

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 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 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 I Systems

OBD I vehicles use the same PCM, controller area network (CAN) serial data communication link, J1962 Data Link Connector, and PCM software as the corresponding OBD II vehicle. The only difference is the possible removal of the rear oxygen sensors, fuel tank pressure (FTP) sensor, EVAP canister vent valve, and a different PCM calibration. Starting in the 2006 model year, all Federal vehicles from 8,500 to 14,000 lbs. Gross Vehicle Weight Rating (GVWR) will have been phased into OBD II and OBD I systems will no longer be utilized in vehicles up to 14,000 lbs. GVWR.

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 2 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. OBD regulations require 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 2 consecutive drive cycles, the MIL is illuminated. Once the MIL is illuminated, 3 consecutive drive cycles without a concern being 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 DTCs have been cleared. Ford vehicles blink 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 model year, OBD II was required on all California and California State gasoline engine vehicles up to 14,000 lbs. GVWR. Starting in the 1997 model year, 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 model year. For example, Delaware, Connecticut, Maine, Massachusetts, New Mexico, New Jersey, New York, Oregon, Pennsylvania, Rhode Island, Vermont and Washington 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 model year, OBD II was also required on all Federal gasoline engine vehicles up to 8,500 lbs. GVWR. Starting in the 1997 model year, diesel engine vehicles up to 8,500 lbs. GVWR required OBD II.

Starting in the 2004 model year, Federal vehicles over 8,500 lbs. are required to phase in OBD II. Starting in the 2004 model year, gasoline fueled medium duty passenger vehicles (MDPVs) are required to have OBD II. By the 2006 model year, all Federal vehicles from 8,500 to 14,000 lbs. GVWR will have been phased into OBD II.

Heavy Duty (HD) OBD II Systems

Starting in the 2010 model year, California and Federal gasoline fueled and diesel fueled on road heavy duty engines used in vehicles over 14,000 lbs. GVWR are required to phase into HD OBD II. All vehicles over 14,000 lbs. GVWR must comply for the 2013 model year. Vehicles that do not comply with HD OBD II during the phase in period must comply with EMD+.

EMD Systems

EMD was required on all 2007 model year 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 particulate matter 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.

The EMD vehicles use the 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 sensors, FTP sensor, EVAP canister vent valve, and a different PCM calibration.

Starting in the 2010 model year, EMD requires functional monitoring of the NO_x aftertreatment system on gasoline engines. This requirement is commonly known as EMD+.

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

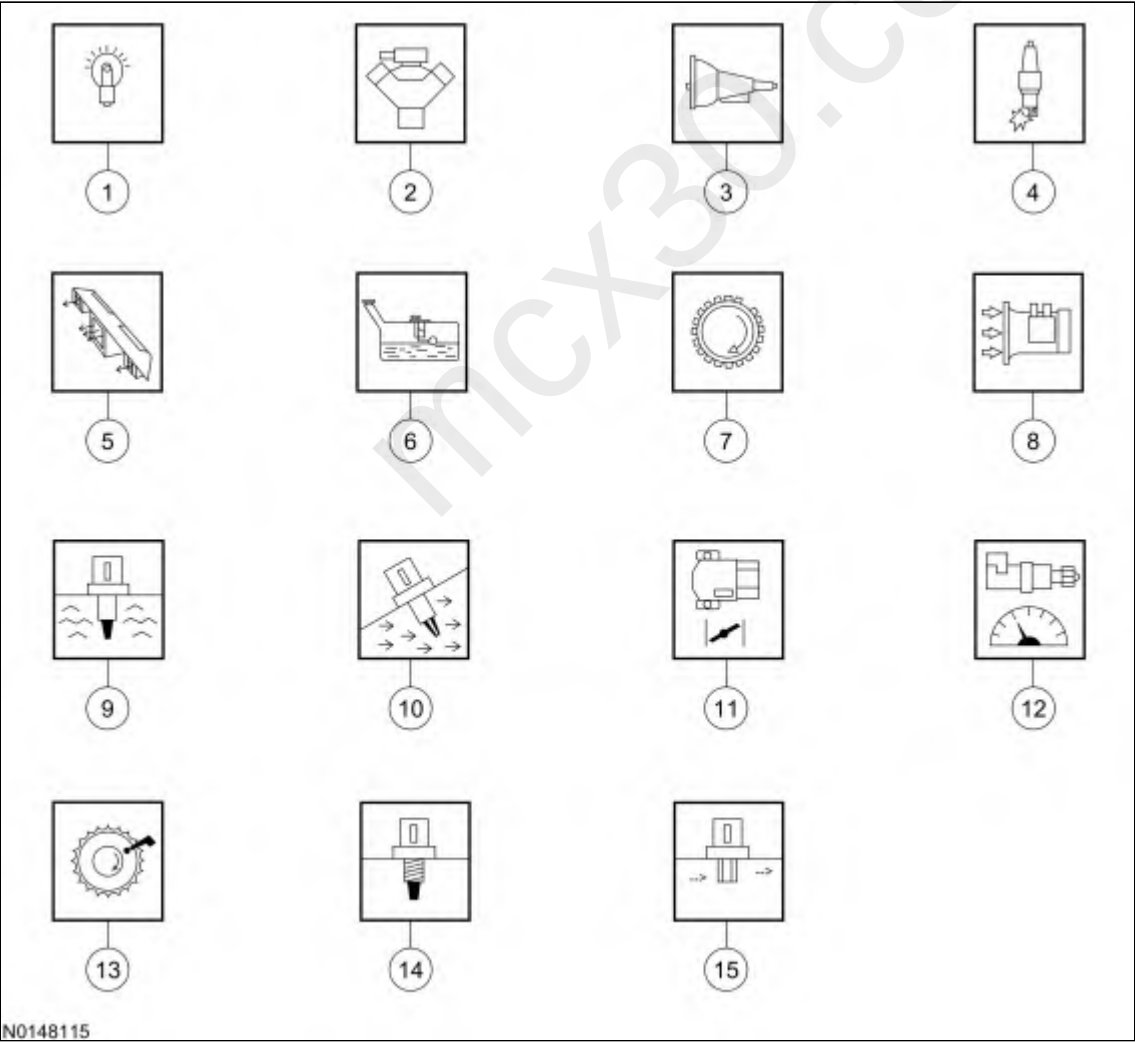
Monitor/Feature	Calibration for Gasoline Engines
Catalyst Monitor	Functional catalyst monitor required starting in the 2010 model year.
Misfire Monitor	Calibrated in for repair, all DTCs are non-MIL. Catalyst damage misfire criteria calibrated out, emission threshold criteria set to 4%, enabled between 66°C (150°F) and 104°C (220°F), 254 second startup delay.
Oxygen Sensor Monitor	Front O2 sensor lack of switching tests and all circuit and heater tests calibrated in, response or delay test calibrated out. Rear O2 sensor functional tests and all circuit and heater tests calibrated in, response or delay test calibrated out.
EGR or VCT Monitor	Same as OBD II calibration except that DTC P0402 test uses a higher threshold.
Fuel System Monitor	Fuel system monitor and fore aft oxygen sensor (FAOS) monitor same as OBD II calibration, Air Fuel Ratio Imbalance monitor calibrated out.
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 EVAP canister vent valve may be deleted.
PCV Monitor	Same hardware and function as OBD II.
Thermostat Monitor	Thermostat monitor calibrated out.

Monitor/Feature	Calibration for Gasoline Engines
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 EMD.
MIL Control	Same as OBD II, it takes 2 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 understanding of the monitor and associated DTCs.

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



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Item	Number	Description

1	—	Malfunction Indicator Lamp (MIL)
2	—	Base Engine Components
3	—	Transmission
4	—	Ignition System
5	—	A/C Or Heater System
6	—	Fuel Level Input (FLI)
7	—	RPM
8	—	Mass Airflow (MAF)
9	—	Engine Coolant Temperature (ECT)
10	—	Intake Air Temperature (IAT)
11	—	Throttle Position (TP)
12	—	Vehicle Speed
13	—	Camshaft Position (CMP)
14	—	Cylinder Head Temperature (CHT)
15	—	Manifold Absolute Pressure (MAP)
