Fuel System

Section 5A - Component Description

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A

Introduction

The following text describes proper diagnosis and service of the Cummins MerCruiser Diesel Electronic Control System (ECS) for the diesel fuel injection system with a high-pressure fuel pump and a common fuel rail (sometimes referred to as an accumulator).

All information is based on the latest product information available at the time of publication. We reserve the right to make changes without notice.

This manual and any subsequent publication provides information required to properly maintain the Cummins MerCruiser Diesel engine control system.

Initial Production vs. Product Improvement Engines

Cummins MerCruiser Diesel (CMD) has modified the production configuration of the QSD 2.0L four-cylinder diesel engine rated at 115, 130 and 150 metric horsepower. The term "initial production" refers to original configuration models, and the term "product improvement" refers to new models. These production changes are:

- Removed fuel cooler
- New sea water pump
- Redesigned exhaust riser
- Redesigned exhaust piping
- New heat exchanger and riser tube
- New glycol oil cooler
- Power steering bracket
- New transmission oil cooler

Precautions

Follow these instructions to ensure safe and proper service and repair of all Cummins MerCruiser Diesel Electronic Control System (ECS) engines.

-
- Replace parts with those recommended by Cummins MerCruiser Diesel.
- Use only special tools as listed in the document.

IMPORTANT: Using replacement parts, service procedures, or tools not recommended by Cummins MerCruiser Diesel can compromise personal safety or engine operation. Ensure that replacement parts have the same part number as the original or one that is directly superseded from the original.

Observe the following when working on ECS equipped engines:

- Observe all Warnings, Cautions, and Notices.
- Before removing any ECM (engine control module) system component, disconnect the negative (–) battery cable.
- Never start the engine with the terminal ends of the battery cables unsecured.
- Never separate the battery from the on-board electrical system while the engine is operating.
- Never separate the battery feed wire from the charging system while the engine is operating.
- Disconnect the battery when using an secondary battery charger.
- Ensure that all cable harnesses are connected solidly and that battery connections are thoroughly clean.

- Never connect or disconnect the wiring harness or injection harness at the ECM when the key switch is in the on position.
- Before attempting any electric arc welding, disconnect the battery leads and the ECM connector.
- When steam cleaning engines, do not direct the steam cleaning nozzle at the ECM system components, as this may result in corrosion or other damage to electrical components.
- Only use the specified test equipment. Unapproved test equipment may give incorrect results or damage ECS components.
- All voltage measurements using a voltmeter require a digital voltmeter with a rating of 10 megaohms input impedance.

Testing Procedure

1. When a test light is specified, a low-power test light must be used. Do not use a high-wattage test light. While a particular brand of test light is not suggested, a simple test, as shown below, on any test light will ensure it to be safe for system circuit testing:
   a. Connect an accurate ammeter (such as the high-impedance digital multimeter) in series with the test light being tested, and power the test light/ammeter circuit with the battery.
   b. If the ammeter indicates less than 3/10 amp current flow (.3 A or 300 mA), the test light is safe to use.
   c. If the ammeter indicates more than 3/10 amp current flow (.3 A or 300 mA), the test light is not safe to use.

***NOTE:** Using a test light with 100 mA or less rating may show a faint glow when test actually states no light.*

2. When using a DVOM to perform voltage measurements, turn the key switch to the off position when connecting the DVOM to the circuitry to be tested.

General Information

Basic Knowledge and Tools Required

To use the information in this manual most effectively you should be familiar with wiring diagrams; the meaning of volts, ohms and amperes; and the basic theories of electricity and electrical diagnostics. System diagnosis requires specialized equipment. Become acquainted with the tools and their use before attempting to diagnose the system. Any special tools required for ECS service are listed in this manual.

Visual and Physical Inspection

IMPORTANT: A careful visual and physical inspection must be performed as part of any diagnostic procedure and may reveal a solution that eliminates the need for further diagnosis.

Inspect all wiring for proper connections, signs of burning, chafing, and pinched or cut wires.

Electrostatic Discharge Damage

Control system electronics operate at a low voltage and are susceptible to damage caused by electrostatic discharge. Less than 100 volts of static electricity can cause damage to electronic components. By comparison, it takes as much as 4,000 volts for a person to feel a static discharge.

A person can become statically charged in several ways, the most common methods are by friction and by induction. An example of charging by friction is a person sliding across a seat which can build up a charge of as much as 25,000 volts. Charging by induction occurs when a person with well-insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges of either type can cause damage. Use caution when handling and testing electronic components.

Diagnostic Information

The diagnostic information and functional checks in **Section 5F** of this manual are designed to locate a faulty circuit or component through the process of elimination. The information assumes that the system functioned correctly at the time of assembly and that there are not multiple failures.

Terminology

Abbreviations

BARO	Barometric Pressure
BAT	Battery Positive Terminal, Battery or System Voltage
B+	Battery Positive
CKT	Circuit
CONN	Connector
CYL	Cylinder
DEG	Degrees
DIAG	Diagnostic
DLC	Data Link Connector
DTC	Diagnostic Trouble Code
DVOM	Digital Volt Ohmmeter
ECM	Engine Control Module
ECT	Engine Coolant Temperature
EEPROM	Electronic Erasable Programmable Read Only Memory
EMI	Electromagnetic Interference
ENG	Engine
GND	Ground
GPH	Gallons Per Hour
IAT	Intake Air Temperature
in.hg	Inches Of Mercury
INJ	Injection
IGN	Ignition
kPa	Kilopascal
KV	Kilovolts
LDF	MAP or Boost Pressure Sensor
LGS	Low Idle Switch
MAP	Manifold Absolute Pressure
MIL	Malfunction Indicator Lamp
msec	Millisecond
mV	Millivolt

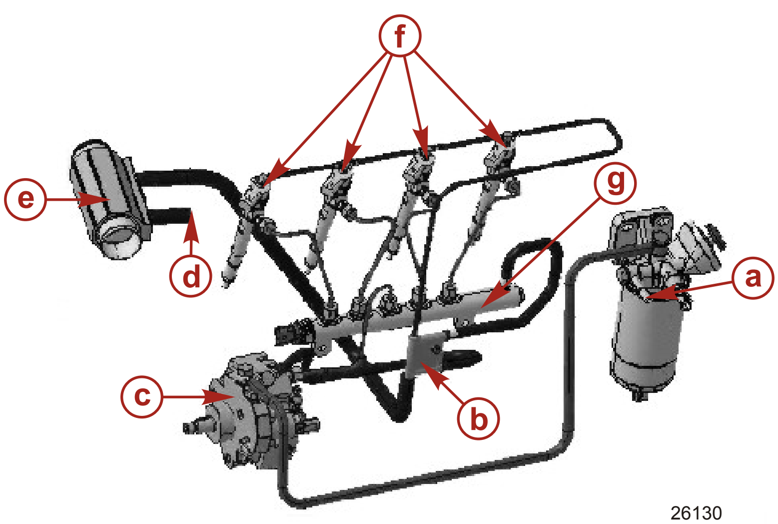
N/C	Normally Closed
N/O	Normally Open
PID	Packet of Informational Data
PROM	Programmable Read Only Memory
RAM	Random Access Memory
REF HI	Reference High
REF LO	Reference Low
ROM	Read Only Memory
SRC	Signal Range Check
SW	Switch
TACH	Tachometer
TERM	Terminal
TP	Throttle Position Sensor
V	Volts
VAC	Vacuum
WOT	Wide Open Throttle

Fuel Flow

Specifications

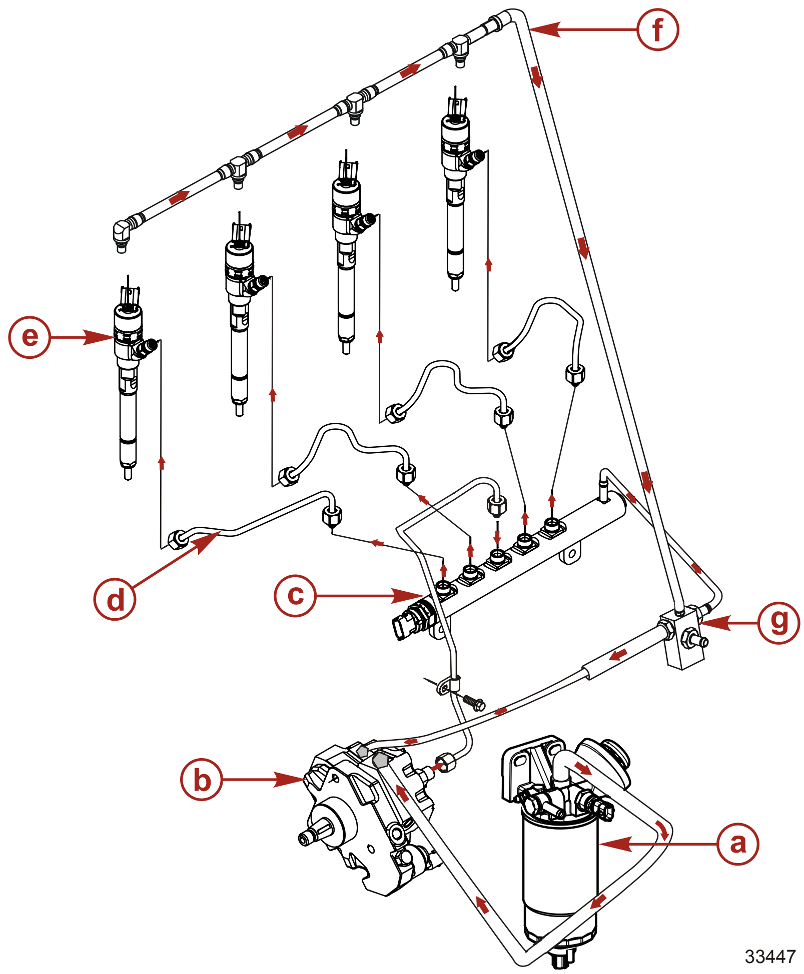
Fuel Flow		
Fuel Inlet Restriction	Maximum	147 mm Hg (5.8 in. Hg)
Fuel return restriction	Maximum	104 mm Hg (4.1 in. Hg)

Diagram



Initial production fuel flow diagram

- **a -** Fuel filter inlet
- **b -** Fuel distribution block
- **c -** Injection pump
- **d -** Fuel return connection
- **e -** Fuel cooler
- **f -** Fuel injectors
- **g -** Fuel rail



Product improvement fuel flow diagram

- **a -** Fuel inlet on filter
- **b -** Injection pump
- **c -** Fuel rail
- **d -** Fuel injector lines
- **e -** Fuel injectors
- **f -** Fuel return connection
- **g -** Fuel distribution block

Electronic Control Module (ECM) and Sensors

General Description

The Cummins MerCruiser Diesel Electronic Control System is equipped with a computer that provides the operator with state-of-the-art control of fuel delivery. Computers use voltage to send and receive information.

Computers and Voltage Signals

Voltage is electrical pressure. Voltage does not flow in circuits. Instead, voltage causes current. Current does the real work in electrical circuits. It is current—the flow of electrically charged particles—that energizes solenoids, closes relays, and lights lamps.

Besides causing currents in circuits, voltage can be used as a signal. Voltage signals can send information by changing levels, changing waveform (shape), or changing the speed at which the signal switches from one level to another. Computers use voltage signals to communicate with one another. The different sections inside computers also use voltage signals to communicate with each other.

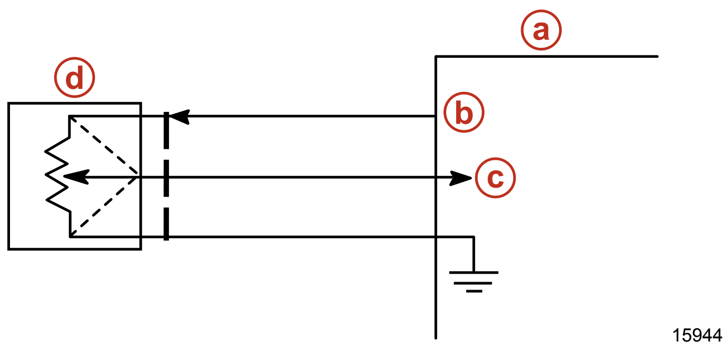
There are two kinds of voltage signals, analog and digital. Both of these are used in computer systems. It's important to understand the difference between them and the different ways they are used.

Analog Signals

An analog signal is continuously variable. This means that the signal can be any voltage within a certain range. An analog signal usually gives information about a condition that changes continuously over a certain range. For example, in a marine engine, information about temperature is usually provided by an analog signal. There are two general types of sensors that produce analog signals: the 3-wire and the 2-wire sensor.

SENSORS WITH MORE THAN TWO-WIRES (MAP / IAT AND TP)

As an example, the following figure shows a schematic representation of a 3-wire sensor. All 3-wire sensors have a reference voltage, a ground, and a variable wiper. The lead coming off of the wiper will be the signal to the ECM. As this wiper position changes, the signal voltage returned to the computer also changes.

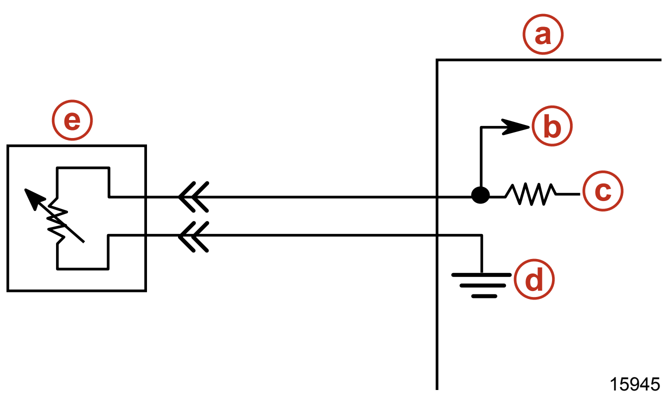


3-Wire sensor

a - ECM
b - Voltage out
c - Signal input
d - Typical sensor

TWO-WIRE SENSORS (ECT)

The following figure is the schematic of a 2-wire type sensor. This sensor is basically a variable resistor in series with a fixed-known resistor within the computer. By knowing the values of the input voltage and the voltage drop across the known resistor, the value of the variable resistor can be determined. The variable resistors that are commonly used are called thermistors. A thermistor's resistance varies inversely with temperature.



2-Wire sensor

a - ECM
b - Sensor signal
c - 5 Volt
d - Sensor ground
e - Typical sensor

Analog Value Conditioning

The analog value conditioning is subdivided into two parts: sampling the analog signals and scaling and checking the raw values.

The following analog values are made available as messages by the analog value conditioning circuits of the ECM:

- Water temperature
- Air temperature
- Fuel temperature
- Intake manifold pressure (boost pressure)
- Atmospheric pressure
- Throttle position (TP)
- Instrumented Injector Needle movement
- TP current
- Reference voltage
- Battery voltage

Analog value sampling

Sampling saves the results of the periodic analog and digital conversion as raw values. The stored values are evaluated at a later time.

In addition to periodic signal sampling there is also an active speed-synchronous sampling. Upon starts, the speed-synchronous sampling conversion that may be running is stopped. In the next signal sampling period, the discontinued conversion is again started.

Analog Value Evaluation

To process the raw values there are three different loop frames: speed-synchronous (speed interrupt-synchronous up to a maximum of 6 ms), fast time-synchronous (20 ms) and slow time-synchronous (100 ms).

To evaluate the analog signals, the raw values are checked and converted. Checking consists of a signal range check (SRC). If the raw values exceed the valid signal range they are replaced by a stored default value. As an example, an engine coolant temperature (ECT) sensor malfunction would set an internal switch, causing a default value to replace the signal from the defective ECT sensor.

The data set parameter is selected so that the default value is accepted over a ramp (time) function or directly. If the raw value is again in a valid range after a SRC error, the new value is brought to the current value.

The raw data values are scaled along a predetermined curve. There are additional special routines for evaluating the TP sensor and MAP sensor which are scaled through their supply voltage.

In case of TP sensor failure, such as a SRC defect on supply voltage, the ECM substitutes a default fuel quantity value and limits engine speed to 800 RPM.

The ECM is also programmed to respond to variations from other components. For example, if certain preset SRC value thresholds are exceeded the ECM will store the errors and may execute internal diagnostic routines to evaluate the data error.

NOTE: *The ECM will attempt to identify the source of a faulty component or input by comparing current input data to stored historical and default data.*

Digital Signals

GENERAL

The ECM uses digital signals in a code that contains only ones and zeros. The high voltage of the digital signal represents a one (1), and no voltage represents a zero (0). Each zero and each one is called a bit of information, or just a bit. Eight bits together are called a word. A word, therefore, contains some combination of eight binary code bits: eight ones, eight zeros, five ones and three zeros, and so on.

Computers use binary code for internal processing and external communication. By stringing together thousands of bits, computers can communicate and store a variety of information quickly and accurately. To a computer that understands binary, 11001011 might mean that it should reset engine RPM at a lower level.

PROCESSING THE DIGITAL INPUTS

The digital inputs are centrally read, processed, and distributed throughout the system. The first input message indicates the raw electrical conditions and includes an internal message indicating the logical, validity-checked conditions of the inputs.

Digital input signals that are processed:

1. Low-idle switch
2. Terminal 15 (battery voltage, key ON)
3. Terminal 15, not validity-checked
4. Logical conditions, validity-checked
5. Electrical conditions, not validity-checked

Inputs that are not used are masked out. Each input signal is checked for validity. Every input is assigned a logic level and compared to four data set parameters:

1. Maximum
2. Off-Limit
3. On-Limit
4. Minimum

IMPORTANT: Terminal 15 (battery voltage, key ON) input is not validity checked and status is also made available.

SWITCH TYPES

Switched (discreet) inputs to the ECM are either pull-up or pull-down data types.

Pull-up type switches provide a voltage signal to the ECM when the switch is closed. Pull-down type switches trigger an ECM response when the ECM recognizes that the switch is open.

Switched input is also used to provide frequency information to the ECM.

PULSE COUNTERS

The ECM uses the time between switched input voltage pulses to determine pulse counter frequency information.

The Crankshaft Speed Sensor provides a pulse input. The ECM compares Crankshaft Speed Sensor pulse frequency to stored pulse per engine revolution data and calculates engine RPM.

Engine Control Module (ECM)

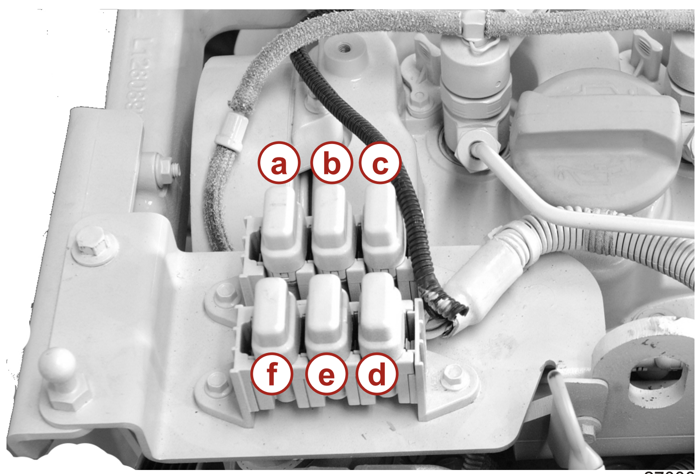
The ECM controls the fuel injection system by monitoring the various sensors and controls systems that affect engine performance.

The ECM also performs a diagnostic function. It can recognize operational problems and store a code or codes, which identify the problem areas and aid the technician in making repairs.

30343

ECM

An ignition key switch controlled 10-ampere circuit breaker located on the circuit breaker panel on top of the engine supplies the ECM with switched power. The engine may crank but will not start If any of the ECM circuit breakers are open. If the ECM does not receive a 12-volt power signal no ECM dependant vessel systems will function properly. SmartCraft instrumentation will display a "no communication" error message.



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Reference	Fuse	Protection	Location on fuse panel (From Front of Engine)
a	20-amp	Un-switched power to helm	Lower left
b	10-amp	Switched power to ECM	Middle left
c	10-amp	Keyed power to ECM	Upper left
d	5-amp	Power—diagnostic connector	Upper right
e	15-amp	ECM switched power to SIM	Middle right
f	15-amp	Switched power to ECM	Lower right

The ECM provides 4.9 volts or 12 volts supply voltage to power various sensors and switches. These ECM circuits will not power a standard test light due to the internal ECM circuits' high resistance. Accurate voltage readings require the use of a 10 megaohm input impedance digital voltmeter.

There are three types of memory storage within the ECM.

- Read-only memory (ROM) is a permanent memory that is soldered to the circuit boards of the ECM. The ROM stores the ECM control programs. ROM memory can not be reprogrammed and does not need power to be retained.
- Random-access memory (RAM) is the microprocessor scratch pad. The processor can write into or read from this memory as needed. This memory is erasable and needs a constant supply of voltage to be retained.
- Electronic erasable programmable read-only memory (EEPROM) is the ECM component that contains engine calibration information specific to the engine application.

Speed Density System

The electronic engine control system fuel management function is a speed and air density system. Three sensors establish the engine speed and air density factors used by the ECM's fuel management routines: the Crankshaft Speed sensor, Intake Air Temperature sensor, and the Manifold Absolute Pressure sensor.

SPEED

The Crankshaft Speed sensor signal comes from a three-wire magnetic pickup mounted on the starboard side of the engine block. The ECM uses this information to determine the RPM factor for fuel quantity and injection timing management.

DENSITY

The Intake Air Temperature (IAT) and the Manifold Absolute Pressure (MAP) sensors are combined in one sensor assembly. The data they provide to the ECM determines the air density factor.

The IAT sensor is a temperature dependant variable resistance thermistor. When intake air temperature is low, circuit resistance is high, when the intake temperature is high circuit resistance is low.

The Manifold Absolute Pressure (MAP) sensor monitors changes in intake manifold pressure due to changes in engine load and atmospheric conditions.

The MAP sensor sends this pressure information to the ECM, and the ECM calculates the fuel delivery schedule to achieve a target engine RPM based upon Throttle Position Sensor input. Fuel delivery is modified by changes in the timing and duration of the fuel injection pulse. A decrease in manifold pressure (or vacuum increase) causes a decrease in the amount of fuel delivered to the engine.

ECM Input and Sensor Descriptions

The ECM converts the input signals from various sensors, switches, and other devices to create digital output instructions that control the fuel system. The following is an overview of that input and output process followed by a brief description of the components.

The ECM microprocessors receive input signals from the sensors listed:

- Crankshaft speed sensor
- Camshaft position sensor
- IAT/MAP sensor
- Rail fuel pressure sensor
- ECT (engine coolant temperature) sensor
- Engine oil temperature and pressure sensor
- Engine fuel temperature sensor
- TP sensor (a setpoint generator)

The ECM microprocessors compares the input signals to stored reference maps and process the output signals shown:

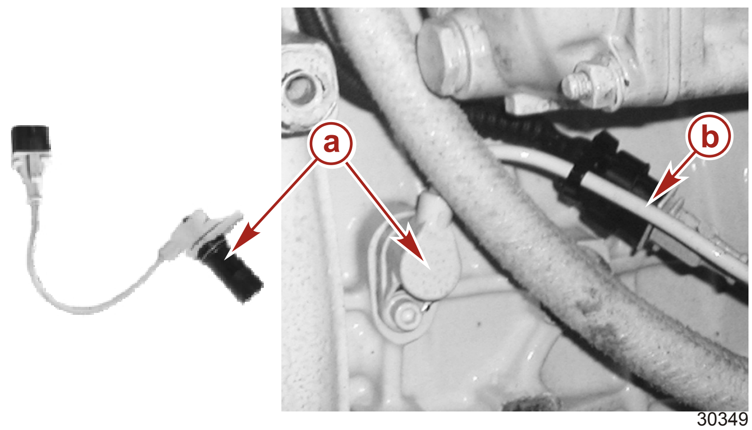
- Starting control
- Start of injection
- Injected fuel quantity
- Engine shut off

The actuators controlled by the ECM output signals include:

- Electronically controlled pressure-control valve (mounted on the high-pressure pump)
- Fuel injectors

Crankshaft Sensor

The crankshaft speed sensor is an induction-type pulse generator that scans for notches on the leading edge of the flywheel to sense the engine speed. The resulting change in magnetic flux induces an AC voltage signal which the ECM evaluates. The ECM processes the signal to establish TDC and the crankshaft position relative to TDC.

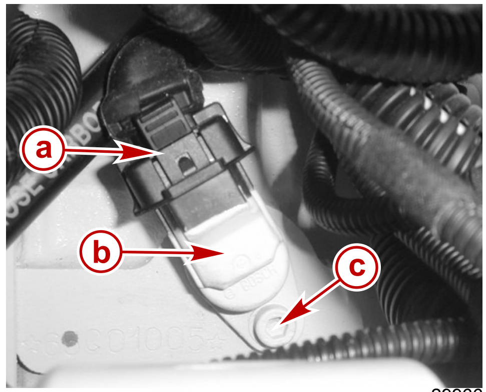


a - Crankshaft speed sensor
b - Harness connector

A failure in the crankshaft speed sensor circuit will set DTC P0335.

Camshaft Position Sensor

The camshaft position sensor uses a Hall effect generated signal to inform the ECM of camshaft position. A magnetic pickup attached to the rotating camshaft passes the camshaft position sensor creating a voltage signal. The ECM processes this short-duration voltage signal to establish when cylinder one is on its compression stroke. This voltage signal indicating the compression stroke on cylinder one is required during the starting sequence and cannot be gathered from the crankshaft-speed sensor.



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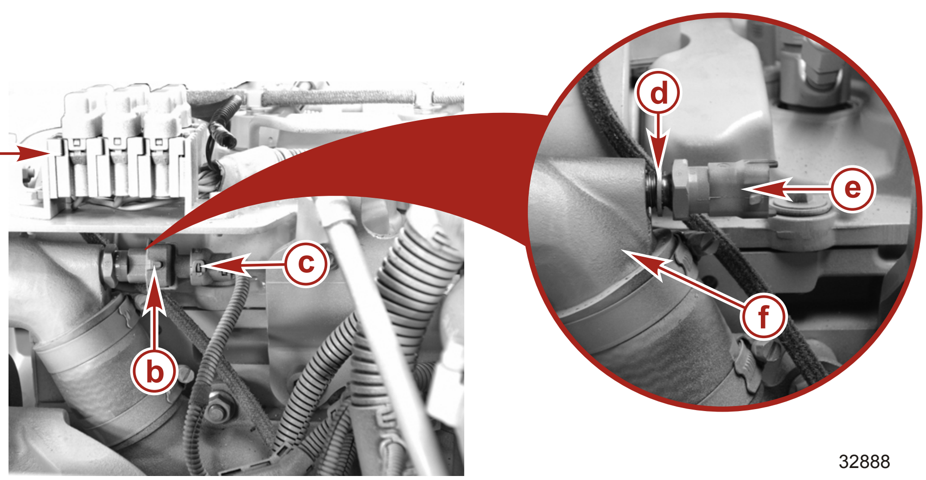
a - Harness connector
b - Camshaft position sensor
c - Screw

A crankshaft-speed signal will allow a running engine will continue to operate after camshaft position sensor failure. The engine will not start without camshaft position sensor information.

A failure in the camshaft position sensor or circuit will set DTCs P0016, P0340, or P0641. Refer to the appropriate DTC diagnostic chart for troubleshooting procedures.

Engine Coolant Temperature (ECT) Sensor

The engine coolant temperature (ECT) sensor is a thermistor immersed in the engine coolant stream. A thermistor is a resistor which changes value based on temperature. Low coolant temperature produces a high resistance, while high temperature causes a low resistance.



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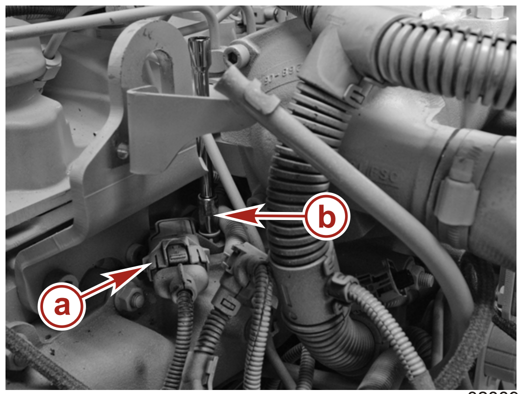
a - Fuse panel
b - ECT sensor
c - Harness connector
d - Sealing washer
e - ECT sensor
f - Coolant manifold

The ECM supplies a fixed current to the ECT through a resistor in the ECM and measures the voltage. The voltage is high when the engine is cold, and low when the engine is hot. By measuring the voltage, the ECM knows the engine coolant temperature. Engine coolant temperature affects most systems the ECM controls.

A failure in the ECT circuit will set DTC P0115. Refer to the appropriate DTC diagnostic chart for troubleshooting procedures. ECT failure generally indicates a sensor failure or wiring short.

Manifold Absolute Pressure Sensor And Intake Air Temperature Assembly

The Manifold Absolute Pressure (MAP) and Intake Air Temperature (IAT) sensor form an assembly.



32889

a - MAP and IAT sensor

b - Hold down screw

INTAKE AIR TEMPERATURE (IAT) SENSOR

The IAT sensor portion of the assembly is a thermistor (a resistor which changes value based on temperature). Low temperature produces a high resistance, while high temperature causes a low resistance.

The ECM supplies a fixed current to the IAT sensor through a resistor in the ECM and measures the voltage. The ECM voltage will be high when the intake manifold air is cold, and low when the intake manifold air is hot.

A failure in the IAT sensor circuit will set DTC P0110. Refer to the appropriate DTC diagnostic chart for troubleshooting procedures.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The manifold absolute pressure (MAP) sensor is a pressure transducer that measures the changes in the intake manifold pressure. The pressure changes as a result of engine load and speed change, and the MAP sensor converts this to a voltage output.

The ECM sends a 5-volt reference signal to the MAP sensor. As the manifold pressure changes, the electrical resistance of the MAP sensor also changes. By monitoring the sensor output voltage, the ECM knows the manifold pressure. A higher pressure, low vacuum (high voltage) requires more fuel, while a lower pressure, higher vacuum (low voltage) requires less fuel. The ECM uses the MAP sensor to control fuel delivery and injection timing.

A closed throttle position on engine coast-down would produce a relatively low MAP output voltage, while a wide open throttle would produce a high MAP output voltage. This higher output voltage is produced because the pressure inside the manifold is increasing. When manifold pressure is high, vacuum is low.

A failure in the MAP sensor circuit will set DTC P0235. Refer to the appropriate DTC diagnostic chart for troubleshooting procedures.

Engine Fuel Temperature (EFT) Sensor

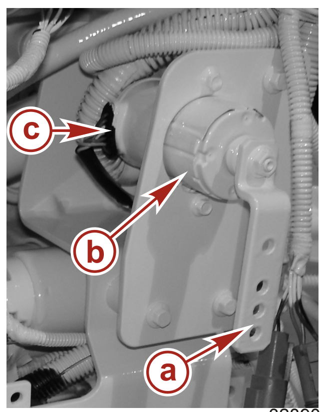
The fuel temperature sensor is a thermistor (a resistor which changes value based on temperature) immersed in the fuel inside the upper chamber of the fuel pump. It is not a serviceable item. Low fuel temperature produces a high resistance, while high fuel temperature causes low resistance.

The ECM supplies a fixed current to the pump through a resistor in the ECM and measures the voltage. The voltage is high when the fuel is cold and low when the fuel is hot. The return voltage is used by the ECM to determine fuel temperature.

A failure in the fuel temperature circuit will set DTC P0180. Refer to the appropriate DTC diagnostic chart for troubleshooting procedures. It is not suggested that the high pressure fuel pump be replaced for this failure unless the customer complains of related performance problems.

Throttle Position (TP) Sensor

The throttle position (TP) sensor is a potentiometer connected to the throttle cable. The TP sensor receives a 5-volt reference signal from the ECM and returns an output voltage based upon throttle position. The three-wire TP sensor connector also includes an ECM ground circuit. At a closed throttle position, the voltage output of the TP is low (approximately 0.4 volt). As the throttle position changes the output increases. At wide open throttle (WOT) the output voltage should be near 4.5 volts. By monitoring the output voltage from the TP sensor, the ECM can determine fuel delivery based on the throttle position (operator demand).



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a - Throttle cable bell crank
b - Throttle position sensor (TPS)
c - TPS electrical pigtail

Potential TP sensor failures:

- TP sensor out of range (SRC high or low).
- Low idle switch defective.
- TP sensor supply voltage incorrect.
- Plausibility (possibility of error) between TP sensor and low idle switch signal to the ECM.

Any TP sensor error or failure will set DTC P1515. Once this DTC is set the ECM will limit engine speed to 800 RPM. Refer to the appropriate DTC diagnostic chart for troubleshooting procedures.

Fuel Management

Modes of Operation

ENGINE STARTING

During engine startup the ECM determines fuel delivery needs based upon the camshaft position signal, crankshaft speed, and engine coolant temperature input information. Throttle position has no influence on the starting procedure. Camshaft position sensor failure will cause a crank-no-start condition.

ENGINE OPERATION

During engine operation the ECM uses data signals from the throttle position and crankshaft speed sensors to determine correct fuel delivery through the electronic fuel injectors. The ECM uses a rail fuel pressure sensor to control the fuel supply from the high-pressure fuel pump. Fuel delivery is also adjusted according to the following information:

- **Fuel temperature**: The ECM uses this information to calculate the correct air-to-fuel ratio. Fuel temperature and volume data is used to determine the density of the injected fuel.
- **Air intake temperature and absolute barometric pressure**: These inputs are used by the ECM to optimize the ideal air-to-fuel ratio for the prevailing engine operating conditions.

The maximum flow rate of the fuel entering the engine is also limited by the ECM according engine speed.

ENGINE SPEED CHANGES

The ECM adjusts the engine operating strategy during acceleration and deceleration in order to provide smooth operation while reducing engine noise and exhaust emissions.

ENGINE SHUT OFF

The principle of auto-ignition as applied to the diesel engine means that the engine can only be switched off by interrupting the supply of fuel.

The engine is switched OFF by the ECM stopping the signal to the fuel injectors resulting in no fuel being supplied to the engine.

Fuel Supply Components

HIGH PRESSURE FUEL PUMP

NOTE: The high-pressure fuel pump, pressure-control valve, RFP sensor, and injectors are not serviceable. If any need service, consult a Cummins MerCruiser Diesel Authorized Repair Facility or the nearest Bosch Dealer Service Network office.

The high pressure fuel pump consists of a gear-driven eccentric cam mechanism that drives three separate pistons in calibrated volume cylinders. The fuel is compressed until the pressure reaches or exceeds the fuel pressure in the fuel rail. An outlet valve in each chamber then opens releasing pressurized fuel into the fuel rail which functions as a high pressure fuel accumulator. The high pressure fuel pump supplies fuel in a volume proportional to engine speed.

Excess fuel is returned to the low-pressure side of the fuel supply system by the RFP sensor mounted on the fuel rail.

The high pressure fuel pump is highly efficient and results in less parasitic power loss than a conventional diesel injection pump.

FUEL RAIL (ACCUMULATOR)

The common fuel rail, shared by all injectors, functions as an accumulator to dampen the effects of the high-pressure pump output and minimize fuel pressure fluctuation when the injectors open. The volume of the rail and the RFP sensor ensure that fuel rail pressure remains nearly constant at all times ensuring proper delivery under all engine operating conditions.

RAIL FUEL PRESSURE (RFP) SENSOR

A rail fuel pressure (RFP) sensor measures fuel rail pressure. The ECM processes the RFP signal and as necessary sends a signal to the electronically controlled Pressure-control Valve in the fuel rail to hold or release fuel pressure until the pressure in the fuel rail is correct.

ELECTRONICALLY CONTROLLED PRESSURE-CONTROL VALVE

An electronically controlled pressure-control valve is used to return excess fuel volume and relieve excess fuel pressure in the fuel rail during idle and in less than full-load operating conditions. The pressure control valve can operate as either a straight mechanical device or as an ECM controlled (energized) valve. The ball and seat design employs a spring that maintains fuel pressure in the rail at approximately 100 bar 1450 PSIand an electromagnet that can be energized by the ECM to hold the valve open or closed until the correct fuel pressure is reached.

SENSORS

See **ECM Input and Sensor Descriptions** for a complete listing and brief description of the other sensors involved in fuel management.

Diagnosis and Testing

IMPORTANT: For component specific diagnostic and testing information see SECTION 5F.

ECM Self-Diagnostics

The ECM performs a continual self-diagnosis on certain control functions. This diagnostic capability is complemented by the diagnostic procedures contained in this manual. The ECM's language for communicating the source of a malfunction is a system of diagnostic codes. The codes are four digit numbers preceded by the letter P. The prefix letter "P" is an abbreviation for Power train, an internationally standardized reference. When a malfunction is detected by the ECM, a code is stored in ECM memory.

ECM Reactions During Operation

The ECM performs diagnostic checks of the electronic diesel fuel injection system. When a problem is detected a Diagnostic Trouble Code (DTC), or fault code, will be stored in the ECM's memory. Specific DTC numbers are generated according to the component that is reporting data that falls outside the range of values expected by the ECM.

DTCs can be displayed by the appropriate SmartCraft instrumentation and retrieved and displayed with the Computer Diagnostic System (CDS) tool. The CDS tool is available through Cummins MerCruiser Diesel.

Notes: