Fuel System

Section 3B - Diagnostics and Troubleshooting

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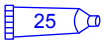
Fuel System Specifications

Fuel System Specifications		
Fuel lift pump type		Mechanical water-cooled (plunger/ diaphragm)
Fuel pump pressure (maximum)		20–41 kPa (3–6 psi)
Plunger stroke		5.9 mm (0.232 in.)
Fuel tank capacity		Accessory
Fuel injection system		Sequential
Fuel injector resistance		10–13.5 ohms
Electric fuel pump	Pressure	290–303 kPa (42–44 psi)
	Engine running - after five minutes	295 kPa (43 psi)
Mechanical fuel pump	Minimum pressure at 1000 RPM with pinched fuel outlet line	20.7 kPa (3 psi)
	Minimum vacuum at 1000 RPM with fuel inlet line pinched	102 mm Hg (4 in. Hg)
Vapor separator float height - float needle seated		36.5–39.5 mm (1.437–1.555 in.)
Idle RPM (neutral) warm		750 ± 25 RPM
Idle RPM (forward gear) warm		750 ± 25 RPM

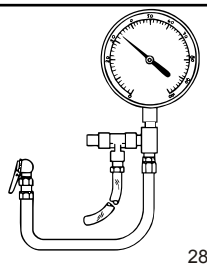
Lubricant, Sealant, Adhesives

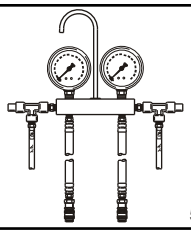
Tube Ref No.	Description	Where Used	Part No.
	Liquid Neoprene	Grounds and ring terminals	92- 25711 3

Special Tools

CDS G3 Diagnostic Interface Tool With Harness	8M0046124
 41993	Provides diagnostic support for the Computer Diagnostic System.

CDS G3 Termination Harness	84-8M0045065
 43351	Contains termination resistors to allow communication when G3 is connected to the engine's diagnostic connector.

Fuel Pressure Gauge Kit	91-881833A03
 2807	Tests the fuel pump pressure; can be used to relieve fuel pressure.

Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
 5822	Tests fuel and air pressure; the dual gauges allow the viewing of both pressures simultaneously.

DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM on spark ignition (SI) engines, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

Wire Color Code Abbreviations

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

30/40 EFI Gen III ECM Pin Identification

Pin	Gen III ECM	Color Code
1	Empty	Empty
2	Empty	Empty
3	Idle air control (IAC) valve driver	wht/orn
4	Analog tach signal out or tach link configuration[1.]	gry
5	Empty	Empty
6	Empty	Empty
7	Empty	Empty
8	Main power relay (MPR) driver (pin that controls MPR)	yel/ppl
9	Empty	Empty
10	Empty	Empty
11	Oil pressure signal	lt blu
12	Empty	Empty
13	CPS signal (–)	wht
14	Crankshaft position sensor (CPS) signal (+)	red
15	Empty	Empty
16	Empty	Empty
17	Empty	Empty
18	Empty	Empty

1. May be switchable with the CDS G3.

Pin	Gen III ECM	Color Code
19	Empty	Empty
20	Intake air temperature (IAT) signal	tan
21	Engine coolant temperature (ECT) signal	tan/blk
22	Manifold absolute pressure (MAP) signal	yel
23	CAN 1 (+) signal for SmartCraft gauges and CDS G3 tool	wht
24	CAN 1 (–) signal for SmartCraft gauges and CDS G3 tool	dk blu
25	Empty	Empty
26	Empty	Empty
27	Empty	Empty
28	Not for service	dk blu/wht
29	Not for service	wht/lt blu
30	Empty	Empty
31	Empty	Empty
32	EST coil #1 driver (controls smart coil)	grn
33	EST coil #2 driver	grn/red
34	Sensor power (power 1) 5 V (+) from ECM to sensors	ppl/yel
35	Empty	Empty
36	Empty	Empty
37	Empty	Empty
38	Empty	Empty
39	Empty	Empty
40	Empty	Empty
41	Emergency stop (through 14 pin main engine harness)	blk/yel
42	Sensor ground (5 V [–]), sometimes called filtered ground	blk/orn
43	Empty	Empty
44	Empty	Empty
45	Empty	Empty
46	Empty	Empty
47	Empty	Empty
48	Empty	Empty
49	Fuel injector #1 driver (controls negative side of injector)	pnk/brn
50	Fuel injector #2 driver (controls negative side of injector)	pnk/red
51	Empty	Empty
52	Wake up (key switch +)	ppl
53	Throttle position sensor (TPS) signal	lt blu/wht
54	Empty	Empty
55	Empty	Empty
56	Empty	Empty
57	Driver power (12 V [+]) (from MPR into the ECM)	red/blu
58	Driver power (12 V [+]) (from MPR into the ECM)	red/blu
59	Empty	Empty
60	Empty	Empty
61	Empty	Empty

Pin	Gen III ECM	Color Code
62	Empty	Empty
63	Warning horn driver (controls negative side of horn)	tan/lt blu
64	Empty	Empty
65	Fuel injector #3 driver (controls negative side of injector)	pnk/orn
66	EST coil #3 driver	grn/orn
67	Battery positive (+) to ECM	red/ppl
68	Ground (to engine block/negative battery terminal)	blk
69	Fuel pump driver (controls fuel pump negative side)	red/blk
70	Ground (to engine block/negative battery terminal)	blk

Pin	Cryptic Name	Description	Color Code	Companion Circuits	Service Information	Service Notes
3	LSO2	Driver - Idle air control (IAC) valve driver	wht/orn	IAC positive terminal receives battery volts from main power relay.	ECM grounds pin 3 using pulse width modulation (PWM) to control the IAC valve opening.	Pulse width percent is displayed on data stream.
4	Tach_ Link	Analog tach signal out or tach link configuration[1].	gry	Ground	Use "Set Tach Link" active test in G3 to configure this output. By default, function is disabled.	If SmartCraft products are used, you must "enable" the "Set Tach Link" function. If a conventional 3 wire tachometer (power, ground, and signal), then you must "Disable" the "Set Tach Link" function.
8	MPRD	Driver - Main power relay (MPR) driver (pin that controls MPR)	yel/ppl	Relay control coil is connected to battery volts on one end and ECM pin 8 on the other.	ECM pin 8 controls the ground for the relay's control coil. When grounded, the relay turns on. When opened, the relay turns off.	A relay that clicks may not be working correctly. The relay must provide a closed circuit (low resistance) between relay pins 30 and 87A when turned on, and an open circuit (high resistance) when turned off.
11	SWG1	Input - Oil pressure signal	lt blu	Engine ground	One wire pressure sensor switch.	Switch provides ground through engine block. Switch open = good pressure. Switch closed = no pressure. When open, the circuit (lt blue) will read 5 V (or close to 5 V). When closed, the circuit will read 0 V (or close to 0 V).
13	CNK VR –	Input - Crankshaft position sensor (CPS) signal (–)	wht	Pins 13 and 14 are companions and are isolated from other circuits.	Circuit is isolated from ground. Voltage only flows between sensor and ECM through pins 13 and 14.	As the flywheel rotates, the timing vanes pass by the sensor and produce an AC voltage signal the ECM uses to determine crankshaft position and speed.
14	CNK VR +	Input - Crankshaft position sensor (CPS) signal (+)	red	Pins 13 and 14 are companions and are isolated from other circuits.	Circuit is isolated from ground. Voltage only flows between sensor and ECM through pins 13 and 14.	As the flywheel rotates, the timing vanes pass by the sensor and produce an AC voltage signal the ECM uses to determine crankshaft position and speed.
20	AN2	Input - Manifold air temperature (MAT) signal	tan	Pin 42 (sensor ground)	Two wire thermistor.	Sensor signal voltage is high when cold and low when hot.
21	AN3	Input - Engine coolant temperature (ECT) signal	tan/blk	Pin 42 (sensor ground)	Two wire thermistor.	Sensor signal voltage is high when cold and low when hot.
22	AN1	Input - Manifold absolute pressure (MAP) signal	yel	Pin 34 (sensor power) and 42 (sensor ground)	Three wire pressure sensor.	Signal is highest when reading barometric pressure. Signal is lowest when throttle is closed. Verify MAP readings change with throttle movement. MAP sensors can stick at a single value. This will cause the engine to run poorly except at the exact speed the MAP reading is correct.

Pin	Cryptic Name	Description	Color Code	Companion Circuits	Service Information	Service Notes
23	CAN1H	Communication - SmartCraft CAN P High (+)	wht	Pin 23 and pin 24 are companions on an isolated communication circuit	Data highway for ECM, G3 tool, and SmartCraft devices. Opening or shorting either circuit (pin 23 or pin 24) will result in no communication between devices.	Requires CAN terminator resistors to communicate. No resistors = no communication.
24	CAN1L	Communication - SmartCraft CAN P Low (–)	dk blu	Pin 23 and pin 24 are companions on an isolated communication circuit	Data highway for ECM, G3 tool, and SmartCraft devices. Opening or shorting either circuit (pin 23 or pin 24) will result in no communication between devices.	Requires CAN terminator resistors to communicate. No resistors = no communication.
32	Sprk_ IGBT1	Driver - EST coil #1 driver	grn	Coil positive terminal receives battery volts from main power relay. Coil negative (green) circuit is connected to ECM.	ECM grounds pin 32 to charge the #1 ignition coil and opens this pin to discharge the coil.	Since primary current flows through the ECM, it is critical the ECM is grounded. Verify the black leads coming from pins 68 and 70 are connected to ground. The hardware must be clean and tight. High resistance grounds will cause premature ECM failure.
33	Sprk_ IGBT2	Driver - EST coil #2 driver	grn/red	Coil positive terminal receives battery volts from main power relay. Coil negative (green) circuit is connected to ECM.	ECM grounds pin 33 to charge the #1 ignition coil and opens this pin to discharge the coil.	Since primary current flows through the ECM, it is critical the ECM is grounded. Verify the black leads coming from pins 68 and 70 are connected to ground. The hardware must be clean and tight. High resistance grounds will cause premature ECM failure.
34		Sensor power (power 1) from ECM to sensors (5 V +)	ppl/yel	Pin 42 (sensor ground)	5 V to all 2 and 3 wire sensors. Pin 42 provides a ground for all sensors using this circuit. Sensor power voltage displayed on data stream.	If sensor power voltage is higher or lower than normal, all 2 and 3 wire sensors signals will be skewed higher or lower than normal. Sensor power should always be at or near 5 V.
41		Input - Emergency stop (through 10 pin CAN connector)	blk/yel	Pin 42 (sensor ground)	Circuit must be open to run. When shorted to ground, ECM will not allow the engine to run.	When open, the black/yellow circuit will read approximately 8 V. When closed, the circuit is approximately 1 V.
42		Sensor ground 5 V (–), sometimes call filtered ground	blk/on	Pin 34 (sensor power)	Dedicated 5 V ground circuit for all 2 and 3 wire sensors.	If open, engine will not start. All sensors will be skewed high or low.

1. May be switchable with the CDS G3.

Pin	Cryptic Name	Description	Color Code	Companion Circuits	Service Information	Service Notes
49		Fuel injector #1 driver (controls negative side of injector)	pnk/brn	Fuel injector positive terminal receives battery volts from main power relay circuit. Injector negative (pink/brown) is controlled by the ECM.	ECM grounds pin 49 to fire the #1 fuel injector. When opened, the fuel injector closes.	The length of time the injector is open is called pulse width. Pulse width information is displayed on the data stream.
50		Fuel injector #2 driver (controls negative side of injector)	pnk/red	Fuel injector positive terminal receives battery volts from main power relay. Injector negative (pink/red) is connected to the ECM.	ECM grounds pin 59 to fire the #2 fuel injector. When opened, the fuel injector closes.	The length of time the injector is open is called pulse width. Pulse width information is displayed on the data stream.
52		Voltage input - Wake up (key switch +)	ppl	ECM ground	12 V from key switch to turn the ECM on.	Key switch voltage is displayed on the data stream.
53		Input - Throttle position sensor (TPS) signal	lt blu/wht	Pin 34 (sensor power) and pin 42 (sensor ground)	Three wire position sensor.	TPS signal voltage will be lowest when throttle is closed and highest when throttle is open.
57		Driver power - from MPR into the ECM (12 V +)	red/blu	Pin 57 and pin 58 are spliced together in the engine harness.	12 V from main power relay circuit. Voltage only present when MPR is active.	A relay with burned contacts between pin 30 and pin 87A can cause low voltage to the driver power. This voltage is displayed on the data stream.
58		Driver power - from MPR into the ECM (12 V +)	red/blu	Pin 57 and pin 58 are spliced together in the engine harness.	12 V from main power relay circuit. Voltage only present when MPR is active.	A relay with burned contacts between pin 30 and pin 87A can cause low voltage to the driver power. This voltage is displayed on the data stream.
63		Driver - Warning horn (controls negative side of horn)	tan/lt blu	Battery volts from ignition switch	ECM grounds this pin to activate the warning horn.	The warning horn status is displayed on the data stream.
65		Driver - Fuel injector #3 driver (controls negative side of injector)	pnk/orn	Fuel injector positive terminal receives battery volts from main power relay. Injector negative (pnk/orn) is connected to the ECM.	ECM grounds pin 65 to fire the #3 fuel injector. When opened, the fuel injector closes.	The length of time the injector is open is called pulse width. Pulse width information is displayed on the data stream.
66		EST coil #3 driver	grn/orn	Coil positive terminal receives battery volts from main power relay. Coil negative (grn) circuit is connected to the ECM.	ECM grounds pin 66 to charge the #3 ignition coil and opens this pin to discharge the coil.	Primary current flows through the ECM and it is critical the ECM is grounded. The black leads coming from pins 68 and 70 are connected to ground. The hardware must be clean and tight. High resistance grounds will cause premature ECM failure.
67		Voltage input - Battery (+)	red/ppl	ECM ground	Constant 12 V + when battery is connected.	Large terminal with a heavy gauge wire.

Pin	Cryptic Name	Description	Color Code	Companion Circuits	Service Information	Service Notes
68		Ground (to engine block/ negative battery terminal)	blk	Pin 68 and 70 are both ECM ground.	ECM ground circuit.	Large terminal with a heavy gauge wire.
69		Driver - High pressure electric fuel pump	red/blk	Fuel pump positive terminal receives battery volts from main power relay. Fuel pump negative terminal connects to ECM pin 69.	Fuel pump current draw (measured within the ECM) can be viewed on the data stream. The fuel pump runs when the ECM grounds pin 69.	Large terminal with a heavy gauge wire.
70		Ground (to engine block/ negative battery terminal)	blk	Pins 68 and 70 are both ECM ground	ECM ground circuit.	Large terminal with a heavy gauge wire.

Troubleshooting without a CDS G3

Troubleshooting without the CDS G3 tool is not recommended. The CDS G3 tool is required to access the necessary faults, data, active tests, and historic data that is available from the ECM. Checking only the resistance on some of the sensors is not a recommended method for diagnosis.

Typical failures usually do not involve the ECM. Most likely at fault are the connectors, set-up, and mechanical wear.

- The engine may not run or may not run above idle with the wrong spark plugs installed.
- Swap ignition coils to see if the problem follows the coil or stays with the particular cylinder.
- Any sensor or connection can be disconnected and reconnected while the engine is operating without damaging the ECM. Disconnecting the crankshaft position sensor will stop the engine.
  IMPORTANT: Any sensor that is disconnected while the engine is running will be recorded as a fault in the ECM Fault Hours.
- If all cylinders exhibit similar symptoms, the problem is with a sensor or harness input to the ECM.
- If problem is speed related or intermittent, it is probably connector or contact related. Inspect connectors for corrosion, loose wires, or loose pins. Secure connector seating. If dielectric compound was used to protect the wire connections, the dielectric compound must be removed.
- Inspect the harness for obvious damage: pinched wires, chaffing.
- Check fuel pump connections and fuel pump pressure.
- Secure grounds and all connections involving ring terminals. Coat grounds and ring terminals with Liquid Neoprene.

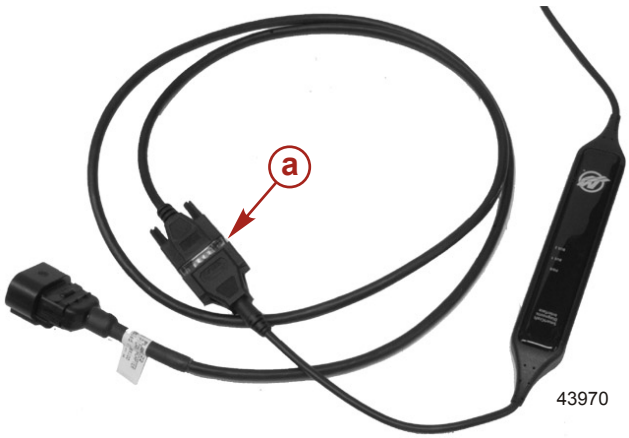
Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Grounds and ring terminals	92- 25711 3

Troubleshooting with the CDS G3

Accessing ECM Information

1. Connect the USB cable end into one of the computer USB ports.
   IMPORTANT: Always connect to the same USB port when acquiring data.

2. Connect the SmartCraft Diagnostic Interface 9 pin connector to the CAN P/CAN H adapter harness 9 pin connector.

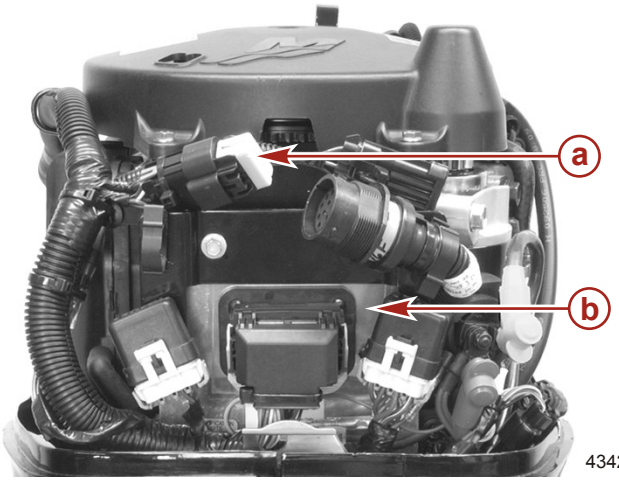


a - 9 pin connector

3. Remove the CAN P termination resistor from the engine harness.
4. Connect the CAN P/CAN H adapter harness to the CAN P/CAN H termination harness (84-8M0045065)
5. Connect the CAN P/CAN H termination harness to the CAN P engine harness SmartCraft diagnostic port.
   IMPORTANT: The G3 CAN P/CAN H termination harness (84-8M0045065) contains the correct termination resistor for the CDS G3 SmartCraft Diagnostic Interface to communicate with the ECM.
6. Key-up the engine.
7. Open the G3 software program.

NOTE: *The following lights on the G3 interface should be lit:*

- *Pwr*
- *Bus I*
- *Bus II (disregard any activity on these engines)*



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a - SmartCraft diagnostic port
b - ECM

The ECM is designed that if a sensor fails, the ECM will compensate so the engine continues to run efficiently as possible. However, the air/fuel mixture will not be as accurate without all of the sensors providing input. Under most conditions, a sensor failure results in an air/fuel mixture that is richer than normal. Because of this, disconnecting a sensor for troubleshooting purposes will produce noticeably different effects on the running quality, depending on which sensor is disconnected.

The CDS G3 system was developed specifically to help technicians diagnose and repair Mercury Marine engines and systems.

The CDS G3 will monitor sensors and ECM data values including the status of switches.

CDS G3 Diagnostic Interface Tool With Harness	8M0046124
CDS G3 Termination Harness	84-8M0045065

Engine Information Displayed by CDS G3

The **Module Data** screen will display the following information for each module it finds on the CAN Bus.

- Status (online or offline)
- Electronic Address (city ID)
- CAN bus on P or H
- Calibration ID
- Informational Messages

Faults

A **Fault** indicates the ECU has either sensed the circuit in question has reported a sensor value outside of its acceptable parameters or a sensor value has gone outside its normal range. For example:

A circuit with an open or short would give a fault that is "CUT HI" or "CUT LO." This indicates the sensor has failed with an open or short circuit, or one of the leads between the sensor and the PCM/ECM is open or shorted.

A sensor showing a reading outside of its normal range, but not shorted or open, would give a fault identifying an abnormal operating condition, such as "ECT Coolant Overheat," which indicates the ECT circuit is operating correctly, and the engine is overheating.

- Fault codes can be displayed active or historic.

- An **active fault** is a fault that is present right now. It is occurring at this instant. Active faults affect how the engine is running right now. Active faults will activate the Guardian program, which will reduce engine power based on the severity of the problem. Refer to **Guardian Protection System**.
- An **occurred fault** is a fault that was active during this key switch cycle, but is not active now. Occurred faults do not affect how the engine is running. They are valuable for diagnosing intermittent faults (faults that come and go, but do not stay active permanently). Without the intermittent/historic fault, we would not know that a problem occurred in the past.
- The **View Fault** displays active and inactive faults, the code number, description, and the source of the faults. When the status column shows "YES," they are active. When the status shows "NO," they are inactive/historic, which also means intermittent (a fault that comes and goes, but does not stay active permanently).

Freeze Frame Buffer CDS G3 Display Information

Freeze Frames are captures of selected data stream items at the time a fault occurs. A Buffer can be created for each fault that is enabled on a particular calibration. When a fault becomes active, the ECM will store the data items in the first buffer using the values the instant the fault became active.

Buffer Data Item	Service Description	Service Information
FF_FaultIndex	Lists the fault name	Refer to the fault listing for more fault information
FF_Occurance_Cnt_Data	Lists the number of times the fault has occurred. This count starts at 0, where 0=1, 1=2, 3=2 and so on.	The number of times the fault has occurred is important. Low number of occurrences could be someone tampering with the system. One or two occurrences over a long time are not cause for concern. A single occurrence 30 minutes ago needs to be checked out. High numbers can indicate an intermittent problem. Look for loose and corroded connections. Check both battery cable connections at the battery and engine. Check for corrosion on connectors and terminal studs.
FF_ActualGear_Data	Lists the gear position at the time of the fault.	Not applicable on this engine. No sensor (switch) installed. Will always read "In_gear."
FF_APC_Data	Lists the air per cylinder per cycle calculation at the time of the fault.	Compare to previously saved data.
FF_Baro_Data	Lists the barometric pressure reading taken at the start of the run cycle during which this fault occurred. The barometric reading is taken once per run cycle, when the key is turned on.	The barometric reading is a reference pressure reading that relates to the altitude the ECM was at when the fault was stored. Higher than normal readings will cause the engine to be richer than normal. Lower than normal readings will cause the opposite. Barometric pressures will change with the weather. The barometric sensor displays absolute pressure, which means it is a raw reading that has not been compensated.
FF_BaseSparkAdv_Data	Lists the spark advance at the time of the fault.	Spark advance is ignition timing and is listed in degrees before top dead center (BTDC). Negative numbers indicate degrees after top dead center.
FF_BattVolt_Data	Lists the battery voltage at the time of the fault .	Battery voltage anywhere on the engine should always be within one volt of the voltage at the battery terminals. The battery should not drop below 11.0V during normal operation, except while starting the engine. Low voltages at the ECM can indicate problems with loose or corroded connections, excessive accessory loads, defective charging system and/or battery. The voltage that determines this fault is measured at Pin 67 (and/or pin 52).

Buffer Data Item	Service Description	Service Information
FF_ECT_Data	Lists the engine temperature at the time of the fault.	Temperatures below normal operating temperature are usually the result of debris holding the thermostat open. A cold-running engine will run rich and can eventually dilute the engine oil with gasoline. EFI engines must reach an operating temperature to run properly.
FF_EngineState_Data	Displays the engine operating mode at the time of the fault.	Possible engine states are: dead, stall, crank, run, and unknown. This helps you understand the operating mode the engine was in at the time of the fault. Normal values are stall, crank, or run.
FF_EngRunTime_Data	Lists the total engine run time when the fault occurred. For example, if the buffer data is 11.8 hours and total engine run time is 13.2 hours, the fault occurred 1.4 engine run hours ago. Recent faults deserve more attention than faults from long ago.	A fault that stored a couple of times a long time ago and occurred again is usually something to not spend time on. In these cases, record the buffer data on the work order in case it shows up again, then clear the fault buffer. Old buffers are relevant when the customer complaint is about something that happened a long time ago. Review the buffer data and inspect the relevant circuit and components.
FF_FaultIndex_Data	Fault number - a specific number tied to a specific fault name.	Currently CDS G3 displays the fault number in freeze frame buffers, but does not display the fault number in active/inactive faults.
FF_GuardianLatchedPwrLim_ Data	Lists the available power at the time the fault occurred.	Guardian will reduce available power the most for severe problems: low oil pressure and engine overheat. Mild problems (sensor circuit high) will result in a small reduction in available power.
FF_IAT_Data	Lists the intake (manifold) air temperature at the time the fault occurred.	Intake air temperature data is used to calibrate the air/fuel mixture. It cannot cause drastic changes to the air/fuel mixture. Do not blame major engine issues on this sensor.
FF_IdleAir_Data	Lists the IAC valve position at the time of the fault.	The IAC valve will open on deceleration to prevent stalling. Low numbers, or even 0 at idle, indicate air leaks into the intake manifold. Higher than normal numbers can indicate tampering with the throttle body.
FF_MAP_Data	Lists the manifold absolute pressure at the time of the fault.	Similar to Baro, the MAP sensor modify the fuel curve richer or leaner. The MAP reading will change with throttle, RPM and load changes. Higher than normal MAP readings cause rich mixtures. Lower than normal reading cause lean mixtures.
FF_OilPress_Data	Lists the oil pressure status at the time of fault. 0.0 kPa indicates the oil pressure switch was closed. 87.0 kPa indicates the oil pressure switch was open.	The oil pressure switch opens at a predefined pressure. If the switch is closed (shorted to ground), then oil pressure is not high enough for safe engine operation. If the switch is open (no continuity to ground), then oil pressure is high enough for safe engine operation.
FF_RPM_Data	Lists the engine RPM at the time the fault occurred.	No additional information.

Buffer Data Item	Service Description	Service Information
FF_RunFPC_Data	Lists the fuel per cylinder per cycle value at the time the fault occurred.	Indication of fuel flow through injectors. Higher numbers indicate richer mixtures, lower numbers indicate lean mixtures.
FF_SeaPumpPress_Data	Lists the water pressure inside the engine block.	Not applicable on this engine. No sensor installed. Will always read 0.0 kPa, regardless of the actual water pump pressure.
FF_SysVolt_Data	Lists the system voltage at the time the fault occurred.	System voltage starts at the battery and flows to the MPR and fuses. When the MPR is turned on, battery voltage flows from the MPR and into the ECM on pins 57 and 58. System voltage is used to control actuators: IAC valve, fuel injectors, fuel pumps, and ignition coils.
FF_TPS_Data	Lists the throttle position at the time the fault occurred.	TPS data can be used to determine operator demand. TPS and MAP data mirror each other in most operating conditions. High TPS = high MAP. Low TPS = low MAP. This is only true when the engine is running.
FF_XDRPa_Data	Lists the sensor power voltage at the time the fault occurred. This value should be 5V.	Ideally, this reads 4.98–5.02V. 4.90–5.10V is the maximum acceptable range. When it is unacceptable, it is usually pulled down by a shorted sensor or sensor harness. If it is too high, it has shorted to battery voltage. Sensors cannot display accurate data when sensor power is unacceptable.

Default Sensor Information

Default sensor values are preprogrammed amounts used by the PCM to calculate fuel and ignition values when the sensor in question has exceeded its preprogrammed diagnostic limits. Default sensor values are typically used when the sensor has a circuit high or circuit low fault. For example, all 2 wire sensors operate the same. When you unplug the sensor, a circuit high fault occurs and when you short the two wires together, a circuit low fault occurs.

Most temperature sensors default to 0 °C (32 °F). This can be verified by unplugging the sensor in question and watching the data stream value with the CDS.

Most pressure sensors default to a preprogrammed number also. The MAP sensor is an exception. A failed MAP sensor will display a value that is near the actual value, but diagnosed with displayed fault codes. Refer to **Fault Information**.

Data Count to Voltage Table

Some data on the CDS G3 screen is presented as analog to digital conversion (ADC) counts. ADC is a method of changing the sensor signal into display information for diagnosis. In diagnosing circuits that use data counts it is helpful to convert the counts into volts to allow the use of a multimeter on that circuit.

The display range for data counts is 0–1023. Zero counts equal zero volts and 1023 counts equal 5 V.

ECM70 Series Controller	
Digital to Analog Voltage Conversion (ADC Counts)	
0 Counts = 0 Volts, 1023 Counts = 5.0 Volts	
Counts from Service Tool Data Stream	DC Voltage
0	0
10	0.049
20	0.098
102	0.498
205	1.001
410	2.002
615	3.003
819	4.00
900	4.395
950	4.639
1000	4.883
1023	5.000

Data stream value x 0.0048828 = equivalent DC voltage.

Data Stream

Data Item Name	Description from G3	Significance	Service Information
ActiveFaultMarquee	N/A	Continuously scrolls through all active faults approximately one per second. Displays dashes when there are no faults.	Convenient to see if active faults are present without switching to the fault page.
ActiveFaultPwrLim	Available power due to active faults	Displays how much available power remains after all active faults have reduced it from 100%.	Most technicians use the data item "GuardianLatchedPwrLim" to determine the total amount of power available to the operator.
APC	Air per Cylinder per Cycle (APC)	Similar to FPC. A calculation of air passing through the cylinders.	Compare to previously recorded values.
BARO	Barometric Pressure	Displays the current barometric pressure. Baro on an EFI engine is absolute, often called raw. Raw data must be used to calculate fuel delivery at different altitudes. Baro data determines the fuel delivery at start up.	A technician should understand what the typical Baro value is at his location. Compensate your shop value for extremely high or low barometric pressures due to extreme weather conditions. When Baro readings are incorrect and higher than actual (due to sensor or circuit problems) the engine will run rich. When incorrect and lower than actual, the engine will run lean.
BaseIdleRPM	Default Idle RPM	This is the idle RPM the ECM wants the engine to idle at when at operating temperature and running normal.	This may not be the actual idle speed the ECM is trying to achieve. Use the data item IdleCtrlSetpointRPM for the actual idle speed the ECM is trying to achieve when the engine is running.
CurrentEngineLocation	N/A	Displays the current engine location programmed into the ECM.	Use the G3 tool to change the engine location; STBD Outer (default), PORT Outer, STBD Inner or PORT Inner.

Data Item Name	Description from G3	Significance	Service Information
DemandLinear	Operator Demand (from TPS sensor)	How much power is requested from the engine.	Important when working with the Guardian program.
DRVP	Battery Voltage from Main Power Relay	Shows if the ECM is receiving the voltage it needs to control all of the actuators. The voltage should be within 0.5V of actual battery voltage. The ECM measures this voltage at pins 57 and 58.	If voltage is low and battery voltage is correct (at battery terminals), test the main power relay and engine fuses. Check battery cables for loose, corroded, or high resistance connections. Verify ECM grounds to the negative battery cable. Test the red/blue between the ECM, the MPR, and fuse block.
ECT	Engine Coolant Temperature (ECT)	Temperature of the Engine Coolant. EFI engines will not run correctly unless they reach operating temperature. Running too cold will cause rich mixtures (like a stuck choke). The engine will idle very poorly until the problem is resolved. Always verify proper ECT temperature when diagnosing an engine.	The cooling system uses raw water to cool the engine. Debris in the cooling system can hold the thermostat open causing the engine to run cold.
ECUP	Battery Voltage from Ignition Switch	Voltage from the ignition switch to pin 52 on ECM. This voltage tells the ECM to wake up and turn itself on.	If this voltage is more than 1 V below actual battery voltage, check the circuit to the helm, key switch and back to engine for high resistance, loose connections, corrosion, or other causes for voltage drop.
EngineState	N/A	Displays the current operating mode of the engine: Dead, Stall, Crank, Run, Unknown. Typical modes are Stall, Crank, or Run.	More critical when used in the freeze frame buffer. Displayed to allow familiarization with the data.
ESTOP	Emergency Stop (ESTOP)	Tells whether the emergency stop program is active. 0=no, 1=yes. When ESTOP circuit black/yellow is shorted to ground, the engine stops and will not start.	ESTOP starts at ECM pin 41. Black/yellow circuit goes to the 14 pin main harness connector and any lanyard safety switches on the engine or at the helm. Defective lanyard and ignition switches can cause high-speed misfires when they intermittently short this circuit to ground.
ESTOP_ADC	EStop Circuit in Counts	Displays the ESTOP circuit analog-to-digital conversion in "ADC" counts. Counts range between 0 (low) and 1023 (high). ESTOP is off when counts are high and on when counts are low. The ESTOP circuit should never indicate near the middle of the ADC range. Counts above 100 or below 900 are an indication of trouble in the ESTOP circuit.	If counts are higher than 150 when ESTOP is on, or lower than 850 when ESTOP is off, the black/yellow ESTOP circuit has a problem. Check the ignition and lanyard switches for excessive resistance, corrosion, or damage. Check the black/yellow circuit between the ECM and the ignition switch for shorts to ground or any other circuit that could provide a ground path. On remote control boats, check the ESTOP circuit to the helm.
FPC_Total	Fuel per Cylinder per Cycle (FPC)	A calculation of fuel flow through the injectors. Useful when compared to known good values. Large numbers - rich fuel mixtures, smaller numbers - lean mixtures.	This legacy item is used through many generations of engines. New ECMs are switching to pulse width as a measurement of fuel flow through the injector.

Data Item Name	Description from G3	Significance	Service Information
FuelPumpCurrent	N/A	Fuel pump current flowing through ECM. Allows a technician to monitor the condition of the fuel pump over time. Current draw changes can be an early indication of electrical, mechanical, or fuel supply problems.	Excessive current can result from shorted armature windings or excessive internal friction within the pump. Current draw below normal can result from high resistance in the armature or fuel pump circuits, aerated fuel, fuel vapor, or pump cavitation from wear or damage.
FuelRate	N/A	Fuel consumption listed by an individual cylinder. Displayed where each cylinder value is shown.	
GuardianCause	N/A	Lists four possible choices of Guardian. Helps determine the component or system that is activating Guardian. Similar to "Guardian due to:" on original CDS tool.	Displays one of the following: None, Volts, ECT, Oil Pressure, or Active Fault. Example: If GuardianLatchedPwrLim (available power) is 65%, None is displayed until the operator exceeds 65% demand. A demand 65% or greater, Guardian limits engine output to 65% power and will display Volts, ECT Oil Pressure, or Active Fault. The engine will run normal below 65% and the data will display None.
GuardianLatchedPwrLim	Available Power	Maximum Power allowed by the Guardian System at any given time. When 100%, the engine can produce full power without any Guardian restrictions.	Guardian will reduce available power significantly for severe problems: low oil pressure and engine overheat. Mild problems (sensor circuit high) will result in a small reduction in available power.
GuardianState	N/A	Displays whether Guardian is active or inactive. Guardian will only display active when operator demand exceeds GuardianLatchedPwrLim (available power).	Guardian limits engine power when problems are detected. It reduces power by adjusting fuel injection and ignition timing. It can stop cylinders from firing when necessary.
HornOutputState	Warning Horn Status: 1=On, 0=Off	Displays when the ECM expects the horn to be audible.	Horn should be audible whenever the data value is 1.
IAT	Intake Air Temperature (IAT)	Displays the temperature of the air in the intake manifold. Intake air temp and manifold air temp are terms that are often used interchangeably.	Intake air temp data is used to calibrate the air-fuel mixture. It cannot cause drastic changes to the air/fuel mixture. Major engine issues are not related to this sensor.
IAT_ADC	IAT Sensor in Counts	Displays the IAT sensor value in analog-to-digital conversion (ADC) counts. Counts range between 0 (low) and 1023 (high). Very low readings (0–10) indicate a circuit low fault. Very high readings (1015–1023) indicate a circuit high fault.	Counts can be related and converted to voltage. Sensor circuits are 0–5 volt circuits. 0 counts = 0 V and 1023 counts = 5 V. The data is proportional. Counts can be multiplied by 0.0048828 to convert it to volts. Do not round the multiplier, it will not produce accurate results. Converting the counts allows you to measure the voltage in the circuit when checking for circuit problems, such as shorts, opens, and high resistance.
IdleAir	Idle Air Control (IAC) Valve	Displays the pulse width modulation (PWM) signal sent from the IAC driver. Signals range from 0% (valve closed), proportionally to 100% (valve open).	PWM is a measurement of the time a signal is on or off. 0% indicates the valve is off (closed). 100% indicates the valve is open.
IdleControlState	N/A	Displays one of the six possible modes of idle control operation that is active.	Possible modes are: Crank, Flare_Inc, Idle_Entry, Base_Idle_no_offset, Base_idle_with_offset, and off_idle

Data Item Name	Description from G3	Significance	Service Information
IdleCtrlSetpointRPM	Desired Idle RPM	This is the idle speed the ECM wants to achieve. Idle speed is ECM controlled when the TPS is closed, typically a range between 0–5%. When the ECM considers the throttle open, the ECM does not control engine idle speed.	Helps diagnose idle problems. If desired idle speed is higher than base idle, something is causing the ECM to raise the idle speed. The most common reason for elevated idle speed is a cold engine or a throttle-body not returning to its idle stop.
InjEPWOffset	N/A	The time required for the injector to react to the electric signal. Displayed where each cylinder's value is shown.	
InjMPW	N/A	Time the injector should be mechanically open. Adding the MPW to the EPW equals the total time the electrical signal is on. Displayed where each cylinder's value is shown.	Longer MPW values result in more fuel injected: rich mixture. Shorter MPW values results in less fuel: lean mixture.
LoadPercent	Calculated Engine Load	A calculation of the engine work load. The data is not relevant unless the engine is running.	
MAF	Calculated Engine Air Flow	Calculated mass air flow (MAF).	
MAP	Manifold Absolute Pressure (MAP)	Displays the intake manifold pressure. MAP data must follow throttle, RPM and load changes. MAP readings have a large effect on air/fuel ratios.	When determining if the MAP sensor is delivering accurate data, do not compare a standard vacuum gauge reading to the MAP sensor. Vacuum gauges are referenced against the current atmospheric pressure (about 14.7 psi), while a MAP sensor is referenced against a nearly perfect vacuum.
MAP_ADC	MAP Sensor in Counts	Displays the MAP sensor value in analog-to-digital conversion (ADC) counts. Counts range between 0 (low) and 1023 (high). Very low readings (0–10) normally indicate a circuit low fault. Very high readings (1015–1023) normally indicate a circuit high fault.	Counts can be related and converted to voltage. Sensor circuits are 0–5 V circuits. 0 counts = 0 V and 1023 counts = 5 V. The data is proportional. Counts can be multiplied by 0.0048828 to convert it to volts. Do not round the multiplier, it will not produce accurate results. Converting the counts allows you to measure the voltage in the circuit when checking for circuit problems, such as shorts, opens, and high resistance.
MAPIsDefaulted	MAP Data Status: Live=0, Default=1	If MAP status is the default, then the engine is not using the MAP sensor data to run. This is usually because of a MAP circuit high or circuit low fault.	
OccurredFaultMarquee	N/A	Displays all faults that have occurred in this key cycle. Continuously scrolls through all faults one per second. If a fault is present here, but not in the ActiveFaultMarquee, then the fault is not active. Displays dashes when there are no faults.	If the fault is present in this list and in ActiveFaultMarquee, then the fault is active. The dedicated fault page is the best place to view inactive faults.

Data Item Name	Description from G3	Significance	Service Information
OilPressSw	N/A	Oil pressure is normal or low. The sensor is a pressure switch that is either open or closed to engine ground. When the engine is off, the switch is closed, when oil pressure is present, the switch is open.	The ECM monitors the voltage at pin 11. If the switch is closed, or the sensor lead is shorted to ground, the voltage at pin 11 will be near 0 (low). If the switch is open, or the sensor lead is open, the voltage at pin 11 will be near 5V (high) and the oil pressure is good.
PctMaxPower	Engine Power Output	Displays the percent of maximum power the engine is producing. The lower the number, the less horsepower produced. The higher the number, the more power produced.	
RPM	Engine Speed	How fast the engine's crankshaft is rotating in revolutions per minute.	
SparkAdvAverage	N/A	Ignition timing in degrees before top dead center (BTDC).	Timing that is after top dead center (ATDC) will appear as negative values.
TotalEngRunTime	Total Engine Operating Hours	The total time the engine has been running.	Total engine run time cannot be erased or cleared.
TotalFuel	Calculated Total Fuel Consumption	An estimate of the total fuel consumed during this run event.	
TPS1	Throttle Position Sensor	Throttle plate position in percent. When moving the throttle slowly from idle to wide-open throttle, the data must increase steadily with the throttle movement. If the data freezes, dips or is erratic, the TPS sensor is suspect.	The TPS reads low numbers when the throttle plate is closed and high numbers when the throttle plate is opened. The TPS and MAP sensor mirror each other.
TPS1_ADC	TPS Sensor in Counts	Displays the TPS sensor value in analog-to-digital conversion counts. Counts range between 0 (low) and 1023 (high). Counts can be converted to voltage. 0 counts = 0 V. 1023 counts = 5 V. Values in between can be calculated by multiplying the ADC value by 0.0048828.	The ECM reads the TPS signal at pin 53.
XDRPa	Power 1 - Sensor Power (5 vdc)	5.0 vdc power for operating all sensors. When this voltage is incorrect, all sensor data can be out of calibration. Whenever you have multiple sensor faults, verify this voltage is correct.	Normal reading: 4.98–5.02 V. 4.90–5.10 V is the maximum acceptable range. When the voltage is too low, it is usually caused by the sensor or sensor harness short. If the voltage is high, it has shorted to battery voltage. Sensor power comes from ECM pin 34.

Fault Conditions

Most faults can be detected without the engine running, or key on, engine off. However, some faults require the presence of engine RPM, and cannot be detected key on, engine off. Examples of this type of fault are EST (cylinders 1–3) shorted circuit or fuel injector faults.

Some faults are only detected in the key on, engine off mode. An example of this type of fault would be EST (cylinders 1–3) open circuit.

In addition, some faults are programmed to ignore certain engine speeds. For example, a low block pressure sensor fault (sea pump pressure on a MerCruiser) is typically not enabled until enough RPM has been achieved to develop a reasonable amount of water pressure. Therefore, this fault will not be set at idle.

Basic Diagnostic Outline

G3 Diagnostics

1. Verify the customer complaint. Try to duplicate the symptom.
2. Connect the G3 system and read all fault information.
   - Document all the fault information.
3. Diagnose the active faults.
   - Use the Data Stream and Active Tests to assist with the diagnostics of the faults.
4. Diagnose Inactive Faults next.
   - Use Freeze Frame Buffer data to assist with diagnostics of these faults.
5. Clear faults as they are diagnosed and test the engine to see if any faults return.
   - Faults rarely indicate a defective ECM. Assume the ECM is working correctly until complete and thorough troubleshooting procedures prove that it is defective.
6. Again diagnose faults that have reoccurred.
7. When all faults have been diagnosed and do not reoccur, check to see if the original customer complaint still exists.
8. If customer complaint still exists, repeat the diagnosis of the symptom.
9. 9. Perform the Visual/Physical Inspection. It process will help diagnose symptoms that do not produce faults.

Faults

1. If the fault is a CUT HI or CUT LO, refer to the appropriate wiring diagram and check each of the leads between the suspect sensor and the PCM/ECM for open and short circuits. The short circuit does not have to be to ground, it could be to any other wire in the harness. If all of the leads test good, then the sensor should be replaced.
   a. When troubleshooting Active Faults (faults displayed under the "Fault Status" screen), the circuit in question is an active failure. Look for an open circuit or short circuit in the two or three wires involved with the sensor in question. The sensor itself has actually failed or the connections at the ECU have failed.
   b. When troubleshooting intermittent faults (faults displayed under the "Fault History" screen), the circuit in question is not an active failure at the moment. You are looking for an intermittent connection or an intermittent short circuit that is not present currently. Check the circuits for opens and shorts and wiggle the wires and connectors during all tests in an attempt to locate the poor connection. Carefully look for subtle problems, such as corroded connections and internal wiring harness splices; and for connectors with a loose fit between the male and female pins.

      NOTE: *An excellent way to find an intermittent problem is to use the data monitor function in the CDS G3 tool. While observing the data from the suspect circuit, wiggle the wires and connectors while the key is on or while the engine is running. When you locate the bad connection the data reading will fluctuate.*
2. If the fault is an abnormal operating condition, repair the system as needed. For example, if the engine coolant temperature is too hot, check the water pickups for obstructions or replace the water pump impeller as needed.

Active Test Table

The CDS G3 can send commands to the ECM to perform special functions. These functions called Active Tests are useful for verifying proper function of various actuators and systems, in addition to diagnosing problems with engine performance. The following table lists the active tests available.

CDS G3 Active Tests	Additional Information
Set engine location	Change the electronic address stored in the ECM. Used in preparing the engine for delivery.
Set tachometer link	Set the tachometer output to operate a SmartCraft AGI or other SmartCraft gauges. Used in preparing the engine for delivery or adding new accessories to the boat.
Cylinder misfire	Drop cylinders on a running engine to compare power output of each cylinder. Assists with diagnosing a poorly running engine or an engine with low power.
Fuel pump output	Operate the fuel pump to verify function, current draw, and assist in diagnosis of the fuel pump.
IAC output	Operate the IAC valve to verify function and assist in diagnosis of idle control problems.
Horn output	Operate the warning horn to verify function and assist in diagnosis of horn malfunctions.

Visual/Physical Inspection

1. Verify that the battery is fully charged and is of sufficient capacity for the engine being tested. If necessary, substitute a known good battery.

2. Check the battery cable connections. Ensure they are clean and tight. If present, discard wing nuts and replace with corrosion resistant hex nuts. Ensure the cable connections are tight at the starter solenoid and the ground stud. Verify the ground stud is not loose in the engine block, even if the nut is tight.
3. If there is any doubt about the mechanical condition of the engine, perform a cylinder leak-down test.
4. Ensure the safety lanyard is correctly installed and that the customer understands the correct starting procedure.
5. Unplug and inspect the main harness (14 pin) connector between the engine and boat harnesses. If there is any doubt about the boat harness, substitute a shop harness and key switch assembly and rerun the boat. If the problem disappears, the problem is in the boat harness, not the engine harness. A test harness is available from Mercury Parts and Accessories as part number.
6. Check for adequate fuel pressure at the fuel rail (test port at the VST).
7. If there is no fuel pressure, check that the fuel pump is actually operating. The pump must run for at least two seconds each time the key is turned to the on position. If the fuel pump and the warning horn are not operating as the key is turned on, verify the ECM is powering up.
8. The low-pressure supply pump is a mechanical pump on this engine. The pump is driven by a lobe on a camshaft. It must maintain the fuel level in the VST for the high-pressure electric pump.
9. The rail fuel pressure does not vary with engine speed and/or load. The regulator vent line is not connected to manifold vacuum. Fuel pressure should be stable from idle to full throttle.
10. If fuel pressure drops at higher speed and higher engine loads, check the boat's fuel system for restrictions with an accurate vacuum gauge and clear hose at the water separating fuel filter's inlet. As the engine is run from idle to wide-open throttle and back to idle, the clear hose must not show any air bubbles and the vacuum gauge must not read higher than 2 in. hg.
11. If the supply system tests OK, but the fuel pressure is low at high speeds and loads, replace any fuel filters and test. If rail pressure remains low, the electric fuel pump is suspected as defective.
12. Check any and all vacuum lines for splits, kinks, and proper connections.
13. Check for any air leaks in the induction system, such as throttle body and intake manifold gaskets. If the normal IAC percentage for the engine is known, then any air leak will result in a lower IAC percent than normal. IAC should read 30–50%.
14. Unplug and inspect the ECM connector. Ensure there are no ECM pins bent over and that all of the correct pins are present. Refer to the service manual charts for the pins used and not used. Look for signs of tampering, corrosion, damage to the pin locking mechanisms, melted insulation, and any other evidence of shorts or other damage.
15. Unplug and inspect as many of the sensors and actuators as you can reasonably access. Look for signs of tampering, corrosion, damage to the pin locking mechanisms, melted insulation, and any other evidence of shorts or other damage. Based on the results of this inspection, further inspection of the harness may be necessary. There are many internal splices in the harness that may be damaged or defective. If there is damage on the external connections, you will have to inspect several of the internal splices to verify that the damage is not also present at these locations.

30/40 EFI Fault Information

NOTE: *Not all faults may be enabled on any specific engine. Each calibration can have its own fault setup.*

Fault Text	Type	Description	Service Information	Circuit information
MAF_too_High	Sticky	Mass air flow is too high. Check for proper ECM calibration number and/or modified components.	The PCM estimates the amount of air flowing throughout the engine. If this exceeds predefined limits, the fault it active. Usually the result of the wrong calibration or engine modifications.	Not applicable
Driver (system) Voltage too Low	Non_ Sticky	Driver (system) voltage too low.	The voltage entering the ECM at pins 57 and 58 is too low. This is usually caused by a defective alternator, excessive accessory load, or high resistance in the MPR, the fuse and/or the entire circuit. The fault sets when the voltage is approximately 11 V or lower.	Pins 57 and 58 (driver power) Pins 68 and 70 (ECM ground)
ESTOP_Active	Non_ Sticky	Emergency stop circuit is activated. The engine will not start as long as it is on.	Check lanyard stop switch. Check ESTOP circuit for short to ground.	Pin 41 (ESTOP) Pin 42 (sensor ground)

Fault Text	Type	Description	Service Information	Circuit information
EncoderFault CrankCamtrigger	Non_ Sticky	Crankshaft position sensor signal is erratic. This engine does not use a camshaft sensor.	Check sensor for proper mounting. Check white and red circuits for intermittent shorts and opens. Check for damage to the flywheel encoder ring.	Pins 13 and 14 (crankshaft position sensor)
FuelPumpCurrent High	Non_ Sticky	Fuel pump is drawing too much current. The pump could be locked up or its windings shorted.	Most likely a defective pump (short). Check for 12 V pump positive circuit shorted to the fuel pump driver circuit (pin 71), red/black circuit.	Battery + to fuel pump Pin 69 (fuel pump driver) Pins 68 and 70 (ECM ground)
FuelPumpCurrent Low	Non_ Sticky	Fuel pump is not drawing enough current. The impeller may not be turning with the pump or there may be excessive resistance in the pump armature and pump circuits.	Possible defective pump (open circuit). Check wiring for low or no 12 V to the fuel pump or high resistance on the fuel pump driver circuit (pin 71), red/black circuit.	Battery + to fuel pump Pin 69 (fuel pump driver) Pins 68 and 70 (ECM ground)
XDRPaInputHigh	Non_ Sticky	Sensor power 1 - voltage too high	Check sensor power circuit for short to battery voltage or other higher voltage source.	Pin 34 (sensor power) Pin 42 (sensor ground)
XDRPaInputLow	Non_ Sticky	Sensor power 1 - voltage too low	Check for shorted sensor by unplugging one sensor at a time while watching sensor power on data stream. When voltage goes up, you have located the problem sensor.	Pin 34 (sensor power) Pin 42 (sensor ground)
MAPInputHigh	Sticky	MAP circuit high	Check sensor and circuits for open sensor ground, short between sensor power and sensor signal, and short between sensor signal and other voltage source.	Pin 22 (MAP signal) Pin 34 (sensor power) Pin 42 (sensor ground)
MAPInputLow	Sticky	MAP circuit low	Check sensor and circuits for open sensor power, open sensor signal, or short between sensor signal and sensor ground.	Pin 22 (MAP signal) Pin 34 (sensor power) Pin 42 (sensor ground)
DRVPInputHigh	Non_ Sticky	Driver (system) voltage too high	The voltage entering the ECM is too high (usually above 16 volts). This can be caused by a defective voltage regulator, can also be caused by a circuit with higher voltage shorting to this circuit.	Pins 57 and 58 (driver power) Pins 68 and 70 (ECM ground)
Guardian_ OilPressure	Non_ Sticky	Oil pressure is too low, Guardian enabled	Check oil level. Check oil pressure with a mechanical gauge.	Pin 11 (sensor signal) Pin 68 and 70 (ECM ground)
Guardian_ Overheat	Non_ Sticky	Engine coolant is too hot, Guardian enabled	Check cooling system for possible malfunction.	Pin 21 (ECT signal) Pin 42 (sensor ground)
OilPress_Low	Non_ Sticky	Oil pressure is too low	Check oil level. Check oil pressure with a mechanical gauge.	Pin 11 (sensor signal) Pin 68 and 70 (ECM ground)
BaroRange	Non_ Sticky	Baro Value out of expected range	Baro pressure is absolute pressure. It is not compensated for altitude.	Pin 22 (MAP signal) Pin 34 (sensor power) Pin 42 (sensor ground)
ECT_Overtemp	Non_ Sticky	Engine coolant temperature too hot	Check cooling system for possible malfunction.	Pin 21 (ECT signal) Pin 42 (sensor ground)
EST1_OutputFault	Non_ Sticky	EST 1 primary circuit open or shorted	Check ignition coil primary circuit for opens and shorts. Check circuit between ignition coil and ECM for opens and shorts.	Battery + to ignition coil Pin 32 (EST 1) Pin 68 and 70 (ECM ground)

Fault Text	Type	Description	Service Information	Circuit information
EST2_OutputFault	Non_ Sticky	EST 2 primary circuit open or shorted	Check ignition coil primary circuit for opens and shorts. Check circuit between ignition coil and ECM for opens and shorts.	Battery + to ignition coil Pin 33 (EST 2) Pin 68 and 70 (ECM ground)
EST3_OutputFault	Non_ Sticky	EST 3 primary circuit open or shorted	Check ignition coil primary circuit for opens and shorts. Check circuit between ignition coil and ECM for opens and shorts.	Battery + to ignition coil Pin 66 (EST 3) Pins 68 and 70 (ECM ground)
Guardian_Active_ Fault	Non_ Sticky	Guardian is active due to an active fault	Check fault listing.	Not applicable
Guardian_Voltage	Non_ Sticky	Battery voltage problem, Guardian enabled	Check for low or high voltage on pin 52, 57, 58, and 67.	Pin 52 (key switch) Pins 57 and 58 (driver power) Pin 67 (battery) Pins 68 and 70 (ECM ground)
INJ1_OutputFault	Non_ Sticky	Injector 1 circuit is open or shorted	Check injector and circuit between ECM and injector for opens and shorts.	Battery + (to fuel injector) Pin 49 (injector 1 driver) Pins 68 and 70 (ECM ground)
INJ2_OutputFault	Non_ Sticky	Injector 2 circuit is open or shorted	Check injector and circuit between ECM and injector for opens and shorts.	Battery + (to fuel injector) Pin 50 (injector 2 driver) Pins 68 and 70 (ECM ground)
INJ3_OutputFault	Non_ Sticky	Injector 3 circuit is open or shorted	Check injector and circuit between ECM and injector for opens and shorts.	Battery + (to fuel injector) Pin 65 (injector 3 Driver) Pins 68 and 70 (ECM ground)
LIAC_OutputFault	Non_ Sticky	Idle air control valve is open or shorted	Check IAC valve and circuit between ECM and IAC valve for opens and shorts.	Battery + (to IAC valve) Pin 3 (IAC Driver) Pins 68 and 70 (ECM ground)
MAPR_ TPS1Rationality	Non_ Sticky	MAP and TPS are not reading as expected.	For any given MAP signal, the TPS is not reading as expected. Check MAP and TPS circuits for high resistance. Check if MAP and TPS data appear correct.	Pin 22 (MAP signal) Pin 53 (TPS signal) Pin 34 (sensor power) Pin 42 (sensor ground)
TPS1_RangeHigh	Non_ Sticky	TPS circuit high	Check sensor and circuits for open sensor ground, short between sensor power and sensor signal, and short between sensor signal and other voltage source.	Pin 53 (TPS signal) Pin 34 (sensor power) Pin 42 (sensor ground)
TSP1_RangeLow	Non_ Sticky	TPS circuit low	Check sensor and circuits for open sensor power, open sensor signal, or short between sensor signal and sensor ground.	Pin 53 (TPS signal) Pin 34 (sensor power) Pin 42 (sensor ground)
TPS_AdaptMech	Non_ Sticky	TPS cannot adapt	Check linkage for anything preventing throttle from fully closing. Throttle must be closed when engine is started.	Pin 53 (TPS signal) Pin 34 (sensor power) Pin 42 (sensor ground)
ECTInputHigh	Non_ Sticky	ECT circuit high	Check for open sensor, open sensor signal, or open sensor ground circuit.	Pin 21 (ECT signal) Pin 42 (sensor ground)
ECTInputLow	Non_ Sticky	ECT circuit low	Check for shorted sensor or sensor signal circuit shorted to ground.	Pin 21 (ECT signal) Pin 42 (sensor ground)

Fault Text	Type	Description	Service Information	Circuit information
Guardian_ Overspeed	Non_ Sticky	Engine overspeed, Guardian enabled	Check for proper propeller pitch, damaged propeller, or other causes of ventilation. Possible slipping propeller hub.	Not applicable
IATInputHigh	Non_ Sticky	IAT circuit high	Check for open sensor, open sensor signal, or open sensor ground circuit.	Pin 20 (IAT signal) Pin 42 (sensor ground)
IATInputLow	Non_ Sticky	IAT circuit low	Check for shorted sensor or sensor signal circuit shorted to ground.	Pin 20 (IAT Signal) Pin 42 (sensor ground)
RxDoc2_SOH	Non_ Sticky	CAN COMM fault - type 2	Check for proper CAN P termination. Check CAN P circuits for opens and shorts.	Pin 23 and 24 (CAN circuits)
HORN_Output Fault	Non_ Sticky	Warning horn problem - check circuit	Check horn and tan/blue circuit for open and short circuits. Check horn for battery voltage at purple lead when key is on.	Battery + (to horn) Pin 63 (horn driver) Pins 68 and 70 (ECM ground)

"Non-Sticky" indicates the fault will go inactive as soon as the problem is corrected.

"Sticky" indicates the fault will remain active until the problem is corrected and the key switch is cycled. Cycle key often when diagnosing faults.

CDS G3 Text - Guardian Cause

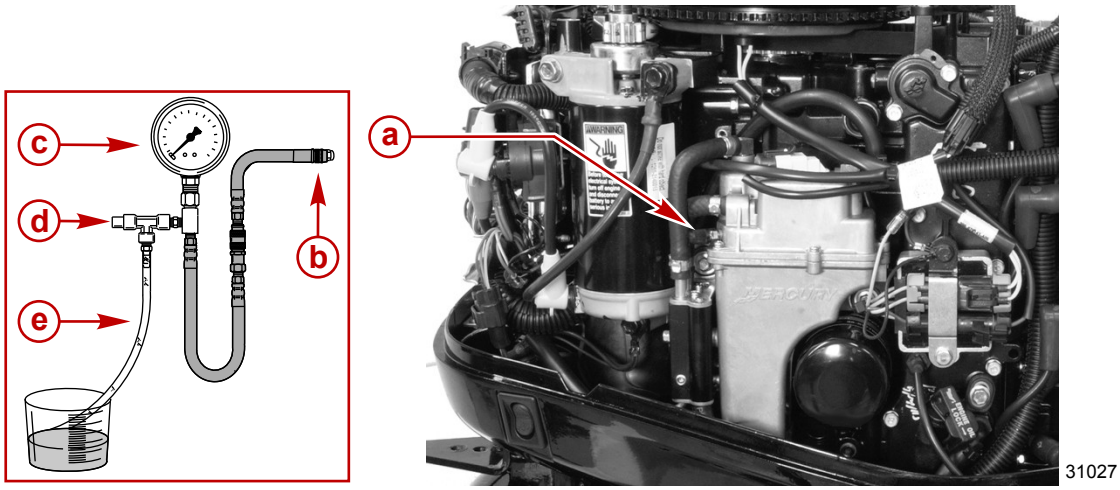
CDS G3 Text for Data Stream item "Guardian Cause"	
Text	**Probable Cause**
None	Guardian is not currently active. No faults or operator demand is less than GuardianLatchedPwrLim.
ECT (engine coolant temperature) Hot	ECT is hot. Diagnose the cooling system.
Volts	Battery voltage is too low or high. Diagnose the charging system.
Active Fault	A circuit high or circuit low sensor failure has occurred. Check fault status.
Oil Pressure	4-stroke mechanical oil pump pressure is low.

Fuel System

Pressure Regulator Test (Electric Fuel Pump)

1. Install the fuel pressure gauge onto the Schrader valve located on the VST.

2. Start the engine. The fuel pressure should be within specification.



a - Schrader valve
b - To Schrader valve
c - Fuel pressure gauge
d - Pressure relief button
e - Drain hose

Fuel Pump Pressure	
At all speeds	290–303 kPa (42–44 psi)

Fuel Pressure Gauge Kit	91-881833A03
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1

Anti-Siphon Valves

While anti-siphon valves may be helpful from a safety standpoint, they clog with debris, they may be too small, or they may have too heavy a spring. The pressure drop across these valves can, and often does, create operational problems and/or powerhead damage by restricting fuel to the fuel lift pump and, subsequently, the high-pressure fuel pump. Some symptoms of restricted (lean) fuel flow, which could be caused by use of an anti-siphon valve, are:

- Severe fuel rail pressure fluctuation
- Loss of fuel pump pressure
- High speed surging
- Outboard cuts out or hesitates upon acceleration
- Outboard runs rough
- Outboard quits and cannot be restarted
- Outboard will not start
- Vapor lock

Since any type of anti-siphon device must be located between the outboard fuel inlet and fuel tank outlet, a simple method of checking if such a device (or bad fuel) is a problem source, is to operate the outboard with a separate fuel supply which is known to be good, such as a remote fuel tank.

If, after using a separate fuel supply, it is found that the anti-siphon valve is the cause of the problem, there are two solutions to the problem; either 1) replace the anti-siphon valve with one that has a lighter spring tension, or 2) replace it with a solenoid-operated fuel shut off valve.

Mechanical Fuel Pump Test (Vacuum)

Fuel system vacuum can be checked by using a short piece of extra fuel hose, vacuum gauge, and a T-fitting.

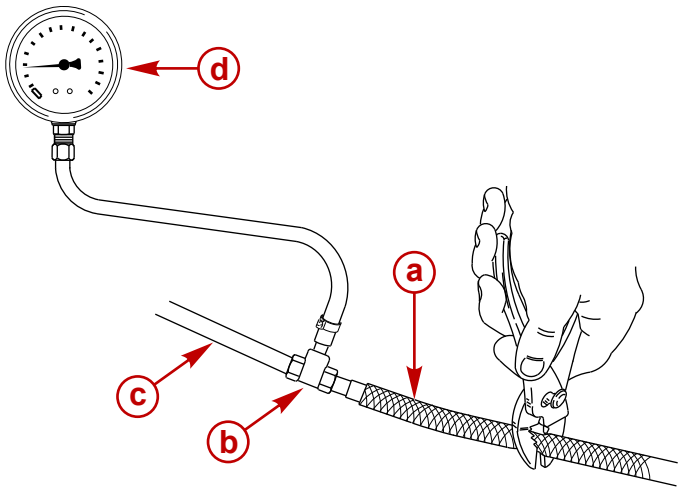
1. Conduct the test with water to the engine cooling system using one of the following methods:
   a. In a test tank
   b. With the boat/outboard lower unit in water
2. Disconnect the fuel hose from the inlet fitting of the mechanical fuel pump.

3. Connect an extra fuel hose onto the outlet fitting of the pump.
4. Install a T-fitting into the extra hose making the connection as close to the pump as possible.
5. Connect a vacuum gauge and the fuel inlet hose onto the T-fitting.
6. Start the engine and run at 1000 RPM, normal fuel system vacuum (lift) should be to specifications.

   NOTE: *The system vacuum test is normally performed at 1000 RPM. As engine RPM is increased, there will be a slight increase in vacuum; this increase should not exceed normal readings.*

Mechanical Fuel Pump Vacuum (Lift)	
Vacuum at 1000 RPM	25–50 mm Hg (1–2 in. Hg)

7. To isolate the mechanical fuel pump from the rest of the fuel system:
   a. Pinch off/restrict the fuel supply hose between the vacuum gauge and the fuel tank.
   b. The mechanical fuel pump vacuum (lift) should be to specifications.
   c. If the vacuum reading for the pump is below specifications, the pump needs rebuilding.



a - Fuel supply hose from fuel tank
b - T-fitting
c - Extra hose to inlet fitting of the mechanical fuel pump
d - Vacuum gauge

Mechanical Fuel Pump Vacuum (Lift)	
Minimum vacuum at 1000 RPM with fuel line pinched	102 mm Hg (4 in. Hg) minimum

8. If the fuel pressure reading is not within specifications, refer to **Fuel Pump Pressure Troubleshooting** table.
9. Stop the engine, remove the gauge, and reconnect the fuel line to the inlet fitting of the fuel pump.

   NOTE: *The fuel pump is designed to lift fuel (vertically) approximately 152 cm (60 in.) if there are no other restrictions in the system using a fuel hose that is 8 mm (5/16 in.) minimum diameter. As restrictions are added, such as filters, fittings, valves, etc., the amount of fuel pump lift decreases.*

Fuel Pump (Vacuum) Troubleshooting		
Condition	**Cause**	**Correction**
Fuel system vacuum (lift) above specification	Restricted anti-siphon valve	Refer to **Anti-Siphon Valves**, preceding
	Plugged fuel tank pickup screen	Clean/replace fuel pickup screen
	Pinched/collapsed fuel hose	Inspect/replace fuel hoses
	Dirty/plugged water separating fuel filter	Clean/replace water separating fuel filter
	Restriction in fuel line thru-hull fitting	Clean/replace fitting
	Restriction in fuel tank switching valve	Clean/replace valve
	Restriction within primer bulb	Rebuild/replace primer bulb

Fuel Pump (Vacuum) Troubleshooting		
Condition	**Cause**	**Correction**
Fuel system vacuum (lift) below specification	Low fuel level in fuel tank	Fill tank with fuel
	Hole/cut in pickup tube of fuel tank	Replace fuel pickup tube
	Loose fuel line connection	Check/tighten all connections
	Hole/cut in fuel line	Inspect/replace fuel hoses
	Loose fuel pump screws	Torque screws to specification
	Fuel pump gaskets worn or leaking	Rebuild/replace fuel pump
	Fuel pump check valves/seals leaking	Rebuild/replace fuel pump
	Leaky fuel pump diaphragm	Rebuild/replace fuel pump
	Worn/broken fuel pump springs	Rebuild/replace fuel pump
	Leaky fuel pump seals	Rebuild/replace fuel pump
	Fuel filter bowl loose	Tighten fuel filter bowl
	Fuel filter gasket cut/worn	Replace gasket
	Fuel vaporization	Check for plugged fuel pump water-cooling circuit

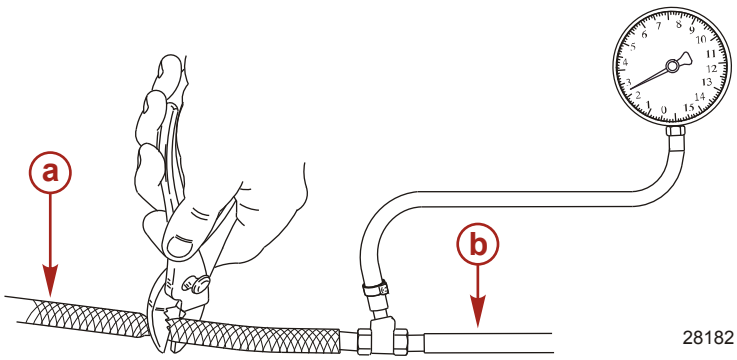
Mechanical Fuel Pump Test (Pressure)

Fuel system pressure troubleshooting can be performed by using a piece of clear fuel hose 10 cm (4 in.) long, a pressure gauge, and a T-fitting.

1. Conduct the test with water to the engine cooling system using one of the following methods:
   - In a test tank
   - With the boat/outboard lower unit in water
2. Disconnect the fuel hose from the outlet fitting of the mechanical fuel pump.
3. Connect the clear fuel hose onto the outlet fitting of the pump.
4. Install the T-fitting onto the clear fuel hose.
5. Connect the pressure gauge and fuel outlet hose (to VST) onto the T-fitting.
6. Start the engine and run at 1000 RPM, normal fuel system pressure should be to specifications.

Normal Mechanical Fuel System Pressure	
Pressure at 1000 RPM	13.8 kPa (2 psi)

7. To isolate the mechanical fuel pump from the rest of the fuel system:
   a. Pinch off/restrict the fuel hose between the T-fitting and the VST.
   b. The mechanical fuel pump pressure should be to specifications.
   c. If pressure reading for the pump is below specifications, the pump needs rebuilding.
8. If the fuel pressure reading is below specifications, refer to **Fuel Pump Pressure Troubleshooting** table.
9. Stop the engine, remove the gauge, and clear hoses. Reconnect the fuel line to the outlet fitting of the fuel pump.



a - Fuel hose (to VST)
b - Clear hose (from mechanical fuel pump outlet to T-fitting)

Mechanical Fuel Pump Pressure	
Pressure at 1000 RPM with pinched fuel line	20.7 kPa (3 psi)

Fuel Pressure Gauge Kit	91-881833A03
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1

Fuel Pump Pressure Troubleshooting

Mechanical Fuel Pump (Pressure) Troubleshooting		
Condition	**Cause**	**Correction**
Fuel system pressure below specification	Restricted anti-siphon valve	Refer to **Anti-Siphon Valves**, preceding
	Low fuel level in fuel tank[1].	Fill tank with fuel
	Plugged fuel tank pickup screen	Clean/replace fuel pickup screen
	Hole/cut in pickup tube of fuel tank[1].	Replace fuel pickup tube
	Loose fuel line connection[1].	Check/tighten all connections
	Hole/cut in fuel line[1].	Inspect/replace fuel hoses
	Fuel line primer bulb check valves not opening	Replace fuel line primer bulb
	Fuel hose/line internal diameter too small	Use 8 mm (5/16 in.) fuel hose
	Restriction in fuel line thru-hull fitting	Clean/replace fitting
	Restriction in fuel tank switching valve	Clean/replace valve
	Restriction within primer bulb	Rebuild/replace primer bulb
	Pinched/collapsed fuel hose	Inspect/replace fuel hoses
	Dirty/plugged water separating fuel filter	Clean/replace water separating fuel filter
	Fuel filter bowl loose[1].	Tighten fuel filter bowl
	Fuel filter gasket cut/worn[1].	Replace gasket
	Loose fuel pump screws[1].	Tighten screws to specification
	Fuel pump gaskets worn or leaking[1].	Rebuild/replace fuel pump
	Fuel pump check valves/seals leaking	Rebuild/replace fuel pump
	Leaky fuel pump diaphragm[1].	Rebuild/replace fuel pump
	Worn/broken fuel pump springs	Rebuild/replace fuel pump
	Leaky fuel pump seals	Rebuild/replace fuel pump
	Fuel vaporization	Check for plugged fuel pump water-cooling circuit

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.

1. Air bubbles may also be visible as fuel passes through the clear fuel (test) hose installed between the mechanical fuel pump outlet fitting and the VST.

IMPORTANT: The Guardian Protection System cannot guarantee that powerhead damage will not occur when adverse operating conditions are encountered. The Guardian Protection System is designed to 1) warn the boat operator that the engine is operating under adverse conditions and 2) reduce power by limiting maximum RPM in an attempt to avoid or reduce the possibility of engine damage. The boat operator is ultimately responsible for proper engine operation.

Warning Horn/Guardian System Operation		
Sound	**Condition**	**Description**
One beep on key up	Normal	System test.
Six beeps on key up, or during a running failure	Failure detected with MAP, IAT, TPS, or Flash Check Sum (ECM)	Engine should run well, however, service will be required.
Three beeps every four minutes	Failure detected with: • Battery voltage • EST - Open detected at key up. Short detected with engine running. • Fuel injector - Detected while cranking/ running • Coolant sensor - ECT • IAC	Engine will start hard, run rough, and/or stall. Utilizing the neutral fast idle feature may assist starting. Service is required.
Intermittent beeps	Failure detected with: • Fuel pump - May start momentarily • Main Power Relay (MPR) - No start • ECM reference voltage to MAP/TPS - Starts but stalls under load	Engine may or may not start. If engine starts, it easily stalls. Service is required.
Continuous beep	Engine overheat	Engine Guardian Protection System is activated. Power limit will vary with level of overheat. Stop engine and check water intake for obstruction. Advancing throttle above idle may provide additional cooling.
	Low oil pressure	Guardian Protection System is activated. Engine power is limited to 10% of maximum. Stop engine and check oil level. Add oil if necessary.
	Battery voltage less than 10 V or more than 16 V	Engine Guardian Protection System is activated. Engine power is limited to 75% of maximum.
	Coolant sensor failure - ECT	Engine Guardian Protection System is activated. Engine power is limited to 50% of maximum. Engine overheat protection is compromised.
	Engine speed limiter	Exceeding 6200 RPM cuts spark/injection on cylinders #2 and #3 to reduce engine speed. Exceeding 6350 RPM cuts spark/injection on all cylinders to reduce engine speed.

Overheat Temperature Parameters

30/40 EFI FourStroke

When troubleshooting these models of engines, questions often arise as to what the actual engine overheat parameters are for Guardian. Please see the table below as a reference point for this information:

Engine Temperature	Percent of Available Power (GuardianLatchedPwrLim)
Below 77 °C (170 °F)	100%
77–79 °C (170–174 °F)	60%
79–82 °C (174–180 °F)	40%
85–87 °C (185–189 °F)	30%
Above 87 °C (189 °F)	20%

NOTE: *These models of engines are able to run at idle speed with temperatures up to 90 °C (194 °F) before any Guardian or horn is activated.*
Keep in mind that the operator must attempt to operate the engine above the available power limit to activate the Guardian system. If the engine is operating at one of the above temperatures, but below the available power limit, no reduction in speed or warning horn will be noticed.
GuardianLatchedPwrLim = available power.

IMPORTANT: One of the many causes of an overheat condition can be a damaged or plugged thermostat. If the engine has a thermostat that allows the engine to reach temperatures between 71–77 °C (160–170 °F) the Guardian system may activate due to engine load as part of the calibration not covered in the above chart. In these scenarios the fault will be recorded as a RPM Limit fault.

Gen III EFI System Troubleshooting Guide

Condition	Cause/First	Warning Mode	Check
Engine cranks, but will not start	Lanyard stop switch is in the "OFF" position	None	Set lanyard stop switch to "RUN."
	Weak battery or bad starter motor. Battery voltage drops below 8 volts while cranking (ECM cuts out below 6 volts) (fuel pump requires 8 volts)	Three beeps every four minutes for low battery voltage	Check condition of battery/starter solenoid terminals and cables. Charge/replace battery. Inspect condition of starter motor.
	Blown fuse	None	Replace fuse (located in the port fuse holder). Inspect engine wiring harness and electrical components. Fuse #2 - Fuel injectors/IAC/fuel pump Fuse #3 - Main power relay/accessory Fuse #4 - Ignition coils
	Main power relay	Intermittent beeps	Listen for relay to click when key switch is turned to "ON" 81–99 ohms Between pin 8 (yel/ppl) of the ECM connector and (red/blu) wire of fuse #3 (fuse removed) - or - Between pin #85 and pin #86 of relay - or - Test suppression diode. Refer to **Section 2B - Suppression Diode Tests.**
	Crankshaft position sensor (CPS)	None ***NOTE:*** *No RPM reading at tachometer*	300–350 ohms Between pin 29 (red) and pin 13 (wht) of the ECM connector. - or- Between pin #1 (red) and pin #2 (wht) of CPS connector.
	Electric fuel pump	Intermittent beeps	Listen for pump. Fuel pump should run two seconds after key switch is turned to "RUN" position. 32–41 ohms Between pin 69 (blk/blu) and pin 57 or 58 (red/blu) - or - Between pins of fuel pump connector.
	Flywheel misaligned	None	Remove flywheel and inspect flywheel key/keyway.
	Engine coolant temperature (ECT) sensor	Three beeps every four minutes	See ECT sensor resistance chart. Advancing the remote control fast idle feature or advancing the tiller handle throttle grip halfway may assist starting.

Condition	Cause/First	Warning Mode	Check
Engine cranks, starts, and stalls	Remote control to engine wiring harness connection is poor	None	Clean and inspect male and female connections.
	Air in fuel system/lines	None	Crank and start engine several times.
	Manifold absolute pressure (MAP) sensor	Six beeps at key up or failure	See MAP sensor resistance chart.
	Throttle position sensor (TPS)	Six beeps at key up or failure	Typical TPI range with CDS: Idle 0.39–1.0 volts, WOT 3.66–4.80 volts.
	Idle air control (IAC)	Three beeps every four minutes	20–24 ohms Between pin 3 (wht/org) and pin 57 or 58 (red/blu) of the ECM connector. - or - Between pin A and pin B of IAC.
	ECM reference voltage to MAP/TPS	Intermittent beeps	5 V between ppl/yel pin of MAP sensor wiring harness connector and engine ground (key switch to "RUN").
	Fuel pressure at VST fitting	None	See fuel pressure test.
	Flywheel misaligned	None	Remove flywheel and inspect flywheel key and keyway.
Engine idles fast after warm-up (900–1100 RPM)	Engine coolant temperature (ECT) sensor	Three beeps every four minutes	See ECT sensor resistance chart.
Poor off idle or WOT running quality	Fuel injector	Three beeps every four minutes	10.0–13.5 ohms Between fuel injector pin #1 and pin #2. - or - Between (removed) fuse #2 (red/blu) wire and the ECM connector: Pin 49 (pnk/brn) fuel injector #1 Pin 50 (pnk/red) fuel injector #2 Pin 65 (pnk/org) fuel injector #3
	Ignition coil (EST)[1].	Three beeps every four minutes	See ignition coil resistance chart - **Section 2A - Ignition.**
	Fuel pressure at VST fitting	None	See fuel pressure test.
	Fuel filter plugged	None	Replace fuel filter.
	Improper spark plugs	None	Use recommended resistor spark plugs.
	Loose grounds	None	Check all ground connections.
	Flywheel timing tooth pattern	None	Check tooth pattern for partially missing or damaged teeth.
	Fouled spark plug	None	Replace spark plug.

1. The ECM will only monitor the EST connection to the ignition coil, use resistance tests and /or spark gap test to confirm an ignition coil failure.

Condition	Cause/First	Warning Mode	Check
Poor idle quality	Crankshaft position sensor	None	300–350 ohms Between pin 14 (red) and pin 13 (wht) of the ECM connector. - or - Between pin #1 (red) and pin #2 (wht) of CPS connector.
	Manifold absolute pressure (MAP) sensor	Six beeps at key up or failure	See MAP sensor resistance chart.
	Throttle position sensor (TPS)	Six beeps at key up or failure	Typical TPI range with CDS: Idle 0.39–1.0 volts, WOT 3.66–4.80 volts.
	Engine coolant temperature (ECT) sensor	Three beeps every four minutes	See ECT sensor resistance chart.
	Manifold air temperature (MAT) sensor	Six beeps at key up or failure	See MAT sensor resistance chart.
	Fuel injector	Three beeps every four minutes.	10.0–13.5 ohms Between fuel injector pin #1 and pin #2. - or - Between (removed) fuse #2 (red/blu) wire and the ECM connector. Pin 49 (pnk/brn) fuel injector #1 Pin 50 (pnk/red) fuel injector #2 Pin 65 (pnk/org) fuel injector #3
	Ignition coil (EST)[1.]	Three beeps every four minutes	See ignition coil resistance chart - **Section 2A - Ignition.**
	Idle air control (IAC)	Three beeps every four minutes	20–24 ohms Between pin 3 (wht/org) and pins 57 or 58 (red/blu) of the ECM connector. - or - Between pin A and pin B of IAC.
	Fuel pressure at VST fitting	None	See fuel pressure test.
	Loose grounds	None	Check all ground connections.
	Fouled spark plug	None	Replace spark plug.
Engine runs rich	Fuel pressure regulator	None	42–44 psi (290–303 kPa) at VST fitting.
	Engine coolant temperature (ECT) sensor	Three beeps every four minutes	See ECT sensor resistance chart.
	Thermostat stuck open	None	Remove and inspect thermostat - **Section 4A - Cylinder Head.**
Speed reduction Engine RPM limited to 2000	Low oil pressure or grounded oil pressure switch lead	Continuous horn above 10% power setting	Check engine oil level and add oil as needed. Remove oil pressure switch and install oil pressure gauge, (warm engine) oil pressure should be: Above 2.9 psi (20.0 kPa) at idle 30–40 psi (207–278 kPa) at 3000 RPM. See **Oil Pressure Switch Test** in **Section 4B - Cylinder Block/Crankcase.** Check for short between pin 11 (lt blu) of the ECM connector and open connector of oil pressure switch.

Condition	Cause/First	Warning Mode	Check
Speed reduction Engine RPM limited	Engine overheat	Continuous	Engine Guardian System is activated. Power limit will vary with level of overheat. Stop engine and check water intake for obstruction. Advancing throttle above idle may provide additional cooling.
	Battery voltage Less than 10 V or more than 16 V	Continuous horn above 75% power setting	Engine Guardian System is activated. Engine power is limited to 75% of maximum.
	Engine coolant temperature (ECT) sensor failure	Continuous horn above 50% power setting	Engine Guardian System is activated. Engine power is limited to 50% of maximum. Engine overheat protection is compromised.

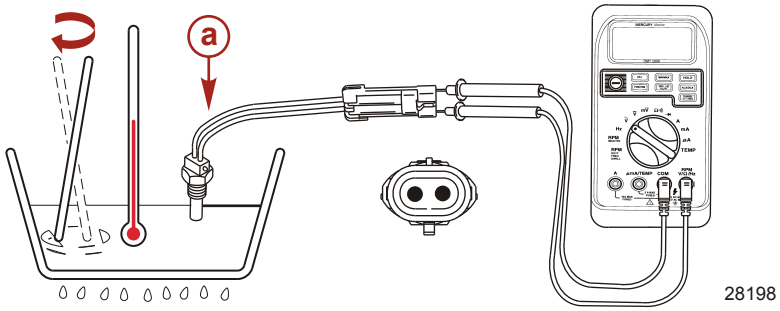
IMPORTANT: In all instances check wiring harness integrity (especially ground connections) in boat and on engine.

Component Resistance Tests

Engine Coolant Temperature (ECT) Sensor and Manifold Air Temperature (MAT) Sensor

The ECT and MAT sensors are thermistors (a resistor that changes value based on temperature). Low temperature produces a high resistance. High temperature causes low resistance.

1. Place the temperature sensor in a container filled with water.
2. Place a thermometer in the water and slowly heat the water.
3. Measure the resistance when the specified temperature is reached. If the reading is out of specification, replace the sensor.

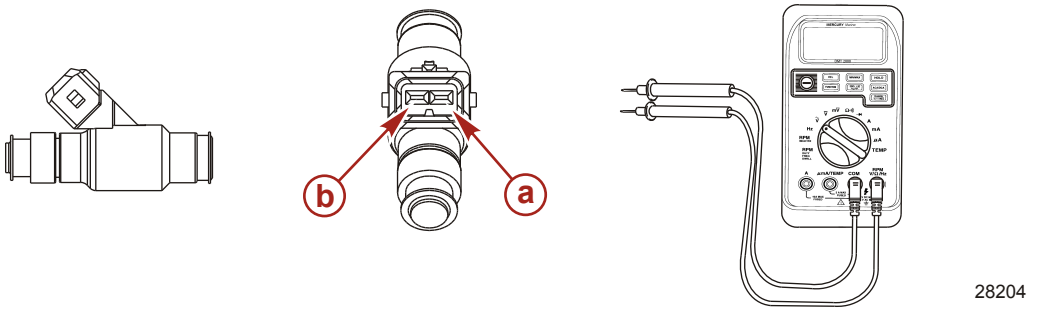


a - Temperature sensor

DMT 2004 Digital Multimeter	91-892647A01

Approximate Temperature-to-Resistance Values		
°F	°C	ohms
210	100	680
160	70	1,752
104	40	5,327
70	20	12,493
41	5	25,396
32	0	32,654
23	-5	42,324
-4	-20	97,060
-40	-40	336,000

Fuel Injector

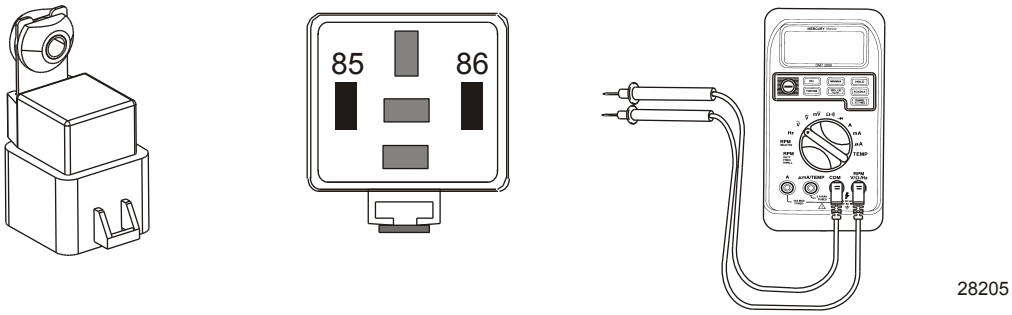


a - Pin A
b - Pin B

DMT 2004 Digital Multimeter	91-892647A01

Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Pin A	Pin B	Ω	10.0–13.5

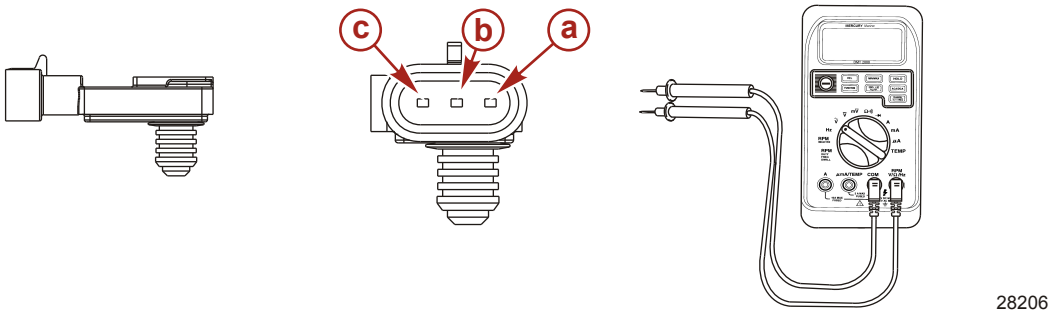
Main Power Relay



DMT 2004 Digital Multimeter	91-892647A01

Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Terminal 85	Terminal 86	Ω	81–91

Manifold Absolute Pressure (MAP) Sensor

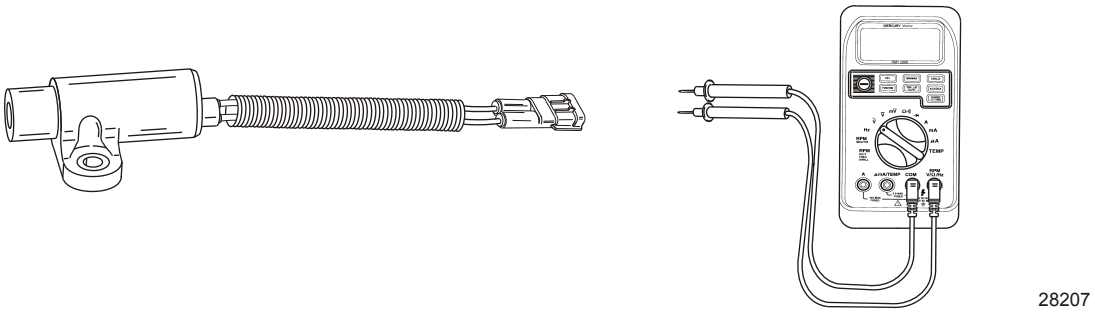


a - Pin A (blk/org)
b - Pin B (yel)
c - Pin C (pur/yel)

DMT 2004 Digital Multimeter	91-892647A01

Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Pin A	Pin B	Ω	95–105 k
Pin A	Pin C	Ω	3.9–4.3 k
Pin B	Pin C	Ω	95–105 k

Crankshaft Position Sensor (CPS)



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Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Red	White	Ω	300–350

DMT 2004 Digital Multimeter	91-892647A01

Notes: