Service Manual
Trucks

Group **28**

Engine Control Module (ECM), Diagnostic Trouble Code (DTC), Guide

2010 Emissions

CHU, CXU, GU, TD

PV776-88961816

Foreword

The descriptions and service procedures contained in this manual are based on designs and methods studies carried out up to March 2010.

The products are under continuous development. Vehicles and components produced after the above date may therefore have different specifications and repair methods. When this is believed to have a significant bearing on this manual, supplementary service bulletins will be issued to cover the changes.

The new edition of this manual will update the changes.

In service procedures where the title incorporates an operation number, this is a reference to a Labor Code (Standard Time).

Service procedures which do not include an operation number in the title are for general information and no reference is made to a Labor Code (Standard Time).

Each section of this manual contains specific safety information and warnings which must be reviewed before performing any procedure. If a printed copy of a procedure is made, be sure to also make a printed copy of the safety information and warnings that relate to that procedure. The following levels of observations, cautions and warnings are used in this Service Documentation:

Note: Indicates a procedure, practice, or condition that must be followed in order to have the vehicle or component function in the manner intended.

Caution: Indicates an unsafe practice where damage to the product could occur.

Warning: Indicates an unsafe practice where personal injury or severe damage to the product could occur.

Danger: Indicates an unsafe practice where serious personal injury or death could occur.

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Repl:

Contents

Design and Function

Engine Control Module (ECM)

The manufacturer scan tool is the preferred tool for performing diagnostic work. Contact your local dealer for more information or visit “www.premiumtechtool.com”.

Note: The use of a scan tool is necessary to perform diagnostic work as well as clearing of any diagnostic trouble codes (DTCs). DTC(s) can no longer be cleared using the vehicles instrument cluster digital display and stalk switch control.

System Overview

Six electronic control units (ECUs) are used; the engine control module (ECM), instrument control module (ICM), Vehicle Electronic Control Unit (VECU), transmission control module (TCM), the gear selector control module (GSCM) and the aftertreatment control module (ACM). Together, these modules operate and communicate through the SAE J1939 (CAN 1) data link to control a variety of engine and vehicle cab functions. The ECM controls such things as fuel timing and delivery, fan operation, engine protection functions, engine brake operation, the exhaust gas recirculation (EGR) valve and the turbocharger nozzle. The VECU controls cruise control functions, accessory relay controls and idle shutdown functions. The ICM primarily displays operational parameters and communicates these to the other ECUs. All have the capability to communicate over the SAE J1587 data link primarily for programming, diagnostics and data reporting.

In addition to their control functions, the modules have on board diagnostic (OBD) capabilities. The OBD is designed to detect faults or abnormal conditions that are not within normal operating parameters. When the system detects a fault or abnormal condition, the fault will be logged in one or both of the modules’ memory, the vehicle operator will be advised that a fault has occurred by illumination a malfunction indicator lamp (MIL) and a message in the driver information display, if equipped. The module may initiate the engine shutdown procedure if the system determines that the fault could damage the engine.

In some situations when a fault is detected, the system will enter a "derate" mode. The derate mode allows continued vehicle operation but the system may substitute a sensor or signal value that may result in reduced performance. In some instances, the system will continue to function but engine power may be limited to protect the engine and vehicle. Diagnostic trouble codes (DTCs) logged in the system memory can later be read, to aid in diagnosing the problem using a diagnostic computer or through the instrument cluster display, if equipped. When diagnosing an intermittent DTC or condition, it may be necessary to use a scan tool connected to the Serial Communication Port.

The use of a scan tool is necessary to perform diagnostic work as well as clearing of any diagnostic trouble codes (DTCs). DTC(s) can no longer be cleared using the vehicles instrument cluster digital display and stalk switch control. Additional data and diagnostic tests are available when a scan tool is connected to the Serial Communication Port.

For diagnostic software, contact your local dealer.

The ECM is a microprocessor based controller programmed to perform fuel injection quantity and timing control, diagnostic fault logging, and to broadcast data to other ECUs. The fuel quantity and injection timing to each cylinder is precisely controlled to obtain optimal fuel economy and reduced exhaust emissions in all driving situations.

The ECM controls the operation of the injectors, engine brake solenoid, EGR valve, turbocharger nozzle position, and cooling fan clutch based on inputs from many sensors and information received over the data links from other ECUs.

The VECU and ECM are dependent on each other to perform their specific control functions. In addition to switch and sensor data, the broadcast of data between modules also includes various calculations and conclusions that each module has developed, based on the input information it has received.

On Board Diagnostic (OBD) Monitors

System Electronic Control Unit (ECU) Overview

The engine control module (ECM) monitors and models (using physical principles) engine parameters to monitor the engine system's performance in real time. This is performed to aid the ECM with its self diagnostic capabilities. Many sensors are used for input to the emission control system.

The system contains the following “emission critical” ECUs that are monitored;

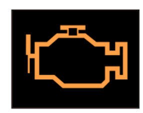
- Engine Control Module (ECM)
- Vehicle Electronic Control Unit (VECU)
- Aftertreatment Control Module (ACM)
- Aftertreatment Nitrogen Oxides (NOx) Sensors
- Engine Variable Geometry Turbocharger (VGT) Smart Remote Actuator (SRA)

These ECUs all communicate with the ECM via data links. The VECU communicates across the SAE J1939 (CAN1) data link while the others use the SAE J1939-7 (CAN2) data link.
The OBD systems use SAE J1939 data link protocol for communication with scan tools but, MACK trucks still are capable of communicating via the SAE J1587 data link for diagnostics. The use of a scan tool is necessary to perform diagnostic work as well as clearing of any diagnostic trouble codes (DTCs). DTC(s) can no longer be cleared using the vehicles instrument cluster digital display and stalk switch control.

There are other ECUs such as the Instrument Control Module (ICM), Transmission Control Module (TCM) and Anti-lock Brake System (ABS) Module that provide data to the emission control system or the diagnostic system but are not “emission critical”.

Malfunction Indicator Lamp (MIL), Description and Location

A MIL located in the instrument cluster. This amber colored lamp is used to inform the driver that a “emission critical” malfunction signal has occurred.



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Systems Monitoring Information

Section Content

Accelerator Pedal Position (APP) Sensor, Overview

The APP sensor input is an analog voltage signal proportional to the pedal position that is read by the vehicle electronic control unit (VECU). The angular position of the pedal is divided in three different areas used for fault detection and/or recovery. The value that is transmitted under normal conditions (value of 0 - 100%), is directly proportional to the pedal's angular position. The physical accelerator assembly also supports a digital DC voltage (On/Off) generated by an idle validation (IV) switch that is also powered by the same regulated reference voltage source.

Active/intrusive Injection (Aftertreatment Hydrocarbon Doser Clogging)

This diagnostic is based on the checking the aftertreatment diesel particulate filter (DPF) intake temperature during aftertreatment DPF active parked regeneration cycles. If the aftertreatment DPF intake temperature does not reach a minimum regeneration temperature within a specified time then the aftertreatment hydrocarbon doser is considered to be clogged.

Aftertreatment Diesel Exhaust Fluid (DEF) Feedback Control

The aftertreatment DEF control consists of a feedforward control together with a feedback control. The feedforward control value is how much urea that must be injected in order to obtain the demanded nitrogen oxides (NOx) conversion efficiency. The feedback controls the ammonia (NH_3) buffer in the aftertreatment selective catalytic reduction (SCR).

Aftertreatment Diesel Exhaust Fluid (DEF) Quality

Aftertreatment DEF quality is evaluated and determined through conversion efficiency. If the aftertreatment SCR system efficiency is below the specified limit, a fault is reported.

Aftertreatment Diesel Particulate Filter (DPF)

The aftertreatment DPF collects particulate and soot in a ceramic wall-flow substrate. The strategy to manage the accumulation of soot is to take advantage of natural aftertreatment DPF passive regeneration whenever possible, and to invoke an operating mode that enhances aftertreatment DPF passive regeneration when necessary. Aftertreatment DPF active regeneration is performed using an aftertreatment hydrocarbon doser.

Aftertreatment Diesel Particulate Filter (DPF) Regeneration Frequency

This function detects if the aftertreatment DPF regeneration frequency increases to a level that it would cause the non-methane hydro carbon (NMHC) emissions to exceed the legal limitation or if the frequency exceeds the design requirements. If the number of aftertreatment DPF regenerations are above the threshold at the end of the time period a fault is reported.

Aftertreatment Diesel Particulate Filter (DPF) Incomplete Regeneration

The aftertreatment DPF regeneration strategy is to reduce the soot level in the DPF using passive regeneration. However, if the driving conditions do not enable enough exhaust heat for passive regeneration to keep up with the soot loading an active parked aftertreatment DPF regeneration will be required. An interrupted parked aftertreatement DPF regeneration is detected by this function. This is not a fault mode but handled by the aftertreatment system. If the ratio between the uncompleted and completed regenerations is above the specified limit, a fault is reported.

Aftertreatment Diesel Particulate Filter (DPF) Regeneration Feedback Control

This function monitors the particulate matter regeneration feedback control and detects:

- If the system fails to begin feedback control
- If a failure or deterioration causes open loop
- If the feedback control has used up all of the allowed adjustment

When the aftertreatment hydrocarbon doser is used, the feedback control is monitored for a saturated controller or a saturated actuator. A saturated controller or actuator means that all allowed adjustment has been used up. The monitors detect a malfunction if the controller is saturated more than a given percentage of the time and the target temperature can not be reached or if the actuator is saturated more than a given percentage of the time.

Aftertreatment Fuel System, Rationality Monitors

The aftertreatment fuel system consists of a aftertreatment fuel shutoff valve, a separate aftertreatment hydrocarbon doser (injector), and an aftertreatment fuel pressure sensor. The aftertreatment fuel shutoff valve diagnostic function look at the aftertreatment fuel pressure when the valve is opened and closed. When conditions are proper for the diagnostic, the function requests an opening of the aftertreatment fuel shutoff valve in order to pressurize the aftertreatment fuel system. This action should increase system pressure. When the aftertreatment fuel shutoff valve is closed the system pressure should decrease since the valve has an internal drain pipe that constantly depressurizes the system. For more information about these components refer to “Aftertreatment Fuel Pressure Sensor, Circuit Monitors”, page 16, “Aftertreatment Fuel Shutoff Valve, Circuit Monitors”, page 16 or “Aftertreatment Hydrocarbon Doser, Circuit Monitors”, page 16.

Aftertreatment Non-Methane Hydro Carbons (NMHC) Catalyst

To detect when the hydrocarbon conversion fails in the aftertreatment diesel oxidation catalyst (DOC), the temperature reaction at the aftertreatment DOC outlet is monitored when fuel is injected in the exhaust. The amount of hydrocarbon supplied by the aftertreatment hydrocarbon doser will determine the expected increase in temperature after the aftertreatment DOC. The aftertreatment hydrocarbon doser injection rate (duty cycle) is monitored and used to calculate whether there should be a corresponding heat reaction. Once it has reached an acceptable accumulated duty cycle the expected temperature difference can be calculated. This difference should then be above a certain limit if the hydrocarbon conversion was achieved.

Aftertreatment Nitrogen Oxides (NOx) Sensor(s) Overview

The NOx sensors consist of:

- Housing holding the sensing element.
- An electronic control unit (ECU), interfacing the sensor and the engine control module (ECM).
- A wire, electrically connecting the sensing element with the ECU.

There are two aftertreatment NOx sensors, one before and one after the aftertreatment selective catalytic reduction (SCR) catalyst. The aftertreatment NOx sensor before and after SCR catalyst have unique CAN identification numbers hence can not be swapped. The sensor before the SCR catalyst monitors the engine out NOx level. The sensor after SCR monitors system out NOx level.

Aftertreatment NOx sensor diagnostics monitor the sensors signal quality and performance. The purpose of this function is to detect the following,

- Bad signal quality
- Removed sensor
- Missing signal

Circuit integrity of the aftertreatment NOx sensor is checked by the sensor itself and the status is transmitted to the engine control module (ECM) over the CAN data link. The following can be transmitted,

- open circuit
- high voltage
- circuit low or high

Aftertreatment Selective Catalytic Reduction (SCR)

The aftertreatment SCR system is a catalyst system that is used to reduce exhaust Nitrogen Oxides (NOx) emissions. This reduction is performed by injecting diesel exhaust fluid (DEF) (a urea solution) into the exhaust fumes prior to the aftertreatment SCR catalyst. A chemical process performed by aftertreatment SCR catalyst and DEF, converts NOx to nitrogen oxide (NO) and water (H_2O). The aftertreatment control module (ACM) is used to control the aftertreatment SCR components and relays system information to the Engine Control Module (ECM). The ECM controls the overall system function.

Aftertreatment Selective Catalytic Reduction (SCR) Conversion Efficiency

The aftertreatment SCR catalyst diagnosis calculates the low temperature performance of the aftertreatment SCR system and compares it to the performance when the catalyst is warm enough to reach high nitrogen oxides (NOx) conversion. This is based on the premise that a deteriorated catalyst can be considered as a catalyst with less volume. The volume is critical to reach the low temperature performance of the aftertreatment SCR system.

Ambient Air Temperature (AAT) Sensor, Overview

The AAT sensor is an analog input that is read by the instrument cluster electronic control unit. The instrument cluster processes the raw signal and transmits the AAT value on the SAE J1939 data link. The vehicle electronic control unit (VECU) receives the AAT value and based on certain vehicle conditions the value is adjusted. The VECU then transmits the AAT value back on the SAE J1939 data link where it is received by the engine control module (ECM).