



Electrical and Electronic Application and Installation Guide

- 2000 C-10, C-12, C-15, & C-16
Truck Engines

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INTRODUCTION AND PURPOSE

Electronic engine controls have been developed for heavy duty diesel truck engines to improve performance and fuel consumption. Caterpillar developed an electronic control system and fuel system with electronically controlled unit injectors for the C-10, C-12, C-15 and C-16 truck engines. A description of that system follows.

This document is intended to provide necessary information for correct electrical & electronic application and installation of the C-10, C-12, C-15 and C-16 truck engines into an on-highway truck, bus, motor coach or vocational chassis. Caterpillar expects there will be some additions and modifications to this document as the engine program development continues, and as OEM requests for information not currently addressed are added. The information contained in this version of the document reflects the Caterpillar design for production engines built as of the publication date with NOV99 Personality Module Software.

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General Electronic Engine Operation

1.0 Engine Functions

1.1 Electronic Governing

A full engine speed range electronic governor is used. The electronic governor functions like the Caterpillar mechanical governor in the mid operating range but includes the special features of isochronous low idle and the reduction of governor overrun.

1.2 Fuel/Air Ratio Control

The control system has full authority over engine fuel delivery. The mechanical fuel/air ratio control is eliminated. Electronic control of the fuel/air ratio provides optimum performance while limiting emissions.

1.3 Injection Timing Control

Injection timing is varied as a function of engine operating conditions to optimize engine performance for emissions, noise, fuel consumption, and drivability.

1.4 Torque Rise Shaping

Electronic controls provide increased flexibility to tailor the torque curve over a wide speed range.

1.5 Engine Monitoring

The control system includes an Engine Monitoring feature which monitors engine oil pressure, engine coolant temperature and intake manifold air temperature. Coolant Level is also available as an OEM installed option. All C-10, C-12, C-15 and C-16 engines are shipped with the Caterpillar oil pressure sensor, coolant temperature sensor and intake manifold air temperature sensor installed. There are four Customer Programmable Levels for the Engine Monitoring system:

- 1) Off
- 2) Warning
- 3) Derate
- 4) Shutdown

1.5.1 Engine Monitoring Coolant Level Sensor

The OEM is responsible for providing, installing, and programming the ECM to monitor the coolant level sensor. The coolant level sensor will respond to the programmed level of Engine Monitoring System. Coolant Level is selected/programmed through a separate Customer Programmable Parameter "Coolant Level Sensor" with a default factory setting of No (Not Installed). For installation guidelines, programming options, and sensor electrical requirements refer to "11.0 Coolant Level Sensor" on page 42.

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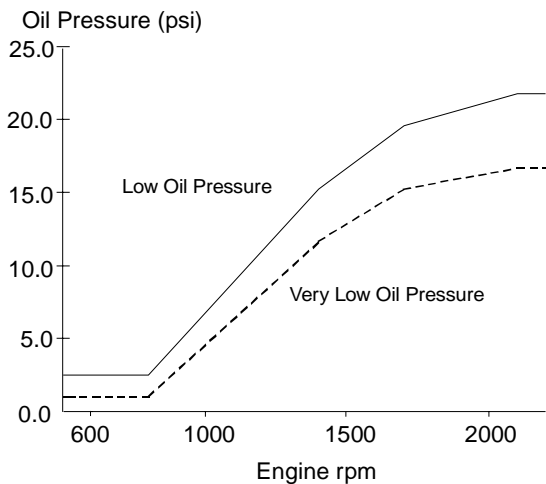
1.5.2 Engine Monitoring Programmed “Off”

The ECM will not indicate low oil pressure, low coolant level, high coolant temperature or high intake manifold air temperatures. Coolant Temperature will be used for Cold Mode and cooling fan control. Intake Manifold Air Temperature is used for cold air operation and for cooling fan control. Coolant Level sensing is not used.

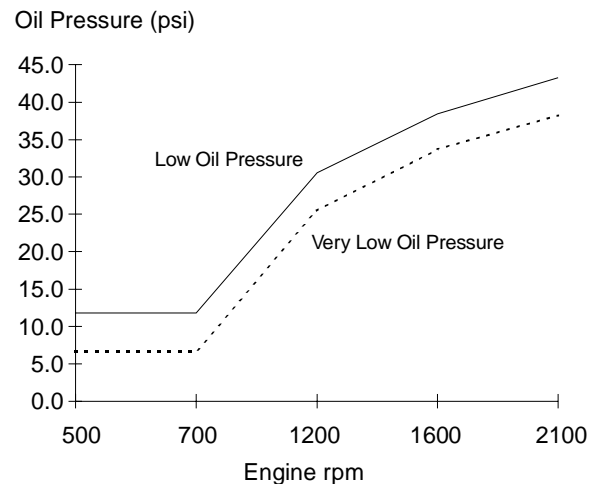
1.5.3 Engine Monitoring Programmed to “Warning”

If Engine Monitoring is programmed to Warning, the ECM monitors oil pressure, coolant temperature, intake manifold air temperature, and coolant level (if a coolant level sensor is installed). The following table and graph indicate the diagnostic codes available, their trip point, and their effect on engine performance when active. The Check Engine Lamp will flash and the Warning Lamp will illuminate as indicated in the table when the diagnostic code is active.

| PID-FMI | Code Description | C-10 and C-12 Trip Points | C-15 and C-16 Trip Point | Warning Lamp | Derate |
|---------|--|---------------------------|--------------------------|--------------|--------|
| 100-01 | Low Oil Pressure Warning | See Figure1 | See Figure1 | SOLID | NONE |
| 100-11 | Very Low Oil Pressure | See Figure1 | See Figure1 | SOLID | NONE |
| 105-00 | High Intake Manifold Air Temp. Warning | 195°F (91°C) | 195°F (91°C) | SOLID | NONE |
| 105-11 | Very High Intake Manifold Air Temp. | 229°F (109°C) | 229°F (109°C) | SOLID | NONE |
| 110-00 | High Coolant Temp. Warning | 218°F (103°C) | 227°F (108°C) | SOLID | NONE |
| 110-11 | Very High Coolant Temperature | 224°F (107°C) | 233°F (112°C) | SOLID | NONE |
| 111-01 | Low Coolant Level Warning | See Figure 2 | See Figure 2 | SOLID | NONE |
| 111-11 | Very Low Coolant Level | See Figure 2 | See Figure 2 | SOLID | NONE |



C-10 & C-12 Engine Monitoring Oil Pressure Graph



C-15 & C-16 Engine Monitoring Oil Pressure Graph

Figure 1 - Low Oil Pressure Graphs

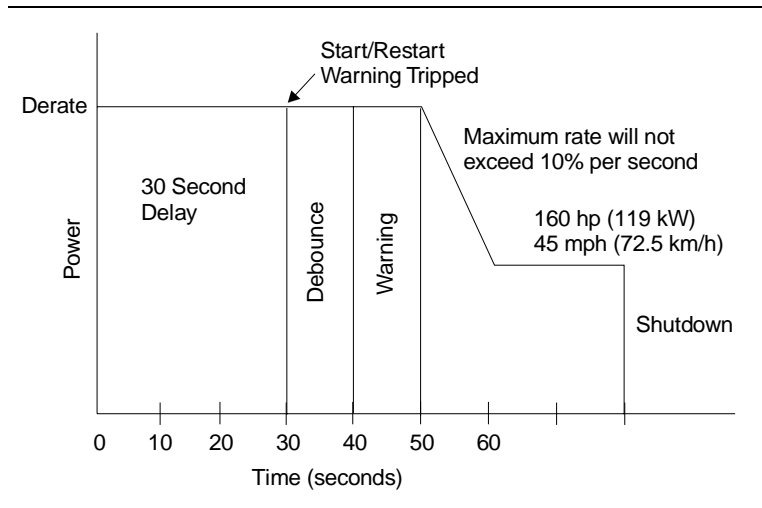


Figure 2 - Low and Very Low Coolant Level Graph

1.5.4 Engine Monitoring Programmed to “Derate” or “Shutdown”

If Engine Monitoring is programmed to Derate or Shutdown the ECM will alter engine performance when operating parameters are exceeded. Whenever the engine is derated, the Check Engine Lamp (due to active diagnostic) and Warning Lamp will flash. For the DERATE column in the following table, mph indicates vehicle speed is limited (maximum speed is 45 mph [72.5 km/h]), “pwr” indicates engine power is limited (maximum derate is 160 hp [119 kW]), and rpm indicates engine speed is limited (maximum derate is 1350 rpm). For operating conditions causing these codes see the appropriate section for the sensor under consideration.

| PID-FMI | Code Description | C-10 and C-12 Trip Points | C-15 and C-16 Trip Point | Warning Lamp | Derate |
|---------|--|---------------------------|--------------------------|--------------|---------------|
| 100-01 | Low Oil Pressure Warning | See Figure1 | See Figure1 | SOLID | NONE |
| 100-11 | Very Low Oil Pressure | See Figure1 | See Figure1 | FLASH | mph, pwr, rpm |
| 105-00 | High Intake Manifold Air Temp. Warning | 195°F (91°C) | 195°F (91°C) | SOLID | NONE |
| 105-11 | Very High Intake Manifold Air Temp. | 229°F (109°C) | 229°F (109°C) | SOLID | NONE |
| 110-00 | High Coolant Temperature Warning | 218°F (103°C) | 227°F (108°C) | FLASH | mph, pwr |
| 110-11 | Very High Coolant Temperature | 224°F (106°C) | 233°F (112°C) | FLASH | mph, pwr |
| 111-01 | Low Coolant Level Warning | See Figure 2 | See Figure 2 | SOLID | NONE |
| 111-11 | Very Low Coolant Level | See Figure 2 | See Figure 2 | FLASH | mph, pwr |

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1.5.5 Engine Monitoring Time to Shutdown

The following table indicates active diagnostic codes capable of shutting down the engine when the ECM is programmed to Shutdown. The "Time to Shutdown" column indicates the minimum time before the engine will shutdown if the engine has already been running for at least 30 seconds. "Start/Restart Time" is running time if the code is active when the engine starts, or following an Engine Monitoring caused shutdown. "NO" indicates the code will not shutdown the engine. Note these times assume the condition causing the code exists continuously and is not intermittent.

| PID-FMI | Code Description | Time To Shutdown | Start/Restart Time |
|---------|--|------------------|--------------------|
| 100-01 | Low Oil Pressure Warning | NO | NO |
| 100-11 | Very Low Oil Pressure | 30 SEC. | 18 SEC. |
| 105-00 | High Intake Manifold Air Temperature Warning | NO | NO |
| 105-11 | Very High Intake Manifold Air Temperature | NO | NO |
| 110-00 | High Coolant Temperature Warning | NO | NO |
| 110-11 | Very High Coolant Temperature | 20 SEC. | 60 SEC. |
| 111-01 | Low Coolant Level Warning | NO | NO |
| 111-11 | Very Low Coolant Level | 30 SEC. | 80 SEC. |

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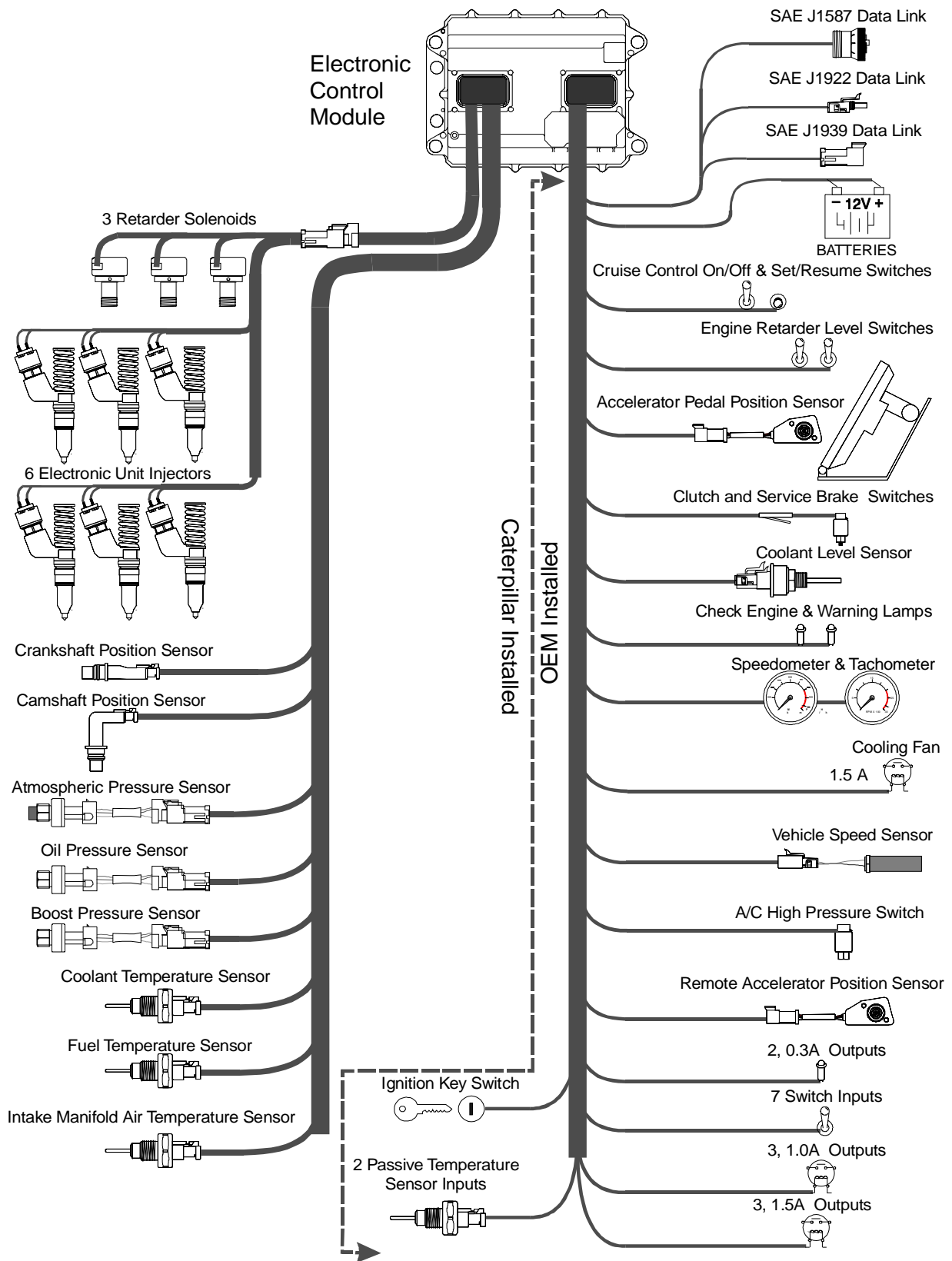


Figure 3 - C-10, C-12, C-15 and C-16 Component Diagram