Outboard V6 EFI

Technician's Guide

Table of Contents

Section 1 - General Information

Table of Contents

Speed/Density System

Notes

Speed/Density Theory

Outboard EFI engines operate on the fuel injection strategy called "Speed/Density". This means that the ECM primarily looks at the engine's **speed** and the intake manifold's air **density** in order to calculate the correct amount of fuel to inject.

The engine requires an air/fuel mixture of approximately 14:7 to 1 in the combustion chambers.

Since the EFI system doesn't control air flow, it must determine how much air is flowing through the engine in order to calculate the correct amount of time to fire the fuel injectors. The net result is that there must be 1 part of fuel for every 14.7 parts of air going through the engine.

Since the engine is basically an air pump, we know that an engine is capable of pumping a certain (maximum) amount of air at any specific rpm. The actual amount of air it pumps (at a specific rpm) depends on the density of the air in the intake manifold. The air density (in the intake manifold) will vary depending on rpm, throttle plate position and barometric pressure.

If the air density in the intake manifold is known, the actual amount of air flowing through the engine (the "Air Mass" or "Mass Air Flow") **could** be calculated. This calculated (and the actual) air flow is a repeatable function, meaning that at a specific rpm and a specific manifold absolute pressure reading, the air flow through the engine will always be the same.

However, in the speed/density system we do not actually calculate the actual air flow. Instead, the ECM measures the rpm and the air density, then refers to a programmed "lookup table" in the ECM's EEPROM. This lookup table will be programmed with the correct fuel injector information for every rpm and density reading. The programming engineer has to come up with these figures, because the ECM is not actually calculating the Mass Air Flow.

The speed-density system depends on the engine being unmodified (from its original production state). If we change the volumetric efficiency of the engine in any manner, the amount of air flow for a given rpm and air density will change, causing the ECM to deliver the incorrect amount of fuel. Any modification to the following components will influence the air flow through the engine, throwing the speed-density system out of calibration.

- Pistons and combustion chambers (anything that changes the compression ratio).
- Changes to intake and exhaust port size, as well as "porting and polishing"

Notes

Fuel Injection System Function

Fuel is delivered directly to the engine by way of fuel injectors. These injectors are provided with a constant supply of fuel delivered to the fuel rail. The injectors are opened and closed electronically by the Electronic Control Module (ECM). The ECM receives input signals from various sensors in the EFI system which in turn transmits controlling outputs (open/close) to the injectors. The length of time the injectors stay open is considered pulse width. The pulse width will widen (richer) or narrow (leaner) depending on signals the ECM receives from sensors, to allow efficient operation at all speeds and conditions.

Section 2 - 1987-2001 2.4/2.5L EFI

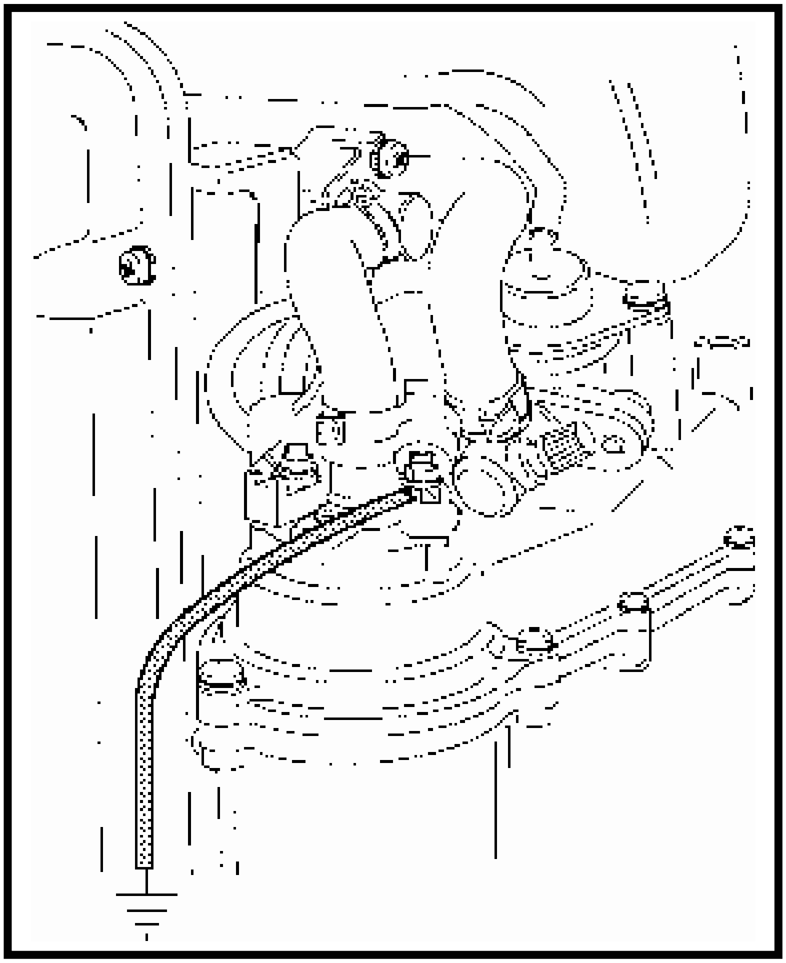
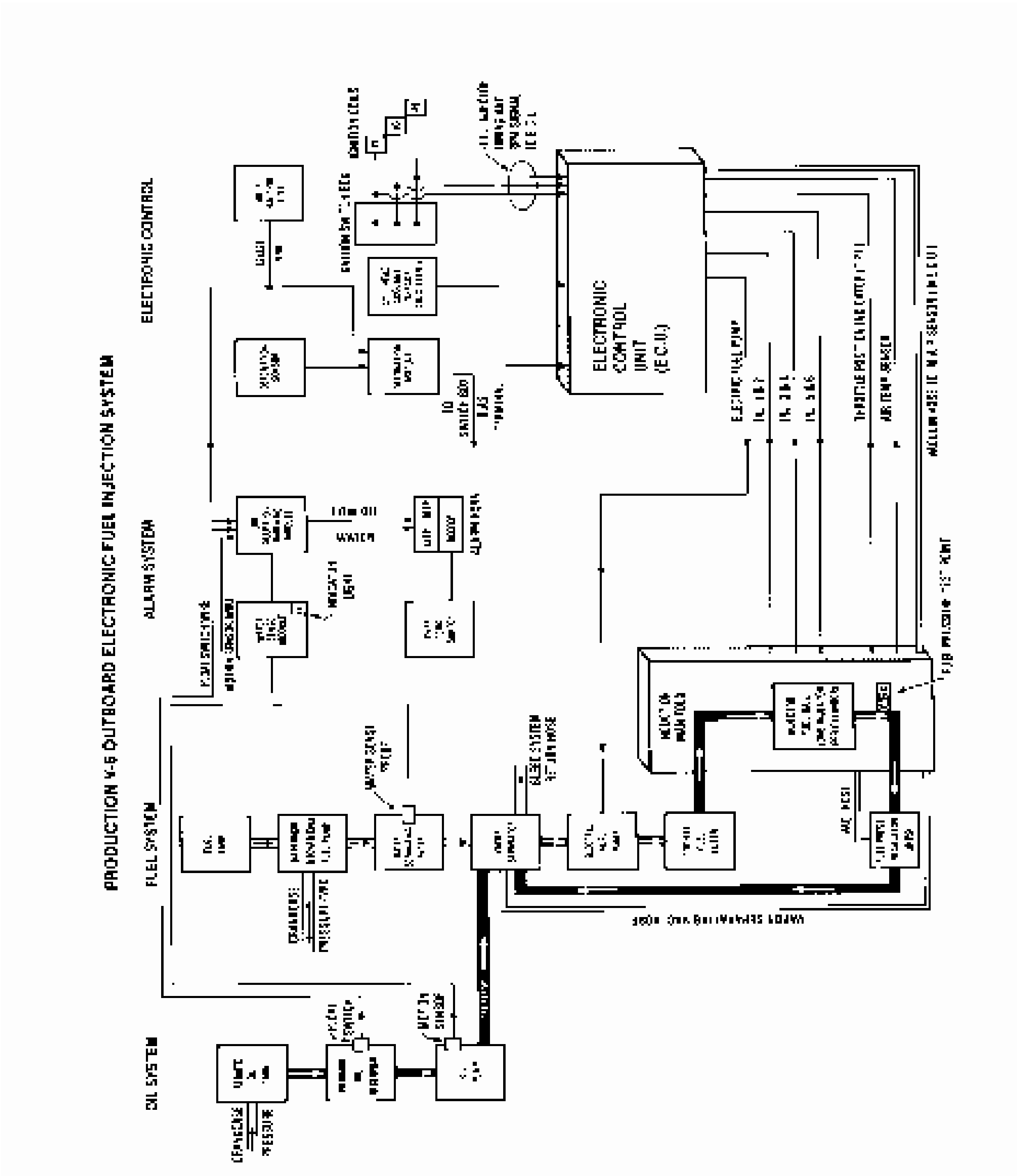
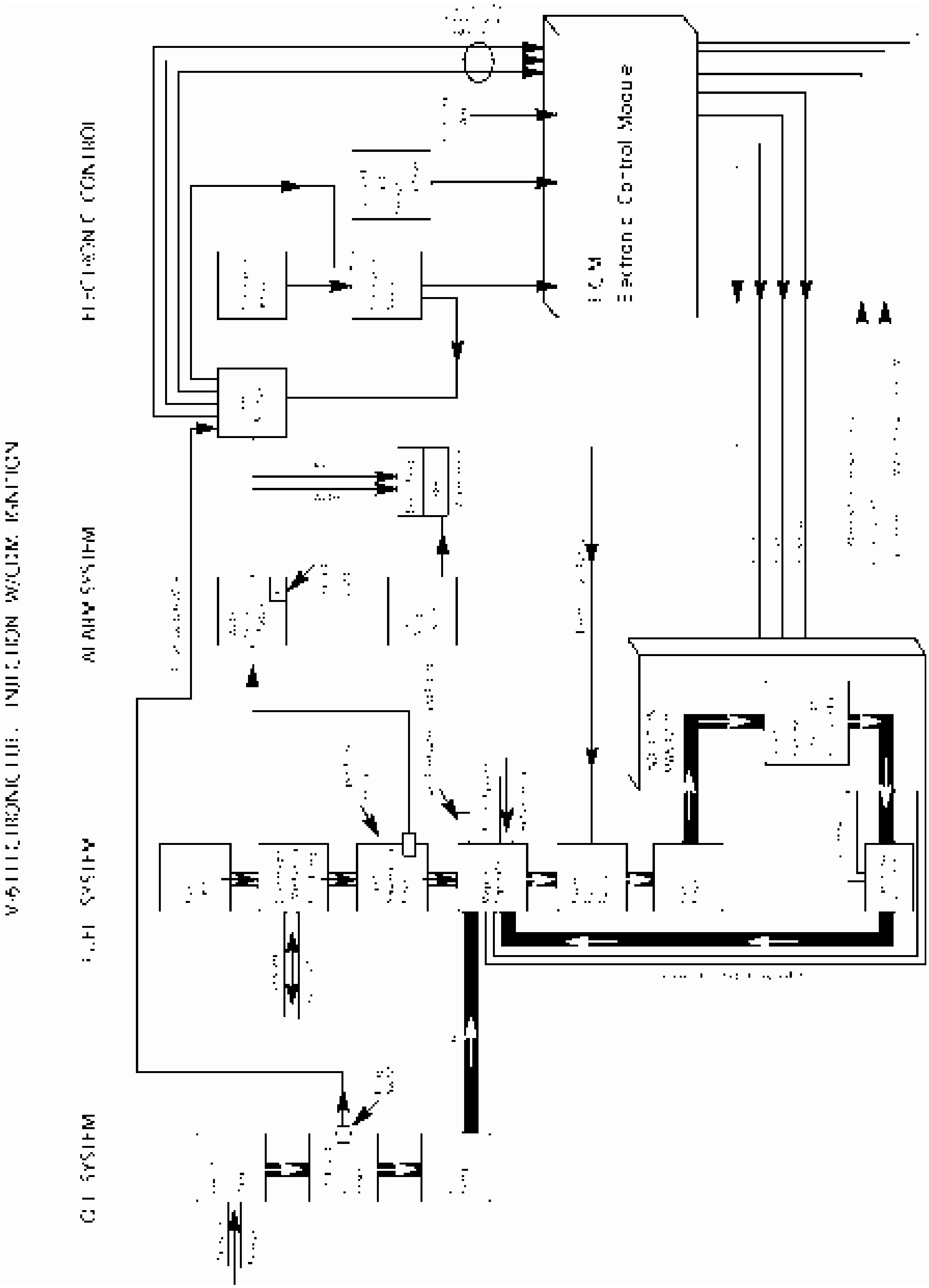


Table of Contents

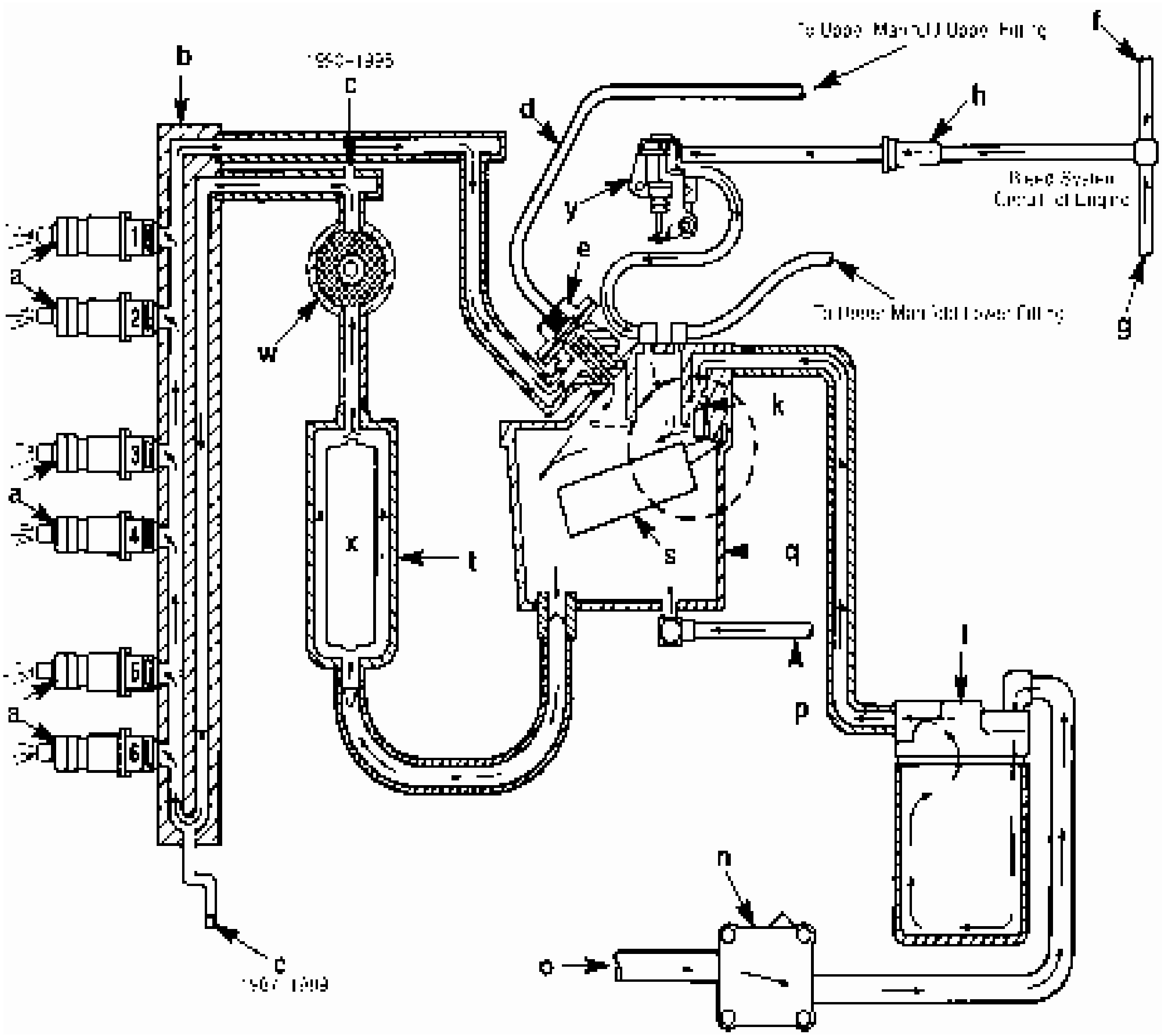
2.4 / 2.5L System Block Diagram W/ADI Ignition



2.5L System Block Diagram w/CDM Ignition



1987-1995 2.4L / 2.5L Fuel Flow Diagram

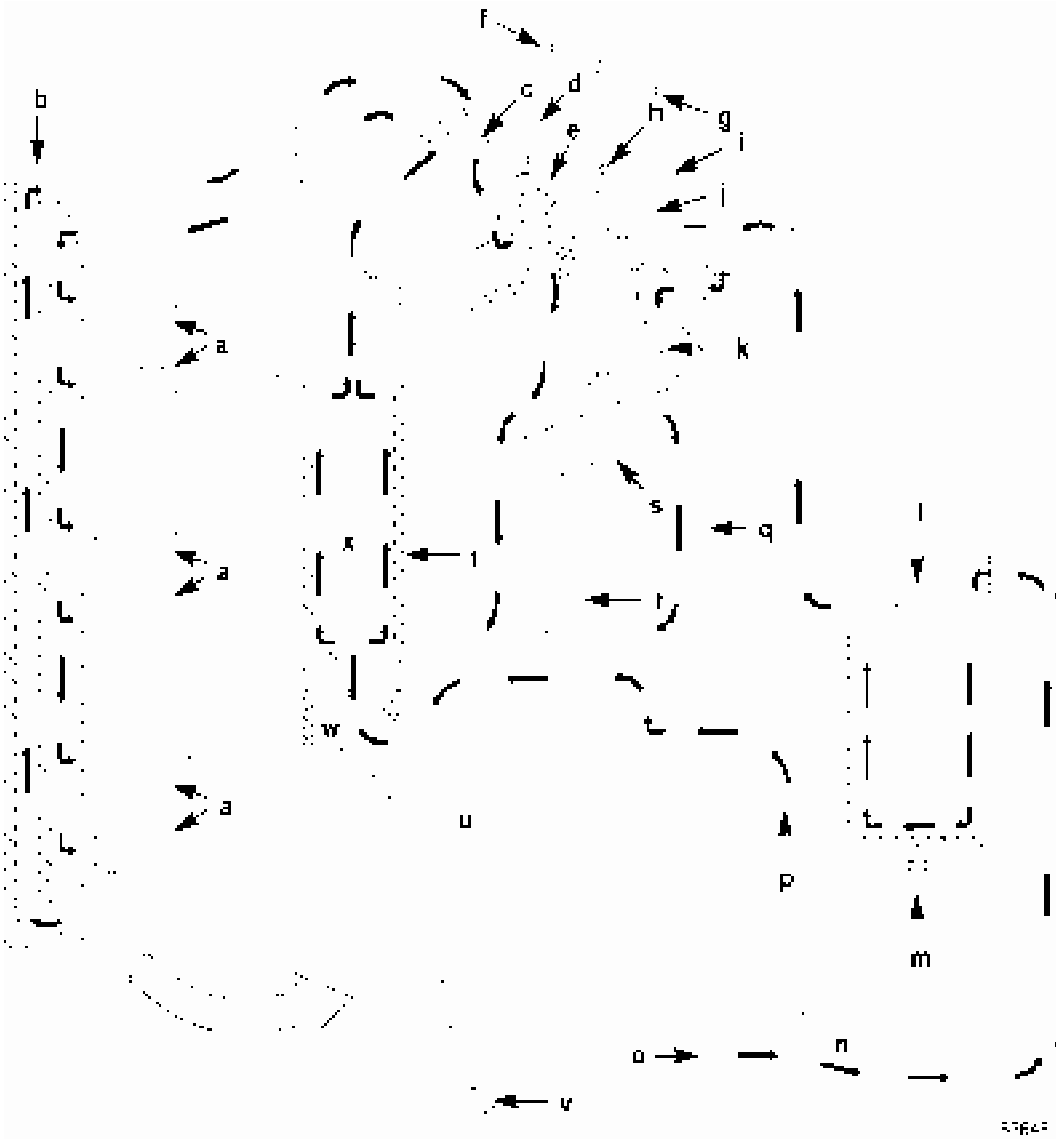


- a) Fuel Injectors (6)
- b) Fuel Rail
- c) Fuel Rail Pressure Port
- d) Fuel Pressure Regulator Manifold Hose
- e) Fuel Pressure Regulator
- f) To Starboard Bleed Junction Box
- g) To Port Bleed Junction Box
- h) Bleed System Filter
- i) (NOT USED)
- j) (NOTUSED)
- k) Needle & Seat
- l) Water Separator
- m) Water Sensor
- n) Pulse Fuel Pump
- o) From Fuel Tank
- p) From Oil Pump
- q) Vapor Separator
- r) (NOT USED)
- s) Vapor Separator Float
- t) Electric Fuel Pump
- u) (NOT USED)
- v) (NOT USED)
- w) Final Filter
- x) Armature
- y) Bleed Shut Off Valve

Notes

1996-2001 2.5L Fuel Flow Diagram

a) Fuel Injectors (6)
b) Fuel Rail
c) Fuel Rail Pressure Port
d) Fuel Pressure Regulator Manifold Hose
e) Fuel Pressure Regulator
f) To Starboard Bleed Junction Box
g) To Port Bleed Junction Box
h) Bleed System Filter
i) MAP Sensor (3.0L only)
j) MAP Sensor Manifold Hose
k) Needle & Seat
l) Water Separator
m) Water Sensor
n) Pulse Fuel Pump
o) From Fuel Tank
p) From Oil Pump
q) Vapor Separator
r) Manifold Bleed Hose to VST
s) Vapor Separator Float
t) Electric Fuel Pump
u) Manifold
v) Injector Wiring Harness
w) Final Filter
x) Armature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Notes

2.4/2.5L Fuel Flow Component Description

Pulse Fuel Pump

The pulse fuel pump operates through alternating crankcase pressure to deliver fuel through the water-separating filter to the vapor separator.

- Fuel pressure @ Idle – 2-3 psi (Minimum – 1 psi).
- Fuel Pressure @ Wide-Open-Throttle – 6-8 psi (Minimum – 4 psi).

Water Separating Filter

The water separating filter protects the fuel injectors from water and debris. The filter contains a sensor probe which monitors water level in the filter. If water is above the sensor probe, the water detection light will come on and the warning horn will begin a series of beeps.

Vapor Separator

The vapor separator is a fuel reservoir which continuously blends and circulates fresh fuel, oil and unused fuel/oil from the fuel rail.

1) Fuel Inlet – Fresh fuel delivered from the water separator by the crankcase mounted pulse fuel pump. The amount of fuel allowed to enter the vapor separator is controlled by a needle/seat and float assembly mounted in the cover of the vapor separator.
2) Oil Inlet – Oil delivered by the crankshaft driven oil pump.
3) Crankcase Bleed Inlet – Recirculated (unburned) fuel/oil mixture delivered from the bleed lines through a filter into the vapor separator.
4) Fuel Pressure Regulator Inlet – Unused fuel/oil mixture being recirculated from the fuel rail back into the vapor separator.

Bleed System

On carbureted engines, excess fuel which collects in the crankcase is channeled into the transfer ports to be burned.

On EFI engines, excess crankcase fuel is directed through a filter (to eliminate contaminates) and emptied into the vapor separator. It mixes with fresh incoming fuel and is pumped to the fuel rail and fed through the injectors.

A 30 micron filter is installed in the bleed line to prevent contaminants from entering the vapor separator. If the filter becomes clogged, the engine will load up at idle and hesitate upon acceleration.

1989–1995 2.4L/2.5L

The bleed system flow is closed off to the vapor separator during off idle speeds by the bleed shut off valve. The bleed shut off valve is activated by throttle linkage on the manifold. At idle speeds the flow can be close to 1000cc's of gasoline per hour.

Final Filter

1996–2001 2.5L/1995–2001 3.0L

The final filter is located below the electric fuel pump in the vapor separator. The filter collects debris and prevents them from flowing through the electric pump and into the fuel rail and injectors.

1987–1995 2.4L/2.5L

The final filter is located above the electric fuel pump. The filter collects debris flowing from the electric fuel pump to the fuel rail and can withstand blockage up to 50% and still allow adequate fuel flow.

Electric Fuel Pump

1998–2001 2.5L/1995–2001 3.0L

The electric fuel pump runs at variable speeds to provide fuel in excess of engine demands. The excess fuel is circulated through the fuel rail to the fuel pressure regulator and back to the vapor separator.

1987–1997 2.4L & 2.5L

The electric fuel pump is continually providing fuel in excess of engine demands. The excess fuel circulates through the fuel rail back to the vapor separator. With the key in “run” position (engine off), the ECM signals the pump to run for approximately 30 seconds then shut off. With the key in run position (engine running), the ECM determines pump speed (2 speeds) depending on RPM. During low speed operation pump is at low speed.

Induction Manifold

The induction manifold is a common plenum chamber for accurate pressure measurement. It contains 4 throttle shutters on 2 throttle shafts. The shutter opening (idle air opening) can be adjusted during EFI set-up procedure. The manifold contains the fuel rail, injectors, throttle position sensor and air temperature sensor. A fuel rail pressure port is located on the fuel pressure regulator.

Notes

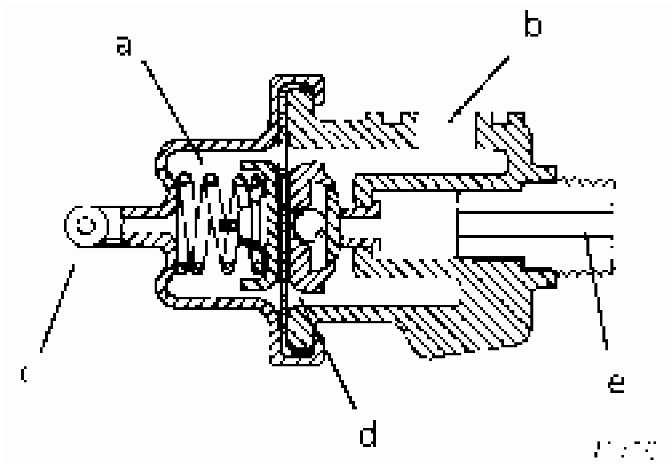
Notes

Fuel Pressure Regulator

The fuel pressure regulator is located on top of the vapor separator and is continuously regulating fuel pressure produced by the electric fuel pump. The electric pump is capable of producing90 psi (621 kPa) of fuel pressure.

NOTE: Units with external electric fuel pump limits pressure to 36–39 psi.

NOTE: Units with internal electric fuel pump limits pressure to 34–36 psi.



a) Spring
b) Fuel Rail Pressure
c) Vacuum Line To Intake Manifold
d) Diaphragm
e) To Return Fuel Passage In Fuel Rail

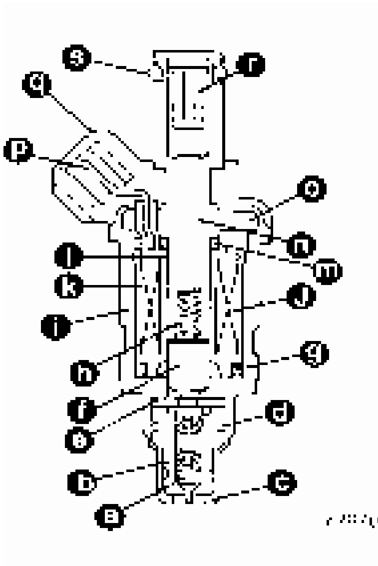
Fuel Injectors

The EFI injector is a solenoid- operated device, controlled by the ECM, that meters pressurized fuel to a pair of cylinders. The fuel injectors are located inside the induction manifold on the fuel rail.

The injector receives signals from the Electronic Control Module. These signals (pulse width) open the pintle valve, allowing fuel to flow past the pintle valve.

The injector's tip has holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. The pulse width will widen (richer) or narrow (leaner) depending on various signals received from sensors connected to the ECM.

A four wire harness connects the fuel injectors to the ECM. The RED wire is at 12 volts and connects to all injectors. The BLUE, YELLOW and WHITE wires each go to a pair of injectors and are normally at 12 volts for a zero differential. To fire the injectors this voltage is brought down to near ground creating a potential across the injectors.



- a) Needle Valve
- b) Nozzle
- c) Cap
- d) O-ring
- e) Valve Stopper
- f) Core
- g) O-ring
- h) Spring
- i) Housing
- j) Solenoid Coil
- k) Tape
- l) Bobbin
- m) O-ring
- n) Inner Collar
- o) Sleeve
- p) Terminal
- q) Connector
- r) Filter
- s) O-ring

1987–1999 2.4L & 2.5L

Injectors are triggered from primary ignition voltage from cylinders 1, 3, & 5.

- Cyl # 1 primary triggers injectors 3 & 4.
- Cyl # 3 primary triggers injectors 5 & 6.
- Cyl # 5 primary triggers injectors 1 & 2.

2000–2001 2.5L

Injectors are triggered from the trigger signal via the ignition control module using 1, 3, & 5.

- Cyl # 1 trigger signal fires injectors 3 & 4.
- Cyl # 3 trigger signal fires injectors 5 & 6.
- Cyl # 5 trigger signal fires injectors 1 & 2.

Notes

Notes

EFI Electrical Components

EFI Electronic Control Module

The ECM continuously monitors various engine conditions (temperature, throttle opening) and climate conditions (induction air temperature, barometric pressure, and altitude level) needed to calculate fuel delivery (pulse width length) of injectors. The pulse width is constantly adjusted (rich/lean conditions) to compensate for operating conditions, such as cranking, cold starting, climate conditions, altitude, acceleration and deceleration; allowing the outboard to operate efficiently at all engine speeds.

SENSOR INTERACTION WITH THE ECM

The ECM relies on sensor feedback to provide proper fuel rates and timing advance for optimum engine performance under all conditions.

IMPORTANT: DO NOT run engine for extended periods of time with sensors disconnected or bypassed (shorted). Serious engine damage may result.

AIR TEMPERATURE SENSOR

The air temperature sensor transmits manifold air temperature, through full RPM range, to the ECM. As air temperature increases “sensor” resistance decreases causing the ECM to decrease fuel flow (leaner mixture). Disconnecting the air temp sensor (open circuit) will increase fuel flow (richen mixture) by 10%. Bypassing air temp sensor (short in circuit) will cause fuel flow to decrease 10%.

The air temperature sensor circuit can be tested using the EFI tester. The air temperature sensor can be tested following air temperature sensor test.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

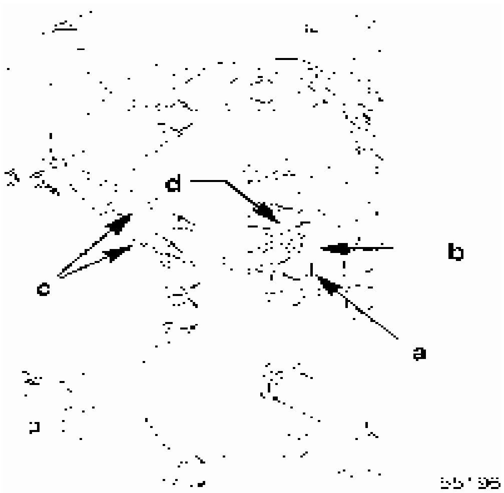
The MAP sensor is a non-serviceable sensor mounted in the ECM box. The MAP sensor is used to sense changes in manifold absolute pressure and is connected to the intake manifold by the way of a vacuum hose. The MAP sensor is functioning through the full RPM range and is continually signaling induction manifold pressure readings to the ECM. The ECM in turn determines fuel flow as signals are received. Drawing a vacuum on the MAP sensor hose will create a lean fuel condition altering engine operation. If no change occurs when drawing vacuum, MAP sensor is not functioning properly.

NOTE: *MAP sensor can be tested with the EFI tester.*

ENGINE HEAD TEMPERATURE SENSOR

The Engine Head Temperature Sensor provides the ECM signals related to engine temperature to determine level of fuel enrichment during engine warm up. The ECM is receiving information at all engine temperatures but stops fuel enrichment at an engine temperature of 90° F (32° C). An open circuit on the temperature sensor will increase fuel flow up to 40% but will not be affected at wide open throttle. If no change occurs when sensor is disconnected, sensor may not be functioning properly. The engine head temperature sensor can be tested following Engine Head Temperature Sensor Test.

NOTE: *If sensor does not make clean contact with cylinder head a rich condition may exist.*



THROTTLE POSITION SENSOR (TPI)

The TPI transmits information to the ECM during low speed and mid range operation, related to throttle angle under various load conditions. TPI adjustment is a critical step in engine set up (Section 2C). Disconnecting the TPI will increase fuel flow 40% at idle but does not effect WOT.

NOTE: *The higher the resistance the richer the fuel flow. Refer to TPI Adjustment.*

Other Components Associated With ECM

12 VOLT BATTERY

The 12 volt battery provides power to the ECM even with the ignition switch in the “OFF” position.

IMPORTANT: When disassembling EFI System DISCONNECT BATTERY CABLES.

STARTER SOLENOID / KEY SWITCH

Provides 12 volt signal when key is in the “start” position. In the “start” position, injector pulse widths are tripled when engine head temperature is below 90° F (32.2° C) to provide adequate fuel for quick start up. When key is returned to the run position or engine head temperature is above 90° F (32.2° C), pulse widths return to normal value.

FUEL INJECTORS

A four wire harness connects the fuel injectors to the ECM. The red wire is at 12 volts and connects to all injectors. The blue, yellow and white wires each go to a pair of injectors and are normally at 12 volts for a zero differential. To fire the injectors this voltage is brought down to near ground creating a potential across the injectors.

Notes

Notes

ELECTRIC FUEL PUMP

The ECM contains a fuel pump driver circuit that provides power to the electric fuel pump (2 speeds). The fuel pump does not have its negative terminal (-) “red/purple wire” grounded to the pump housing. The fuel pump positive terminal (+) “red wire” and the negative terminal (-) are at 12 volts with the ignition switch in the off position for a zero differential. When the pump is on, the negative terminal is brought down to near ground (i.e. 1.5 volts at high speed). The fuel pump is run at two speeds by the ECM. It is run on slower speed during slow speed engine operation, and at a faster speed when the engine is operated above approximately 2000 RPM.

WATER SENSING SYSTEM

The system consists of a water separating fuel filter (starboard side powerhead), sensing probe (bottom of filter) and a water sensing module (below ECM box). The water sensing module has four wires:

- **Purple** - Connects to 12 volt power supply.
- **Light Blue** - Connects to lube alert, which sounds the warning horn when activated.
- **Tan** - Connects to sensing probe.
- **Black** - Connects to ground.

EFI Detonation Control System

2.4L & 2.5L (1987–1999)

The Detonation Control System consists of a detonation control sensor located on the port side cylinder head and a detonation control module mounted on the engine. The detonation control module has seven wires:

- **White/Blue** - Connects to knock sensor, transmits knock signal to control module.
- **Green** - Connects to #2 primary wire. The primary voltage signals the controller to monitor combustion “noise” during a window of time.
- **White/Black** - Two of these wires connect to the switch boxes bias circuit terminals. A third wire is spliced in one bias circuit (inner switchbox) and connects to the idle stabilizer module.
- **Gray/White** - Connects to the ECM; signals ECM to enrich fuel mixture when knocking occurs.
- **Purple** -12 Volt power supply.

DETONATION CONTROL SYSTEM FUNCTION

1) Combustion noise (or vibration) excites the piezoelectric circuit located inside the detonation sensor, which transmits a voltage to the control module.
2) When cylinder number two ignition primary fires, it signals the controller to look at a one millisecond window of sensor output, which it retains as a reference level of combustion “background noise.”
3) When “background noise” reaches a measurable value, usually between 2500 and 3500 RPM (it is dependent on load), the ignition timing is advanced 6 degrees beyond what the mechanical timing is set at. Timing advance is accomplished by lowering the bias voltage.
4) The controller continues to monitor sensor output. If the output exceeds a pre-determined threshold level over the “background noise” (which is indicative knock is occurring) ignition timing is retarded by up to 8 degrees and fuel flow is enriched by up to 15% until the sensor output is reduced below the threshold level.

The detonation control system actually acts as an ignition advance module, when knock occurs it takes away the advance. Ignition timing will not advance if:

- Knock sensor fails.
- Blue/White wire becomes disconnected.
- Black wire has poor ground connection.
- Purple power wire becomes disconnected.

NOTE*: Disconnected Gray/White wire will not affect ignition timing and will not allow fuel enrichment.*

Notes

Notes

2000–2001 Models with CDM Ignition

The Detonation control system will only retard the timing approximately 1-2 degrees (uses same system as shift stabilizer on carburetor models).

The Detonation Control System consists of a detonation control sensor located on the cylinder head and a detonation control module mounted on the engine. The detonation control module uses the following wires:

- **White/Blue –** Connects to knock sensor, transmits knock signal to control module.
- **Green –** Connects to #2 trigger. The trigger voltage signals the controller to monitor combustion “noise” during a window of time.
- **White/Black –** Wire connects to the control module bias circuit.
- **Gray/White –** Connects to the ECM
- **Purple –** 12 Volt power supply.

DETONATION CONTROL SYSTEM FUNCTION

1) Combustion noise (or vibration) excites the piezoelectric circuit located inside the detonation sensor, which transmits a voltage to the control module.
2) When cylinder number two trigger generates a voltage pulse, it signals the controller to look at a one millisecond window of sensor output, which it retains as a reference level of combustion “background noise.”
3) When ”background noise” reaches a measurable value, usually between 2500 and 3500 RPM (it is dependent on load), the ignition timing is advanced 3 degrees beyond what the mechanical timing is set at. Timing advance is accomplished by lowering the bias voltage.
4) The controller continues to monitor sensor output. If the output exceeds a predetermined threshold level over the “background noise” (which indicates that knock is occurring) ignition timing is retarded by up to 1-2 degrees until the sensor output is reduced below the threshold level.

The detonation control system actually acts as an ignition advance module, when knock occurs it takes away the advance. Ignition timing will not advance if:

- Knock sensor fails.
- Blue/White wire becomes disconnected.
- Black wire has poor ground connection.
- Purple power wire becomes disconnected.

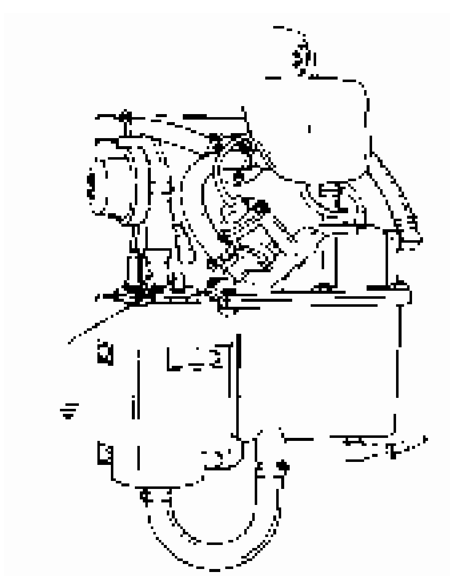
NOTE*: Disconnected Gray/White wire will not affect ignition timing and will not allow fuel enrichment. For further testing information, refer the Service Manual.*

1987 - 1995 2.4L & 2.5L - Fuel Pump Test

VOLTAGE TEST CHART

Engine Mode	BLACK Meter Lead to Engine Ground; RED Meter Lead to:	Approximate Voltage Reading	If Approximate Voltage is not obtained, this indicates:
1. All models	(+) terminal of fuel pump	12 – 13.5 volts	If reading is below 12 volts, the battery is bad, discharged or has bad connection(s).
2. Ignition key in “OFF” position.	(–) terminal of fuel pump.	Same reading should be obtained as reading in check No. 1 (above)	If reading is lower than in check 1, the fuel pump is bad.
3. Ignition key in “ON” position and engine NOT running.	(–) terminal of fuel pump.	2 volts or less (voltage should rise to 12 – 13.5 volts after approximately 30 seconds.	Bad ECM or bad fuel pump.*
4. Engine being cranked.	(–) terminal of fuel pump.	2 volts or less.	Bad ECM or bad fuel pump.*
5. Engine running below approximately 2000 RPM.	(–) terminal of fuel pump.	2 volts or less (for approximately 30 seconds and then switch to approximately 5 volts.	Bad ECM or bad fuel pump.*
6. Engine running above approximately 2000 RPM.	(–) terminal of fuel pump.	2 volts or less	Bad ECM or bad fuel pump.*

* Check for proper electrical operation of electric fuel pump

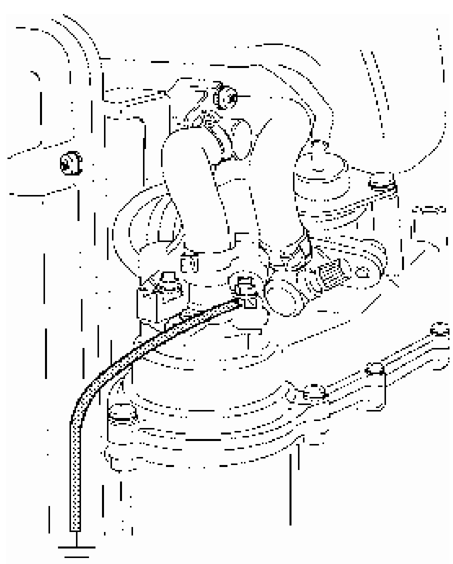


1996 and newer 2.5L - Fuel Pump Test

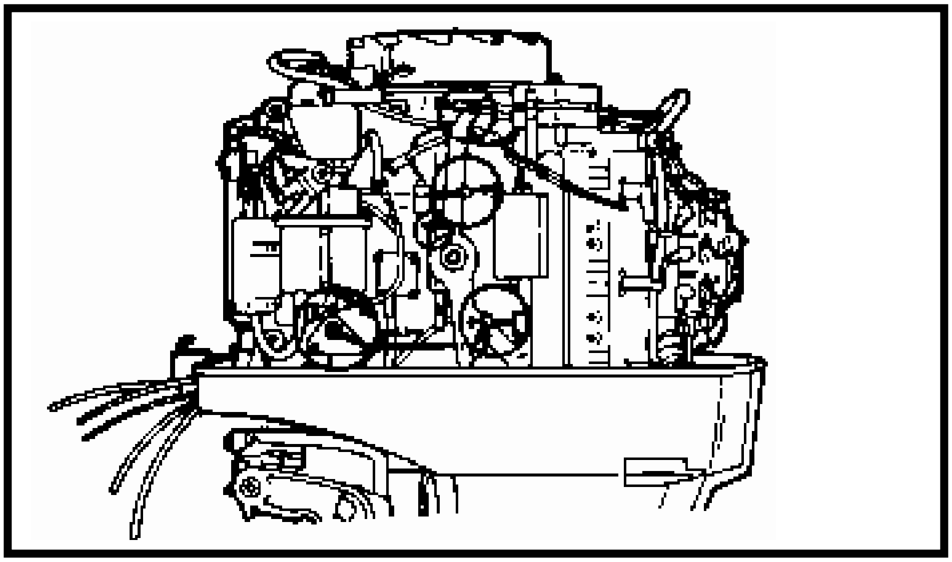
VOLTAGE TEST CHART

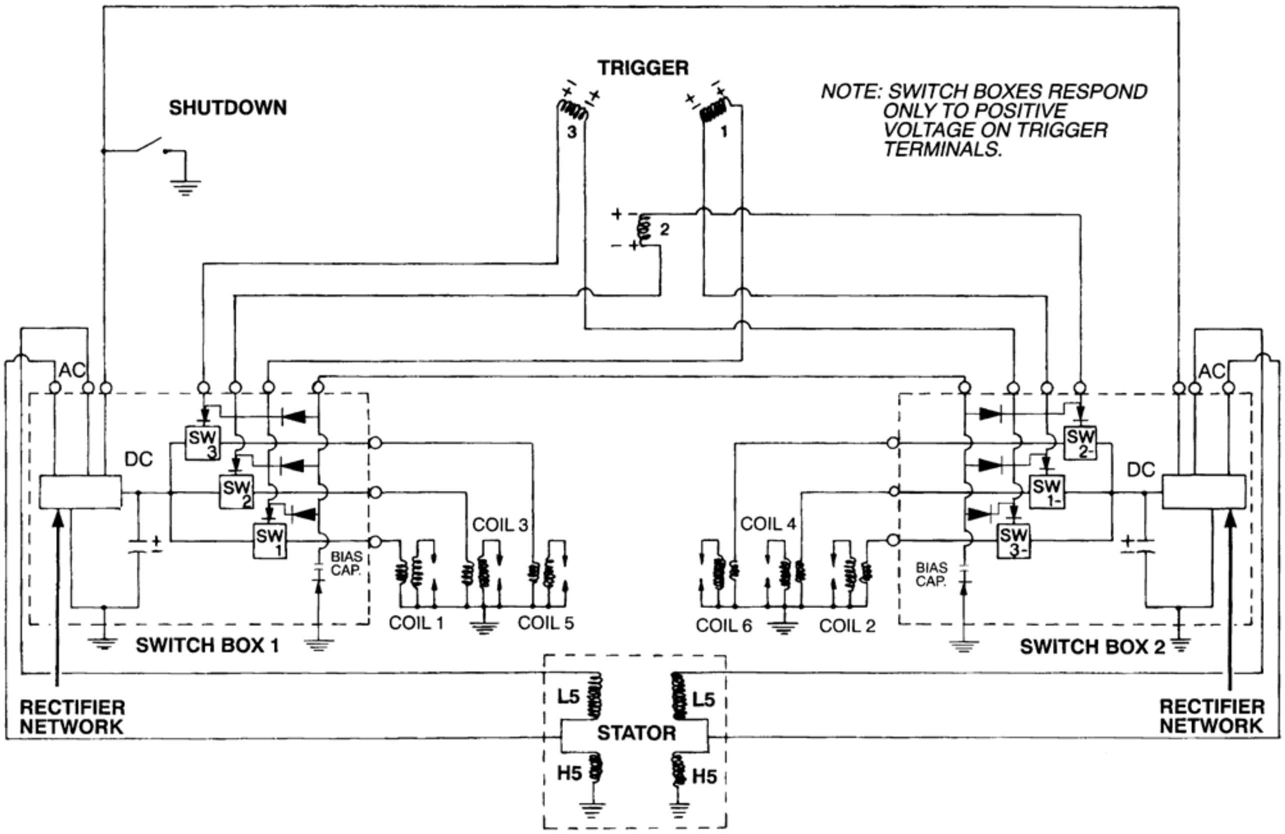
Engine Mode	BLACK Meter Lead to Engine Ground; RED Meter Lead to:	Approximate Voltage Reading	If Approximate Voltage is not obtained, this indicates:
1. All models	(+) terminal of fuel pump	12 – 13.5 volts	If reading is below 12 volts, the battery is bad, discharged or has bad connection(s). If reading is higher than 13.5 volts, the battery is over-charged
2. Ignition key in "OFF" position.	(-) terminal of fuel pump	Same reading should be obtained as reading in check No. 1 (above)	If reading is lower than in test 1, there is an open circuit in fuel pump.
3. Ignition key in "ON" position and engine NOT running.	(-) terminal of fuel pump	1.5 volt or less (voltage should rise to 12 – 13.5 volts after approximately 30 seconds.	Bad ECM or bad fuel pump.*
4. Engine being cranked.	(-) terminal of fuel pump	1.5 volt or less.	Bad ECM or bad fuel pump.*

* Check for proper electrical operation of electric fuel pump.



Ignition Systems




TRIGGER
SHUTDOWN
NOTE: SWITCH BOXES RESPOND ONLY TO POSITIVE VOLTAGE ON TRIGGER TERMINALS.
AC
DC
SW 3
SW 2
SW 1
BIAS CAP.
COIL 3
COIL 1
COIL 5
SWITCH BOX 1
COIL 4
COIL 6
COIL 2
SW 2-
SW 1-
SW 3-
SWITCH BOX 2
RECTIFIER NETWORK
L5
STATOR
H5

Description

The V-6 outboard ignition system is alternator-driven with distributor-less capacitor discharge. Major components of the system are the flywheel, stator assembly, trigger assembly, 2 switch boxes, 6 ignition coils and 6 spark plugs.

The stator assembly is mounted below the flywheel and has 4 capacitor charging coils. The 4 capacitor charging coils are composed of 2 high speed and 2 low speed coils - 1 high speed and 1 - low speed coil for each switch box. The low speed coils provide primary voltage for the switch boxes from idle to approximately 2500 RPM. The high speed coils provide primary voltage from 2000 RPM to the maximum RPM the outboard is capable of achieving.

The flywheel is fitted with permanent magnets inside the outer rim. As the flywheel rotates, the permanent magnets pass the capacitor charging coils producing AC voltage. The AC voltage is conducted to the switch boxes where it is rectified and stored in a capacitor.

The trigger assembly (also mounted under the flywheel) has 3 coils. Each coil controls the spark to 2 cylinders -1 cylinder each bank. The flywheel also has a second set of permanent magnets located around the center hub. The flywheel rotates, the magnets pass the trigger coils producing AC voltage. The AC voltage is conducted to an electronic switch (SCR) in the switch box. The switch discharges the capacitor voltage into the ignition coil at the correct time and in firing order sequence.

Capacitor voltage is conducted to primary side of ignition coil. As this voltage goes to ground through the primary circuit of the coil, it induces a voltage rise in the secondary side of the ignition coil. This voltage can increase to approximately 40000 volts before bridging the spark plug gap to ground.

The preceding sequence occurs once per engine revolution for each cylinder.

Spark timing is advanced or retarded by the movement of the trigger assembly attached to the throttle/spark arm

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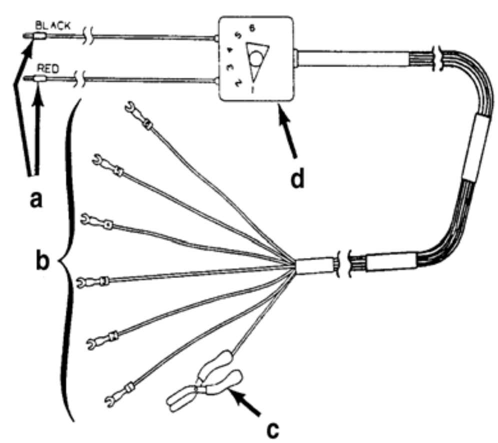
Notes

Notes

2.4L & 2.5L - Troubleshooting Tips

1) Intermittent, weak or no spark output at 2 spark plugs (one plug from each bank of three cylinders) usually is caused by a bad TRIGGER.
2) A SWITCH BOX can also cause 2 cylinders (1 each bank) to lose spark.
3) Intermittent, weak or no spark output at 3 spark plugs (a complete bank of 3 cylinders) usually is caused by a bad STATOR or SWITCH BOX.
4) An IDLE STABILIZER/ADVANCE MODULE can also cause 3 cylinders on 1 bank to lose spark.
5) Intermittent, weak or no spark output at any one spark plug (single cylinder) usually is a bad COIL or SWITCH BOX.
6) Loss of spark to 1 cylinder could also be caused by a loose or broken PRIMARY LEAD between the switch box and ignition coil or a broken or loose GROUND lead between the ignition coil and engine ground.
7) To more easily troubleshoot high speed ignition problems, it is recommended that test harness 91-14443A1 be installed on outboard. This long harness allows the mechanic to remain at the driver's seat while checking primary voltage, stator voltage, trigger voltage and bias voltage.



a) Plug into Meter
b) Attach to Appropriate Terminals
c) Attach to engine ground
d) Selector Switch

8) A heat gun, hair dryer or heat lamp can be used to warm electrical components up (to find a short); or components can be place in a refrigerator to cool them down (to find an open).Resistance values will change as a component is heated or cooled. However, the resistance change should not be drastic as in a short or open unless the component is defective.

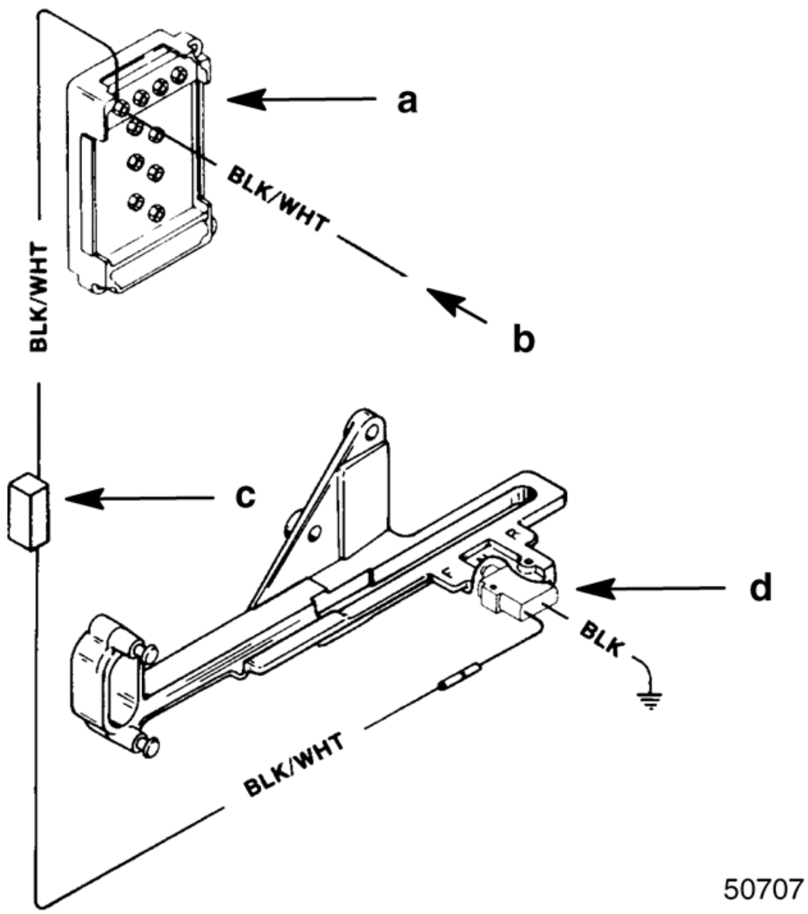
NOTE: *If using a heat device to warm electrical components, maximum temperature electrical components can be heated to without damage is 311 F° (155 C°).*

9) Repeat failures of the same electrical component could be caused by other electrical components.
   - If one circuit in a switch box keeps failing, it could be the result of high resistance in the primary of a coil, primary lead between the switch box and coil or high resistance on the coil primary ground wire.
   - If same switch box keeps failing, it could be because of a random open circuit in the trigger.
10) When testing DVA voltage at coil primary, the NEGATIVE test lead MUST be touching the NEGATIVE terminal of the ignition coil and NOT common ground.
11) Switch leads between components to isolate problem. Example:
   - If voltage is low to 1 switch box, move the RED and BLUE stator leads from 1 switch box to the other switch box. If voltage problem moves, STATOR is defective. If problem does not move, SWITCH BOX is defective.
   - No spark on 1 cylinder could be ignition coil or switch box. Moving the primary lead from 1 ignition coil to another should isolate the problem source. If the problem follows, the SWITCH BOX is defective. If the problem stays with the same cylinder, the IGNITION COIL is defective.
   - No spark to 2 cylinders could be a switch box or trigger. Move a pair of trigger leads from 1 switch box to another. If problem follows, TRIGGER is defective. If problem does not follow, SWITCH BOX is defective.
12) Trigger Voltage can be checked with a voltmeter set on the 20 VAC scale. Place 1 voltmeter lead on the switch box trigger terminal and the other voltmeter lead to engine ground. Voltage should be present; if not, reverse voltmeter leads. If voltage is still not present, trigger is defective.
13) Inspect spark plug high-tension leads (especially spark plug boots) for cuts, nicks or abraisions which can allow voltage to leak to ground.

Notes

Notes

Idle Stabilizer Shift System



a) Inner Switch Box
b) To Outer Switch Box
c) Resistor (6.8K)
d) Shift Switch

IDLE STABILIZER SHIFT SYSTEM DESCRIPTION

The idle stabilizer shift system advances ignition timing three degrees each time the outboard is shifted into gear.

The purpose of this system is to help prevent the outboard from stalling when shifting into gear while using a high pitch propeller.

IMPORTANT: Models equipped with Idle Stabilizer Shift Kit Accessory (P/N 87-814281A1), excluding 175 EFI models, require maximum timing (cranking speed) to be retarded 3° from specifications. Note, Stabilizer Shift Kit is standard on 175 EFI models and already has retarded timing degrees calibrated into specifications.

TEST FOR PROPER FUNCTION OF IDLE STABILIZER SHIFT SYSTEM

Notes

Connect timing light to number one spark plug lead (top, starboard bank). Start the engine and allow it to idle at specified engine RPM. Place outboard in gear while monitoring ignition timing. Timing will advance three degrees if system is functioning correctly.

TROUBLESHOOTING IDLE STABILIZER SHIFT SYSTEM

When outboard is idling IN NEUTRAL, shift switch circuit is in the OPEN position and system is INACTIVE.

When outboard is shifted INTO GEAR, shift switch circuit CLOSES. BIAS VOLTAGE from each switch box is changed by a 6.8K (±.34K) resistor located in the WHITE/BLACK lead between the switch boxes and the shift switch. The shift switch is now CLOSED and completes the circuit to ground. THREE DEGREES of timing advance occurs when the shift system works properly.

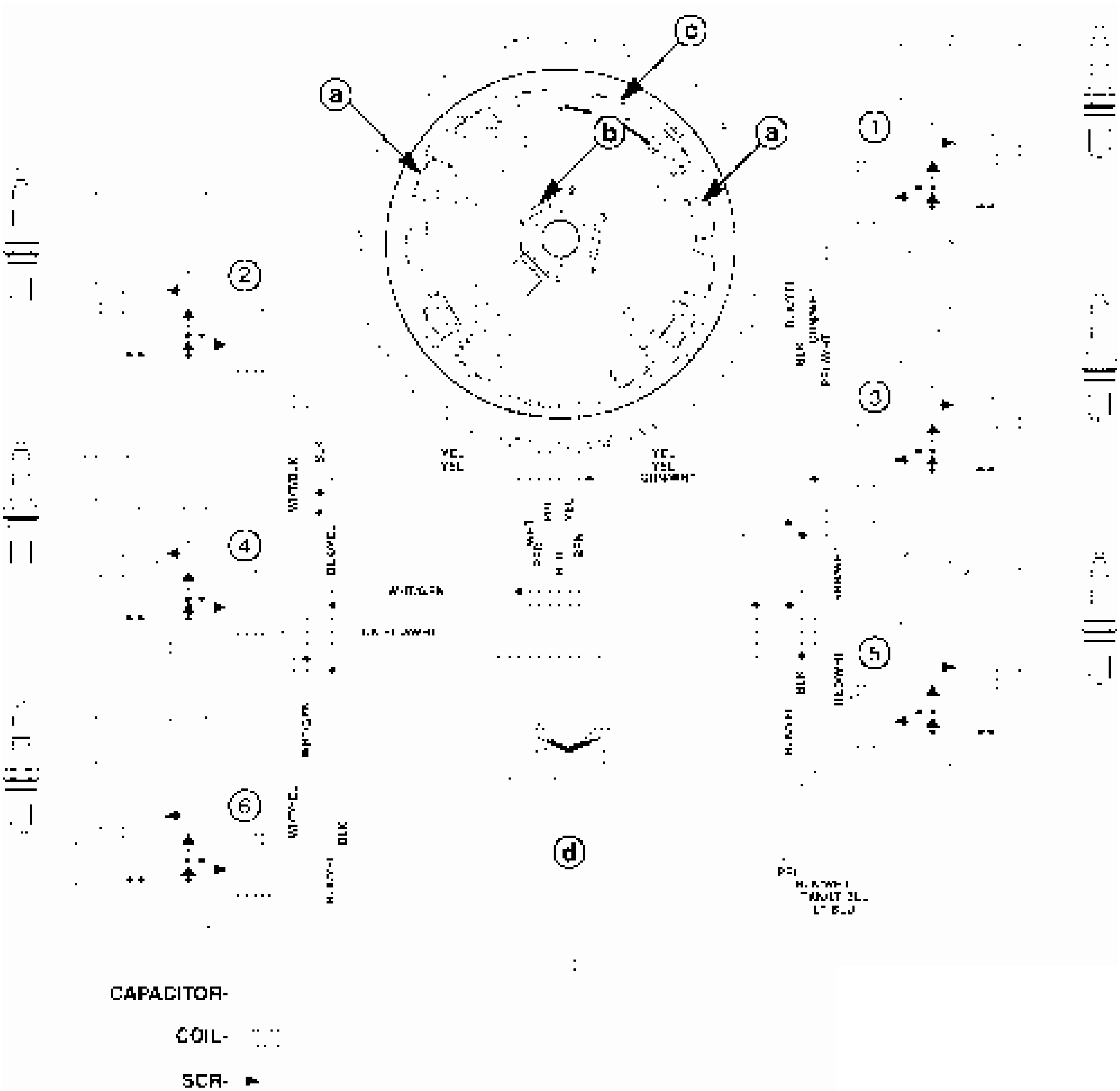
If the resistor is OPEN or the shift switch circuit stays OPEN, the THREE DEGREES of advance will not occur when the outboard is shifted into gear AND maximum timing at W.O.T. will be RETARDED THREE DEGREES.

If the resistor should SHORT TO GROUND, engine timing will be overly advanced and damaging powerhead detonation will occur.

Connect a timing light to No. 1 spark plug lead (top, starboard bank). Start the engine, and allow it to idle above 600 RPM, then retard the ignition timing by slowly pulling forward on the spark advance lever. Observe that the system is functioning by noting a rapid spark advance (as much as 9° from the idle setting) as the engine slows down to below approximately 550 RPM.

The idle stabilizer is not repairable. Should the idle stabilizer fail to function as described, it will require replacement.

2000-2001 V6 2.0L/2.5L CDM Ignition



a) Battery Charging Coils
b) Trigger Coils
c) Capacitor Charging Coils
d) Control Module

Theory of Operation

The V– 6 Outboard CDM ignition system is alternator– driven with distributor–less capacitor discharge. Major components of the system are the flywheel, stator assembly, trigger assembly, control module, 6 CDM assemblies and 6 spark plugs.

The stator assembly is mounted below the flywheel and has 3 capacitor charging coils. The flywheel is fitted with permanent magnets inside the outer rim. As the flywheel rotates, the permanent magnets pass the capacitor charging coils producing AC voltage. The AC voltage is conducted to the CDMs where it is rectified, regulated to 300 volts, and stored in capacitors.

The trigger assembly (also mounted under the flywheel) has 3 coils. Each coil controls the spark to 2 cylinders - one on each bank. The flywheel also has a second set of permanent magnets located around the center hub. As the flywheel rotates, the magnets pass the trigger coils producing AC voltage. The AC voltage is conducted to the control module, which shapes the signal before sending it to the electronic switch (SCR) inside the appropriate CDM. The switch discharges the capacitor voltage into the primary side of the ignition coil (inside the CDM).

As this voltage goes to ground through the primary circuit of the coil, it induces a voltage rise in the secondary side of the ignition coil. This voltage can increase to approximately 40,000 volts before bridging the spark plug gap and returning to ground.

The preceding sequence occurs once per engine revolution for each cylinder.

Spark timing is advanced or retarded by the movement of the trigger assembly attached to the throttle/spark arm.

The control module provides rev– limit (carb models), bias control, shift stabilizer, idle stabilizer, injector timing signal (EFI models), and low oil warning.

Capacitor Charging #1, #2, & #3 CDMs

The STATOR assembly is mounted to the block below the flywheel and has 3 CAPACITOR CHARGING COILS connected in series. The FLYWHEEL is fitted with 6 permanent magnets inside the outer rim. The flywheel rotates the permanent magnets past the capacitor charging coils causing the coils to produce AC voltage (260-320 volts). The AC voltage is then conducted to the CAPACITOR DISCHARGE MODULES (CDM), where it is rectified (DC) and stored in a capacitor. The stator voltage return path is through the ground wire one of the other CDMs and back through that CDM’s charging coil wire to the capacitor charging coils.

NOTE: *The CDM contains a zener diode (not shown for clarity). The zener diode regulates the capacitor voltage to 300 volts, preventing overcharging of the capacitor (and possible failure) if the SCR does not receive a trigger pulse.*

Notes

Notes

Capacitor Charging #4, #5 & #6 CDMs

The flywheel rotates the permanent magnets past the capacitor charging coils causing the coils to produce AC voltage (260-320 volts). The opposite voltage pulse is then conducted to the CAPACITOR DISCHARGE MODULES (CDM), where it is rectified (DC) and stored in a capacitor. The stator voltage return path is through the ground wire one of the other CDMs and back through that CDM's charging coil wire to the capacitor charging coils.

NOTE: *The CDM contains a zener diode (not shown for clarity). The zener diode regulates the capacitor voltage to 300 volts, preventing overcharging of the capacitor (and possible failure) if the SCR does not receive a trigger pulse.*

#1 Cylinder Trigger Circuit

The TRIGGER assembly (also mounted under the flywheel) has three coils, one for two cylinders - one on each bank. These coils are mounted adjacent to the flywheel center hub. The center hub of the flywheel contains a permanent magnet with two north-south transitions.

As the flywheel rotates, the magnet north-south transitions pass the trigger coils. This causes the trigger coils to produce a voltage pulse which is sent to the control module. The control module shapes the signal before sending it onto the capacitor discharge module (CDM). A positive voltage pulse will activate the electronic switch (SCR) inside the capacitor discharge module (CDM). The switch discharges the capacitor voltage through the coil primary windings. The return voltage pulse exits the CDM through the ground wire and returns through the control module.

Spark timing is advanced or retarded by the movement of the trigger assembly attached to the throttle/spark arm.

Ignition Coil Circuit

As the capacitor voltage flows through the primary windings of the ignition coil, a voltage is induced into the ignition coil secondary windings. This secondary voltage rises to the level required to jump the spark plug gap and return to ground. This secondary voltage can, if necessary, reach approximately 40,000 volts. To complete the secondary voltage path, the released voltage enters the ground circuit of CDM module.

Stop Circuit

To stop the engine, the stop switch is closed allowing the capacitor charge current from the stator to drain directly to ground.

Control Module

Notes

The control module provides rev– limit (carb models), bias control, shift stabilizer, idle stabilizer, injector timing signal (EFI models), and low oil warning.

On carburetor models, the rev– limiter affects the cylinders in the following sequence 2– 3– 4– 5– 6– 1. As the engine RPM exceeds the maximum specification (5900 ± 100), the control module will retard the timing on cylinder #2. The controller will retard the timing a maximum of 30 degrees and then, if necessary, stop spark on the cylinder. If the engine rpm are still above the maximum specification, the controller will begin to retard timing on the next cylinder, then stop spark, continuing in sequence until the engine rpm drops below the maximum specification.

Bias Circuit

Bias voltage is Negative (–) voltage applied to the ignition system to raise the trigger firing threshold as engine RPM is increased, thus stabilizing ignition timing and preventing random ignition firing.

Disconnect neutral switch before performing test.

Test Black/White wire to engine ground. Reading is negative (–) voltage and performed at 2500 RPM. Normal readings are – 25 to – 40 volts @ 2500 RPM.

If readings are not within specifications, replace control module.

Shift Stabilizer Circuit

The shift stabilizer circuit (not used on all models is designed to increase the idle to timing approximately 2 degrees when the engine is shifted into gear.

Check idle timing with engine out– of– gear, activate the switch, timing should increase approximately 2 degrees.

Shift switch may be tested with a resistance test. Continuity between the back wires (disconnected) with the engine in gear and No continuity with the engine in NEUTRAL.

Idle Stabilizer Circuit

The idle stabilizer will electronically advance the ignition timing by as much as 3 degrees if the engine idle speed falls below approximately 550 RPM. This timing advance raises the idle RPM to an acceptable level (550 RPM). When the idle stabilizer senses the idle RPM has reached the acceptable level, it returns the timing to the normal idle timing.

NOTE: *Retarding the timing with the spark arm is not an effective method of checking idle stabilizer.*

Check idle timing with engine in– gear, slight movements of timing indicates idle stabilizer operation.

Notes

EFI Injector Timing Signal Test

Use DDT to monitor injector timing signals.

EFI Detonation Control System

The Detonation Control System will only retard the timing approximately 1-2 degrees (uses the same system as shift stabilizer on carburetor models).

Use DDT monitor Knock Volts.

CDM Stop Diode Troubleshooting

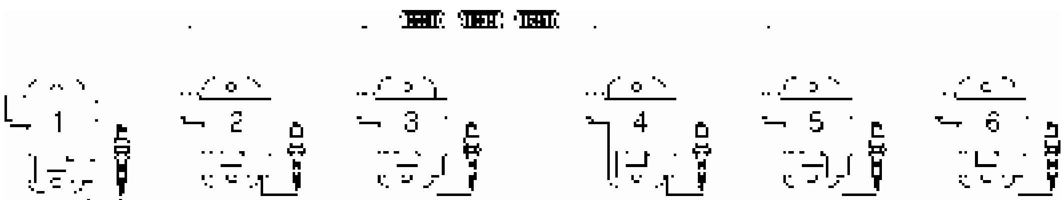
2.0/2.5 LITRE 6 CYL.:

CDM #1, #2 and #3 get their charging ground path through CDM #4, #5 or #6.

CDM #4, #5 and #6 get their charging ground path through CDM #1, #2 or #3.

A shorted Stop Diode in CDM #1, #2 or #3 would prevent CDMs #4, #5 and #6 from sparking.

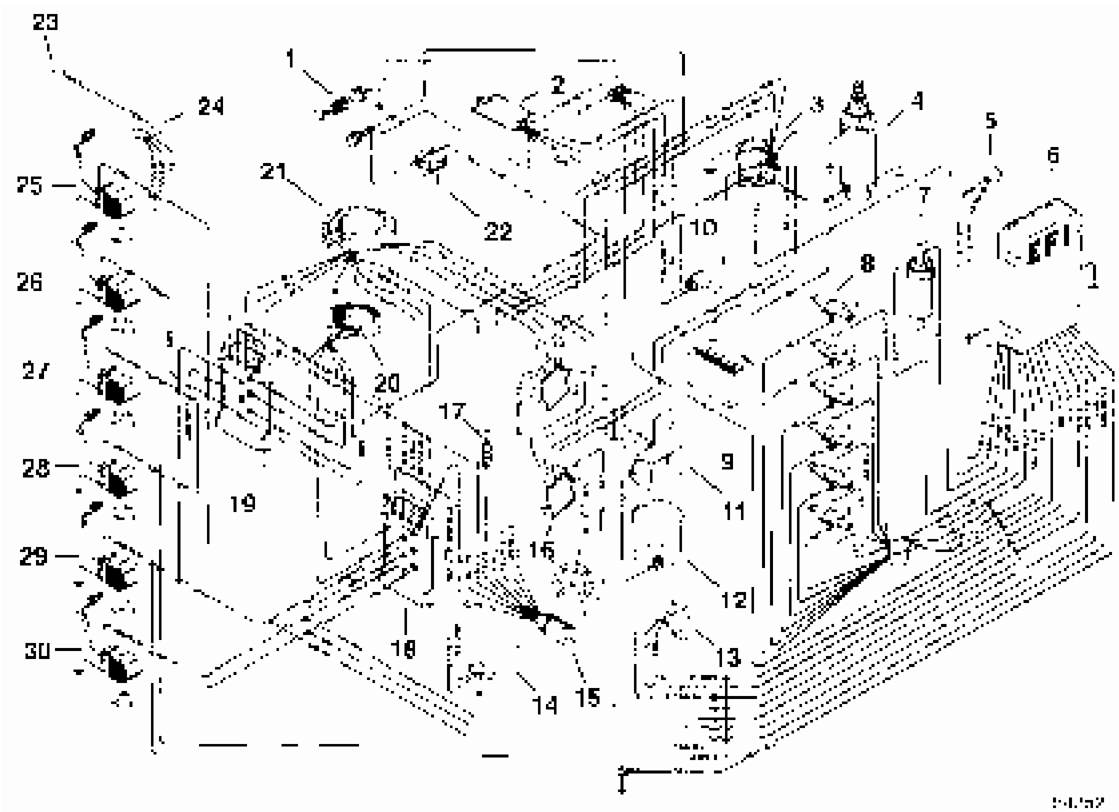
A shorted Stop Diode in CDM #4, #5 or #6 would prevent CDMs #1, #2 and #3 from sparking.



1992–1999 150 EFI/175 EFI Wiring Diagram

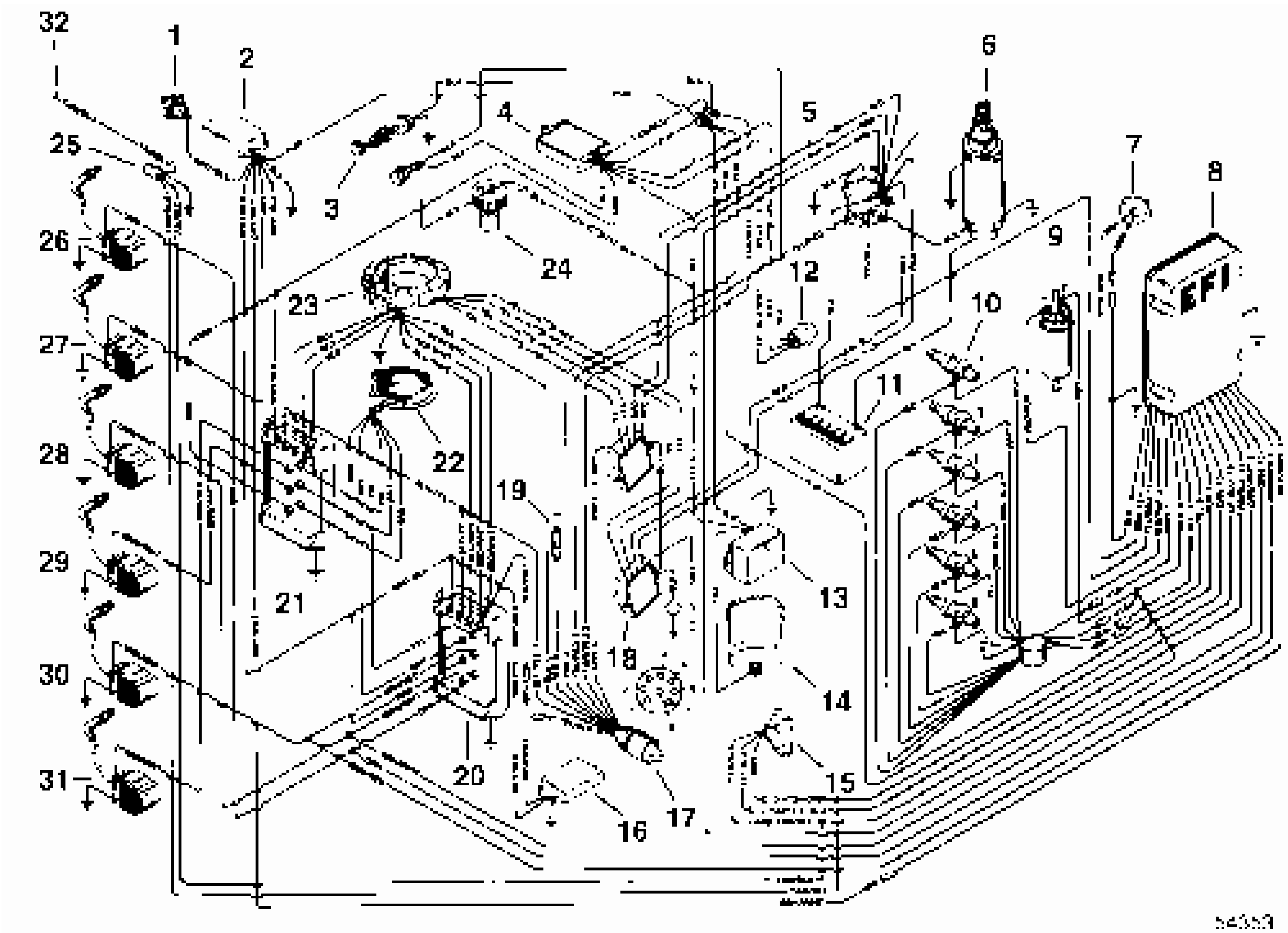
BLK = BLACK
BLU = BLUE
BRN = BROWN
GRY = GRAY
GRN = GREEN
PUR = PURPLE
RED = RED

TAN = TAN
VIO = VIOLET
WHT = WHITE
YEL = YELLOW



1) Water Temperature Switch
2) 2Warning Module
3) Starter Solenoid
4) Starter Motor
5) Air Temperature Sensor
6) Electronic Control Unit
7) Fuel Pump
8) Injectors
9) 12 Volt Battery
10) Rotational Sensor
11) Water Sensing Warning Module
12) Water Separating Filter
13) Throttle Position Sensor
14) Idle Stabilizer
15) Engine Harness Connector
16) Voltage Regulator (2)
17) 20 Ampere Fuse
18) Outer Switch Box
19) Inner Switch Box
20) Trigger
21) Stator
22) Oil Tank Cap/Oil Level Sensor
23) To Temperature Gauge
24) Temperature Sensor
25) Coil # 1
26) Coil # 2
27) Coil # 3
28) Coil # 4
29) Coil # 5
30) Coil # 6

1992–1999 200 EFI Wiring Diagram



BLK = BLACK

BLU = BLUE

BRN = BROWN

GRY = GRAY

GRN = GREEN

PUR = PURPLE

RED = RED

TAN = TAN

VIO = VIOLET

WHT = WHITE

YEL = YELLOW

1) Detonation Sensor
2) Detonation Module
3) Water Temperature Switch
4) Warning Module
5) Starter Solenoid
6) Starter Motor
7) Air Temperature Sensor
8) Electronic Control Module
9) Fuel Pump
10) Injectors
11) 12 Volt Battery
12) Rotational Sensor
13) Water Sensing Warning Module
14) Water Separating Filter
15) Throttle Position Sensor
16) Idle Stabilizer
17) Engine Harness Connector
18) Voltage Regulator (2)
19) 20 Ampere Fuse
20) Outer Switch Box
21) Inner Switch Box
22) Trigger
23) Stator
24) Oil Tank Cap/Oil Level Sensor
25) Temperature Sensor
26) Coil # 1
27) Coil # 2
28) Coil # 3
29) Coil # 4
30) Coil # 5
31) Coil # 6
32) To Temperature Gauge

Miscellaneous Checks

Mechanical Checks

Marine engines are, by the nature of their environment, engineered to be trouble-free, durable power plants. The experienced mechanic, when investigating a possible marine engine problem, will isolate boat related support systems from the marine engine. This can be accomplished through the use of a remote fuel tank filled with fresh fuel and utilizing a known good fuel line/primer bulb assembly. If the engine runs properly after being connected to the remote fuel tank, the mechanic's troubleshooting time will be spent in the boat checking for pinched/damaged fuel lines, stuck anti-siphon valves, plugged filters or draining fuel tanks of poor quality fuel.

If the engine does not run properly on the remote fuel tank, the mechanic can sometimes further isolate the problem by squeezing the fuel line primer bulb. If the engine runs properly, the problem lies in fuel delivery – defective or weak mechanical fuel pump, electric fuel pump, plugged filters or leaking fuel lines.

Poor running characteristics of a particular outboard can usually be identified as the result of a problem in one of three areas: Mechanical, Electrical, or Fuel Management.

Before disassembling and replacing EFI components, the experienced mechanic will isolate the problem(s) to one (or more) of the 3 aforementioned areas.

Mechanical – A compression check should be performed with the powerhead warm (if possible), all spark plugs removed, the throttle shutters held wide open and a fully charged battery employed for cranking duties. Normal compression psi should be within specifications. Inspect powerhead for leaking seals, gaskets or broken/disconnected throttle spark linkages.

Due to the precise fuel delivery characteristics of electronic fuel injection and its dependency on many sensors to determine the correct fuel/air ratio during all conditions, IT IS IMPERATIVE THAT SET-UP PROCEDURES BE FOLLOWED EXACTLY AS STATED IN FACTORY SERVICE LITERATURE.

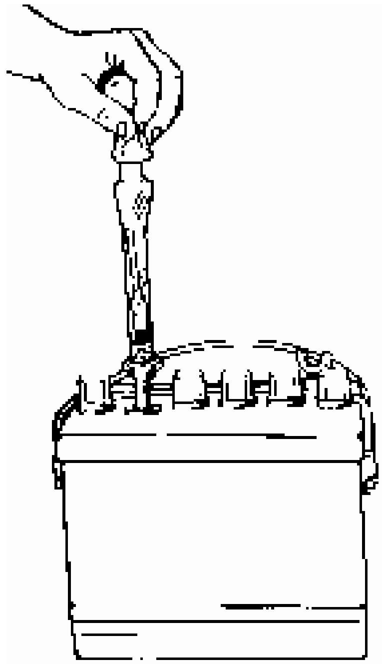
Fresh Quality Fuel

Using a remote fuel tank containing a major brand of premium unleaded gasoline, test run the outboard to eliminate any problems related to restricted fuel supply (clogged lines, malfunctioning anti-siphon valve, etc.) and/or marginal gasoline.

Notes

Notes

Low Battery Voltage



Low battery voltage can cause EFI system to deliver fuel in an inconsistent manner.

Inspect battery connections and charging system. The EFI system requires a substantial amount of voltage to function properly. Operating engine at a low RPM for an extended period of time can cause low voltage.

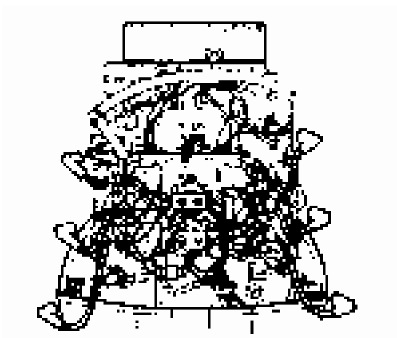
2.4L & 2.5L - Preliminary Steps

Ignition Spark Check

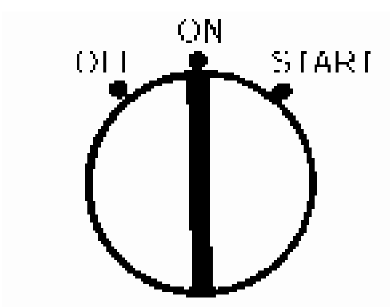
Purpose: This test determines if the ignition system is delivering usable spark to the spark plugs. By performing this test, the probable cause can be isolated to either the ignition system or fuel system.

Procedure:

1) Disconnect all spark plug wires from spark plugs.



2) Connect spark gap tester Quicksilver (91-63998A1) to No. 1 spark plug wire and to good ground on engine.
   a) Connect Remote Starter Switch Quicksilver (P/N 91-52024A1).
   b) Connect red lead from switch to large positive (+) terminal with red banded cable attached [(+) cable from battery].
3) Connect YELLOW lead from switch to small terminal with yellow/red lead attached.
4) Turn ignition key switch to the “ON” position.



5) Turn over engine using remote starter switch.
6) Look at spark gap tester viewing port for presence of good quality spark. Complete steps 1 through 6 on each spark plug.

Results: A steady, blue spark should be present at each spark plug wire. If a good spark is present, problem may not be ignition related. If good spark is not present, problem may be ignition related. Trouble shoot ignition system or make sure engine timing is set correctly. Refer to appropriate ignition section in this service manual.

Notes

Notes

IMPORTANT: The presence of a good spark will not necessarily indicate condition of timing. Ignition timing may be off far enough to prevent the engine from starting, but still allow a good spark to be present in the spark gap tester.

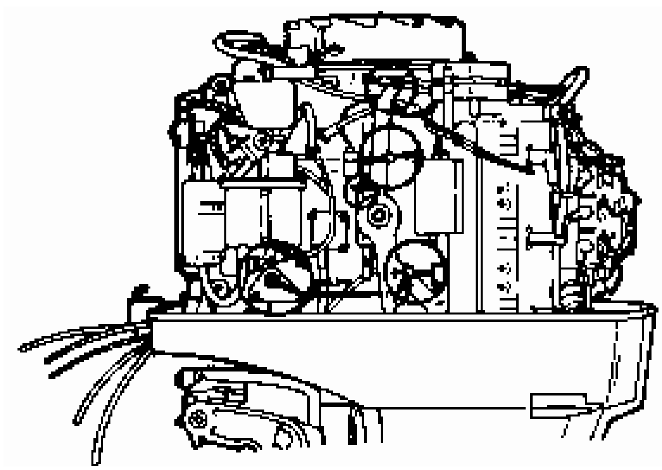
Ignition system failure (switch box, stator, trigger, etc.) can cause fuel delivery problems. Injectors are triggered in pairs by one, three, five primary circuits (inner switch box).

No. 1 Primary Triggers	No. 3 & 4 Injectors
No. 3 Primary Triggers	No. 5 & 6 Injectors
No. 5 Primary Triggers	No. 1 & 2 Injectors

Failure in one or more of these primary circuits will cause no spark and no fuel to respective cylinders (above). Check spark and spark plugs on all cylinders before attempting EFI tests.

Electronic Fuel Injection Set Up

IMPORTANT: Follow EFI Timing/Synchronizing/Adjustment before attempting tests on EFI system.



EFI set up procedures must be followed before tests on system are performed . Improper set up can result in poor engine performance (i.e. uncontrollable idle speeds, lean sneezing, low power during acceleration or engine will simply not run.) Failure to properly set up the EFI system can lead to misdirection in solving simple problems in the EFI system.

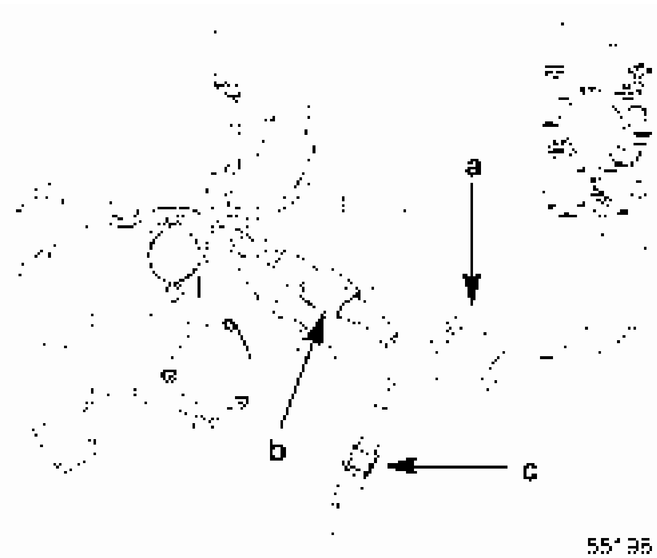
2.4L & 2.5L - Throttle Position Sensor Adjustment

IMPORTANT: Engine harness MUST BE disconnected from the EFI tester 91-11001A2 and reconnected in the normal running configuration in order to test or adjust the throttle position sensor.

IMPORTANT: TPS can be adjusted using a digital meter. Analog (needle) type may be used although it may be difficult to read the low voltage setting accurately with most meters.

1) Disconnect TPS from EFI harness.

2) Connect digital meter using TPS Test Lead Assembly (P/N 91-816085) between TPS connector and EFI harness connector. Set voltmeter to 2 DC volts.



a) TPS Test Harnes Lead Assembly
b) TPS Connector
c) EFI Harness Connector

IMPORTANT: TAN/BLK head temperature leads must be disconnected from port cylinder head before adjusting TPS.

3) Disconnect TAN/BLACK engine head temperature sensor leads located on port cylinder head.
4) Turn key to the "ON" position.

Notes

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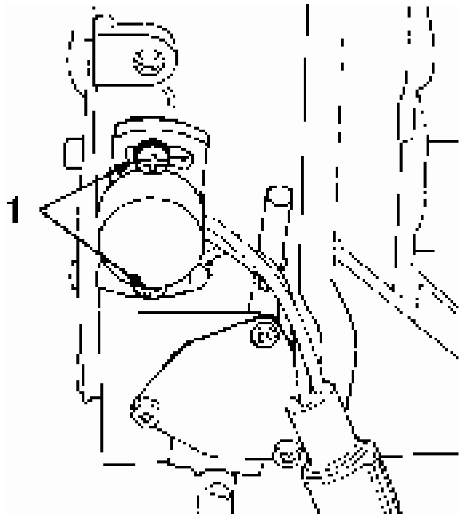
5) Loosen screws (1) securing TPS to manifold.



6) Rotate TPS fully clockwise (holding throttle shaft in closed position). Voltmeter should read .200 - .300. If readout is not within specifications, adjust TPS to obtain readout of .240 - .260.

TPI voltage reading shown below.

.135 ± .010 Models with ECM P/N 14632A13 and below.

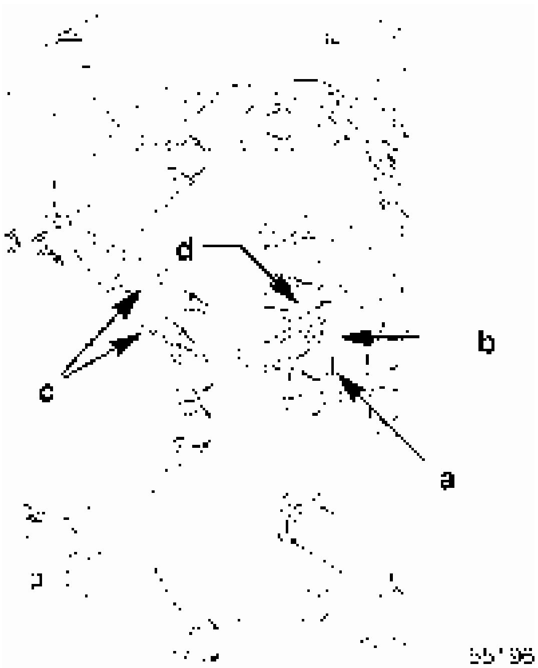
.250 ± .010 Models with ECM P/N 14632A15 and up and 824003-1 and up.

.250 ± .050 Models with ECM P/N 14632A16 and up.

IMPORTANT: If engine appears to run too rich or too lean, TPI can be readjusted. Decreasing voltage yields leaner mixture. Increasing voltage yields richer mixture. Allowable TPS range: .200 - .300 volts.

7) Tighten TPI screws to 20 lb. in. (2.0 N· m) holding correct tolerance.
8) Disconnect remote control cable from throttle lever.
9) Slowly move throttle lever to full open position while monitoring voltage reading. Voltage reading should increase and decrease smoothly.
10) Set volt meter to 20 DC volts. Maximum voltage reading at full throttle is approximately 7.46 volts.
11) Remove test lead and reconnect TPI harness to EFI harness.
12) Reconnect TAN/BLACK engine head temperature sensor leads located on port cylinder head.

13) Disconnect wires and remove sensor.



a) Screw
b) Retaining Plate
c) Wires
d) Sensor

Notes

Hard To Start 2.4L , 2.5L , EFI Engines (Cold Weather)

There have been occasional reports of hard starting EFI engines (150 to 200 HP 2.4 & 2.5 Litre) in cold weather.

The symptom normally is that the engine will start and run good in warm weather (above 50° F., 10° C). When the temperatures drop, typically the engine will crank over, start and stall. After several attempts the engine starts runs rough for one or two minutes then smoothes out runs and starts good for the rest of the day.

The following list, are item to check if you receive a report of an EFI engine that is hard starting in cold weather.

1) Make sure the customer is using the correct starting technique, as outlined in the Operation and Maintenance Manual.
2) Check timing and set-up.
3) Check fuel pressure on fuel rail.
4) Check ignition system.
5) Check connections on ECM, TPS, and injector harnesses.
6) Test head temperature sensor.
7) Test air temperature sensor.
8) Check for good continuity on the YELLOW/RED wire that runs between the starter solenoid and the ECM.
9) Try setting the pick-up timing higher. Note increasing pick-up timing could increase idle speed above acceptable limits.
10) Confirm that the idle control circuit in the idle stabilizer or advance module is working correctly.
11) Check battery voltage when cranking engine. Voltage at battery should not drop below 10 volts.
12) Check cranking speed (RPM) of engine. Even though battery voltage is good, cranking speed may be low due to a faulty starter, or mechanical problems in the engine. Normal cranking speed is 300 RPM starting problems may be experienced if cranking speed is below 200. Most good shop tachometers will measure cranking speed.
13) Check for air leaks in the intake manifold area.
14) Pre-loaded reed valves may cause hard starting.
15) On engines with the ECM, P/N 14632A15 and below, the TPS setting will affect start up. Try setting TPS higher (richer). On engines with ECM P/N 14632A16 and higher TPS has no affect on start up.

Notes

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Injector Electrical Harness Test

Purpose: This test will determine if electrical or fuel delivery problem exists during the fuel delivery process by checking for open circuits in injector harness.

1) With outboard in water, start and allow to warm up. Raise engine speed to 2000-2500 RPM. Remove spark plug leads one at a time and note RPM change. Determine nonworking (no RPM change) cylinder. Stop engine.
2) Disconnect injector harness (4 pin connector).

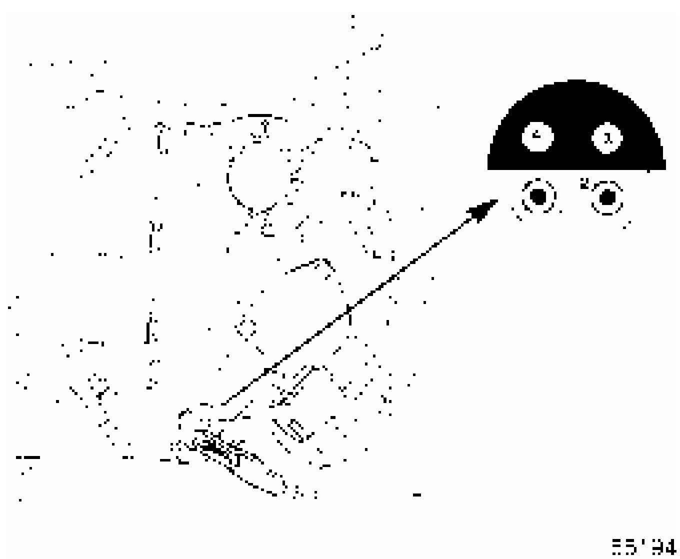
IMPORTANT: Use digital ohmmeter when testing injector harness.

3) Connect digital ohmmeter (dial set at 200 scale) leads. POSITIVE lead from ohmmeter connects to POSITIVE prong “2” (RED wire) of harness connector. Connect NEGATIVE lead from ohmmeter to the remaining wires of harness connector as follows:

WHITE Lead = Injectors, Cylinders 1 and 2

DARK BLUE Lead = Injectors, Cylinders 3 and 4

YELLOW Lead = Injectors, Cylinders 5 and 6



1) YELLOW
2) RED
3) DARK BLUE
4) WHITE

Results: If readings are 1.1 ± .2 both injector circuits are complete. Perform Injector Fuel Delivery Test.

If readings are 2.2 ± .2 one injector does not have a complete circuit. Perform induction manifold disassembly and inspection following.

ECM Injector Driver Test

To verify that the ECM is operating the injector pairs, connect test harness (91-833169) between manifold connector and engine harness. Start engine.

Use DVA meter (91-99750). Set DVA to 200 scale. Connect BLACK meter lead to engine ground and RED test lead to each BLUE, WHITE or YELLOW female bullet connector.

Normal voltage for a 2.4L – 2.5L engines will be 25 to 60 volts. Voltage will vary with RPM.

Notes

Notes

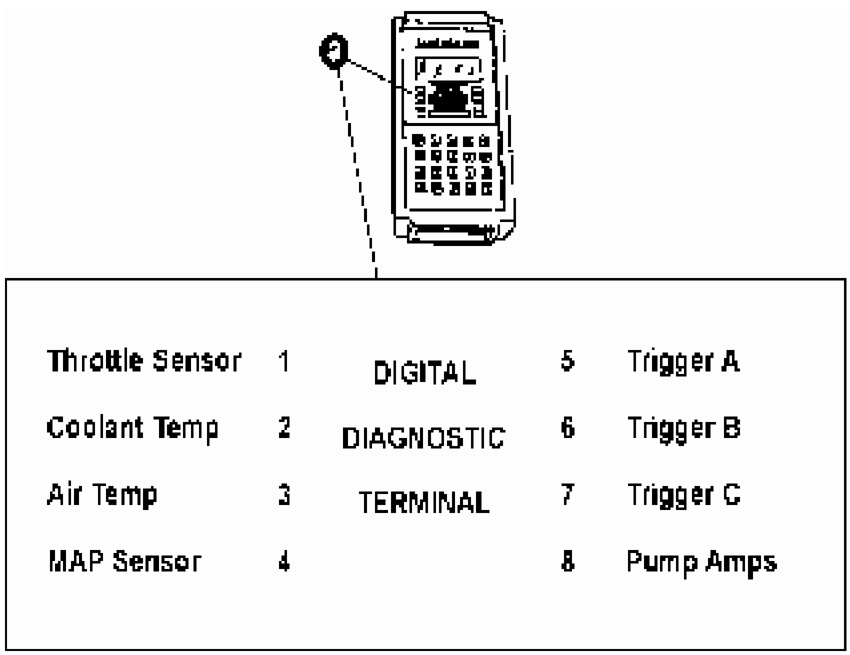
824003 Fuel ECM

OVERVIEW

The systems diagnostic cartridge contains a diagnostic program for the Fuel ECM that allows the technician access to all of the diagnostic capabilities available from the Fuel ECM.

Simply hook the diagnostic cable to the ECM diagnostic connector and plug in the software cartridge. You will be able to see the current state of the engine status, sensors and switches.

The 824003 Fuel ECM program can help diagnose intermittent engine problems. It will record the state of the engine sensors and switches for a period of time, much like a tape recorder would. Then you can playback and review the recorded information.



a) LED Indicators

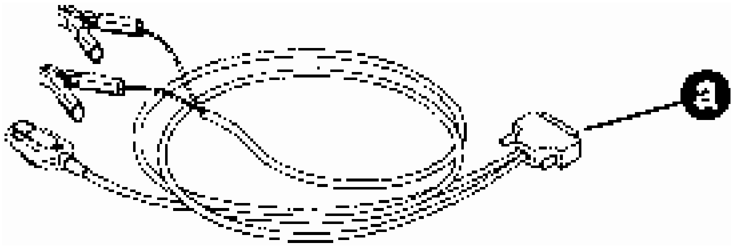
Refer also to the SWITCH/LED Definition tables for 824003 2.5L

Fuel ECM, located in the Appendix.

824003 Fuel ECM

ADAPTER CABLES

84-822560A5

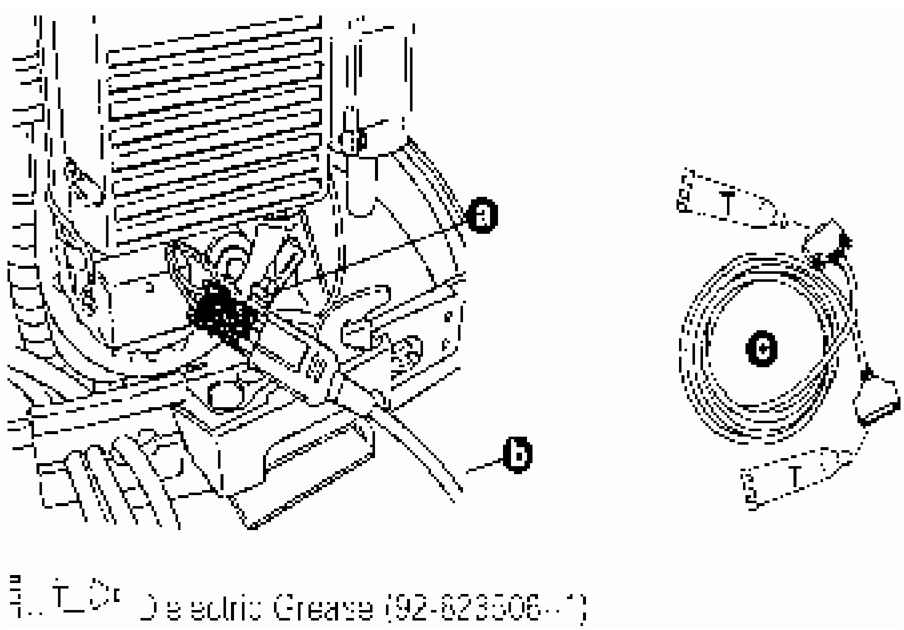


a) 84-822560A5

DIAGNOSTIC PORT LOCATIONS

IMPORTANT: Engine must be OFF before connecting the DDT adaptor cable to the ECM.

1) Connect the DDT adaptor cable to the ECM diagnostic port as shown. Attach the battery clips to a 12v battery.
2) Connect the DDT Interface Cable between the DDT and the DDT adaptor cable, if required.



a) Diagnostic Port
b) DDT Adapter Cable
c) DDT Interface Cable

NOTE: *Apply a small amount of dielectric grease to the 25 pin ends of the interface cables. This will minimize corrosion in the saltwater environment.*

Notes

Notes

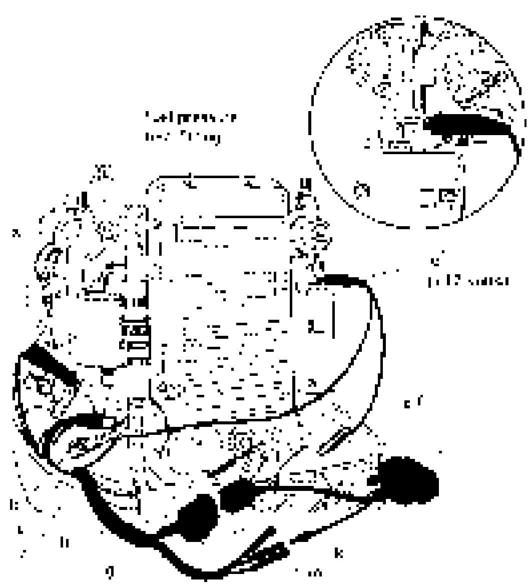
Injector Test

PROCEDURE

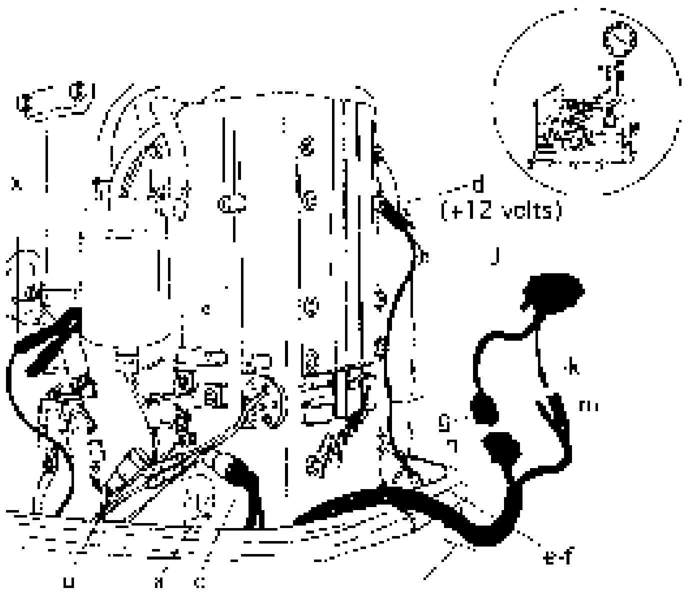
For these procedures, refer to engine setup illustrations 1 and 2 on the following page.

NOTE: *Test cables required for all standard 2.4/2.5L and 3.0L EFI models with injectors mounted inside the induction manifold. Use cables 84–822560A 7 and 84–830043A 1 for injector test.*

1) Disconnect the 4–pin injector harness plugs (a & b) at the manifold assembly as shown. Connect the injector test harness adaptor 4–pin rubber plug (c) to (a) at the manifold.
2) Connect the black alligator clip (x) to engine ground (starter motor body) and connect the red alligator clip (d) to the positive red wire at the electric fuel pump. The unused bullet connector (e & f) should be plugged together when not in use to prevent exposed wire from touching ground. Newer style fuel pumps may have a bullet connector for attaching to the pump terminals and in that case, remove the bullet connection from the positive terminal of the pump and connect the male terminal (e) to the harness from the pump and slide the female bullet (f) connector back to the positive terminal at the pump. Slide the unused alligator clip (d) back into the red boot to prevent contact to engine ground.
3) Connect the 4–pin DDT connector (g) to the mating connector on the injector test harness (h). The DB–25 connector (j) is plugged into the rear of the DDT. The DDT should power up once the software cartridge is inserted into the DDT. If the DDT does not power up, make certain that you engine battery is properly charged and that ground and power clips are correctly attached as indicated in Step 2.
4) The green/white pigtail lead (k) exiting the rear of the DB– 25 connector can now be plugged into one of three female bullet terminals (m). Select either a yellow, white or blue wire to test the selected injector pair.



5) Attach the Fuel Pressure Gauge to the fuel pressure test fitting. Turn the ignition key switch to the ON position and observe the fuel pressure reading after the pump driver times out (15 to 30 seconds).
6) Refer to the following section labeled Multi Test. From the Marine Diagnostic menu screen, select 3–Injector Test. From the Injector Test menu, select 1 –Multi Pulse Test. Use the ∀ key to increment the number of cycles in test to 50. Select the O key to move to the total on-time-milliseconds. Next use the ∀ key to adjust on-time to 300. For all outboard products test data is based on the previous settings.
7) Press the enter key. The DDT will cycle the injector pair selected. Make note as to the drop in pressure reading on the fuel pressure gauge.
8) Next, turn the ignition key switch to the OFF position and then back to ON in order to repressurize the fuel rail. Remove the green/white pigtail wire from the injector harness and select another pair and repeat step 7. Repeat this for all injector pairs and take note of the average drop in fuel pressure for each pair tested. Any differences greater than 3 PSI may indicate a problem with the injector(s) or the injector filter(s). The manifold may be disassembled and the test can be performed to isolate a single injector by unplugging the suspect injector and repeating the test to isolate the problem injector.



Notes

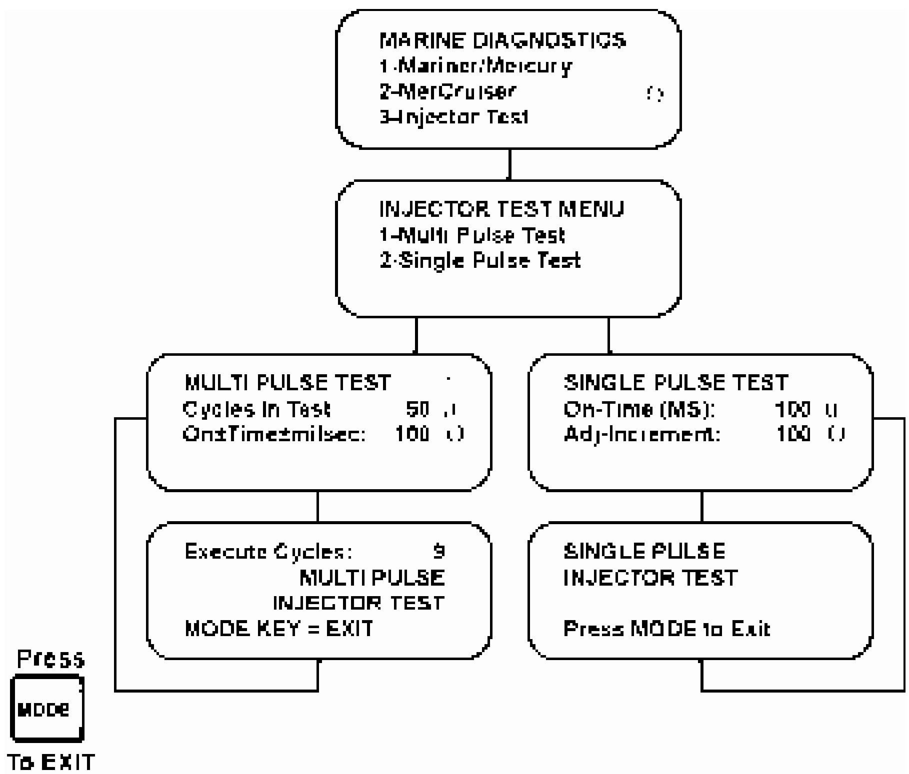
Notes

Multi Pulse Test

1) . From the INJECTOR TEST MENU screen, press 1. The MULTI– PULSE TEST screen will appear. The cursor will be positioned in the Cycles in Test field.
2) Use the left and right arrow keys to set the number of times you want the injector to be cycled ON, then OFF, during the test.
3) Use the up and down arrow keys to move the cursor to the ON–Time or cycles selection.
4) Use the left and right arrow keys to set the total time you want the injector to be On during the test. The number must be between 100 and 600 milliseconds (in increments of 100).
5) Press ENTER to start the test.

The DDT will cycle the injectors ON and OFF according to the values you entered in the previous screen.

To perform the test again, repeat this procedure beginning with step



2.5L EFI Scan Data Worksheets

824003 ECM

Data Monitor			
824003 ECM	**IDLE**	**1500**	**3000**
Engine RPM			
Coolant Temp.			
TPS			
Knock Volts			
Injector A Msec			
Injector B Msec			
Injector C Msec			
Atmosphere PSI			
MAP PSI			
Pump Amps			
Status Switches			
TPS		Trigger C	
Coolant Temp.		Pump Amps	
Air Temp.		Pump Status	
MAP SNR		Start Signal	
Trigger A		EEPROM	
Trigger B			
PROM ID			
PROM ID			
ECM Part#			

LED Indicarors Illuminated	# 1	# 5
	# 2	# 6
	# 3	# 7
	# 4	# 8

Non-Programmable - ECM History

Notes

14632A1

Original 1987 220 Magnum EFI/Laser XRi.

Identification: The part number is hand written in black ink on the back plate. Engine re-quires inductor spark plugs. Has some improved RFI shielding after ECM S/N 5540 – Dated 2/11/87 - Engine serial number 0B197682.

14632A6

The latest and best 220 calibration.

Introduced as a running change in 1987 and was intermixed with the A7 ECM. Also used on 1988 220 and 1989 200 XRi. Engine may require inductor spark plugs. Has the most improved RFI shielding.

Identification: printed label on the top of the upper mounting flange.

14632A7

Installed on 1988 220 and 1989 200 XRi.

This is a rework of the A1 ECM to change calibration to something close to that of the A6 ECM. Approximately 1300 ECM’s were reworked. Engine requires inductor spark plugs.

Identification: printed label on the top of the upper mounting flange.

14632A10 - SST 14632A12

1989 Mariner 175 Ski - 2.4 litre.

Identification: printed decal on the upper mounting flange.

14632A12

1989 running change / 1990 175 Ski 2.4 litre.

Replaces the A10.

Identification: printed decal on the upper mounting flange.

14632A13 - SST 824003A16

1991 Mercury 200 XRi - 2.5 litre.

Problem with the circuit not grounded to the housing - screws not tightened - suspect date code 9043 thru 9049 - engine runs rich - tester will not detect the poor internal ground – stock inspected by the vendor and a black dot is applied after the part number.

Identification: printed decal on the upper mounting flange.

Notes

14632A15 - SST 824003A14

1991 175 Magnum EFI/XRi - 2.4 litre.

First ECM that requires the TPI to be set at .250 volts. Problem with the circuit not grounded to the housing - screws not tightened - suspect date code 9043 thru 9049 - engine runs rich - tester will not detect the poor internal ground - stock inspected by the vendor and a black dot is applied after the part number.

Identification: printed decal on the upper mounting flange.

14632A16 - SST 824003A2

1992 175 Magnum EFI/Ski (Europe only) - 2.5 litre.

TPI set at .250 volts. Senses air entering the engine, i.e. senses boat load - TPI does not need to be set leaner on lighter boats.

Identification: printed decal on the top of the upper mounting flange.

14632A17 - SST 824003A3

1992 200 Magnum EFI/XRi - 2.5 litre.

TPI set at .250 volts. Senses air entering the engine, i.e. senses boat load - TPI does not need to be set leaner on lighter boats.

Identification: printed decal on the top of the upper mounting flange.

14632A18

1991/1992 Mod VP

Limited production race circuit. Has the fuel adjustment on the back.

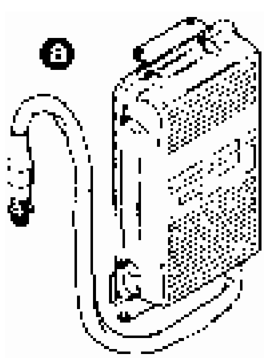
14632A19 - SST 824003A4

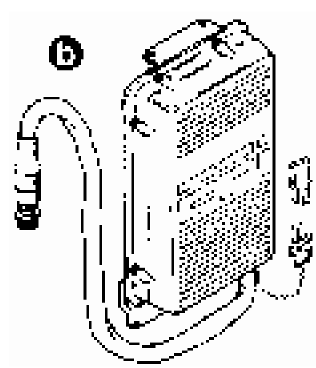
1993 150 Magnum EFI/XRi and Hi-Performance Super Magnum/Pro Max - 2.5 Litre.

14632A20 - SST 824003A5

1994 200 Super Magnum/Pro Max - 2.5 litre.

Leaner mixture at high engine speeds to allow 6800 RPM.





a) Analog Electronic Control Module
b) Digital Electronic Control Module

Programmable - ECM History

PROM Identification

PROM ID	Year	Engine Type	ECM Type	ECM Service P/N
		Mercury Racing 2.0 – 3.0 Litre		
Not Available	94	2.0L Hi Perf	Fuel	11350A26, 29
2615	95	2.0L Hi Perf	Fuel	11350A34, 45
2612	95	2.0L Hi Perf	Fuel	11350A54
2613 or 2650	95	2.0L Hi Perf	Fuel	11350A53
2514	Service	2.4L Hi Perf	Fuel	11350A40
Not Available	94	2.5L ROS	Fuel	11350A30, 32
2509	95-96 ½	2.5L ROS	Fuel	11350A35, 36
2718	96	2.5L ROS	Fuel	11350A62
2511	95	2.5L Drag	Fuel	11350A44, 48
2719 or 2796	96	2.5L Drag	Fuel	11350A63
Not Available	94	2.5L S3000	Fuel	11350A31, 33
2508 or 2522	95	2.5L S3000	Fuel	11350A43, 47
2717 or 2776	96	2.5LS 3000	Fuel	11350A61
2510	96-98	2.5L CON	Fuel	11350A42, 49
2622	97	2.5L PROP	Fuel	11350A65
7110	Service	2.5L Hi Perf	Fuel	849849A1
7115	98	2.0L Mod U	Fuel	849849A2
7113	Service	2.0L PROP	Fuel	849849A3
7114	Service	2.4L Hi Perf	Fuel	849849A4
7109	Service	2.5L ROS	Fuel	849849A5
7119	98	2.5L Drag	Fuel	849849A6
7108	Service	2.5L S3000	Fuel	849849A7
7117	98	2.5L S3000	Fuel	849849A8
7122	Service	S3000 PROP	Fuel	849849A9
7323	99	2.5L PROP	Fuel	849849A10
E307	98	ProMax 300	Ign	830044-16
F307	98	ProMax 300	Fuel	830046-3
EB00	00	250XB	Ign	830044-19
FB00	00	250XB	Fuel	830046-15

ROS = Race Offshore CON = Consumer Drag = Drag Racing

PROP = Professional Racing Outboard Performance Tour

PROM Identification (Cont.)

PROM ID	Year	Engine Type	ECM Type	ECM Service P/N
		2.5 Litre		
E683 or E556	94-95	200 2.5L XRi	Fuel	824003-1, A1
A7C0	94-95	175 2.5L Xri	Fuel	824003-2, A2
E57A	94-95	150 2.5L Xri	Fuel	824003-4, A4
8714	95	200 PRO MAX	Fuel	824003-5, A5
C9C2 or AD49	95	225 PRO MAX	Fuel	824003-6, A6
A470	95	150 PRO MAX	Fuel	824003-7, A7
5AA0 or 4227	96	200 2.5L XRi	Fuel	824003-8, A8
436F or C2A0	96	175 2.5L Xri	Fuel	824003-9, A9
1BB6 or 24C5	96	150 2.5L Xri	Fuel	824003-10, A10
A287	96	200 PRO MAX	Fuel	824003-11, A11
3E97	96	150 PRO MAX	Fuel	824003-13, A13
67E4	91	175 Xri	Fuel	824003-14, A14
1831	Service	200 Offshore	Fuel	824003-15, A15
C5D9	91	200 Xri	Fuel	824003A16
5E62	96	225 PRO MAX	Fuel	824003A17
2E88	98	225 PRO MAX 15DSH	Fuel	824003A23
8EA0	99	175 2.5L Xri	Fuel	824003A25
1BE0	99	200 2.5L XRi	Fuel	824003A26
E8CD	00	150 2.5L Xri	Fuel	824003A27
D31E	00	175 2.5L Xri	Fuel	824003A28
AC74	00	200 2.5L XRi	Fuel	824003A29

Section 3 - 1995-2001 3.0L EFI

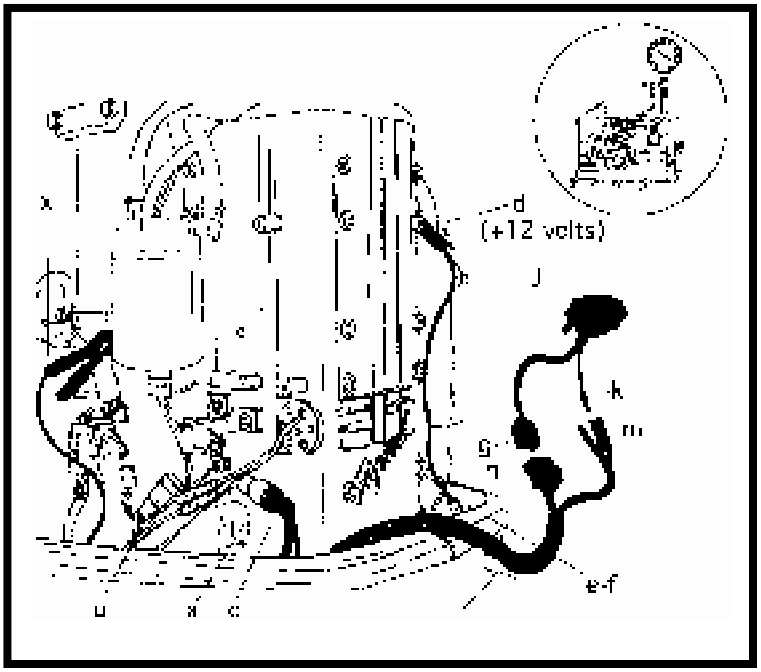
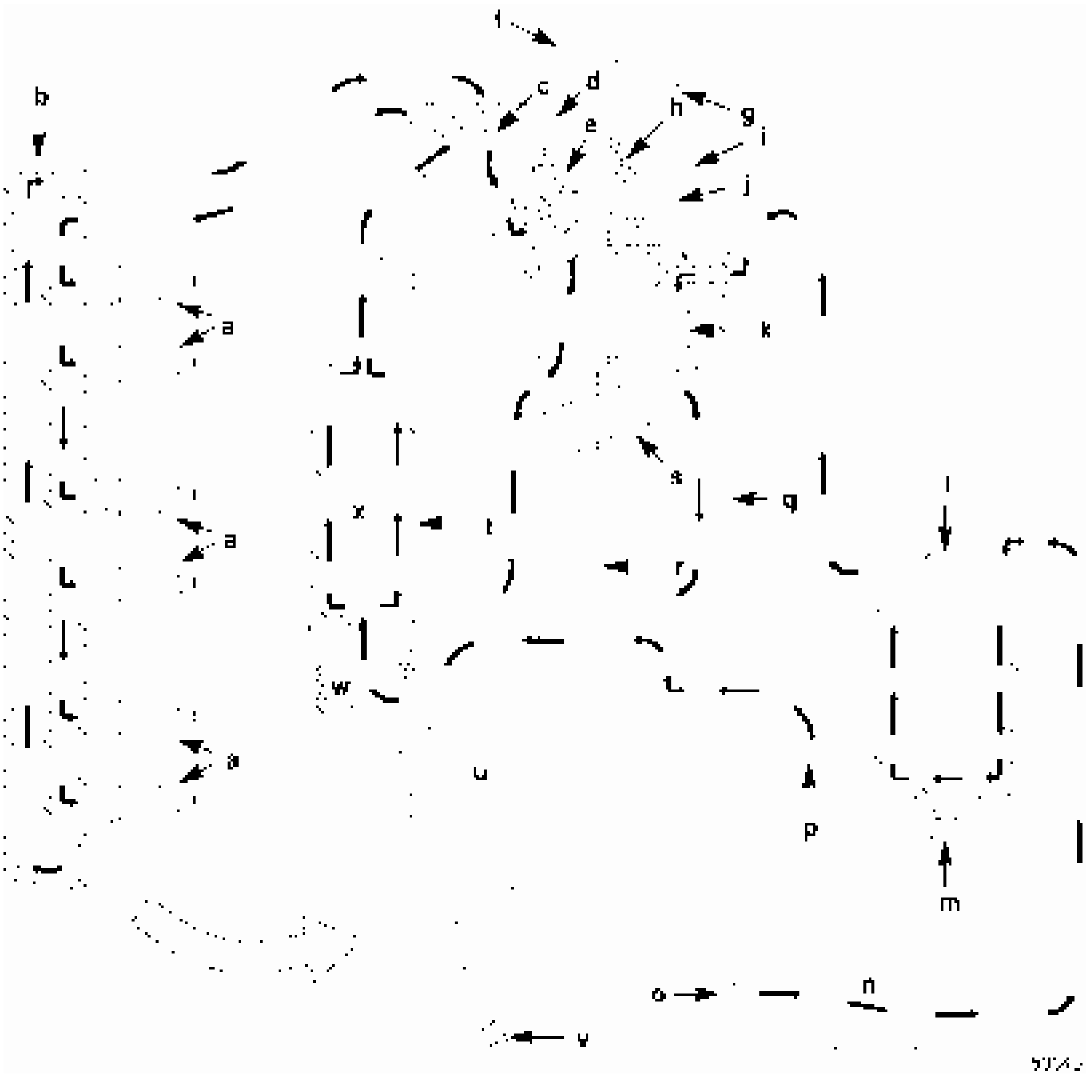


Table of Contents

1995-2001 3.0L Fuel Flow



a) Fuel Injectors
b) Fuel Rail
c) Fuel Rail Pressure Port
d) Fuel Pressure Regulator Manifold Hose
e) Fuel Pressure Regulator
f) To Starboard Bleed Junction Block
g) To Port Bleed Junction Block
h) Bleed System Filter
i) MAP Sensor (3.0L Only)
j) MAP Sensor Manifold Hose
k) Needle and Seat
l) Water Separator
m) Water Sensor
n) Pulse Fuel Pump
o) From Fuel Tank
p) From Oil Pump
q) Vapor Separator
r) Manifold Bleed Hose to Vapor Separator
s) Vapor Separator Float
t) Electric Fuel Pump
u) Manifold
v) Injector Wiring Harness
w) Final Filter
x) Armature

EFI Electrical Components

Notes

1995-2001 3.0L

SENSOR INTERACTION WITH ECM

The ECM relies on sensor feedback to provide proper fuel rates and timing advance for optimum engine performance under all conditions.

Should a sensor fail, the ECM will try to compensate for lack of sensor information by providing predetermined fuel rates and timing advance for average conditions.

Therefore, a change in engine performance may not be readily noticeable. However, a sensor failure will result in the ECM activating a warning horn to alert the operator.

The Fuel ECM uses a pulse from the stator feed into #1 CDM to locate crankshaft position, then uses the gray tachometer signal wire (RPM) from the ignition ECM to determine when to fire the injectors in pairs.

IMPORTANT: DO NOT run engine for extended periods of time with sensors disconnected or bypassed (shorted). Serious engine damage may result.

AIR TEMPERATURE SENSOR

The air temperature sensor transmits manifold air temperature, through full RPM range, to the EFI ECM. As air temperature increases “sensor” resistance decreases causing the ECM to decrease fuel flow (leaner mixture).

NOTE: *A warning horn will sound if the sensor fails or is disconnected on 1996 models, only.*

The air temperature sensor circuit can be tested using a volt/ohm meter.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The MAP sensor is mounted on the vapor separator. This sensor monitors changes in manifold absolute pressure and is connected to the intake manifold by a vacuum hose. The MAP sensor functions through the full RPM range and is continually signaling induction manifold pressure readings to the EFI ECM. The EFI ECM determines fuel flow as signals are received. Drawing a vacuum on the MAP sensor hose will create a lean fuel condition altering engine operation. If no change occurs when drawing vacuum, MAP sensor is not functioning properly.

NOTE: *A warning horn will sound if sensor fails or is disconnected on 1996 models, only. The engine may, however, run rough at idle if the sensor is inoperative on all models.*

ENGINE HEAD TEMPERATURE SENSOR

This sensor provides the EFI ECM with signals related to engine temperature to determine level of fuel enrichment during engine warm-up. The EFI ECM receives information at all engine temperatures but stops fuel enrichment at an engine temperature of 110° F (43° C).

Notes

An overheat condition will occur if engine temperature exceeds 200° F (93° C). A constant warning horn will sound as long as the overheat condition exists. If the overheat condition should occur at wide-open-throttle, the engine RPM will be reduced to 3000. The engine will return to normal operating condition when the temperature drops below 200° F (93° C).

The temperature sensor can be tested using a digital volt/ohm meter.

NOTE: *If sensor does not make clean contact with cylinder head, a rich condition may exist.*

THROTTLE POSITION SENSOR (TPS)

The TPS transmits information to the ECM during low speed and mid range operation, related to throttle angle under various load conditions. TPS adjustment is a critical step in engine set up.

Other Components Associated With the ECM.

IMPORTANT: When disassembling EFI System DISCONNECT BATTERY CABLES.

FUEL INJECTORS

A four wire harness connects the fuel injectors to the ECM. The RED wire is at 12 volts and connects to all injectors. The BLUE, YELLOW and WHITE wires each go to a pair of injectors and are normally at 12 volts for a zero differential. To fire the injectors this voltage is brought down to near ground creating a potential across the injectors.

ELECTRIC FUEL PUMP

The EFI ECM contains a fuel pump driver circuit that provides power to the electric fuel pump. The amount of time the fuel pump operates varies with the RPM of the engine. Above approximately 3000 RPM, the fuel pump is operating continuously (or at 100% of its duty cycle).

WATER SENSING SYSTEM FUNCTION

The system consists of a water separating fuel filter (starboard side powerhead) and a sensing probe (bottom of filter).

1) The filter separates the accumulated water from the fuel.
2) A voltage is always present at sensing probe. When water reaches top of probe it completes the circuit to ground.
3) The completed circuit activates the warning.

NOTE: *The water detection light will stay on and the warning horn will "BEEP" 4 times and remain off for 2 minutes. This cycle will continue until the water is removed. This warning is the same as for the "Low Oil" warning.*

The system can be tested by disconnecting the TAN wire from sensor probe and holding to a good engine ground connection for 30 seconds.

INDUCTION MANIFOLD

The induction manifold is a common plenum chamber for accurate pressure measurement. It contains 4 throttle shutters (*see below) on 2 throttle shafts. The shutter opening (idle air opening) can be adjusted during EFI set-up procedure. The manifold contains the fuel rail, injectors, throttle position sensor and air temperature sensor. A fuel rail pressure port is located on the fuel pressure regulator.

- 3.0L 1995– 1999 225HP 2 shutters
- 3.0L 2000– 2001 225HP 4 shutters
- 3.0L 1996– 2001 250HP 4 shutters

ECM Injector Driver Test

To verify that the ECM is operating the injector pairs, connect test harness (91-833169) between manifold connector and engine harness. Start engine.

Use DVA meter (91-99750). Set DVA to 200 scale. Connect BLACK meter lead to engine ground and RED test lead to each BLUE, WHITE or YELLOW female bullet connector.

Normal voltage for a 3.0L engines will be 60 to 100 volts. Voltage will vary with RPM.

Notes

3.0L Fuel Pump Test

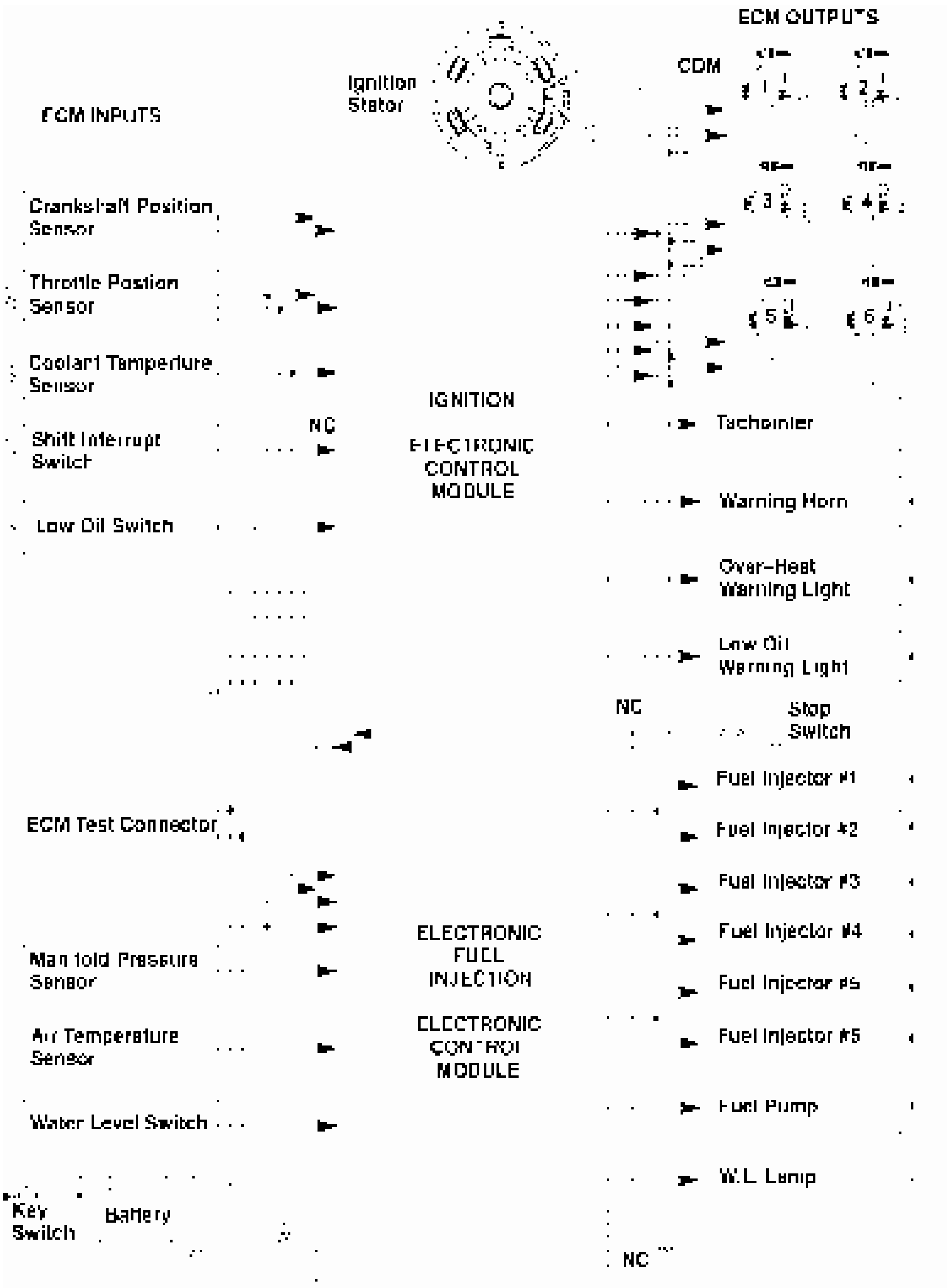
VOLTAGE TEST CHART

Engine Mode	Black Meter Lead To Engine Ground, Red Meter Lead To:	Approx. Voltage Reading	If approx. Voltage Is Not Obtained, This Indicates:
All Models	(+) terminal of fuel pump.	12-13.5 Volts	If reading is below 12 volts, the battery is bad or discharged, or a bad connection(s) on battery harness. If reading is higher than 13.5 volts, the battery is over-charged.
Ignition key in “OFF” position.	(-) terminal of fuel pump.	Same reading should be obtained as reading in check No. 1 (above).	If reading is lower than in check 1, the fuel pump or wire in harness is defective.
Ignition key in “ON” position and engine NOT running.	(-) terminal of fuel pump.	1 volt or less (voltage should then raise to 12-13.5 volts after approx. 15 seconds).	Defective ECM or fuel pump. *
Engine being cranked.	(-) terminal of fuel pump.	1 volt or less.	Defective ECM or fuel pump. *
Engine running below approx. 3000 RPM.	(-) terminal of fuel pump.	The voltage will vary as engine RPM changes.	Defective ECM or fuel pump. *
Engine running above approx. 3000 RPM.	(-) terminal of fuel pump.	1 volt or less.	Defective ECM or fuel pump. *

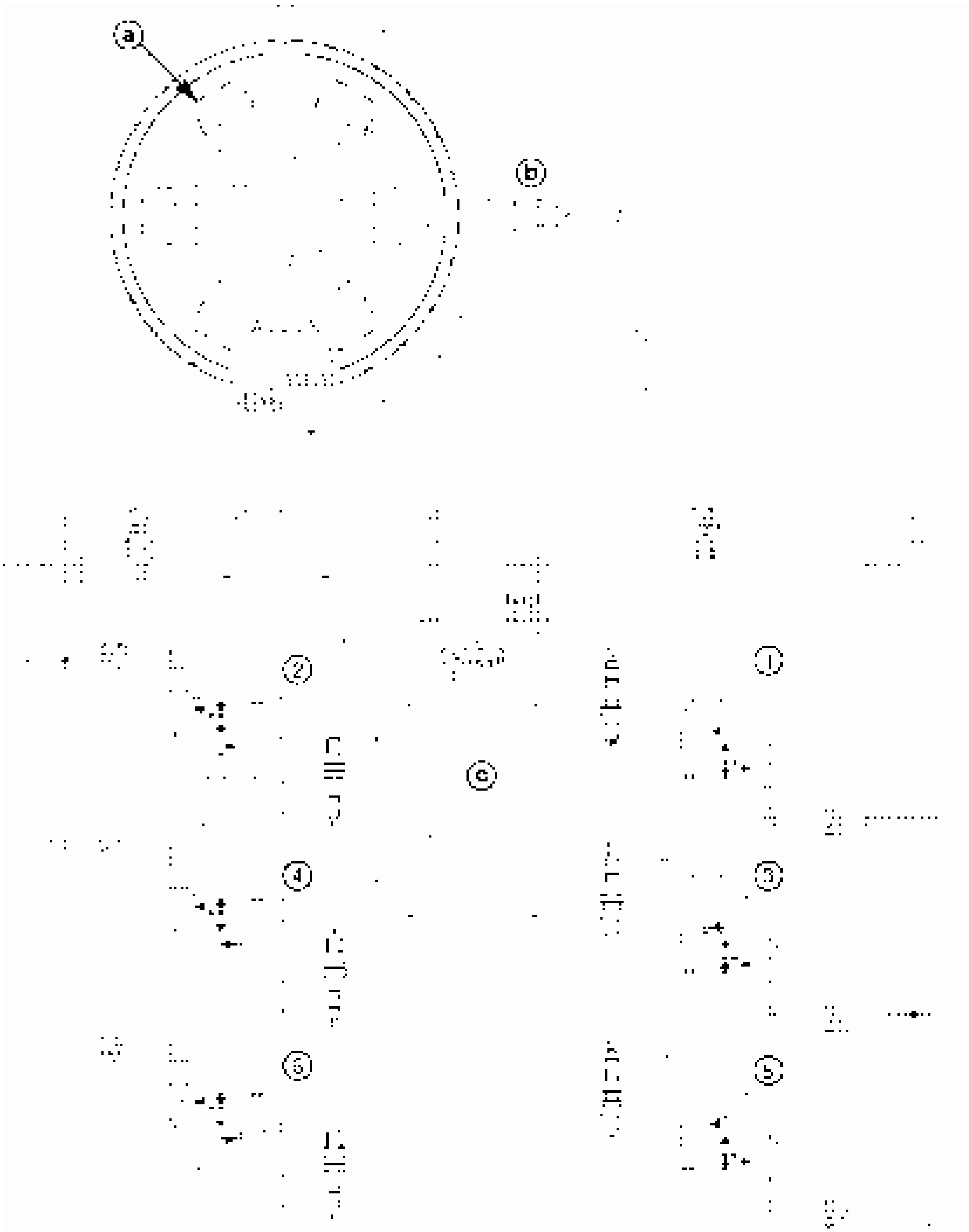
* Check for proper electrical operation of electric fuel pump.

a) Negative Terminal

3.0L ECM Wiring Diagram



1995-2001 3.0L - Ignition System

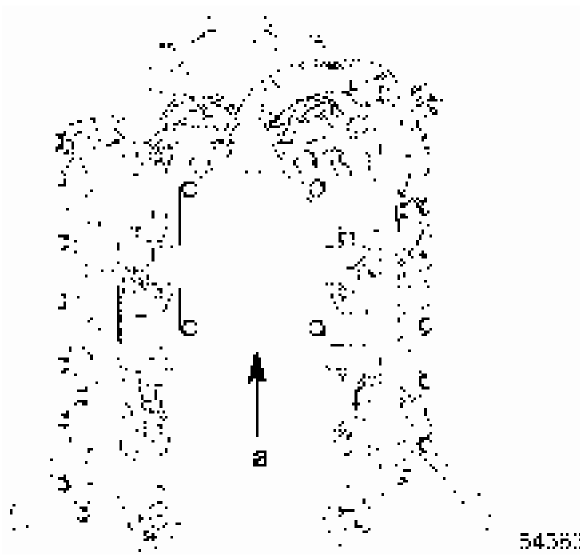


Theory of Operation

Ignition current is generated by the stator under the flywheel. The stator consists of six bobbins - one for each cylinder. The positive current wave charges the capacitor in the capacitor discharge module (CDM). The electronic control module (ECM) activates the switching device (SCR) in the CDM which allows the capacitor to discharge, causing the spark to occur. Ignition timing is regulated by the ECM which receives status input from a variety of sensors. These sensors include: crank position, throttle position sensor (TPS), engine temperature. There are six CDMs - one for each cylinder. The CDM consists of a capacitor, switching device, primary winding, secondary winding, and spark plug lead.

Ignition Component Description

ELECTRONIC CONTROL MODULE (ECM)



a) Electronic Control Unit

Under normal conditions, ECM controls and provides:

Spark timing by monitoring engine RPM, throttle shutter opening and coolant temperature.

Cold engine starting by advancing spark timing.

Over-speed protection in the event engine RPM exceeds 6000 for carb models and 6100 for EFI models. This is accomplished in two stages. Initially timing is gradually retarded to reduce RPM to 5900 for carb models and 6000 for EFI models. If RPM continues to increase above 6400 for carb models and 6500 for EFI models – i.e.– propeller breaks water surface – timing will rapidly retard to 2° ATDC to prevent any further RPM increase. When an over speed condition occurs, the low-oil and overheat lamps will illuminate alternately and the warning horn will be activated.

Notes

Notes

Warning control of LOW-OIL, WATER SEPARATOR and OVER-HEAT conditions. Warning is provided through activation of a horn and indicator lamps. A LOW-OIL condition exists when switch in engine-mounted oil tank is shorted to ground (CLOSED). A WATER SEPARATOR condition exists when excessive water accumulates in the bottom of the separator to short out the sensor. In either case, 30 seconds after switch is closed, the warning lamp will illuminate and the warning horn will be activated. The horn will beep 4 times in 1 second intervals followed by a 2 minute off-period. It will then repeat its beep sequence. Continuous lamp illumination and horn beep sequence will occur until the key switch is turned off. If there is no LOW-OIL condition then the WATER SEPARATOR must be checked. An OVER-HEAT condition occurs when the coolant temperature rises above 200°F (93.3°C). The warning lamp will illuminate and the over-heat horn will sound continuously. The ECM will retard the ignition timing until a maximum RPM of approximately 3000 is obtained. The ECM will maintain this RPM until engine temperature drops to 190°F (87.8°C).

Idle stabilizer function by advancing the ignition timing the number of degrees indicated, following, at the respective RPM.

RPM	DEGREES
450	3°
Below 450	6°

Throttle position and engine temperature sensor failure warning to boat operator. Sensor failure is indicated by alternately illuminating the low-oil and over-heat lamps as well as activating the warning horn. This warning will occur 15 seconds after a sensor failure has been detected by the ECM. The warning will continue until the key switch is turned off or sensor problem is corrected.

Controls Power-Up Sequence – 1/2 second after ignition key is turned to “ON”, and power is applied to ECM, warning lamps will illuminate for 1/2 second and horn will beep for 1/2 second.

1996– 2001 MODEL ADDITIONAL ECM FEATURES

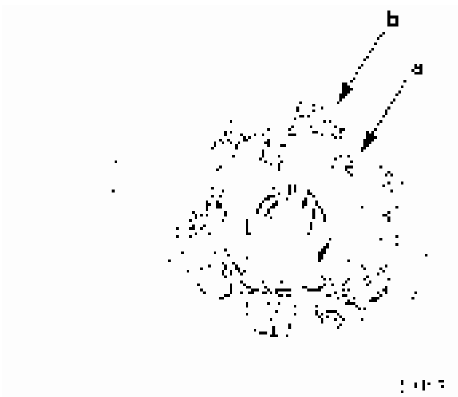
Prom identification with Digital Diagnostic Terminal. Refer to Quicksilver Technician Reference Manual shipped with new diagnostic cartridge.

Air temperature and/or MAP sensor failure will sound an intermittent warning horn and alternately flash the low oil and overheat lights on the dash.

Fuel ECM wire harness plug disconnect will sound an intermittent warning horn and alternately flash the low oil and overheat lights on the dash. Engine will not run.

NOTE: *An ignition ECM failure will not activate the warning horn as the warning signal originates from the ignition ECM.*

STATOR



a) Stator
b) Bobbins

Stator has 6 charging bobbins – 1 bobbin for each ignition module.

Each stator bobbin charges the ignition capacitor in each module.

1995/1996/1997 Model 3 Litre Work/225 Carb/225 EFI/250 EFI – Stator charges ignition capacitor in each module only. 1995/1996 models do not have “LIMP HOME” capability.

CDM IGNITION MODULES

a) Capacitor Discharge Module

Each module contains a capacitor, switching device and ignition coil which can produce approximately 45000 volts (open circuit) at the spark plugs.

1995/1996/1997 MODEL 3.0 Litre WORK/225/225 EFI/250 EFI – Module is triggered by ECM only. Ground wire for each CDM is incorporated in the wire harness. Capacitor is internally protected from being overcharged by the stator.

Notes

Notes

FLYWHEEL

Contains two magnets which charge stator bobbins.

Flywheel has 22 teeth on outside rim which, by passing through crank position sensor's magnetic field, informs the ECM of engine RPM and crankshaft angle.

CRANK POSITION SENSOR

Contains a permanent magnet and is positioned 0.040 ± 0.020 (1.02mm ± 0.51mm) from the flywheel teeth.

The timed passing of the flywheel teeth through the sensor's magnetic field enables the ECM to determine engine RPM and crankshaft angle.

THROTTLE POSITION SENSOR

Measures the amount of throttle opening and sends corresponding voltage signal to ECM.

ENGINE TEMPERATURE SENSOR

Monitors powerhead temperature.

ECM uses this signal to activate fuel enrichment valve on carburetor models and increase fuel injector pulse on EFI models for cold starts and to retard timing in the event of an overheat condition.

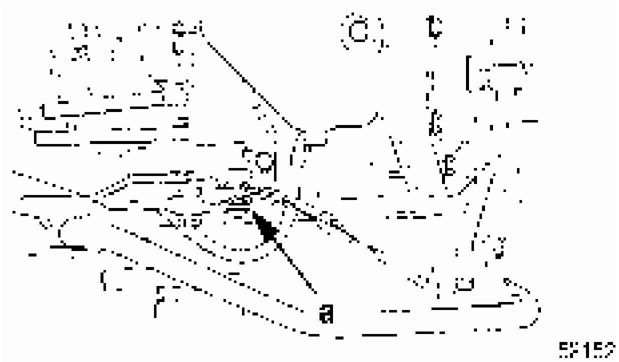
Engine Temperature Sensor Graph.

NOTE*: Engine timing is advanced as a function of engine coolant temperature, which, in conjunction with fuel enrichment, aids in cold starting.*

Block Temperature C° F°	Timing Advanced By:
5 41	10°
10 50	10°
15 59	10°
20 68	10°
25 77	8°
30 86	6°
40 104	4°
50 122	2°
60 146 And Above	0°

NOTE: *The amount of sensor timing advance listed above is in addition to the normal engine timing at a given RPM. Engine timing will not advance as a function of block temperature if crank shaft RPM is above 3000.*

SHIFT INTERUPT SWITCH



a) Shift Interrupt Switch

A shift interrupt switch is mounted below the shift cable on the PORT side of the engine.

1995/1996/1997 MODEL 3.0 Litre WORK/225 Carb/225 EFI/250 EFI – When shift interrupt switch is activated, the ECM retards ignition timing to 20° ATDC. If switch is activated for longer than 2 seconds, the ECM detects switch failure and returns ignition timing to normal.

3.0L LITRE 6 CYLINDER

All CDM's get their charging ground path independently through the stator's white leads.

A shorted Stop Diode in any one CDM will prevent at least 2 other CDM's from sparking.

Notes

225 EFI/250 EFI Warning Panel (3 Function Gauge)

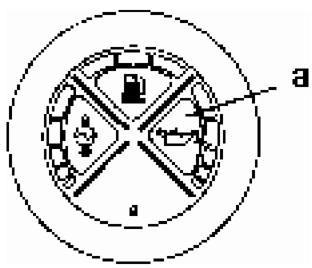
Operation of Warning Panel

When the ignition key is initially turned on, the warning horn will sound (beep) for a moment as a test to tell you the system is working. Failure of this test sound (beep) indicates a problem with the outboard or warning panel.

LOW OIL LEVEL

The low oil level warning is activated when the remaining oil in the engine mounted oil reservoir tank drops below 50 fl. oz. (1.5 liters).

The Low Oil Indicator Light will come on and the warning horn will begin a series of four beeps. If you continue to operate the outboard, the light will stay on and the horn will beep every two minutes. The engine has to be shut off to reset the warning system.

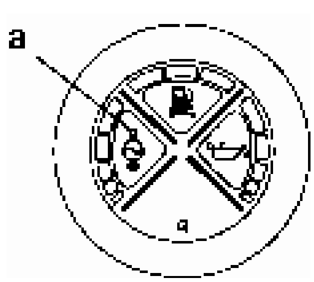


a) Low Oil Level Indicator Light

ENGINE OVERHEAT

The engine overheat warning is activated when the engine temperature is too hot.

The Engine Overheat Indicator Light will come on and the warning horn sounds continuously. The warning system will automatically limit the engine speed to 3000 RPM.

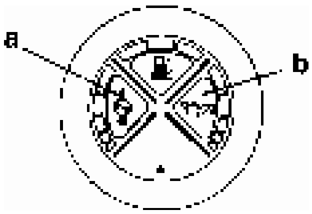


a) Engine Overheat Indicator Light

ENGINE OVER-SPEED

The engine over-speed protection system is activated when the engine speed exceeds the maximum allowable RPM.

Anytime the engine over-speed system is activated, the warning horn begins beeping and the Engine Overheat and Low Oil Indicator Lights will turn on and alternately flash. In addition, the system will automatically reduce the engine speed to within the allowable limit by retarding the ignition timing.

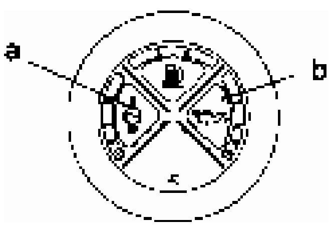


a) Low Oil Level Indicator Light
b) Engine Overheat Indicator Light

ELECTRICAL SENSOR NOT FUNCTIONING

The warning system is activated if the electrical throttle sensor, MAP sensor or engine temperature sensor is not functioning, or is out of its operating range.

The warning horn begins beeping and the Engine Overheat and Low Oil Indicator Lights will turn on and alternately flash.

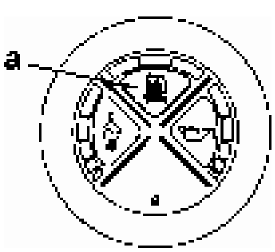


a) Low Oil Level Indicator Light
b) Engine Overheat Indicator Light

WATER SEPARATING FUEL FILTER IS FULL OF WATER

The water level detection warning is activated when water in the water separating fuel filter reaches the full level.

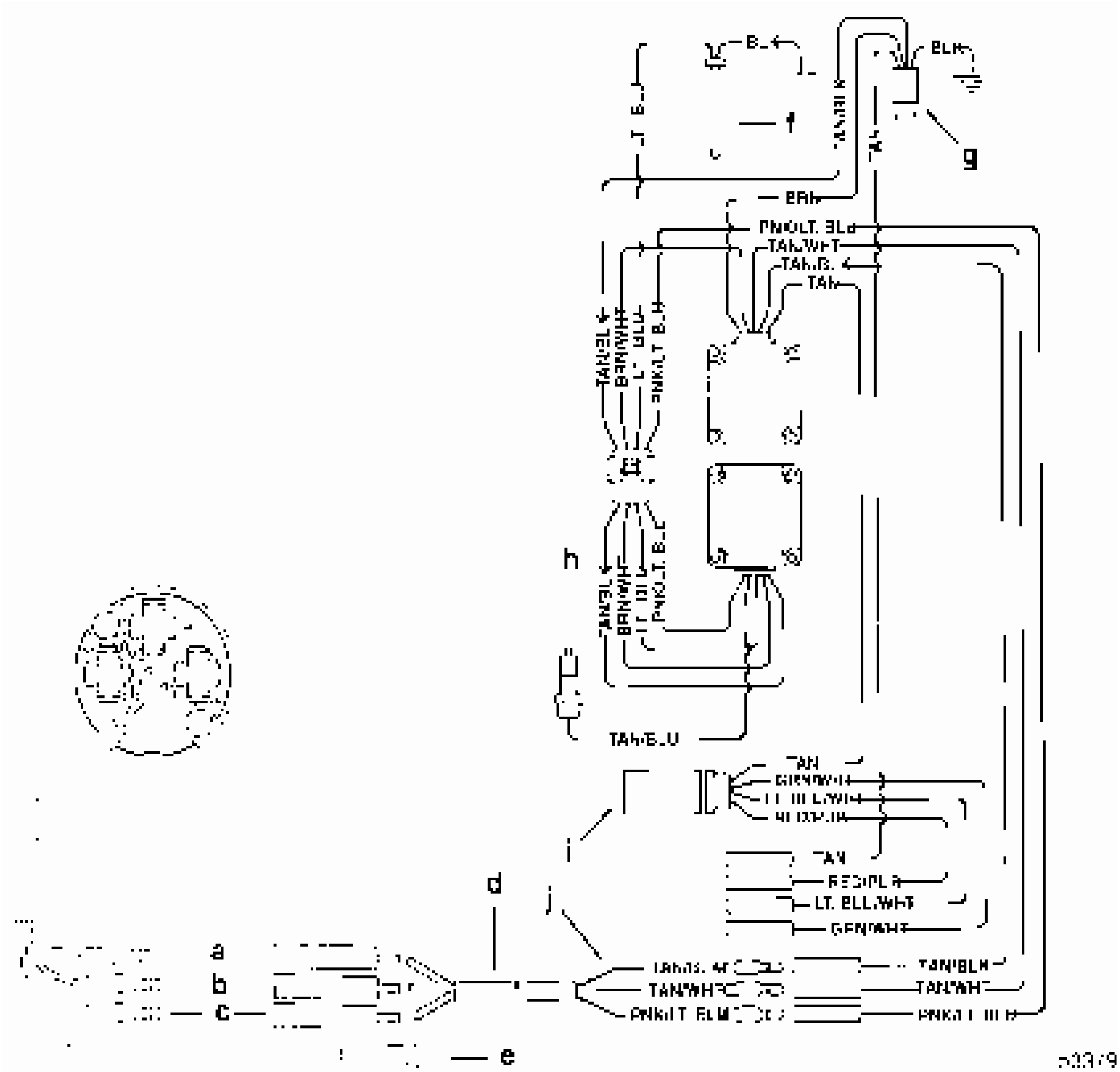
The Water Detection Light will come on and the warning horn will begin a series of four beeps. If you continue to operate the outboard, the light will stay on and the horn will beep every two minutes.



a) Water Detection Light

Notes

3 Function Gauge Wiring



a) Connect TAN/BLACK to TAN/BLACK
b) Connect TAN/WHITE to TAN/WHITE
c) Connect PINK/LT. BLUE to PINK/LT. BLUE
d) Harness Extension
e) Connect PURPLE to 12 Volt Source or Adjacent Gauge
f) Low Oil Sensor
g) Engine Temperature Sensor
h) Water in Fuel Sensor
i) Engine Harness Plug-In
j) Harness Extension Plugging Into Engine Harness

Notes

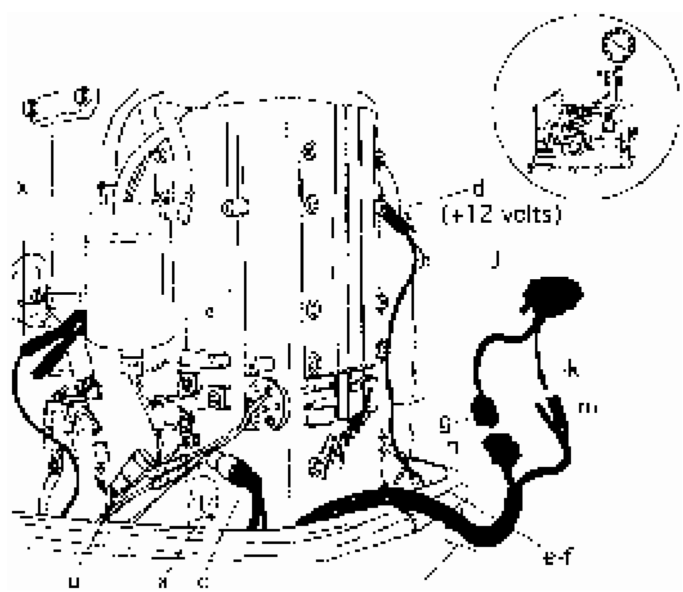
Injector Test

PROCEDURE

For these procedures, refer to engine setup illustrations 1 and 2 on the following page.

NOTE: *Test cables required for all standard 2.4/2.5L and 3.0L EFI models with injectors mounted inside the induction manifold. Use cables 84–822560A 7 and 84–830043A 1 for injector test.*

1) Disconnect the 4–pin injector harness plugs (a & b) at the manifold assembly as shown. Connect the injector test harness adaptor 4–pin rubber plug (c) to (a) at the manifold.
2) Connect the black alligator clip (x) to engine ground (starter motor body) and connect the red alligator clip (d) to the positive red wire at the electric fuel pump. The unused bullet connector (e & f) should be plugged together when not in use to prevent exposed wire from touching ground. Newer style fuel pumps may have a bullet connector for attaching to the pump terminals and in that case, remove the bullet connection from the positive terminal of the pump and connect the male terminal (e) to the harness from the pump and slide the female bullet (f) connector back to the positive terminal at the pump. Slide the unused alligator clip (d) back into the red boot to prevent contact to engine ground.
3) Connect the 4–pin DDT connector (g) to the mating connector on the injector test harness (h). The DB–25 connector (j) is plugged into the rear of the DDT. The DDT should power up once the software cartridge is inserted into the DDT. If the DDT does not power up, make certain that you engine battery is properly charged and that ground and power clips are correctly attached as indicated in Step 2.
4) The green/white pigtail lead (k) exiting the rear of the DB– 25 connector can now be plugged into one of three female bullet terminals (m). Select either a yellow, white or blue wire to test the selected injector pair.



Injector Test (Cont.)

Notes

5) Attach the Fuel Pressure Gauge to the fuel pressure test fitting. Turn the ignition key switch to the ON position and observe the fuel pressure reading after the pump driver times out (15 to 30 seconds).
6) Refer to the following section labeled Multi Test. From the Marine Diagnostic menu screen, select 3–Injector Test. From the Injector Test menu, select 1 –Multi Pulse Test. Use the ∀ key to increment the number of cycles in test to 50. Select the Ο key to move to the total on-time-milliseconds. Next use the ∀ key to adjust on-time to 300. For all outboard products test data is based on the previous settings.
7) Press the enter key. The DDT will cycle the injector pair selected. Make note as to the drop in pressure reading on the fuel pressure gauge.
8) Next, turn the ignition key switch to the OFF position and then back to ON in order to repressurize the fuel rail. Remove the green/white pigtail wire from the injector harness and select another pair and repeat step 7. Repeat this for all injector pairs and take note of the average drop in fuel pressure for each pair tested. Any differences greater than 3 PSI may indicate a problem with the injector(s) or the injector filter(s). The manifold may be disassembled and the test can be performed to isolate a single injector by unplugging the suspect injector and repeating the test to isolate the problem injector.

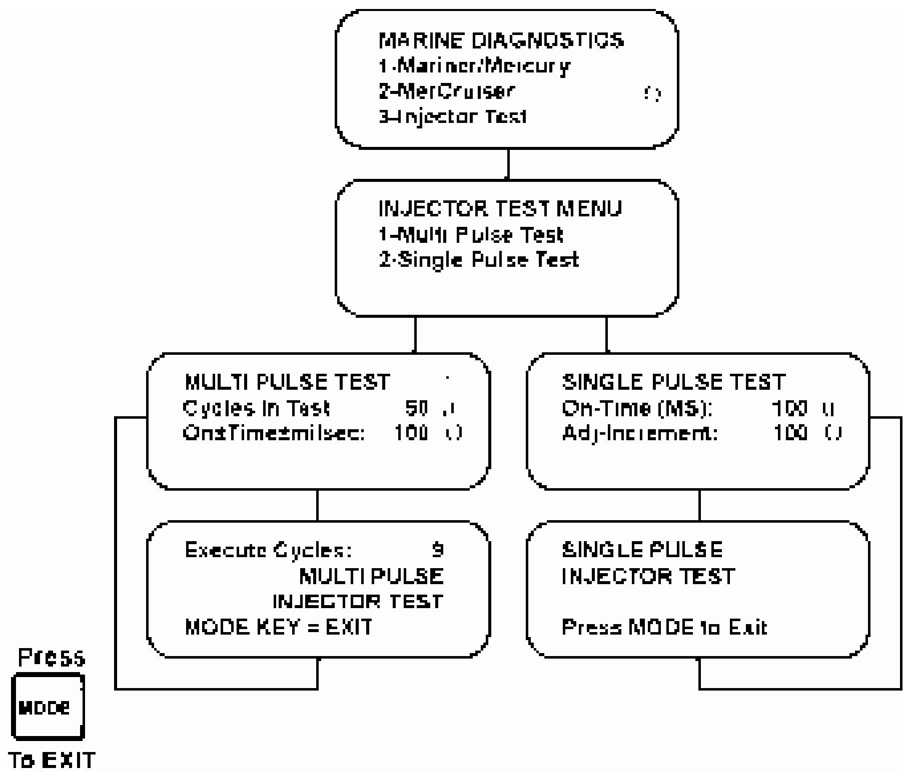
Notes

Multi Pulse Test

1) From the INJECTOR TEST MENU screen, press 1. The MULTI– PULSE TEST screen will appear. The cursor will be positioned in the Cycles in Test field.
2) Use the left and right arrow keys to set the number of times you want the injector to be cycled ON, then OFF, during the test.
3) Use the up and down arrow keys to move the cursor to the ON–Time or cycles selection.
4) Use the left and right arrow keys to set the total time you want the injector to be On during the test. The number must be between 100 and 600 milliseconds (in increments of 100).
5) Press ENTER to start the test.

The DDT will cycle the injectors ON and OFF according to the values you entered in the previous screen.

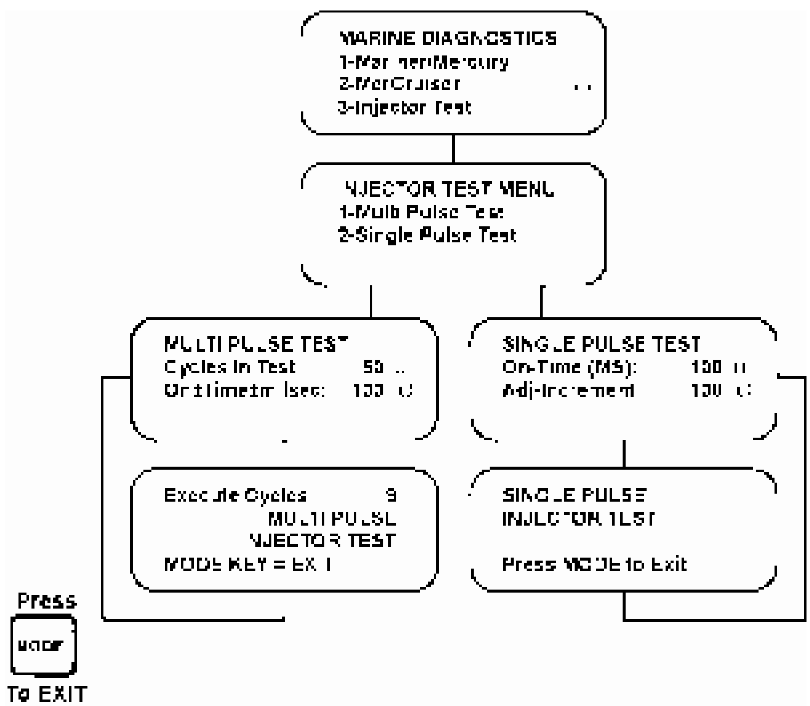
To perform the test again, repeat this procedure beginning with step



Single Pulse Test

1) From the INJECTOR TEST MENU screen, press 2. The SINGLE PULSE TEST screen will appear. The cursor will be positioned in the On-Time (MS) field.
2) Use the υ and ∀ keys to adjust the time up or down. This will be the time the injector is to be ON during the test. The number must be between 0 and 1000 milliseconds.
3) 3. Use the = and Ο keys to move the cursor to the Adj-Increment field.
4) Use the υ and ∀ keys to set the adjustment. For example, a setting of "100" would allow adjustment of the On-Time in 100 millisecond increments.
5) Press ENTER to start the test.

To perform the test again, repeat this procedure beginning with step 3.



Notes

3.0L EFI Scan Data Worksheet

Fuel ECM

Data Monitor			
Fuel ECM	**Idle**	**1500**	**3000**
ENGINE RPM			
COOLANT TMP			
TPS			
BATTERY VOLTS			
ATMOSPH PSI			
MAP PSI			
DELTA PSI			
AIR TEMP			
INJECT Msec			
FUEL PUMP %ON			
KNOCK VOLTS			
Status Switches			
LOW OIL SWITCH		WATER LEVEL	
RPM LIMITER		TPI SNR HIST	
TPS		KNOCK HIST	
COOLANT TEMP		COOL SNR HIST	
AIR TEMP		AIR SNR HIST	
MAP SNR		MAP SNR HIST	
TRIGGER SIGNAL			
PROM ID			
PROM ID		ECM PART#	

LED INDICATORS ILLUMINATED	#1,	#5,
	#2,	#6,
	#3,	#7,
	#4,	#8,

Ignition ECM

Data Monitor			
IGNITION ECM	**IDLE**	**1500**	**3000**
IGNITION ECM			
ENGINE RPM			
COOLANT TEMP			
TPS			
SPARK ANG			
STATUS SWITCHES		**HISTORY**	
WATER LEVEL		0-1000	
LOW OIL SW		1000-2000	
RPM LIMITER		2000-3000	
TPS		3000-4000	
COOLANT TEMP		4000-5000	
FUEL ENR		5000-RPM LIMIT	
OVER TEMP		RPM LIMIT TIME	
TRIGGER SIG		ECM RUN TIME	
SHIFT SWITCH		OVER TMP TIME	
KNOCK HIST		BREAK IN TIME	
COOL SNR HIST		KNOCK TIME	
TPS SNR HIST		RPM LIMIT CNT	
PROM ID			
PROM ID		ECM PART#	

LED INDICATORS ILLUMINATED	#1,	#5,
	#2,	#6,
	#3,	#7,
	#4,	#8,

3.0L PROM ID Chart

PROM ID	YEAR	ENGINE TYPE	ECM TYPE	ECM SERVICE PART#
		3.0 Litre		
0002	94	225 Carb	Ign	821717
FFFE	94	225 Carb	Ign	824866-1
FFFE	95	3.0L Work	Ign	825753-1
FFFE	95	225 Carb	Ign	825753-2
FFFE	95	225L EFI	Ign	825753-3
FFFE	95	225L EFI	Fuel	825754-2
FFFE	95	225XL/XXL EFI	Ign	825753-4
FFFE	95	225XL/XXL EFI	Fuel	825754-2
FFFE	95	250 EFI	Ign	825753-5
FFFE	95	250 EFI	Fuel	825754-1
C306	96	3.0L Work	Ign	830044-1
C206	96	225 Carb	Ign	830044-2
E206	96	225 EFI	Ign	830044-4
F206	96	225 EFI	Fuel	830046-2
E506	96	250 EFI	Ign	830044-5
F506	96	250 EFI	Fuel	830046-1
E216	96 Service	225 EFI	Ign	830044-11
F216	96 Service	225 EFI	Fuel	830046-6
E216	96-1/2 Service	225 EFI	Ign	830044-1
F226	96-1/2 Service	225 EFI	Fuel	830046-9
C307	97-98	3.0L Work	Ign	830044-10
C207	97-98	225 Carb	Ign	830044-7
E207	97	225 EFI	Ign	830044-8
F207	97	225 EFI	Fuel	830046-4
E507	97	250 EFI	Ign	830044-9
F507	97	250 EFI	Fuel	830046-5
E207	97-1/2	225 EFI	Ign	830044-8
F217	97-1/2	225 EFI	Fuel	830046-7
E507	97-1/2	250 EFI	Ign	830044-9
F517	97-1/2	250 EFI	Fuel	830046-8
EA07	97-1/2	225 EFI	Ign	830044-12
FA07	97-1/2	225 EFI	Fuel	830046-10
EA17	97-1/2	250 EFI	Ign	830044-13
FA17	97-1/2	250 EFI	Fuel	830046-11
E208	98	225 EFI	Ign	830044-14
F217	97-1/2, 98	225 EFI	Fuel	830046-7
E508	98	250 EFI	Ign	830044-15
F517	97-1/2, 98	250 EFI	Fuel	830046-8
C309	99	3.0L Work	Ign	830044-16
E500	00	225/250 EFI	Ign	830044-17
F200	00	225 EFI	Fuel	830046-12
F500	00	250 EFI	Fuel	830046-13

3.0L PROM ID Chart (Cont.)

PROM ID	Year	Engine Type	ECM Type	ECM Service P/N
		3.0 Litre DFI		
PROM ID 0102	97	200 DFI	Ign-Fuel	828557-1
ECM ID 4150				
CALIB ID 0102				
ENGINE ID 0101				
PROM ID 0105	97-1/2	200 DFI	Ign-Fuel	850270-6
ECM ID 0102				
CALIB ID 0105				
ENGINE ID 0102				

NOTE: *For 1998 and newer see SYSTEM INFO fo correct ECM ID.*

Section 4 - 2002 & Newer 2.5L/3.0L EFI

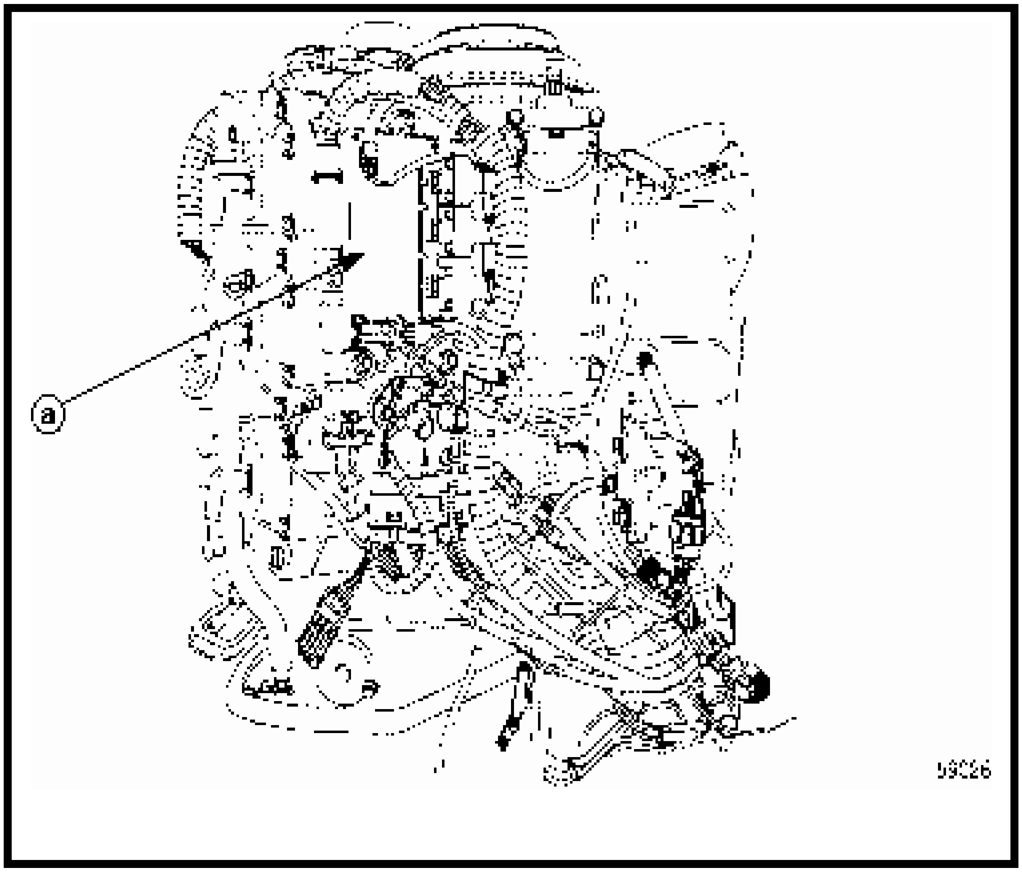
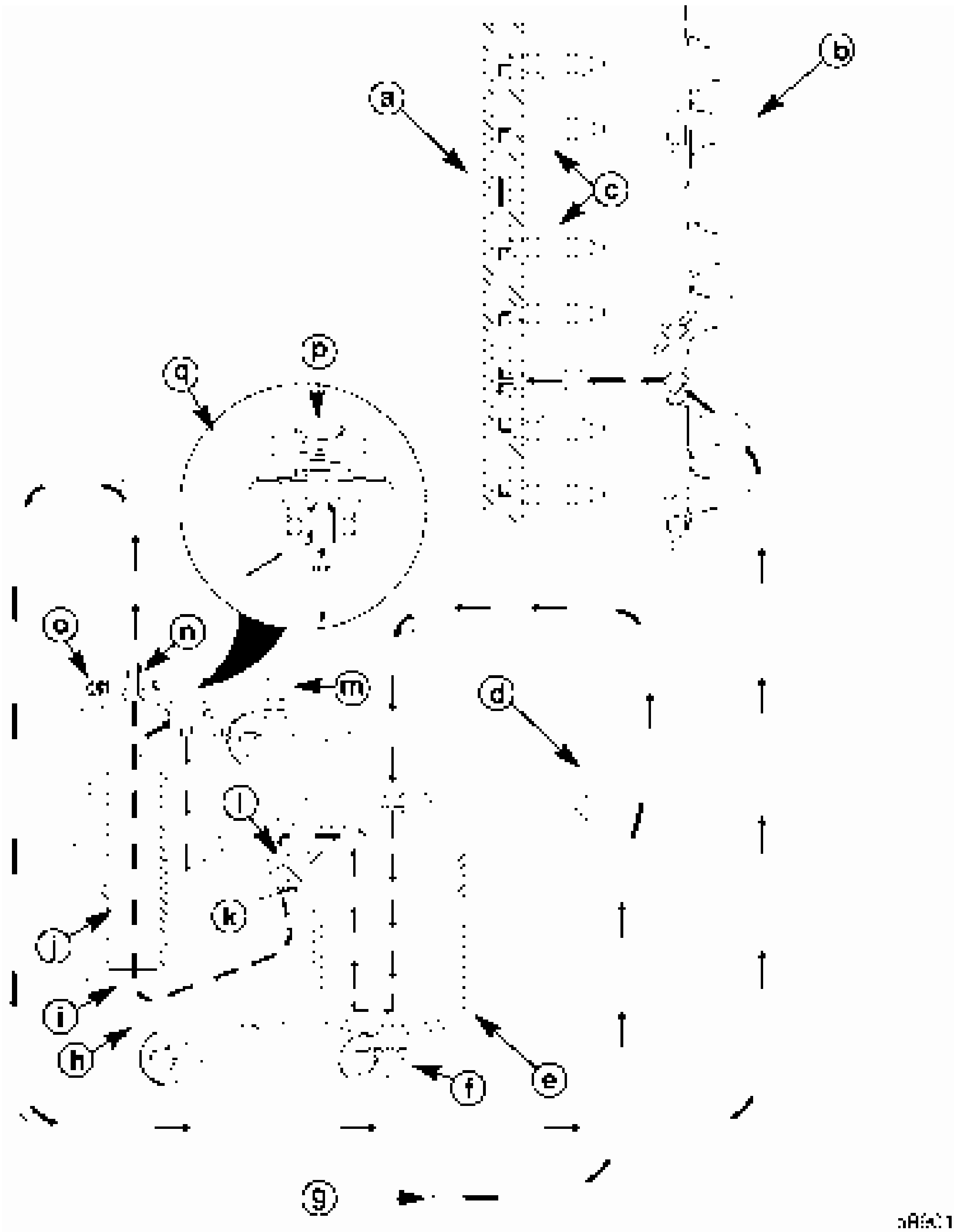


Table of Contents

2002 2.5L/3.0L Fuel Flow Diagram



a) Fuel Rail
b) Reed Block Plate Assembly
c) Fuel Injectors (6)
d) Pulse Fuel Pump
e) Fuel/Water Separator
f) Water Sensor
g) From Fuel Tank
h) Vapor Separator
i) Electric Fuel Pump Filter
j) Electric Fuel Pump
k) Vapor Separator Float
l) Needle and Seat
m) Vapor Separator to Flywheel Cover Vent Hose
n) Final Filter
o) Fuel Rail Pressure Port
p) Fuel Pressure Regulator
q) Fuel Pressure Regulator Vent Hose

Fuel Flow Component Description

Notes

Pulse Fuel Pump (d)

The pulse fuel pump operates through alternating crankcase pressure to deliver fuel through the water separating filter to the vapor separator. Fuel pressure @ Idle: 2 – 3 psi (13.8 – 20.7 kPa) [Minimum – 1 psi (6.9 kPa)]. Fuel Pressure @ Wide-Open-Throttle: 6 – 8 psi (41.4 – 55.2) [Minimum: 4 psi (27.6 kPa)].

Water Separating Filter (e)

The water separating filter protects the fuel injectors from water and debris. The filter contains a sensor probe which monitors water level in the filter. If water is above the sensor probe, the warning horn will begin a series of beeps.

Vapor Separator (h)

The vapor separator is a fuel reservoir which continuously blends and circulates fresh fuel and oil.

1) Fuel Inlet – Fresh fuel delivered from the water separator by the crankcase mounted pulse fuel pump. The amount of fuel allowed to enter the vapor separator is controlled by a needle/seat and float assembly mounted in the cover of the vapor separator.
2) Oil Inlet – Oil delivered by ECM controlled oil pump.
3) Fuel Pressure Regulator Inlet – Unused fuel/oil mixture being recirculated from the
4) pump back into the vapor separator.

Final Filter (n)

The final filter is located above the electric fuel pump in the brass fuel fitting. The filter collects debris and prevents them from flowing into the fuel rail and injectors.

Electric Fuel Pump (Inside Vapor Separator) (j)

The electric fuel pump runs continuously while providing fuel in excess of engine demands. The excess fuel is circulated through the fuel rail to the fuel pressure regulator and back to the vapor separator. Normal fuel pressure is 41 – 45 psi (283 to 310 kPa).

Notes

Fuel Injectors (c)

The fuel injectors are located on the fuel rail. The injector valve body consists of a solenoid actuated needle and seat assembly. The injector receives signals from the EFI Electronic Control Module. These signals determine how long the needle is lifted from the seat (pulse width) allowing a measured fuel flow. The pulse width will widen (richer) or narrow (leaner) depending on various signals received from sensors connected to the EFI ECM. The ECM receives a signal from the crank position sensor to fire each injector accordingly. In the “start” position, injector pulse widths are increased as engine head temperature is reduced to provide adequate fuel for quick start up.

A 12 wire harness connects the fuel injectors to the ECM. The RED wire is at 12 volts and connects to all injectors. The BLUE, YELLOW, WHITE, BROWN, PURPLE and ORANGE wires each go to individual injectors and are normally at 12 volts for a zero differential. To fire the injectors this voltage is brought down to near ground creating a potential across the injectors.

Fuel Pressure Regulator (p)

The fuel pressure regulator is located on top of the vapor separator and is continuously regulating fuel pressure produced by the electric fuel pump. The electric pump is capable of producing 90 psi (621 kPa) of fuel pressure. The pressure regulator limits fuel pressure at the injectors to 41 to 45 psi (283 to 310 kPa).

Operation of Oil Injection System

The oil injection system delivers oil mixture on engine demand, from 120:1 at idle to 50:1 at wide open throttle.

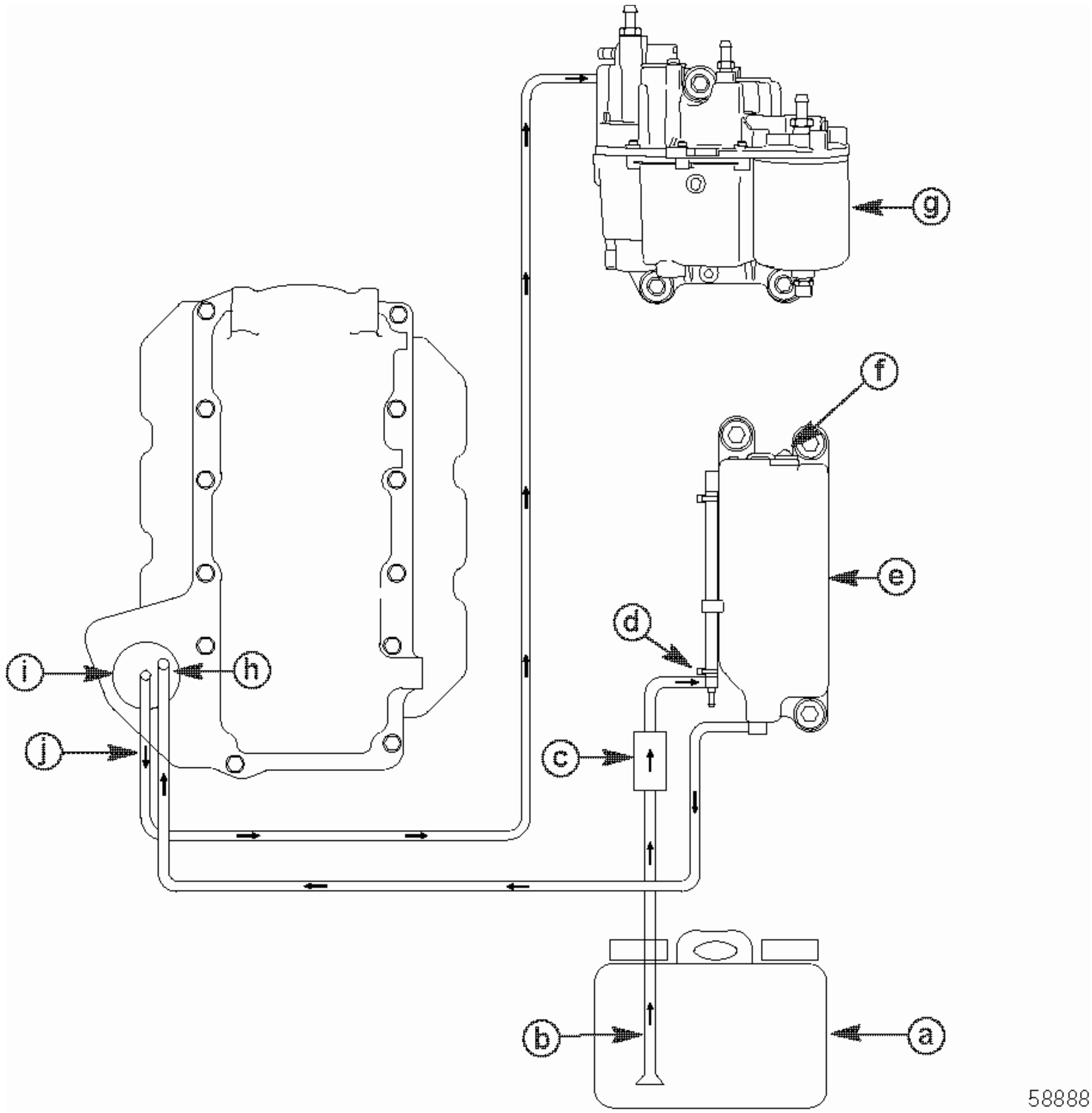
Oil is stored inside a remote oil tank in the boat. This tank holds enough oil for approximately 150 gallons of fuel at wide open throttle.

Crankcase pressure forces oil from the remote oil tank into the engine oil reservoir. The engine oil reservoir feeds oil to the oil pump. The engine oil reservoir contains enough oil for 20–25 minutes of full throttle running after the remote oil tank is empty. The warning horn will sound if the oil level in the engine oil reservoir is low.

The oil pump is ECM driven and pumps oil to the vapor separator tank where it mixes with fuel supplied by the engine mounted pulse pump.

The ECM is programmed to automatically increase the oil supply to the engine during the initial engine break-in period. The oil ratio during the first 120 minutes is 100:1 @ idle and 40:1 @ wide open throttle. After the first 120 minutes, the oil ratio changes to 120:1 @ idle and 50:1 @ wide open throttle.

Oil Injection Flow System



a) Remote Oil Tank
b) Oil Pickup Tube
c) Filter
d) 4 Psi Check Valve
e) Oil Reservoir
f) Low Oil (Float) Sensor (Inside Reservoir)
g) Vapor Separator Tank
h) Oil Inlet To Oil Pump
i) Oil Injection Pump
j) Oil Outlet Hose to Vapor Separator Tank

Oil Injection Components

Notes

REMOTE OIL TANK (A)

Holds 3 gallons (11.5 liters) of oil.

NOTE: *Some boats may be equipped with optional 1.8 gallon (7.0 liters) oil tank.*

The tank is pressurized by air from crankcase pressure thus forcing oil up the outlet hose to the oil reservoir on engine.

OIL PICK UP TUBE (B)

A filter screen is located in end of tube to prevent dirt or other particles from entering the system.

FILTER (C)

Directional filter designed to prevent impurities from entering oil reservoir.

4 PSI CHECK VALVE (D)

If oil flow to reservoir is obstructed and injection pump continues to pump oil, the 4 PSI valve will open to allow air to enter reservoir to prevent a vacuum.

OIL RESERVOIR (E)

The oil reservoir feeds the oil pump and contains enough oil for 20–25 minutes of full throttle running after the remote tank is empty. The warning horn will sound if the oil level in oil reservoir is low.

LOW OIL (FLOAT) SENSOR (F)

If oil level drops in oil reservoir, the sensor will signal the Electronic Control Module (ECM) to sound the warning horn.

VAPOR SEPARATOR TANK (VST) (G)

Contains electric fuel pump which pumps fuel @ 43 psi ± 2 psi (296.5 kPa ±13.8 kPa) to the fuel rail. Oil supplied by the electric oil pump is mixed with fuel supplied by the engine pulse pump in the VST.

OIL INLET HOSE (H)

Hose that carries oil from oil reservoir to electric oil pump.

OIL INJECTION PUMP(I)

Injection pump is electrically operated and controlled by the ECM. Pump varies oil ratio from 120:1 at idle to 50:1 at wide open throttle.

OIL OUTLET HOSE (J)

Hose that carries oil from electric fuel pump to mix with fuel in vapor separator.

Notes

Priming The Oil Pump

NOTE: *If a new powerhead is being installed or oil hoses/oil pump has been removed, it is recommended all air be purged from oil pump/oil lines using gearcase leakage tester (FT-8950)(a). Connect the leakage tester to the inlet t-fitting on the onboard oil reservoir. While clamping off the inlet hose, manually pressurize the reservoir to 10 psi. Using the Digital Diagnostic Terminal 91-823686A2, activate the oil pump prime sequence. Maintain the 10 psi pressure throughout the auto prime sequence. When the auto prime is completed, remove the leakage tester and refill the onboard oil reservoir.*

Priming the oil pump (filling pump and hoses using pressure) is required on new or rebuilt power heads and any time maintenance is performed on the oiling system that allows air into the oil system.

There are three methods for priming the oil pump:

METHOD 1 – SHIFT SWITCH ACTIVATION PRIME

This method does three things:

a) Fills the oil pump, oil supply hose feeding pump and oil hoses going to the crankcase and air compressor.
b) Activates break-in oil ratio.
c) .Initiates a new 120 minute engine break-in cycle.

Refer to priming procedure following.

METHOD 2 – (DDT) DIGITAL DIAGNOSTIC TERMINAL – RESET BREAK-IN

This method is the same as Method 1, except the run history and fault history are erased from the ECM.

Refer to procedure in the Technician Reference Manual provided with the Digital Diagnostic Software Cartridge Part 91-880118A2.

METHOD 3 – (DDT) DIGITAL DIAGNOSTIC TERMINAL – OIL PUMP PRIME

This method fills the oil pump, oil supply hose feeding pump, and oil hoses going to the crankcase and air compressor.

Refer to procedure in the Technician Reference Manual provided with the Digital Diagnostic Software Cartridge Part. No. 91-880118--1.

Conditions Requiring Priming the Oil Pump	
Condition	**Priming Procedure**
New engine	Use Method 1 or 2
Rebuilt powerhead	Use Method 1 or 2
New Powerhead	Use Method 1 or 2
Oil system ran out of oil	Use Method 3
Oil drained from oil supply hose feeding pump	Use Method 3
Oil pump removed	Use Method 3
Oil injection hoses drained	Use Method 3

Priming Procedure – Method 1

METHOD 1 – SHIFT SWITCH ACTIVATION PRIME PROCEDURE

Before starting engine for the first time, prime the oil pump. Priming will remove any air that may be in the pump, oil supply hose, or internal passages.

a) Oil Injection Pump
b) Oil Supply Hose

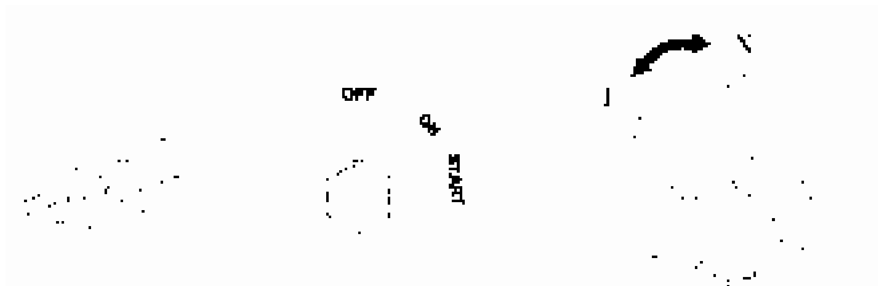
CAUTION
To prevent damage to the fuel pump, fill the engine fuel system with fuel. Otherwise the fuel pump will run without fuel during the priming process.

Notes

Notes

Prime the oil injection pump as follows:

1) Fill the engine fuel system with fuel. Connect fuel hose and squeeze primer bulb until it fells firm.
2) Turn the ignition key switch to the “ON” position.
3) Within the first 10 seconds after the key switch has been turned on, move the remote control handle from neutral into forward gear 3 to 5 times. This will automatically start the priming process.



NOTE: It may take a few minutes for the pump to complete the priming process.

Electronic Control Module (ECM)

The ECM is continually monitoring various engine conditions (engine temperature, engine detonation control , engine throttle opening and climate conditions (induction air temperature, barometric pressure and altitude level) needed to calculate fuel delivery (pulse width length) of injectors. The pulse width is constantly adjusted (rich/lean conditions) to compensate for operating conditions, such as cranking, cold starting, climate conditions, altitude, acceleration and deceleration, allowing the outboard to operate efficiently at all engine speeds.

12 Volt Battery - The 12 volt battery provides power to the ECM through the main power relay.

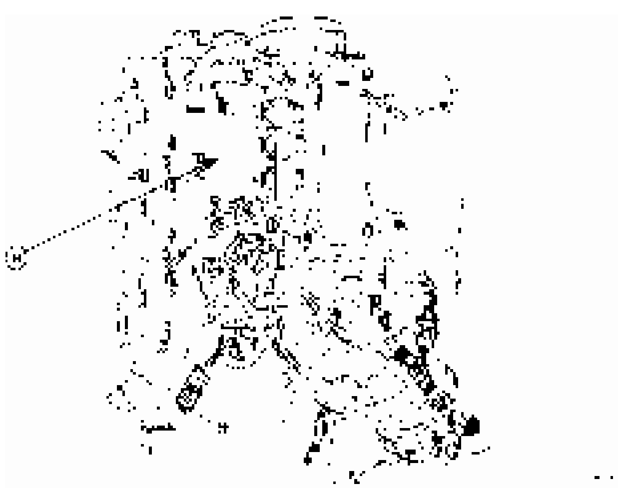
IMPORTANT: When disassembling EFI System DISCONNECT BATTERY CABLES.

The ECM requires 8 VDC minimum to operate. If the ECM should fail, the engine will stop running.

The inputs to the ECM can be monitored and tested by the Digital Diagnostic Terminal 91-823686A2 using adaptor harness 84-822560A5.

The ECM performs the following functions:

- Calculates the precise fuel and ignition timing requirements based on engine speed, throttle position, manifold pressure and coolant temperature.
- Controls fuel injectors for each cylinder and ignition for each cylinder.
- Controls all alarm horn functions.
- Supplies tachometer signal to gauge.
- Controls RPM limit function.
- Contains detonation control circuitry.
- Records engine running information.



c) Electronic Control Module (ECM)

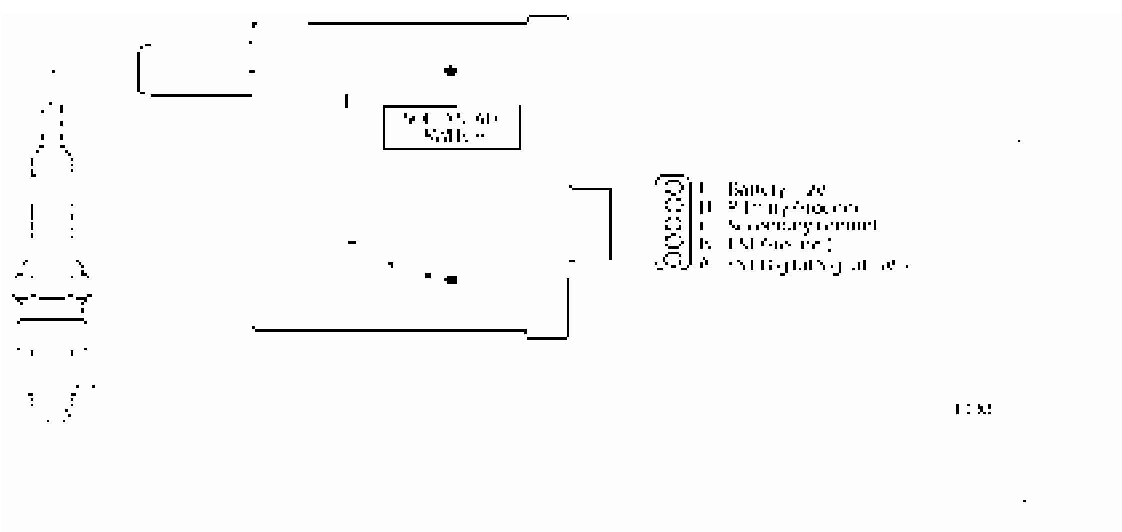
Notes

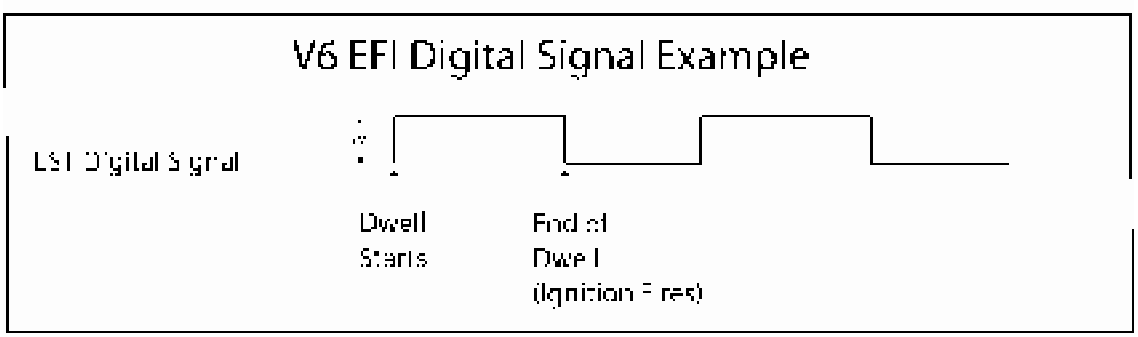
2002 and Up 2.5L/3.0L Ignition System Description

When the ignition key switch is turned to the ”RUN” position, battery voltage is applied to both the Electronic Control Module (ECM) through the purple wire and the main power relay through the red/purple wire. As the ECM receives the ”RUN” signal, it internally completes the ground circuit of the main relay, for a short period of time, energizing the fuel pump for start– up.

As the engine is cranked with the starter motor, the ECM receives the run signal from the Crank Position Sensor (CPS) and completes the ground circuit to the main relay for engine operation. With the main relay closed (completed circuit), D.C. current from the battery/ charging system is transferred through the 20 ampere main relay fuse to the positive terminal of all ignition coil primary windings. The negative terminals of the ignition coil primaries are connected to engine ground through the coils’ internal driver, which is triggered by the ECM.

With the coil drivers closed, a electric magnetic field is allowed to build up within the ignition coil. As the flywheel rotates, the CPS senses the location of the 54 teeth on the flywheel and supplies the trigger signal information to the ECM. The ECM utilizes the CPS information and determines when to remove the trigger signal from the coil driver of each ignition coil. The coil driver then opens the coil primary ground circuit, allowing it’s magnetic field to rapidly collapse across the coil secondary winding, which induces a high voltage charge (50,000 volts) that fires the spark plug.



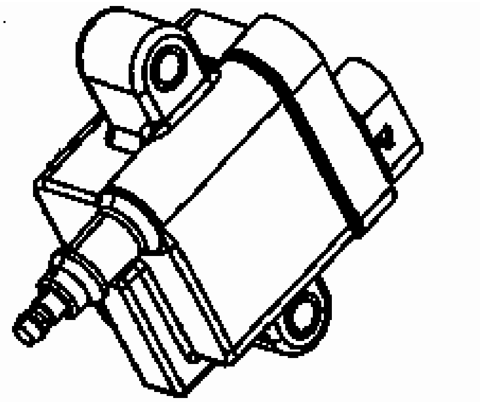


Notes

Notes

Ignition Coil

Each module contains an ignition coil and amplifier circuitry which produces approximately 50,000 volts at the spark plugs.



DDT TEST

1. Operate the Data Monitor function using the DDT and record the data.
2. Check the Fault Status using the DDT and record the data.
3. Connect the Digital Diagnostic Terminal (DDT) to the diagnostic port location on the engine.
4. Perform an ignition load test on the cylinder associated to the coil. Refer to the *Digital Diagnostic Terminal Technicians Reference Manual* for help.

NOTE: This test can also be performed using the Computer Diagnostic System (CDS). Refer to the "Active Diagnostics" section within the CDS application.

RESISTANCE TEST

1. Disconnect the plug end and the harness connector from the coil being tested.
2. Visually inspect the pins at the coil and the wires coming from the connector. Look for broken, bent, or corroded pins at the coil and loose, broken, or corroded wires at the connector. Replace components as necessary.
3. Perform a resistance test on the coil. If the coil fails this test, replace the coil.

NOTE: *Refer to appropriate service manual for test procedure and specifications.*

Electronic Control Module

The ECM requires 8 VDC minimum to operate. If the ECM should fail, the engine will stop running.

The inputs to the ECM can be monitored and tested by the Digital Diagnostic Terminal 91-823686A2 using adaptor harness 84-822560A5.

The ECM performs the following functions:

- Calculates the precise fuel and ignition timing requirements based on engine speed, throttle position, manifold pressure and coolant temperature.
- Controls fuel injectors for each cylinder and ignition for each cylinder.
- Controls all alarm horn functions.
- Supplies tachometer signal to gauge.
- Controls RPM limit function.
- Contains detonation control circuitry.
- Records engine running information.

a) Electronic Control Module (ECM)

Notes

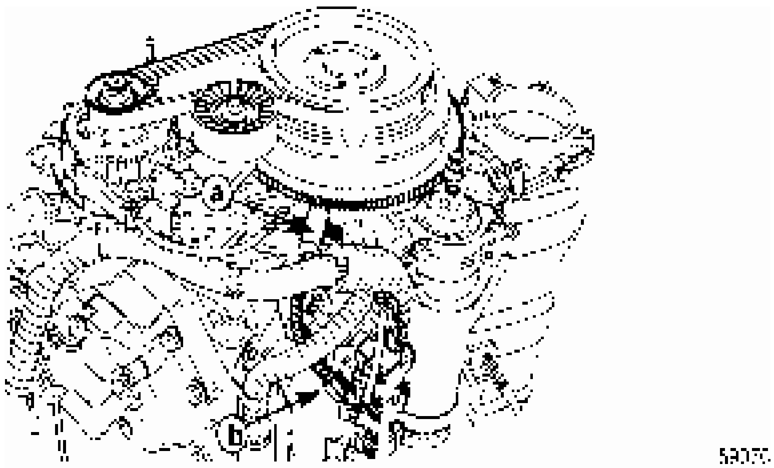
Notes

Flywheel

Flywheel has 54 teeth under the flywheel ring gear which the crank position sensor uses to provide engine rpm and crankshaft position information to the ECM.

Crank Position Sensor

Monitors 54 teeth on flywheel thus determining crankshaft position and sends crankshaft position angle and engine speed signals to ECM. If crank position sensor should fail, engine will stop running.



a) Crank Position Sensor
b) Crank Position Sensor Connector

RESISTANCE TEST

1. Visually inspect the sensor. The tip should be flush across the end. If not, replace the sensor.

NOTE: *There is a magnet mounted in the end of the sensor. If the magnet is missing the sensor will not operate properly.*

2. Visually inspect 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. Replace components as necessary.

3. Perform a resistance test. If the sensor fails this test, replace the sensor.

NOTE: *Refer to appropriate service manual for test procedure and specifications.*

Throttle Position Sensor (TPS)

The TPS transmits throttle angle information to the ECM which varies the injector pulse width accordingly. Should the sensor fail, the warning horn will sound. RPM will be reduced by the ECM. TPS settings are not adjustable. TPS settings can be monitored with the Digital Diagnostic Terminal through the ECM. Voltage change should be smooth from idle to wide open throttle. If voltage change is erratic, TPS is defective.

a) Throttle Position Sensor (TPS)
b) Throttle Stop Screw
c) Roller
d) Pocket

THROTTLE POSITION SENSOR (TPS) TROUBLESHOOTING

If the throttle position sensor is out of the intended operating range when the engine is started, the Electronic Control Module (ECM) will sense that the Throttle Position Sensor (TPS) has failed. The warning horn will sound, check engine light will illuminate, DDT will indicate failed TPS and the engine will go into RPM reduction. When the engine is started, the throttle arm on the engine must be against the throttle stop screw. Do not move throttle or fast idle control lever forward.

- Check throttle cable adjustment. The throttle stop screw on the throttle arm must be against the throttle stop on the cylinder block when the engine is started. Pre-load the throttle cable barrel 1 or 2 turns if necessary.
- Verify driver is not pushing on throttle (if foot throttle is used) or advancing the throttle only on the control box.
- Check throttle cam to roller adjustment. If the roller is not down in the pocket/valley area on the cam, there is a tendency for the roller to ride up or down on the cam which causes the TPS link arm to push/pull on the TPS lever resulting in changing values.

Notes

Notes

DDT TEST

The TPS settings are not adjustable, but can be monitored with the Digital Diagnostic Terminal (DDT). Voltage change should be smooth from idle to wide open throttle. If voltage change is erratic, the TPS is defective.

1. Set the DDT's data monitor to read TPS voltage. Refer to the *Digital Diagnostic Terminal Technician Reference Manual* for instructions.

NOTE: *Refer to appropriate service manual for test procedure and specifications.*

2. If the throttle position sensor(s) are out of the intended operating range when the engine is started, the PCM senses that the TPS has failed. The warning horn sounds, the CHECK ENGINE light illuminates, the DDT indicates a failed TPS, and the engine goes into rpm reduction.

3. Visually inspect the sensor.

RESISTANCE TEST

1. Remove the linkage connected to the TPS.

2. Remove the TPS from the engine and the harness.

3. Connect an Ohmmeter between the PPL/YEL and BLK/ORN leads on the sensor.

Reading:

Approximately 2500 Ω <± 375 Ω)

4. Connect an Ohmmeter between the PPL/YEL and LT BLU/WHT leads on the sensor.

5. Slowly rotate the sensor mechanism from idle position through WOT and observe the reading. Resistance change should be smooth from idle to wide open throttle. If resistance change is erratic, replace the TPS.

6. Connect an Ohmmeter between the BLK/ORN and LT BLU/WHT leads on the sensor.

7. Slowly rotate the sensor mechanism from WOT to idle position and observe the reading. Resistance change should be smooth from idle to wide open throttle. If resistance change is erratic, replace the TPS.

VISUAL INSPECTION

If the DDT determines that the TPS sensor has failed, follow this procedure to determine cause:

1. Disconnect the sensor from the harness connection.

2. Visually inspect 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. Replace components as necessary.

3. Check the throttle cable adjustment. The throttle stop screw on the throttle arm must be against the throttle stop on the cylinder block when the engine is started. Pre-load the throttle cable barrel 1 or 2 turns if necessary.

4. Verify that the driver is not pushing on the throttle (if a foot throttle is used) or advancing the throttle only on the control box.

5. Check the throttle cam-to-roller adjustment. If the roller is not down in the pocket/ valley area on the cam, the roller has a tendency to ride up or down on the cam, causing the TPS link arm to push/pull on the TPS lever. This results in changing values.

6. Heat or pressure-test the TPS.

SENSOR HEAT TEST

IMPORTANT: Excessive heat damages the TPS.

1. With the engine at idle, heat the TPS with a hot air gun below the electrical connection until the sensor is warm to the touch.

2. Watch for any of the following symptoms:

- RPM change
- CHECK ENGINE light illumination
- Momentary warning horn signal
- TPS voltage value change (0.5 volt) on DDT

Notes

Notes

SENSOR PRESSURE TEST

IMPORTANT: When testing TPS voltage, do not move the drive mechanism (rotor/wiper).

1. Connect the DDT and rotate the key to the ON position.
2. Set the DDT to read TPS voltage; expand the screen to show Now/Min/Max.

NOTE: *Test accuracy is improved when the TPS is at its lowest voltage reading (engine at idle).*

3. Clear the minimum/maximum values on the DDT.
4. Watch the DDT readings while pressing below the electrical connection point on the TPS cover.
5. The voltage reading should change:

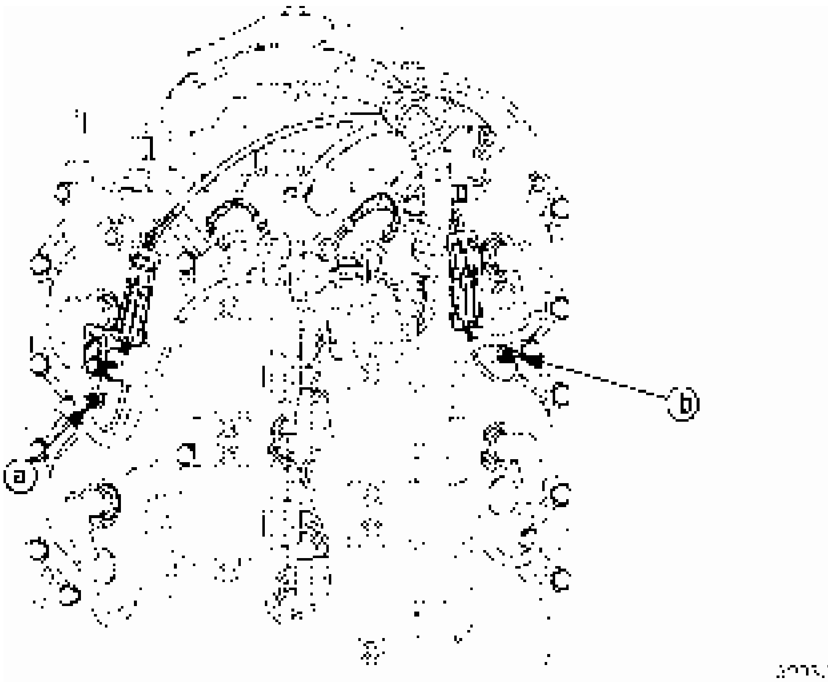
- Less than a couple of digits (i.e. 1.90 v to 1.92 v)
- Less than 10 millivolts (i.e. 0.293 v to 0.285 v)

NOTE: *Version 5.0 cartridges give 3 decimal point (millivolts) accuracy if below 1 volt. If the TPS fails either test, replace the sensor.*

Cylinder Head Temperature Sensor

Two (2) temperature sensors are used to provide temperature information to the ECM. One sensor is mounted in each cylinder head.

The ECM uses this information to increase injector pulse width for cold starts and to retard timing in the event of an over-heat condition. Should a temperature sensor fail, the ECM will default to a temperature value of 32 °F (0 °C).



a) Cylinder Temperature Sensor (PORT)
b) Cylinder Temperature Sensor (STARBOARD)

DDT TEST

1. Set the DDT's data monitor to read coolant temp. Refer to the *Digital Diagnostic Terminal Technician Reference Manual* for instructions.

2. If the sensor reading appears to be incorrect or invalid, perform a resistance test on the suspected sensor.

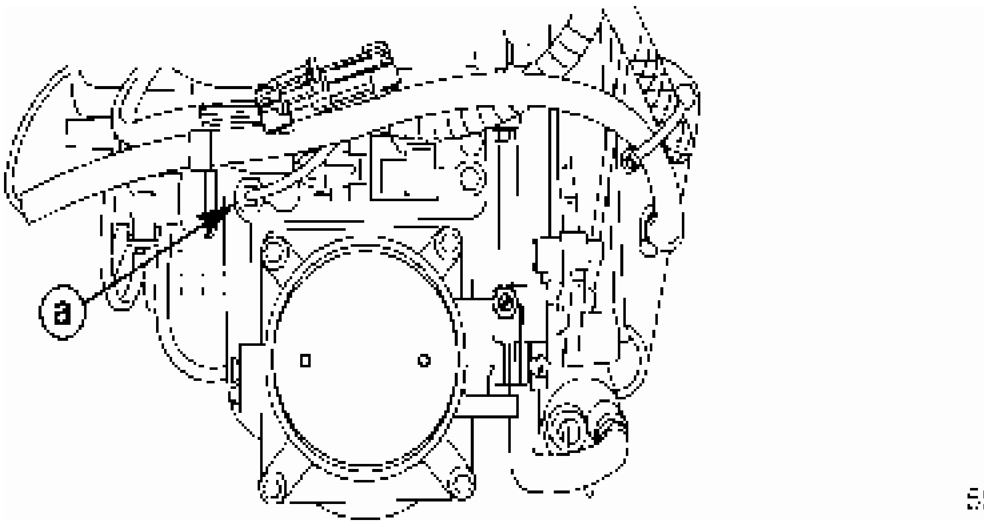
NOTE: *Refer to appropriate service manual for test procedure and specifications.*

Notes

Notes

Air Temperature Sensor

The air temperature sensor is mounted on top of the air plenum. The ECM regulates fuel flow, in part, based on manifold air temperature. As air temperature increases, the ECM decreases fuel flow. Should the air temperature sensor fail, the ECM will default to a temperature value of 32 °F (0 °C).



a) Air Temperature Sensor

DDT TEST

1. Set the DDT's data monitor to read air temp. Refer to the *Digital Diagnostic Terminal Technician Reference Manual* for instructions.

2. If the sensor reading appears to be incorrect or invalid, perform a resistance test on the suspected sensor.

NOTE: *Refer to appropriate service manual for test procedure and specifications.*

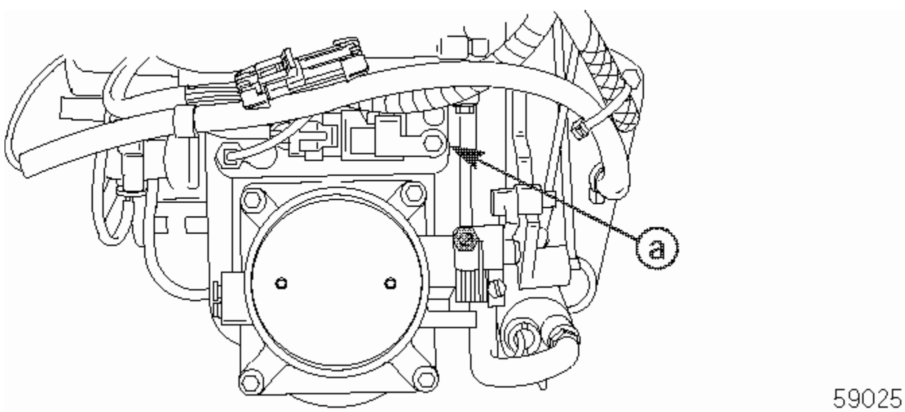
Manifold Absolute Pressure (MAP) Sensor

The MAP sensor is located on top of the air plenum. The ECM regulates fuel flow, in part, based on manifold absolute pressure. The MAP sensor becomes more critical in engine running quality as the engine is operated at higher altitudes (i.e. mountain lakes). Should the MAP sensor fail, the ECM will default to a value of approximately 14.7 psi.

The MAP sensor's DDT readout will vary according to altitude, throttle plate opening and barometric pressure. However, for a given location and weather conditions (I.E. altitude and barometric pressure), the MAP sensor readout between engines should be approximately the same when the ignition key is turned to the "ON" position. For example, if two engines indicate 15 psi when the key is turned "ON" and a third engine indicates 10 psi, the third engine's MAP sensor would be suspect. When the engines are started, MAP sensor readout should drop. When the engines are initially accelerated, the MAP sensor readout will drop momentarily and then begin to rise. Throttle plate opening will also affect the MAP readout. Refer to Service Manual Section 2C for correct throttle plate clearance.

The Digital Diagnostic Terminal (DDT) can be used to determined whether the MAP sensor is functioning properly. As throttle is advanced, numerical value on DDT display should increase. As throttle is retarded, numerical value should decrease indicating MAP sensor is functioning. If numerical value does not change as throttle setting varies, MAP sensor is defective.

NOTE: *If MAP sensor is not functioning, #4 LED indicator light on DDT will be illuminated.*



a) Manifold Absolute Pressure (MAP) Sensor

Notes

Notes

DDT TEST

IMPORTANT: A fouled or faulty MAP sensor displays a default value of approximately 14.7 psi.

1. With the DDT connected, start the engine.

2. Quickly open the throttle and close it again while observing the MAP sensor readings on the Data Monitor function of the DDT.

3. If the sensor responds quickly to the changes in throttle position, the sensor is good.

4. If the MAP sensor does not change, or changes slowly, disconnect and visually inspect the sensor opening for blockage by oil. Clear the opening and re-install the sensor. Repeat step 3.

Another sign that the MAP sensor is the problem is if the MAP sensor range of values changes by more than 2.1 kPa (0.3 psi) while the engine remains at a constant rpm and throttle opening.

Example: With the engine operating at a constant 2000 rpm, the MAP numbers change from 93.8 kPa (13.6 psi) down to 92.4 kPa (13.4 psi) and then up to 95.1 kPa (13.8 psi), and back again. This indicates a problem with the MAP sensor. If the readings are incorrect, replace the MAP sensor.

VOLTAGE TEST

IMPORTANT: The Propulsion Control Module (PCM) is dependable and should not be replaced before testing the sensor or wiring harness. The corrosive environment combined with vibration suggests that most problems occur with either the wiring or the sensor.

NOTE: *Shake or move the harness and connector by hand as you perform the following tests. If the voltmeter readings vary during the tests, a broken, loose, or corroded wire is most likely causing the failure. Repair the problem wire and retest the circuit as follows.*

1. Set the key switch to RUN with the engine off.

2. Disconnect the sensor from the harness connection.

3. Visually inspect 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. Replace components as necessary.

4. Connect a voltmeter across the PPL/YEL and the BLK/ORN wires at the connector.

Example:

Lead to PPL/YEL

Lead to BLK/ORN

5+ Volts

5. The voltmeter should read +5 volts, if not, connect the voltmeter across the PPL/YEL wire and the engine ground. If the voltmeter indicates +5 volts, there is an open in the ground circuit (BLK/ORN).

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

6. If the the voltmeter does not indicate +5 volts, there is an open circuit between the PCM and the connector (PPL/YEL).

NOTE: *All the +5 volts power wires for the sensors are spliced together and connect to the PCM (pin 22 of A connector). Unless there are multiple sensor failures, the most likely failure would be at the splice point, the connector or in between the connector and the splice point.*

7. Test the sensor.

a. Remove the sensor from the engine and attach the connector to the sensor.

b. Insert the positive probe of a voltmeter to the input lead of the connector going to the PCM.

c. Insert the negative probe of the voltmeter at the ground (BLK/ORN) lead of the connector.

d. Attach a vacuum gauge to the sensor and refer to the table to determine the voltage reading at the applied pressure. If there is no input voltage or if the input voltage is incorrect, replace the sensor and retest.

DC Volts	0.0	0.3	0.6	0.9	1.3	1.5	1.9	2.1	2.5	2.8	3.1	3.4	3.8	4.0	4.4	4.7	4.9
kPa	10	16	22	28	34	40	46	52	58	63	69	75	81	87	93	99	105
InHg	27	25	23	21	20	18	16	14	13	11	9.1	7.3	5.6	3.8	2.1	0.3	-1

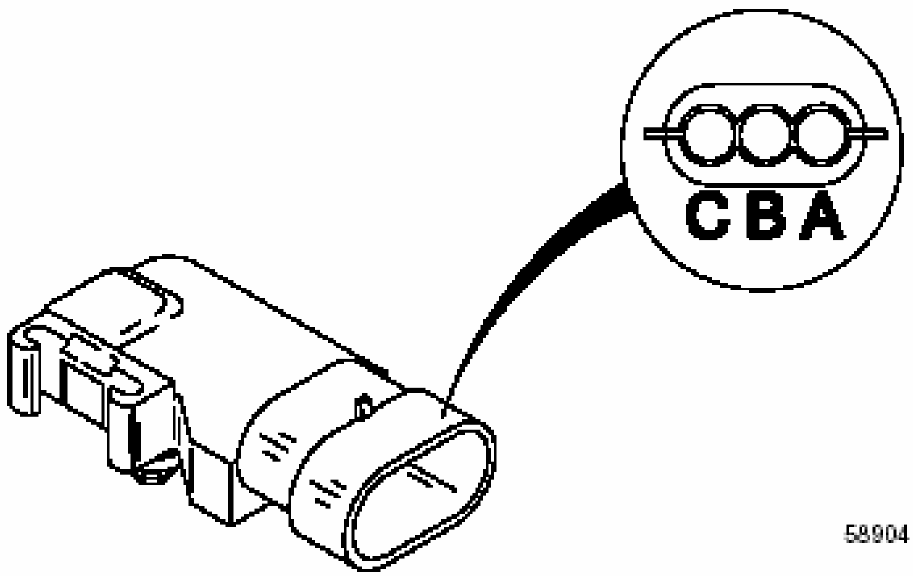
8. If the voltage was present at the sensor insert a probe at the yellow input wire to the PCM (pin 3, connector A). If no input voltage is present, repair the wire from the sensor to the PCM and retest.

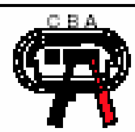
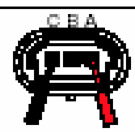
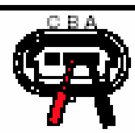
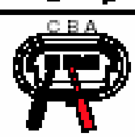
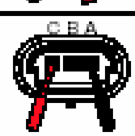
9. If voltage is present at the PCM, replace the PCM and retest.

Notes

RESISTANCE TEST

1. Disconnect the sensor from the harness connection.
2. Visually inspect 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. Replace components as necessary.
3. Perform a resistance test. If the sensor fails this test, replace the sensor.

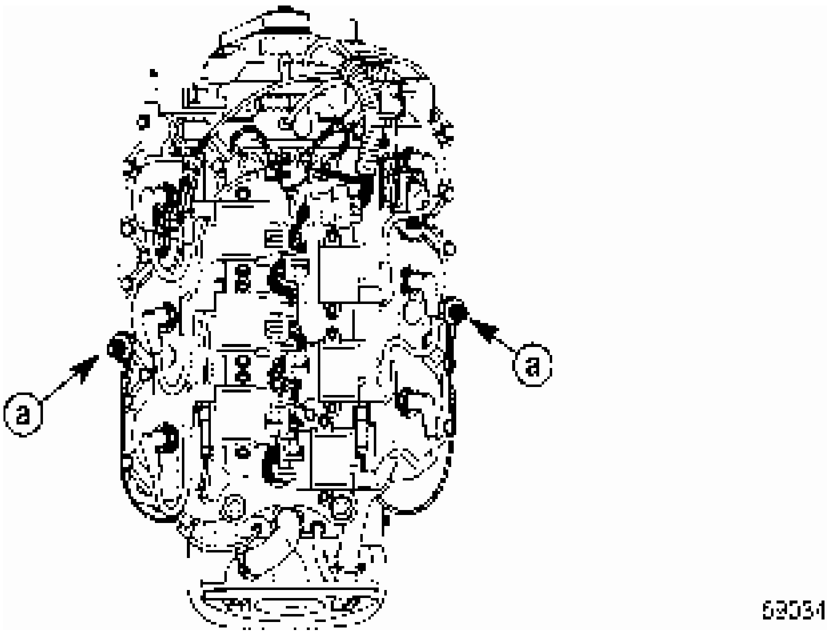


Example	Description	Reading
	Red lead to pin A. Black lead to pin B.	95 - 105 kΩ
	Red lead to pin A. Black lead to pin C.	3.9 - 4.1 kΩ
	Red lead to pin B. Black lead to pin A.	95 - 105 kΩ
	Red lead to pin B. Black lead to pin C	95 - 105 kΩ
	Red lead to pin C. Black lead to pin A.	3.9 - 4.1 kΩ
	Red lead to pin C. Black lead to pin B.	95 - 105 kΩ

EFI Detonation Control System

Notes

The detonation control circuit is located in the ECM. This circuit monitors 2 detonation (knock) sensors; 1 each located in each cylinder head. When detonation is initially detected, timing is retarded. If detonation continues, fuel mixture is richened.



a) Detonation Sensor (1 Per Cylinder Head)

Spark Plugs and Wires

Damaged or loose spark plug wires may cause plug fouling. Most wire damage is the result of rough handling and the use of incorrect tools to remove and install wires.

- Check that all of the plug wires are fully engaged onto the coil towers and the spark plugs.
- Check the spark plug wire boots for damage.

NOTE: *Slightly stretching the boot may show a cut or hole that otherwise may not be seen.*

NOTE: *To prevent spark plug cross-threading, use a piece of hose pushed over the plug. (Gray fuel hose with 8 mm (0.315 in.) I.D. works well.) This will allow you to thread the plug into the spark plug hole by hand while avoiding cross-threading. Torque plug to the specified value.*

Notes

Main Power Relay

Typically, the starter draws 210 amps when cranking the engine, lowering the voltage available from the battery. If the battery voltage available from the battery is less than 7 volts during cranking, the Main Power Relay (MPR) may not close or even remain closed during cranking, resulting in no spark, no injector activity, or no voltage to the electric fuel pump. Under these conditions the PCM concludes that the relay output circuit is at fault and sets a code, which is stored in the Freeze Frame buffer of the DDT. The main power relay fault is uncommon. Close examination of the MPR Freeze Frame buffer will probably indicate a very low battery voltage condition when the fault was recorded. The higher the frequency count, the more likely that the battery voltage is low.

Stop Switch Circuit

To test for a shorted stop switch circuit:

1. Disconnect the key switch harness from the engine.

2. Turn the ignition key to the RUN position and make sure the lanyard switch is in the RUN position.

3. Check for continuity between the BLACK/YELLOW and BLACK wires in the key switch harness - there should be no continuity.

Example:

Connect meter leads between BLACK and BLACK/YELLOW pins. There Should be “No Continuity”.

Shift Interrupt Switch

The shift interrupt switch reduces the torque load on the gear case components to assist in shifting. The switch is monitored by the PCM, which momentarily interrupts the fuel flow to three cylinders (#1, #2 and #4) when engine speed exceeds 600 rpm in neutral.

- The DDT can monitor switch function. The DDT displays ON when the outboard is in neutral and OFF when in gear.
- The switch is open when the outboard is in gear. A resistance test will result in no continuity.
- The switch is closed when the outboard is in neutral. A resistance test will result in continuity.
- If shift operation is difficult, shift interrupt switch function can be checked by the DDT or an ohmmeter - for open or closed operation and for a continuity check of the switch harness for shorts or open wiring.

Visually inspect the pins at the switch 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. Replace components as necessary.

Water Sensing System

The system consists of a water separating fuel filter (port side powerhead) and a sensing probe (bottom of filter).

Water Sensing System Function

1) The filter separates the accumulated water from the fuel.

2) A voltage is always present at sensing probe. When water reaches top of probe it complete the circuit to ground.

3) The completed circuit activates the warning horn which intermittantly sounds.

The system can be tested by disconnecting the TAN wire from sensor probe and holding to a good engine ground connection for 10 seconds.

Notes

Notes

Component Description and Diagnostics

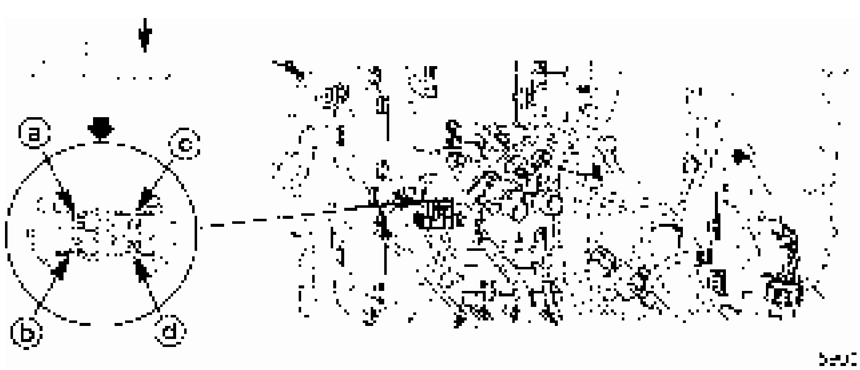
The Propulsion Control Module (PCM) is dependable and should not be replaced before testing the suspected sensor or wiring harness. The corrosive environment of marine applications combined with vibration suggests that most problems occur with either the wiring or the sensor. If the engine is running poorly or not starting and there are no specific fault codes, some preliminary investigation is needed before replacing a sensor or the PCM. Conditions resulting in poor drive-ability or ignition can be attributed to:

- Fouled spark plugs
- Faulty plug wires
- A weak ignition coil
- Vacuum leaks
- Low compression
- Dirty injectors
- Low fuel pressure
- Low air pressure
- Low charging voltage

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) Open the fuse holder and look at the silver colored band inside the fuse. If band is broken, replace the fuse. Replace fuse with a new fuse with the same rating.
2) The fuses and circuits are identified as follows:
   a) Smart Craft Data Bus Circuit – SFE 15 Ampere Fuse
   b) Fuel Injector Harness, Electric Fuel Pump and Oil Pump
   c) Main Power Relay, Remote Control Harness and Power Trim
   d) Ignition Coils



Charging System Alternator

Battery charging system is contained within the belt driven alternator, including the regulator. At cranking speeds, electrical power for the engine is provided by the boat battery – mini-mum recommended size is 490 Cold Cranking Amperes (CCA) or 630 Marine Cranking Amperes (MCA). Above 550 RPM, all electrical power is provided by the alternator. Should engine rpm drop below 550 RPM, the alternator is not capable of providing sufficient output and the battery becomes the primary source of electrical power.

Alternator output (when hot) to the battery @ 2000 RPM is approximately 35 - 41 amperes.

a) Alternator

Notes

2002 Warning System Signals

NOTE: *The warning system signals which includes audible and visual indicator involving the horn and gauges will identify the potential problems listed in the chart.*

Problem	Horn	Monitor Display	Guardian Activated	Engine Speed Reduction Activated
Power Up/System Check	Single Beep	Yes	N/A	No
Low Oil	4 Beep… 2 Minutes Off	Yes	No	No
Oil Pump Electrical Failure		Yes	Yes	Yes (See Guardian System)
Over Heat	Continuous Beep	Yes	Yes	Yes (See Guardian System)
Water In Fuel	4 Beep… 2 Minutes Off	Yes	No	Yes (See Guardian System)
Over Speed	Continuous Beep	Yes	Yes	Yes (See Guardian System)
Coolant Sensor Failure	No	Yes	No	No
MAP Sensor Failure	No	Yes	No	No
Air Temperature Sensor Failure	No	Yes	No	No
Ignition Coil Failure	No	Yes	No	No
Injector Failure	No	Yes	No	No
Horn Failure	N/A	Yes		No
Battery Voltage too high (16V) or too low (11V) or very low (9.5V)	No	Yes	Yes	Yes (See Guardian System)
Throttle Sensor Failure	Continuous Intermittent Beeping	Yes	Yes	Yes (See Guardian System)
Block Water Pressure	Yes	Yes	Yes	Yes (See Guardian System)
Calculated Oil Level Critical	Yes	Yes	Yes	Yes

Notes

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 ad-verse 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 re sponsible for proper engine operation.

Guardian System Operation with Gauges

Smartcraft Gauge/Monitor	System will sound warning worn and display the warning message.

Guardian System Activation

Warning Horn		
Function	**Sound**	**Description**
Cooling System Problem	Continuous	Engine Guardian System is activated. Power limit will very with level of overheat. Shift outboard into neutral and check for a steady stream of water coming out of the water pump indicator hole. If no water is coming out of the water pump indicator hole or flow is intermittent, stop engine and check water intake holes for obstruction. The Guardian system must be RESET before engine will operate at higher speeds. Moving throttle lever back to idle resets the system.
Oil Level Is Critically Low	Continuous	Engine Guardian System is activated. Power limit will limit engine speed. The oil level is critically low in the engine mounted oil reservoir tank. Refill the engine mounted oil reservoir tank along with the remote oil tank.
Oil Pump Failure	Continuous	Engine Guardian System is activated. Power limit will limit engine speed. The warning horn is activated if the oil pump should ever stop functioning electrically. No lubricating oil is being supplied to the engine.
Engine Overspeed	Continuous	The warning horn is activated any time engine speed exceeds the maximum allowable RPM. The system will limit the engine speed to within the allowable range. If the overspeed condition continues, the Engine Guardian System will place the engine in power reduction. The Guardian system must be RESET before engine can resume full power. Moving throttle lever back to idle resets the system. Engine overspeed indicates a condition that should be corrected. Overspeed could be caused by incorrect propeller pitch, engine height, trim angle, etc.
Sensor out of Range	Continuous	Engine Guardian System is activated. Power limit may activate at full throttle speed.
	Intermittent Beep	Engine Guardian System is activated. Power limit may restrict engine speed to idle.

Smartcraft Data Worksheet

Dealer Name:	Engine S/N:
Dealer Number:	Engine Type:
Technician Name:	ECM Part Number:
Date:	DDT Software Version:

Data Monitor – Two Stroke EFI

ENGINE #	IDLE	1500 RPM	3000 RPM	NOTES
ENGINE RPM				
TPI 1 VOLT				
BATTERY VOLTS				
PWR 1 VOLTS				
COOL TMP STB F				
COOL TMP PRT F				
MAP PSI				
AIR TMP F				
BLOCK PSI				
OIL INJ CNT				
TPI %				
AIR COM TMP F				
OIL LEVEL				
FUEL LEVEL				
AVAILABLE PWR %				
SHIFT				
TRIM				
PITOT				
PADDLE WHEEL				
LAKE/SEA TMP F				
SPARK ANG BTDC				
FPC TOTAL OZ				

Smartcraft Data Worksheet - 90-881929--1

Dealer Name:	Engine S/N:
Dealer Number:	Engine Type:
Technician Name:	ECM Part Number:
Date:	DDT Software Version:

Fault Seconds	**Engine #1**	**Engine #2**	**Run History**	**Engine #1**	**Engine #2**
BATT VOLT HIGH			RUN TIME HR		
BATT VOLT LOW			RPM 0-749		
BLOCK PRESS LOW			750-1499		
COMP OVERHEAT			1500-2999		
ETC MOTOR OPEN			3000-3999		
ETC MOTOR SHORT			4000-4499		
FUEL P INPUT HI			4500-4999		
FUEL P INPUT LO			5000-5499		
GUARDIAN			5500-6249		
KNOCK SENS1			6250+		
KNOCK SENS2			BREAK-IN LEFT		
OIL PSI STR			RPM LIMIT Sec		
OIL REMOTE SRT			GRD LIMIT Sec		
OIL RESERVE STR			ACT TEMP Sec		
MAP INPUT HI			BLOCK PSI Sec		
MAP INPUT LO			CTS TEMP Sec		
MAP IDLE CHECK			CTP TEMP Sec		
OIL PUMP			LOW OIL Sec		
OVERSPEED			OIL PMP Sec		
PORT OVERHEAT					
STAR OVERHEAT			**Boat Information**		
WARNING HORN			WOT RPM		
H2O IN FUEL			Propeller Type		
	#1	#5	Propeller Size		
LED INDICATORS	#2	#6	Boat Type		
ILLUMINATED	#3	#7	Boat Length		
	#4	#8	Weather Condition		

SmartCraft Data Worksheet

Dealer Name:	Engine S/N:

FREEZE FRAME FAULT BUFFER DATA

FAULT ID	**Fault Buffer 0**	**Fault Buffer 1**	**Fault Buffer 2**	**Fault Buffer 3**	**Fault Buffer 4**	**Fault Buffer 5**	**Fault Buffer 6**	**Fault Buffer 7**	**Fault Buffer 8**	**Fault Buffer 9**
BREAK-IN										
BARO PSI										
BATT VOLTS										
BLOCK PSI										
BOAT SPEED										
AIR TEMP F										
COOL TEMP F										
DEMAND %										
ENGINE RPM										
ENGINE STATE										
FPC TOTAL										
FREQ COUNTER										
FUEL LEVEL %										
SHIFT										
LAKE/SEA TEMP F										
LOAD %										
MPRLY										
MAP PSI										
OIL LEVEL %										
PORT TAB POS										
AVAILABLE PWR %										
RUN TIME										
STAR TAB POS										
TPS %										
TRIM POS										
COOL TEMP STB F										
COOL TEMP PRT F										

What was the engine speed when the failure occurred? ______________________________

How was the engine being operated before the failure?

1) Steady RPM 3) Accelerating

2) Decelerating 4) Extended Idle

SmartCraft Data Worksheet Fault ID Description

Notes

BREAK-IN

- Engine is still within oil break-in clock

BARO PSI

- The barometric pressure when the fault occurred

BATT VOLTS

- The battery voltage when the fault occurred

BLOCK PSI

- The engine block pressure when the fault occurred

BOAT SPEED

- Boat speed when the fault occurred

AIR TEMP F

- The engine temperature when the fault occurred

COOL TMP F

- The primary (CTS) coolant temperature when the fault occurred

DEMAND %

- The demand % (TPI%) when the fault occurred

ENGINE RPM

- The engine RPM when the fault occurred

ENGINE STATE

- The engine state when the fault occurred

FPC TOTAL

- The calibrated fueling level when the fault occurred

FREQ COUNTER

- The number of times the fault occurred. 0=1 occurrence, 1=2 occurrences

FUEL LEVEL %

- The main fuel tank level % when the fault occurred

SHIFT

- The engine was in gear (or neutral) when the fault occurred

LAKE/SEA TMP F

- The temperature of the lake/sea water when the fault occurred

LOAD %

- The engine load % when the fault occurred

Notes

MPRLY

- A value of zero indicates there was no request made to activate the main power relay. A value greater than zero indicates that the main power relay was active.

MAP PSI

- The MAP pressure when the fault occurred

OIL LEVEL %

- The main oil tank level % when the fault occurred

PORT TAB POS

- The position of the port trim tab when the fault occurred

AVAILABLE PWR %

- Available Engine Power % when the fault occurred

RUN TIME

- The time at which the fault occurred (ECM run time)

STAR TAB POS

- The position of the starboard trim tab when the fault occurred

TPS %

- The TPI % (Demand %) when the fault occurred

TRIM POS

- The trim position when the fault occurred

COOL TMP STB F

- The starboard coolant temperature sensor reading when the fault occurred

COOL TMP PRT F

- The port coolant temperature sensor reading when the fault occurred

SmartCraft Overview

SmartCraft is Mercury's approach to vessel system integration based on a "Platform" technology. Platform technology first pioneered by the automotive industry, enables automobile manufacturers to link and share electronic information between propulsion, chassis, and automobile body electrical systems. In automobiles this modular, integrated approach enables the linking of inputs and outputs for activities such as brake and traction control, trip computing (estimated distance to empty, range, etc.), electronic throttle, torque control, and integrated control of vehicle stability through monitoring and control of vehicle pitch, roll, and yaw.

SmartCraft is a platform that enables the boatbuilder or system installer to build an integrated boat based on a platform that will enable the creation of a communication network between typical on– board electronics devices. In its most sophisticated current embodiment, the SmartCraft system will provide value to the consumer through enabling the following activities:

1) **SmartCraf**t Fuel Flow, and Range (SC1000, SC5000 Series Products) calculations (if the system includes either the System Tachometer and Speedometer, System Monitor or System View).
2) Additionally, many of the SmartCraft devices listed in item (b) above drive digital System Link gauges (SC100 Series Products) that have dedicated single– function analog read– out dial faces for monitoring the following propulsion functions:

- Tachometer (6,000/8,000rpm)
- Speedometer (80/120mph/kph)
- Engine oil temperature
- Engine oil pressure
- Engine coolant temp
- Engine water pressure (outboard)
- Battery voltage
- Drive/Outboard motor trim/trailer position
- Rudder/Drive angle
- Fuel tank No. 1 level
- Fuel tank No. 2 level
- Oil tank level (outboard)
- Fresh water tank level
- Waste tank level
- Fuel flow

3) Some SmartCraft products are designed to accept data from non– Mercury devices such as certain compatible GPS receivers.

Notes

Notes

4) As the SmartCraft system evolves one can envision automated trim tabs controlling vessel pitch, roll, and yaw. Because the platform can accept compatible products, this, and any other approved product may be integrated (installed) to the Platform by an approved dealer, after the platform vessel leaves the boatbuilder.

NOTE: *Because SmartCraft offers so many options for custom tailoring of the vessel and its systems, product configurations may differ from builder to builder or from boat model to model. The essence of SmartCraft is that when a boatbuilder or dealer chooses Mercury's SmartCraft Platform, he or she may custom tailor the system products based on the guidelines in this manual, to the needs of the consumer.*

SmartCraft Platform - Kvaser CAN Kingdom Overview

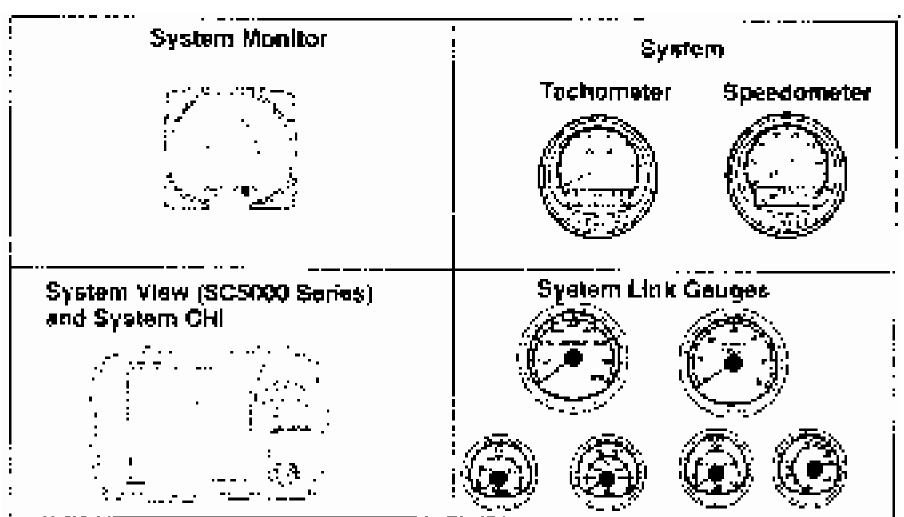
What is CAN?

CAN stands for Control Area Network, where the inputs and outputs of electronic devices in a network are controlled for the common good of the system or area.

CAN Kingdom, a communication technology patented by Kvaser Industries is a hierarchy based protocol that is applied to a standard J1939, or NMEA 2000 CAN bus. Hierarchy protocol technology allows an otherwise completely open data– bus to be organized to enhance the safety and reliability of the CAN bus for use with safety critical products such as boat propulsion systems, and propulsion electronic remote controls.

NOTE: *Mercury Marine is utilizing Kvaser's CAN Kingdom protocol for its SmartCraft Platform data transmission structure.*

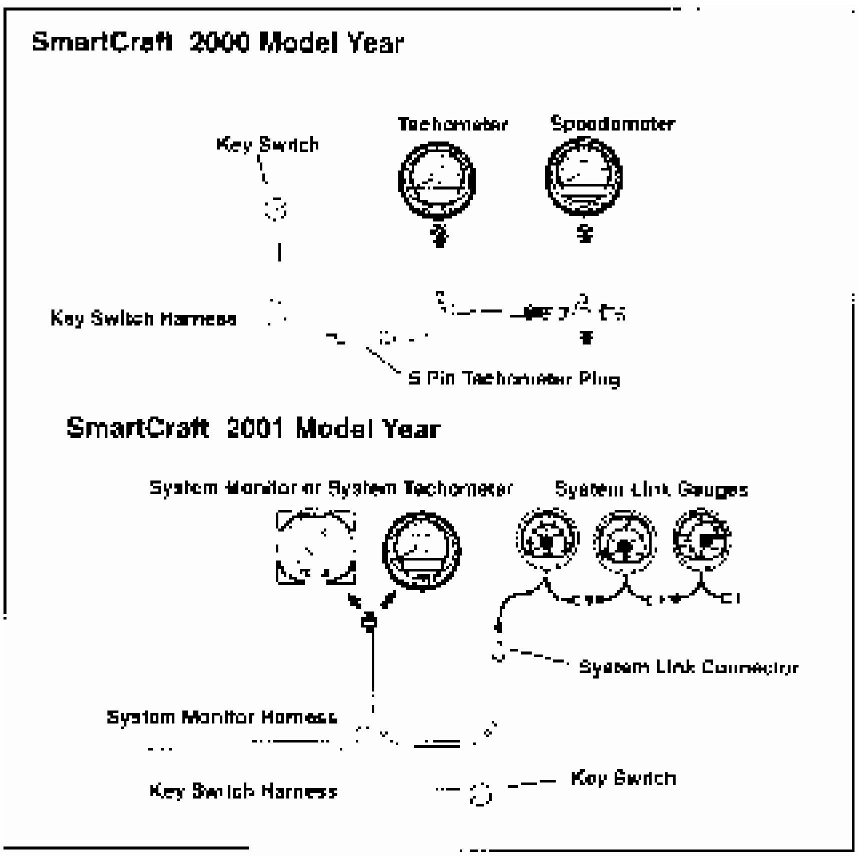
SmartCraft System Products



SmartCraft System Rules

1) Each system must contain exactly two (2) terminators.
2) Terminators should be located at the furthest ends of the main CAN bus.
3) The total CAN bus should not exceed 130 ft (39.6 meters)
4) Each CAN Bus must only be powered from one engine.
5) All unused junction ports must be capped using weather caps.

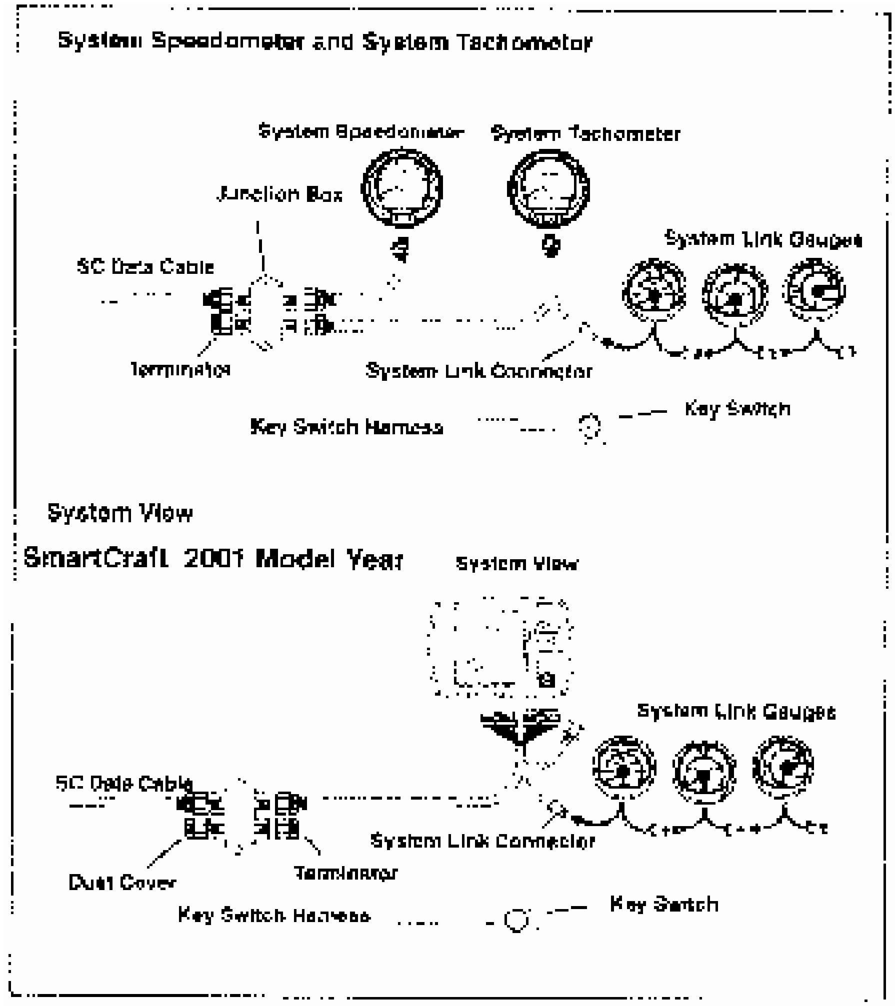
SmartCraft System Typical Layout



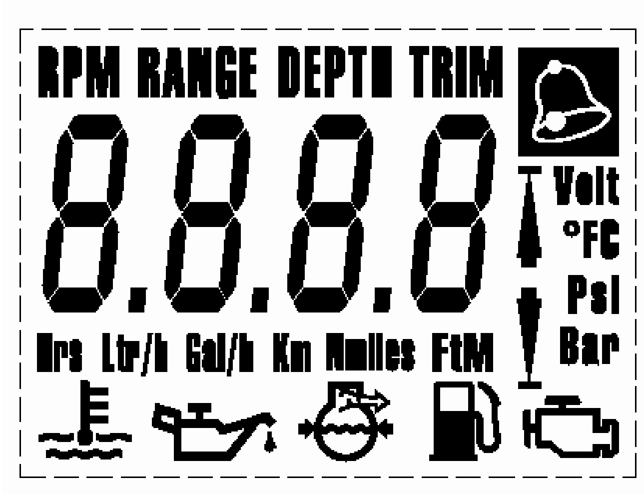
Notes

Notes

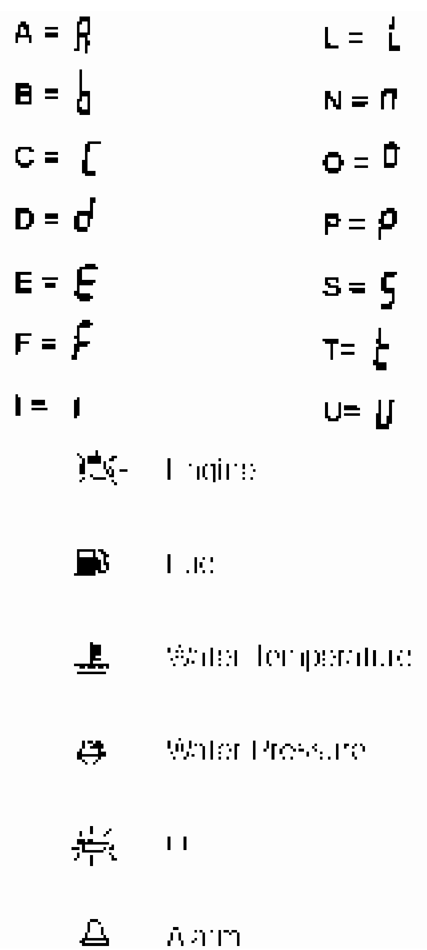
SmartCraft System Typical Layout (Cont.)



System Monitor



System Monitor Legend



Section 5 - Product Changes

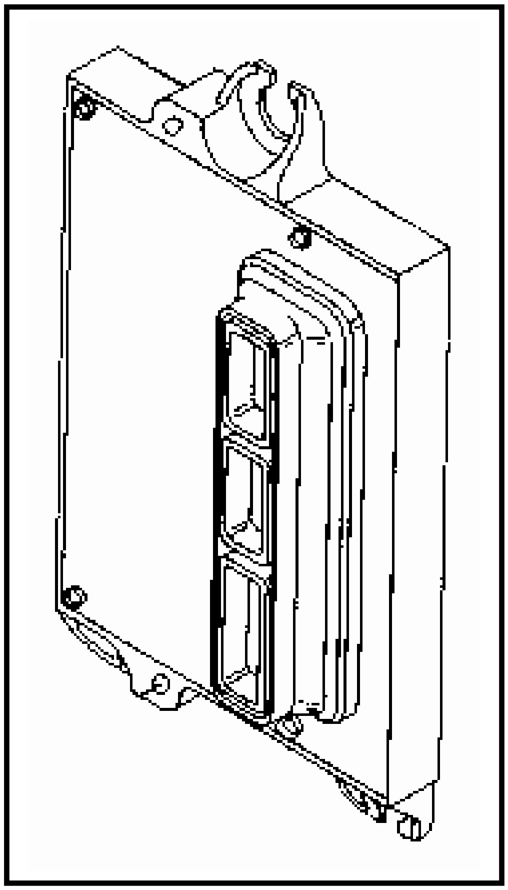


Table of Contents

Notes

Model Year Changes

ECM/PCM

2004 MY

- Improved reference voltage circuit for SmartCraft sensors
- Higher tolerance to under cowl heat (105° C).
- ECM base P/N 885557 Mechanical, 885558 DTS

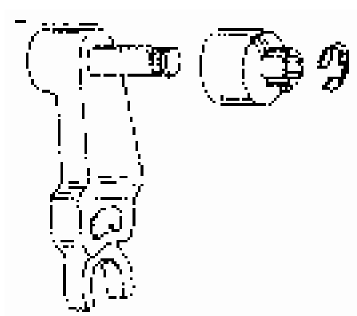
Throttle Roller

2004 MY

Three improvements to the throttle roller assembly:

- Roller material changed to a more robust, wear resistant plastic.
- Roller is cut from extruded stock, which results in consistent roundness.
- Roller is now retained on the lever with washer and lock nut. Prior to this the roller was retained with retainer ring/E-clip, or retainer clips built onto the roller.

Roller arm assembly complete will back fit, but will not supersede the old lever and roller. Two kits with instruction sheet will be available # 90-891933.



Cylinder Head Location Pins - 3.0 Litre Models

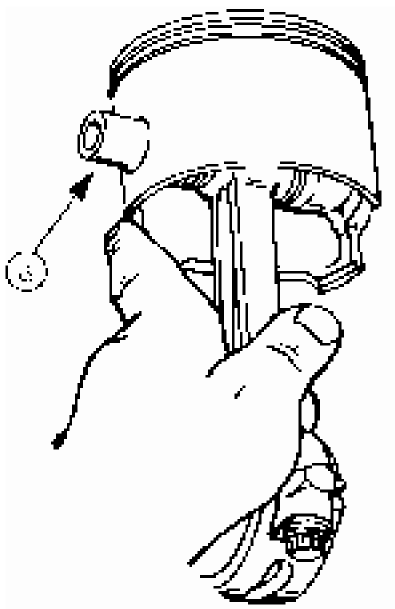
2004 MY

Cylinder heads will have location pins between the head and the cylinder block deck surface. Product improvement, increases bore seal life and durability, reducing bore seal leakage.

Piston Pin Material Change - 3.0 Litre Models

2004 RUNNING CHANGE

New piston pin material, high chromium bearing steel (harder), product improvement and increased durability. Is currently scheduled to be a running change in early 2004 model year.



a – Piston Pin

Notes

Notes

New Model - 200 HP 3.0 Litre

2004 MY

This new model 200 HP, 3.0 Liter EFI will replace the 200 HP, 2.5 Liter EFI. This engine will use the 3.0 Liter work EFI cylinder block with the 225 EFI heads, and a new ECM calibration. This is a late 2003 model year release Feb. 2003.

The 3.0L engine will answer the bass boat market demand for a higher displacement 200 EFI engine. Higher displacement to give the engine more power to lift a heavy, loaded bass boat out of the hole and adds top end speed – two critical performance factors for the bass market. In addition, the **3.0L 200 EFI** features dual water pickups on the lower unit, a feature that ensure a steady flow of cooling water, regardless of trim angle.

The 3.0L 200 EFI will perform very well, especially on heavy bass boats. For example, Mercury's initial boat testing shows the following performance differences versus the 2.5L 200 EFI:

Engine	Acceleration 0-20mph	Top Speed (mph)
2003 2.5L 200 EFI	6.4	63
2003.5 3.0L 200 EFI	4.1	68

For 2003 model year, both the **2.5L 200 EFI (1-200413AD)** and **3.0L 200 EFI (1-200453AD)** will be available in 20" shaft lengths. However, in 2004 model year, the 3.0L will supercede the 2.5L (20" shaft only).

Returnable Engine Carton

2004 RUNNING CHANGE

Starting with the 2004 model year Mercury will start shipping some outboards in steel frame returnable engine cartons. Rigid container, lower shipping damage, has 3-way fork entry, easy to pack, easy to unpack, ability to ship and store outdoors, minimal disposal. The engine is bolted to the steel frame and the frame is covered with a vinyl cover.

To remove the engine:

- Remove outer cover/bag
- Remove 4 hairpins
- Secure gusset into place
- Remove top frame
- Remove end frame
- Remove top cowl from engine and remove engine from frame

To return steel frame:

- Collapse and reassemble
- Call toll free phone number, freight is pre-paid
- Collapsed engine cartons can be stacked 5 high for return

The 3.0 Liter OptiMax DTS model will be the first to use this returnable carton. The 1.5 Liter, 3 cylinder OptiMax is also planned to use this carton, but this has not been finalized.

The 3.0 Liter EFI work engine will get steel frame but will use cardboard cover. For international the frame was not intended to be returned its just lower cost then the current steel frame used in for international.

Steel frame returnable engine carton with a water resistant vinal cover.

Notes

Notes

Steel frame returnable engine carton in up right position.

Steel frame returnable engine carton collapsed, reassembled and ready to return.

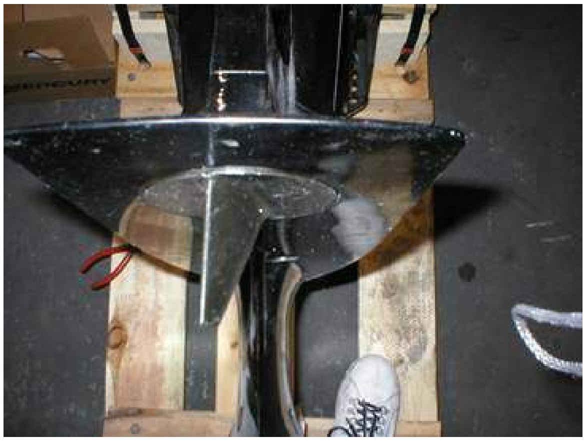
Trim Tab Removed - 2.5L EFI

Notes

2004 RUNNING CHANGE

S/N 0T962390

- Trim tab removed per OEM request
- Replaced with flat anode plate



250 Long 20 Inch

LATE 2004 INTRODUCTION

S/N 0T861546

- Replaces 250 XB
- Torque master lower unit
- Solid lower engine mounts

Notes

Shift Link 3.0 EFI

2004 RUNNING CHANGE

- Added shoulder on front stud of shift link
- Eliminate hard shifting due to over tightened shift shaft to shift link retainer nut
- 883142A 2 – SST – 883142 A03

Thermostat Hose Clamp - 3.0 EFI

2004 RUNNING CHANGE

S/N 0T945848

- Plastic cable tie replaced with stainless steel clamp
- Reduce water leaks & under cowl corrosion
- New clamp   P/N 54-888988 014

Starter Motor – 2.5 and 3.0L

2005 MODEL YEAR

- First implimented on Verado
- Improved bottom end cap bushing
- Improved durability to axial thrust load
- Starter 50-853329 1- SST -50-892339

Notes

Notes

2005/2006 Model Year Changes14 Pin Adapter and Control Harnesses

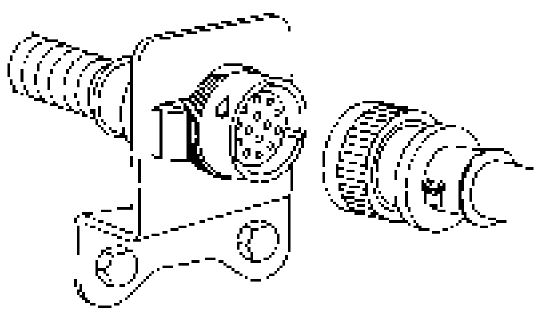
Models Affected

4-stroke models 9.9 thru 225 HP V-6 EFI (Excluding Verado)

2-stroke V-6 Outboards 135 thru 250 HP (Excluding Jet Drive)

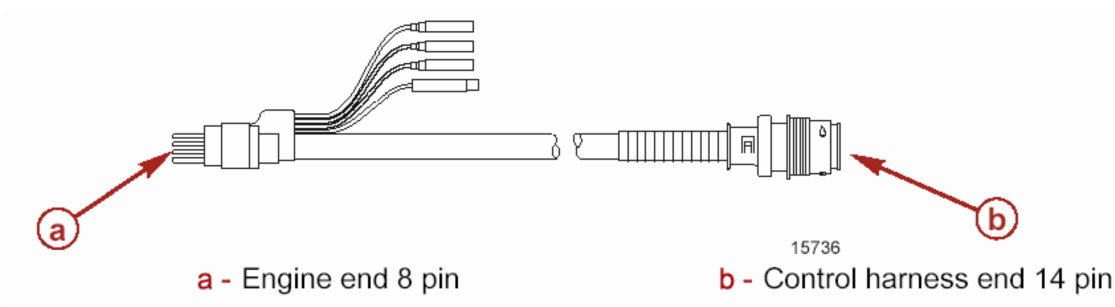
The 2006 models listed above will be changing to a 14 pin connector for the main engine to boat control harness connection. A number of harness adapters have been developed to allow the use of older controls on new engines that use the 14 pin connector. Some of the new adapters will also allow the 2005 and prior models to use the new style 14 pin controls and key/choke harnesses.

- New engine harness requires a new 14 pin key/choke harnesses & controls. CAN # 1 & 3 built into harness with separate terminator locations. Old will NOT supersede to new.
- Reference Current Parts Catalogue for part numbers.



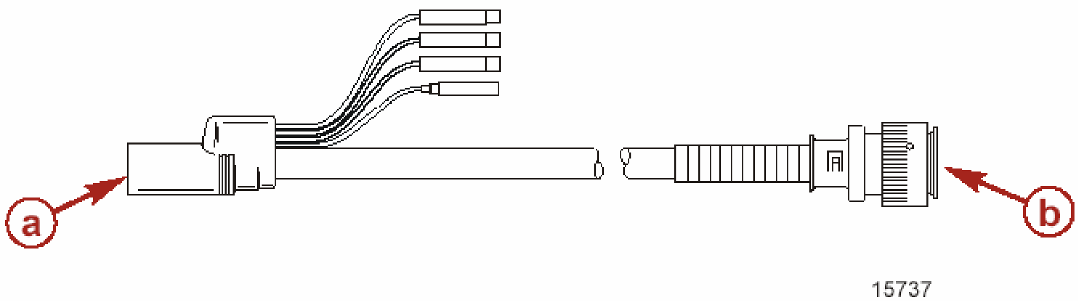
Adapter Harnesses (Key/Choke)

84-896539T_ Adapts 2005 model year and prior engines that use the round 8 pin harness to the new 14 pin key/choke harness. Use with engines not being equipped with SmartCraft gauges.



Adapter Harness

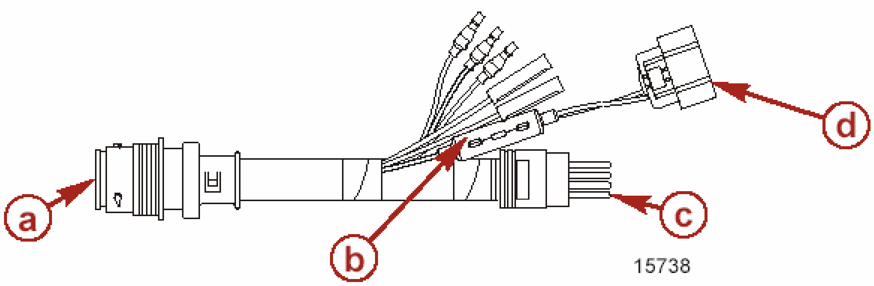
84-896542T_ Adapts 2006 model year and newer engines that use the 14 pin harness to the old round 8 pin control or key/choke harness. Use with engines not being equipped with SmartCraft gauges.



a - Control harness end 8 pin
b - Engine end 14 pin

Adapter Harness

84-892092T_ Adapts 2005 model year and prior engines that use the round 8 pin harness to the new 14 pin control or key/choke harness. Use with engines being equipped with SmartCraft gauges. The adapter allows engine and boat data to be transmitted through the new 14 pin control or key/choke harness. The new 14 pin control or key/choke harnesses have connections at the helm for SmartCraft gauges. A separate blue data harness would longer be required.



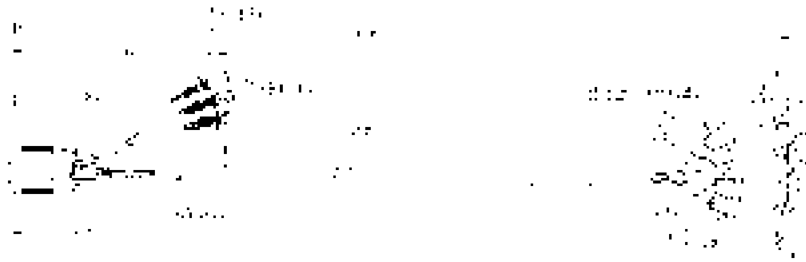
a - Control harness end 14 pin
b - Resistor for SmartCraft
c - Engine end 8 pin
d - CAN connection at engine

Notes

Notes

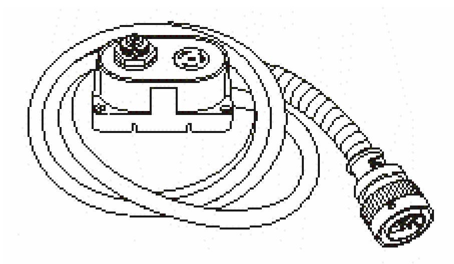
Analog Instrument Harness

84-892990T01 connects to the 10 pin/J-box connection on new 14 pin key/choke harness, to operate analog gauges



New Test Key Switch 14 pin15000A12

Service tool to isolate the boat from the engine.



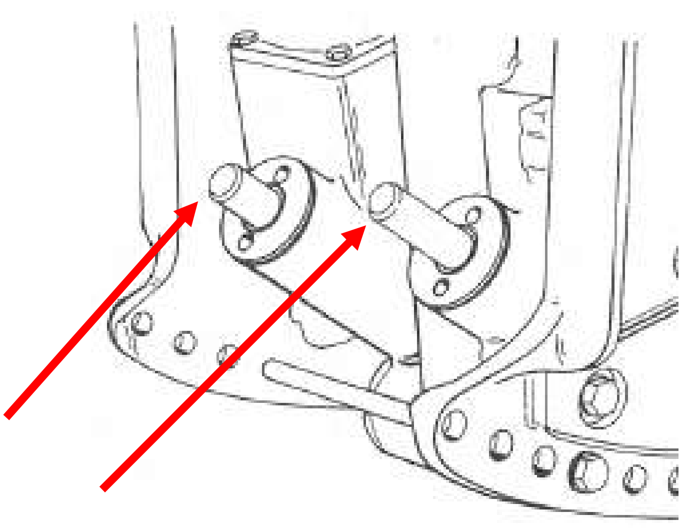
8 pin Service Key Switch 15000A7

New Decal Design

- All engines will be salt water version
- Stainless steel parts added to 20 inch versions

Power Trim Rams

- Ball at end of trim rams will be nickel plated to reduce rust/corrosion of the ball.
- Corrosion would prevent the ball from rotating.
- Product improvement, will back fit, no P/N change



Notes

Notes

Dielectric Grease

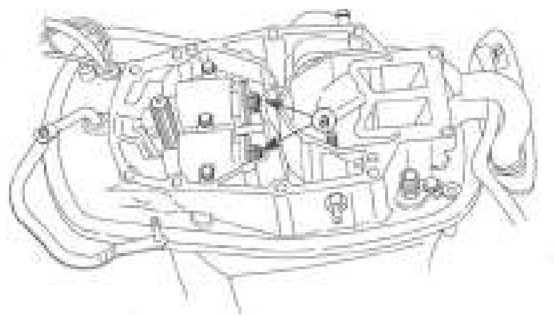
- Dielectric grease will no longer be used on electrical connection except the 8 pin cannon plug on 2005 product
- Improved electrical connection allows the removal of the grease

Drive Shaft Seal Carrier

- Orange coating on carrier O-ring flaking off, replaced with black O-ring.
- Carrier changed to Yellow for contrast between carrier & O-ring

Upper Engine Mounts

- 3.0 Liter EFI running change 2005 MY
- New improved heat treated nuts on upper engine mounts
- Prevents loss of clamp load for better mount durabilit



Thermostat Discharge Fitting

- 3.0 Liter EFI running change 2005 MY S/N 1B118633
- Fitting changed from brass to plastic
- Reduce corrosion of fitting and adapter plate, reducing water leaks
- Will back fit, but does not supersede
- New fitting 22-858855

Notes

Notes

Gear Case Mounting Nuts

- 3.0 Liter EFI 2006 MY
- The current nickel plated brass nut can crack due to corrosion
- Changing to a stainless steel nut. The change will occur about model year switch over
- New nut 11-896895 will back fit.

Traditional 2-Stroke

- The traditional 2-stroke engines include all Carb and EFI 9.9 to 200 HP. Due to emission rules in the U.S., these engines can no longer be sold in the U.S. at the end of 2005 MY. Currently (2005 MY) on the S/N mat for these engines it is marked NOT FOR SALE IN CA. S/N decal on swivel bracket and the EPA label is marked with 2005 MY.

- The emission rules in Canada are slightly different and will allow the sale of traditional 2-stroke engines until the end of 2005 CY. Because of this, engines built after 2006 MY start will be shipped with the S/N mat marked as a 2005 MY engine, S/N decal will be 2006, and 2005 EPA label on the engine. The S/N mat will be marked NOT FOR SALE IN THE U.S.

- Engine built after the end of 2005 CY will have no EPA label, the S/N decal and mat will be 2006 and the S/N mat will be marked NOT FOR SALE IN THE U.S. & CANADA.

- V-6 carb engines (150/200 HP) will no longer be built after the end of 2005 CY, the V-6 EFI engines (2.5 & 3.0 liter) will continue to be built for international sales only, excluding Canada.

Hi-Performance Gear Lub

All Outboards built in Fond du Lac will receive the Hi-Performance gear lubrication. The V-6 product recommendation in the operations manual will be changed to state the use of the Hi-performance lub

Section 6 - Tools

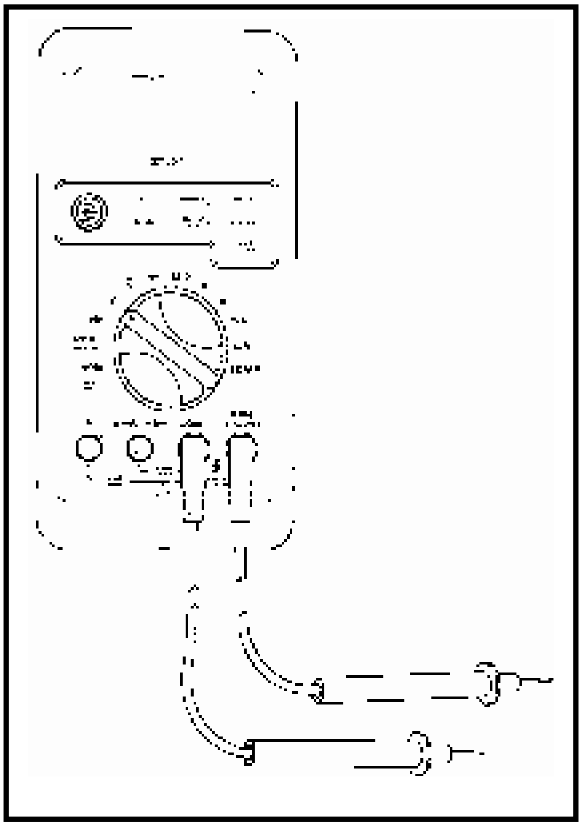


Table of Contents

Special Tools

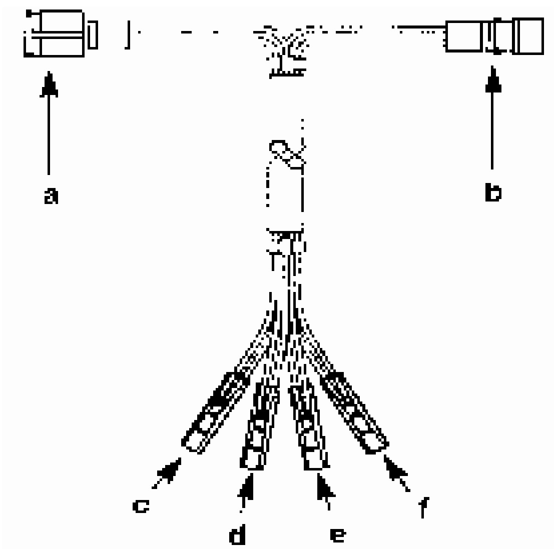
Notes

Digital Diagnostic Terminal - P/N 91-823686A2

Refer to the Digital Diagnostic Terminal Order Form for all cartridge and adapter harness part numbers.

Injector Test Harness - P/N 91-833169A1

For 2.4L, 2.5L, and 3.0L EFI.



a) To Injector Manifold
b) To Engine Harness
c) RED
d) WGITE
e) BLUE
f) YELLOW

Notes

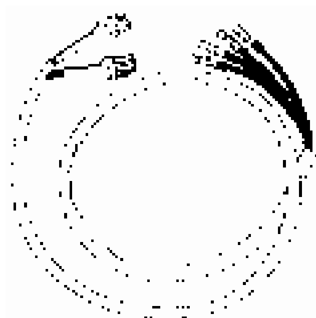
CDM Test Harness - P/N 84-825207A1

Early Style (Mercury) CDM, 3 pin.

TPI Test/Adjust Harnesses for 1995– 2001 3.0L EFI and carb engines.

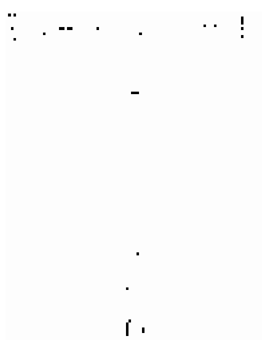
CDM Test Harness - P/N 84-825207A2

Later Style (Echlin) CDM, 4 pin.



TPS Test Harness - P/N 84-816085

2.4L/2.5L 1987– 1999 Models.



TPS Test Harness - P/N 84-859199

2.5L 2000– 2001 Models.

DDT Carrying Case P/N 804805

Service Tachometer DMT 2000 - P/N 91-854009A3

Service Tachometer DMT 2004 - P/N 91-892647A01

DMT 2000A and 2004 Accessories

INDUCTIVE PICK-UP - P/N 91-854010-1

TEMPERATURE PROBE – P/N 91-854011-1

REPLACEMENT FERRITE CORE – P/N 91-________

INTERFACE MODULE – P/N 91-854013-1

HARD CARRYING CASE – P/N 91-854014-1

USER'S GUIDE – P/N 90-854015-1

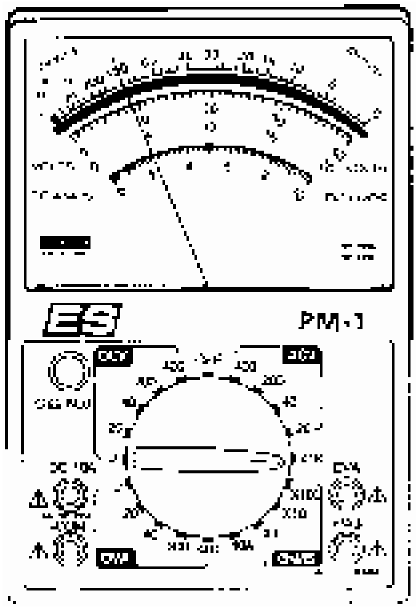
TEST LEADS – P/N 91-80265

CLAMP-ON CURRENT PROBE – P/N 91-802650-1

Notes

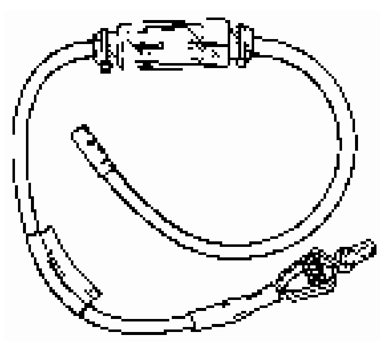
Notes

Multi-Meter DVA Tester - P/N 91-99750A1

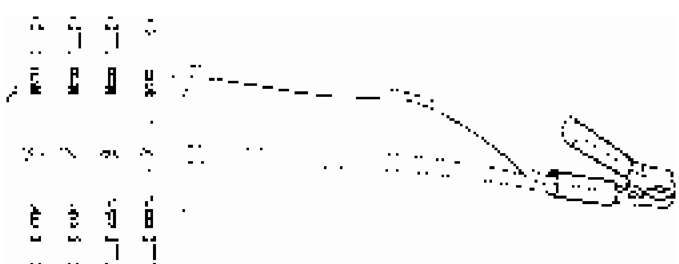


NOTE: *There are 3 different Multi-Meter DVA Testers using the part number 91-99750 or 91-99750A1 having a DVA built in. Any one of these testers will work with the small V-6 EFI system.*

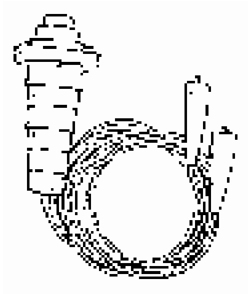
Spark Gap Tester - P/N 91-63998A1



Spark Board - P/N 91-850439T

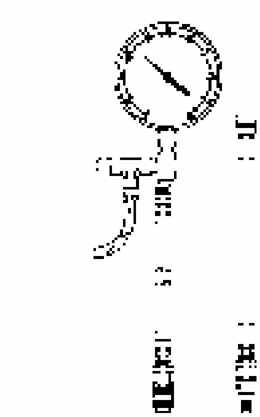


Remote Starter Switch - P/N 91-52024A1



Single Fuel/Air Pressure 160 PSI Gauge - P/N 91-16850A7

NOTE: *To convert 100 psi gauge P/N 91-16850A1 to 160 psi gauge, order upgrade 91-16850--1.*



Timing Tape - P/N 91-853883-3

Allows timing checks to be performed on individual cylinders. Works on any cast iron V-6 flywheel.

Notes