On Board Diagnostics (OBD) Monitors

OBD-I, OBD-II and Engine Manufacturer Diagnostics (EMD) Overview

The California Air Resources Board (CARB) began regulating OBD systems for vehicles sold in California beginning with the 1988 model year. The initial requirements, known as OBD-I, required identifying the likely area of concern with regard to the fuel metering system, exhaust gas recirculation (EGR) system, emission-related components and the powertrain control module (PCM). A malfunction indicator lamp (MIL) was required to illuminate and alert the driver of the concern and the need to repair the emission control system. A diagnostic trouble code (DTC) was required to assist in identifying the system or component associated with the concern.

Starting with the 1994 model year, both CARB and the Environmental Protection Agency (EPA) mandated enhanced OBD systems, commonly known as OBD-II. The objectives of the OBD-II system are to improve air quality by reducing high in-use emissions caused by emission-related concerns, reducing the time between the occurrence of a concern and its detection and repair, and assisting in the diagnosis and repair of emission-related problems.

OBD-II Systems

The OBD-II system monitors virtually all emission control systems and components that can affect tailpipe or evaporative emissions. In most cases, concerns must be detected before emissions exceed 1.5 times the applicable 120,000 or 150,000 mile emission standards. Partial zero emission vehicles (PZEV) and super ultra low emission vehicles (SULEV-II) can use 2.5 times the standard in place of the 1.5 times the standard. If a system or component exceeds emission thresholds or does not operate within a manufacturer's specifications, a DTC is stored and the MIL is illuminated within two drive cycles.

The OBD-II system monitors for concerns either continuously, (regardless of driving mode), or non-continuously (once per drive cycle during specific drive modes). A pending DTC is stored in the PCM keep alive memory (KAM) when a concern is initially detected. Pending DTCs are displayed as long as the concern is present. Note that OBD regulations required a complete concern-free monitoring cycle to occur before erasing a pending DTC. This means that a pending DTC is erased on the next power-up after a concern-free monitoring cycle. However, if the concern is still present after two consecutive drive cycles, the MIL is illuminated. Once the MIL is illuminated, three consecutive drive cycles without a concern detected are required to extinguish the MIL. The DTC is erased after 40 engine warm-up cycles once the MIL is extinguished.

In addition to specifying and standardizing much of the diagnostics and MIL operation, OBD requires the use of a standard data link connector (DLC), standard communication links and messages, standardized DTCs and terminology. Examples of standard diagnostic information are freeze frame data and Inspection/Maintenance (I/M) readiness indicators.

Freeze frame data describes data stored in KAM at the point the concern is initially detected and the pending DTC is stored. Freeze frame data consists of parameters such as engine RPM, engine load, vehicle speed or throttle position. Freeze frame data is updated when the concern is detected again on a subsequent drive cycle and a confirmed DTC is stored; however, a previously stored freeze frame is overwritten if a higher priority fuel or misfire concern is detected. This data is accessible with the scan tool to allow duplicating the conditions when the concern occurred in order to assist in repairing the vehicle.

OBD I/M readiness indicators show whether all of the OBD monitors have been completed since the last time the KAM or the PCM DTC(s) have been cleared. Ford stores a DTC P1000 and blinks the MIL after 15 seconds of ignition on engine off time to indicate that some monitors have not completed. In some states, it may be necessary to carry out an OBD check in order to renew a vehicle registration. The I/M readiness indicators must show that all monitors have been completed prior to the OBD check.

Starting in the 1996 MY, OBD-II was required on all California and California State gasoline engine vehicles up to 14,000 lbs. gross vehicle weight rating (GVWR). Starting in the 1997 MY, diesel engine vehicles up to 14,000 lbs. GVWR required OBD-II.

California states are ones that have adopted California emission regulations, starting in the 1998 MY. For example, Massachusetts, New York, Vermont and Maine have adopted California's emission regulations. These

states receive California-certified vehicles for passenger cars, light trucks, and medium-duty vehicles up to 14,000 lbs GVWR.

Starting in the 1996 MY, OBD-II was also required on all Federal gasoline engine vehicles up to 8,500 lbs. GVWR. Starting in the 1997 MY, diesel engine vehicles up to 8,500 lbs. GVWR required OBD-II.

Starting in the 2004 MY, Federal vehicle over 8,500 lbs. were required to phase in OBD-II. By the 2006 MY, all of Ford's Federal vehicles from 8,500 to 14,000 lbs GVWR have been phased into OBD-II. OBD-I systems are no longer used in vehicles up to 14,000 lbs GVWR.

EMD Systems

EMD was required on all 2007 MY and beyond California gasoline and diesel fueled on-road heavy duty engines used in vehicles over 14,000 lbs GVWR. EMD systems are required to functionally monitor the fuel delivery system, exhaust gas recirculation (EGR) system, particulate matter trap, as well as emission related PCM inputs for circuit continuity and rationality, and emission-related outputs for circuit continuity and functionality. For gasoline engines which have no PM trap, EMD requirements are very similar to current OBD-I system requirements. As such, OBD-I system philosophy is employed, the only change being the addition of some comprehensive component monitor (CCM) rationality and functionality checks.

EMD vehicles use that same PCM, CAN serial data communication link, J1962 DLC, and PCM software as the corresponding OBD-II vehicle. The only difference is the possible removal of the rear oxygen sensor(s), fuel tank pressure sensor, canister vent solenoid, and a different PCM calibration.

The following list indicates what monitors and functions have been altered from OBD-II for gasoline engine EMD calibrations:

Monitor/Feature	Calibration for Gasoline Engines
Catalyst Monitor	Not required, monitor calibrated out, rear O2 sensors may be deleted.
Misfire Monitor	Calibrated in for repair, all DTC are non-MIL. Catalyst damage misfire criteria calibrated out, emission threshold criteria set to 4%, enabled between 66℃ (150° F) and 104℃ (220℉), 254 second start-up delay.
Oxygen Sensor Monitor	Rear heated oxygen sensor (HO2S) test calibrated out, rear HO2S may be deleted, front HO2S response test calibrated out.
EGR Monitor	Same as OBD-II calibration except that DTC P0402 test uses a higher threshold.
Fuel System Monitor	Same as OBD-II calibration.
Secondary Air Monitor	Functional (low flow) test calibrated out, circuit codes are same as OBD-II calibration.
Evaporative Emission (EVAP) System Monitor	EVAP system leak check calibrated out, fuel level input circuit checks retained as non-MIL. Fuel tank pressure sensor and canister vent solenoid may be deleted.
PCV Monitor	Same hardware and function as OBD-II
Thermostat Monitor	Thermostat monitor calibrated out.
Comprehensive Component Monitor (CCM)	All circuit checks, rationality and functional tests are the same as OBD-II.
Communication Protocol and DLC	Same as OBD-II, all generic and enhanced scan tool modes work the same as OBD-II, but reflect the EMD calibration that contains fewer supported monitors. OBD supported PID indicates.
MIL Control	Same as OBD-II, it takes two drive cycles to illuminate the MIL.

The following monitor descriptions provide a general description of each OBD monitor. In these descriptions, the monitor strategy, hardware, testing requirements, and methods are presented to provide an overall understanding of monitor operation. An illustration of each monitor may also be provided. These illustrations should be used as typical examples and are not intended to represent all possible vehicle configurations.

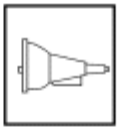
Each illustration depicts the PCM as the main focus with primary inputs and outputs for each monitor. The icons to the left of the PCM represent the inputs used by each of the monitor strategies to enable or activate the

monitor. The components and subsystems to the right of the PCM represent the hardware and signals used while carrying out the tests and the systems being tested. The CCM illustration has numerous components and signals involved which are shown generically. When referring to the illustrations, match the numbers to the corresponding numbers in the monitor descriptions for a better comprehension of the monitor and associated DTCs.

These icons are used in the illustrations of the OBD monitors and throughout this section.

MALFUNCTION INDICATOR LAMP (MIL)

BASE ENGINE OR ANY OF ITS COMPONENTS



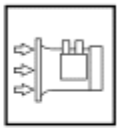
TRANSMISSION OR TRANSAXLE

IGNITION SYSTEM

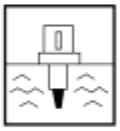
AIR CONDITIONER (A/C) OR HEATER SYSTEM

FUEL LEVEL INPUT (FLI)

CRANKSHAFT POSITION CKP OR RPM

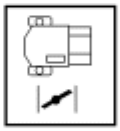


MASS AIR FLOW (MAF)

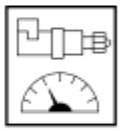


ENGINE COOLANT TEMPERATURE (ECT)

INTAKE AIR TEMPERATURE (IAT)

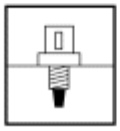


THROTTLE POSITION (TP)



VEHICLE SPEED

CAMSHAFT POSITION (CMP)



CYLINDER HEAD TEMPERATURE (CHT)

MANIFOLD ABSOLUTE PRESSURE (MAP)

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