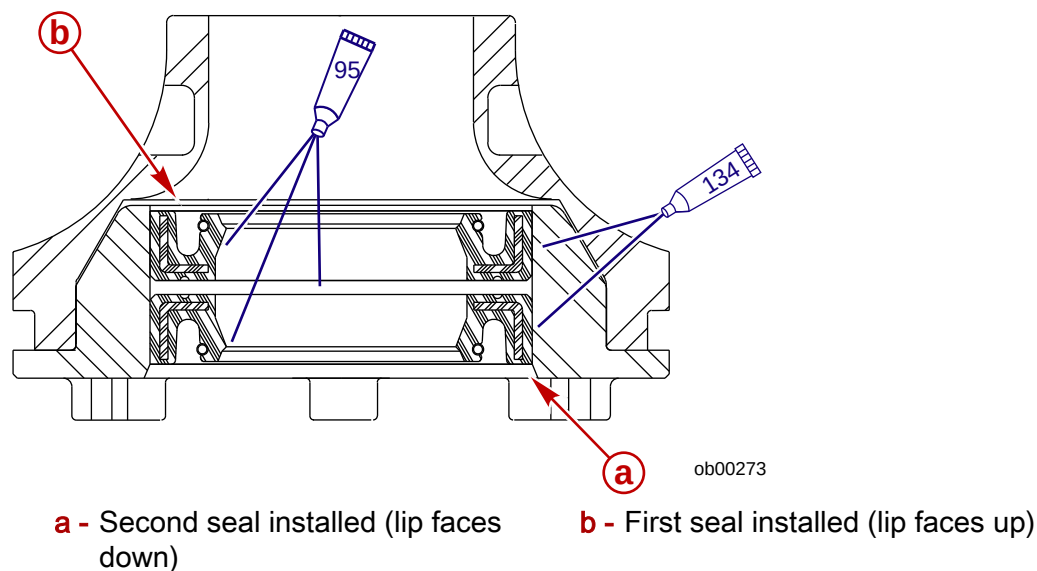
- Reverse seal driver and using short side of driver, press second seal in until seal driver is flush with carrier surface.



Oil Seal Driver

91-889844T

- Apply 2-4-C with Teflon to seal lips.



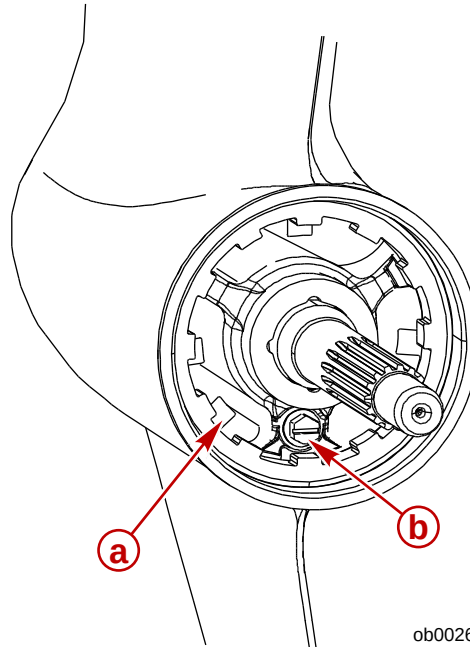
Tube Ref No.	Description	Where Used	Part No.
	2-4-C Marine Lubricant with Teflon	Oil seal lips and between oil seals	92-802859A1
	Loctite 380	Outer diameter of oil seals	Obtain Locally

Bearing Carrier and Propeller Shaft

Removal

- Straighten the tab on the tab washer.

NOTE: Drain plug in bearing carrier must be removed before using Bearing Carrier Retainer Nut Wrench to remove bearing carrier retainer.



a - Tab

b - Drain plug

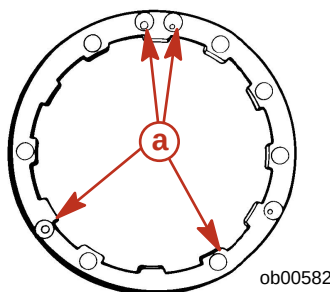
Bearing Carrier Retainer Nut Wrench	91-61069T
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2. Remove the bearing carrier retainer following step "a" or "b" as follows:

⚠ CAUTION

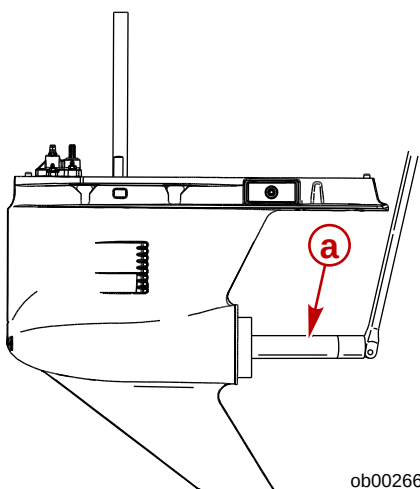
Do not drill into the gear housing retainer threads when using the following procedure for removing the retainer.

- a. If the retainer is corroded in place, drill four holes in the retainer and fracture the retainer with a chisel. Pry the remaining segments out.



a - Drilled holes

- b. Remove bearing carrier retainer using Bearing Carrier Retainer Nut Wrench .



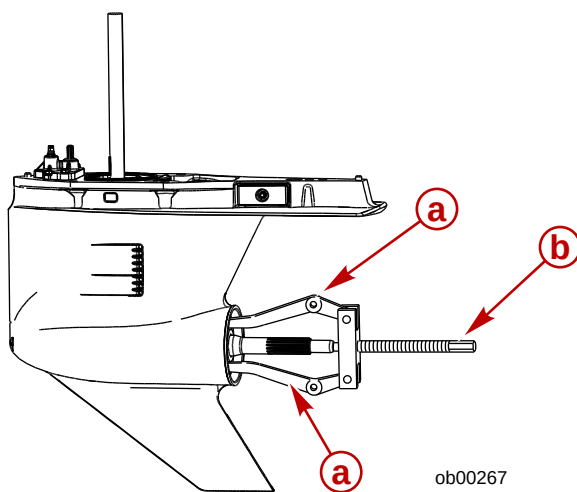
ob00266

a - Bearing Carrier Retainer Nut Wrench

Bearing Carrier Retainer Nut Wrench	91-61069T
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3. Pull the bearing carrier from the gear housing by pulling on the outer ring of the bearing carrier. Position puller jaws close to bosses in carrier.

NOTE: If the bearing carrier is seized in the gear housing, it may be necessary to use heat to loosen the carrier.



ob00267

a - Puller Jaws Assembly

b - Puller Bolt

Puller Jaws Assembly	91-46086A1
Puller Bolt	91-85716

Cleaning/Inspection

IMPORTANT: It is recommended that all seals and O-rings be replaced (as a normal repair procedure) to assure effective repair.

1. Clean bearing carrier with solvent and dry with compressed air.

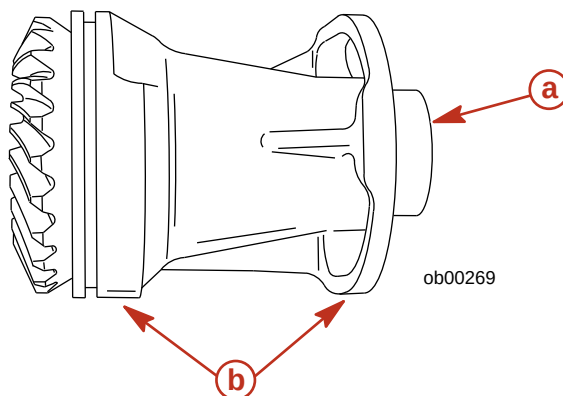
⚠ WARNING

Avoid serious injury or death. Do not allow the bearings to spin when drying them with compressed air. The bearings can explode, even if they are spun at very slow speeds.

⚠ CAUTION

Do not spin bearings dry with compressed air, as this could cause bearing to score.

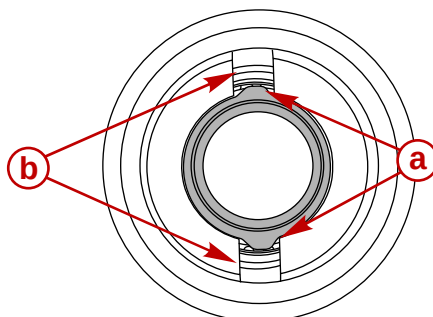
2. Inspect the bearing carrier for signs of excessive corrosion especially in the area where the bearing carrier touches the gear housing. If excessive corrosion is evident replace the carrier.



a - Bearing carrier

b - Inspect for corrosion

3. The propeller shaft utilizes a tapered roller bearing and cup for shaft support just forward of the bearing carrier seals. The forward gear and bearing adapter assembly must be removed from the bearing carrier to gain access to the propeller shaft tapered bearing for inspection.
4. Forward gear can be removed from the adapter/bearing carrier assembly by rotating gear until forward gear sleeve tabs align with slots in adapter. Forward gear can then be removed from adapter/bearing carrier assembly.

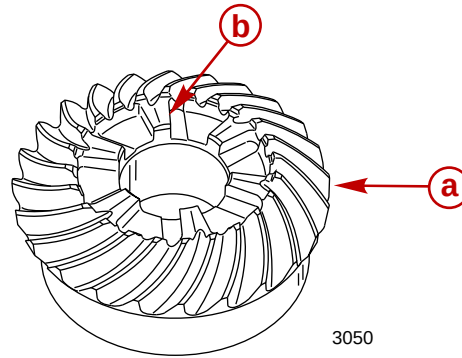


a - Forward gear sleeve tabs

b - Adapter slots

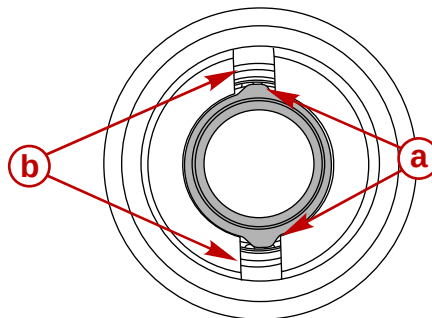
5. Inspect forward gear for pitted, chipped, broken teeth, hairline fractures and excessive or uneven wear. Replace forward gear and the pinion gear if any defects are found.

6. Check clutch jaws on forward gear for damage. Replace forward gear, if damage is found on clutch jaws.

**a - Forward gear****b - Clutch jaws**

Disassembly

1. Remove and discard O-ring from between bearing carrier and thrust washer.
2. Remove forward gear assembly by rotating forward gear sleeve tabs to align with bearing adapter slots and remove gear.

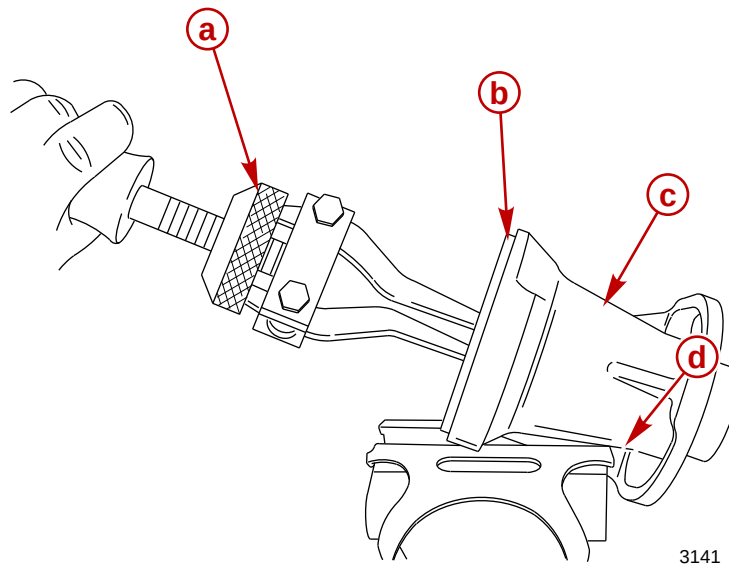
**a - Forward gear sleeve tabs****b - Adapter slots**

⚠ CAUTION

Clamp onto the reinforcing rib of the bearing carrier ONLY, or damage to the carrier may result.

3. Remove forward gear bearing adapter by placing the bearing carrier in a vise, clamping on the reinforcing rib.

4. Remove the bearing adapter as an assembly, using a slide hammer puller.

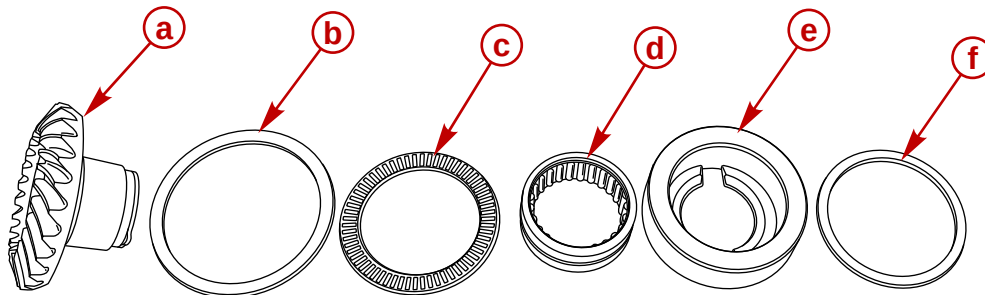


a - Slide Hammer Puller
b - Bearing adapter

c - Bearing carrier
d - Bearing carrier reinforcing rib

Slide Hammer Puller	91-34569A1
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5. Clean the forward gear bearing adapter assembly with a suitable solvent and dry it using compressed air.



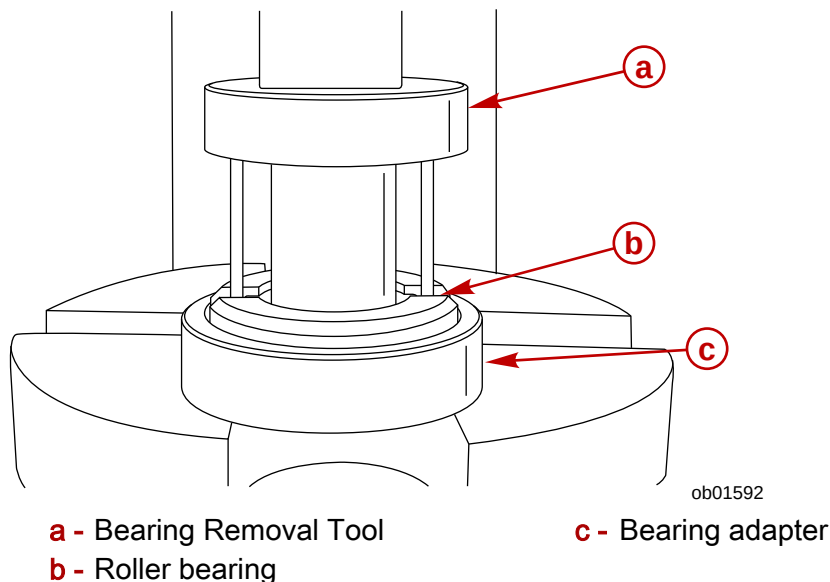
a - Forward gear
b - Thrust washer
c - Thrust bearing

d - Roller bearing
e - Bearing adapter
f - Shim

NOTE: The condition of the bearing surfaces on the forward gear in the areas that the bearings of the bearing adapter and the thrust bearing rides, is an indication of the condition of respective bearings. Replace the bearings if the surface of the gear and/or thrust washer is pitted, grooved, scored, worn unevenly, discolored from overheating or has embedded metal particles.

IMPORTANT: Do not remove the roller bearing from the bearing adapter unless replacement is necessary. Bearing should not be reused after it has been removed from bearing adapter.

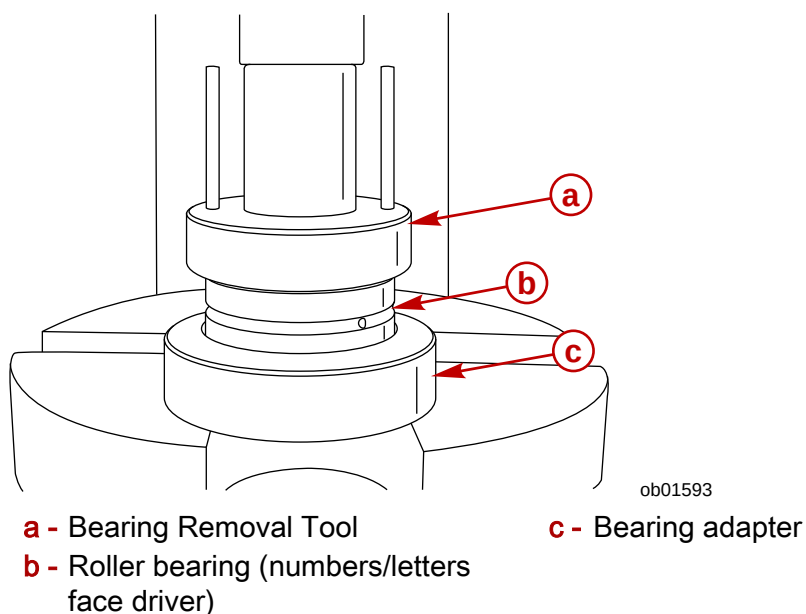
6. If roller bearing in bearing adapter must be replaced, remove bearing from adapter using Bearing Removal Tool. Align the pins of the tool with slots of the adapter and apply force to the center of the tool so that the pressure is equal on both of the pins. Discard the bearing after removal.



Bearing Removal Tool

91-816245

7. Reassemble the adapter as follows:
- Lubricate the bore that the roller bearing is pressed into with 2-4-C with Teflon.
 - Install the roller bearing into the adapter with the numbered end of the bearing facing the driver shoulder.
 - Press the roller bearing into the adapter using Bearing Removal Tool until the Bearing Removal Tool contacts the adapter.



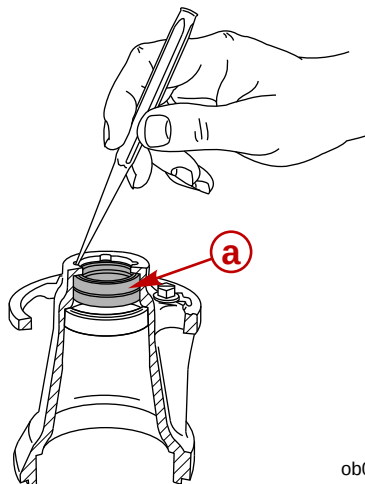
Bearing Removal Tool

91-816245

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Bore that roller bearing is pressed into	92-802859A1

8. Perform the following step "a" or "b" as necessary.

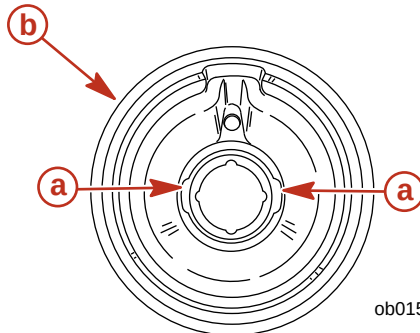
- a. **If replacing the seals only:** Remove the oil seals with a suitable punch, being careful not to damage the bore of the bearing carrier. Discard both of the seals.



ob01548

a - Seals

- b. **If replacing the tapered roller bearing and seals:** Remove the seals with a punch as noted above. There are slots cast into the carrier to aid in the removal of the bearing race with puller jaws.

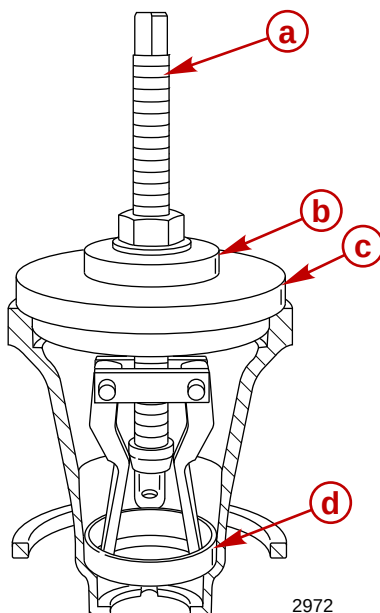


ob01555

a - Slots

b - Bearing carrier

- c. Remove the tapered bearing race from the carrier using Bearing Puller Assembly, Pilot Washer and Seal Driver Guide. Discard the bearing, race and both seals.



a - Bearing Puller Assembly

b - Pilot Washer

c - Seal Driver Guide

d - Race

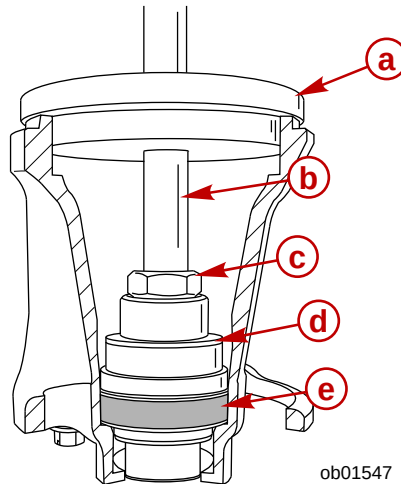
Bearing Puller Assembly	91-83165T
Pilot Washer	91-36571
Seal Driver Guide	91-889845

Reassembly

NOTE: Complete the instructions in this section only if the assembly components have been disassembled and repaired or replaced.

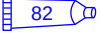
1. Clean all of the components with a suitable solvent and dry the parts thoroughly using compressed air.
2. Lubricate the bore that the roller bearing race is pressed into with Premium Gear Lubricant.
3. Assemble the bearing race onto the driver.

4. Press the bearing race into the bearing carrier until the race bottoms out in the bearing carrier.

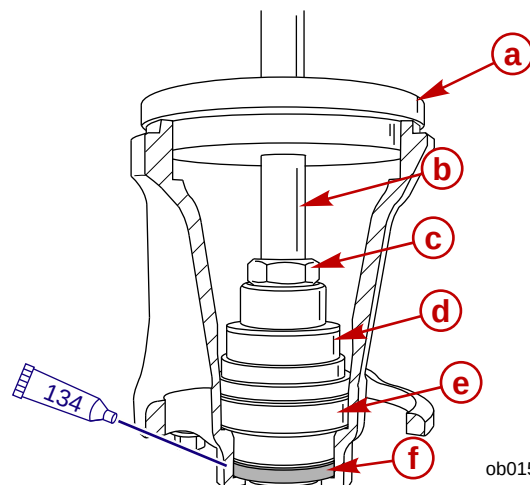


- a - Seal Driver Guide
- b - Driver Rod
- c - Hex Nut
- d - Oil Seal Driver
- e - Tapered Bearing Race

Seal Driver Guide	91-889845
Bearing Removal and Installation Kit	91-31299A7
Oil Seal Driver	91-889844T

Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Bore that roller bearing is pressed into	92-802846A1

5. Thoroughly clean the bore in which the first seal is to be pressed.
6. Assemble the first seal (with the lips of the seal facing away from the driver shoulder) onto the long end of the oil seal driver.
7. Apply Loctite 380 to the outside diameter of the oil seal.
8. Press on the oil seal driver until the driver bottoms on the bearing race.

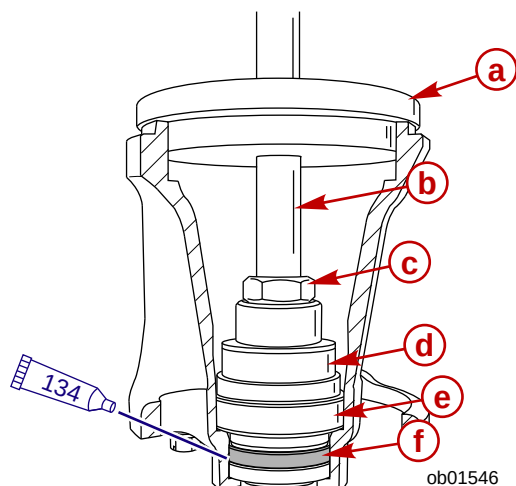


- a - Seal Driver Guide
- b - Driver Rod
- c - Hex Nut
- d - Oil Seal Driver
- e - Bearing race
- f - Oil seal

Seal Driver Guide	91-889845
Bearing Removal and Installation Kit	91-31299A7
Oil Seal Driver	91-889844T

Tube Ref No.	Description	Where Used	Part No.
 134	Loctite 380	Outer diameter of oil seal	Obtain Locally

9. Assemble the second seal (with the lips of the seal facing the driver shoulder) onto the short end of the driver.
10. Apply Loctite 380 to the outside diameter of the oil seal.
11. Press the oil seal with the driver until the driver bottoms out on the bearing race.



a - Seal Driver Guide
b - Driver Rod
c - Hex Nut

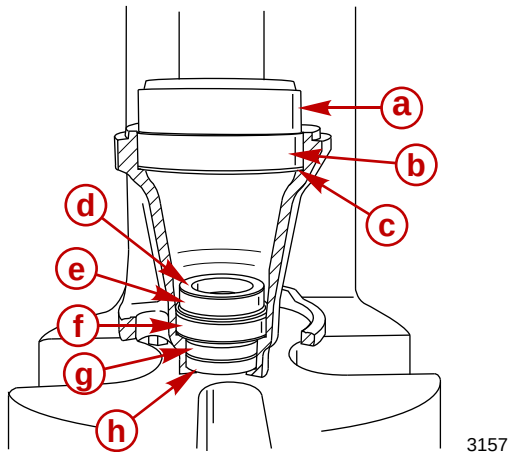
d - Oil Seal Driver
e - Bearing race
f - Oil seal

Seal Driver Guide	91-889845
Bearing Removal and Installation Kit	91-31299A7
Oil Seal Driver	91-889844T

Tube Ref No.	Description	Where Used	Part No.
 134	Loctite 380	Outer diameter of oil seal	Obtain Locally

12. Lubricate the seal lips and fill the area between the seals with 2-4-C with Teflon.
13. Install propeller shaft tapered roller bearing into carrier bearing race.
14. Lubricate the bore that the bearing is pressed into with Premium Gear Lubricant.
15. Install bearing adapter shim into bearing carrier.

16. Press the bearing adapter into the carrier and until the adapter bottoms out in bearing carrier.

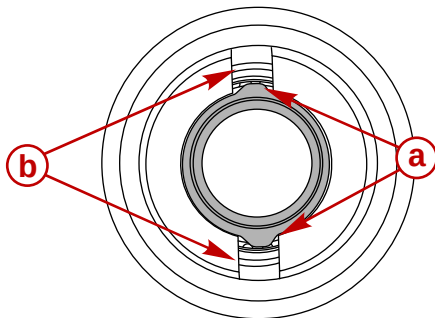


- a - Bearing Cup Driver
- b - Bearing adapter
- c - Bearing adapter shim
- d - Shim
- e - Spacer
- f - Tapered bearing
- g - Seal
- h - Seal

Bearing Cup Driver		91-885592T	
Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Oil seal lips and between oil seals	92-802859A1

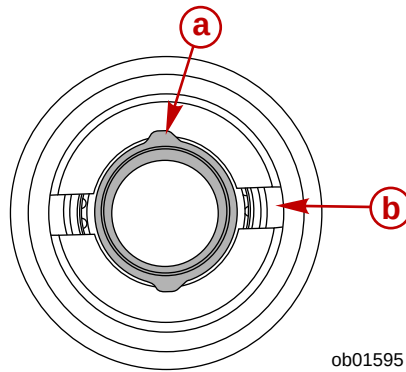
NOTE: The shim and spacer above the tapered bearing may be installed before the propeller shaft or both placed on the propeller shaft and installed into the carrier with the propeller shaft. However, without the propeller shaft installed in the bearing carrier, the shim, spacer, and tapered bearing may fall out of alignment.

17. Install thrust bearing onto bearing adapter.
18. Install thrust washer onto bearing adapter.
19. Install forward gear into bearing adapter by aligning forward gear adapter sleeve tabs with slots in bearing adapter.



- a - Forward gear sleeve tabs
- b - Bearing adapter slots

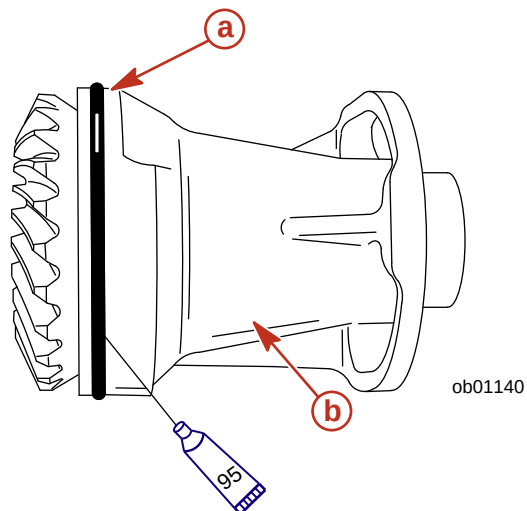
20. Rotate forward gear 90 degrees after installing gear into bearing adapter.



a - Forward gear sleeve tabs

b - Bearing adapter slots

21. Lubricate the O-ring with 2-4-C with Teflon and install the O-ring onto the bearing carrier.



a - O-ring

b - Bearing carrier

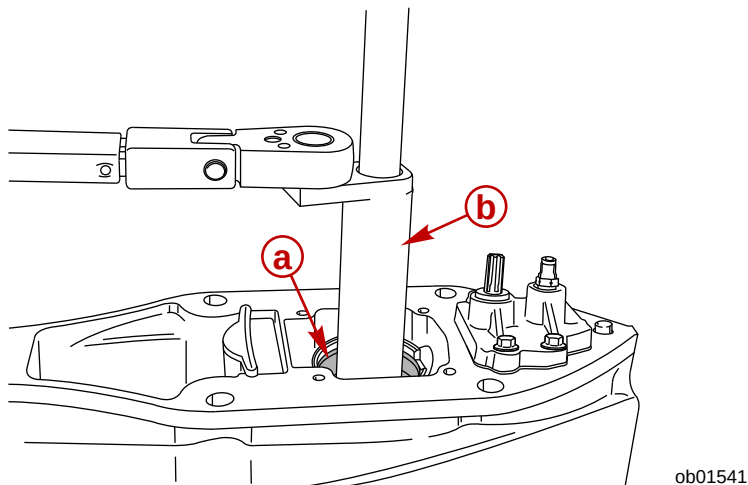
Tube Ref No.	Description	Where Used	Part No.
	2-4-C Marine Lubricant with Teflon	Bearing Carrier O-ring	92-802859A1

Driveshaft Assembly

Removal

1. Remove the driveshaft pinion nut as follows:

- a. Remove the upper driveshaft tapered bearing retainer.

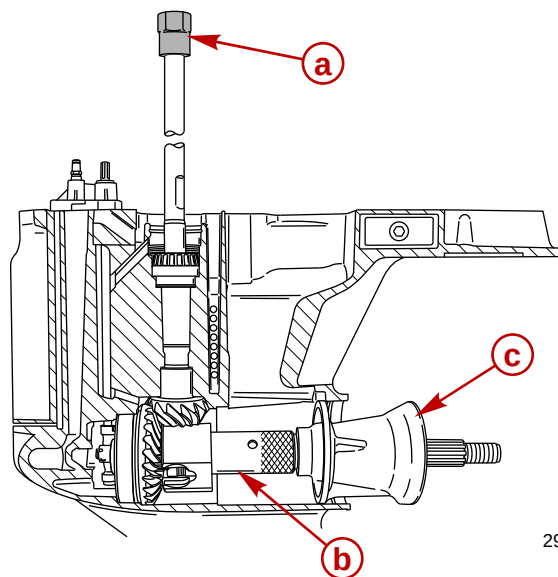


a - Retainer

b - Driveshaft Bearing Retainer Wrench

Driveshaft Bearing Retainer Wrench	91-43506T
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- b. Place the driveshaft nut wrench onto the driveshaft.
- c. Insert the Pinion Nut Wrench with the MR slot facing the pinion gear into the gear housing. It may be necessary to slightly lift and rotate the driveshaft to align the pinion gear nut into the Pinion Nut Wrench slot.
- d. Install the bearing carrier into the gear housing backwards to support the prop shaft and to keep the Pinion Nut Wrench aligned.
- e. Rotate the driveshaft counter clockwise and loosen the pinion nut.

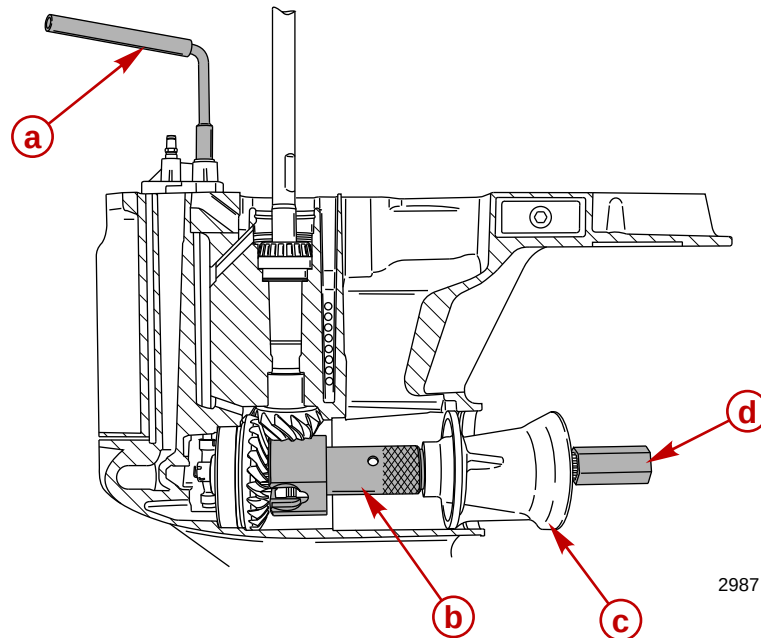


a - Driveshaft Holding Tool
b - Pinion Nut Wrench

c - Bearing carrier (installed backwards)

Driveshaft Holding Tool	91-889958T
Pinion Nut Wrench	91-61067003

- f. If the driveshaft is broken, place Propeller Shaft Nut Adapter onto the propeller shaft splines, hold shift shaft in forward gear and loosen the pinion nut by rotating prop shaft counterclockwise to turn gears, thus loosening the pinion nut.

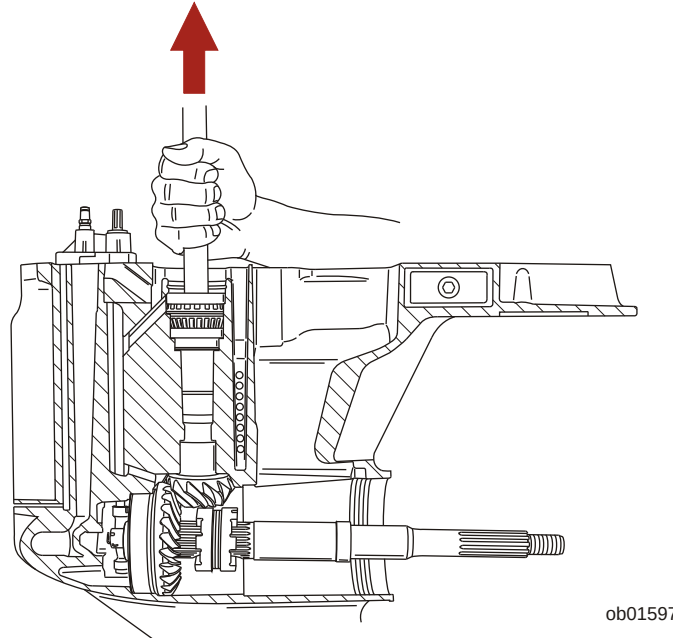


- a** - Shift Shaft Tool (fabricate from old shift shaft) **c** - Bearing carrier (installed backwards)
b - Pinion Nut Wrench **d** - Propeller Shaft Adapter

Pinion Nut Wrench	91-61067003
Propeller Shaft Adapter	91-61077

- g. Completely unscrew the driveshaft bearing retainer.
h. Completely unscrew the pinion nut by rotating the driveshaft (or the propeller shaft) in a counterclockwise direction.
i. Remove all tools.

2. Remove the driveshaft and all components by pulling the driveshaft straight out of the gear housing as shown.

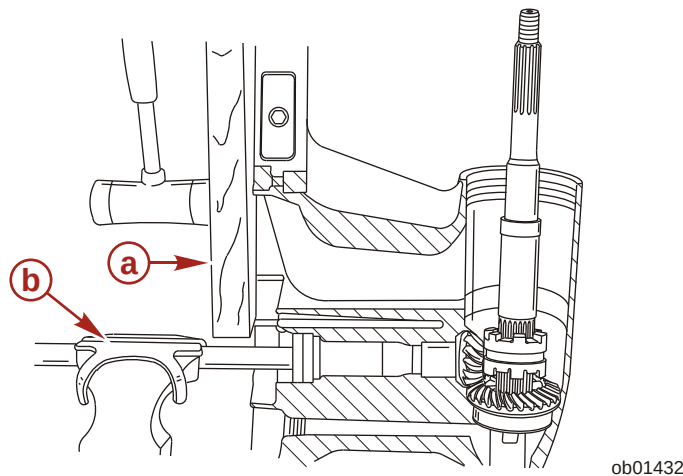


IMPORTANT: The pinion bearing rollers are free to fall out of the pinion bearing once the driveshaft is removed. Be careful not to loose the (18) rollers.

NOTE: If pinion gear is seized onto the driveshaft, place gearcase in vise using soft jaw vise covers. Place a block of wood on gear housing mating surface. Use a mallet and carefully tap gear housing away from driveshaft.

⚠ CAUTION

To prevent possible impact damage to the gear housing, do not strike the gear housing directly with the mallet. Striking a gear housing directly with a mallet or dropping the gear housing could distort the gear housing. Distortion damage may result in gear housing failure.

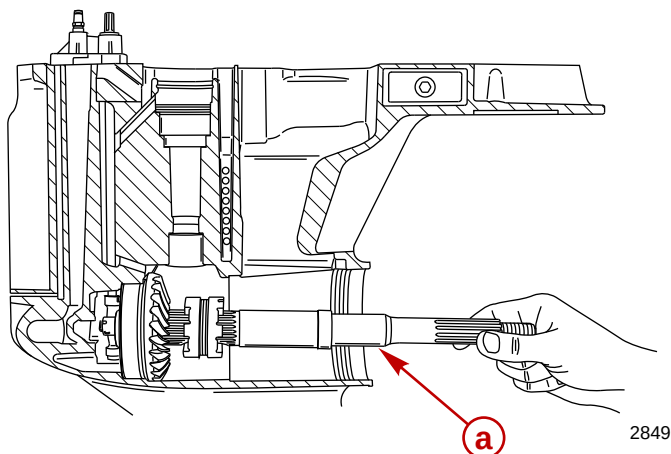


a - Wood block

b - Driveshaft in soft jaw vise

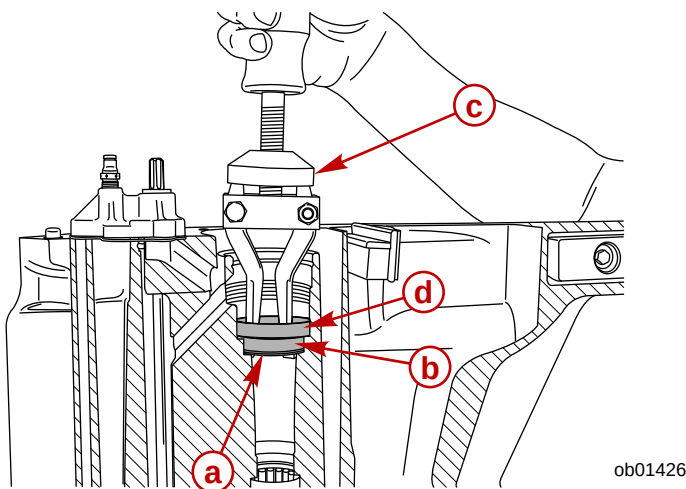
3. Retrieve the pinion gear, the washer and the nut from the inside of the gear housing

4. Move the prop shaft to the port side of the gear case to disengage the propeller shaft assembly from the shift crank and remove propeller shaft.



a - Propeller shaft

5. Remove spacer, lower driveshaft bearing cup and shims using Slide Hammer Puller (retain shims and spacer for re-installation).



a - Shims

b - Bearing race

c - Slide Hammer Puller

d - Spacer

Slide Hammer Puller	91-34569A1
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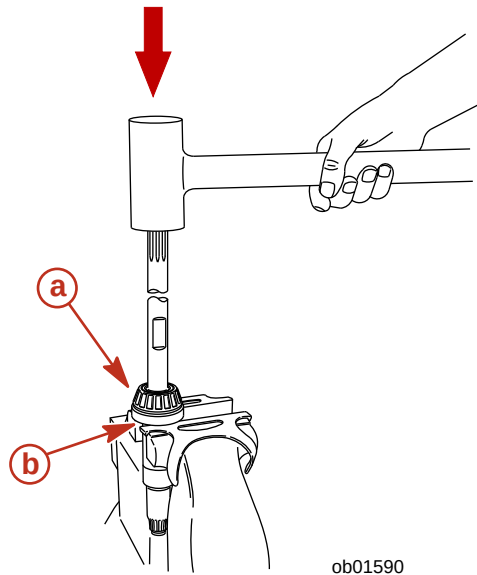
Disassembly

NOTE: Do not remove upper and lower tapered roller bearings from driveshaft unless replacement is indicated. Bearings cannot be reused after removal from driveshaft.

NOTE: If one driveshaft tapered roller bearing is damaged, both tapered bearings and spacer must be replaced as a set.

1. Both upper and lower tapered roller bearings can be removed from the driveshaft in one operation. Using the bottom bearing cup removed from the gearcase, place the cup on top of a vise leaving the vise jaws open enough to allow the driveshaft to slide through.

2. Place the driveshaft through the cup and vise until the bottom bearing is resting in the cup. While holding the driveshaft, tap on the top of the shaft with a dead blow hammer until the bearings are free. Do not drop the shaft when performing this operation.

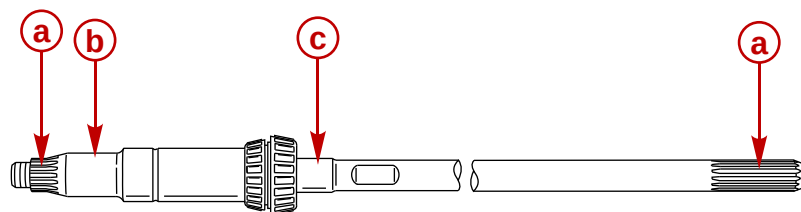


a - Driveshaft with both upper and lower bearings

b - Lower bearing cup removed from gearcase

Inspection

1. Clean all parts with a suitable solvent and dry the parts thoroughly using compressed air, being careful not to spin the bearings.
2. The condition of the upper and lower driveshaft bearing cups is an indication of the condition of each of the tapered roller bearings on the driveshaft. Replace the bearing and bearing cup if the cup is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.
3. Inspect the bearing surface on the driveshaft where the needles of the lower pinion bearing roll. Replace the pinion bearing and driveshaft if the shaft is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles.
4. Inspect the splines at both ends of the driveshaft for a worn or twisted condition. Replace the driveshaft if either condition exists.
5. Inspect driveshaft for grooves where water pump base oil seals contact shaft. Replace driveshaft if grooves are found.



a - Splines

b - Pinion bearing surface

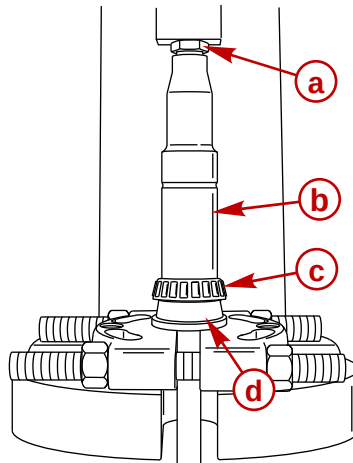
c - Seal surface

6. Inspect the pinion gear for pitting, chipped or broken teeth, hairline fractures, and excessive or uneven wear. Replace the pinion gear and the forward gear as a set if any defects are found.

Reassembly

NOTE: Complete the instructions in this section only if the components have been disassembled.

1. Apply a light coat of Premium Gear Lubricant on I.D. of driveshaft tapered bearing.
2. Assemble a new lower tapered roller bearing to the driveshaft with the large O.D. of the bearing facing the pinion gear end of the driveshaft.
3. Thread a used pinion nut onto end of driveshaft. Leave approximately 2 mm (1/16 in.) of nut threads exposed. Driveshaft threads must not extend beyond nut or thread damage could result while pressing.
4. Press the lower tapered roller bearing onto the driveshaft using the universal puller plate and a suitable mandrel, (an old tapered roller bearing inner race).

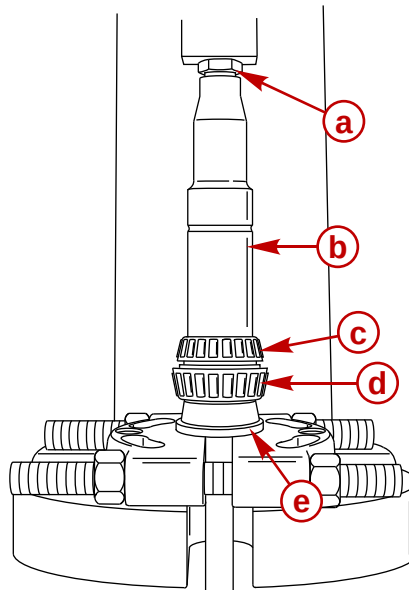


3267

a - Pinion nut
b - Driveshaft

c - Lower driveshaft tapered bearing
d - Old tapered roller bearing inner race

5. Press the new upper tapered roller bearing onto the driveshaft using the universal puller plate and a suitable mandrel, (an old tapered roller bearing inner race).



ob01455

a - Pinion nut
b - Driveshaft
c - Lower driveshaft tapered bearing

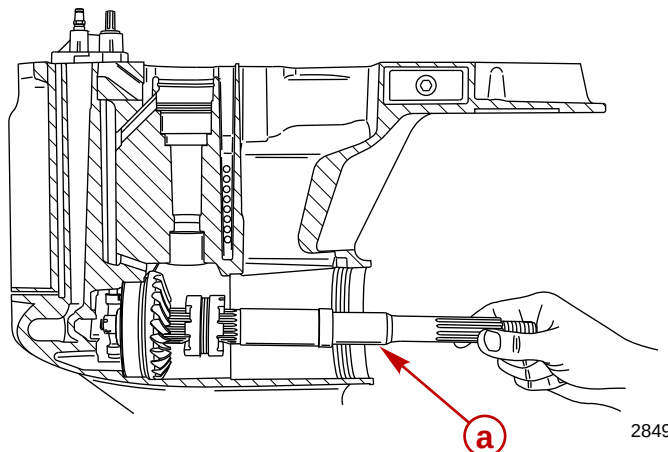
d - Upper driveshaft tapered bearing
e - Old tapered roller bearing inner race

Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Inside diameter of driveshaft tapered bearings	92-802846A1

Propeller Shaft Assembly and Reverse Gear Bearing Cup

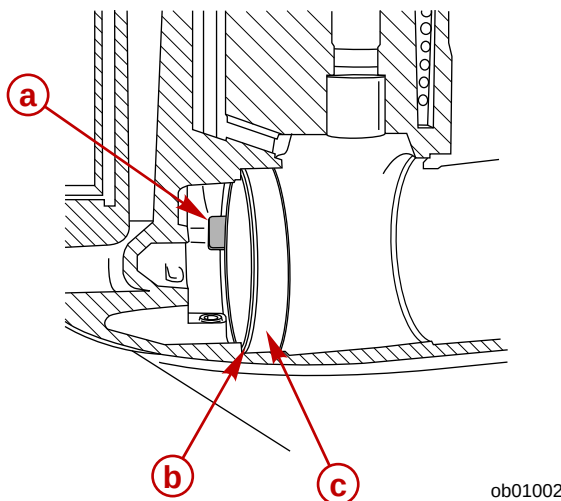
Removal

1. Tilt the propeller shaft to the port side of the gear housing and remove the shaft.



a - Propeller shaft

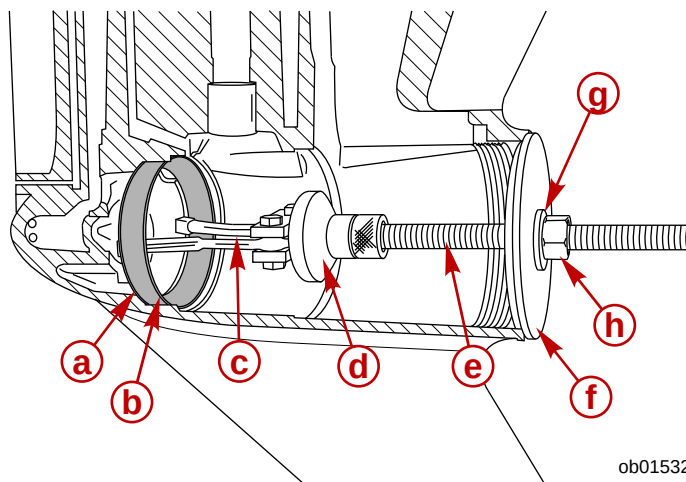
2. Two notches are provided in the gear housing just forward of the reverse gear bearing cup to position puller jaws for easier removal of the bearing cup and shims.



a - Notches
b - Shims

c - Reverse gear bearing cup

3. Remove reverse gear bearing cup and shims. Measure and make note of the shim thickness. If the shims are not damaged, they may be reused.



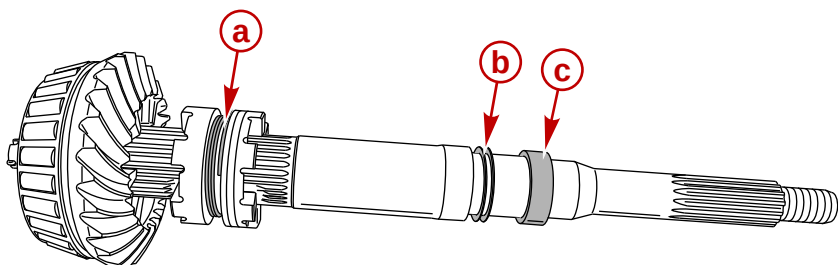
- | | |
|---|-------------------------|
| a - Shims | e - Puller Shaft |
| b - Bearing cup | f - Guide Plate |
| c - Jaws (from Slide Hammer Puller Kit) | g - Washer |
| d - Puller Head (from Slide Hammer Puller Kit) | h - Hex Nut |

Slide Hammer Puller	91-34569A1
Bearing Removal and Installation Kit	91-31229A7

Disassembly

NOTE: When accomplishing the next step, all of the parts are free to come apart. Work closely over a work bench to ensure that the parts are not dropped or damaged and to avoid personal injury.

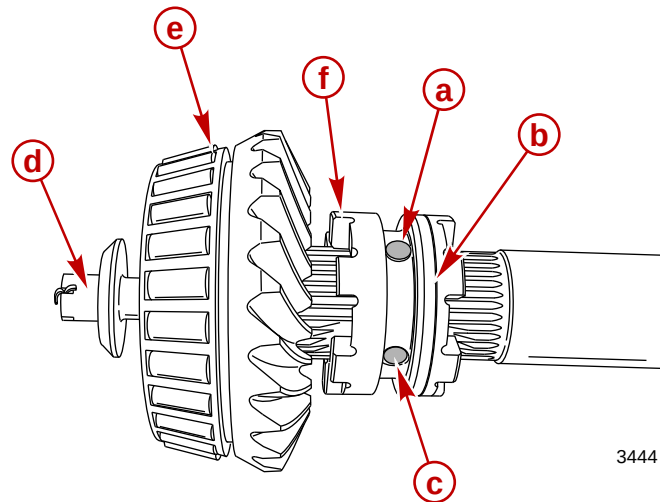
1. Remove the spring around the clutch being careful not to over-stretch it during removal. If the spring does not coil back to its normal position once it has been removed, it must be replaced.



- | | |
|-------------------|---------------------------|
| a - Spring | c - Preload spacer |
| b - Shims | |

2. Remove detent pin.
3. Remove the cross pin that goes through the clutch.

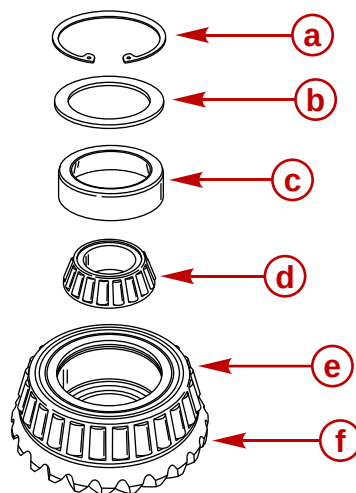
4. Remove the remainder of the components.



- | | |
|-------------------------------|--|
| a - Detent pin | d - Spool and actuating shaft assembly |
| b - Ring - faces forward gear | e - Reverse gear assembly |
| c - Cross pin | f - Clutch |

Inspection

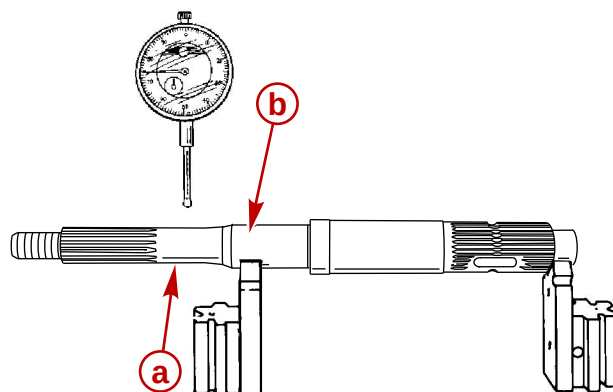
1. Clean all the parts with a suitable solvent and dry the parts thoroughly using compressed air, being careful not to spin bearings.
2. Inspect the sliding clutch jaws for damage. Jaws must not be chipped or rounded off. Replace the clutch if they are.
3. The propeller shaft utilizes two tapered roller bearing and cup assemblies for propeller shaft support. One tapered bearing is just forward of the bearing carrier seals. The forward gear assembly and bearing adapter must be removed from the bearing carrier to gain access to this bearing for inspection. The other tapered bearing is located inside the reverse gear assembly. The reverse gear assembly must be removed from the propeller shaft and a snap ring retainer and flat washer removed from the reverse gear assembly to gain access to this tapered bearing for inspection.



- | | |
|--------------------------|--------------------------|
| a - Snap ring | d - Tapered bearing |
| b - Flat washer | e - Reverse gear bearing |
| c - Tapered bearing race | f - Reverse gear |

NOTE: Reverse gear bearing should not be removed from reverse gear unless replacement is necessary. Bearing is not reusable if bearing is removed.

4. Inspect the propeller shaft splines at both ends for a broken, worn, or twisted condition. Replace the propeller shaft if any of these conditions exists.
5. Inspect the surface of the propeller shaft where the bearing carrier seal lips contact the shaft. If the oil seals have made grooves, replace the propeller shaft and oil seals.
6. Inspect the propeller shaft for a bent condition using v-blocks and a dial indicator.
 - a. Position the propeller shaft bearing surfaces on v-blocks.
 - b. Adjust the height of v-blocks to level the propeller shaft.
 - c. Position the dial indicator tip just forward of the propeller shaft splines.
7. Rotate the propeller shaft and observe the dial indicator movement. If the indicator in the dial moves more than 0.23 mm (0.009 in.), replace the propeller shaft.



ob01640

a - Check movement with Dial Indicator here

b - Seal surface area

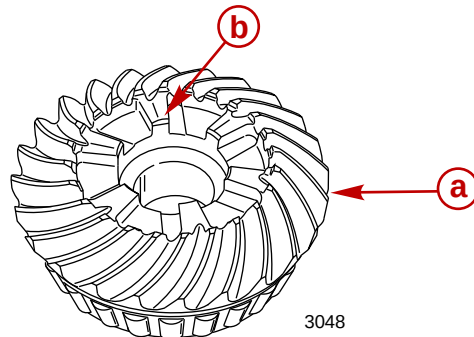
Dial Indicator	91-58222A1
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Reverse Gear Assembly

Inspection

1. Clean the reverse gear assembly with a suitable solvent and dry with compressed air. Be careful not to spin the bearings.
2. Inspect the gear for pitting, chipped or broken teeth, hairline fractures, and excessive or uneven wear. Replace the reverse gear and the pinion gear as a set if any defects are found.

3. Inspect the clutch jaws of the gear for damage. The surfaces must not be chipped or rounded off. Replace both the reverse and pinion gear as a set if any of these conditions exist.



a - Reverse gear teeth

b - Clutch jaws

4. Inspect the propeller shaft tapered roller bearing on the inside of the reverse gear and its respective bearing cup. If either the bearing or the bearing cup surface is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles, remove and replace the tapered roller bearing assembly in the reverse gear as outlined in the next section.
5. Inspect the tapered roller bearing pressed onto the reverse gear and the bearing surface on the reverse gear bearing cup. If either the roller bearing or the bearing surface of the reverse gear bearing cup is pitted, grooved, scored, worn unevenly, discolored from overheating, or has embedded particles, replace the reverse gear bearing cup and remove and replace the tapered roller bearings as outlined in the next section.

Disassembly

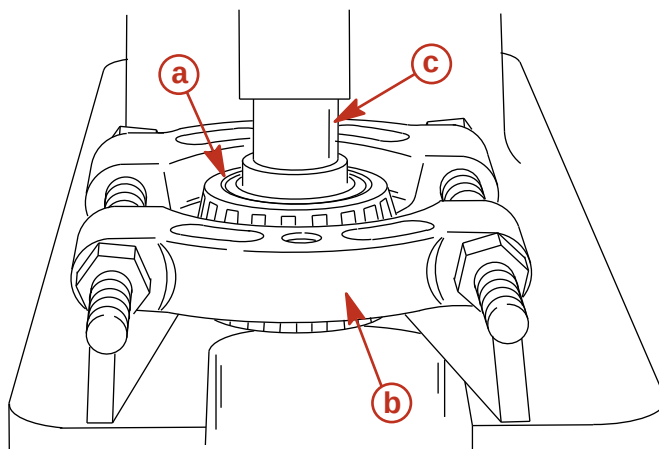
NOTE: Reverse gear and propeller shaft can only be removed from gear housing after driveshaft and pinion gear have been removed.

1. Tilt the propeller shaft to the port side of gear housing and remove the propeller shaft and gear assembly.

IMPORTANT: Do not remove pressed on tapered bearing from reverse gear unless replacement of bearing is required. Bearing cannot be reused after it has been removed.

2. If inspection determines that replacement of reverse gear tapered bearing is required, separate gear from bearing as follows:
 - a. Press Universal Puller Plate between reverse gear and tapered bearing.
 - b. Place assembly on press and press gear out of bearing with suitable mandrel.

NOTE: Tapered bearing and race must be replaced as a set.



a - Reverse gear bearing
b - Universal Puller Plate

ob01638

c - Mandrel

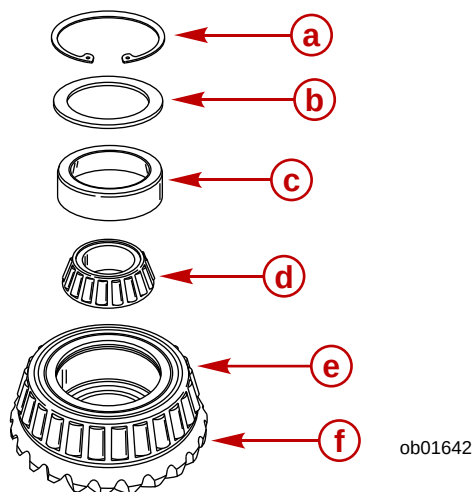
Universal Puller Plate	91-37241
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3. If inspection determines that replacement of propeller shaft tapered roller bearing is required, remove bearing as follows:

a. Clamp reverse gear in a soft jaw vise securely.

IMPORTANT: Use suitable eye protection when removing or installing snap ring.

- b. Use snap ring pliers to remove snap ring. Push tapered roller bearing assembly out of inside of reverse gear.



a - Snap ring
b - Flat washer
c - Tapered bearing race

d - Tapered bearing
e - Reverse gear bearing
f - Reverse gear

ob01642

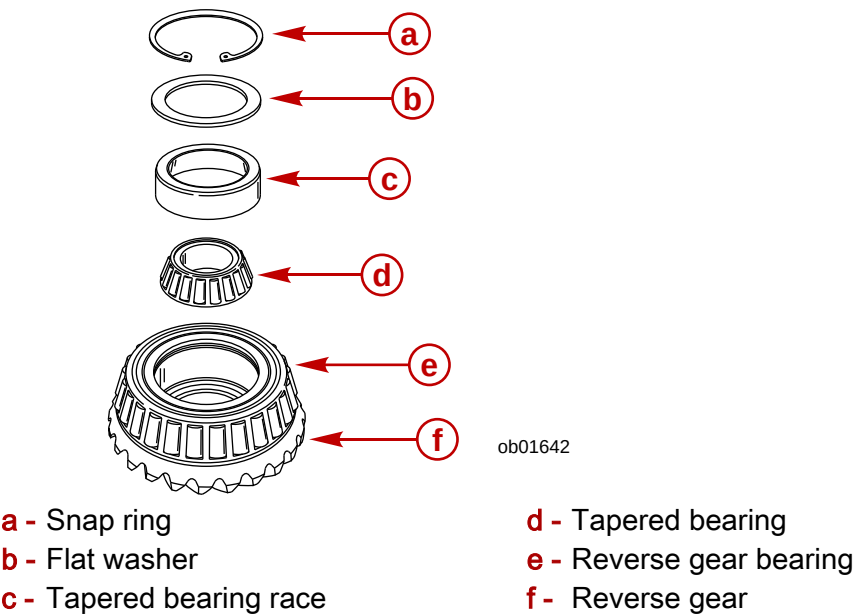
Reverse Gear Reassembly

NOTE: Complete the instructions in this section only if the assembly components have been disassembled and repaired or replaced.

1. Apply Premium Gear Lubricant to O.D. of reverse gear. Using a suitable mandrel that contacts only the inner portion of the race, press tapered roller bearing assembly onto reverse gear until bearing seats.

IMPORTANT: Use suitable eye protection when removing or installing snap ring.

- 2. Install washer snap ring into groove of reverse gear to secure tapered roller bearing assembly.

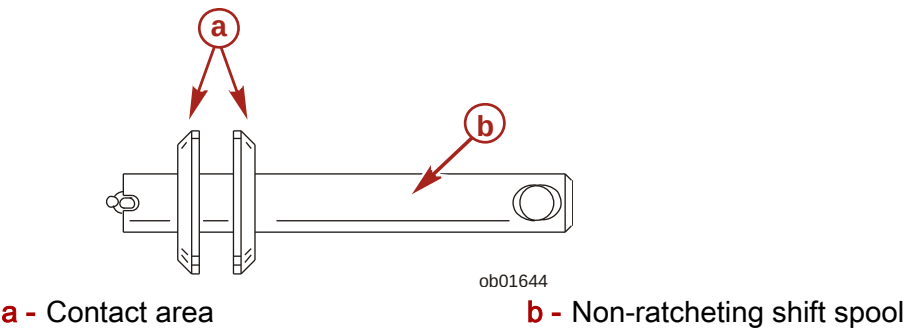


Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Outside diameter of reverse gear	92-802846A1

Shift Spool Assembly

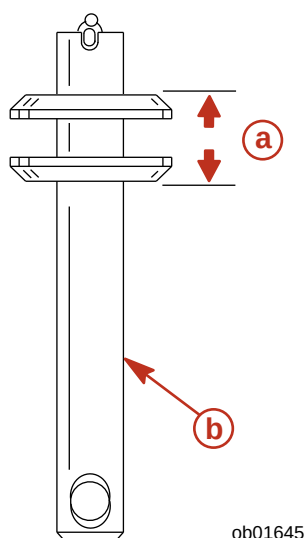
Inspection

- 1. Clean the assembly with a suitable solvent and dry the parts using compressed air.
- 2. Inspect the shift spool assembly for damage. Small nicks and burrs may be smoothed. If any parts are damaged or worn excessively, it will be necessary to replace the complete shift spool assembly. Individual parts are not available for the assembly.
- 3. Inspect the shift spool for wear in the area where the shift crank comes into contact.



- 4. Inspect to ensure that the spool spins freely (it may be helpful to lightly tap the castle nut end of the shift spool against a firm surface to align the internal parts).

5. Inspect to ensure that the spool has end play. This end play may be achieved by turning the castle nut clockwise down until it is snug and then backing off the nut counterclockwise to the first cotter pin slot.



a - End play

b - Shift spool

Shift Spool	
End Play	0.05 mm - 0.25 mm (0.002 - 0.010 in.)

Disassembly

NOTE: If the spool spins freely and has the proper clearance, it will not be necessary to disassemble and reassemble the spool. If the spool does not function properly, proceed with the following disassembly procedures.

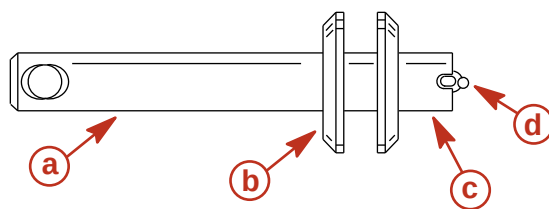
NOTE: Disassembly of the shift spool is for cleaning and inspection of the internal parts due to an improperly functioning shift spool assembly or debris in the gear housing and/or shift spool assembly. Individual components for the shift spool are not available as replacement parts. If the shift spool does not function properly and the following cleaning and adjustment procedures do not correct the problem, it will be necessary to order a new shift spool assembly.

1. Remove and discard the cotter pin.
2. Remove the castle nut and spool.

Reassembly

1. Place the shift spool onto the shift spool shaft.
2. Screw the castle nut down until it touches the spool and a slight resistance is felt.
3. Loosen the castle nut until the cotter pin slot of the nut is aligned with the hole in the shaft. If, when the castle nut is screwed down, the cotter pin slot is already aligned at the hole in the shaft, back the castle nut off until the next available slot in the nut is aligned with the hole in the shaft.
4. Insert a new cotter pin and bend ends of the cotter pin in opposite directions.

- Verify the spool has end play. If it does not, readjust the castle nut again.



ob01646

a - Shift shaft

b - Spool

c - Castle nut

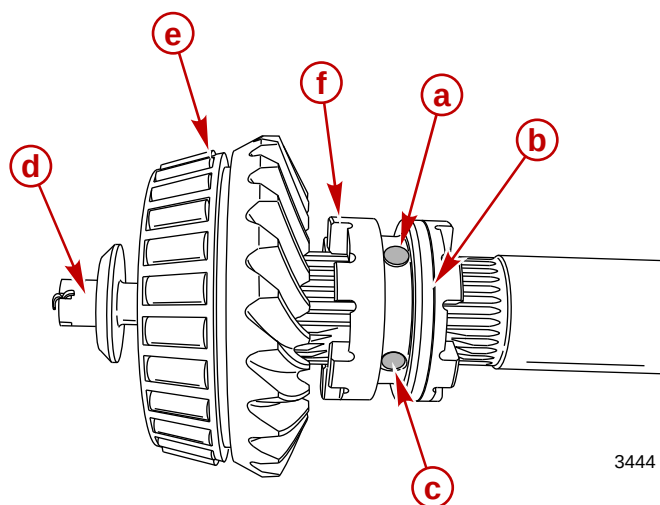
d - Cotter pin

Shift Spool	
End Play	0.05 mm - 0.25 mm (0.002 - 0.010 in.)

- If this adjustment did not produce the desired results it will be necessary to disassemble, clean, and reassemble the shift spool assembly. If the spool assembly has already been disassembled and cleaned it will be necessary to replace the shift spool assembly.

Propeller Shaft Reassembly

- Install the sliding clutch on the propeller shaft. Align cross pin holes in the clutch with the slot in the propeller shaft.
- Assemble the reverse gear assembly to the propeller shaft.
- Assemble the shift spool assembly to the propeller shaft, making sure to align the cross pin hole of the shift spool shaft with the clutch.
- Assemble the cross pin through the sliding clutch, through the propeller shaft and through the shift spool shaft hole.
- Install detent pin in third hole in clutch.



3444

a - Detent pin

b - Clutch band (faces aft)

c - Cross pin

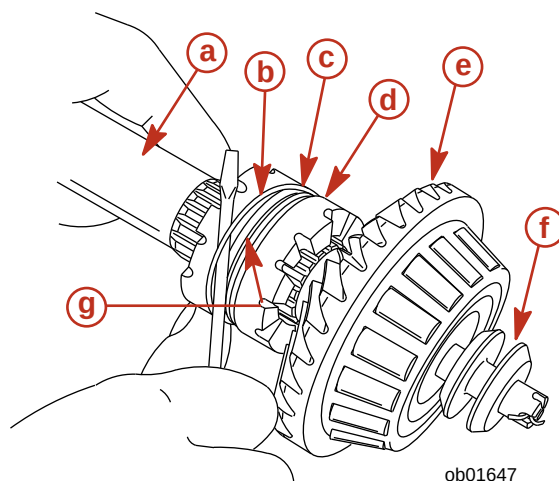
d - Shift spool and actuating shaft

e - Reverse gear assembly

f - Clutch

- Assemble the cross pin retaining spring over the propeller end of the propeller shaft and wind it around the clutch over the cross pin hole. Be careful not to distort the spring while assembling it.

IMPORTANT: Verify the spring is wound on so that it does not cross over on itself and that it lies flat against the clutch once it is assembled. If it does not lie flat against the clutch, a new spring must be installed.



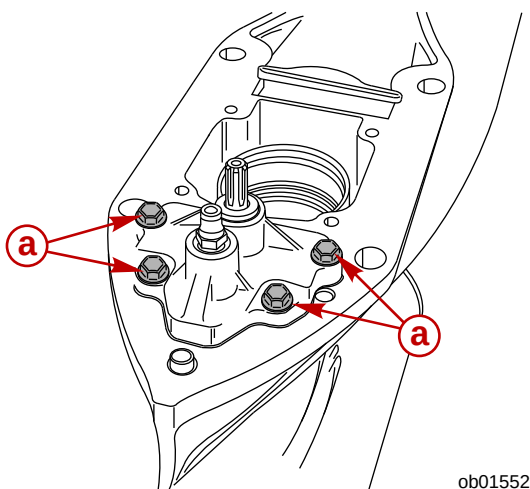
- | | |
|---------------------------------------|---|
| a - Propeller shaft | e - Reverse gear assembly |
| b - Cross pin retaining spring | f - Spool and actuating shaft assembly |
| c - Cross pin (not shown) | g - Detent pin (not shown) |
| d - Sliding clutch | |

Shift Shaft Assembly

Removal

NOTE: It is possible to remove and service the shift shaft assembly (but not the shift crank inside the gearcase) without removing any of the internal components of the gear housing.

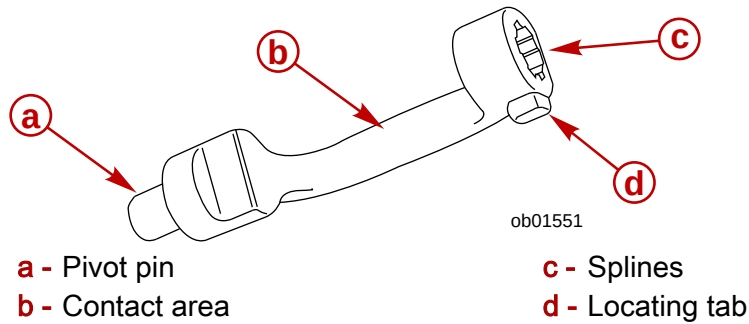
1. Remove the shift shaft bushing screws. Remove the shift shaft and bushing by pulling both straight out of gear housing.



- a** - Shift shaft bushing screws

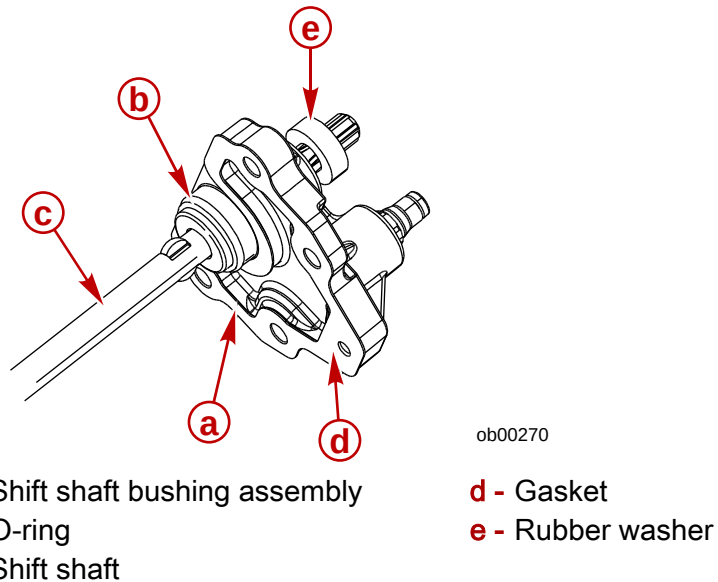
2. Remove the shift crank from the inside of the gear housing. Clean it with a suitable solvent and dry it thoroughly. Inspect it for wear in the areas that contact the shift spool and inspect the splines and the pivot pin for damage or wear.

NOTE: The shift crank has a locating tab. On right hand rotation gearcases, the tab faces toward the forward gear bearing assembly. On left hand rotation gearcases, the tab faces away from the reverse gear bearing assembly.



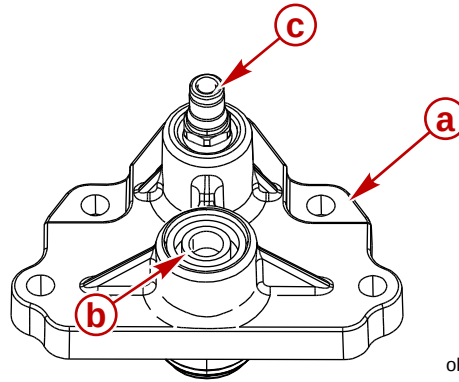
Disassembly and Inspection

1. Remove the coupler from the shift shaft. Slide the bushing assembly off the shift shaft.



2. Clean all components with a suitable solvent and dry thoroughly with compressed air.
 - a. Inspect the shift shaft bushing for cracking, damage, or excessive wear.
 - b. Inspect the oil seal inside the bushing, the sleeve, and the O-rings on the outside of the bushing for damage or excessive wear.
 - c. Inspect the speedometer connector for damage or blockage.
 - d. Inspect the speedometer passage through the shift shaft bushing for debris.

NOTE: If any of these conditions exist, replace the appropriate components.



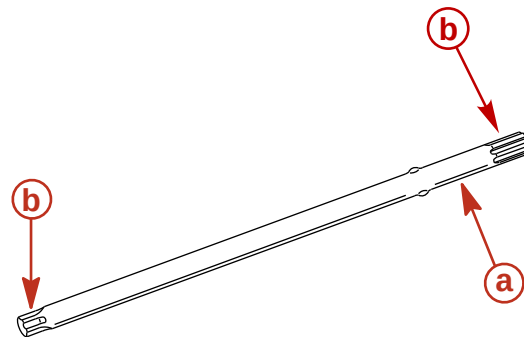
ob00271

a - Shift shaft bushing

c - Speedometer tube connector

b - Oil seal (seal is replaceable)

3. Inspect the shift shaft splines and oil seal surface for corrosion and/or excessive wear. Replace the shift shaft if either if these conditions are found.



ob01648

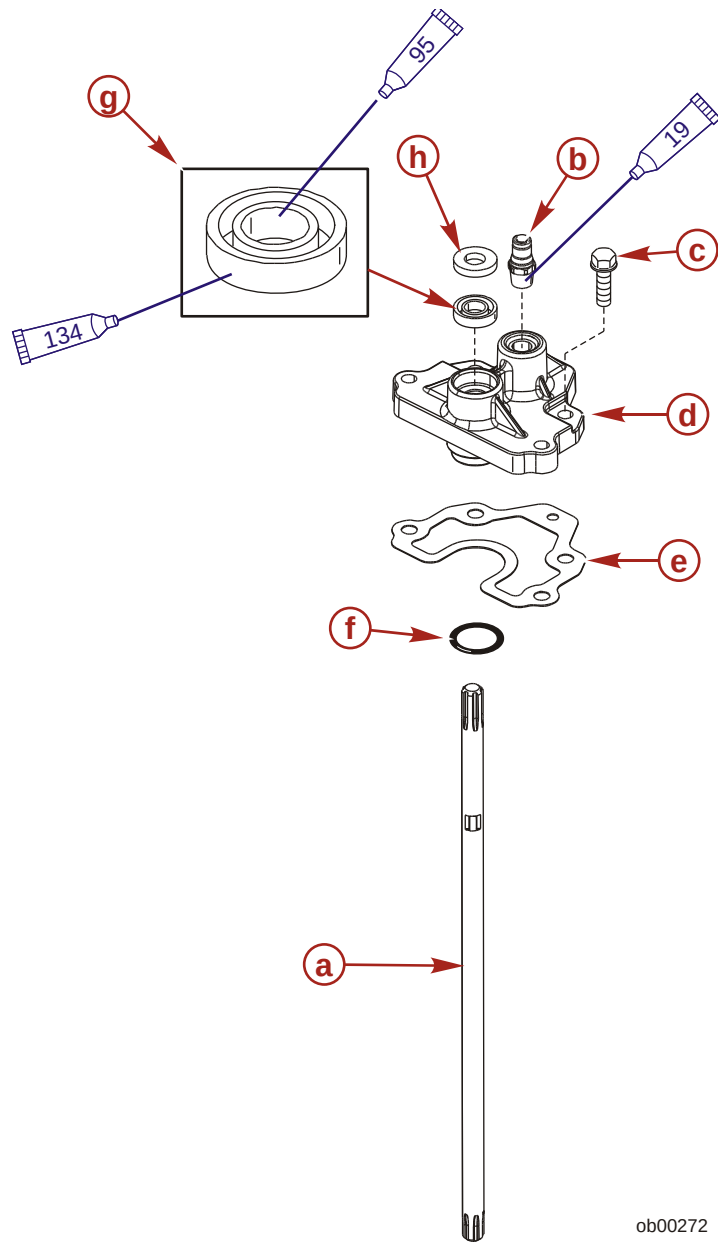
a - Oil seal surface

b - Splines

Reassembly

1. Lightly lubricate the seat of the O-ring diameter on the bushing and the lip of the oil seal with 2-4-C with Teflon.
2. Apply Loctite 380 to the outside diameter of the oil seal. Wipe off any excess Loctite.
3. If the speedometer connector was removed and/or replaced, lightly coat the threads of the connector with Perfect Seal. Assemble the speedometer connector to the bushing and torque the connector to specification.

4. Assemble all components as shown below. Be sure to position O-ring onto bushing before installing bushing into gear housing.



- a** - Shift shaft

b - Speedometer hose connector

c - Screws

d - Bushing assembly
- e** - Gasket

f - O-ring

g - Seal (lip faces up)

h - Rubber washer

Tube Ref No.	Description	Where Used	Part No.
	Perfect Seal	Speedometer connector threads	92-34227-1
	2-4-C Marine Lubricant with Teflon	Seat of shift shaft bushing O-ring diameter and lip of oil seal	92-802859A1
	Loctite 380	Outer diameter of oil seals	Obtain Locally

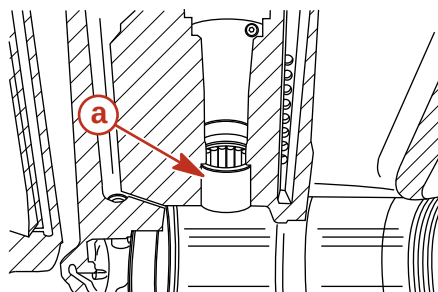
Description	Nm	lb. in.	lb. ft
Speedometer connector	2.8	25	
Bushing assembly screws (M6 x 20) (4 each)	7	60	

Pinion Bearing Removal

NOTE: Inspect the bearing surface on the driveshaft where the needles of the lower pinion bearing roll. The condition of the driveshaft at this location gives an indication of the condition of the needle bearing. Replace lower pinion bearing (needles and race as a set) if the driveshaft is pitted, grooved scored, worn unevenly, discolored from overheating, or has embedded particles.

IMPORTANT: All the needle bearings (18) must be in place inside bearing race while driving the pinion bearing from the gear housing. It is recommended that the cardboard tube provided with a new pinion bearing be used to keep the bearings in place while driving out the old pinion bearing.

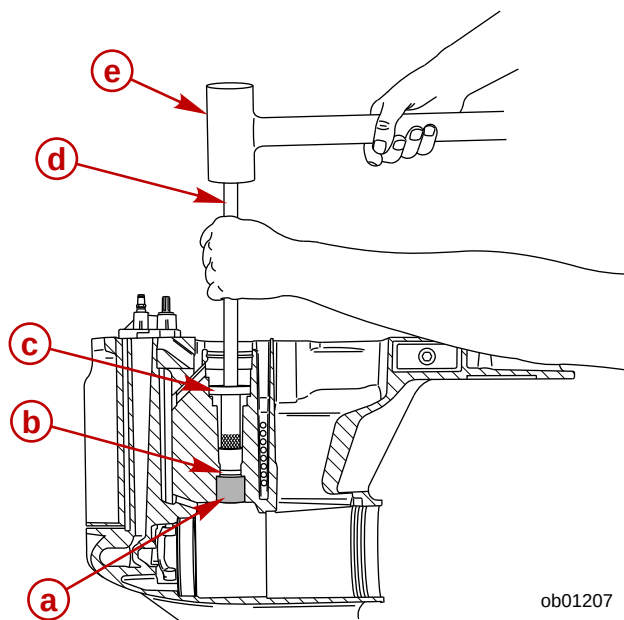
IMPORTANT: Do not reuse the bearing (race or rollers) once it has been removed.



ob01538

a - Pinion bearing

Remove and discard the pinion bearing (race and rollers) using tools as shown.



ob01207

a - Pinion bearing
b - Driver Head
c - Pilot Washer

d - Driver Rod
e - Dead blow hammer

Driver Head	91-36569T
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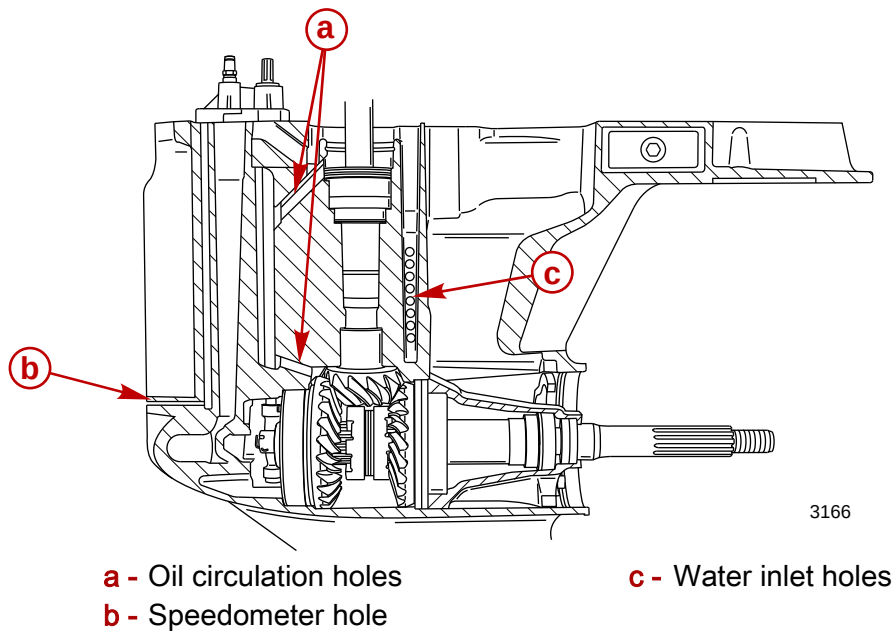
Pilot Washer	91-36571
Driver Rod	91-37323

Gear Housing Inspection

1. Clean the gear housing thoroughly with a suitable solvent and a hard bristle brush. Dry the gear housing thoroughly using compressed air. Ensure that all sealants, locking agents and debris are removed.
2. Verify the 2 oil circulation holes in the driveshaft bore and the shift shaft hole are clear and free of debris.
3. Inspect the gear housing for excessive corrosion, impact or any other damage. Excessive damage and/or corrosion requires replacement of the gear housing.
4. Inspect the bearing carrier retainer threads in the gear housing for corrosion and/or stripped threads. Damage or corrosion to the threads requires replacement of the gear housing.

NOTE: The upper driveshaft bearing cup is a slip fit within the driveshaft bore and may show signs of movement. All other bearing cups are press fit and should not show any signs of movement.

5. Inspect bearing race/cup contact areas for evidence of bearing cup spinning. Check that bearing cups are not loose in bearing bores. A press fit type bearing bore in which the race/cup is loose will require replacement of the gear housing.
6. Inspect for blockage in water inlet holes and the speedometer hole, clean as necessary. Be careful not to enlarge the speedometer hole as this could cause erroneous speedometer readings.

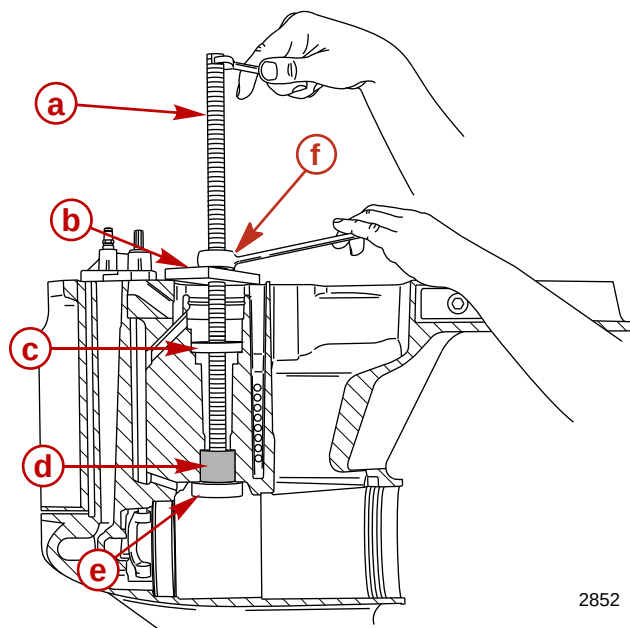


7. Verify that the locating pins are in place in the gear housing and that the corresponding holes in the driveshaft housing are not elongated. The driveshaft may break if the housings are not aligned properly due to missing locating pins or elongated holes.

Pinion Bearing Installation

IMPORTANT: Install only a new pinion bearing. Do not reinstall a pinion bearing that has been previously removed from a gear housing.

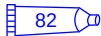
1. Lubricate the bore into which the pinion bearing is to be installed with Premium Gear Lubricant.
2. Position the new pinion bearing (with the cardboard shipping sleeve in place) onto the driver head, with the lettered and numbered side of the bearing oriented upward.
3. Insert the driver with the bearing assembly, into position (by way of the propeller shaft bore) at the driveshaft bore as shown.
4. Install the bearing by screwing down the nut until the bearing is fully seated against the bore shoulder.



a - Puller Rod
b - Puller Plate
c - Pilot

d - Pinion bearing
e - Mandrel
f - Hex Nut

Bearing Removal and Installation Kit	91-31229A7
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Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Pinion bearing bore	92-802846A1

Reverse Gear Bearing Cup

Installation

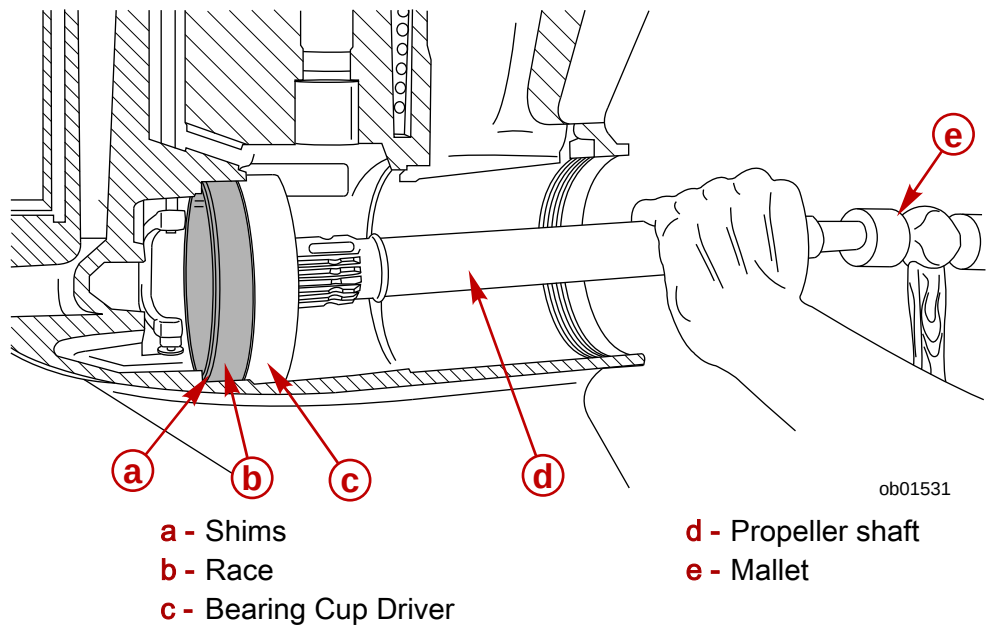
Reverse Gear	
Backlash	1.27 mm to 1.47 mm (0.050 in. to 0.058 in.)

NOTE: If the reverse gear, reverse gear bearing and cup, or gear housing were not replaced, install the same quantity of shims that were taken out when cup was removed. If the reverse gear, reverse gear bearing/cup, or gear housing were replaced, install 0.51 mm (0.020 in.) of shims.

NOTE: If backlash has already been checked and it was determined that it needs to be adjusted, (see Checking Reverse Gear Backlash), adding or subtracting 0.03 mm (0.001 in.) shims will change the gear backlash by the same amount.

- 1. Lubricate the bore into which the reverse gear bearing cup is to be installed with Premium Gear Lubricant.
- 2. Place the shim into reverse bore of gear housing.
- 3. Press the bearing cup into the gear housing using the installation tool.

IMPORTANT: Verify that the bearing cup is positioned as straight as possible to avoid cocking it in the bore while pressing it in.

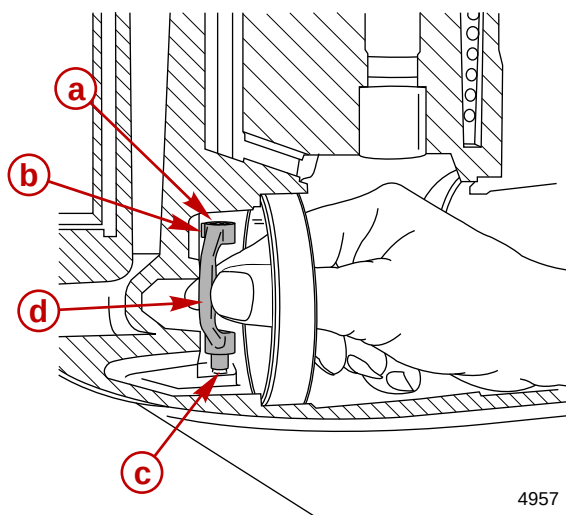


Bearing Cup Driver		91-885592T	
Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Reverse gear bearing cup bore	92-802846A1

Shift Shaft Installation

- 1. Place the shift crank into the pivot pin hole in the forward section of the gear housing. Ensure that the shift crank faces towards the left (port) side of the gear housing.

NOTE: On right hand rotation gearcases, the locating tab faces toward the forward gear bearing assembly. On left hand rotation gearcases, the locating tab faces away from the reverse gear bearing assembly.



4957

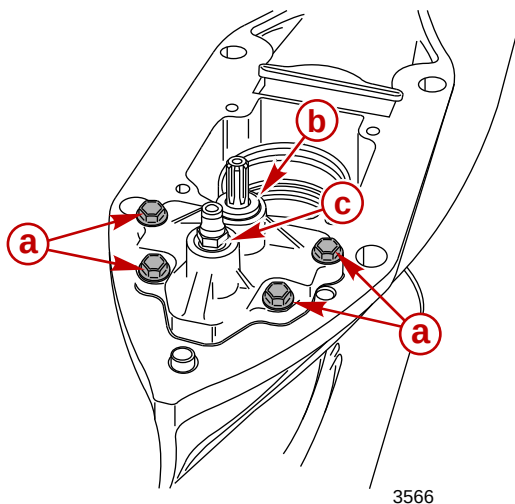
a - Shift shaft splines

b - Locating tab

c - Pivot pin

d - Shift crank

2. Install the shift shaft assembly into the gear housing as shown. Engage the splined end of the shift shaft with the shift crank. Verify O-ring is positioned properly on bushing and lubricated with 2-4-C with Teflon. Secure shift shaft bushing with four screws. Torque screws and speedometer fitting to specification.
3. Install rubber washer onto shift shaft and slide washer down until it just touches the oil seal in the bushing.



3566

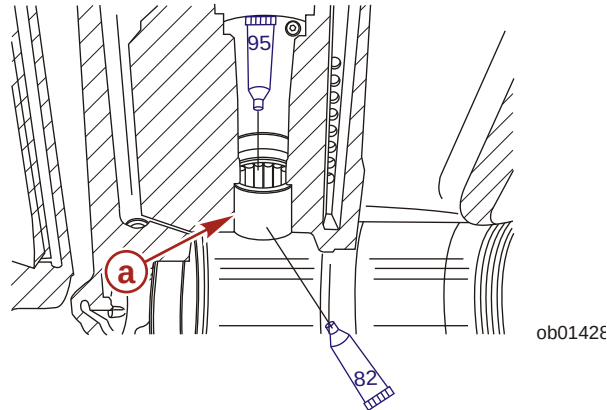
a - Screws

b - Rubber washer

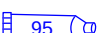
c - Speedometer fitting

Description	Nm	lb-in.	lb-ft
Screws (4)	7	60	
Speedometer fitting	2.8	25	

NOTE: If the pinion bearing needle bearings have fallen out, install 18 needles into needle bearing outer race. Use 2-4-C with Teflon, to help hold needles in place.

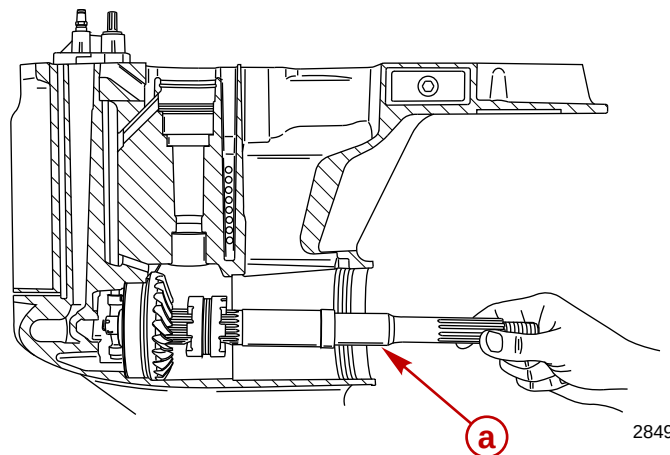


a - Pinion bearing

Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Outside diameter of pinion bearing	92-802846A1
 95	2-4-C Marine Lubricant with Teflon	Hold pinion needle bearings in place	92-802859A1

Propeller Shaft Installation

- To allow for the engagement of the shift spool with the shift crank, tilt the propeller end of the propeller shaft assembly to the left (port) side of gear housing and rotate the shift shaft from reverse to neutral while installing shaft.



a - Propeller shaft

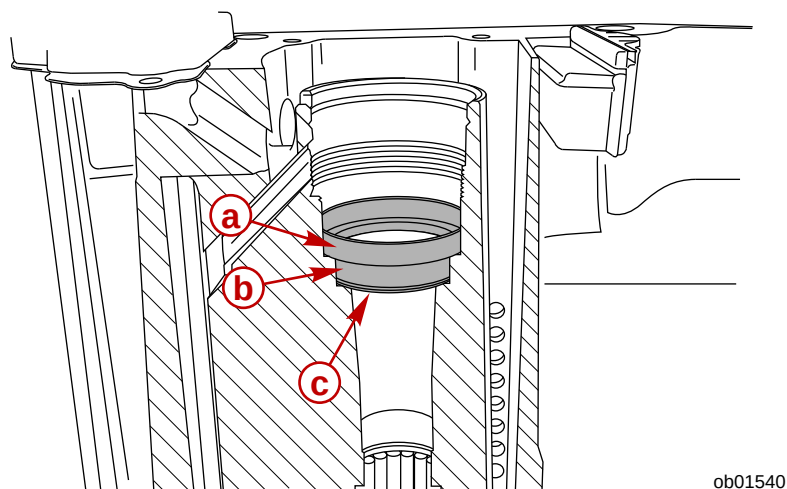
- Operate the shift shaft to ensure that it has been properly installed. The sliding clutch should move forward when the shift shaft is turned clockwise, and should move aft when the shift shaft is turned counterclockwise.

Driveshaft and Pinion Gear Installation

NOTE: If the original shims were not retained or if pinion gear, driveshaft, driveshaft upper tapered roller bearing and cup, or gear housing were replaced, start off by installing a 0.508 mm (0.020 in.) shim, for the lower tapered roller bearing.

NOTE: If the original shims were retained (or measurement known) and none of the above listed parts were replaced, reinstall the same shims or same amount of shims.

1. Place the lower tapered bearing shims into the driveshaft housing bore.
2. Install lower tapered bearing race into the driveshaft housing bore.
3. Install spacer (flanged end faces down).



a - Spacer

b - Tapered bearing race

c - Shims

4. Apply Loctite 271 to the threads of the pinion gear nut and place the pinion gear nut into the MR slot of the pinion nut adapter.

Tube Ref No.	Description	Where Used	Part No.
 7	Loctite 271 Threadlocker	Pinion gear nut threads	92-809819

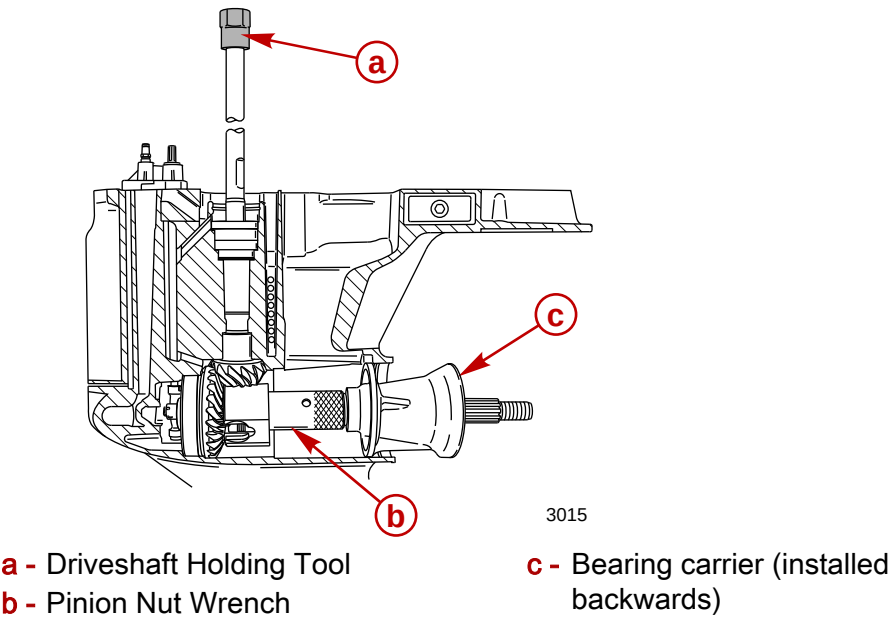
NOTE: Install the pinion gear nut with the flat side of the nut away from the pinion gear.

NOTE: For ease of installation, glue the washer to the pinion gear, using 3M Adhesive, or Bellows Adhesive, or equivalent.

NOTE: If the backlash may have to be changed, it is recommended that Loctite 271 not be applied to the pinion nut until the backlash setting is finalized. Do not reuse the old pinion nut. Install a new pinion nut after backlash is finalized.

5. Place the pinion gear and washer into the gear housing.
6. With the propeller shaft horizontal, insert the pinion nut holding tool (with the nut) into the gear housing.
7. Insert the driveshaft into the gear housing driveshaft bore. It may be necessary to rotate the driveshaft to engage the driveshaft splines into the pinion gear splines.
8. Start the pinion nut onto the driveshaft threads by rotating the driveshaft until the nut is snug.
9. Install the bearing carrier into the gear housing backwards to hold the propeller shaft and the pinion nut holding tool in position.

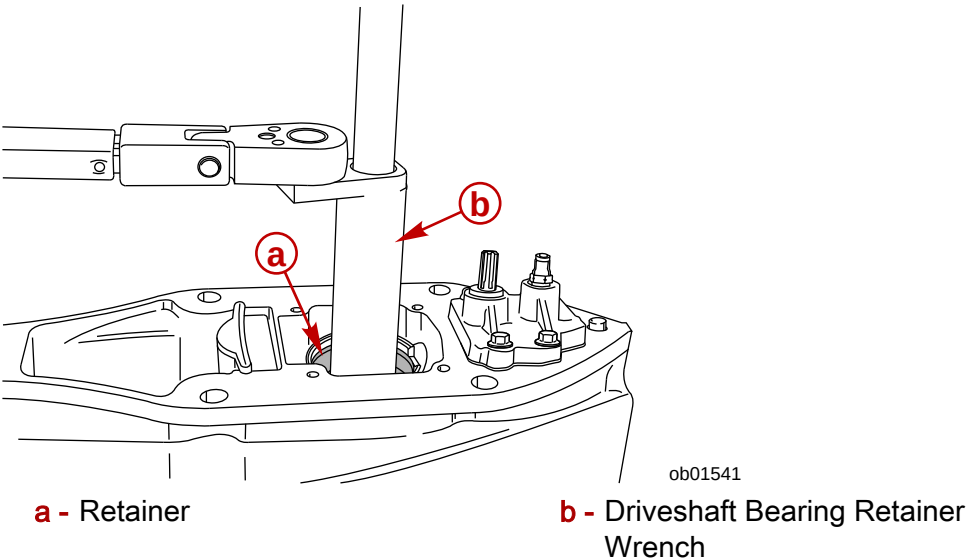
10. Torque the pinion nut to specification by turning the driveshaft using the driveshaft holding tool and torque wrench.



Driveshaft Holding Tool	91-889958T
Pinion Nut Wrench	91-61067003

Description	Nm	lb. in.	lb. ft.
Pinion Nut	101.7		75

11. Install the upper driveshaft tapered roller bearing cup. Apply 2-4-C with Teflon to the retainer threads and install the retainer. Torque retainer to specification.



Driveshaft Bearing Retainer Wrench	91-43506T
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Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Retainer threads	92-802859A1

Description	Nm	lb. in.	lb. ft.
Retainer	135.5		100

12. Remove the bearing carrier, Pinion Nut Wrench and Driveshaft Bearing Retainer Wrench.

NOTE: Units correctly assembled to this point would show a driveshaft rolling torque of 0.2 - 0.9 Nm (2 - 8 lb. in.).

Pinion Gear Height

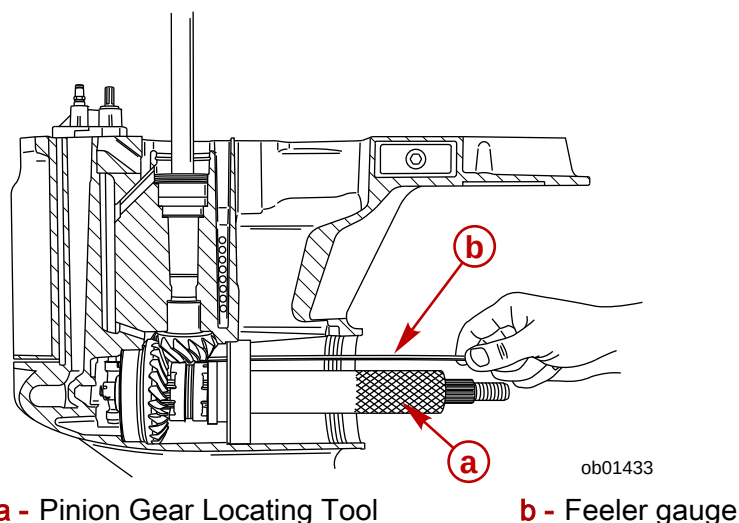
Checking and Adjusting using Pinion Height Tool 91-56048001

NOTE: The prop shaft and reverse gear can be installed when checking pinion height if Pinion Gear Locating Tool (91-56048001) is used.

1. Place the pinion gear shimming tool into the gear housing.

NOTE: Take the following measurements at 3 locations, rotating the driveshaft 120 degrees between each reading.

2. Insert the thickest feeler gauge that fits snugly between one tooth of the pinion gear and the high point of the shimming tool.



Pinion Gear Locating Tool	91-56048001
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3. Rotate the driveshaft 120 degrees in a clockwise direction and take another reading.
4. Repeat this process until 3 readings have been taken.
5. Add the 3 readings together and divide the sum by 3 to get the average pinion gear height. Make note of this average measurement.

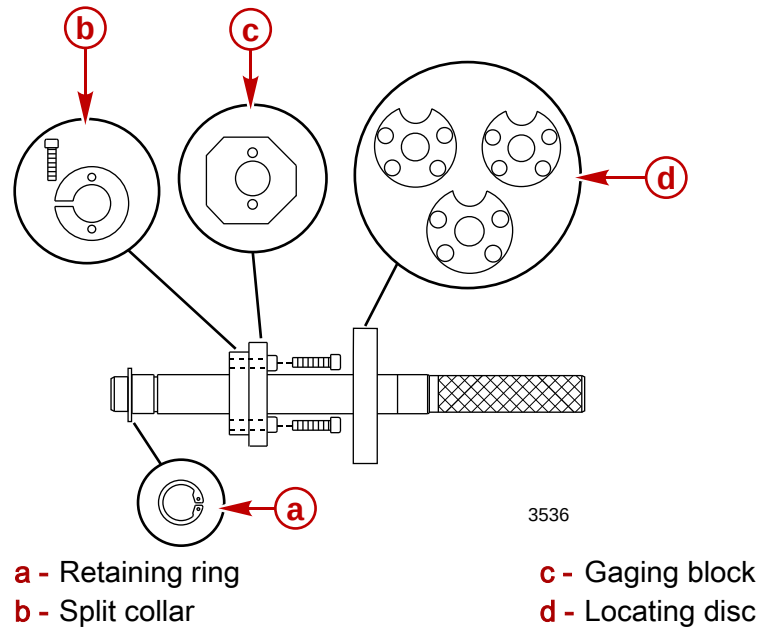
Pinion Gear	
Height	0.64 mm (0.025 in.)

6. If the average pinion gear height is not correct, add or subtract shims beneath the lower driveshaft tapered bearing race.
7. Reinstall removed components and re-torque retainer to specifications.

Description	Nm	lb. in.	lb. ft.
Retainer	135.5		100

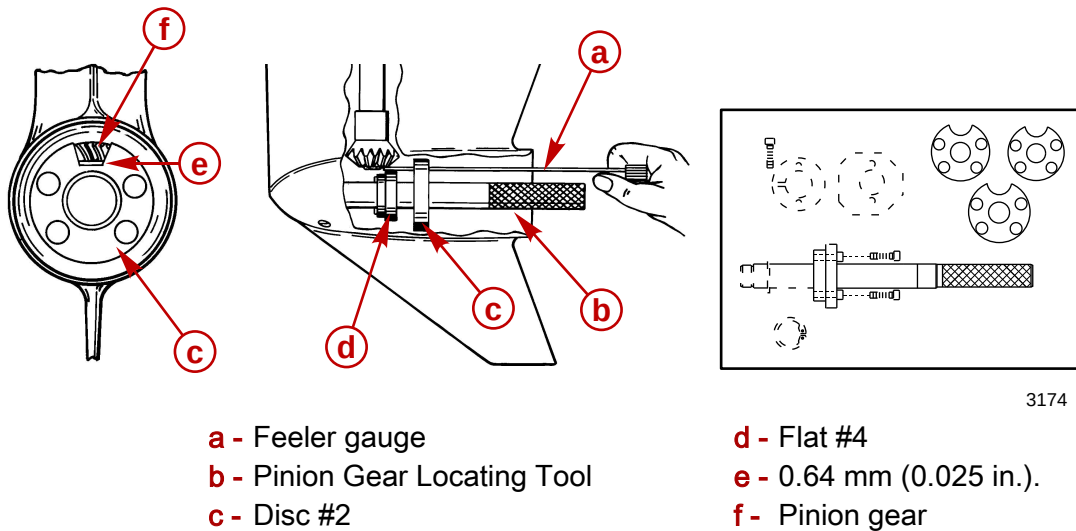
8. Rotate the driveshaft at least 3 full turns in a clockwise direction. Recheck the pinion gear height. If pinion height is not within specification, adjust shim thickness and recheck. Repeat this process until the average pinion height is within specification.

Checking and Adjusting using Pinion Gear Locating Tool 91-12349A05



NOTE: The reverse gear assembly must be installed when using Pinion Height Tool (91-12349A05).

1. Using Disc #2 and Flat #4, install Pinion Gear Locating Tool into gearcase.



Pinion Gear Locating Tool	91-12349A05
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NOTE: Take the following measurements at three locations, rotating the driveshaft 120 degrees between each reading (always rotate the driveshaft in a clockwise direction).

2. Insert the thickest feeler gauge that fits snugly between one tooth of the pinion gear and high point of the shimming tool.
3. Rotate the driveshaft 120 degrees in a clockwise direction and take another reading.
4. Repeat this process until three readings have been taken.

5. Add the three readings together and divide the sum by three to get the average pinion gear height. Make note of this average measurement.

Pinion Gear	
Height	0.64 mm 0.025 in.

6. If the average pinion gear height is not correct, add or subtract shims beneath the lower driveshaft tapered bearing race.
7. Reinstall removed components and re-torque retainer to specifications.

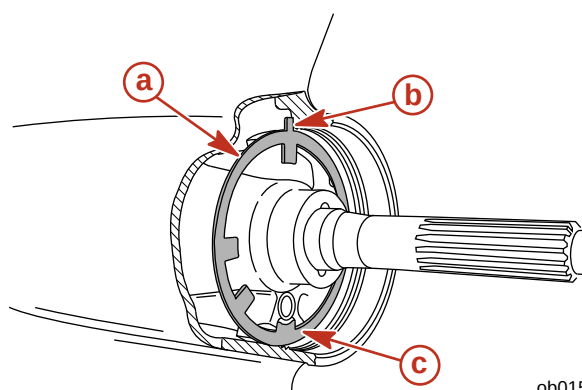
Description	Nm	lb. in.	lb. ft.
Retainer	135.5		100

8. Rotate the driveshaft at least 3 full turns in a clockwise direction. Recheck the pinion gear height. If pinion height is not within specification, adjust shim thickness and recheck. Repeat this process until the average pinion height is within specification.

Bearing Carrier Installation

NOTE: If backlashes have already been checked and they are to specification proceed to **Bearing Carrier Final Installation** section

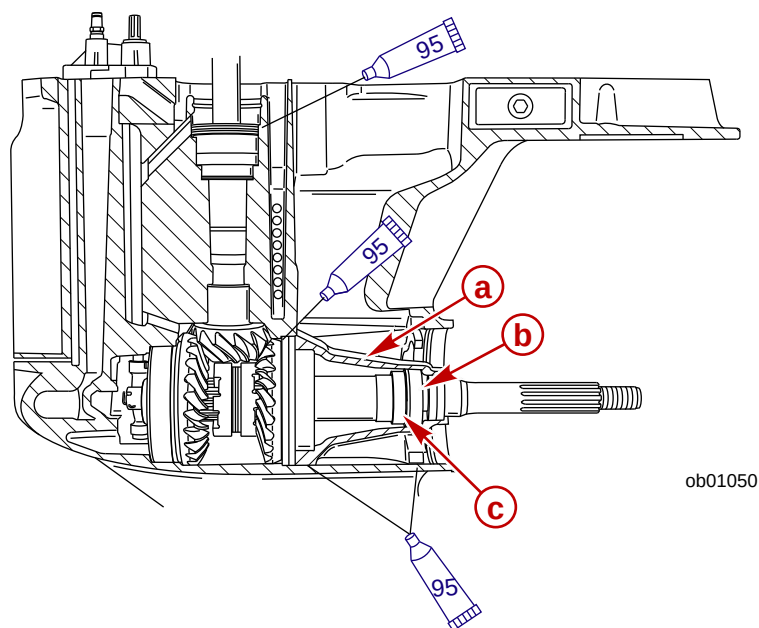
1. Place the bearing carrier assembly into the gear housing. It may be necessary to turn the driveshaft to align the teeth of the pinion and the forward gears.
2. Insert the small rectangular tab of the tab washer into its corresponding slot in the gearcase at the 12 o'clock position above the bearing carrier while aligning the u-shaped tab of the tab washer with its corresponding slot below the lubricant fill screw in the bearing carrier.



a - Tab washer
b - Rectangular tab

c - U-shaped tab

3. Lubricate the bearing carrier retainer threads and corresponding gear housing threads with 2-4-C with Teflon. Start the retainer into the gear housing threads and screw it down fully by hand.



- a - Bearing carrier assembly
- b - Propeller shaft bearing
- c - Preload spacer

Tube Ref No.	Description	Where Used	Part No.
	2-4-C Marine Lubricant with Teflon	Bearing carrier retainer threads, corresponding gear housing threads and upper driveshaft bearing retainer threads	92-802859A1

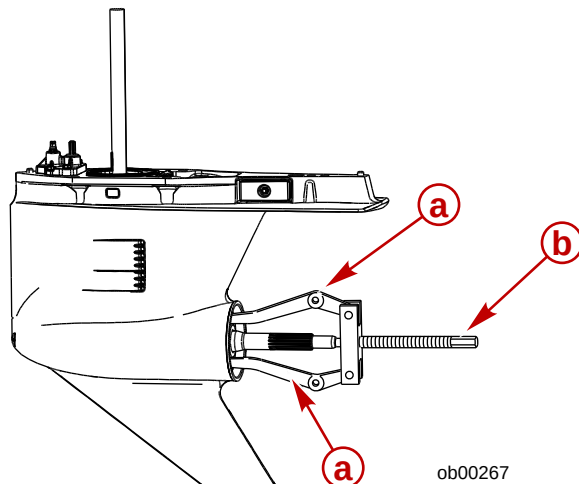
Reverse Gear Backlash

Reverse Gear	
Backlash	1.27 mm to 1.47 mm (0.050 in. to 0.058 in.)

NOTE: Pinion height must be set before checking reverse gear backlash.

1. Apply forward pressure on the propeller shaft as follows:
- a. Attach Puller Jaws Assembly onto bearing carrier bosses and propeller shaft

- b. Torque propeller nut to specification. Rotate the driveshaft three full turns in a clockwise direction and re-torque the propeller nut.

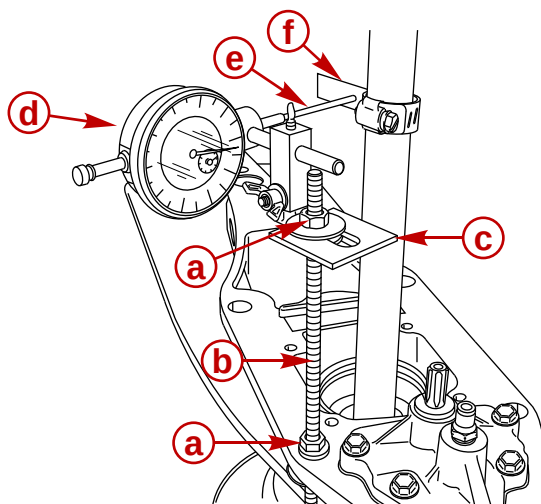


ob00267

a - Puller Jaws Assembly**b - Puller Bolt**

Puller Jaws Assembly	91-46086A1		
Puller Bolt	91-85716		
Description	Nm	lb. in.	lb. ft.
Propeller nut	5	45	

2. Install a dial indicator and align the dial indicator pointer so that it is perpendicular to and touching the "I" mark on the dial indicator tool. Tighten the indicator tool onto the driveshaft and rotate the driveshaft so that the needle in the dial makes at least one full revolution and comes to "0" on the dial indicator scale.



ob01534

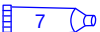
a - Nuts (4) (obtain locally)**b - Threaded rod - 9.5 mm (3/8 in.)
obtain locally****c - Dial Indicator Adapter****d - Dial Indicator****e - Indicator Pointer****f - Backlash Indicator Rod**

Dial Indicator	91-58222A1
Dial Indicator Adapter	91-83155

3. Take the backlash readings by lightly turning the driveshaft back and forth, so as to feel the backlash between the gears, (no movement should be noticed at the propeller shaft).
 - a. Observe the dial indicator and record the reading.
 - b. Loosen the indicator tool and rotate the driveshaft 90 degrees in a clockwise direction.
 - c. Repeat step 2 above and take and record another reading. Repeat step 3 until a total of 4 backlash readings have been taken.
4. Add the four readings together and divide the sum by four. The result is the average backlash.

Reverse Gear	
Average Backlash (1.86:1)	1.27 mm - 1.47 mm (0.050 in. - 0.058 in.)

5. If the backlash is less than the specified minimum, remove shims from in front of the reverse bearing race to obtain the correct backlash. When reinstalling pinion nut, apply Loctite 271 to threads of nut.
6. If backlash is more than the specified maximum, add shims in front of the reverse gear bearing race to obtain the correct backlash. When reinstalling pinion nut, apply Loctite 271 to threads of nut.

Tube Ref No.	Description	Where Used	Part No.
	Loctite 271 Threadlocker	Pinion gear nut threads	92-809819

NOTE: By adding or subtracting 0.025 mm (0.001 in.) shim, the backlash will change approximately 0.025 mm (0.001 in.).

Forward Gear Backlash

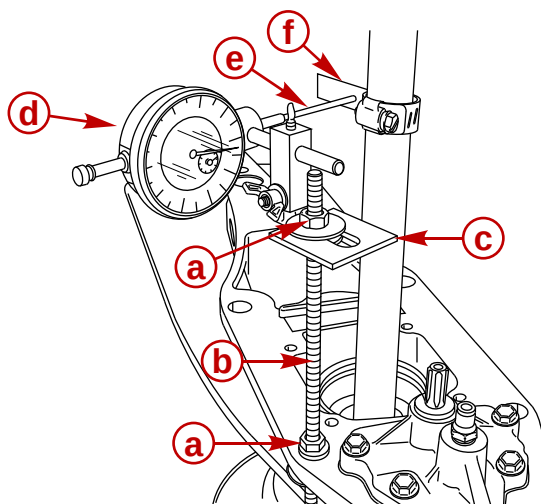
Forward Gear	
Backlash	0.457 mm - 0.685 mm (0.018 in. - 0.027 in.)

NOTE: Pinion height must be set before checking forward gear backlash.

NOTE: Propeller shaft shims must be removed from propeller shaft to check forward gear backlash.

Description	Nm	lb. in.	lb. ft.
Cover nut	285		210

1. Install a dial indicator and align the dial indicator pointer so that it is perpendicular to and touching the "I" mark on the dial indicator tool. Tighten the indicator tool onto the driveshaft and rotate the driveshaft so that the needle in the dial makes at least one full revolution and comes to "0" on the dial indicator scale.



ob01534

- a** - Nuts (4) (obtain locally)
b - Threaded rod - 9.5 mm (3/8 in.)
 obtain locally
c - Dial Indicator Adapter
d - Dial Indicator
e - Indicator Pointer
f - Backlash Indicator Rod

Dial Indicator Adapter	91-83155
Dial Indicator	91-58222A1
Backlash Indicator Rod	91-78473

2. Apply backward pressure on the propeller shaft by holding shift crank against forward gear.
3. Take the backlash readings by lightly turning the driveshaft back and forth, (no movement should be noticed at the propeller shaft).
 - a. Observe the dial indicator and record the reading.
 - b. Loosen the indicator tool and rotate the driveshaft 90 degrees in a clockwise direction.
 - c. Repeat step 2 above and take and record another reading. Repeat step 3 until a total of 4 backlash readings have been taken.
4. Add the four readings together and divide the sum by four. The result is the average backlash.

Forward Gear	
Average Backlash (1.86:1)	0.457 mm - 0.685 mm (0.018 in. - 0.027 in.)

5. If backlash is less than the specified minimum, remove shims from behind the forward gear bearing adapter to obtain correct backlash.
6. If backlash is more than the specified maximum, add shims behind the forward gear bearing adapter to obtain correct backlash.

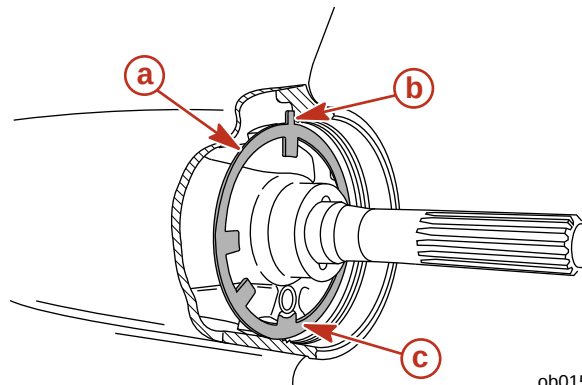
NOTE: By adding or subtracting 0.025 mm (0.001 in) shim, the backlash will change approximately 0.025 mm (0.001 in). Recheck backlash after making shim adjustments.

Propeller Shaft Bearing Preload

NOTE: All gear housing components must be installed and correctly shimmed before checking propeller shaft bearing preload. Propeller shaft tapered roller bearing must be properly seated in race during installation. Driveshaft retainer should be torqued to specification.

Description	Nm	lb. in.	lb. ft.
Driveshaft retainer	135		100

1. Remove bearing carrier.
2. Slide preload spacer off propeller shaft.
3. Install (retained) propeller shaft preload shims onto propeller shaft. If shims were lost, start with 0.9 mm (0.035 in.) shim thickness.
4. Reinstall preload spacer onto propeller shaft.
5. Reinstall bearing carrier, aligning rear propeller shaft bearing with propeller shaft. It may be necessary to turn the driveshaft to align the teeth of the pinion with reverse gear.
6. Insert the small rectangular tab of the tab washer into its corresponding slot in the gearcase at the 12 o'clock position above the bearing carrier while aligning the u-shaped tab of the tab washer with its corresponding slot below the lubricant fill screw in the bearing carrier.



a - Tab washer
b - Rectangular tab

c - U-shaped tab

7. With gear housing in neutral, torque bearing carrier retainer nut to initial specification.
8. Rotate propeller shaft several times to seat propeller shaft tapered roller bearings in their races.
9. Torque bearing carrier retainer nut to final specification.

Description		Nm	lb. in.	lb. ft.
Bearing carrier retainer nut	First	135		100
	Final	284		210

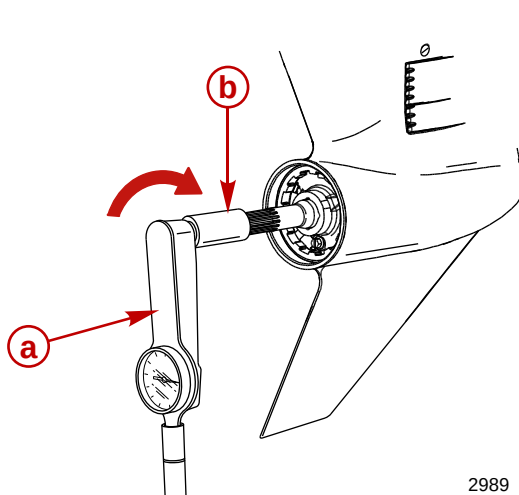
10. Install Propeller Shaft Adapter and using a torque wrench, rotate propeller shaft in the direction of normal rotation with a slow steady motion.
11. Verify rolling torque is within specification for new or used bearings.

Description	Nm	lb. in.	lb. ft.
Bearing rolling torque (new bearings)	1.1 - 1.8	10 - 16	

Description	Nm	lb. in.	lb. ft.
Bearing rolling torque (used bearings)	0.45 - 1.1	4 - 10	

NOTE: Preload will change approximately 0.056 Nm (1/2 lb. in.) of rolling torque per 0.025 mm (0.001 in.) of shim change.

12. If rolling torque is too high, remove shims from propeller shaft ahead of tapered bearing/spacer in bearing carrier. If torque is too low, add shims.



a - Torque wrench

b - Propeller Shaft Adapter

Propeller Shaft Adapter	91-61077
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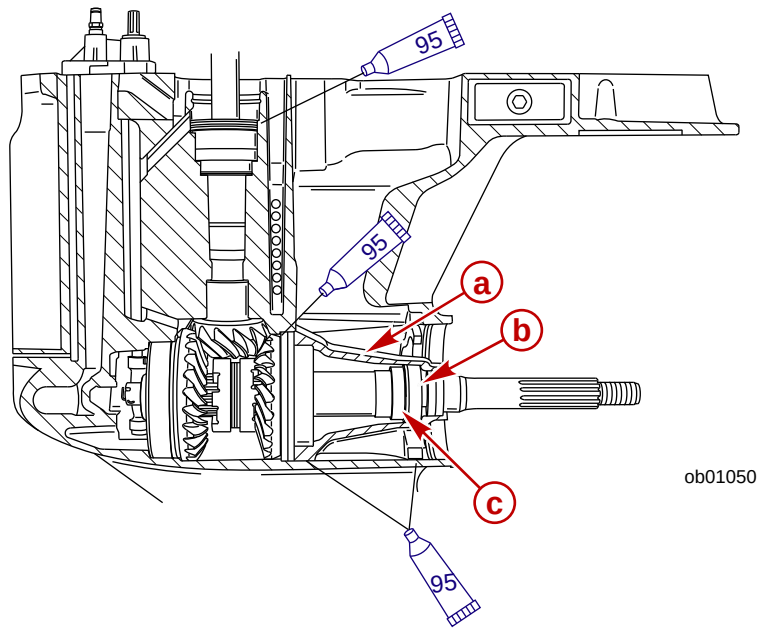
NOTE: If shims are changed, torque bearing carrier to initial specification. Rotate propeller shaft several times to seat propeller shaft tapered bearing. Re-torque retainer nut to final specification. Use torque wrench to check rolling torque. Repeat this procedure each time shims are changed.

Description		Nm	lb. in.	lb. ft.
Bearing carrier	First	135		100
	Final	284		210

Bearing Carrier Final Installation

1. Remove the bearing carrier and lubricate the following as specified:
 - a. Lubricate the carrier O-ring with 2-4-C with Teflon.
 - b. Lubricate both the forward and aft outer diameters of the bearing carrier and gearcase area where carrier will seat with 2-4-C with Teflon.

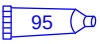
- c. Fill the space between the carrier oil seals with 2-4-C with Teflon.



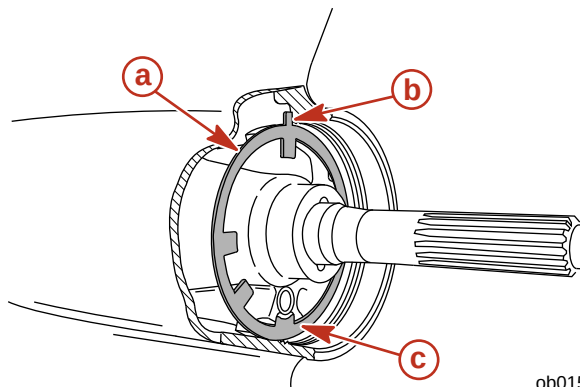
a - Bearing carrier

b - Propeller shaft bearing

c - Preload spacer

Tube Ref No.	Description	Where Used	Part No.
	2-4-C Marine Lubricant with Teflon	Carrier O-ring, forward and aft outer diameters of bearing carrier, gearcase area where carrier will seat, space between carrier seals	92-802859A1

- Place the bearing carrier assembly into the gear housing, being careful to align rear propeller shaft bearing. It may be necessary to turn the driveshaft to align the teeth of the pinion and the reverse gears.
- Lubricant fill screw in bearing carrier should be located at the 6 o'clock position.
- Insert the small rectangular tab of the tab washer into its corresponding slot in the gearcase at 12 o'clock position above the bearing carrier while aligning the u-shaped tab of the tab washer with its corresponding slot below the lubricant fill screw in the bearing carrier.



a - Tab washer

b - Rectangular tab

c - U-shaped tab

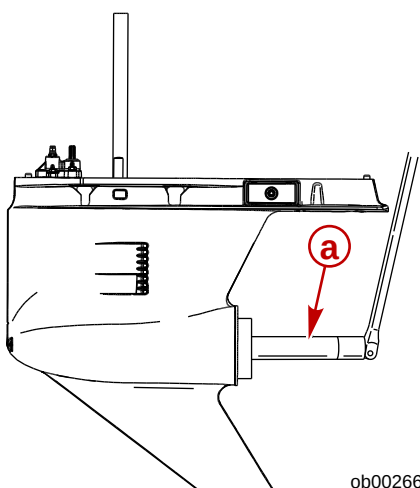
5. Fill the bearing carrier retainer nut threads and corresponding gear housing threads with 2-4-C with Teflon. Start the retainer into the gear housing threads and screw it down fully by hand.

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Bearing carrier retainer nut threads and corresponding gear housing threads	92-802859A1

IMPORTANT: Before torquing bearing carrier retainer, gearcase must be bolted to driveshaft housing or securely fastened in a gearcase holding fixture to avoid possible damage to gear housing.

NOTE: Torque retainer nut to initial specification first. Rotate propeller shaft several times to seat tapered roller bearings. Retainer nut can then be torqued to final specification.

6. Torque the bearing carrier retainer to specification. If one tab does not align up in space between two of the notches, continue to tighten retainer until alignment is achieved. Do not loosen retainer to achieve alignment.



a - Bearing Carrier Retainer Nut Wrench

Bearing Carrier Retainer Nut Wrench		91-61069T		
Description		Nm	lb. in.	lb. ft.
Bearing carrier retainer nut	First	135.5		100
	Final	285		210

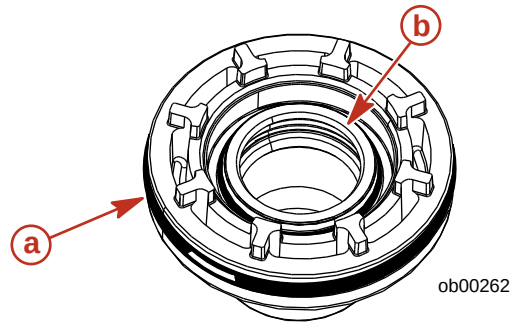
7. Bend one tab aft (outward) into a space between two of the notches of the retainer. Bend all the remaining tabs forward (inward).

Oil Seal Carrier Installation

NOTE: Oil seal carrier maybe lightly tapped into position by sliding Driveshaft Bearing Retainer Wrench over the driveshaft.

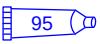
Driveshaft Bearing Retainer Wrench	91-43506T
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1. Lubricate the oil seal carrier oil seal lips, space between seals and O-ring with 2-4-C with Teflon and install the oil seal carrier over the driveshaft and into the gearcase.

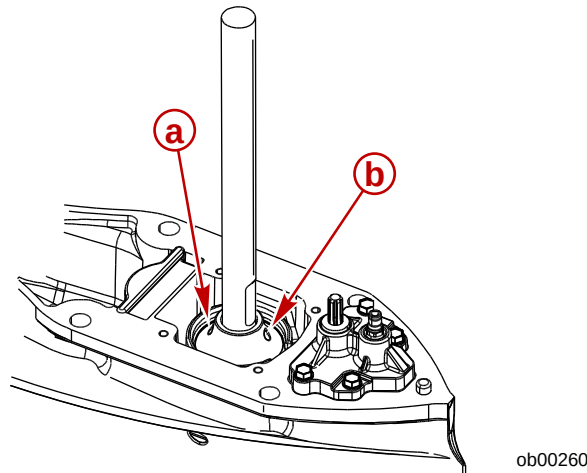


a - O-ring

b - Oil seal lips

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Oil seal carrier seal lips, space between oil seals and O-ring	92-802859A1

2. Reinstall retaining ring above oil seal carrier.



a - Retaining ring

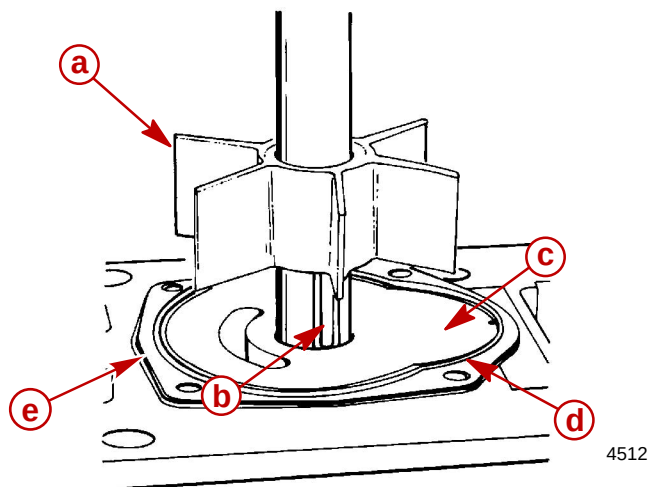
b - Oil seal carrier

Water Pump Installation

1. Install water pump base gasket.
2. Install water pump face plate.
3. Install water pump cover gasket.
4. Place a small amount of 2-4-C with Teflon on the flat surface of the impeller key and install the key onto the driveshaft keyway.

IMPORTANT: When using an impeller whose blades have taken a set, face the curl of the blades in a counterclockwise direction. Do not install the impeller with its blades oriented in a reversed direction from original rotation, or premature impeller failure will occur.

5. Assemble the water pump impeller onto the driveshaft and down over the key.

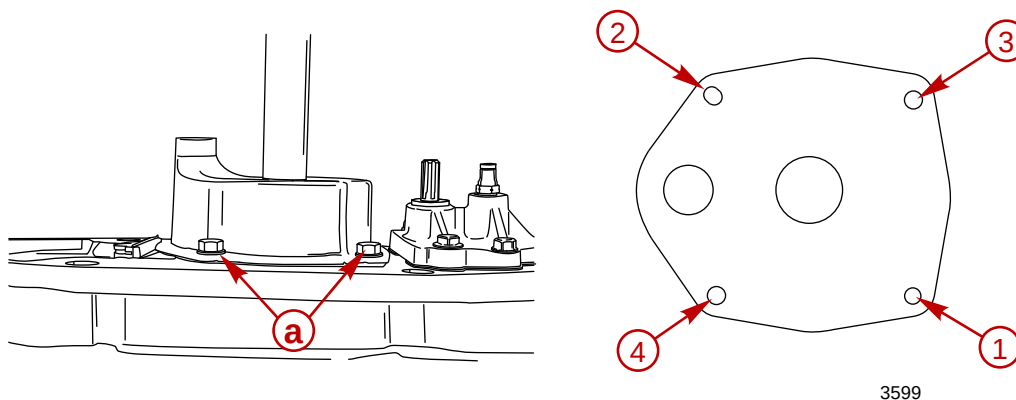


a - Impeller
b - Key
c - Face plate

d - Pump cover gasket (gray seal bead faces up)
e - Pump base gasket

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Flat surface of the impeller key	92-802859A1

6. Apply a light coat of 2-4-C with Teflon to the inside of the pump cover. Rotate the driveshaft in a clockwise direction, while pushing down on the water pump cover to ease the water pump cover over the impeller blades.
7. Hand start starboard front fastener first into the water pump assembly. Install the remaining 3 fasteners. Run all fasteners down and torque in sequence to specification.



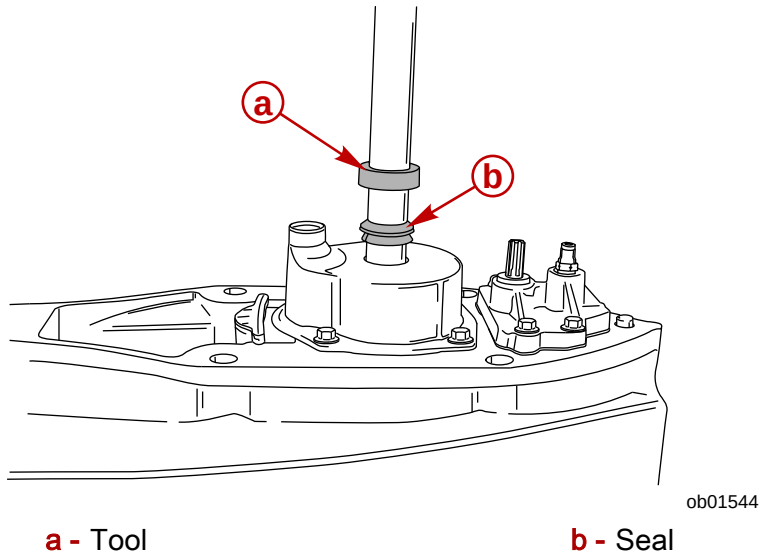
a - Water pump cover screws (4)

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Inside of water pump cover	92-802859A1

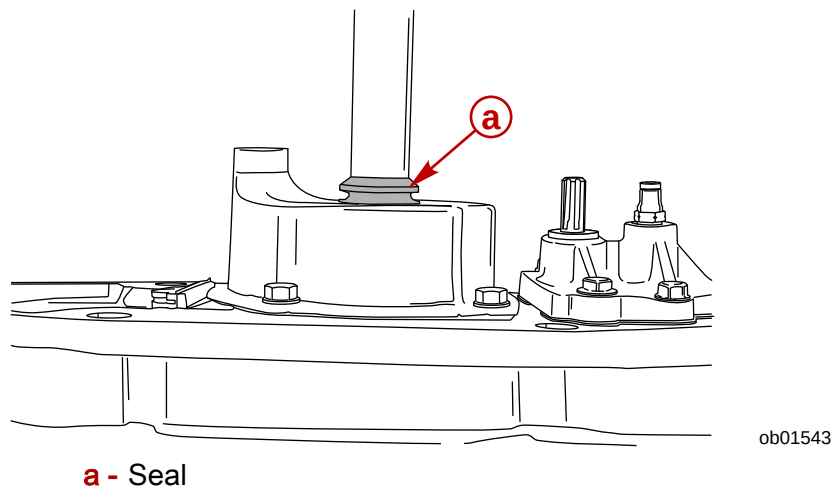
Description	Nm	lb. in.	lb. ft.
Water pump cover screws (4)	7	60	

IMPORTANT: If seal installed above pump housing is not at the proper height, air will be drawn into the pump resulting in overheating of the engine.

8. Using tool provided in Seal Kit or Water Pump Kit, press seal down over driveshaft (do not grease driveshaft) until tool seats against pump housing.



NOTE: If tool is not available, lightly press seal against housing until specified height is obtained.



Water Pump Cover	
Seal Height	8.9 mm $\pm$ 0.76 mm (0.350 in. $\pm$ 0.030 in.)

Gear Lubricant Filling Instructions

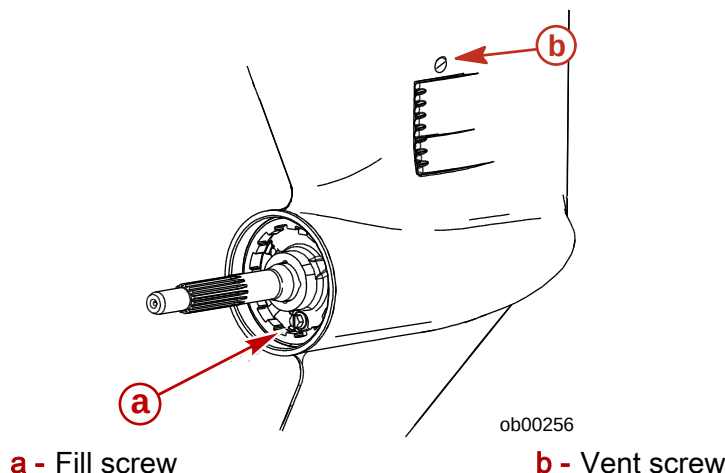
1. Inspect fill and vent sealing washers for cuts or abrasions. Replace washers if necessary.

IMPORTANT: Never apply lubricant to gear housing without first removing vent screw, or gear housing cannot be filled because of trapped air. Fill gear housing only when housing is in a vertical position.

2. Slowly fill housing through fill hole with Premium Gear Lubricant until lubricant flows out of vent hole and no air bubbles are visible.
3. Install vent screw into vent hole.

IMPORTANT: Do not lose more than 30cc (1 fl. oz.) of gear lubricant while reinstalling fill screw.

- Remove grease tube (or hose) from fill hole and quickly install fill screw into fill hole. Torque fill and vent screws to specification.



Tube Ref No.	Description	Where Used	Part No.
 82	Premium Gear Lubricant	Gear housing	92-802846A1

Description	Nm	lb. in.	lb. ft.
Fill and vent screws	6.8	60	

Installing Gear Housing to Driveshaft Housing

⚠ WARNING

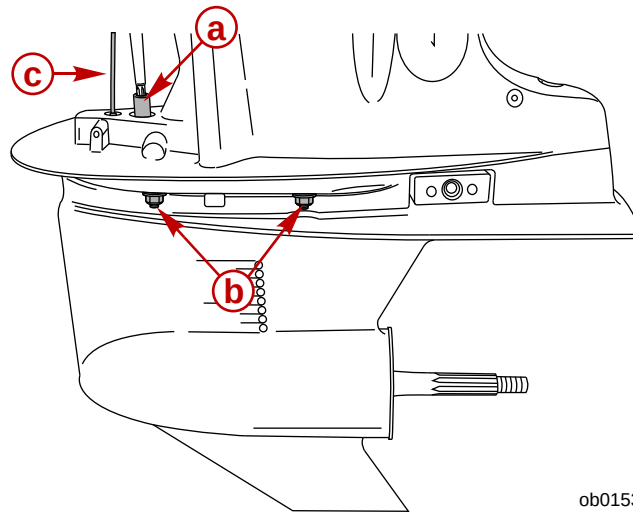
To prevent accidental engine starting, remove and isolate spark plug leads from spark plugs before removing or installing gear housing.

- Tilt engine to full up position and engage the tilt lock lever.
- Apply a light coat of 2-4-C with Teflon onto driveshaft splines.
- Apply a light coat of 2-4-C with Teflon onto shift shaft splines. Do not allow lubricant on top of shift shaft.

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Driveshaft splines; shift shaft splines	92-802859A1

- Insert anodic plate bolt into hole in rear of gear housing to driveshaft housing machined surface.
- Verify neutral position switch is in the neutral position. Verify that the gearcase is in the neutral position.
- Position gear housing so that the driveshaft is protruding into driveshaft housing. If, while performing Step 7, the driveshaft splines will not align with crankshaft splines, lower the gearcase and turn the driveshaft slightly in a clockwise direction. Repeat as required until driveshaft splines match with crankshaft splines.
- Move gear housing up toward driveshaft housing while aligning shift shaft splines with shift shaft coupler and water tube outlet on water pump cover with water tube coupler (in driveshaft housing).

8. Place flat washers onto studs (located on either side of driveshaft housing). Start a nut on these studs and tighten finger-tight.
9. Insert speedometer tube into speedometer tube coupler.

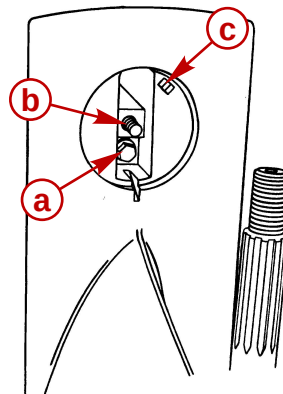


ob01535

- a** - Shift shaft coupler
b - Nuts and flat washers (2 each side)

c - Speedometer tube

10. Start screw at rear of gear housing inside trim tab recess. Do not tighten screw at this time.



ob01286

- a** - Screw
b - Anodic plate attaching bolt

c - Ribs (align carefully with anodic plate)

IMPORTANT: Do not force gearcase up into place with attaching nuts.

11. Evenly tighten two nuts which were started in Step 8. Torque to specification.

Description	Nm	lb. in.	lb. ft.
Nuts (2 each side)	75		55

12. After two nuts (located on either side of driveshaft housing) are tightened, check shift operation as follows:

- a. Turn ignition switch to the "ON" position and move remote control to forward gear position; propeller shaft should rotate clockwise and then lock (no ratcheting motion).
- b. Move remote control into neutral position. Propeller shaft should rotate freely clockwise/counterclockwise.

- c. Move remote control into reverse gear position; propeller shaft should rotate counterclockwise and then lock (no ratcheting motion).

IMPORTANT: If shifting operation is not as described, preceding, the gear housing must be removed and the cause corrected.

13. Install remaining washers and nuts onto drive shaft studs and torque to specification.

Description	Nm	lb. in.	lb. ft.
Gearcase attaching nut (2 each side)	75		55

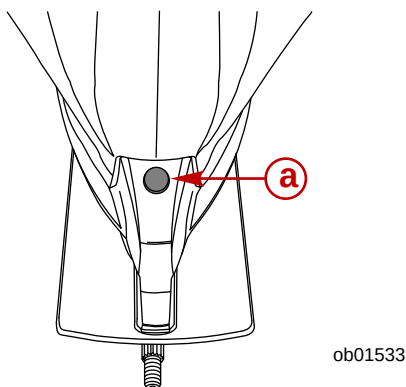
14. Torque screw (started in Step 10) to specification.

Description	Nm	lb. in.	lb. ft.
Screw (M12 x 35)	75		55

15. Position trim tab or anodic plate in gear housing. Align grooves of trim tab with ribs in trim tab pocket. Adjust to position in which it had previously been installed, and while holding trim tab, torque screw to specification

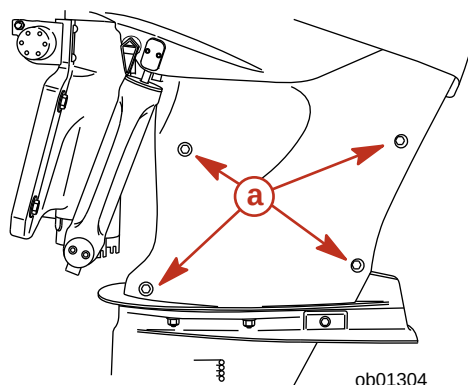
Description	Nm	lb. in.	lb. ft.
Screw (0.437 - 14 x 1 - 3/4 in.)	54		40

16. Install plastic cap into trim tab bolt opening at rear edge of driveshaft housing.



a - Cap

17. Reinstall the port driveshaft housing chap. Torque screws to specification.



a - Screws (4) or (6) for XXL shaft

Description	Nm	lb. in.	lb. ft.
Driveshaft housing chap screws (4 or 6 each side)	6	53	

Attachments

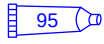
Section 7A - Attachments

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7
A

Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Loctite 271 Threadlocker	First four threads of tie bar attaching screw	92-809819
		First four threads	
	2-4-C with Teflon	Clevis attaching screw shoulder	92-802859A1
		Clevis/tie bar arm attaching screw shoulder	
		Screw shoulder	

Dual Tie Bar

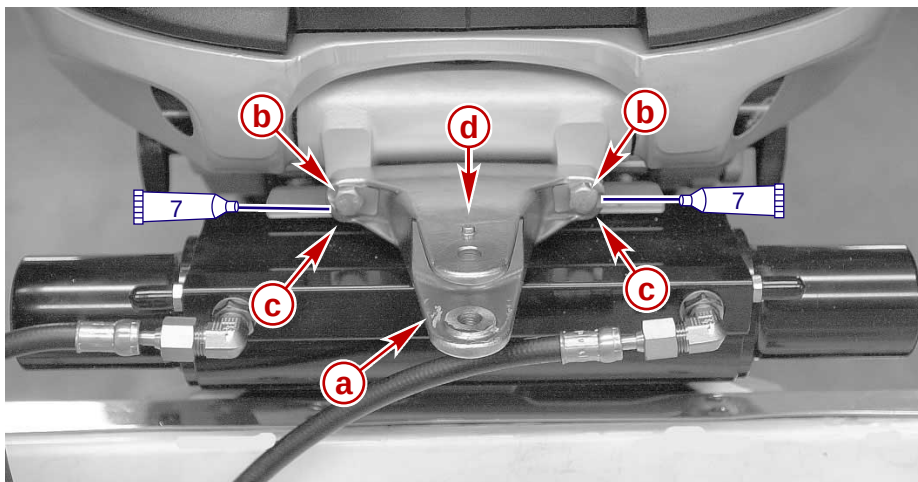
Installation

IMPORTANT: The tie bar arms must be fastened to each engine using special screws (10-896555025). The use of any other unauthorized fastener may result in the tie bar arm disconnecting from the engine.

⚠ WARNING

Improper tightening of fasteners may result in loosening or disengagement of tie bar arm. Disengagement of the tie bar arm from engine can result in boat taking a full, sudden, sharp turn. This potentially violent action can cause occupants to be thrown overboard exposing them to serious injury or death.

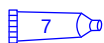
1. Install the tie bar arm to each engine with two screws and two locking retainers. Apply Loctite 271 to first four threads of screws. Position tie bar arm on each engine with locating tab facing up.
2. While holding locking retainer in position, torque screws to specification. Bend one corner of locking retainer against flat of each screw.



4662

- a** - Tie bar arm
b - Tie bar arm attaching screw
c - Locking retainers
d - Locating tab

Description	Nm	lb. in.	lb. ft.
Tie bar arm attaching screw (M8 x 25 mm)	55		40.6

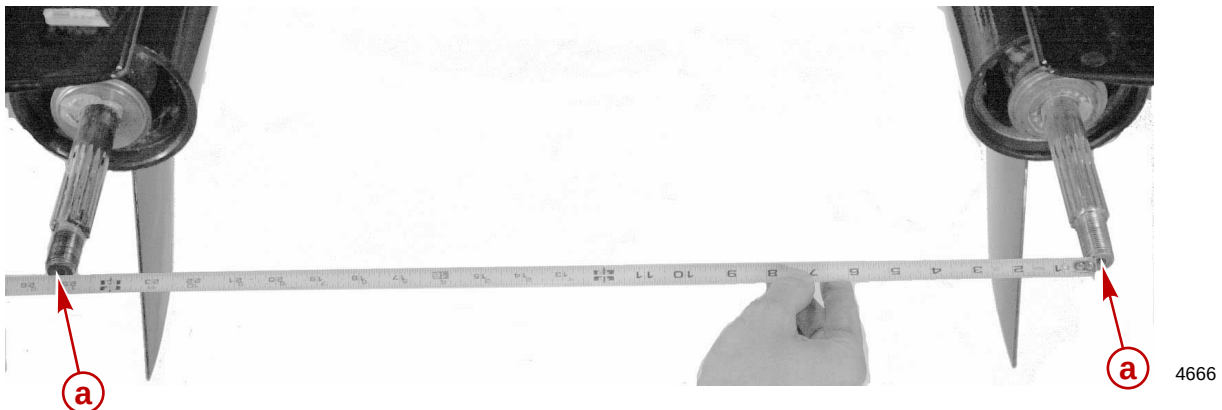
Tube Ref No.	Description	Where Used	Part No.
	Loctite 271 Threadlocker	First four threads of tie bar attaching screw	92-809819

3. Measure distance between tie bar arm centers. Record distance.



a - Tie bar arm centers

4. Measure distance between propeller shaft centers. Record distance.



a - Propeller shaft centers

5. Adjust engines to equalize both measurements.

IMPORTANT: Both tie rod ends must be threaded into coupler 19 mm (0.75 in) minimum and jam nut torqued against coupler 35 Nm (25.8 lb. ft.) to prevent coupler from turning. Insufficient engagement of the tie rod threads could result in tie rods pulling out of the coupler and disengaging the steering tie rod.

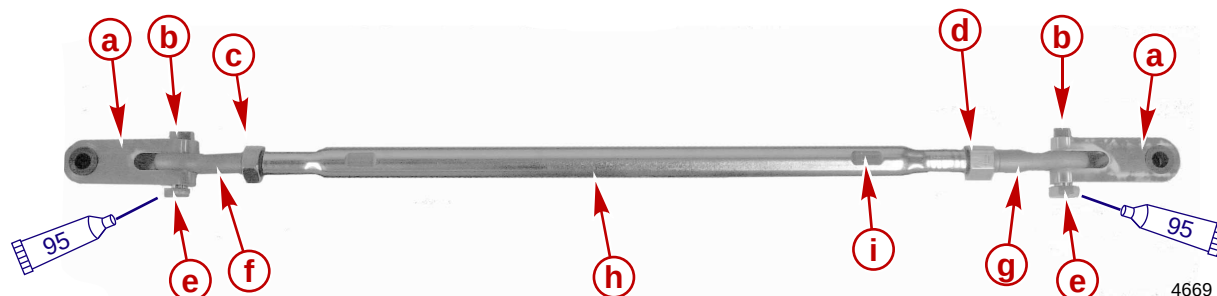
⚠ WARNING

Avoid possible serious injury or death from loss of boat control due to disengagement of the steering tie rod. A sudden, sharp, unexpected turn can result in boat occupants being thrown overboard or thrown violently within the boat. Carefully follow tie rod installation instructions.

6. Assemble each tie rod end to tie rod coupler with corresponding jam nut.

NOTE: Tie rod coupler is threaded for left hand (LH) and right hand (RH) tie rod ends respectively. Assemble corresponding tie rod end to correct end of coupler. Do not tighten jam nuts at this time.

7. Install clevis assembly to each tie rod end. Secure clevis with screw and nut. Apply 2-4-C with Teflon to screw shoulder. Torque screw and nut to specification.



- a** - Clevis
b - Clevis attaching nut (M8 x 1.25)
c - Tie rod end/coupler attaching nut (M14 x 200 RH)
d - Tie rod end/coupler attaching nut (M14 x 200 LH [marked "L"])
e - Clevis attaching screw (M8 x 35.3 mm)
f - Tie rod end RH
g - Tie rod end (marked "L")
h - Coupler
i - Flat with "L" imprinted (left hand threads)

Description	Nm	lb. in.	lb. ft.
Clevis attaching nut (M8 x 1.25)	25		18.4
Clevis attaching screw (M8 x 35.3 mm)	25		18.4

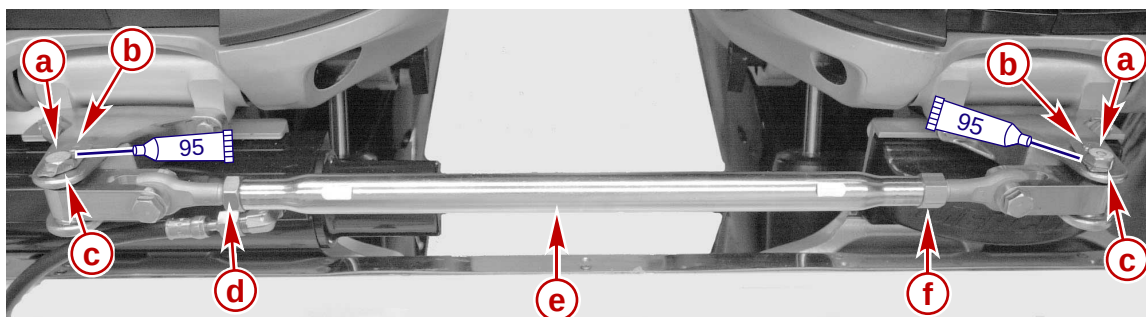
Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C with Teflon	Clevis attaching screw shoulder	92-802859A1

8. Adjust tie bar ends equally so that clevis mounting bolt holes match engine center line distance previously noted. Do not tighten jam nuts at this time.

NOTE: To aid in the installation of the second tie bar mount bolt, turn the tie bar coupler to help align the mounting bolt holes between the tie bar arms and the tie bar clevises.

9. Install tie bar assembly onto tie bar arms. Secure tie bar assembly with screw and locking retainer. Apply 2-4-C with Teflon to screw shoulder. Align retainers with alignment tabs on tie bar arm.
10. Torque screws to specification. Bend one corner of locking retainer against flat of each screw.
11. Turn tie bar coupler, if necessary, to equalize distance between tie bar arm centers and propeller shaft centers.

12. When engines are centered, tighten jam nuts against coupler. Torque nuts to specification.



4670

- a** - Clevis/tie bar arm attaching screw (M8 x 46.75 mm)
b - Locating tab
c - Locking retainer
d - Tie rod end/coupler attaching nut (M14 right hand thread)
e - Coupler
f - Tie rod end/coupler attaching nut (M14 left hand thread [marked "L"])

Description	Nm	lb. in.	lb. ft.
Clevis/tie bar arm attaching screw (M8 x 46.75 mm)	25		18.4
Tie rod end/coupler attaching nut (M14 right hand thread)	35		25.8
Tie rod end/coupler attaching nut (M14 left hand thread [marked "L"])	35		25.8

Tube Ref No.	Description	Where Used	Part No.
	2-4-C with Teflon	Clevis/tie bar arm attaching screw shoulder	92-802859A1

IMPORTANT: After installation is complete (and before operating outboards), check that boat will turn right when steering wheel is turned right and that boat will turn left when steering wheel is turned left. Check steering through full range (left and right) at all trim and tilt angles to ensure interference free movement.

Maintenance Instructions

Maintenance inspection is the owner's responsibility and must be performed at the specific intervals.

Normal service - Every 50 hours of operation or 60 days (whichever comes first).

Severe service - Every 25 hours of operation or 30 days (whichever comes first).

NOTE: Operation in salt water is considered severe service.

1. Check steering system components for wear. Replace any worn parts.
2. Check steering system fasteners to ensure they are torqued to correct specifications.
3. Refer to operating and maintenance instructions for power steering system.

Plus One Tie Bar

Installation

IMPORTANT: The tie bar arms must be fastened to each engine using special screws (10-896555025). The use of any other unauthorized fastener may result in the tie bar arm disconnecting from the engine.

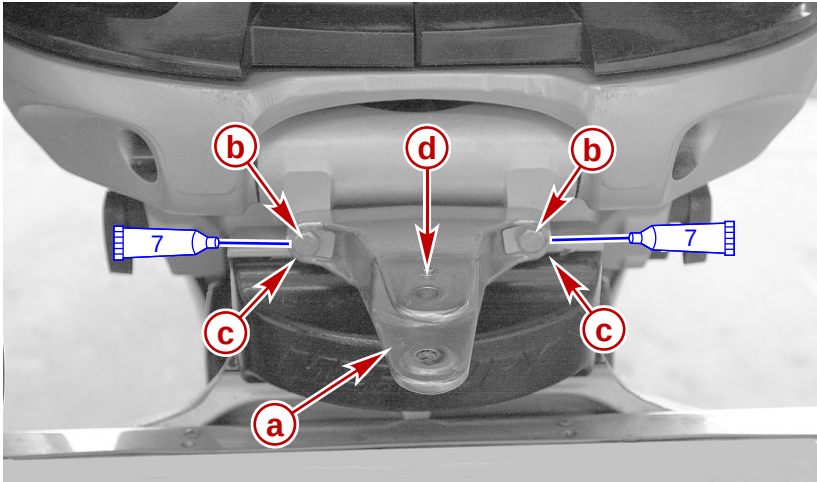
⚠ WARNING

Improper tightening of fasteners may result in loosening or disengagement of tie bar arm. Disengagement of the tie bar arm from engine can result in boat taking a full, sudden, sharp turn. This potentially violent action can cause occupants to be thrown overboard exposing them to serious injury or death.

1.

Install tie bar arm to each engine with two screws and two locking retainers. Apply Loctite to first four threads of screws. Position tie bar arm on engine with locating tab facing up.
2.

While holding locking retainers in place, torque screws to specification. Bend one corner of locking retainer against flat of each screw.



5082

- a - Tie bar arm

b - Attaching screw

c - Locking retainer

d - Locating tab

Tube Ref No.	Description	Where Used	Part No.
	Loctite 271 Threadlocker	First four threads	92-809819

Description	Nm	lb. in.	lb. ft.
Attaching screw (M8 x 25)	55		40.6

3.

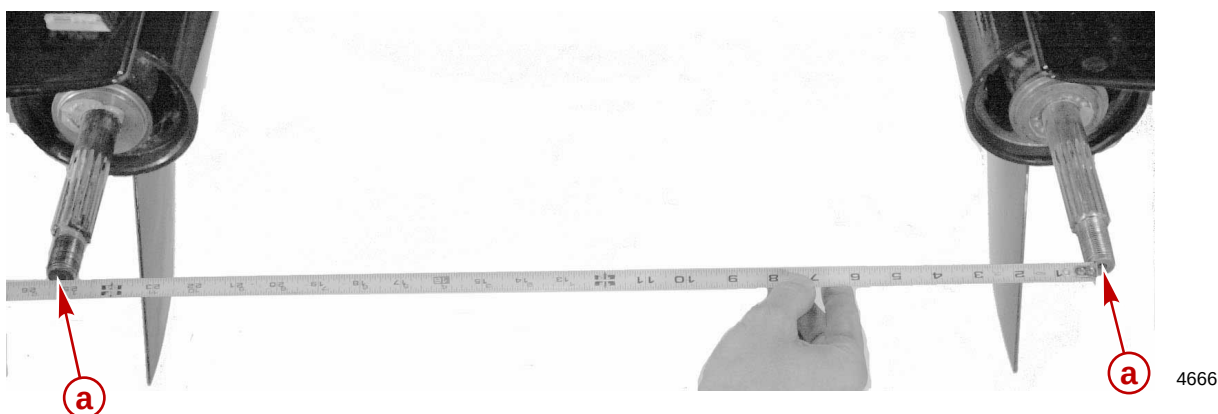
Measure distance between tie bar arm centers. Record distance.



4664

- a - Tie bar arm centers

4. Measure distance between propeller shaft centers. Record distance.



a - Propeller shaft centers

5. Adjust engines to equalize both measurements.

IMPORTANT: Both tie rod ends must be threaded into coupler 19 mm (0.75 in.) minimum and attaching nut torqued against coupler 35 Nm (25.8 lb. ft.) to prevent coupler from turning. Insufficient engagement of the tie rod threads could result in tie rod ends pulling out of the coupler and disengaging the steering tie rod.

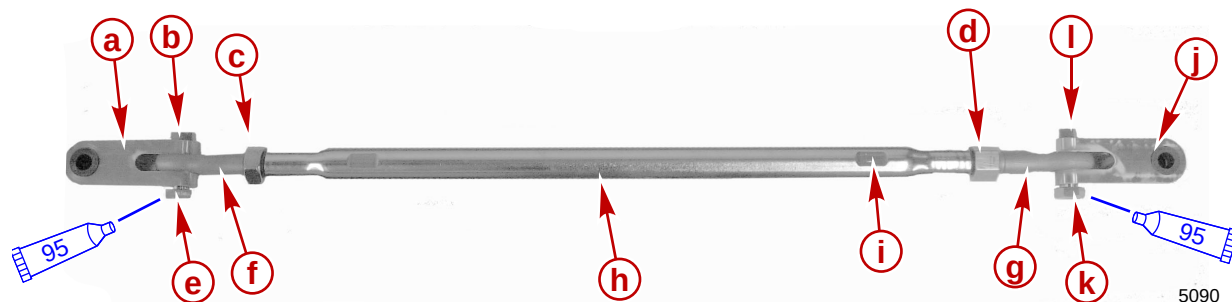
⚠ WARNING

Avoid possible serious injury or death from loss of boat control due to disengagement of the steering tie rod. A sudden, sharp, unexpected turn can result in boat occupants being thrown overboard or thrown violently within the boat. Carefully follow tie rod installation instructions.

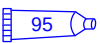
6. Assemble each tie rod end to tie rod coupler with corresponding attaching nut.

NOTE: The tie rod coupler is threaded for left hand (LH) and right hand (RH) tie rod ends respectively. Assemble corresponding tie rod end to correct end of coupler. Do not tighten tie rod end/coupler attaching nuts at this time.

7. Install clevis assembly to each tie rod end. Secure clevis with screw and nut. Apply 2-4-C with Teflon to screw shoulder. Torque screw and nut to specification.



- a** - Clevis (892469A01)
- b** - Clevis attaching nut (M8 x 1.25)
- c** - Tie rod end/coupler attaching nut (M14 x 2.00 RH)
- d** - Tie rod end/coupler attaching nut (M14 x 2.00 LH [marked "L"])
- e** - Clevis attaching screw (M8 x 35.3 mm)
- f** - Tie rod end (RH)
- g** - Tie rod end (marked "L")
- h** - Coupler
- i** - Flat with "L" imprinted (left hand threads)
- j** - Clevis (from Dual Tie Bar Kit)
- k** - Clevis attaching screw (M8 x 35.3 mm) (from Dual Tie Bar Kit)
- l** - Clevis attaching nut (M8 x 1.25) (from Dual Tie Bar Kit)

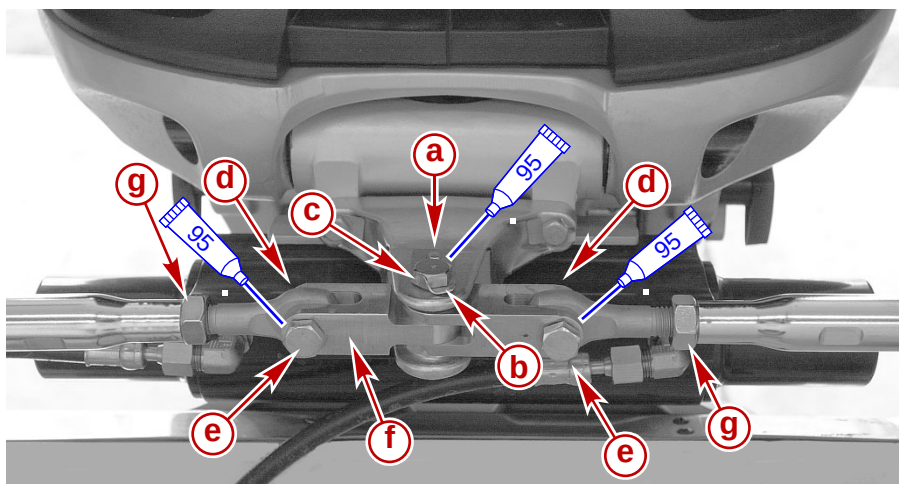
Tube Ref No.	Description	Where Used	Part No.
	2-4-C Marine Lubricant with Teflon	Clevis attaching screw shoulder	92-802859A1

Description	Nm	lb. in.	lb. ft.
Clevis attaching screw (M8 x 35.3 mm)	25		18.4
Clevis attaching nut (M8 x 1.25)	25		18.4

NOTE: On triple engine installations, install the double clevis assembly on the center engine. On quadruple engine installations, install the double clevis assemblies on the center engines. Single clevis assemblies are always used on the outside engines.

8. Install double clevis/tie bar assembly to center/inner engine. Secure tie bar assembly with screw and locking retainer. Apply 2-4-C with Teflon to screw shoulder. Align locking retainer with alignment tab on tie bar arm.

9. Torque screws and nuts to specification. Bend one corner of locking retainer against flat of screw.



5096

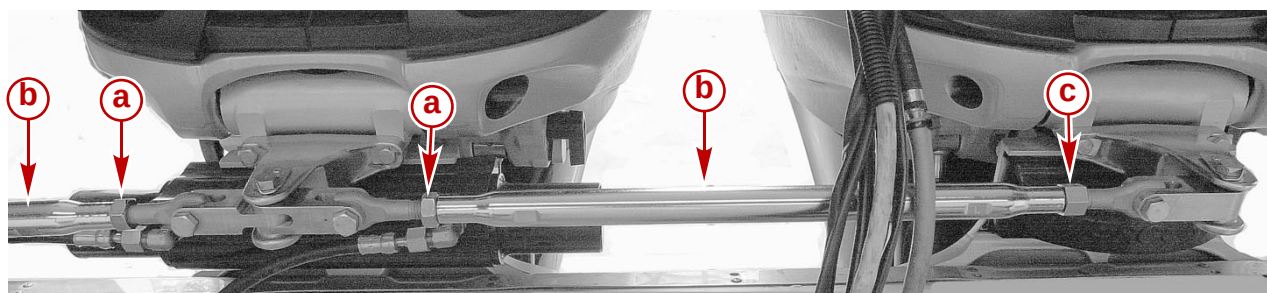
- | | |
|---|--|
| a - Alignment tab | e - Shoulder screw (M8 x 35.3 mm) |
| b - Shoulder screw (M8 x 46.75 mm) | f - Clevis (892468A01) |
| c - Locking retainer | g - Nut (M14 x 2.00) (do not tighten yet) |
| d - Nut (hidden) (M8 x 1.25) | |

Tube Ref No.	Description	Where Used	Part No.
 95	2-4-C Marine Lubricant with Teflon	Screw shoulder	92-802859A1

Description	Nm	lb. in.	lb. ft.
Shoulder screw (M8 x 46.75 mm)	25		18.4
Shoulder screw (M8 x 35.3 mm)	25		18.4
Nut (hidden) (M8 x 1.25)	25		18.4

10. Turn tie bar coupler, if necessary, to equalize distance between tie bar arm centers and propeller shaft centers.

11. When engines are centered, tighten nuts against couplers. Torque nuts to specification.



5099

- | | |
|--|---------------------------------------|
| a - Nuts (M14 x 2.00 RH thread) | c - Nut (M14 x 2.00 LH thread) |
| b - Coupler | |

Description	Nm	lb. in.	lb. ft.
Nut (M14 x 2.00 RH thread)	35		25.8
Nut (M14 x 2.00 LH thread)	35		25.8

IMPORTANT: After installation is complete (and before operating outboards), check that boat will turn right when steering wheel is turned right and that boat will turn left when steering wheel is turned left. Check steering through full range (left and right) at all trim and tilt angles to ensure interference free movement.

Maintenance Instructions

Maintenance inspection is the owner's responsibility and must be performed at the specific intervals.

Normal service - Every 50 hours of operation or 60 days (whichever comes first).

Severe service - Every 25 hours of operation or 30 days (whichever comes first).

NOTE: *Operation in salt water is considered severe service.*

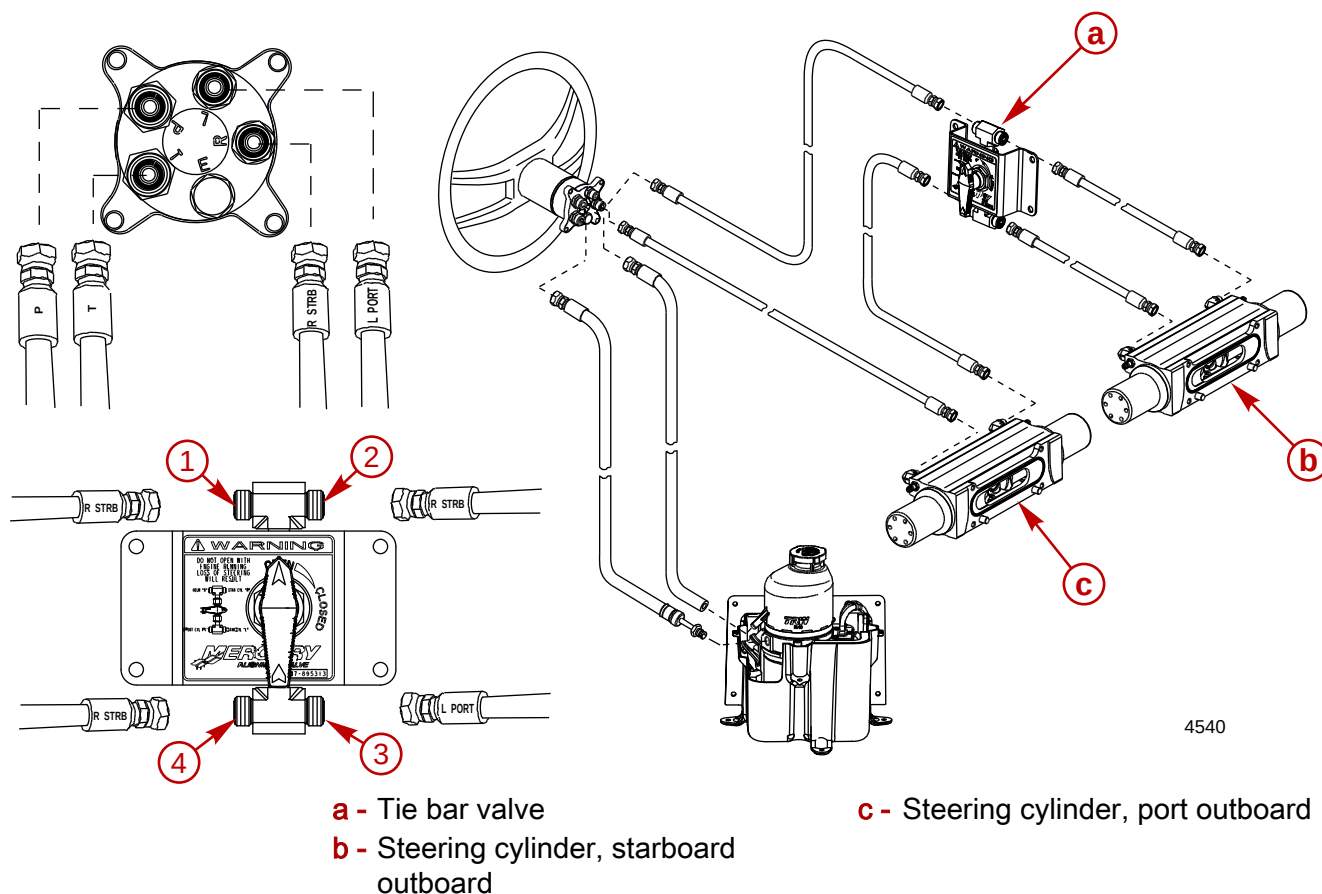
1. Check steering system components for wear. Replace any worn parts.
2. Check steering system fasteners to ensure they are torqued to correct specifications.
3. Refer to operating and maintenance instructions for power steering system.

Liquid Tie Bar

Liquid Tie Bar Installation

1. Mount the tie bar valve in an area where the valve will be accessible for making periodic realignments.
2. Install steering cylinder (896500A01) to left hand rotation outboard (XL, XXL). Follow installations instructions which are provided with steering cylinder.
3. Refer to Mercury Precision Parts Accessories Guide and order the hydraulic hoses in the required length.
4. Connect hydraulic hoses to the steering helm and power steering pump following instructions which accompany the steering helm and pump.

5. Connect hydraulic hoses between tie bar valve and steering cylinders.



Steering Helm Fitting ID Mark	Hose ID Mark	Description
P	P	Pressure from pump to helm
T	T	Tank low pressure return to pump
R	R-STRB	Hose connects to tie bar valve
L	L-PORT	Hose connects to port side fitting on port steering cylinder

Tie Bar Valve Fitting ID	Hose ID Mark	Description
1	R-STRB	Hose connects to R fitting on steering helm
2	R-STRB	Hose connects to starboard side fitting on starboard steering cylinder
3	L-PORT	Hose connects to port side fitting on starboard steering cylinder
4	R-STRB	Hose connects to starboard side fitting on port steering cylinder

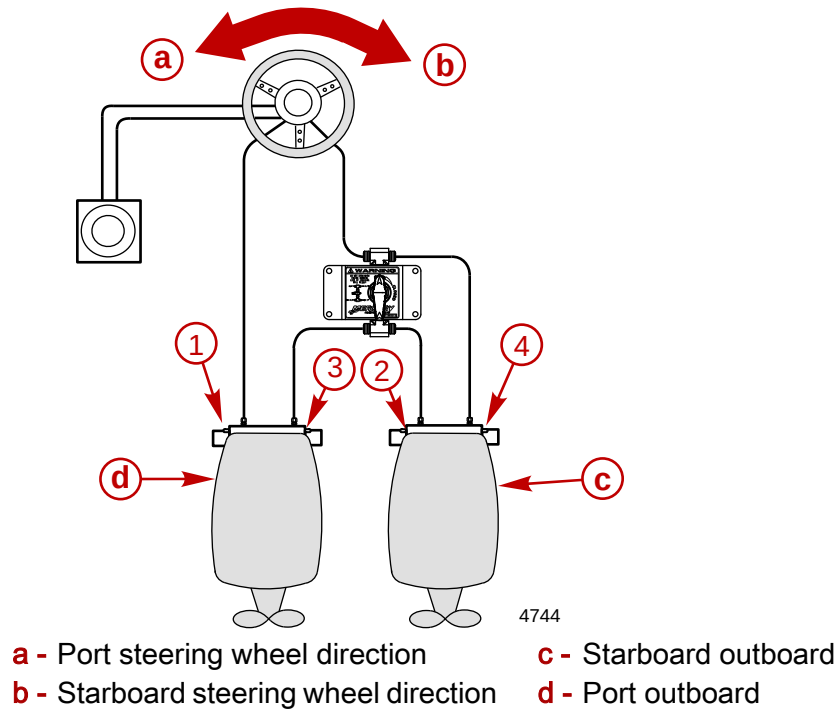
6. Open tie bar valve.

7. Fill steering system with SAE 0W-30 Full Synthetic Power Steering Fluid. Follow filling instructions provided with the power steering pump. Complete the bleeding instructions following.

Bleeding Instructions

1. Have the engines running, or electrically operate the power steering pump using the power steering primer kit (90-89504K01).

2. Open tie bar valve.



NOTE: Attach a 8 mm (5/16 in.) transparent bleed hose to the bleed fitting being opened. Route the other end of the bleed hose back into the steering pump tank. Do not bleed power steering fluid into a different container, this will only be pumping fluid out of the system that was just filled up.

3. Turn steering wheel to starboard until the port outboard is facing bleed fitting 1 and contacting the full steering stop. Do not allow the outboard to move from this position. Open bleed fitting 1 until an air free stream of fluid comes from fitting. Close bleed fitting 1.
4. Take hold of the starboard outboard and turn it so it is facing bleed fitting 2 and contacting the full steering stop. Do not allow the outboard to move from this position. Open bleed fitting 2 until an air free stream of fluid comes from fitting. Close bleed fitting 2.
5. Open bleed fitting 3. Take hold of the port outboard and turn it so it is facing bleed fitting 3 and contacting the full steering stop. Do not allow the outboard to move from this position. Leave bleed fitting open until an air free stream of fluid comes from fitting. Close bleed fitting 3.
6. Open bleed fitting 4. Take hold of the starboard outboard and turn it so it is facing bleed fitting 4 and contacting the full steering stop. Do not allow the outboard to move from this position. Leave bleed fitting open until an air free stream of fluid comes from fitting. Close bleed fitting 4.
7. Close tie bar valve.
8. Turn steering wheel from full stop to full stop a few times.
9. Refer to realignment instructions (following) to ensure outboards are set straight.

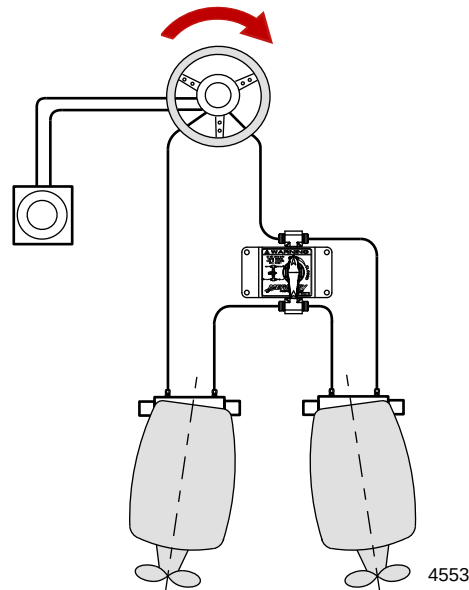
Realignment Instructions

During normal usage, it is possible for the outboards to become misaligned. Outboard alignment should be checked before each use.

If misalignment occurs, complete the following steps to realign.

PROPELLERS TOO FAR APART

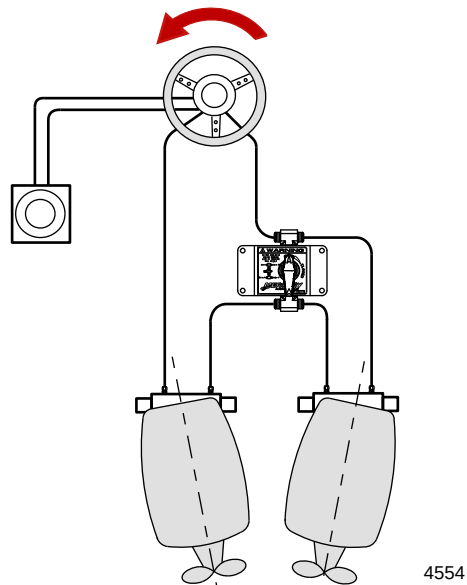
1. Have the engines running, or electrically operate the power steering pump using the power steering primer kit (90-89504K01).
2. Turn the steering wheel to full starboard. Both outboards will move. Starboard outboard will contact its full steering stop first.
3. After the starboard outboard contacts its full steering stop, open the tie bar valve.
4. Continue to turn the steering wheel to full starboard until the port outboard contacts its full steering stop
5. Close the tie bar valve.



PROPELLERS TOO CLOSE TOGETHER

1. Have the engines running, or electrically operate the power steering pump using the power steering primer kit (90-89504K01).
2. Turn the steering wheel to full port. Both outboards will move. Starboard outboard will contact its full steering stop first.
3. After the starboard outboard contacts its full steering stop, open the tie bar valve.
4. Continue to turn the steering wheel to full port until the port outboard contacts its full steering stop

5. Close the tie bar valve.



Power Steering

Power Steering Primer Module

This power steering primer module is intended for bleeding the power steering system of Verado models, after initial installation or after servicing of the power steering system, without the need to run the engine.

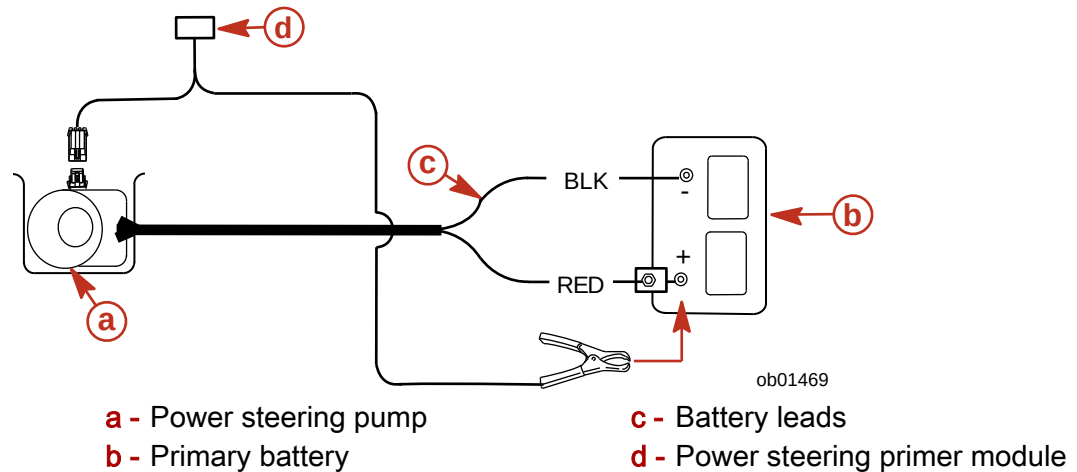
Filling Power Steering System with Engine Not Running

Use SAE 0W-30 Full Synthetic Power Steering Fluid in the power steering system. In an emergency, if recommended power steering fluid is not available, the use of any full synthetic engine oil can be temporarily used. The power steering fluid should then be drained and replaced with SAE 0W-30 Full Synthetic Power Steering Fluid as soon as possible, to avoid loss of performance in power steering system.

Fluid Type	Capacity	Mercury Part Number
SAE 0W-30 Full Synthetic Power Steering Fluid	1 - 2 liters (1 - 2 quarts) depending on length of steering hoses	92-858002K01

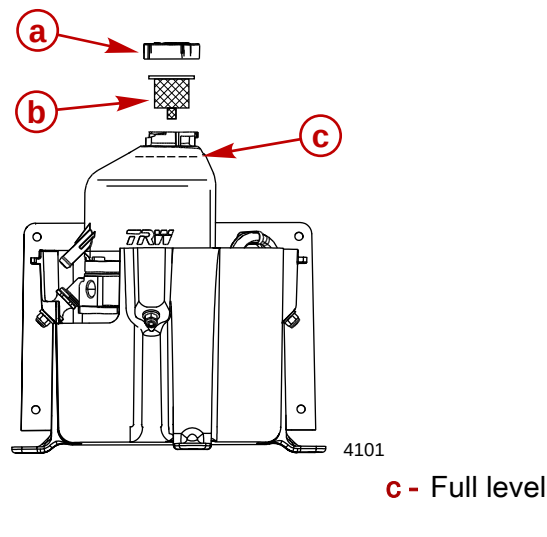
1. Disconnect power steering signal harness from engine signal harness.

2. Connect the Power Steering Primer Module Kit to the power steering pump and 12 volt positive power source as shown.



Power Steering Primer Module Kit	91-895040K01
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3. Remove the filler cap and filter from the power steering pump.
4. Fill the pump tank with recommended power steering fluid.

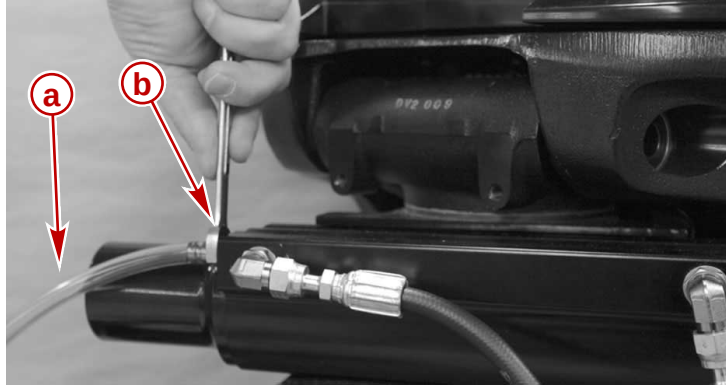


IMPORTANT: The power steering module primer has two switches, "POWER" - "ON" and "OFF", and "PUMP" - "ON" and "OFF". To power up and activate the power steering pump, there are two steps: 1) Turn the "POWER" switch to the "ON" position to power up pump, wait for two seconds, then, 2) Turn the "PUMP" switch to the "ON" position to activate pump.

IMPORTANT: Do not run pump out of fluid. If pump draws air during bleeding, the resulting re-bleeding will take two to three times longer than initial bleeding.

5. Power up and activate the pump until fluid drops halfway. Turn off both switches on the power steering primer module and refill the pump tank. Repeat this operation until pump tank stays full.
6. Power up and activate the pump while slowly turning the steering wheel towards the full lock position in one direction. Carefully monitor the fluid level until fluid drops halfway, stop turning the steering wheel and refill the pump tank. Repeat this operation turning the steering wheel from full lock to full lock 10 times until pump tank stays full.

7. For bleeding any air left in the steering system, power up and activate the pump. Turn the steering wheel in one direction until the full lock position is met.
8. Attach an 8 mm I.D. (5/16 in. I.D.) transparent bleed hose to the bleed valve on the end of the steering cylinder that the engine is pointing to. Route bleed hose into pump tank (do not bleed power steering fluid into a different container, this will only be pumping fluid out of the system that was just filled up).
9. Open bleed valve to release any remaining air in the power steering system. Allow adequate time, depending on length of power steering hose, for air to escape from system. Tighten bleed valve securely and remove bleed hose.



a - Bleed hose

b - Bleed valve in steering cylinder

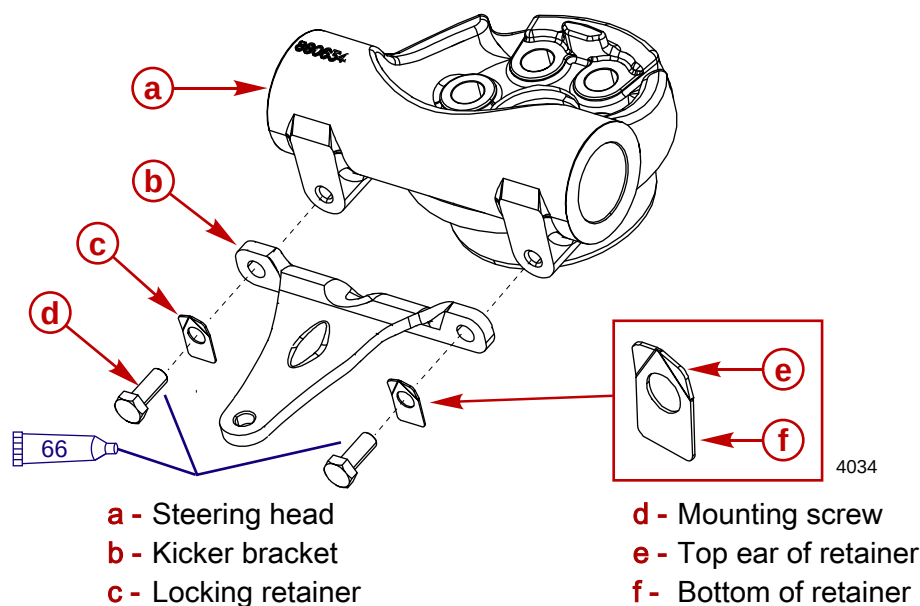
10. Turn the steering wheel to opposite full lock position, and repeat steps 8 and 9.
11. Replace the filter and fill cap on the power steering pump.
12. If desired, the power steering system can be rechecked after sitting overnight to remove any air that may possibly be left in the system. Repeat steps for bleeding steering system, preceding.
13. Turn off both switches, remove the power steering primer module and reconnect the power steering signal harness from the engine to the pump.

Adaptor Steering Arm - Kicker Engine

Installation Instructions

1. Clean threaded holes in steering head.
2. Apply a small amount of Loctite 242 Threadlocker to screw threads.
3. Attach kicker bracket to steering head with locking retainers and screws.

4. Tighten screws to specified torque.



Description	Nm	lb. in.	lb. ft.
Mounting screw (2)	25		18.4

Tube Ref. No.	Description	Where Used	Part Number
66	Loctite 242 Threadlocker	Mounting screws	92-809821

5. Bend top ear of retainer over screw head to lock.
6. Bend bottom of retainer down over bracket.
7. Connect (accessory) steering tie bar between steering arm bracket of main power outboard and steering bracket of kicker outboard, following instructions supplied with steering tie bar.

Analog Gauge Interface (AGI)

Analog Gauge Interface (AGI) Installation

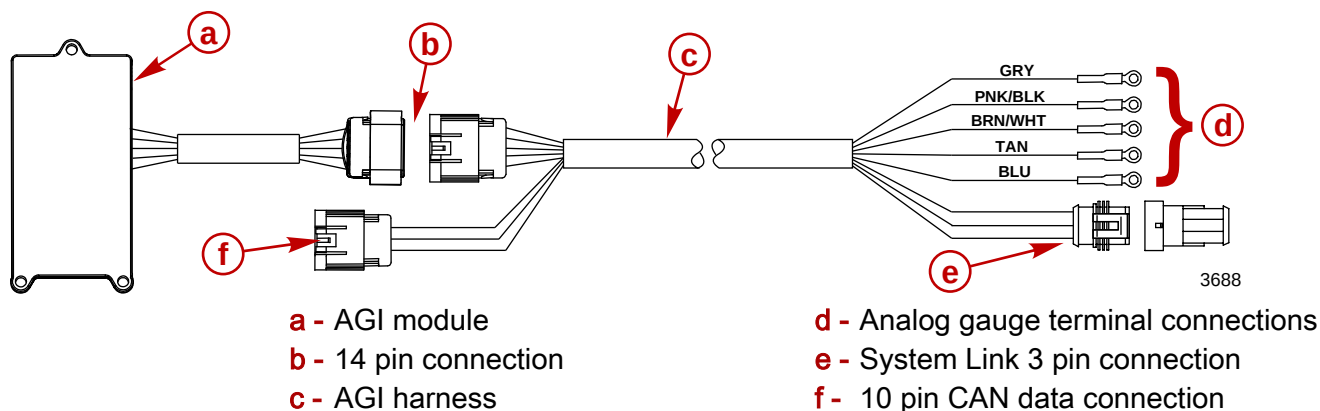
NOTE: This Analog Gauge Interface (AGI) can only be used with the 14 pin Digital Throttle and Shift (DTS) system to drive analog and/or SmartCraft System Link gauges. For analog gauges, use ring terminals on AGI harness to connect to analog sender inputs on gauge backs, and tape back any unused terminals. For SmartCraft System Link gauges, use 3 pin System Link connection on AGI harness. The AGI system can support 10 System Link gauges per helm, 2 helms maximum.

IMPORTANT: Mount AGI module with wires coming out of potting facing downward to prevent moisture from collecting at base of wires and wicking into module. Route and secure all wires and harnesses away from hot or moving parts.

1. With screws and washers supplied in kit, mount the AGI module securely under dash or helm in close proximity to gauges being used.
2. Refer to the following table for AGI harness wire color/analog gauge sender input connections. Tape back any unused terminals. Secure connections per gauge manufacturers specifications.

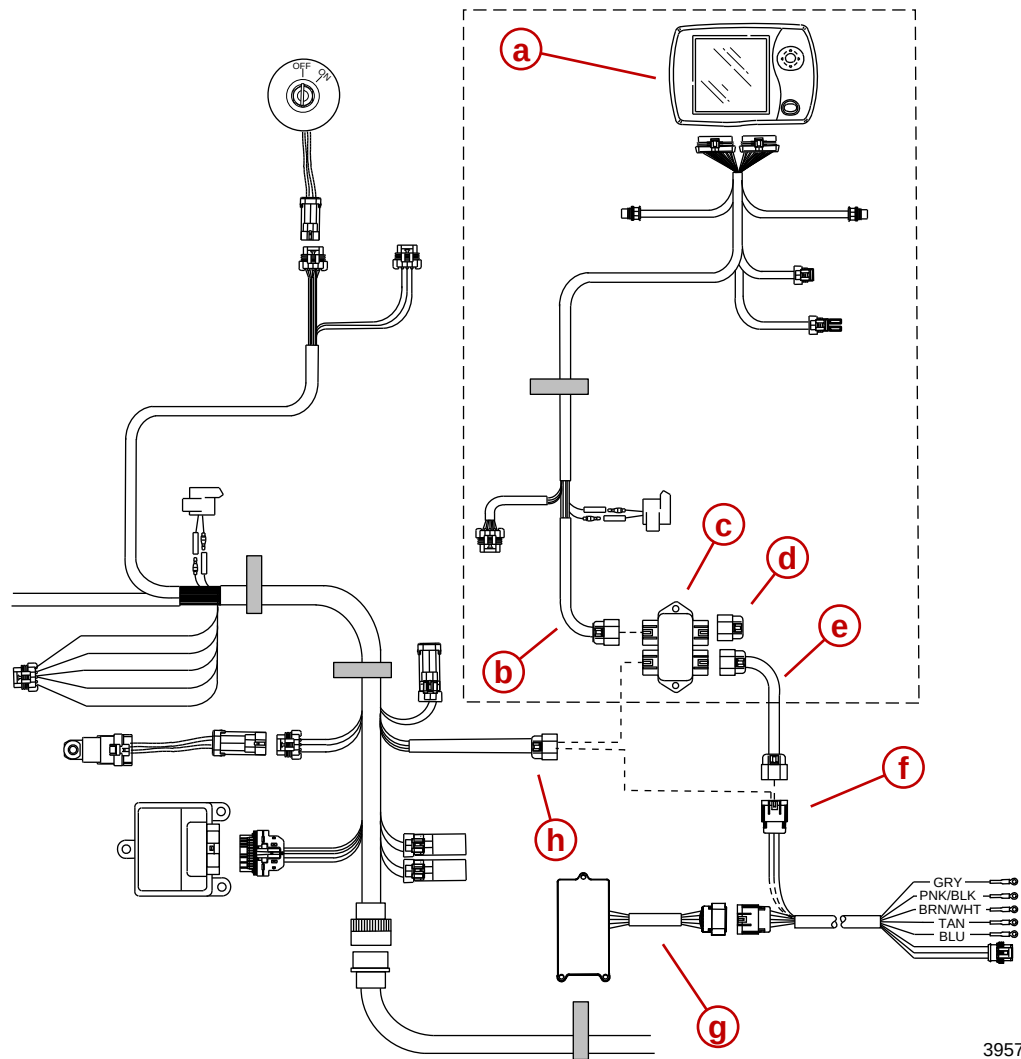
Analog Gauge Type	AGI Harness Wire Color
Tachometer	Gray

Analog Gauge Type	AGI Harness Wire Color
Oil Pressure/Oil Level	Blue
Water Temperature	Tan
Trim Positions	Brown/White
Fuel Level	Pink/Black



- Route and connect wire from key switched 12 volt positive power source to analog gauges. Secure connections per gauge manufacturers specifications.
- Route and connect ground wire from analog gauges to a common ground. Secure connections per gauge manufacturers specifications.
- Connect any SmartCraft System Link gauges to 3 pin System Link connection. The AGI system can support 10 System Link gauges per helm, 2 helms maximum.
- Plug 14 pin AGI harness connection into AGI module.
- Connect 10 pin CAN data harness connection on command module harness to AGI harness.
 - If SmartCraft System View is not being used, plug 10 pin CAN data connection on AGI harness directly into 10 pin CAN data connection on command module harness.
 - If SmartCraft System View is being used, a junction box and harness adaptor will be required. Plug 10 pin CAN data connection on command module harness, 10 pin CAN data connection on System View harness, and one end of harness adaptor into junction box. Plug 10 pin CAN data connection on AGI harness into other end of harness adaptor. Insulate any unused connection ports on junction box with weather caps.

TYPICAL AGI APPLICATION WITH SYSTEM VIEW



3957

- a - System View display
- b - 10 pin CAN data connection on System View harness
- c - SmartCraft Junction Box
- d - Weather Cap
- e - Harness Adaptor
- f - 10 pin CAN data connection on AGI harness
- g - AGI module
- h - 10 pin CAN data connection on Command Module harness

Configuring Analog/Digital Tachometer Signal through PCM

IMPORTANT: The engine Propulsion Control Module (PCM) tachometer configuration factory default has been set to an analog. This will allow the operation of one analog tachometer. Depending on the desired use of analog/digital gauges, the PCM set-up may have to be configured from analog to a digital.

Following are optional uses of analog and digital gauges and the setting for the tachometer configuration in the PCM necessary to run them.

Gauge Configuration	Analog	Digital
Analog Tachometer Only	X	
System Link Gauges used with System View, System Monitor, or System Tach	-	-
System Link Gauges used in conjunction with System Link Adaptor Harness and Command Module Harness without the use of System View, System Monitor or System Tach		X

Gauge Configuration	Analog	Digital
AGI used with or without System View, System Monitor or System Tachometer, to run analog and System Link Gauges		X

The Digital Diagnostic Tool (DDT) or Computer Diagnostic System (CDS) can be used to select analog or digital PCM tachometer configuration.

PCM CONFIGURATION WITH DDT

IMPORTANT: The use of DDT cartridge 1.3.1 or above must be used for PCM configuration.

1. Attach DDT to engine and power up. Refer to DDT Owners Manual if needed.
2. Press 1. "MERCURY MARINE"
3. Press 1. "TO CONTINUE"
4. Press 2. "MANUAL TEST"
5. Arrow down and Press 5. "SPECIAL FUNCTION"
6. Arrow down and Press 9. "TACH LINK CONFIG"
7. "CONFIGURE TACH SOFTWARE DRIVER?" - Press 1. "YES"
8. "TACH LINK CONFIG" - Press 1. "FOR LINK" (Digital) - Press 2. "FOR ANALOG"
9. After task completion confirmation, Press "MODE" to Exit

PCM CONFIGURATION WITH CDS

1. Attach CDS to engine. Refer to on-line help if needed.
2. From Logon screen, navigate to Engine Select screen.
3. From Engine Select screen fill in engine type information and select Tool Box.
4. From Tool Box screen, select Active Diagnostics.
5. From Active Diagnostics screen, scroll down and select Tach Link Config.
6. To change PCM configuration from default of analog to digital, select Enable and then select Run.
7. To change PCM configuration from digital to analog, select Disable and then select Run.

Power Steering

Section 8A - Power Steering

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Power Steering Specifications

Power Steering Specifications	
Fluid Type	SAE 0W-30 synthetic power steering fluid
Capacity	Typical 1 - 2 liters (1 - 2 quarts)
Current Draw	Shall not exceed 75 Amps
Steering Ratio (40 cc helm and single steering cylinder, lock to lock)	4.1 turns
Steering Ratio (50 cc helm with dual steering cylinders, lock to lock)	6.5 turns

Lubricant, Sealant, Adhesives

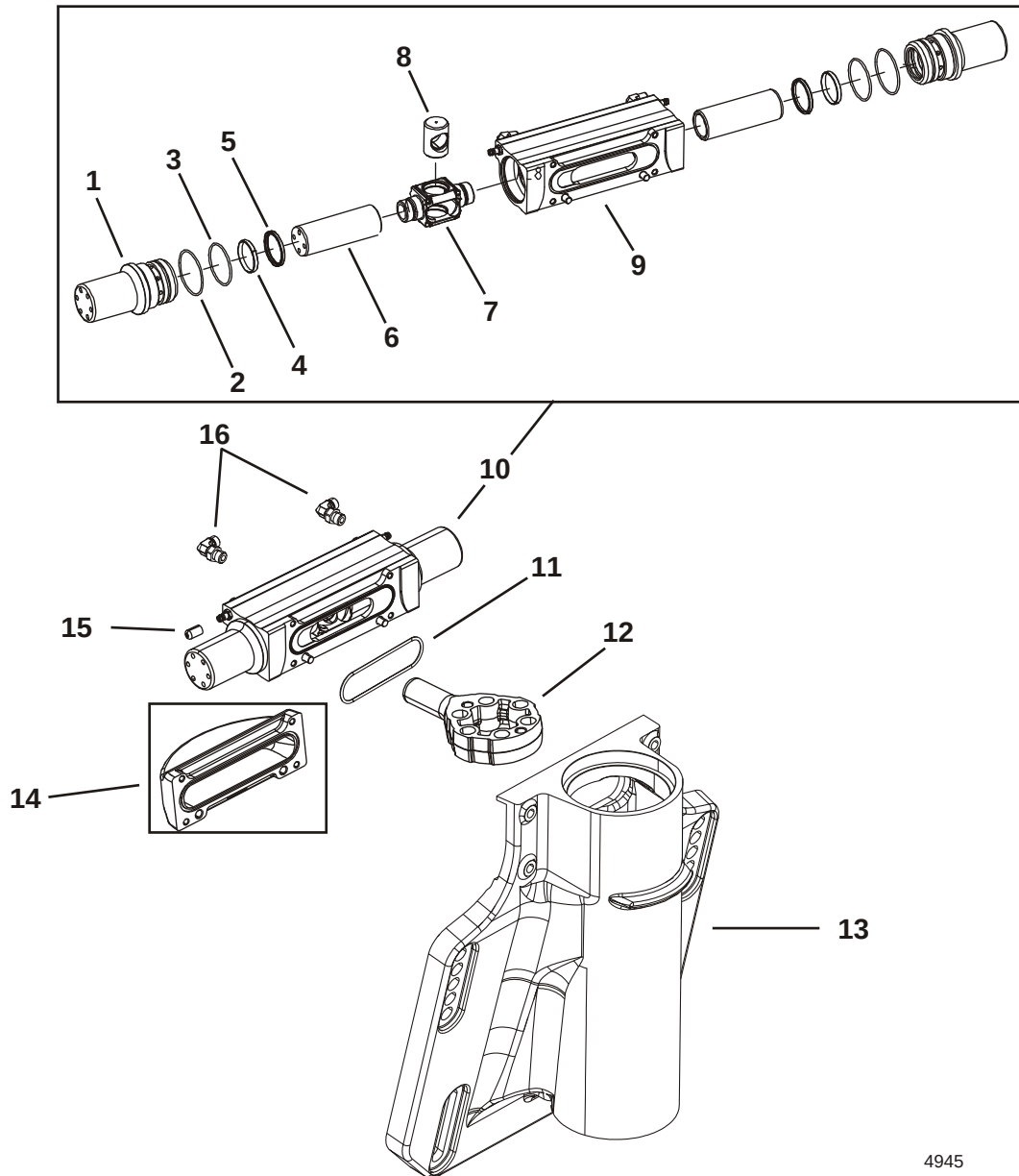
Tube Ref No.	Description	Where Used	Part No.
 138	Synthetic Power Steering Fluid SAE 0W-30	Piston seals, wear ring and O-rings Steering cylinder housing O-ring	92-858002K01

Special Tools - Power Steering

Power Steering Cylinder End Cap Spanner Wrench	Part number currently not available for this publication
 5080	Removes the power steering cylinder end cap.
Power Steering Module Primer Kit	91-895040K01
 5547	Bleeds power steering system without running engine.

Notes:

Power Steering Cylinder Components



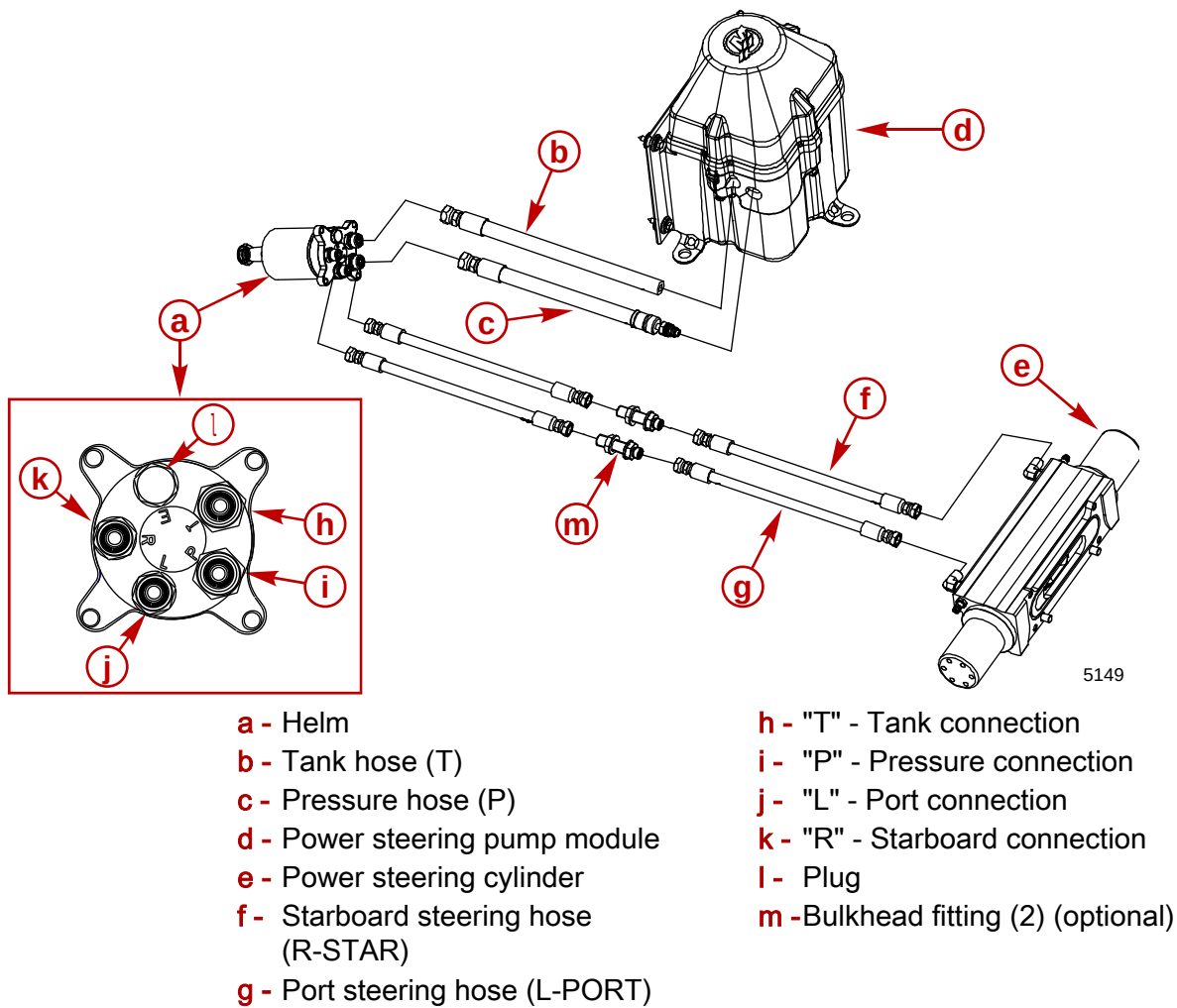
4945

Power Steering Cylinder Components

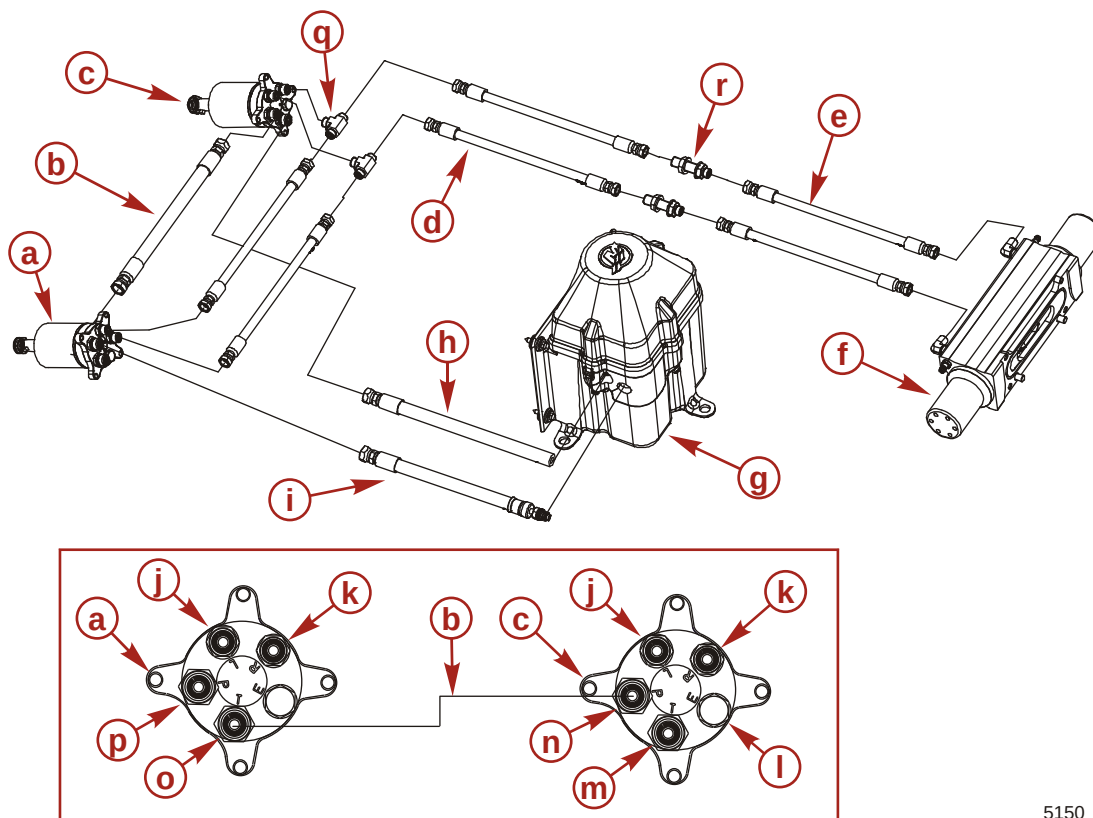
Ref. No.	Qty.	Description	Torque		
			Nm	lb. in.	lb. ft.
1	2	End cap	271		200
2	2	O-ring			
3	2	O-ring			
4	2	Wear ring			
5	2	Seal			
6	2	Piston			
7	1	Center union assembly			
8	1	Pivot pin assembly			
9	1	Steering housing			
10	1	Steering cylinder assembly			
11	1	Seal			
12	1	Steering arm			
13	1	Pedestal			
14	1	Cover counter rotation			
15	1	Cap bleeder			
16	2	Elbow			

Power Steering Systems

Single Helm - Single Cylinder



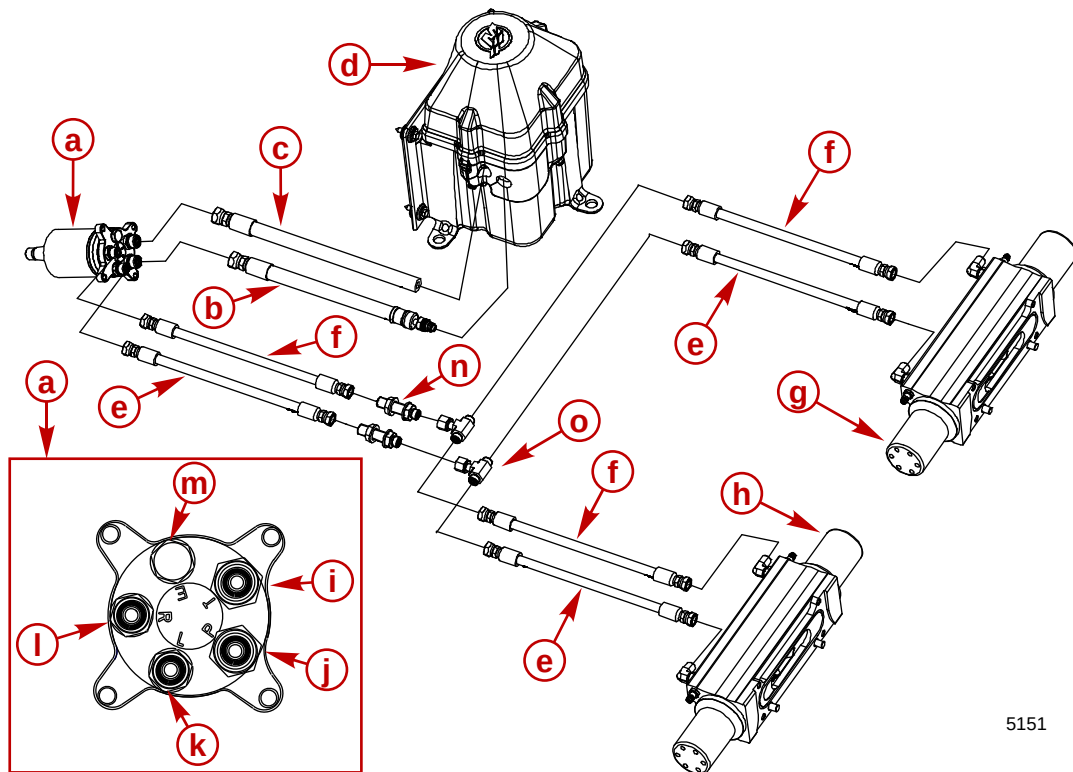
Dual Helm - Single Cylinder



5150

- | | |
|---|---|
| a - Dual helm 1 | j - "L" - Port connection |
| b - Tank 1 to pressure 2 hose | k - "R" - Starboard connection |
| c - Standard helm 2 | l - Plug |
| d - Port steering hose (L-PORT) | m - "T" - Tank 2 connection |
| e - Starboard steering hose (R-STAR) | n - "P" - Pressure 2 connection |
| f - Power steering cylinder | o - "T" - Tank 1 connection (to "P" 2) |
| g - Power steering pump module | p - "P" - Pressure 1 connection |
| h - Tank hose (T) | q - Tee fitting (2) |
| i - Pressure hose (P) | r - Bulkhead fitting (2) |

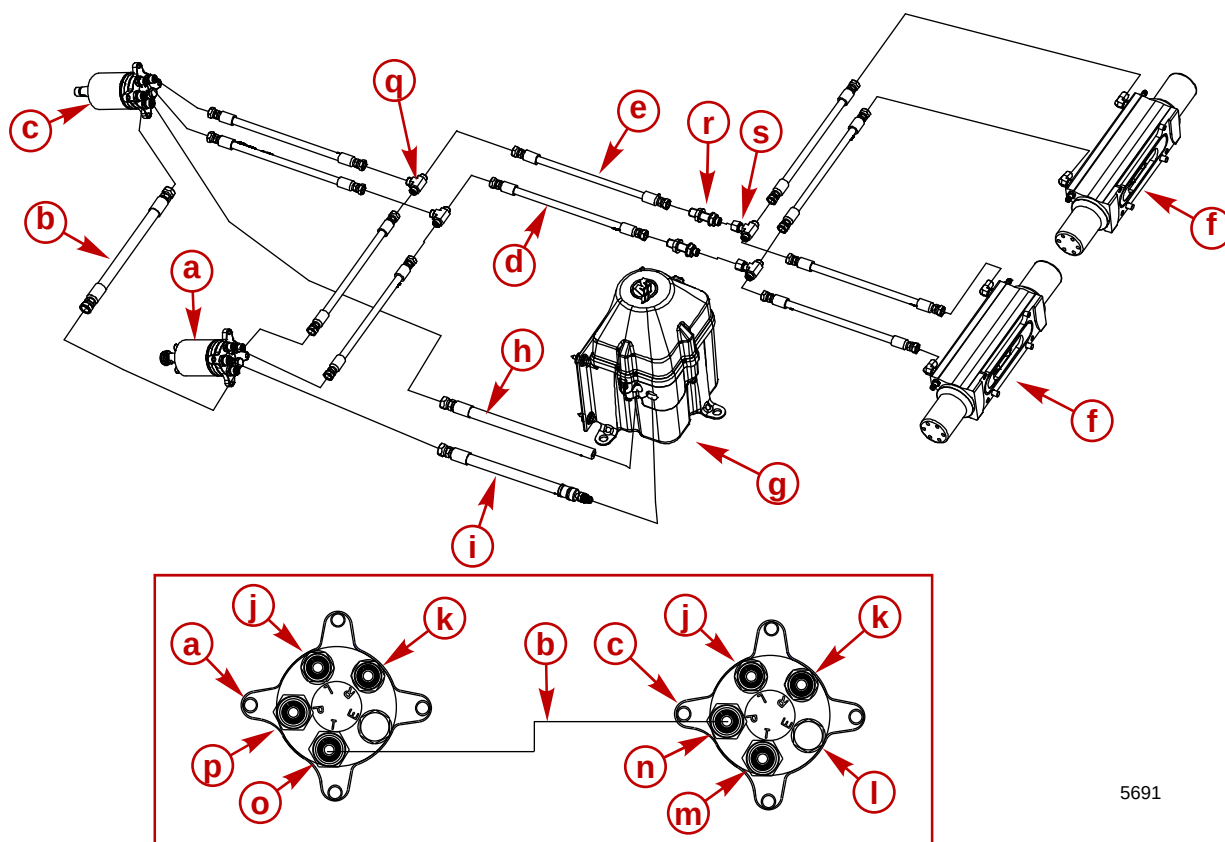
Single Helm - Dual Cylinder



5151

- | | |
|---|---------------------------------------|
| a - Helm | i - "T" - Tank connection |
| b - Pressure hose (P) | j - "P" - Pressure connection |
| c - Tank hose (T) | k - "L" - Port connection |
| d - Power steering pump module | l - "R" - Starboard connection |
| e - Port steering hose (L-PORT) | m - Plug |
| f - Starboard steering hose (R-STAR) | n - Bulkhead fitting (2) |
| g - Power steering cylinder 1 | o - Swivel tee fitting (2) |
| h - Power steering cylinder 2 | |

Dual Helm - Dual Cylinder



5691

- a - Helm 1
- b - Tank 1 to pressure 2 hose
- c - Helm 2
- d - Port steering hose
- e - Starboard steering hose
- f - Power steering cylinder
- g - Power steering pump module
- h - Tank hose
- i - Pressure hose
- j - "L" - Port connection
- k - "R" - Starboard connection
- l - Plug
- m - "T" - Tank 2 connection
- n - "P" - Pressure 2 connection
- o - "T" - Tank 1 connection (to "P" 2)
- p - "P" - Pressure 1 connection
- q - Tee fitting (2)
- r - Bulkhead fitting (2)
- s - Swivel tee fitting (2)

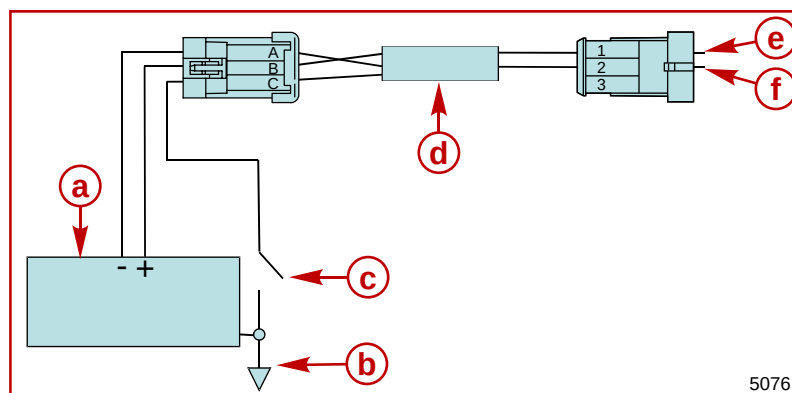
Troubleshooting the Power Steering System

Problem	Possible Cause	Remedy
Power steering system operates (pump runs), but the outboard does not steer.	Hoses connections.	Check pressure and tank hoses for correct connections at helm.
Power steering system operates (pump runs), but the outboard does not steer, steers slowly, or erratic. Hose connections are correct.	Air in system.	Bleed the power steering system. Refer to Filling Power Steering System with Engine Running .
Power steering pump does not operate (pump does not run).	Blown fuse.	1. Check fuse at power steering pump. Replace if blown. 2. Check battery connection.

Problem	Possible Cause	Remedy
Power steering pump does not operate (pump does not run). Fuse is good.	Driver module.	1. Check pin connections. Refer to Testing the Power Steering Driver Module . Replace if defective. 2. Start pump with primer module. If pump starts, replace driver module. Refer to Filling Power Steering System with Engine Not Running .
Power steering pump does not operate (pump does not run). Fuse is good. Driver module is good.	Driver module harness.	Check driver module harness connections. Replace if defective.
Power steering pump does not operate (pump does not run). Fuse is good. Driver module is good. Signal harness is good.	Outboard PCM.	Test PCM. Refer to Section 2A - Troubleshooting with the Digital Diagnostic Terminal .

Testing the Power Steering Driver Module

1. Use the following circuit to test the power steering driver module.



a - 12.0 volt DC power supply

b - Ground

c - Switch

d - Power Steering Driver Module (PSDM)

e - Test output pin 1

f - Test output pin 2

2. The PSDM input connects to the engine's main harness via a 3-way water proof connector.
 - a. Pin A provides system ground
 - b. Pin B provides key-switch battery voltage
 - c. Pin C provides engine-run signal
3. The PSDM output connects to the Electric Power Hydraulic Steering (EPHS) unit via a second 3-way water proof connector.
 - a. Pin 1 provides conditioned engine-run signal
 - b. Pin 2 provides key-switch battery voltage
 - c. Pin 3 is empty
4. Test the following power steering driver module functional characteristics.

Input Conditions	Output Results	With Respect to :
Pin A = ground	Pin 1 = 0 V (ground)	Pin A
Pin B = 12.0 V	Pin 2 = 12.0 V	
Pin C = open		

Input Conditions	Output Results	With Respect to :
Pin A = ground	Pin 1 = 11.5 - 12.5 V	Pin A
Pin B = 12.0 V	Pin 2 = 12.0 V	
Pin C = ground		

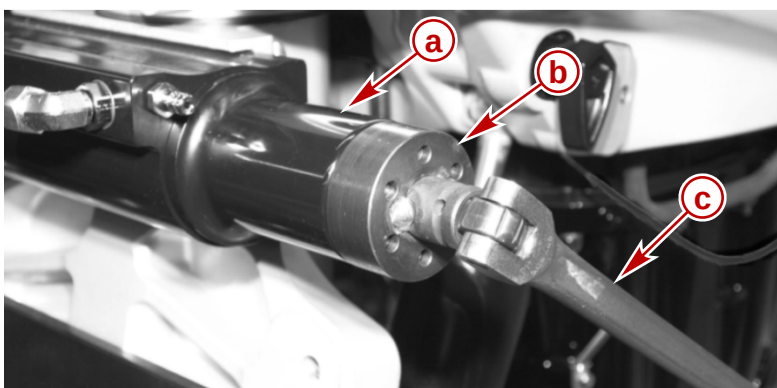
5. Check driver module for cracks, corrosion, separation of material and broken or partially separated leads.
6. If the driver module does not pass the test specifications or material defects are found, discard the driver module. The power steering driver module is not a repairable component.

Power Steering Cylinder

End Cap REMOVAL

IMPORTANT: When servicing hydraulic systems or components, make sure that the work area is clean. Do not use cloth rags to clean components, lint may contaminate the system. Cap or plug all open hydraulic connections. Place disassembled components in clean plastic bags when not working on them. The slightest amount of contamination in the hydraulic system may damage components or cause the system to malfunction.

1. While outboard engine is mounted to transom, remove end cap from steering cylinder housing using steering cylinder end cap spanner wrench.



5049

a - Steering cylinder end cap

c - Breaker bar

b - Steering cylinder end cap spanner wrench

Steering Cylinder End Cap Spanner Wrench	Part number not currently available for this publication
--	--

SEAL REPLACEMENT

1. Remove 2 O-rings from end cap. Using a pick tool, remove wear ring and piston seal from inside diameter of end cap.

IMPORTANT: Do not use a tool that will damage seal lands when removing O-rings, wear ring or piston seal.

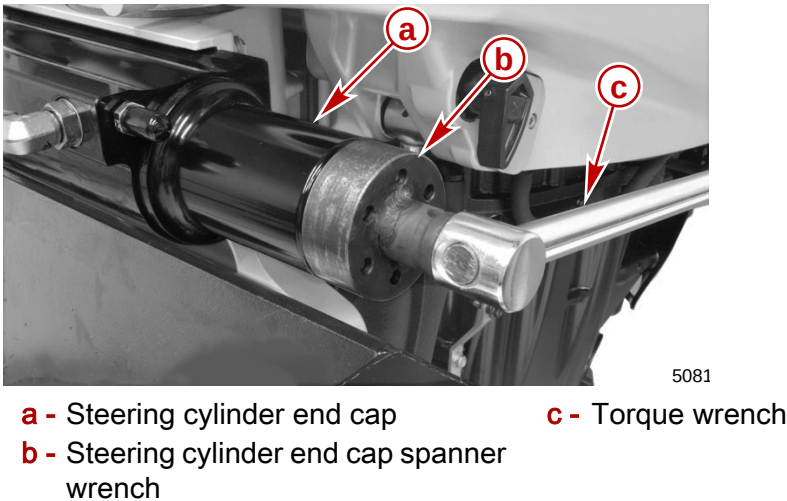


2. Install new lubricated wear ring, piston seal and O-rings.

Tube Ref No.	Description	Where Used	Part No.
 138	Synthetic Power Steering Fluid SAE 0W-30	Piston seals, wear ring and O-rings	92-858002K01

INSTALLATION

Assemble power steering cylinder end cap to the steering housing. Using steering end cap spanner wrench, tighten end cap to specified torque.

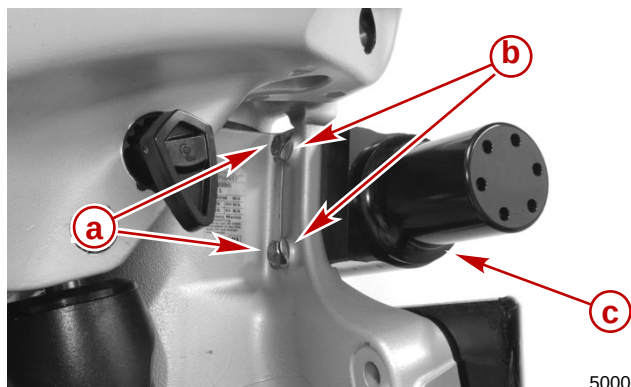


Steering Cylinder End Cap Spanner Wrench		Part number not currently available for this publication		
Description		Nm	lb. in.	lb. ft.
Steering cylinder end cap		271		200

Steering Cylinder
REMOVAL

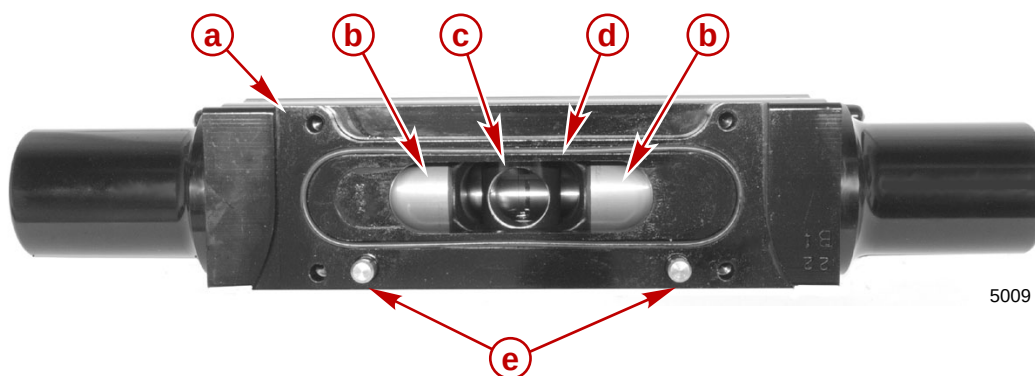
1. Disconnect the port and starboard hoses from steering cylinder. Label port and starboard hoses for reference. Cap and plug steering cylinder and hose end fittings.

2. Plug hose ends and cap the elbow fittings on the steering cylinder.
3. Flatten lock tabs on the steering cylinder mounting screw retainer.
4. Remove 2 mounting screws on each side of the outboard pedestal. Remove steering cylinder from pedestal.



- a** - Steering cylinder mounting screws (4) M8 x 30 **c** - Steering cylinder
- b** - Retainer lock tab

5. Remove O-ring from steering cylinder housing.

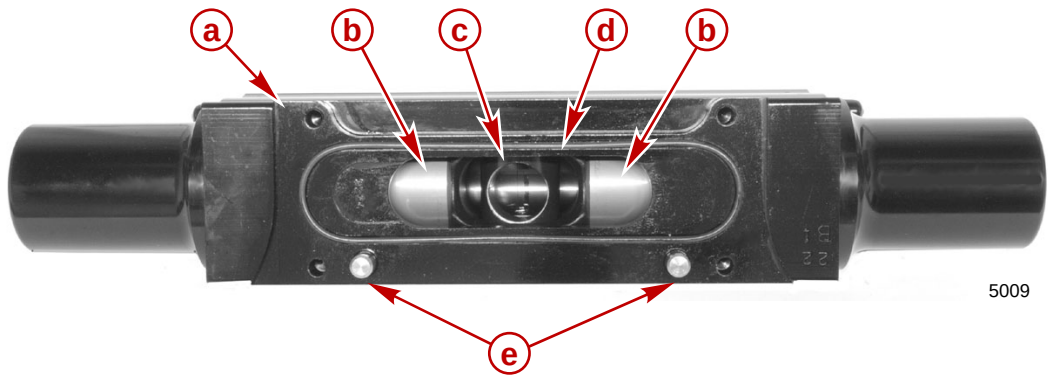


- a** - Steering cylinder housing **d** - O-ring
- b** - Steering cylinder piston **e** - Dowel pin (2)
- c** - Pivot pin assembly and center union assembly

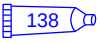
INSTALLATION

1. Ensure mounting surface of the steering cylinder housing and pedestal are free of nicks and burrs.

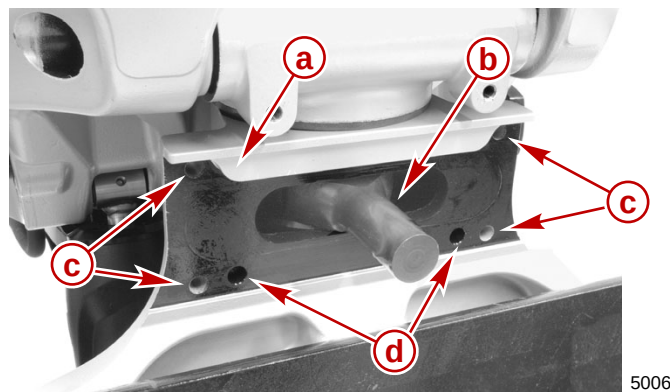
2. Install new lubricated O-ring seal on steering cylinder mounting surface.



- a** - Steering cylinder housing
- b** - Steering cylinder piston
- c** - Pivot pin assembly and center union assembly
- d** - Steering cylinder housing O-ring
- e** - Dowel pin (2)

Tube Ref No.	Description	Where Used	Part No.
 138	Synthetic Power Steering Fluid SAE 0W-30	Steering cylinder housing O-ring	92-858002K01

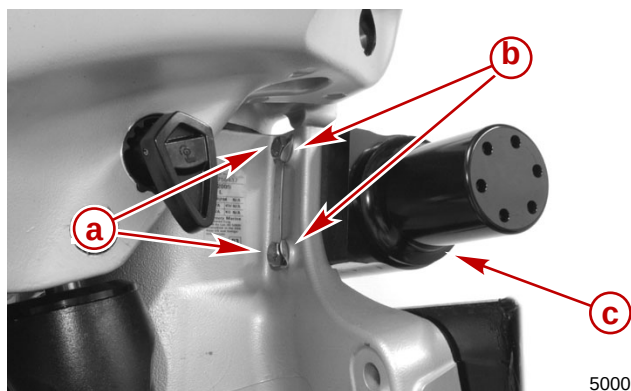
3. Align steering arm to center position.
4. Install steering cylinder on pedestal.



- a** - Pedestal
- b** - Steering arm
- c** - Through holes for mounting screws
- d** - Dowel pin holes

5. Secure steering cylinder with 4 screws and 2 retainers.
6. Tighten mounting screws to specified torque.

7. Bend retainer lock tab over a flat of each mounting screw.

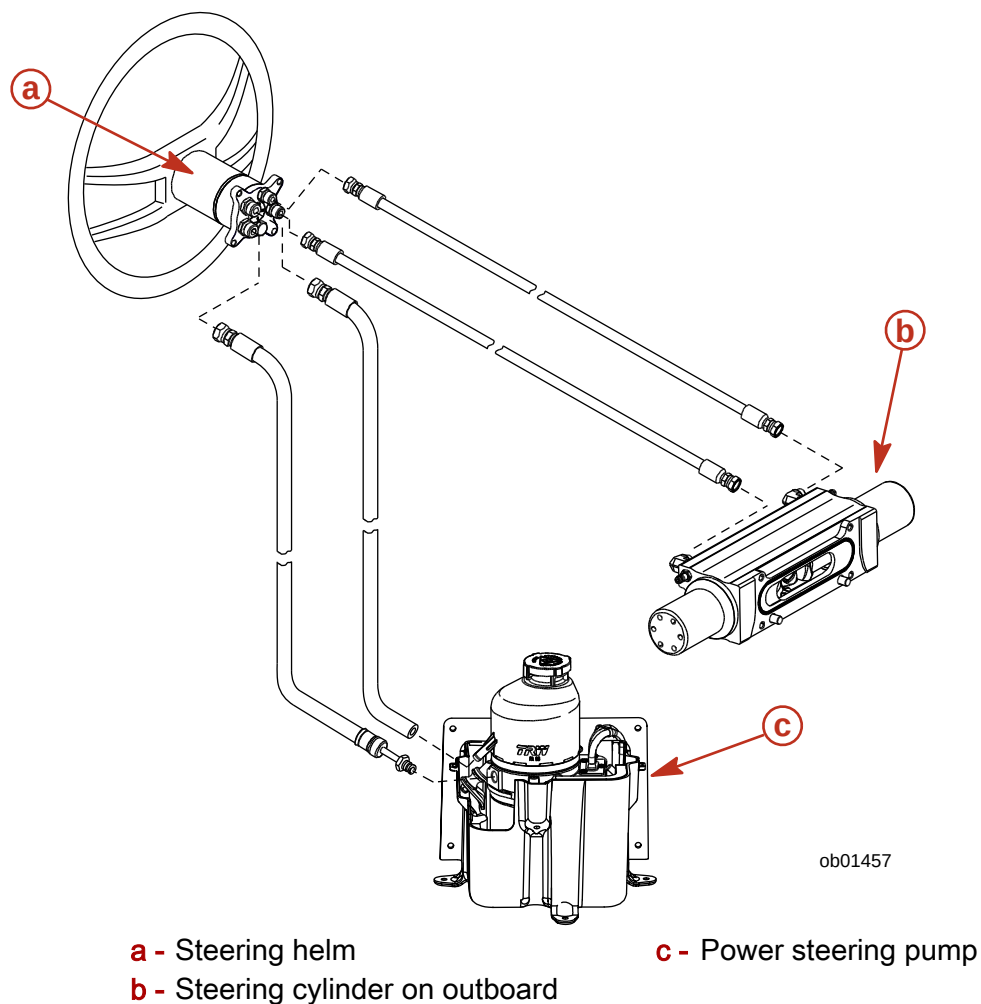


- a** - Steering cylinder mounting screws (4) M8 x 30
b - Retainer lock tab
c - Steering cylinder

Description	Nm	lb. in.	lb. ft.
Steering cylinder mounting screw	24.9		18.3

Power Steering Installation

Power Steering System



Installation Procedure

NOTE: On some large/heavy dual outboard boats the steering forces generated in extreme maneuvers may create loads that exceed the pump's pressure capacity. If the happens, the operator may feel intermittent periods of load feedback at the steering wheel. The steering wheel may feel hard to turn for brief periods during these extreme maneuvers. If this happens and steering performance is deemed unacceptable for the application, a second (accessory) cylinder may be rigged. When using a second steering cylinder the 40cc helm should be replaced with a 50cc helm.

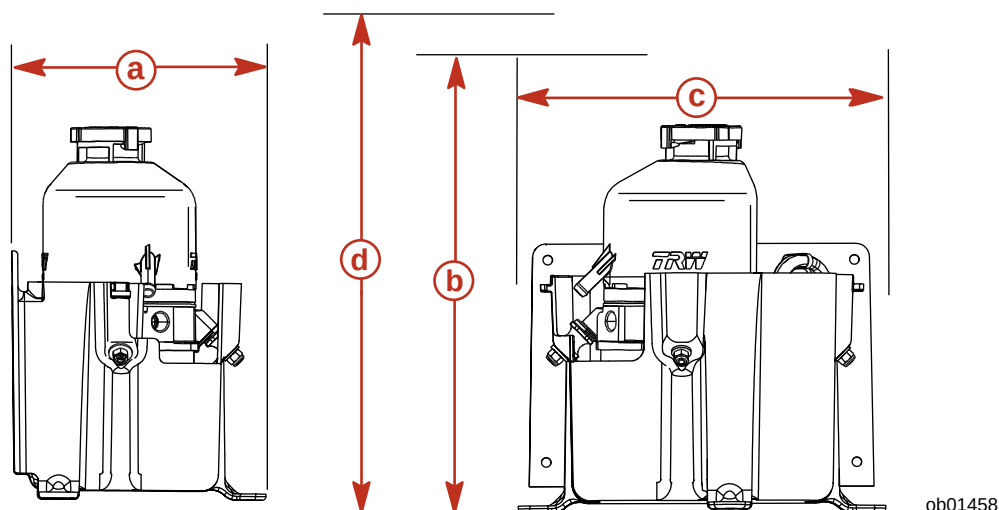
SELECTING LOCATION FOR THE POWER STEERING PUMP

CAUTION

To ensure proper steering operation, hydraulic power steering system must be protected from contamination. Make hydraulic connection in a clean work area. Route hoses with the protective shipping caps in place. Remove protective shipping cap from hose and component fitting as each connection is made.

1. Select a mounting location (floor or side of internal bulkhead) for the installation of the power steering pump that meets the following requirements
 - To reduce noise on aluminum or metal hulls, isolate steering hoses from hull with suitable non-abrasive hangers.
 - Steering hoses from steering wheel helm must be free of twists or stress. Gently secure hose bundle together with a cable tie, located approximately 25.4 cm (10 in.) from the steering wheel helm.
 - Do not mount pump on an angle greater than 15° from vertical position.
 - The pump electrical wiring must be within reach of the auxiliary battery.
 - Pump should be mounted in an area that allows sound enclosure, cover removal, and easy access to the fill cap.
 - Install pump in an area where bilge water will not contaminate the pump.
 - To reduce transmitted noise, mount pump on wood or fiberglass surface. Avoid mounting pump on aluminum or steel surfaces.

REQUIRED MOUNTING CLEARANCES FOR THE POWER STEERING PUMP

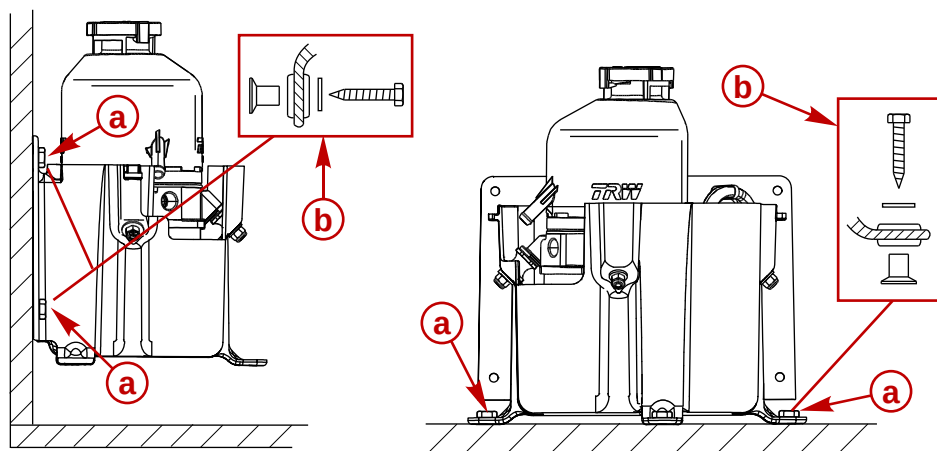


ob01458

- a** - 215 mm (8 1/2 in.)
- b** - 310 mm (12 7/32 in.) to top cover (not shown)
- c** - 285 mm (11 1/4 in.)
- d** - 432 mm (17 in.) clearance required for cover removal

INSTALLING POWER STEERING PUMP

- The power steering pump can be mounted two ways:
 - On a side of the internal bulkhead
 - Mounted on the floor
- Mount the power steering pump at the selected location, using appropriate fastening hardware suitable for the type of material and thickness of the mounting surface.



ob01459

Mounted on internal bulkhead

Mounted on floor

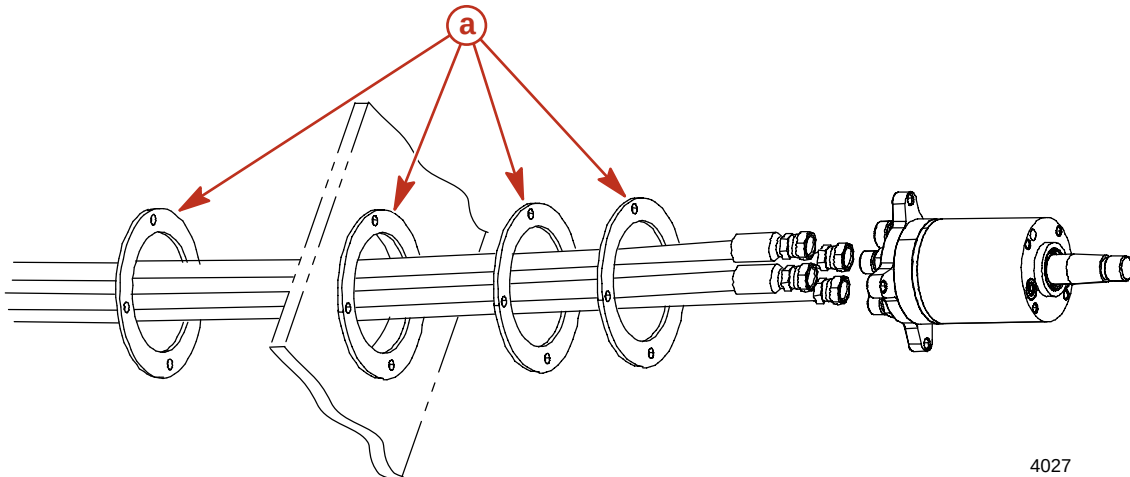
- a** - Lag screws or thru-bolts (3 or 4)
- b** - Mounting hardware

Connection of the Hydraulic Hoses to the Steering Helm

NOTE: Hoses must be routed up through steering helm opening in dash and secured to helm fittings prior to mounting the steering helm.

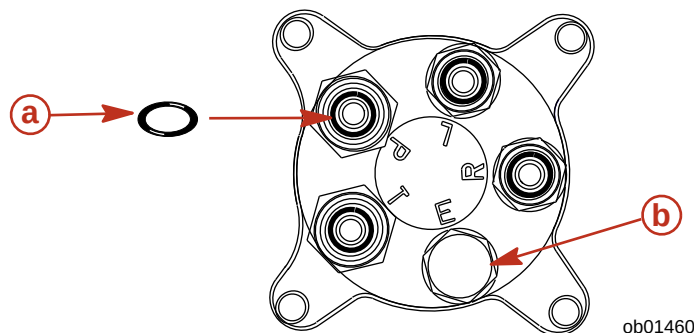
1. Place the steering hoses through one backing plate on the internal side of the dashboard. Route the steering hoses through the drilled opening, and place the required amount of backing plates on the hoses on the external side of the dashboard.

NOTE: The number of backing plates varies depending on helm displacement.



a - Backing plates

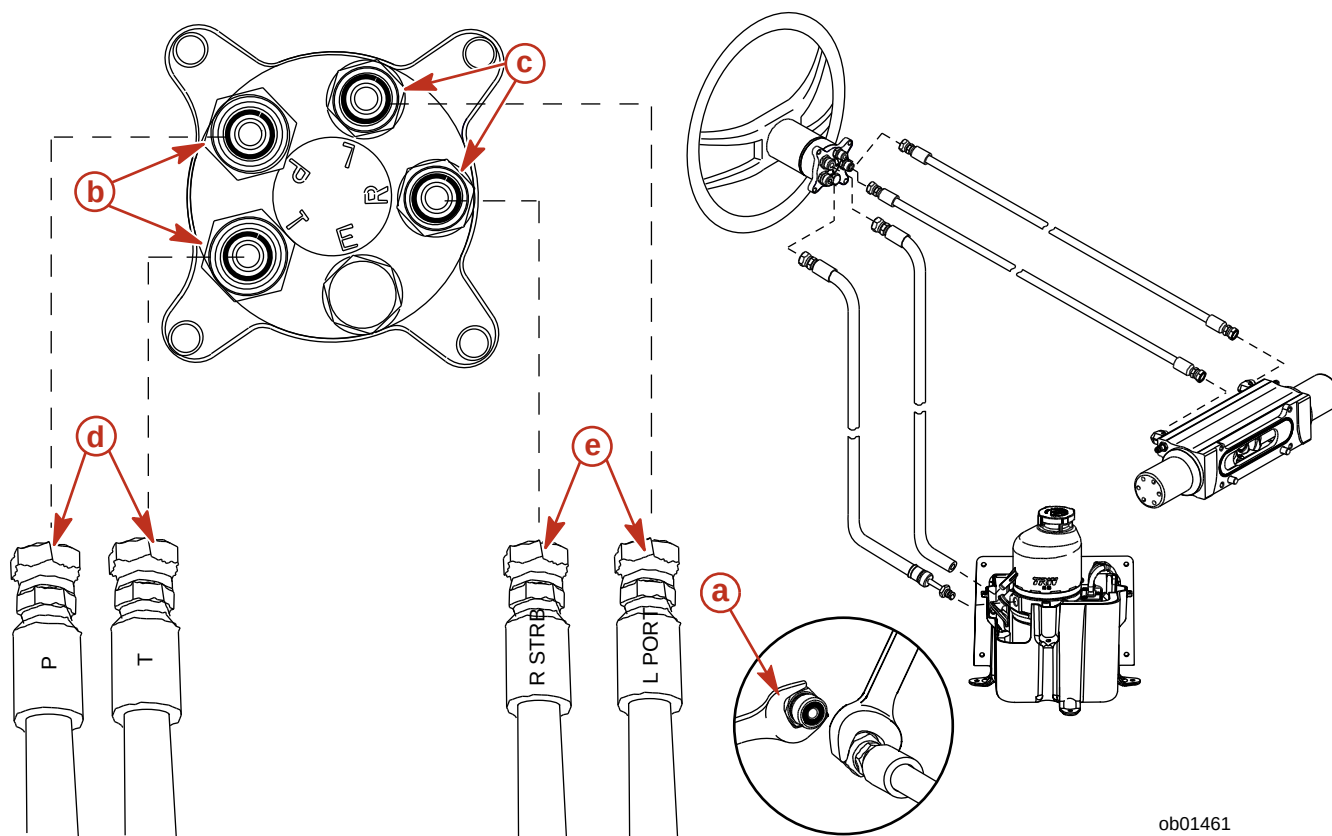
2. Remove and discard the shipping caps from ends of the four fittings on the steering helm. Ensure the O-ring seals did not lift off with the shipping caps.
3. Ensure O-ring seals are in place on end of steering helm fittings.



a - O-ring seals (4)

b - Plug - not used

4. Make the hose connections to the steering helm as shown. Use a thin wrench and hold the helm fittings from turning while tightening hoses. Do not over-tighten the hose connections.



ob01461

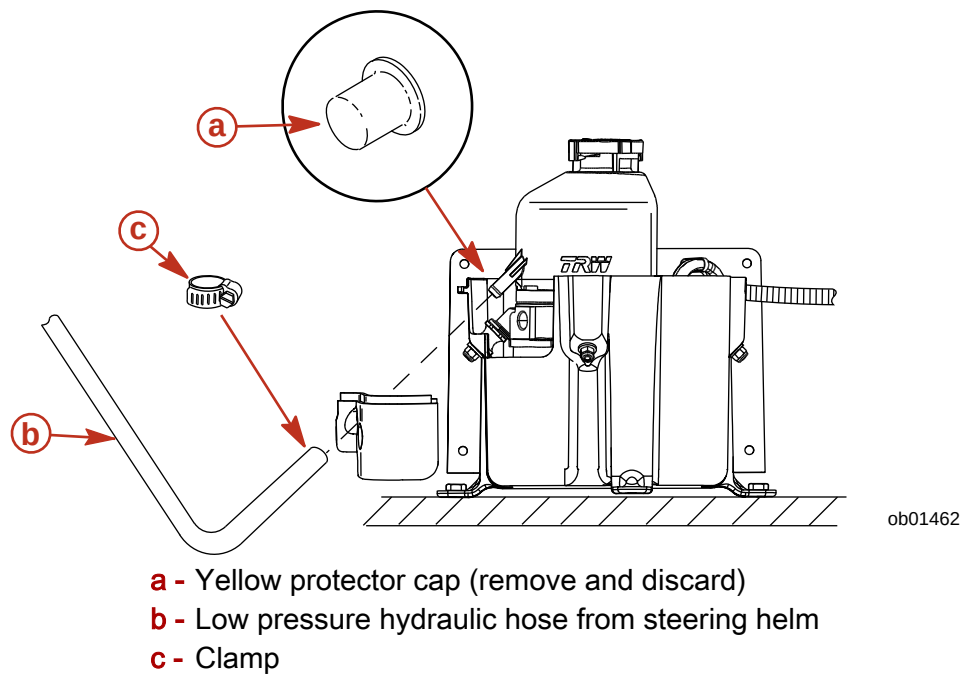
- a** - Thin wrench
- b** - Helm hex fitting wrench size (P & T) - 19 mm (3/4 in.)
- c** - Helm hex fitting wrench size (R & L) - 16 mm (5/8 in.)
- d** - Hydraulic hose hex fitting wrench size (P & T) - 21 mm (13/16 in.)
- e** - Hydraulic hose hex fitting wrench size (R STAR & L PORT) - 18 mm (11/16 in.)

Helm Fitting ID Mark	Hose ID Mark	Description
P	P	Pressure from pump to helm
T	T	Tank low pressure return to pump
R	R-STAR	Hose connects to starboard side of steering cylinder
L	L-PORT	Hose connects to port side of steering cylinder

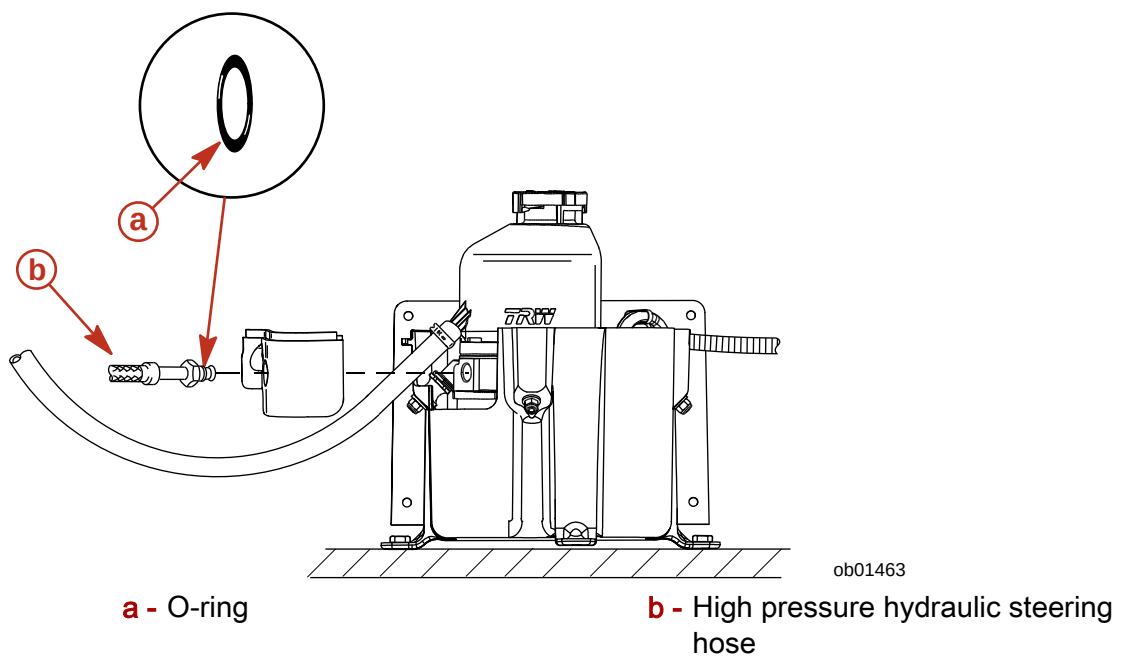
Connection of the Hydraulic Hoses to the Power Steering Pump

1. Remove and discard the yellow protector cap from end of tank low pressure fitting.

2. Connect the low pressure hydraulic hose from the steering helm to the low pressure fitting on the pump reservoir as shown. Fasten hose to fitting with constant tension spring clamp.

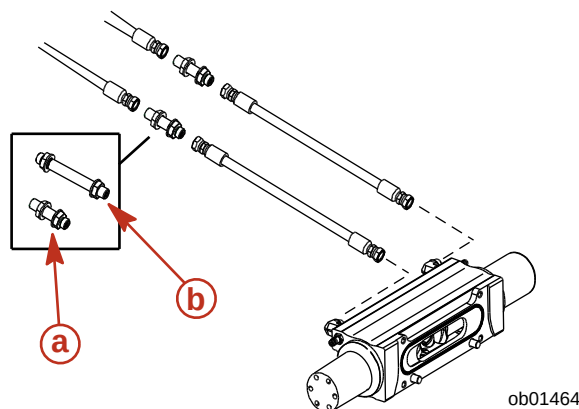


3. Ensure that O-ring seal is on end of hose.
4. Connect the high pressure hydraulic hose from the steering helm to the pump as shown.



Connection of the Hydraulic Hoses to the Steering Cylinder

1. Route the hydraulic hoses to the outboard steering cylinder. Bulkhead fittings are available if an opening does not exist in the engine well.

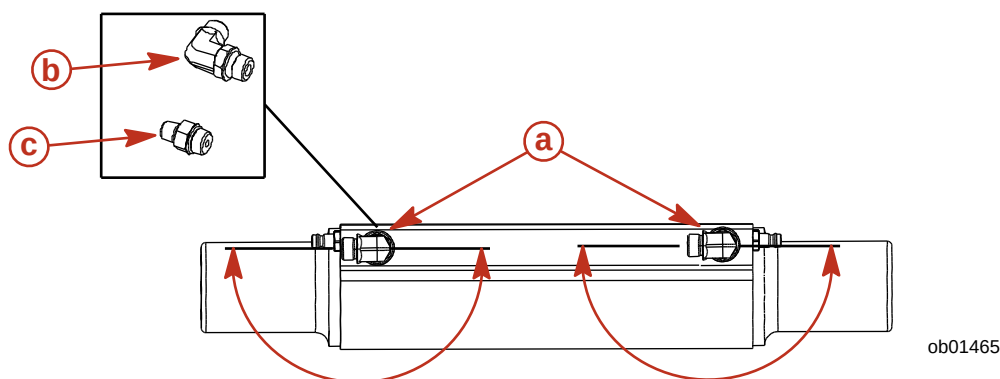


a - Bulkhead fitting - bulkhead thickness up to 1.9 cm (0.75 in.) (22-892517)

b - Bulkhead fitting - bulkhead thickness up to 7.62 cm (3 in.) (22-892518)

NOTE: The 90° hose fittings on the steering cylinder can be rotated to align with hose routing. Straight hose fittings (22-892519) are also available.

2. Position the 90° hose fittings to the desired direction. Loosen fastening nuts in order to rotate. Position fittings and re-tighten fastening nuts.

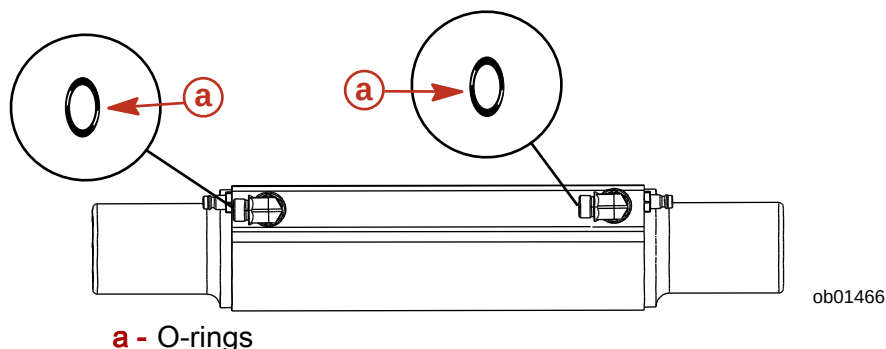


a - Position fittings

b - 90° fitting

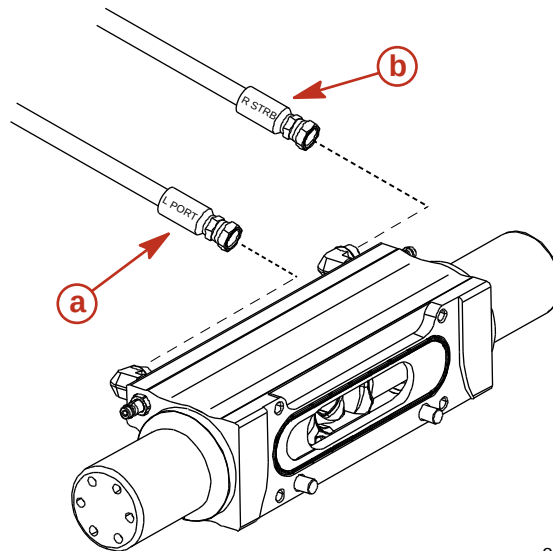
c - Straight fitting

3. Remove and discard the shipping caps from the two fittings on the steering cylinder. Ensure O-ring seals did not lift off with shipping caps.
4. Ensure O-ring seals are in place on end of each fitting.



a - O-rings

5. Make the hydraulic steering hose connections to the steering cylinder as shown.



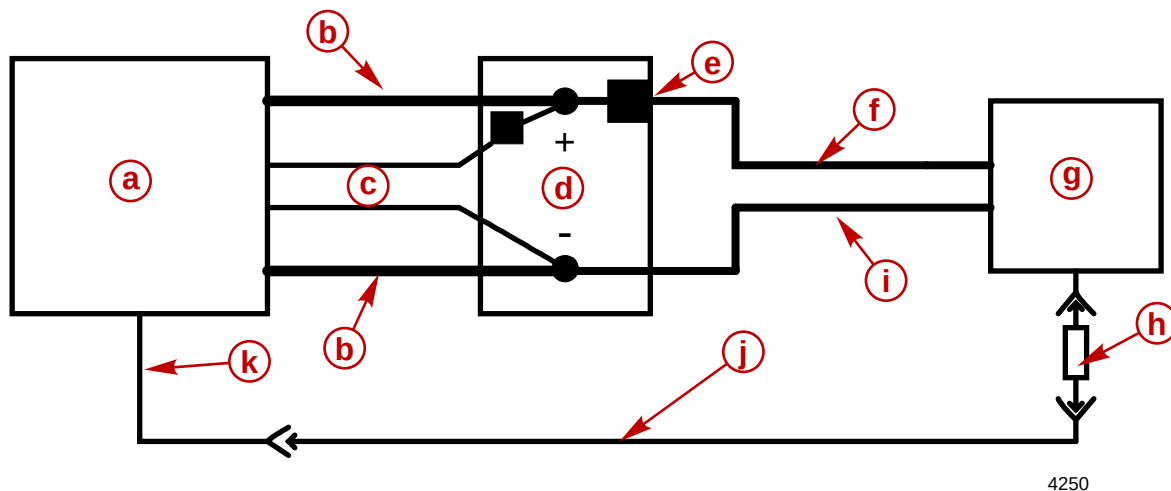
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a - Port fitting (L PORT)

b - Starboard fitting (R STAR)

Electrical Connections to the Steering Pump

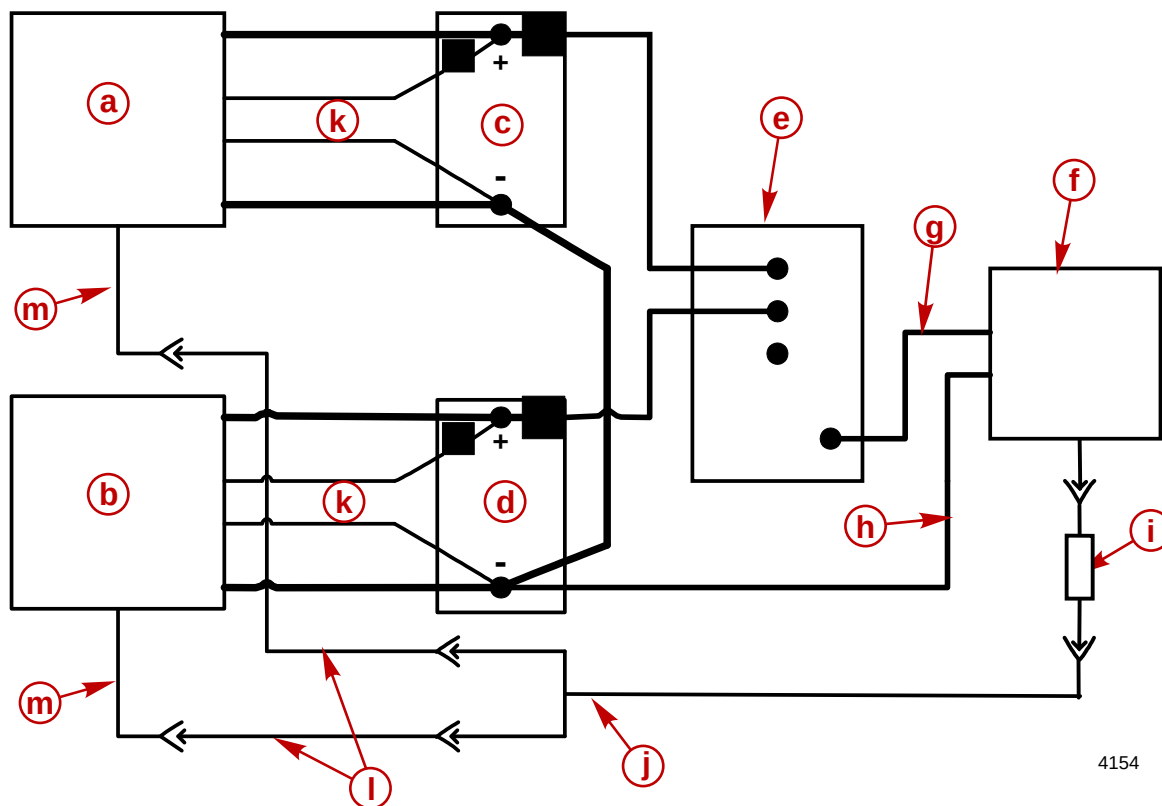
NOTE: For single engine installation, the power steering pump battery cables should be connected directly to the outboard starting battery.



Single Engine Application

- | | |
|---|---|
| a - Engine | g - Power steering pump |
| b - Battery cable | h - Driver module |
| c - DTS power harness | i - Power steering pump ground harness |
| d - Battery | j - Power steering signal harness |
| e - Power steering fuse - 90 Amp | k - Engine signal harness |
| f - Power steering pump 12V positive harness | |

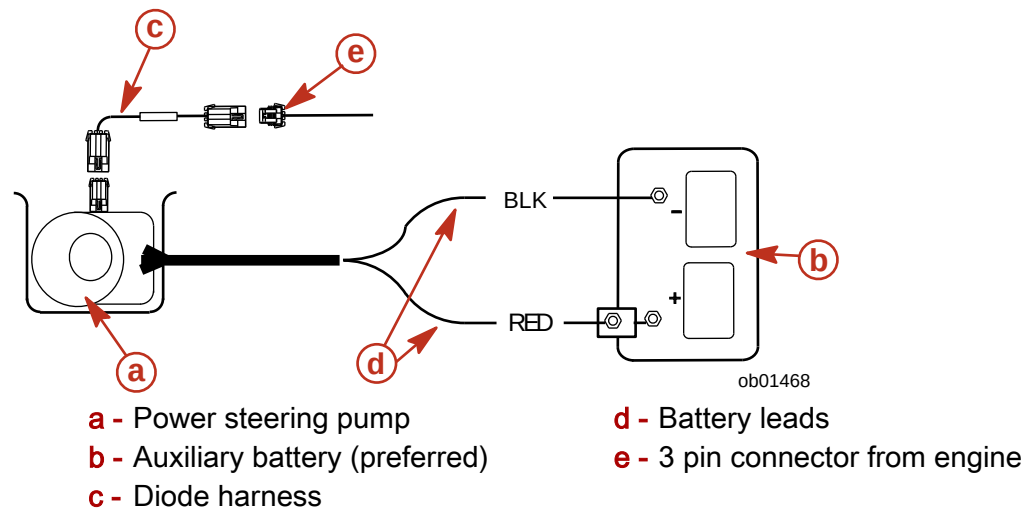
NOTE: On multiple installations, the Automatic Battery Switch (ABS) (87-895091K01), must be used to connect all outboard starting batteries to the power steering pump. The ABS allows battery voltage to be drawn from the starting battery with the highest state of charge.



Dual Engine Application

- | | |
|---|---|
| a - Port engine | h - Power steering pump ground harness |
| b - Starboard engine | i - Driver module |
| c - Port battery | j - Dual engine power steering adaptor |
| d - Starboard battery | k - DTS power harness |
| e - Automatic Power Switch (APS) | l - Power steering signal harness |
| f - Power Steering Pump | m - Engine signal harness |
| g - Power steering pump 12V positive harness | |

1. Make electrical connections to the pump as shown.

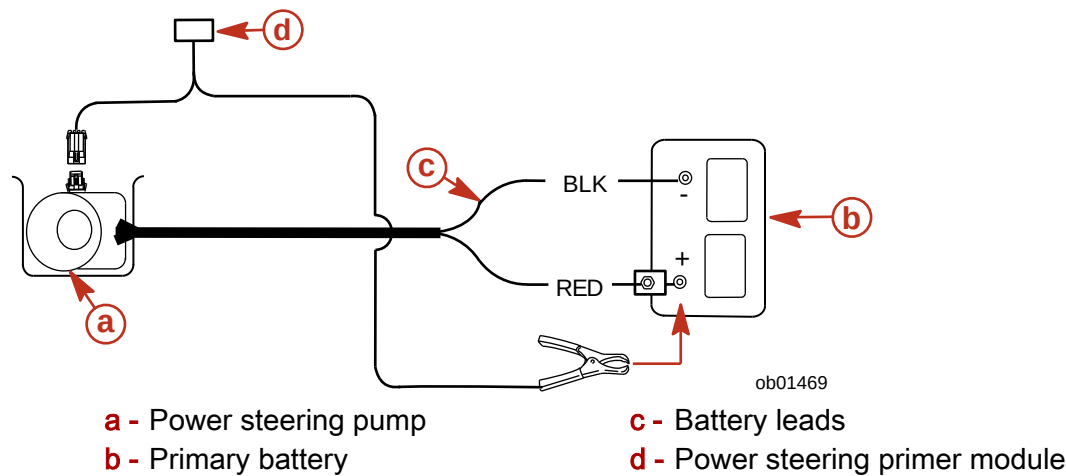


Filling Power Steering System with Engine Not Running

Use SAE 0W-30 Full Synthetic Power Steering Fluid in the power steering system. In an emergency, if recommended power steering fluid is not available, the use of any full synthetic engine oil can be temporarily used. The power steering fluid should then be drained and replaced with SAE 0W-30 Full Synthetic Power Steering Fluid as soon as possible, to avoid loss of performance in power steering system.

Fluid Type	Capacity	Mercury Part Number
SAE 0W-30 Full Synthetic Power Steering Fluid	1 - 2 liters (1 - 2 quarts) depending on length of steering hoses	92-858002K01

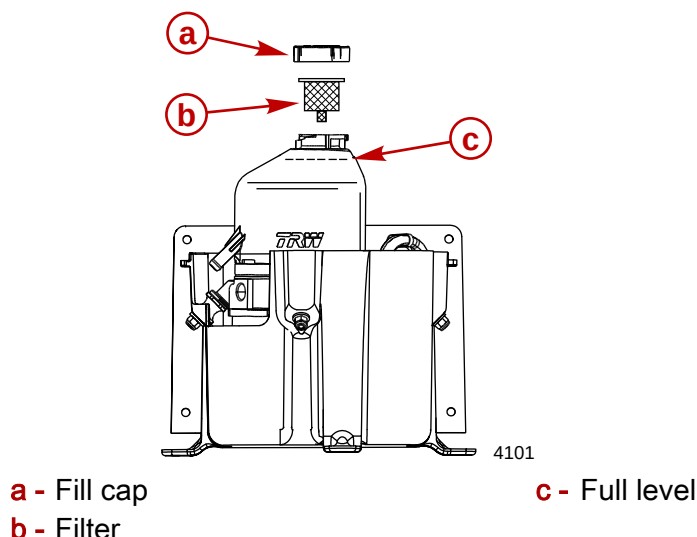
1. Disconnect power steering signal harness from engine signal harness.
2. Connect the Power Steering Primer Module Kit to the power steering pump and 12 volt positive power source as shown.



Power Steering Primer Module Kit	91-895040K01
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3. Remove the filler cap and filter from the power steering pump.

4. Fill the pump tank with recommended power steering fluid.

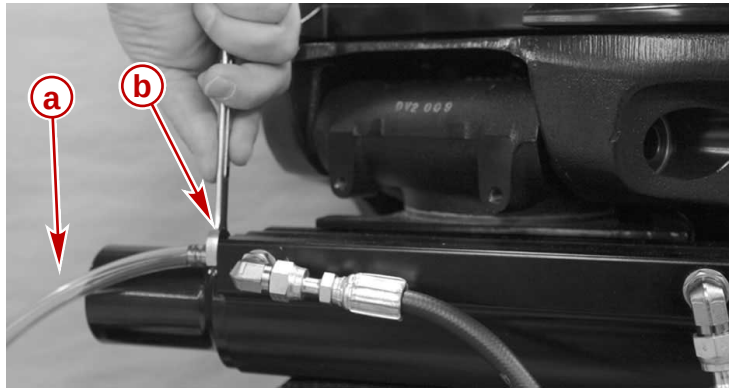


IMPORTANT: The power steering module primer has two switches, "POWER" - "ON" and "OFF", and "PUMP" - "ON" and "OFF". To power up and activate the power steering pump, there are two steps: 1) Turn the "POWER" switch to the "ON" position to power up pump, wait for two seconds, then, 2) Turn the "PUMP" switch to the "ON" position to activate pump.

IMPORTANT: Do not run pump out of fluid. If pump draws air during bleeding, the resulting re-bleeding will take two to three times longer than initial bleeding.

5. Power up and activate the pump until fluid drops halfway. Turn off both switches on the power steering primer module and refill the pump tank. Repeat this operation until pump tank stays full.
6. Power up and activate the pump while slowly turning the steering wheel towards the full lock position in one direction. Carefully monitor the fluid level until fluid drops halfway, stop turning the steering wheel and refill the pump tank. Repeat this operation turning the steering wheel from full lock to full lock 10 times until pump tank stays full.
7. For bleeding any air left in the steering system, power up and activate the pump. Turn the steering wheel in one direction until the full lock position is met.
8. Attach an 8 mm I.D. (5/16 in. I.D.) transparent bleed hose to the bleed valve on the end of the steering cylinder that the engine is pointing to. Route bleed hose into pump tank (do not bleed power steering fluid into a different container, this will only be pumping fluid out of the system that was just filled up).

- Open bleed valve to release any remaining air in the power steering system. Allow adequate time, depending on length of power steering hose, for air to escape from system. Tighten bleed valve securely and remove bleed hose.



3640

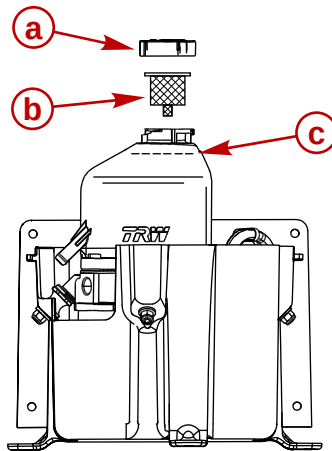
a - Bleed hose

b - Bleed valve in steering cylinder

- Turn the steering wheel to opposite full lock position, and repeat steps 8 and 9.
- Replace the filter and fill cap on the power steering pump.
- If desired, the power steering system can be rechecked after sitting overnight to remove any air that may possibly be left in the system. Repeat steps for bleeding steering system, preceding.
- Turn off both switches, remove the power steering primer module and reconnect the power steering signal harness from the engine to the pump.

Filling Power Steering System with Engine Running

- Remove the filler cap and filter from the power steering pump.
- Fill the pump tank with recommended power steering fluid.



4101

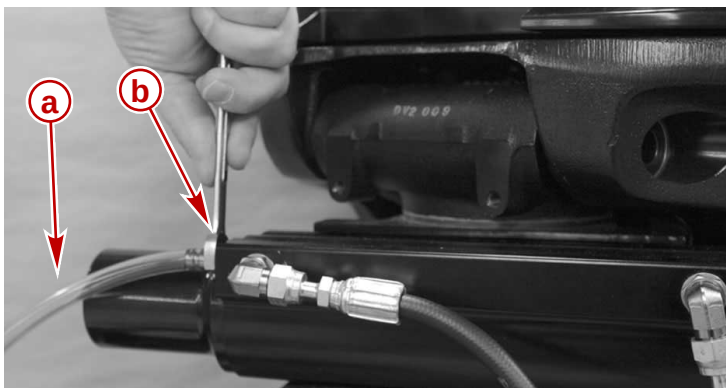
a - Cap

b - Filter

c - Full level

- Start and run the engine until the steering pump fluid drops halfway. Turn off the engine and refill the pump. Repeat this operation until pump stays full.
- Start and run the engine while slowly turning the steering wheel towards the full lock position in one direction. Carefully monitor the fluid level until fluid drops halfway. Stop turning wheel, turn off engine, and refill the pump tank. Repeat this operation turning the steering wheel to full lock to full lock 10 times until pump tank stays full.

5. For bleeding any air left in the steering system, start and run the engine, and turn the steering wheel in one direction until the full lock position is met.
6. Attach an 8 mm (5/16 in.) I.D. transparent bleed hose to the bleed valve on the end of the steering cylinder that the engine is pointing to. Route bleed hose into pump tank (do not bleed power steering fluid into a different container, as this will only be pumping fluid out of the system that was just filled).
7. Open bleed valve to release any remaining air in the power steering system. Allow adequate time, depending on length of power steering hose, for air to escape from system. Tighten bleed valve securely and remove bleed hose.



a - Bleed hose

b - Bleed valve in steering cylinder

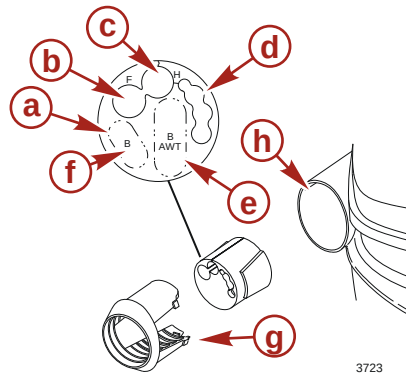
8. Turn the steering wheel to opposite full lock position, and repeat procedure for bleeding steering system.
9. Replace the filter and filler cap on the power steering pump.
10. If desired, the power steering system can be rechecked after sitting overnight to remove any air that may possibly be left in the system. Repeat steps for bleeding steering system, preceding.

Routing Connections Through the Cowl

IMPORTANT: Ensure that sufficient excess exists in the wiring harness and battery cables routed between the cowl fitting and the engine attachment point to relieve stress and prevent hoses from being kinked or pinched. Ensure that excess exists in all hoses and cables in full left and right turns and full tilt position.

NOTE: Mercury Marine suggests routing the wiring, cables and fuel hose through a rigging hose or flexible sleeve from the engine to the boat's gunnel or motor well. Follow the installation instructions included with the Rigging Hose or Flexible Sleeve Kit.

1. Pull out the grommet fitting from the front cowl opening. Route the wiring harnesses, battery cables, and fuel hose through the correct openings in the rubber grommet as shown.



- a** - Rubber grommet
- b** - Fuel hose
- c** - 14 pin data harness
- d** - DTS power harness, vessel sensor harness, power steering pump harness
- e** - Large diameter battery cables
- f** - Small diameter battery cables
- g** - Grommet fitting
- h** - Front cowl opening

2. Insert rubber grommet into fitting and secure fitting in front cowl opening.

Colored Wire Diagrams

Section 9A - Colored Wire Diagrams

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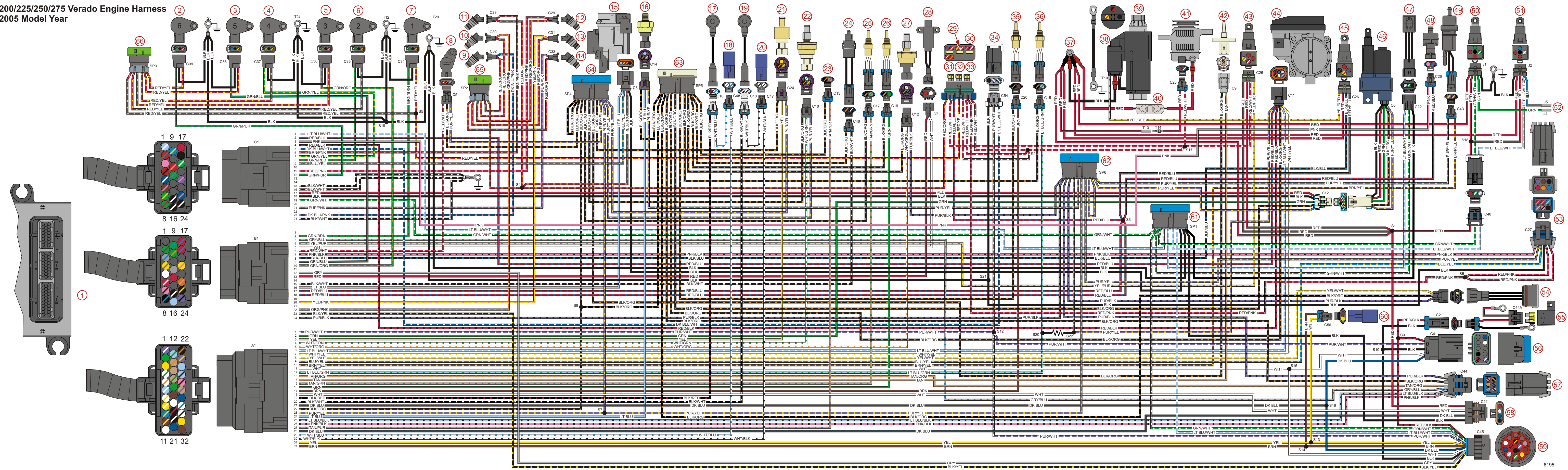
NOTES:

**200/225/250/275 VERADO ENGINE
HARNESS 2005 MODEL YEAR**

200/225/250/275 Verado Engine Harness 2005 Model Year

- | | |
|--|--|
| 1 - Propulsion control module (PCM) | 34 - Power steering signal harness |
| 2 - Ignition pencil coil #6 | 35 - Oil temperature sensor |
| 3 - Ignition pencil coil #5 | 36 - Supercharger outlet air temperature sensor |
| 4 - Ignition pencil coil #4 | 37 - Positive cable terminal |
| 5 - Ignition pencil coil #3 | 38 - Starter solenoid |
| 6 - Ignition pencil coil #2 | 39 - Starter motor |
| 7 - Ignition pencil coil #1 | 40 - 150 ampere fusible link |
| 8 - Camshaft position sensor | 41 - 70 ampere alternator |
| 9 - Fuel injector #5 | 42 - Manifold air temperature (MAT) sensor |
| 10 - Fuel injector #3 | 43 - Main power relay (MPR) |
| 11 - Fuel injector #1 | 44 - Electronic throttle control (ETC) |
| 12 - Fuel injector #2 | 45 - Starter relay |
| 13 - Fuel injector #4 | 46 - Electronic shift control (ESC) |
| 14 - Fuel injector #6 | 47 - Cowl tilt switch |
| 15 - Electronic boost control (EBC) | 48 - Fuel vapor purge valve |
| 16 - Oil pressure sensor | 49 - Vent canister switch |
| 17 - Upper knock sensor | 50 - Trim down relay |
| 18 - Resistor (upper knock sensor) | 51 - Trim up relay |
| 19 - Lower knock sensor | 52 - To trim pump |
| 20 - Resistor (lower knock sensor) | 53 - Fuel system module (FSM) |
| 21 - Manifold absolute pressure (MAP) sensor | 54 - Trim position sensor |
| 22 - Block water pressure sensor | 55 - DTS power harness - SFE 5 ampere fuse |
| 23 - Water in fuel (WIF) sensor connector | 56 - CAN 1 terminator resistor |
| 24 - Shift position switch | 57 - Boat sensor harness |
| 25 - Block coolant temperature sensor | 58 - Diagnostic terminal |
| 26 - Cylinder head coolant temperature sensor | 59 - Electrical data harness |
| 27 - Pitot pressure sensor | 60 - CAN 2 terminator resistor |
| 28 - Crank position sensor (CPS) | 61 - Splice saver SP1 |
| 29 - Spare fuses - ATC 20 ampere | 62 - Splice saver SP6 |
| 30 - Injector power (INJ. PWR) - ATC 20 ampere fuse | 63 - Splice saver SP5 |
| 31 - Fuel delivery (FUEL) - ATC 20 ampere fuse | 64 - Splice saver SP4 |
| 32 - Ignition coils (IGN. COILS) - ATC 20 ampere fuse | 65 - Splice saver SP2 |
| 33 - Propulsion control module (ECM) - ATC 20 ampere fuse | 66 - Splice saver SP3 |

200/225/250/275 Verado Engine Harness
2005 Model Year

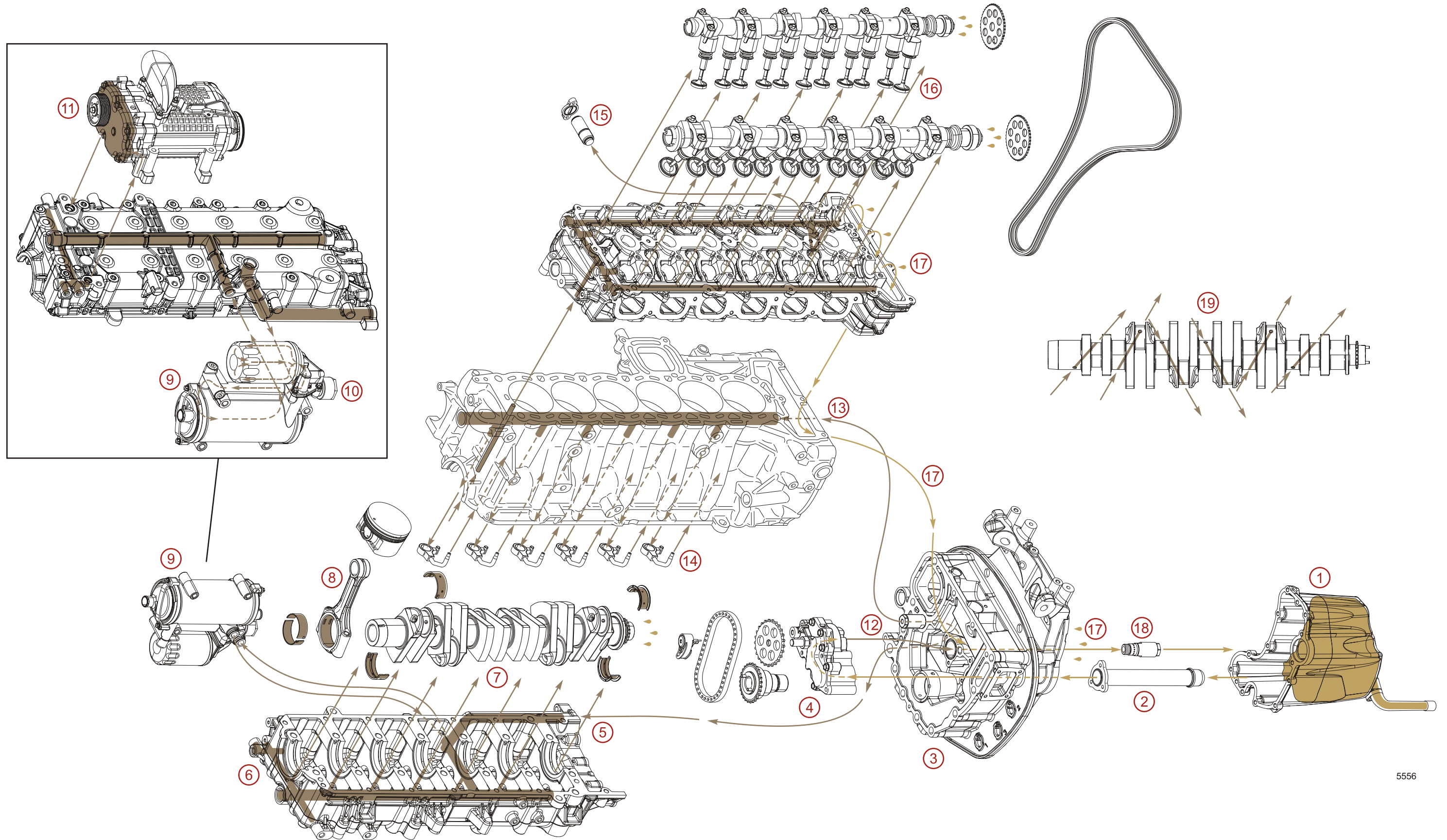


**200/225/250/275 VERADO OIL FLOW
DIAGRAM 2005 MODEL YEAR**

200/225/250/275 Verado Oil Flow Diagram 2005 Model Year

- 1** - Oil sump
- 2** - Oil pick-up tube
- 3** - Oil passage thru adaptor plate
- 4** - Oil pump
- 5** - Oil passage to main gallery
- 6** - Main gallery
- 7** - Crankshaft/main bearings
- 8** - Piston rod/wrist pin
- 9** - Integrated oil module (IOM)
- 10** - Thermostat
- 11** - Supercharger
- 12** - Check valve for piston cooling jet gallery
- 13** - Piston cooling jet gallery
- 14** - Piston cooling jets
- 15** - Timing chain tensioner
- 16** - Camshaft/bearings
- 17** - Oil return
- 18** - Oil pressure relief valve
- 19** - Crankshaft main bearing to connecting rod bearing oiling

200/225/250/275 Verado Oil Flow Diagram 2005 Model Year

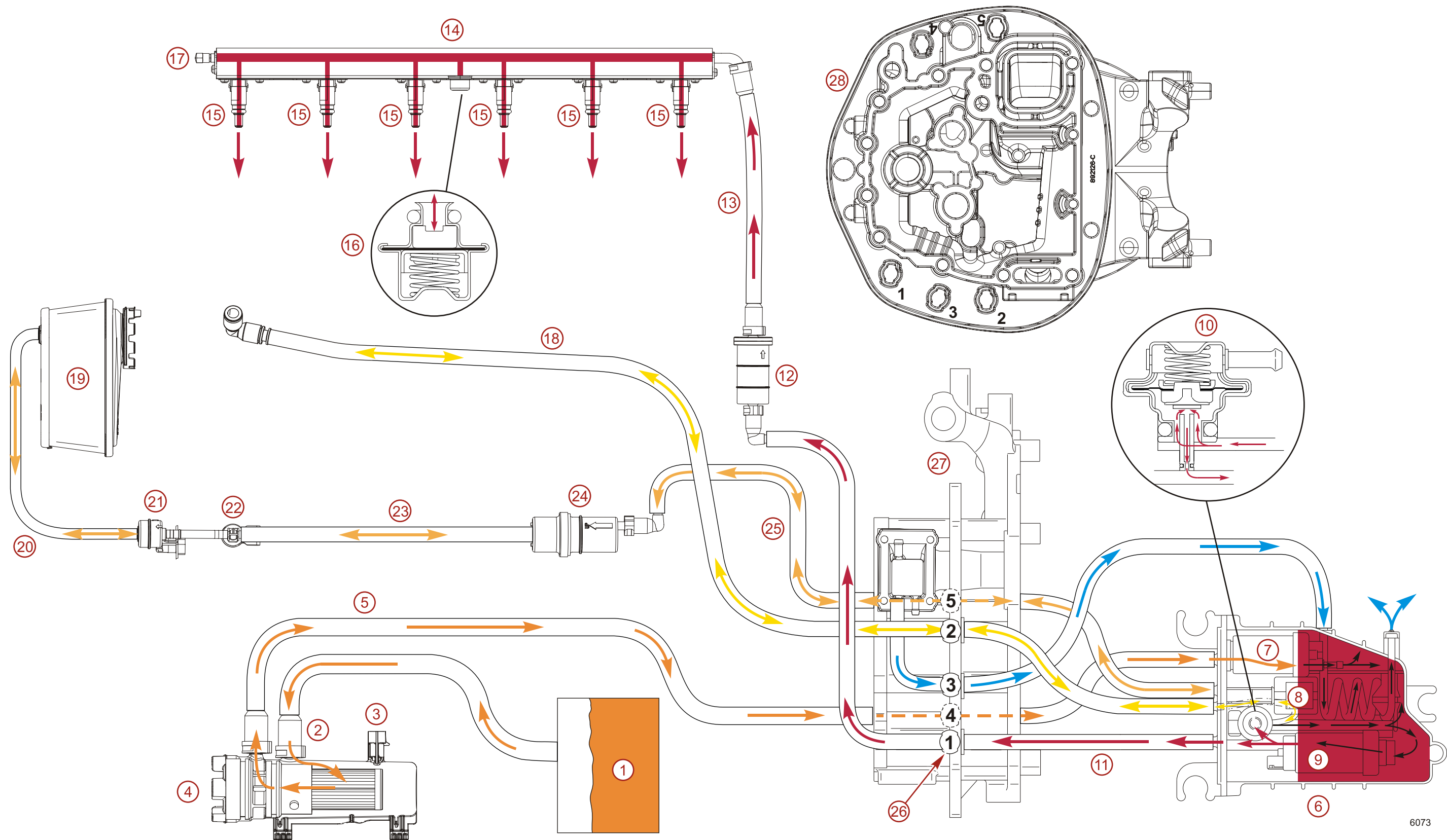


**200/225/250/275 VERADO FUEL FLOW
DIAGRAM 2005 MODEL YEAR**

200/225/250/275 Verado Fuel Flow Diagram 2005 Model Year

- 1 - Fuel tank
- 2 - Fuel inlet
- 3 - Water in fuel sensor (WIF)
- 4 - Water separating fuel filter (2 micron)
- 5 - Fuel inlet line to FSM
- 6 - Fuel system module (FSM)
- 7 - Fuel pump (lift)
- 8 - Float switch
- 9 - Fuel pump (high pressure)
- 10 - Fuel pressure regulator
- 11 - Fuel line (high pressure) FSM to inline filter
- 12 - Fuel filter (20 micron) (high pressure)
- 13 - Fuel line (high pressure) inline filter to fuel rail
- 14 - Fuel rail
- 15 - Fuel injectors
- 16 - Damper
- 17 - Fuel pressure test port (schrader valve)
- 18 - Manifold reference line
- 19 - Air filter
- 20 - Fuel vapor purge line (upper)
- 21 - Fuel vapor purge valve
- 22 - Fuel vapor purge relief valve
- 23 - Fuel vapor purge line (lower)
- 24 - Vent canister
- 25 - FSM to vent canister line
- 26 - Hose routing through adaptor plate (1-5)
- 27 - Adaptor plate port side view
- 28 - Adaptor plate top view

200/225/250/275 Verado Fuel Flow Diagram
2005 Model Year



**200/225/250/275 VERADO WATER
FLOW DIAGRAM 2005 MODEL YEAR**

200/225/250/275 Verado Water Flow Diagram 2005 Model Year

- 1 - Cooling water inlet
- 2 - Water pump
- 3 - Water tube
- 4 - Adaptor plate
- 5 - Cylinder block
- 6 - Charge air cooler (CAC)
- 7 - Flush T fitting
- 8 - Integrated oil module (IOM)
- 9 - Thermostat
- 10 - Cylinder head
- 11 - Manifold housing water strainer
- 12 - Tell-tale
- 13 - Evaporative cooler
- 14 - Fuel system module (FSM) cooling coil
- 15 - Poppet valve
- 16 - Water discharge
- 17 - Water discharge from evaporative cooler

200/225/250/275 Verado Water Flow Diagram
2005 Model Year

