OBD II

TROUBLESHOOTER

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AST Training

Manufactured in the United States

OBD II Overview

The following triple-distilled OBD II overview is designed to provide you with a general overview of OBD II.

What is OBD II?

OBD II is a set of onboard self-tests designed to monitor vehicles during normal operation. The tests are designed to detect vehicle problems that could result in an increase in vehicle **emissions**. Standards for acceptable emission levels are based on a Federal Test Procedure used to certify the vehicles when they are new.

Important! OBD II is designed to monitor the vehicle during normal vehicle operation.

Tests run automatically, under exact conditions, each time the vehicle is driven.

OBD II (Onboard Diagnostics/ Second Generation)

Special onboard vehicle self-tests designed to detect increased vehicle emissions

Onboard

Located in the vehicle inside the vehicle powertrain computer (PCM).

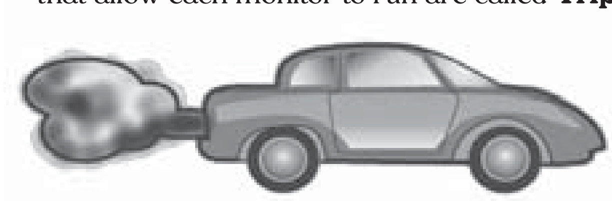
Emissions

By-products of the combustion process that exit through the exhaust to the atmosphere

How does the monitoring system work?

The onboard system waits for vehicle operating conditions to be just right before it will start to run its tests, known as **Monitors.**

Conditions needed to run monitors are met during normal driving. Specific modes of vehicle operation that allow each monitor to run are called **Trips**.



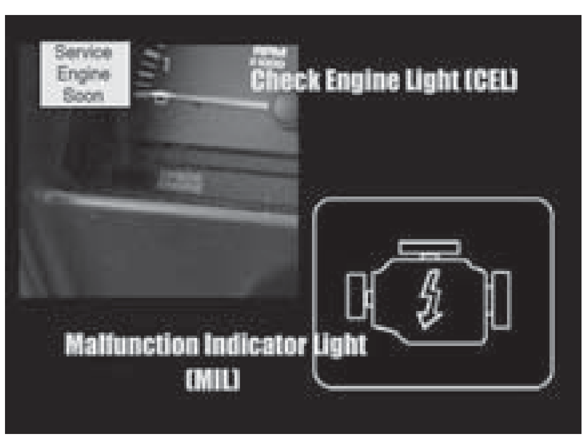
If tests indicate that emissions have increased beyond a test limit, the onboard system records the fault.

How Do We Know if a Problem is Detected?

If the onboard system detects a problem that will result in increased vehicle emissions, it alerts the driver by turning on a dashboard warning light, known as the Malfunction Indicator Lamp ***(MIL)***.

At the same time the MIL illuminates, a code is stored in the vehicle's powertrain computer.

OBD II codes are referred to as Diagnostic Trouble Codes (**DTC**s). We'll use this term frequently throughout the remainder of this manual.



Monitors

Tests run by the onboard diagnostic system

Trips

Driving conditions that allow a monitor to run

MIL

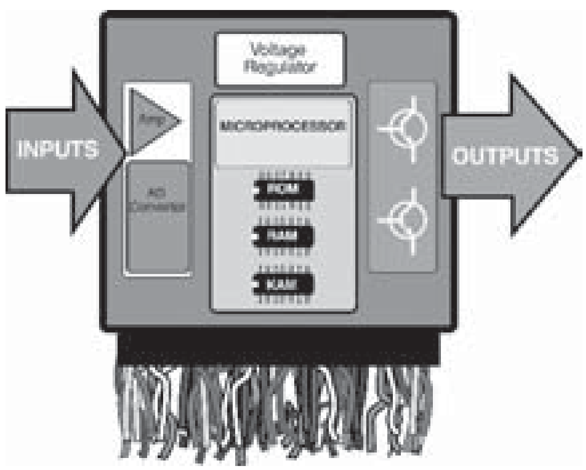
Malfunction Indicator Lamp, formerly referred to as the **Check Engine** or **Service Engine Soon** Light

DTC

Diagnostic Trouble Code is a specific fault definition stored in the computer's memory when a monitor determines that a vehicle problem will result in increased emissions

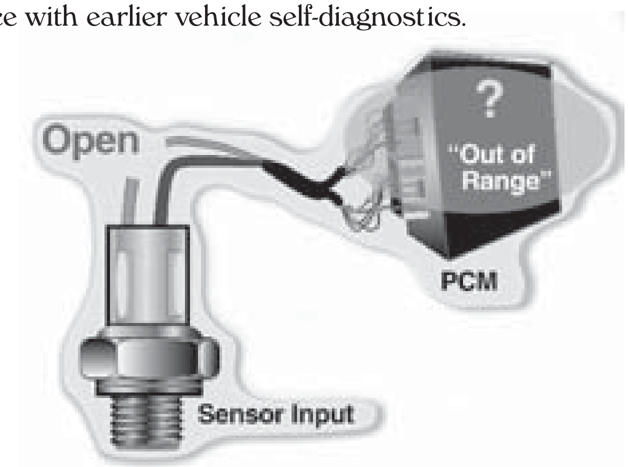
What does the Onboard system test?

The onboard system tests individual components to see if they are experiencing any electrical problems. Components tested include individual **sensors** (ECT, IAT, TP, MAP, etc.) and some **actuators** (ignition coils, solenoids, fuel injectors, etc.)



What kinds of tests are performed by OBD II?

The simplest and most familiar of all OBD II diagnostics are electrical tests for **short** and **open** circuits. Most of us are familiar with these tests and the types of codes stored from our previous experience with earlier vehicle self-diagnostics.



Inputs

Electrical signals sent to the PCM.

Outputs

Commands FROM the PCM to various actuators

Open Circuit

An incomplete electrical circuit. The electrical resistance of an open is infinity.

Short Circuit

A condition where two or more conductors that should be insulated from each other come in contact.

Short circuits are commonly the result of damaged insulation.

Sensors

Electrical measuring devices that provide the computer with information about vehicle operating conditions

Actuators

Electrically operated devices that do work in response to PCM commands

OBD I

The first generation of onboard diagnostics

OBD II tests much more than OBD I.

Continuous and Non-Continuous Monitors

What else is OBD II testing?

OBD II also tests the catalytic converter and several "systems" that are directly responsible for reducing harmful vehicle emissions.

What are the test procedures called?

OBD II test strategies are referred to as **Monitors.**

When do Monitors run?

Some monitors are designed to run once per **Trip** and, when they have run to completion, their test results are stored as a pass or fail in the PCM.

These are referred to as **Non-continuous** monitors. Non-continuous monitors have a beginning, a middle, and an end.

Non-continuous monitors run once per trip to test vehicle systems that are directly related to emission control: **EVAP, EGR, AIR**, **Oxygen Sensor**, and the **Catalytic Converter**.

Monitors
OBD II tests

Trips
Driving conditions that allow a monitor to run

Non-Continuous Monitors
Monitors that run once per trip

EVAP
The Evaporative emission system contains fuel vapors to prevent their escape to the atmosphere.

EGR
Exhaust Gas Recirculation introduces a measured amount of inert exhaust gas to the cylinders to reduce peak combustion temperatures.

AIR
Injects air into the exhaust to promote additional combustion of unburned fuel

Are there other Monitors?

Yes. In fact there are three monitors that run pretty much all the time. These monitors stay “on duty” whenever the vehicle is being operated and are referred to as **Continuous** Monitors, as a result.

There are three Continuous Monitors that will be found in all OBD II vehicles:

- **Comprehensive Component Monitor**
- **Fuel System Monitor**
- **Misfire Monitor**

Why do Continuous Monitors run continuously?

We just saw that Non-continuous monitors keep tabs on vehicle systems that are primarily responsible for emission control. But these systems are basically add-ons. They are not the core systems responsible for vehicle operation.

For example, the vehicle may run normally if there’s a leak in the EVAP system or if the catalyst stops working.

But problems with:
- **Comprehensive components** (sensors or actuators)
- **Excessive Fuel Control**
- **Engine Misfire** (can result in a substantial increase in emissions).

Additionally, misfire can damage the catalyst. That’s why these three critical areas of powertrain operation are monitored continuously.

Continuous Monitors

Run continuously and are never listed as Done or **Complete** in Readiness Status list

Continuous Monitor Types

- Comprehensive Component
- Fuel System
- Misfire

Comprehensive Components

Sensors and actuators

Fuel System Monitor

Tracks the PCM fuel corrections needed to maintain correct air/fuel ratio in closed loop

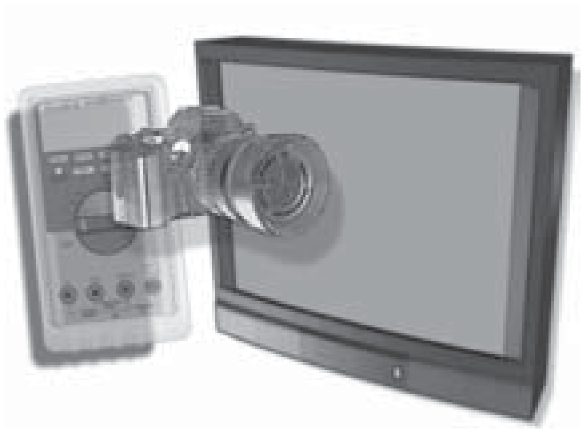
Misfire

Anything that prevents complete combustion

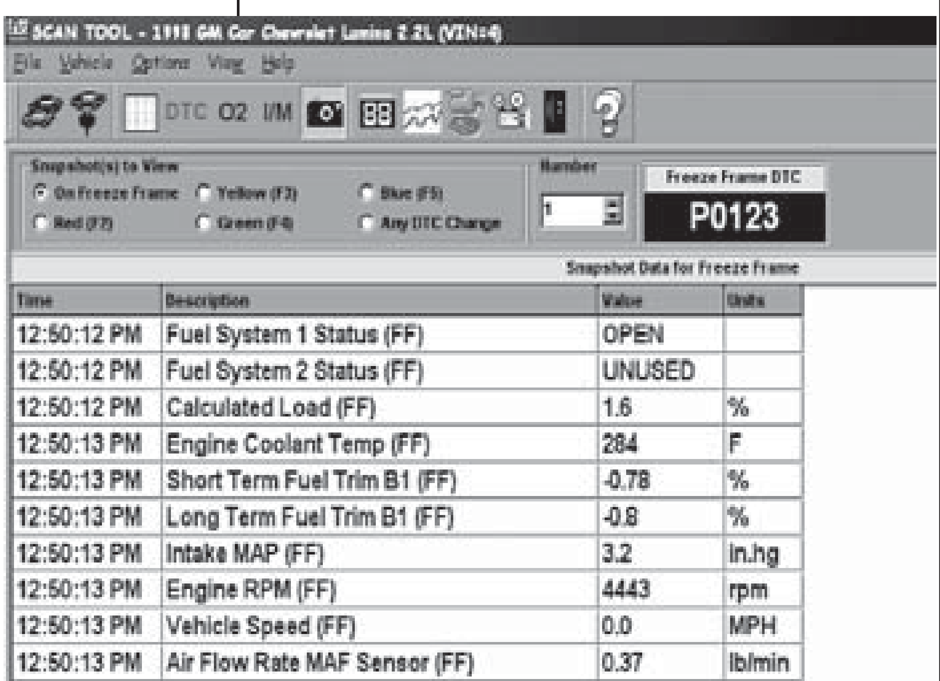
Freeze Frame

Does anything else happen when a DTC is stored and the MIL is illuminated?

When the first DTC is stored, the PCM takes a "snapshot" of vehicle operating conditions at the instant the code was set.



The **Freeze Frame** snapshot lists data **parameters** that include important diagnostic information about critical engine conditions. This information is provided for diagnostic purposes.



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12:50:12 PM	Fuel System 1 Status (FF)	OPEN	
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12:50:12 PM	Calculated Load (FF)	1.6	%
12:50:13 PM	Engine Coolant Temp (FF)	284	F
12:50:13 PM	Short Term Fuel Trim B1 (FF)	-0.78	%
12:50:13 PM	Long Term Fuel Trim B1 (FF)	-0.8	%
12:50:13 PM	Intake MAP (FF)	3.2	in.hg
12:50:13 PM	Engine RPM (FF)	4443	rpm
12:50:13 PM	Vehicle Speed (FF)	0.0	MPH
12:50:13 PM	Air Flow Rate MAF Sensor (FF)	0.37	lb/min

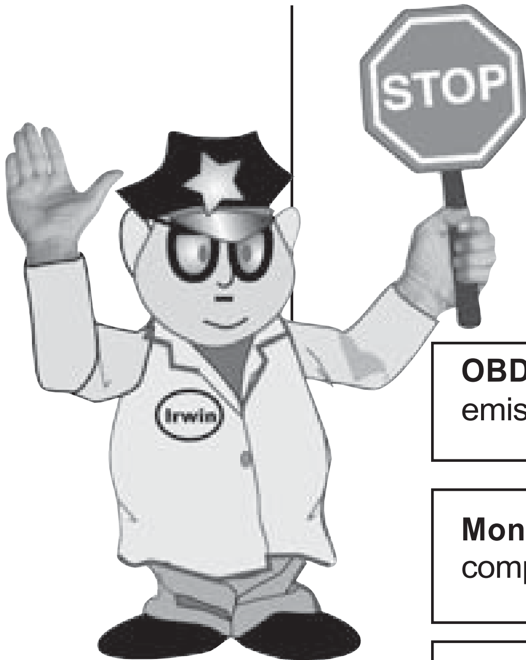
Typical Freeze Frame Data display
(EASE Diagnostics)

Freeze Frame

A 'snapshot" list of key vehicle parameters stored with the first or highest priority DTC

Parameters Listed in Freeze Frame

- DTC number
- Fuel Loop Status (Open or Closed Loop)
- Calculated Engine Load
- Engine Coolant Temperature
- Short Term Fuel Trim
- Long Term Fuel Trim
- MAP
- Engine RPM
- Vehicle Speed
- Air Flow Rate



Let's stop here for a quick review!

OBD II is an onboard monitoring system that looks for emissions related problems

Monitors are test programs that check vehicle components and systems during normal driving.

Trips are specific driving conditions that let the monitors run. Trips definitions vary by monitor.

Some monitors run **Continuously**, while others are **Non-continuous** and run once per trip.

If a component or system fails a test, the test results are sent to the PCM. The PCM may store a **Diagnostic Trouble Code (DTC)** and turn on the **MIL** to alert the driver that a fault has been detected.

A **Freeze Frame** snapshot of critical engine parameters is saved in the PCM memory with the first DTC stored.

We'll return to this list and add additional items as we explain more about OBD II.

Let's move on.

Trips and Enabling Criteria

How do Trips allow Monitors to Run?

Enabling Criteria

Operating conditions that allow a monitor to run

Each monitor needs certain test conditions so it can run to completion and provide accurate test results.

These conditions are known as **Enabling Criteria**.

Most Trips include a Key-on, vehicle operating under carefully defined conditions, followed by a Key-off. The Key-off is an important part of some trip definitions. Even though a code has been stored during a trip, the MIL may not illuminate until the next time the ignition is switched on.

Trip definitions vary by monitor

The definition of a **trip** varies by monitor. **Trips** are not all the same.

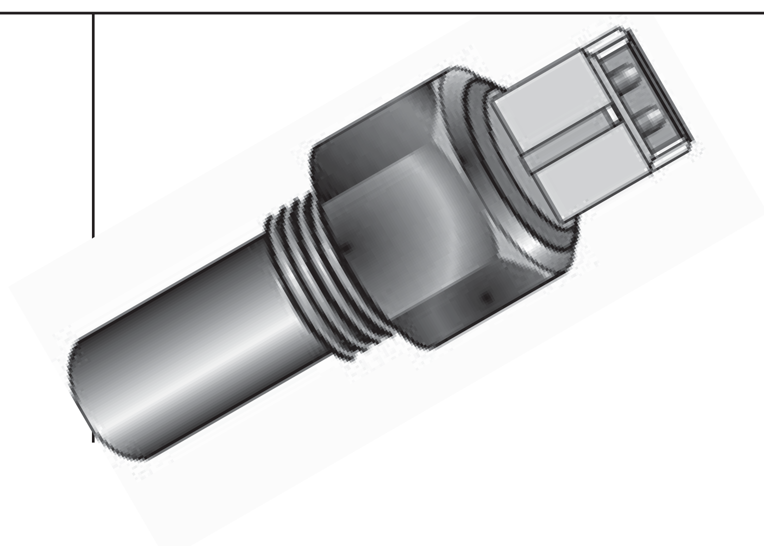
How does the Monitor know if a component passes or fails the test?

The performance of components and systems is compared to test standards.

Example:

DTC Number : **P0117**
DTC Definition: **ECT Sensor Circuit Low Voltage**
Test Conditions and standards:

- No engine codes already stored in memory
- Engine running
- PCM detected ECT sensor input of more than 246° F
- All conditions met for a least 500 ms



Test standards for P0117 or for any other code will vary by make, model, year, and possibly VIN.

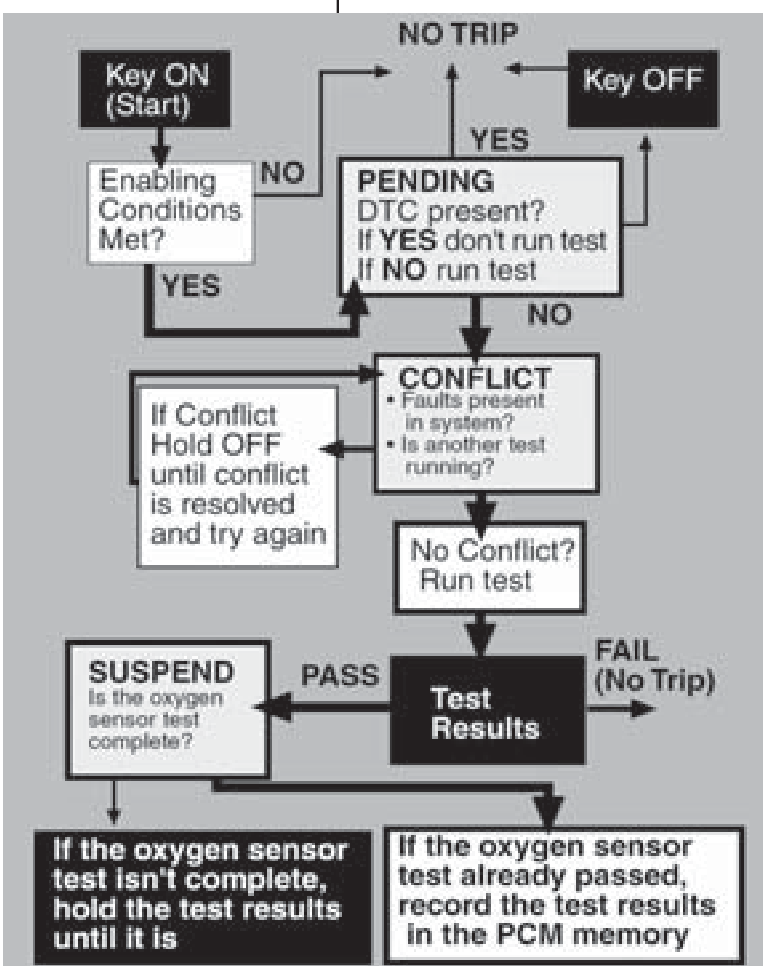
If the conditions aren’t right, will the monitor run anyhow?

Until all the enabling criteria are met, we won’t have a trip. This ensures that monitors run only when they are supposed to run.

Trips allow monitors to run by creating the exact conditions (enabling criteria) needed to run the monitor correctly.

If conditions are not right, the monitor will not run. For example, the PCM may have detected a previously stored DTC. The DTC might indicate that there’s separate problem already present that will keep the monitor from running properly.

A previous DTC may stop a monitor from running.



The chart to the left shows that a trip allows a monitor to test the system.

• All trips start with a key-on.
• Then the PCM looks to see if all enabling criteria are met.

• DTCs and Pending codes can stop monitors. The PCM may wait until the DTC is erased before running other monitors.

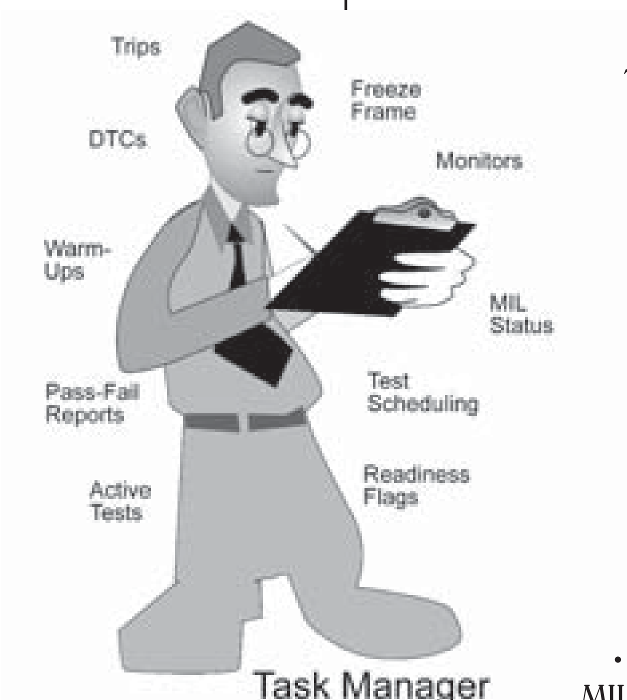
• Monitors must run in the correct order. Monitors running at the same time may conflict.

• Test results from one monitor may be used by another monitor.

The Task Manager/ Diagnostic Executive

What a minute. This is a lot of scheduling and information to keep track of. How does the PCM do this?

Each OBD II PCM has special software that stores test standards and data, schedules all tests, records test data, stores DTCs, and turns the MIL ON and OFF as needed.



This software program is a combination of an accountant and a traffic cop!

The software must:

- Schedule the tests so they run at the right time
- Grade the tests
- Issue a passing or failing grade to the component that was tested
- Store a DTC and turn on the MIL if the component or system flunk the test.

Task Manager- Chrysler

Diagnostic Executive- GM and Ford

GM and Ford refer to our little data manager as the **Diagnostic Executive.**

Chrysler refers to him as the **Task Manager.** The next page contains a large chart showing how many things the Task manager must take into consideration when performing the onboard test procedures known as monitors.

So Much to Do-So Little Time!

As you can see, this is a pretty busy dude!
His job is to make sure:

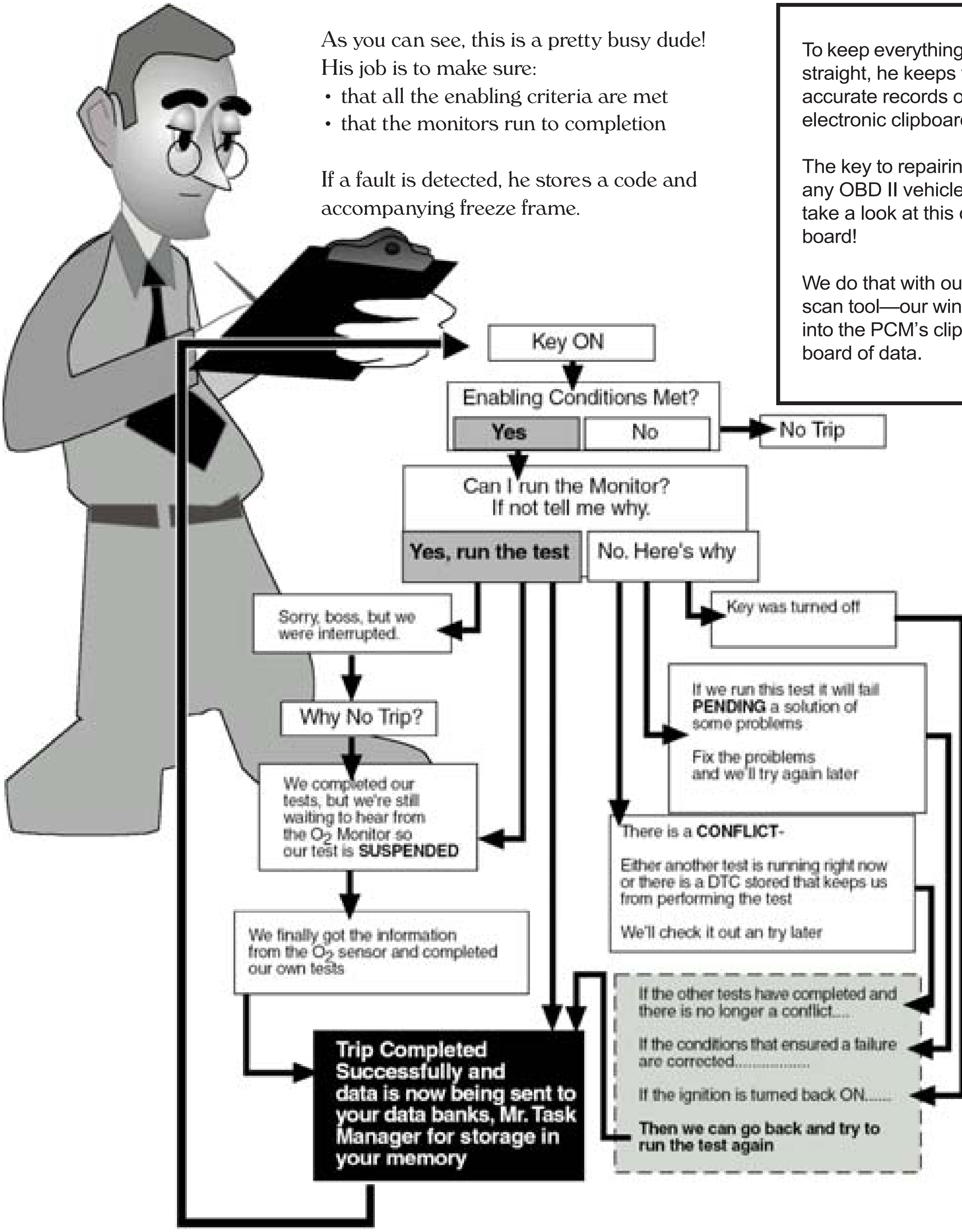
- that all the enabling criteria are met
- that the monitors run to completion

If a fault is detected, he stores a code and accompanying freeze frame.

To keep everything straight, he keeps very accurate records on an electronic clipboard

The key to repairing any OBD II vehicle is to take a look at this clip board!

We do that with our scan tool—our window into the PCM's clip-board of data.



Frequently Asked OBD II Questions

Here are some rapid fire OBD II questions and answers:

Q: How do we know if a vehicle has an OBD II emissions problem?
A: The MIL will be on and a DTC will be stored in memory. (Multiple DTCs may be stored.)

Q: Can the MIL come on even if the fault in the system doesn't cause a performance problem?
A: Yes. The MIL is illuminated for emissions problems, not performance problems.

Q: Who turns on the MIL?
A: The PCM

Q How does the PCM know there is a problem?
A: It runs tests called Monitors

Q: When does it run these tests?
A: During normal driving, when conditions are just right to run the test.

Q: How does the PCM know there is a problem?
A: It receives information from sensors and performs tests of its own on actuators to see if they are working properly.

Q: Can we watch the data used to make these decisions?
A: We can view data parameters on a scan tool. All OBD II vehicles have serial data, so a scan tool is an essential tool for working on OBD II vehicles.

Q: Are all scan tools created equal?
A: No. But there is a minimum standard for OBD II scan tools. It's referred to as the Generic scan tool interface.

At a minimum, the **Generic OBD II scan tool** should allow you to:
- Read and erase DTCs
- View engine (powertrain) data parameters
- View Freeze Frame data
- View a list of Monitors indicating which Non-Continuous monitors have run to completion

Will some scan tools do more than the Generic Tool?

OEM and aftermarket scan tools loaded with enhanced software provide additional data and perform bidirectional tests to help you diagnose both OBD II and non- OBD II (ABS, SIR, etc.) vehicle problems.

How does the OBD II scan tool connect to the PCM interface?

All OBD II vehicles have a diagnostic link connector **(DLC)** that is usually, but not always, located beneath the dash on the driver's side of the vehicle.

The OBD II scan tool needs no external power source. It receives its power from pin 4 of the DLC and grounds though pin 16 (occasionally pin 5).

Is there one standard interface for all OBD II vehicles?

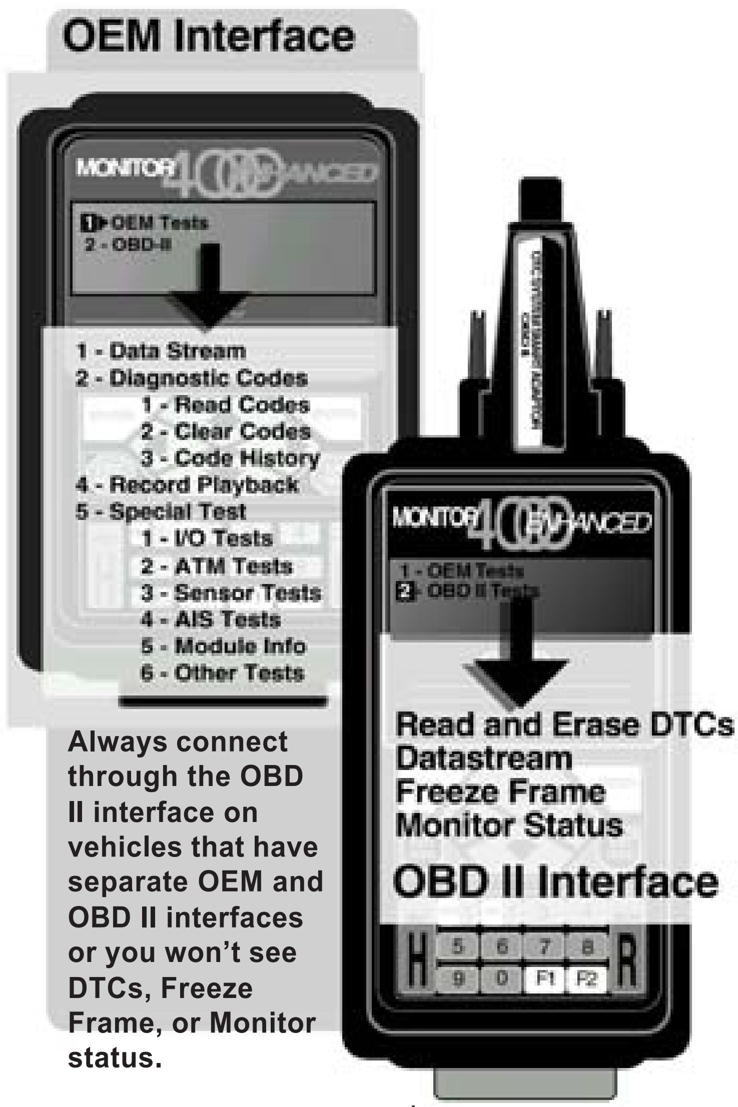
No.

This is extremely important!

In many vehicles you will find that the traditional scan tool interface you've used for years is still available. You may even be asked to enter a VIN number (or parts of a VIN number). This is referred to as the OEM interface.

Notice that the OEM menu choice has a dropdown list of options that include common scan tool functions like retrieving codes, recording movies, and bidirectional (ATM) tests.

But the same scan tool can access the OBD II interface when the correct software and cable interface are installed. Then it becomes an OBD II scan tool displaying OBD II codes and data.



Always connect through the OBD II interface on vehicles that have separate OEM and OBD II interfaces or you won't see DTCs, Freeze Frame, or Monitor status.

Important Diagnostic Information

The Generic OBD II scan tool interface was designed specifically to provide us with useful diagnostic information, including any **DTCs, Freeze Frame, and Datastream.**

Are OBD II DTCs like the OBD I DTCs?

OBD II Diagnostic Trouble Codes are better for several reasons:

- There are many more DTCs covering more components and systems.
- The DTCs are better defined. In many instances, the code definitions are more detailed and specific.

First Digit:
P = Powertrain
B = Body
C = Chassis
U = Network Communications

Second Digit:

0 = SAE Code

1= OEM Code

Third Digit= Affected System

1 = Air Fuel
2 = Fuel System
3 = Ignition/ Misfire
4 = Auxiliary Emissions
5 = Vehicle speed/ idle speed controls
6 = PCM communications
7 = Transaxle
8 = Transaxle

Actual Code,

In this case 18 stands for:
ECT Circuit High Voltage

Quick Tip:
You don't need to memorize this chart to use DTCs.

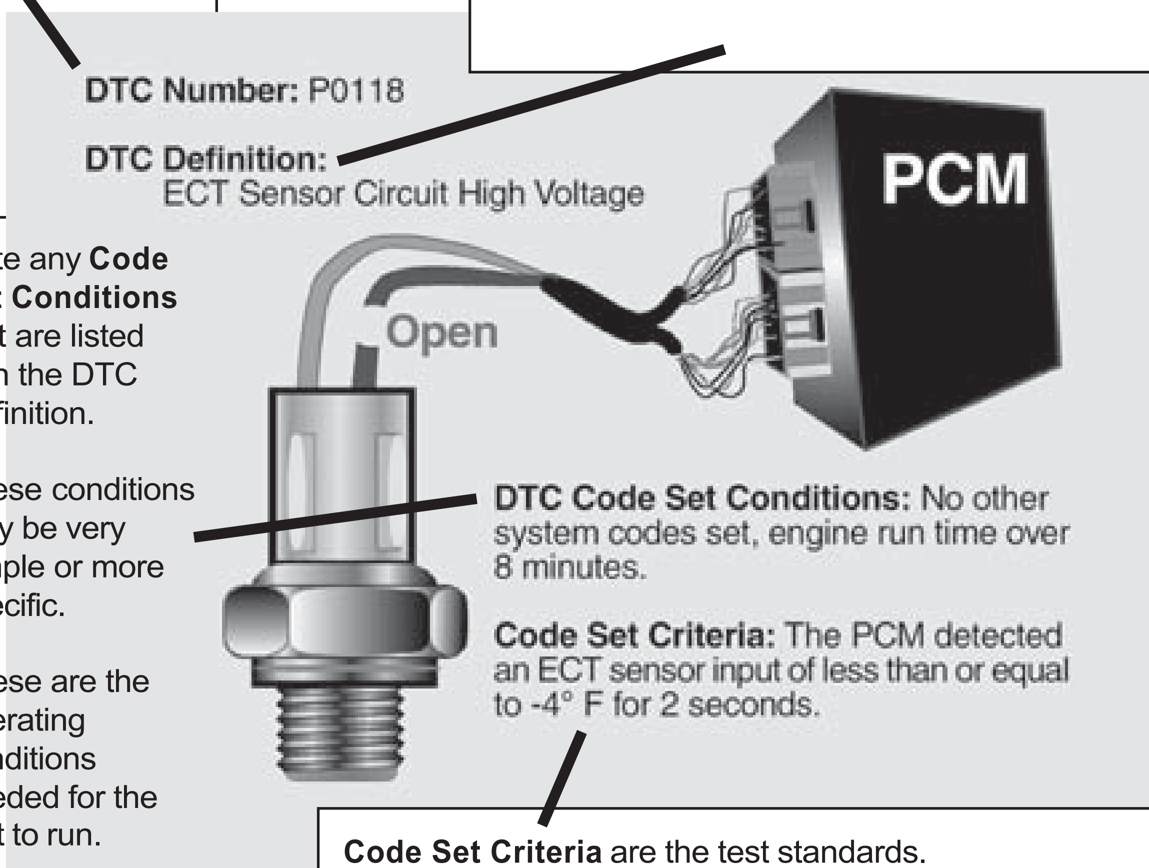
Simply look up the DTC in a repair database.

Using DTCs

DTCs are an extremely useful source of diagnostic information—if you take the time to look up their exact definition. Here's an example.

Start with the **DTC Number**. Retrieve DTCs from the OBD II interface and write them down.

Then look up the **DTC Definition** in a repair database or reference manual.



Note any **Code Set Conditions** that are listed with the DTC Definition.

These conditions may be very simple or more specific.

These are the operating conditions needed for the test to run.

This information can help us duplicate test conditions to check for intermittents.

Code Set Criteria are the test standards.

In this case, the PCM has detected that the ECT is registering a minus 4 degree F coolant temperature in an engine that has been running to 8 minutes! Not likely.

This combination of code set conditions and test standards suggests a higher than acceptable ECT signal voltage, commonly caused by an open in the ECT circuit.

Storing DTCs

Are DTCs stored the instant a problem occurs?

For a DTC to be stored and turn on the MIL, several things must happen:

Code Set Conditions

Conditions needed to run a test

Code Set Criteria

Performance standards that determine a test's pass-fail status

1) The **code set conditions** must be met so the test can run, and the test results must fail, according to the **code set criteria** (test standards). That part is similar to what we've always seen in vehicle onboard diagnostics.

2) Some codes will turn on the MIL in a single trip. These are called **One-Trip Codes.**

One Trip Codes

Store a DTC and Turn on the MIL in a single trip. Also known as Type-A codes.

Some onboard test procedures may not turn on the MIL and store a DTC until a fault is seen on two consecutive trips. In some instances it may actually take more than two consecutive failures to turn on the MIL. Toyota has used two-trip fault detection for years.

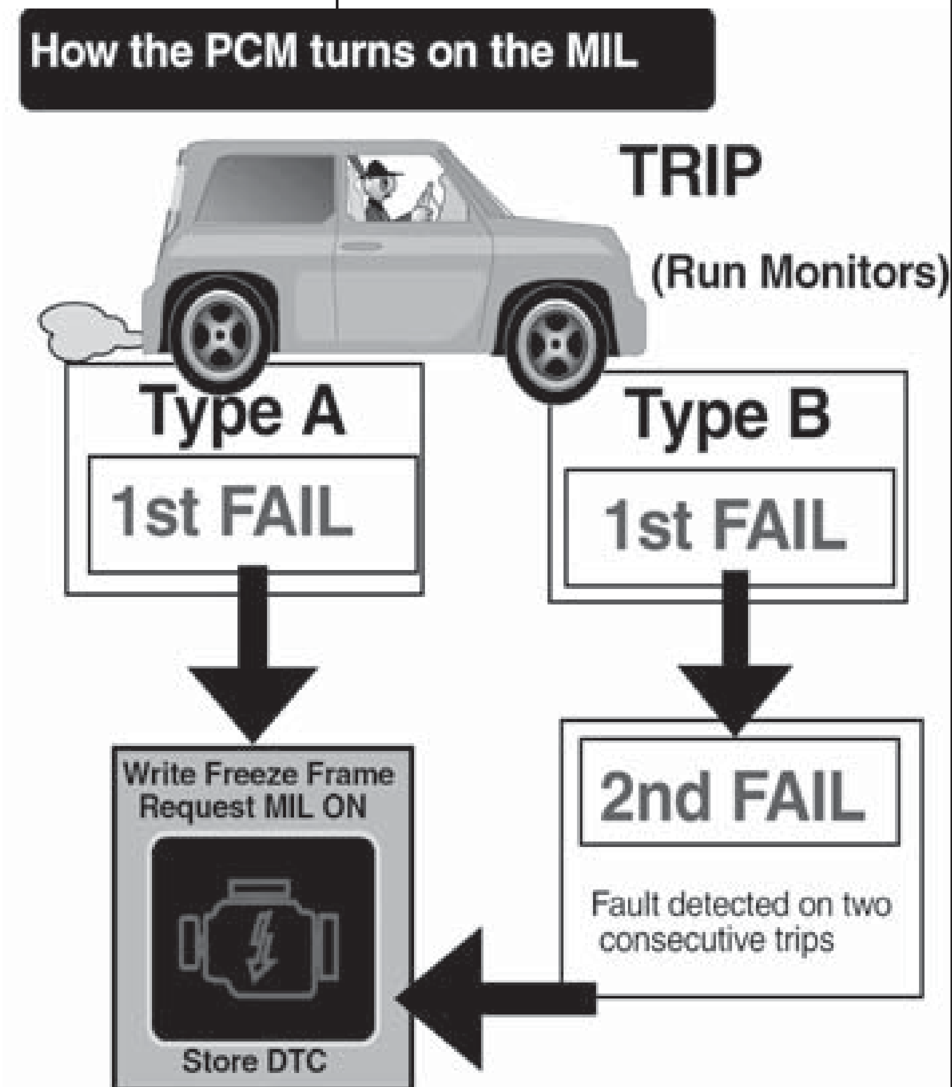
These are called **Two-Trip Codes**.

Two Trip Codes

Store a DTC and Turn on the MIL when the fault is detected on two consecutive trips. Also known as Type-B codes.

If the PCM sees first occurrence of a fault that must be seen again on the next trip to store a DTC, it records a **Pending** code. Pending codes do not turn on the MIL. They are stored when the PCM sees a problem that will **Mature** into a full-blown DTC and turn on the MIL if it is detected again on the next consecutive trip.

Pending codes can be viewed on some scan tool interfaces.



This chart shows how OBD II stores DTCs and Freeze Frame.

Fuel and Misfire DTCs fall into a special category since either can result in catalytic converter damage. In fact, a severe misfire can store a DTC in a single trip, and may even cause the MIL to flash as long as a catalyst-damaging misfire is present.

Most two-trip DTC faults must occur on **consecutive** trips to store a DTC.

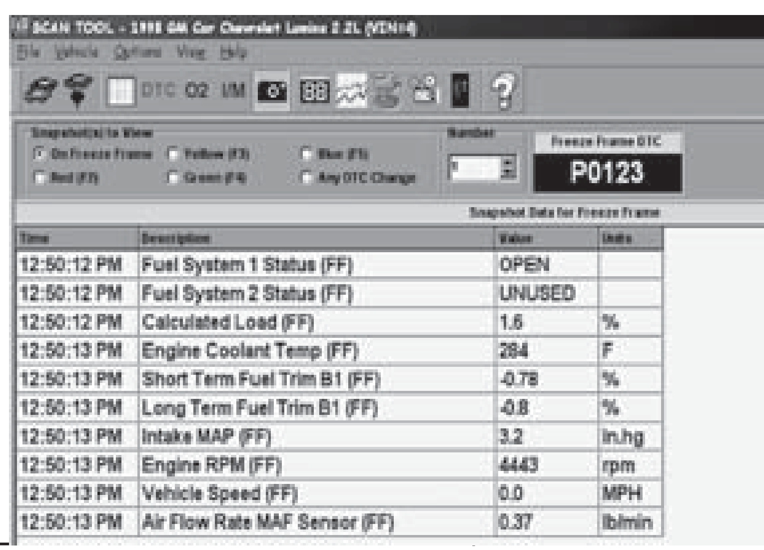
But once a fuel or misfire fault is detected, any repeat of the fault in similar driving conditions during the next **80 trips** can store a DTC.

Freeze Frame is stored with the first DTC.

Note: A Freeze Frame may be overwritten by a later DTC for fuel or misfire.

Caution: If you erase DTCs, you also erase Freeze Frame.

Always record Freeze Frame data before erasing DTCs.



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12:50:13 PM	Vehicle Speed (FF)	0.0	MPH
12:50:13 PM	Air Flow Rate MAF Sensor (FF)	0.37	lb/min

Erasing DTCs and Turning OFF the MIL

Erasing DTCs

DTCs can be erased by removing power from the PCM until Keep Alive Memory is erased. This is NOT the recommended code erasing procedure, however.

Instead, it's better to erase DTCs with a command from your scan tool. That way, you won't erase all the other controller memories— clock, radio presets, etc. — by disconnecting the battery!

Caution: Erasing DTCs will also erase Freeze Frame, and you'll lose the diagnostic information contained in the Freeze Frame data list. You'll also reset any Non-Continuous Monitors to Incomplete.

What does it mean to Reset Monitors to Incomplete?

The OBD II Generic Scan tool interface includes a Readiness Status display.

Readiness Status lists all monitors installed in the vehicle, both Continuous and Non-Continuous.

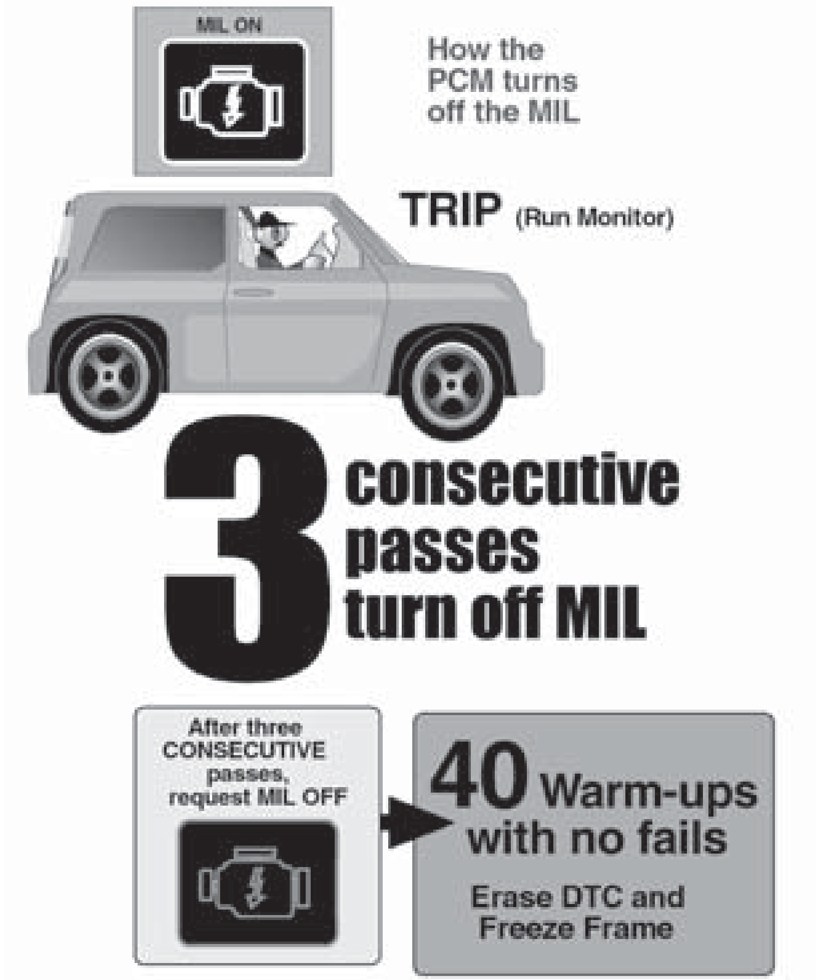
When the PCM loses power (KAM) or DTCs are erased with a scan tool, all Non-Continuous monitors are reset to an incomplete status. They will continue to be displayed as incomplete until each one runs again to completion.

Caution:
While some scan tools use the terms **Incomplete** and **Complete** to indicate current monitor status, some will use terms like **YES/NO**, or **Done/Pending.**

Can the PCM turn out the MIL and erase DTCs?

You bet your scan tool!

If the PCM runs the same test that stored the DTC in the first place—but the test passes on three consecutive trips—the PCM turns OFF the MIL...



But the DTC remains in memory

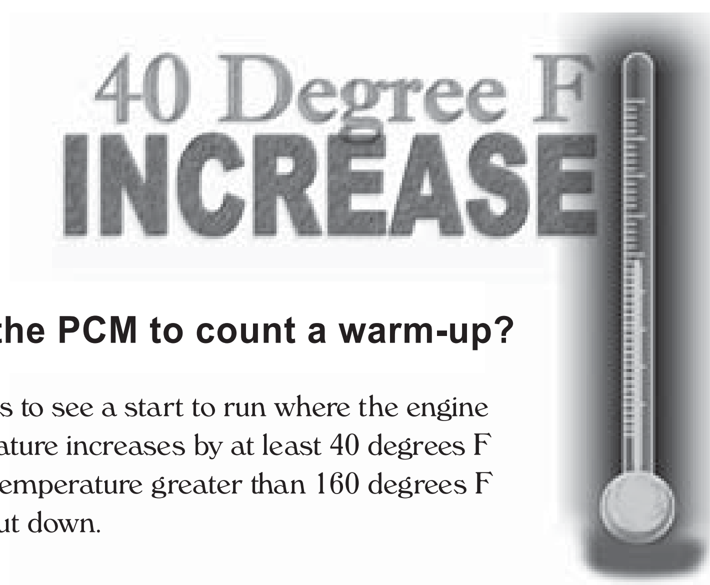
The DTC stays in memory until the PCM counts **40 warm-up** cycles without a recurrence of the fault.

Then it will erase the DTC.

This is very important from a diagnostic perspective.

Just because the MIL is not ON, does not mean that there isn't a DTC in memory.

Always check for DTCs during a vehicle diagnosis, even if the MIL is not presently lit!



What does it take for the PCM to count a warm-up?

The PCM needs to see a start to run where the engine coolant temperature increases by at least 40 degrees F and reaches a temperature greater than 160 degrees F before being shut down.

Let's stop here for a quick review before we move on to OBD II troubleshooting!

What we know so far:

• OBD II is an onboard monitoring system designed to detect vehicle failures that will result in increased vehicle emissions.

• The OBD II scan tool interfaces with the PCM at a standardized Diagnostic Link Connector, referred to as the DLC. The OBD II scan tool is powered through the DLC and requires no external power supply.

• The OBD II Generic interface allows us to read and erase DTCs. It should also allow us to view Freeze Frame, powertrain-related datastream parameters, and Monitor status.

• The OEM and OBD II scan tool interfaces are not the same in most vehicles. Accessing all the repair information available from a vehicle may require separate scan tool interfaces (specialized software and/or cables).

• Monitors test the vehicle. Some Monitors run continuously; others (non-continuous) once per trip.

• All OBD II vehicles have Comprehensive Component, Fuel System, and Misfire Monitors, which are Continuous Monitors.

• Trips are specific modes of vehicle operation that allow monitors to run. Monitors that run and fail store DTCs.

• A single frame snapshot of critical vehicle operating parameters known as Freeze Frame is stored with the first, or highest priority, DTC.

• DTCs are best erased with the scan tool. Erasing DTCs also erases Freeze Frame and resets all Non-Continuous Monitors to Incomplete.

• The PCM may turn off the MIL if the test that stored the DTC runs and passes on three consecutive trips. The PCM may also erase DTCs if the fault is not detected again for 40 warm-ups.

• A warm-up is defined as vehicle operation where the engine coolant increases by 40 degrees F and exceeds 160 degrees before shutdown.

OBD II Troubleshooter

You probably know more than you think about OBD II

This section is about OBD II Troubleshooting.

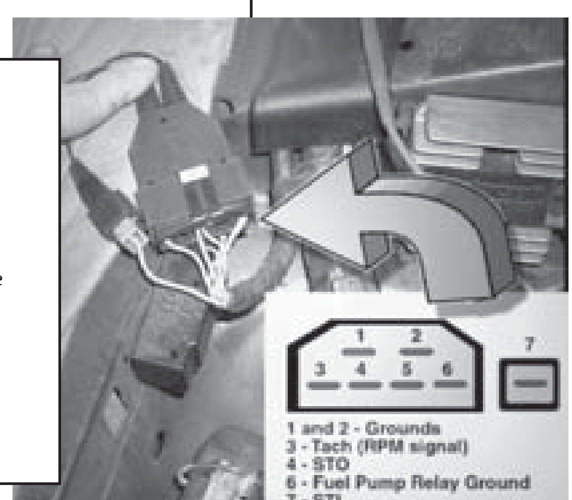
But before we get all nervous and sweaty about having to learn some newfangled, black box, techno-nightmare, pain in the neck diagnostic system from scratch, we need to stop for a minute and think about what's really going on here.

OBD II is not totally new.
OBD II is an upgrade of several old diagnostic strategies.

Here are some examples:

PCM Diagnostic Tests

Onboard diagnostic tests are not new. Ford started using self tests to check computer and component functions, even before their vehicles had datastream. If you understand KOEO and KOER tests, you know that Ford computers can test the PCM and many vehicle sensors and actuators.

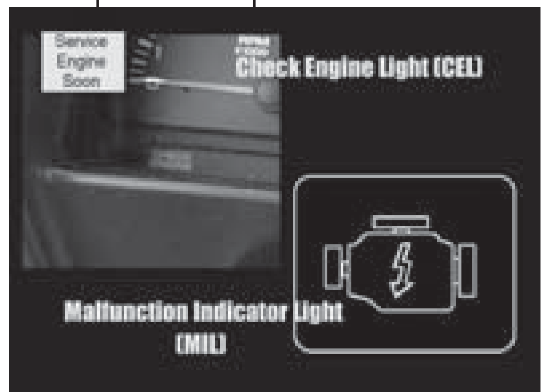


You Know More Than You Think About OBD II

Check Engine Light/MIL

We now call it the Malfunction Indicator Light (MIL), but we used to call it the Check Engine or Service Engine Soon light.

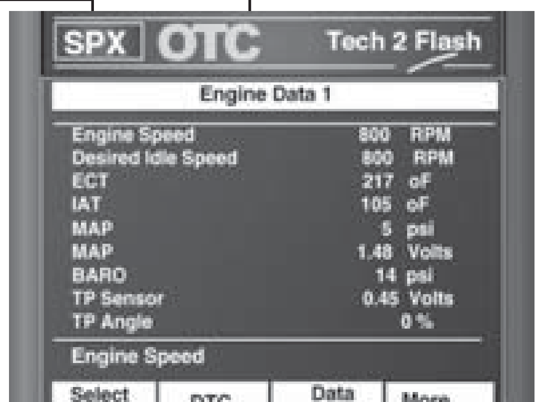
MIL illumination is reserved for emissions-related faults. Failures in other non-emissions related systems will illuminate separate warning lights (ABS, SIR, etc.)



Serial Data

Domestic vehicles have long used serial data to allow scan tool code and data retrieval.

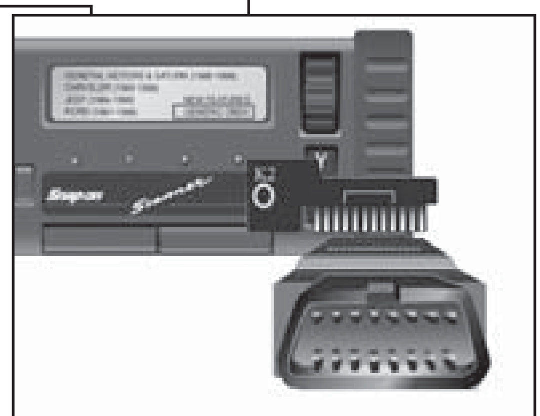
What's new is that all OBD II vehicles must have a serial data interface that supports the Generic Scan tool interface.



The Scan Tool Interface

Similar to OBD I, but an improvement in that the shape of the scan tool connector (DLC) is standardized.

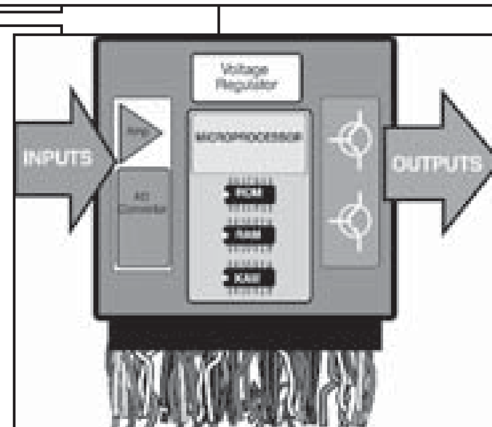
Each DLC has a 16-cavity connector that includes power and ground terminals for the scan tool. Some scan tools need a personality key/ special cartridge to operate as an OBD II scan tool



OEM Powertrain Control Software

OBD II doesn't replace OEM powertrain control software. Ford still has EEC, Chrysler has SBEC, and Jeep has JTEC, etc.

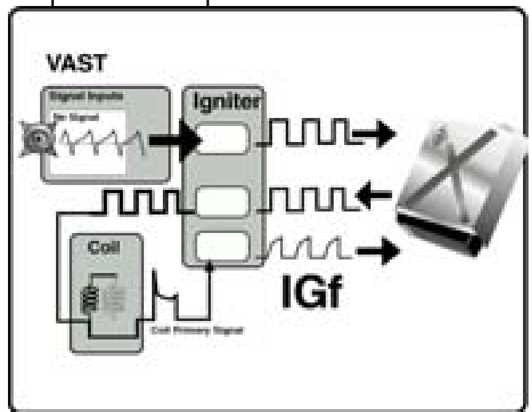
Admittedly, OE systems have been modified and improved, but you don't need to relearn OEM operating strategies from scratch. Build on what you already know and add OBD II!



Misfire Detection

While OBD II misfire detection is more sophisticated than any misfire tests run before, the concept of misfire monitoring isn't new.

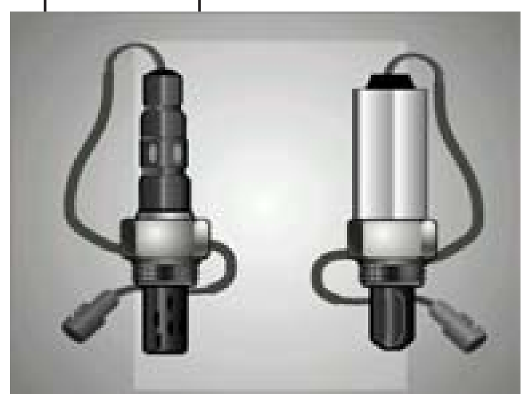
Ford's IDM and Toyota's IGF sensor lines have been used to monitor ignition coil firing even before OBD II came along!



Oxygen Sensors

Oxygen sensors are still the main sensor for closed loop fuel control and Fuel System monitoring, but they play a larger role in OBD II diagnostics.

Oxygen sensors are now heated to operate within minutes of a cold engine start-up. They also serve as a sensor input for several monitors, including: Misfire, Catalyst, EVAP, EGR, and AIR.



Datastream

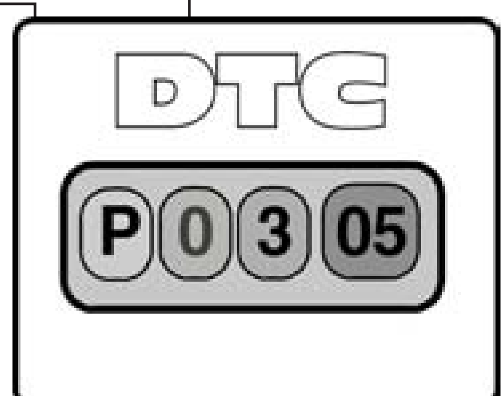
You are already familiar with datastream from your experience with GM, Ford, and Chrysler.

The good news is that generic datastream is now available on all vehicles. This is a big benefit to techs working on vehicles that had no serial data interface before OBD II.

Trouble Codes

You know code, only there are a lot more codes now and they are referred to as DTCs (Diagnostic Trouble Codes). Retrieve them with the scan tool.

Each OBD II DTC is 5 digits long. You're familiar with the concept of codes, and now you can expect more information from DTCs since they are better defined and have more specific fault descriptions.



Comprehensive Components

We've mentioned monitors repeatedly. Over the next few pages, we'll take them in order and outline their major features to give you a better feel for how they fit into the overall OBD II monitoring strategy.

Common Sensors Tested by the CCM

- MAF
- MAP
- BARO
- ECT
- IAT
- VSS
- CKP
- CMP
- CNG Fuel Temp
- TP
- Battery Temp
- P/S Switch
- PRNDL
- O2S Heater
- PCM
- Brake Switch
- TOT

The Comprehensive Components Monitor (CCM) is the core of the onboard monitoring operation. It is a Continuous Monitor.

Vehicle operation and emission control starts with the inputs and outputs monitored by the CCM.

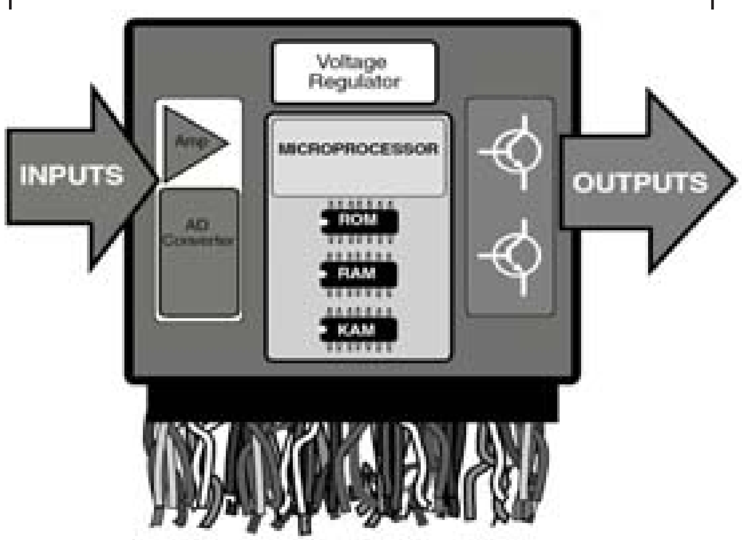
Look to the left column on this page to see commonly monitored **inputs**. Now look to the right to see a similar list of **outputs**.

You can see why it's so important for the onboard monitoring system to verify that the "basics" are all in order, first and foremost.

Failure of any of these core components can affect vehicle operation, increase vehicle emissions, or prevent one or all of the onboard monitors from running.

Common Outputs Tested by the CCM

- Fuel Injectors
- Ignition Coils
- TCC
- Transmission shift solenoids
- IAC
- Purge Solenoid
- EVAP Vent Solenoid
- EGR Solenoid
- Linear EGR
- DPFE
- Oxygen sensor heaters
- Radiator Fan Control



Since all of these inputs and outputs are tested by the PCM, using a scan tool to view datastream becomes an essential part of any diagnosis and repair.

Comprehensive Components

What are Comprehensive Components?

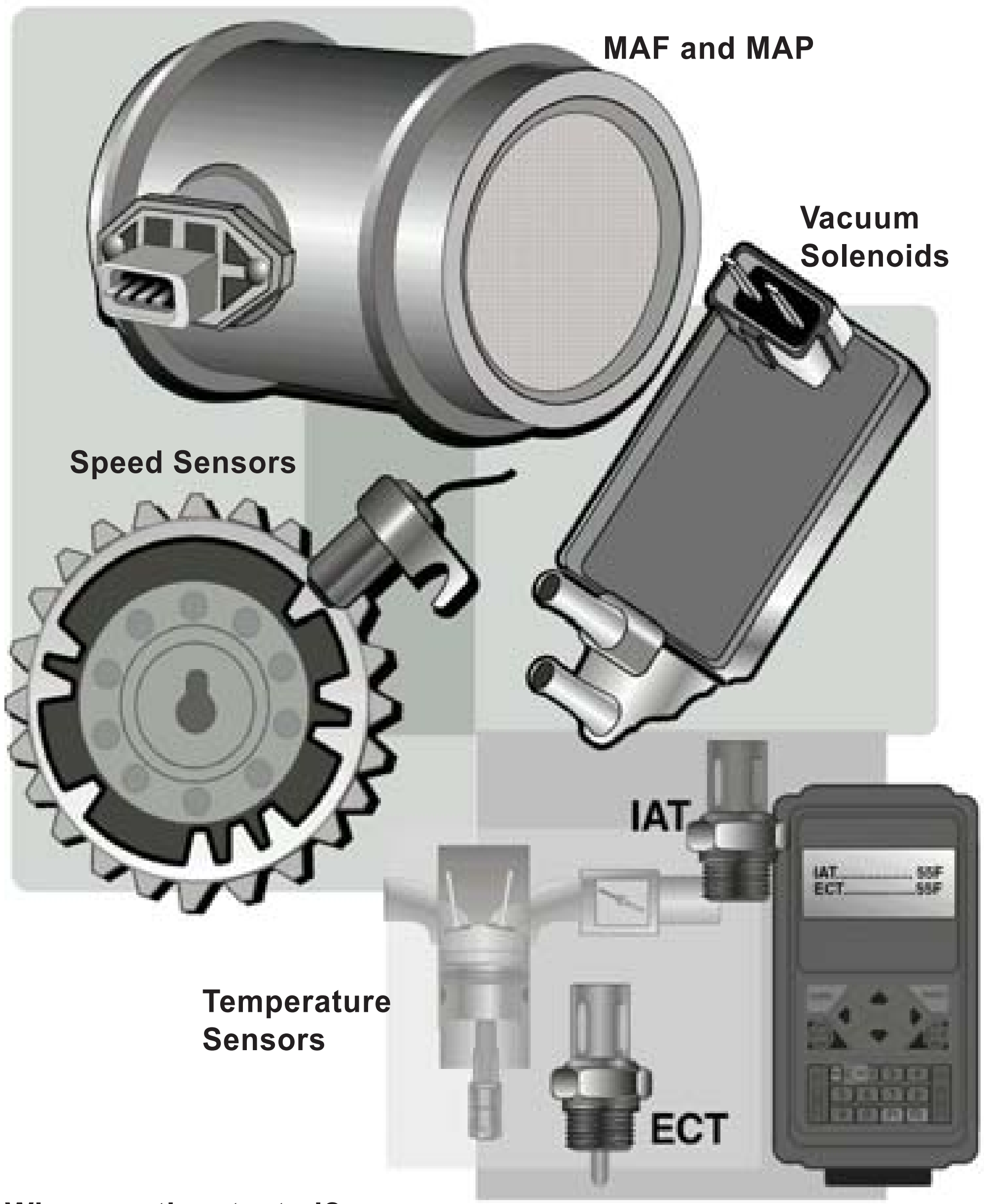
Switches, sensors, motors, solenoids, etc.

What are they tested for?

All components tested by the CCM must pass basic circuit tests to determine if they are shorted or open.

They may also be tested for **functionality**, to ensure that they respond to commands from the PCM.

Rationality tests compare sensor inputs to see if the signals sent to the PCM are rational (make sense) when compared to one another.



When are they tested?

Many CCM tests are run as soon as the ignition is switched on to detect shorts and opens.

Additional functionality and rationality tests may be performed during normal KOER operation.

Misfire Monitor

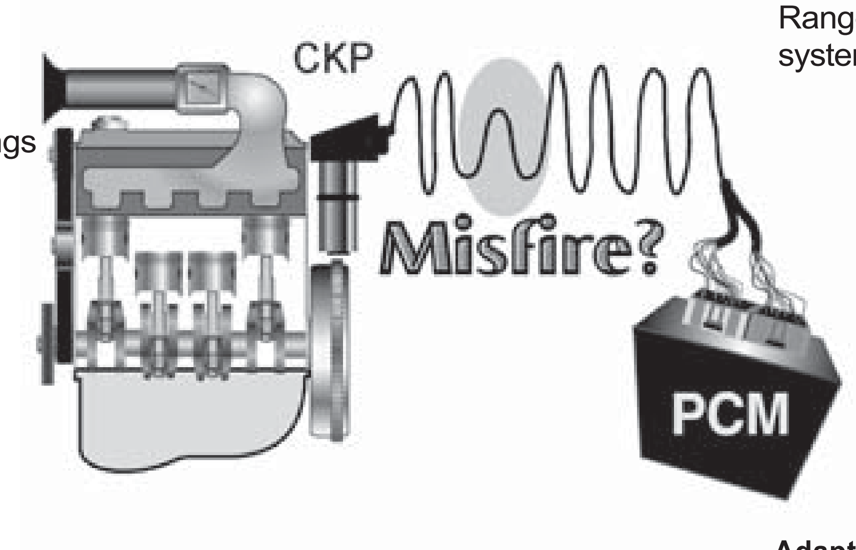
How Does the Misfire Monitor Work?

Common Causes for Misfire DTCs

- Worn spark plugs
- Cracked distributor caps
- Out of Phase distributor/rotor
- Shorted rotors
- Leaking plug wires
- Low fuel pressure
- Low compression
- Sticking valves
- Broken valve springs
- Worn cam lobes
- Incorrect valve or ignition timing
- Leaking EGR
- Vacuum leaks
- Leaking Injectors
- Clogged Injectors
- Contaminated fuel
- Low fuel tank level
- Excessive EVAP purge
- Low ignition system primary voltage
- Cracked coils
- Plugged exhaust
- Excessive PCV flow
- Wiring Harness
- Faulty PCM

The misfire monitor watches the crankshaft sensor, looking for changes in crankshaft speed that would indicate a misfire condition.

This works because the crankshaft slows slightly each time a misfire occurs. Sticking driveline components or rough roads can also slow the crankshaft, so the PCM may use special filtering software to screen out false signals or it may rely on wheel speed sensors to detect rough roads.



We commonly think of spark plugs and plug wires when we think of misfire. Use traditional engine analyzer/power balance tests, vacuum and fuel pressure readings to isolate and correct misfire conditions.

Don't forget all the items listed in the "Common Cause for Misfire" list on this page, especially when troubleshooting those tough misfire problems. Anything that prevents combustion causes misfire.

In some instances, reprogramming the PCM to install revised software may be the only way to cure some misfire codes.

Full Range Misfire

Early OBD II vehicles did not detect misfire at all engine speeds.

Newer misfire monitors detect misfire at all RPM and are referred to as Full Range Misfire systems.

Adaptive Numerator

The PCM must "learn" the crankshaft before the misfire monitor will run. "Learning" the crankshaft allows the PCM to make allowances for slight variations in machining and sensor tolerances that might set false codes.

Procedures vary by manufacturer.

Misfire Monitor

Misfire Monitor may flash the MIL to indicate severe (catalyst damaging) misfire levels.

Sensor Inputs:

Engine Speed Sensor

May also look at additional sensors like the O2S and wheel speed sensors to verify existence of true cylinder misfire

Misfire DTCs:

P0300 Series Codes

Individual cylinder misfire may be identified by last two digits of code.

Example: P0305 indicates misfire on cylinder number 5.

Monitor Disablers

The misfire monitor may not run under some conditions, including:

- Fuel tank level above 85% or below 15%
- Rough road conditions
- Rapid TP voltage fluctuations
- Engine RPM out of range (some)
- PCM has not learned crankshaft characteristics

Fuel System Monitor

What are Fuel Trim Numbers?

The PCM keep running records of the amount of fuel correction it needs to make to maintain the correct air/fuel balance in closed loop.

The amount of fuel that must be added or subtracted to keep the system in closed loop is known as Short Term Fuel Trim (STFT).

The average of STFT corrections over time is called Long Term Fuel Correction (LTFT).

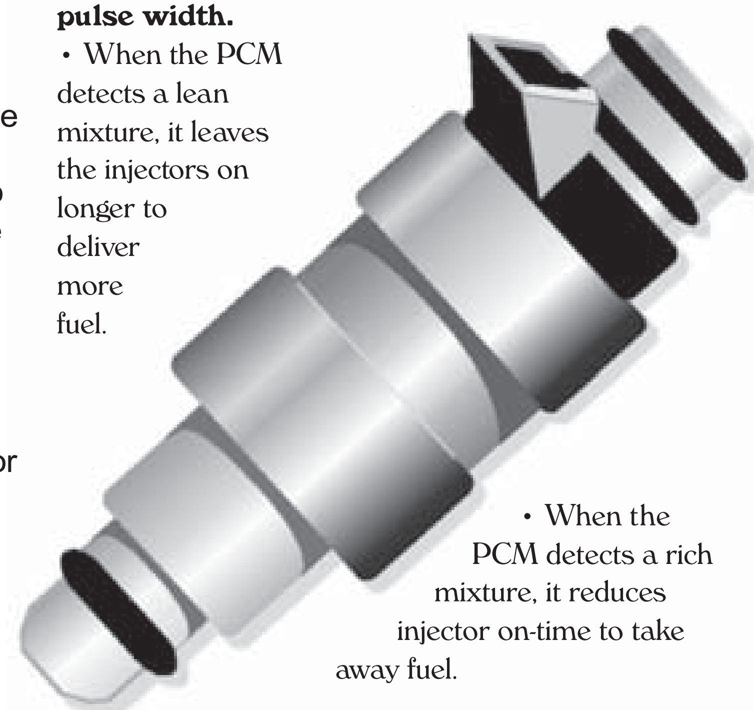
LTFT indicates long term trends in fuel correction.

What does Short Term Fuel Trim do?

It maintains the best fuel air ratio in closed loop. This adjustment changes constantly in response to oxygen sensor inputs.

How does the PCM adjust fuel delivery?

By adjusting injector pulse width.



• When the PCM detects a lean mixture, it leaves the injectors on longer to deliver more fuel.

• When the PCM detects a rich mixture, it reduces injector on-time to take away fuel.

We can watch these continual corrections on the scan tool STFT data parameter, or PID. LTFT will also shift richer or leaner, based on average STFT corrections.

Here's where the DTC is stored: When a combination of STFT and LTFT are greater than the test limit, a DTC is stored to tell us that the system is far to rich, or far too lean.

The DTC tells us that the PCM can no longer control the fuel ratio by adjusting pulse width. Something is driving the system so lean—or so rich-that the PCM can't correct the situation. That "something" is what we need to fix!

How Do We Interpret Fuel Trim Numbers?

STFT and LTFT are displayed on a scan tool as numbers from 0 to 255 in GM vehicles, with 128 being the center.

• At 128, fuel is neither added or subtracted.

• Numbers lower than 128 indicate that fuel is being subtracted.

• Numbers greater than 128 indicate that fuel is being added.

How does OBD II display fuel correction in datastream?

OBD II generic data will display STFT and LTFT a little differently —as a percentage change from zero.

Positive percentages mean fuel is being **added**.

Negative percentages indicate that fuel is being **subtracted** to compensate for an already rich condition.

Fuel System Monitor

What can cause a fuel system DTC?

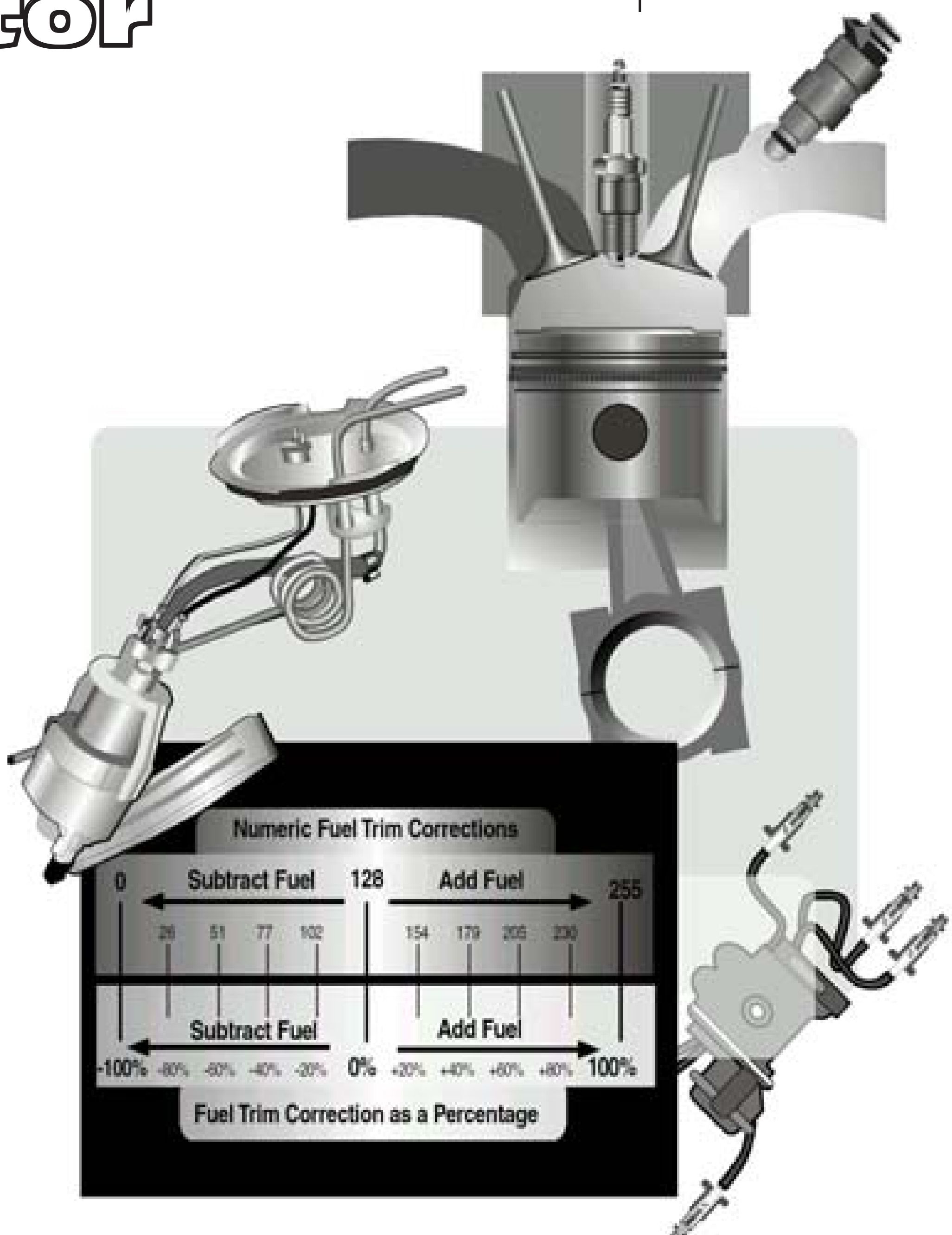
Anything that makes it impossible for the PCM to maintain the correct air fuel ratio.

For example, **Fuel System Lean** DTCs can be caused by things like:

- A weak fuel pump
- Fuel pump low voltage
- A plugged fuel filter
- Restricted fuel supply hose
- Clogged injectors
- Faulty MAF
- Faulty MAP
- Faulty Fuel Pressure regulator

Fuel System Rich DTCs may be caused by things like:

- Excessive fuel pressure
- Leaking injectors
- Excessive injector pulse width



Common Enabling Conditions for the Fuel System Monitor:

- PCM in closed loop fuel control
- Fuel tank above 15% and below 85% of capacity

Non-Continuous Monitors

So far, we've discussed the three Continuous Monitors that can be found in all OBD II vehicles:

- **Continuous Component**
- **Fuel System**
- **Misfire**

Now, it's time to look at the Non-Continuous Monitors is a little more detail. Non-Continuous Monitors test subsystems that are designed to control vehicle emissions, and include:

- **Oxygen Sensor Monitor**
- **Catalyst Monitor**
- **EGR Monitor**
- **EVAP**
- **AIR Monitor**
- **PCV Monitor**
- **Thermostat Monitor**

Which Vehicles Use Which Monitors?

All OBD II vehicles use the same three Continuous Monitors. Non-Continuous Monitor use varies by vehicle.

For example, a manufacturer may not equip their vehicles with air injection, so the AIR monitor won't be used.

To find out which Non-Continuous monitors are installed in a vehicle, connect your scan tool and navigate to the Readiness Status display that will list installed monitors.

Additional Monitors

There are two additional monitors we won't discuss in detail.

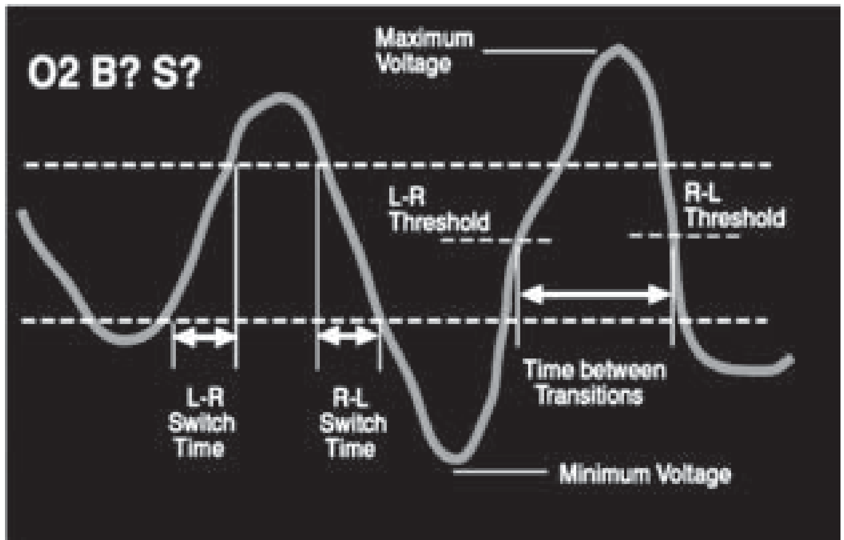
• The **A/C Refrigerant** Monitor which was intended to monitor R-12 systems for leaks. R-12 is out of production.

• The **Heated Catalyst** Monitor is supposed to test catalyst mounted electrical heaters used to bring the catalyst to operating temperature faster.

We may see this monitor in regular use after vehicles change over to 42 volt systems that can provide the massive amounts of current these heaters will consume.

Common abbreviations:
O2S = Oxygen sensor
HO2S = Heated Oxygen Sensor

Oxygen Sensor Monitor



The Oxygen Sensor monitor tests both **upstream sensors** (ahead of the catalyst) and **downstream sensors** (after the catalyst).

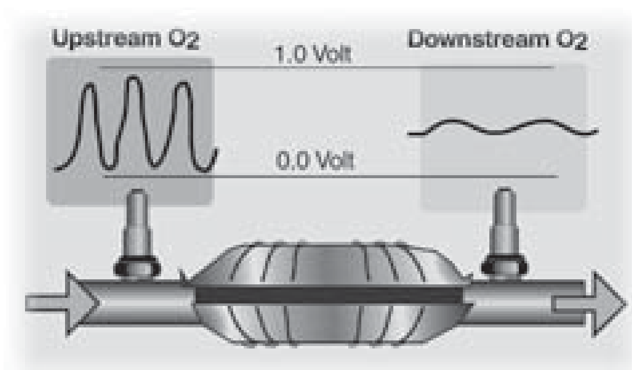
Important: A DTC for the oxygen sensors can prevent several other monitors from running.

The oxygen sensor monitor "measures" oxygen sensor performance in several ways. This chart shows that a good oxygen sensor ought to reach certain minimum and maximum voltage levels and cross rich and lean thresholds. It ought to switch from rich-lean to lean-rich rapidly.

All in all, the sensor is tested for voltage range, reflexes, and time to respond to changes in exhaust gas oxygen content.

Oxygen sensors don't just work with fuel control. They are also used as test inputs for the Misfire, EVAP, EGR, Catalyst Efficiency, and AIR monitors.

Catalyst Efficiency Monitor



- This is a Non-Continuous Monitor
- The Catalyst Monitor depends on up and downstream oxygen sensor accuracy

The Catalyst Efficiency Monitor is one of the more complex OBD II test strategies.

The catalyst test compares the upstream and downstream oxygen sensor voltage signals. If the catalyst is able to store and use oxygen, the downstream sensor voltage will stay relatively flat. If catalyst oxygen storage efficiency falls, however, the downstream signal will begin to mimic that of the upstream sensor, indicating reduced catalyst efficiency.

The PCM may run additional tests and perform some complicated math before ultimately condemning the catalyst and storing a DTC.

EGR Monitor

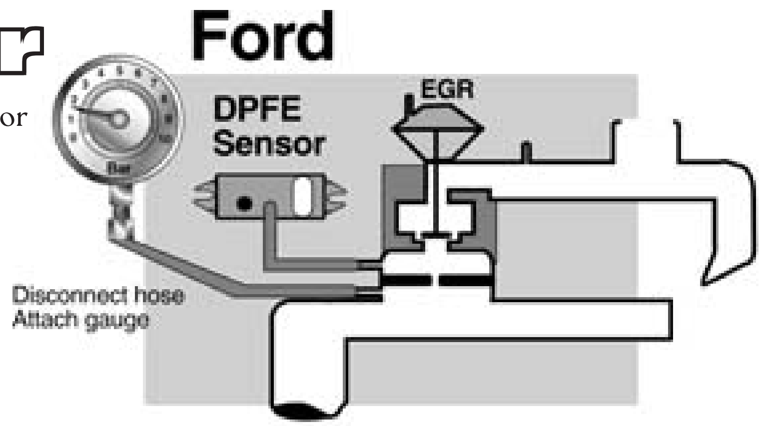
OBD II tests EGR valve operation. It also tests for sufficient exhaust gas flow into the intake manifold.

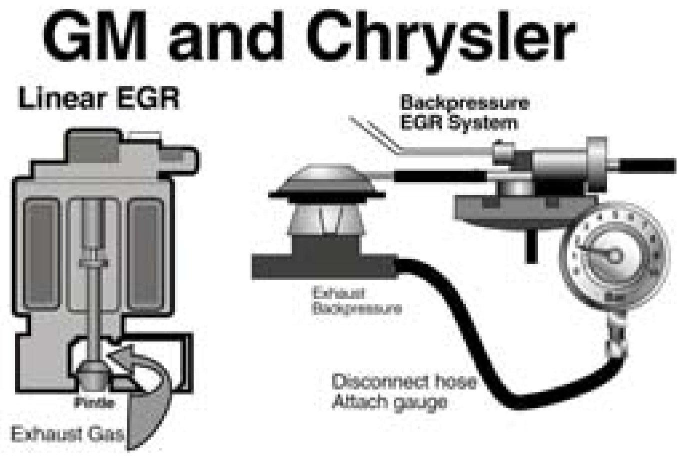
EGR is one area where the OEMs differ on how to best operate and monitor exhaust gas recirculation.

Ford uses a Differential Pressure EGR that senses pressure changes in the manifold as the EGR valve opens.

GM uses a motor-activated EGR with integral position sensor, called a Liner EGR valve. The GM PCM measures changes in manifold pressure to determine exhaust gas flow rates.

Chrysler uses both a Linear EGR similar to GM's and a more traditional backpressure transducer EGR setup. Chrysler checks EGR flow rates in speed density systems with the oxygen sensor by measuring the change in exhaust gas oxygen content as the EGR opens.



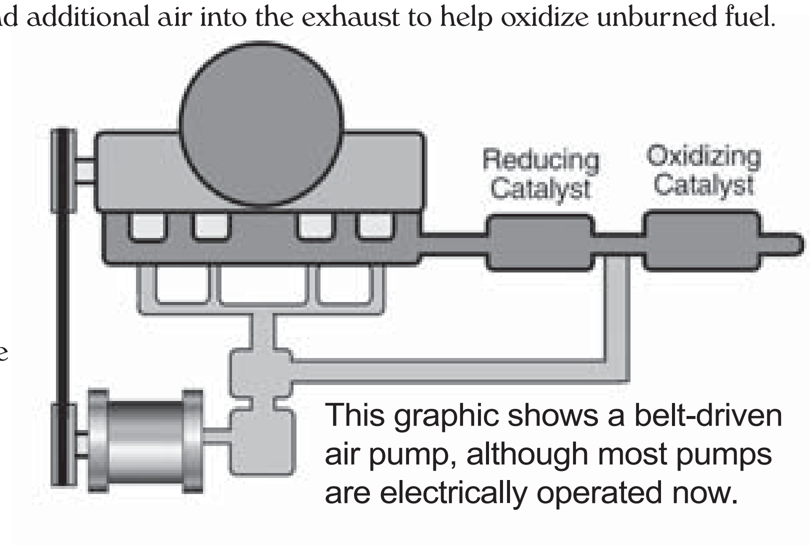


AIR Monitor

An air pump is used in some makes to send additional air into the exhaust to help oxidize unburned fuel.

The AIR Monitor watches oxygen sensor voltage during warm-up, before the system enters closed loop. If the AIR system is pumping air into the exhaust as it should, the added oxygen will drive the O2 sensor voltage low.

If this test is inconclusive, the pump may be turned on again briefly after closed loop starts. Once again, the PCM will look for a change in O2 sensor voltage to indicate air injection is working.



This graphic shows a belt-driven air pump, although most pumps are electrically operated now.

EVAP Monitor

Before OBD, II we had non-enhanced EVAP. The onboard system tested for EVAP purge valve operation, but didn't really test for vapor leaks in the fuel vapor containment system (canister, fuel tank, connecting hoses, etc.).

Enhanced EVAP also tests for leaks in the vapor containment system.

Of all the monitors, Misfire and Enhanced EVAP seem to cause the most aggravation for repair technicians. Misfire is tough because there are so many causes for a misfire to occur.

Most of us are used to measuring pressure in pounds-per-square inch. EVAP system vapor pressures are measured in **inches-of-water.**

Enhanced EVAP is just as tough for different reasons. EVAP must:

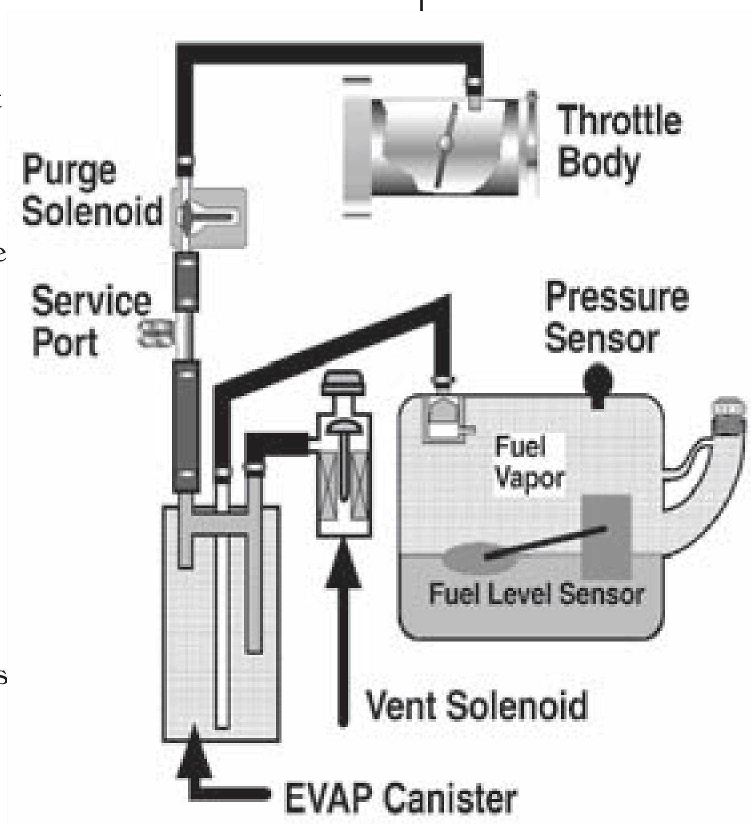
- Test for proper purge flow.
- Detect fuel vapor leaks as small as 0.20 inch.

This is a tough monitor for the PCM to run, since it must compensate for rapid fluctuations in fuel tank pressure caused by changes in ambient temperature, barometric pressure, fuel sloshing around inside the tank, and the effects of hot fuel returning to the tank from the fuel rail.

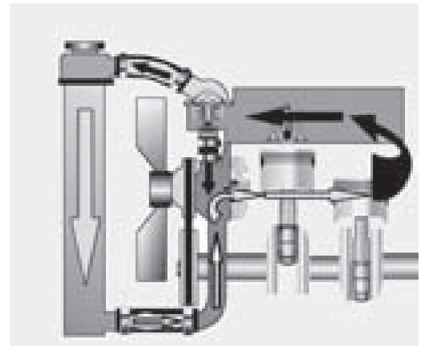
A false leak may be caused by something as simple as a loose fuel filler cap.

- The PCM looks at changes in STFT as the Purge Solenoid is opened to measure fuel vapor purge flow rates.

- EVAP leak tests are different. A combination of vacuum switching valves and vent solenoids seal off parts of the system as a fuel tank pressure sensor monitors tank pressure and vacuum.



Thermostat Monitor

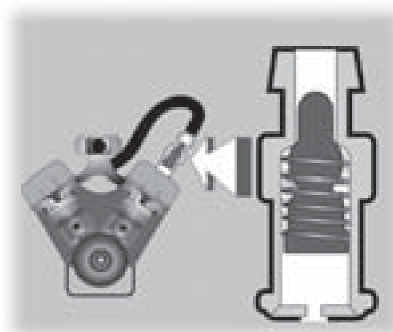


This monitor is being phased in beginning with 2000 M/Y. Its purpose is to ensure that the engine coolant temperature reaches normal operating temperature within a specified time after start-up. This function was previously a part of the ECT test.

Here's an example of a DTC for improper warm-up:

P0118 ECT Sensor Circuit Low Temperature
- Code Set Conditions: Engine run time over 4 minutes
- Code Set Criteria: PCM detects ECT sensor input below -31 degrees F for 5 seconds

PCV Monitor



Brand new for 2002, this monitor will also be phased into production. The purpose of this monitor is to detect PCV leaks, either at the PCV valve itself, or at the engine vacuum connection.

Notes

OBD II Troubleshooting Tips

OBD Tool Box

What tools do you need in order to repair OBD II vehicles? While the possible list is as long as our imagination, we want to give you a core list of tools we feel are essential for successful OBD II repairs.

Number ONE - Scan Tool

A scan tool. There's only one way to retrieve DTCs and Freeze Frame and view datastream and Monitor Readiness information and that's with a scan tool.

Earlier, we suggested that the Task Manager writes down test data and test results on an electronic clipboard located inside the PCM.

The only way to view the contents of that clipboard is to peek over the Task Manager's shoulder and look at contents of that clipboard.

The scan tool is your window into the workings of the Task Manager and the OBD Diagnostic System.

OBD II Troubleshooting Tools and Equipment

Number Two: Information

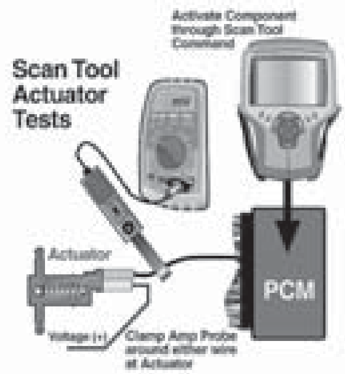
We can't fix the car until we know exactly why it failed. We've shown you that test enabling criteria and test standards are very specific. They often vary by make, model, year, and even VIN.

You need access to repair data, including Technical Service bulletins that list changes in hardware, software, and adjustment procedures.

Number Three: A Good DVOM

Many DTCs are caused by shorts and opens in circuits and sensors. For quick tests of available voltage and voltage drops, there's no substitute for a quality DVOM.

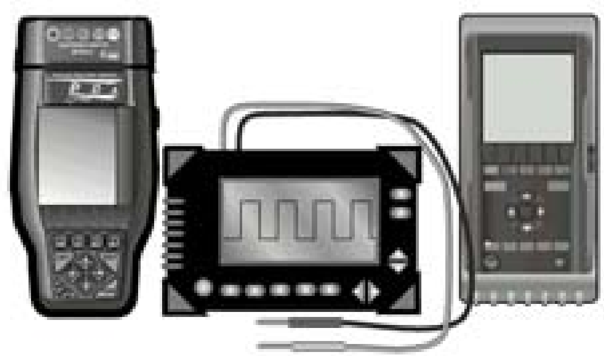
Tip: Use the MIN/MAX and Alert functions on your meter to record intermittents.
Tip: Add a low amp probe and test circuits for correct current while they work.



Number Three: A Labscope

As useful as a DVOM can be for basic voltage and resistance tests, it can't identify certain problems with repetitive waveforms used to signal speed and duty cycle.

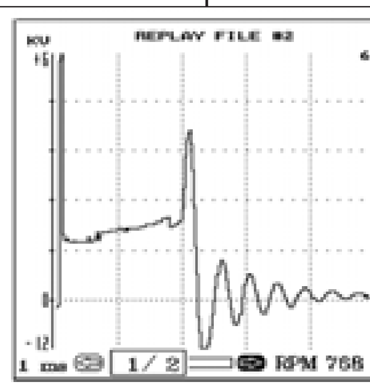
A picture is still worth a thousand words.



Number Four: An Engine Analyzer

An engine analyzer benefits diagnosis of multiple problems because it let's you look at what's happening inside the cylinder.

Misfire, fuel delivery, ignition and valve timing, and engine mechanical problems will all show up on scope primary and secondary patterns.



Number Six: A Fuel Pressure Gauge

One of the most overlooked (and common) reasons for Fuel System codes is low fuel pressure and insufficient fuel volume.

Once you've identified a rich or lean condition in a vehicle, fuel pressure and fuel volume tests become logical and essential parts of a complete diagnosis.

Number Seven: A Smoke Machine

Smoke machines are great for locating intake manifold and exhaust system leaks.

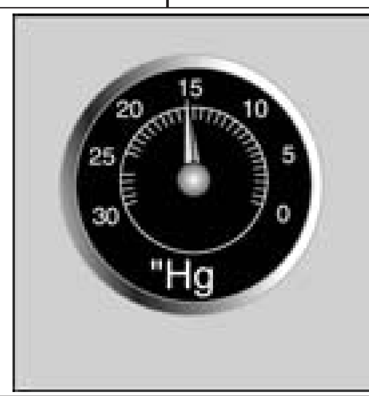
Many techs have also found them a more user-friendly alternative to ultrasonic leak detectors for locating EVAP leaks.

Leaks may seem low tech, but they cause a lot of problems.

Number Eight: A Vacuum Gauge

Low tech and inexpensive, the lowly vacuum gauge is still one of the fastest and most effective ways to diagnose common engine mechanical and exhaust backpressure problems in a running engine.

Also helpful for identifying engine cranking vacuum problems.



This is the short list. You have items you'd like to add. But the tools and equipment listed on this page should be considered essential, core testers for diagnosing OBD II problems.

Before we start the test section, we want to make two simple statements:

1) It is our considered opinion that for the majority of OBD II concerns, the **scan tool** and **accurate vehicle information** are your two most important diagnostic tools.

2) Read Statement 1 again as many times as it takes to remember it.

Now we can move on.

Typical Diagnostic Steps

Let's run through a generic OBD II diagnostic procedure. The MIL is ON!

1) Connect your scan tool and retrieve all DTCs

2) Look up the **exact** DTC definition, including test enabling criteria and code set standards.

3) View Freeze Frame. Look for clues in Freeze Freeze that match the code definition and/or symptom.

4) If the DTC in memory is for a component failure that involves a short or open circuit, locate that component in datastream on the scan tool and view its current value. If the PID indicates that a short or open is still present (hard fault), use a wiring diagram, voltmeter, etc. to locate and correct the fault.

Component DTCs must be repaired first!

5) Compare datastream to Freeze Frame PIDs. Look for data that "matches up" with the DTC definition.

If your scan tool supports a graphing mode, use it to look for dropouts and glitches.

Select PIDs that match the component or system that stored the DTC.

Example: make sure you select the ECT PID for an ECT code.

Don't select too many PIDs at once in Generic OBD II.

Doing so may slow the scanner's update rate significantly.

Limit selected PIDs to about 4 to get the fastest update.

Note: Newer Generic interfaces have improved serial data transfer rates.

Experiment to get the fastest updates.

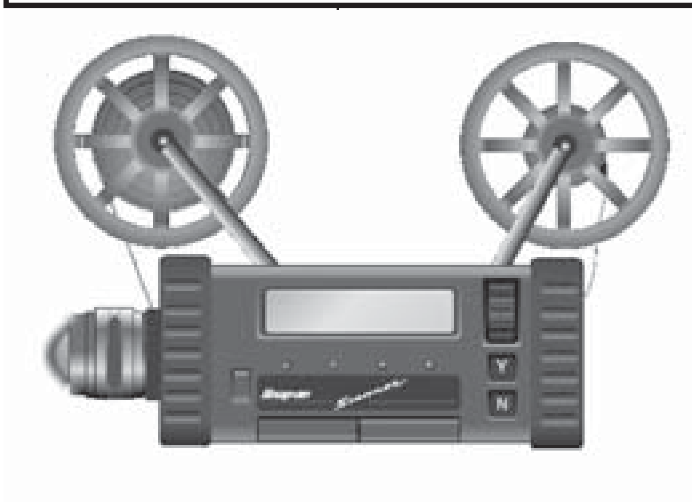
6) Look very carefully at Freeze Frame. FF is supposed to help with a diagnosis.

The Freeze Frame to the right is an example, taken from a case study. The DTC is for a misfire, but Freeze Frame indicates an extremely lean mixture (the PCM is adding 36-38% to the pulse width long term).

The problem? Lean misfire caused by a weak fuel pump.

Freeze Frame for DTC P0305

Fuel System Status B1	Closed
Fuel System Status B2	Closed
Calculated Load	28%
ECT	212°F
STFT B1	24.7%
LTFT B1	38.3%
STFT B2	13.4%
LTFT B2	36.9%
RPM	816



7) Use Freeze Frame to determine the vehicle operating conditions that were present when the DTC was stored. Duplicate those conditions on a test drive with your scanner taking a datastream movie.

This is a great way to catch intermittent problems in the act or to view trends that can lead to a DTC down the road.

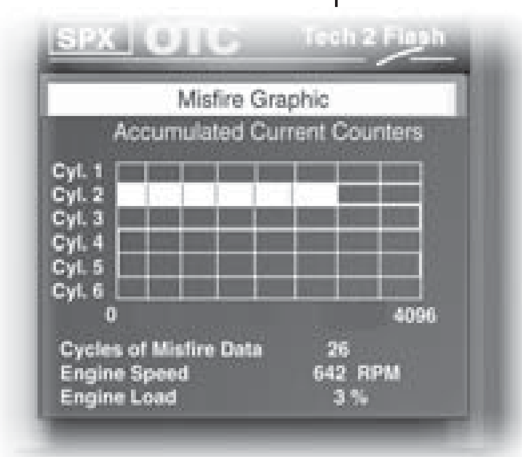
Typical Diagnostic Steps

Do NOT Erase DTCs until you record Freeze Frame data.
Erasing DTCs erases Freeze Frame.

8) Use your scan tool in Actuator Test or Output State test mode to activate suspect components.

Then use your DVOM, labscope, low amp probe, fuel gauge, etc. to verify component operation.

Compare your meter/gauge readings to the data shown on your scan tool.



9) GM vehicles will display both **Current** and **History** Misfire data. Compare the two to identify an intermittent misfire condition.

Then use Freeze Frame, either to duplicate those conditions, or to determine which components might cause misfire under similar conditions.

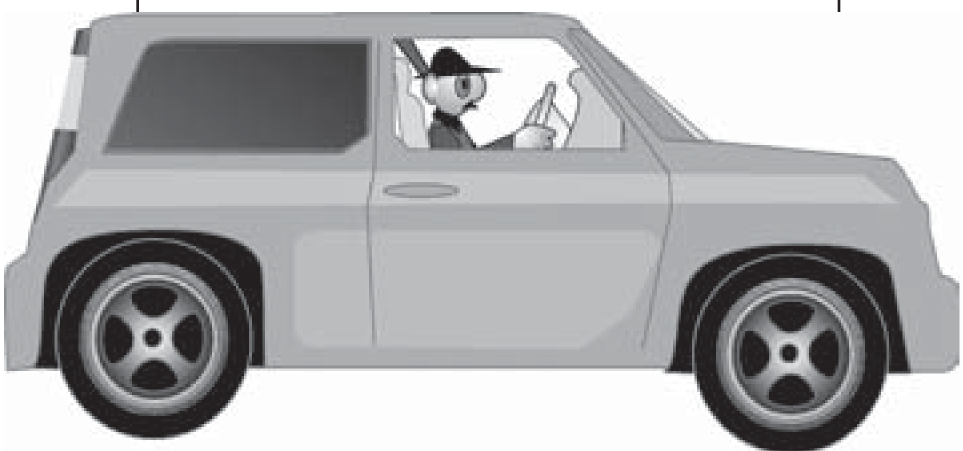
10) Familiarize yourself with special scan tool test modes that can speed diagnosis.

You can still access KOEO and KOER tests on EEC-V OBD II Fords, but you have to do it through the scan tool now.

Don't forget Wiggle Tests. They are very useful for locating intermittent conditions.

11) Fix the car. At this point, we revert to the same standard repair practices we've used for years. In many cases, the problem that stores a DTC will not be any different from similar problems we've diagnosed and repaired in the past: misfires, short circuits, open circuits, fuel starvation, excessive EGR, etc.

When you erase DTCs following repairs, the onboard system will run its monitors again to test your work, and store fresh DTCs, if necessary.

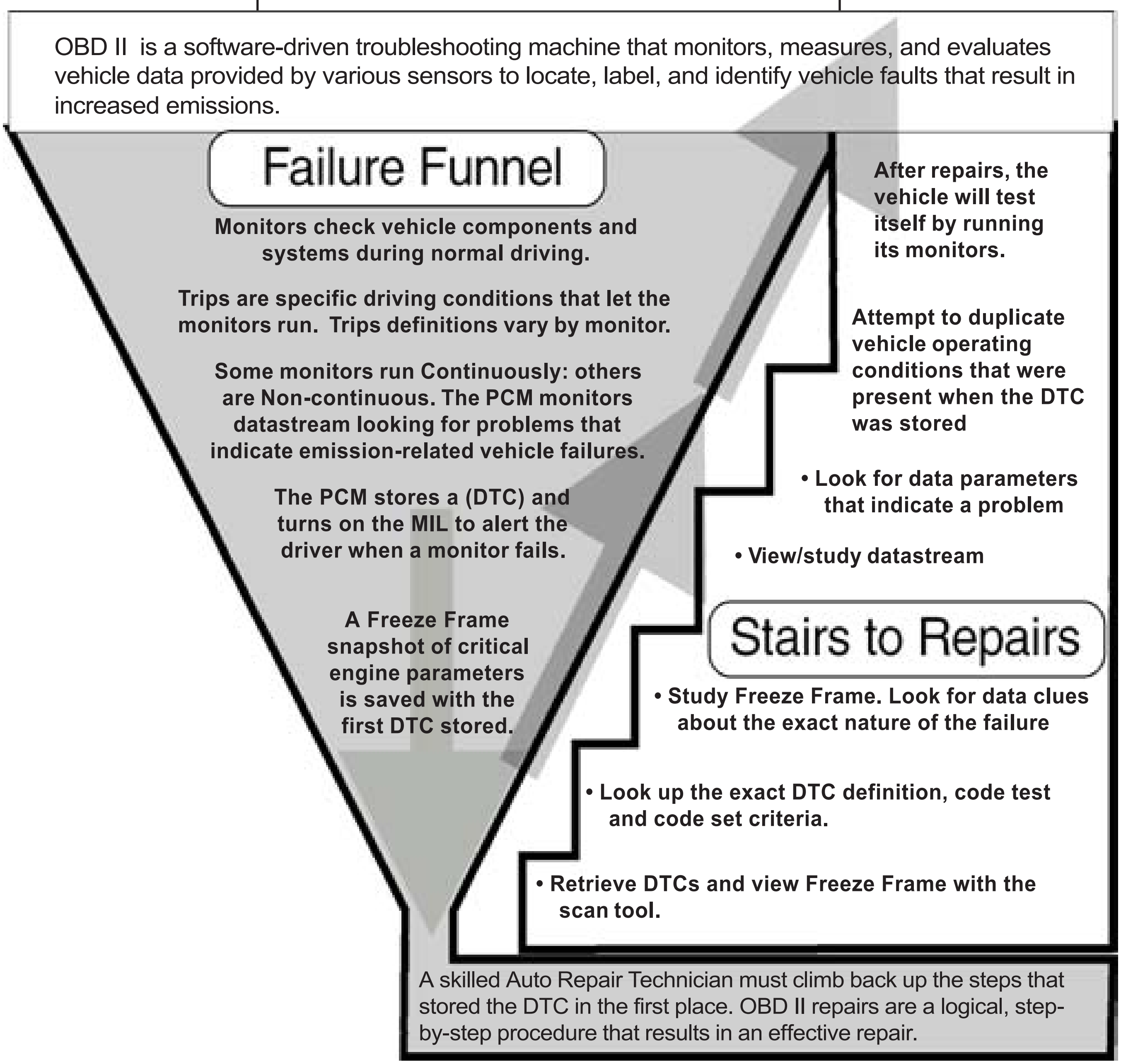


Notes

Typical Diagnostic Steps

Vehicle problems are funneled into the OBD II software to store DTCs and Freeze Frame.

Our task is to climb back through the steps that stored the code to diagnose and repair the vehicle.



What are Modes?

SAE paper J1979 describes the diagnostic test modes necessary to meet CARB and Federal OBD standards for an OBD II scan tool interface.

J1979 lists **eight** modes of scan tool operation.

The eight modes are listed to the right.

Note that the numbering system includes a dollar sign ($).

For example:
Mode $01= Mode 1,
Mode $02= Mode 2,
and so forth.

You are familiar with many of these modes already and use them regularly.

Modes 1-4 are the most familiar, since they allow us to view datastream and review and erase DTCs.

- **Mode $01** - Request Current Powertrain Diagnostic Data (what we normally refer to as datastream)
- **Mode $02** - Request Freeze Frame Data
- **Mode $03** - Request DTCs
- **Mode $04** - Clear/Reset DTCs, Freeze Frame, and reset Readiness Status for non-continuous monitors to INCOMPLETE
- **Mode $05** - Request Oxygen Sensor Monitor test results

- **Mode $06** - Request onboard monitoring test results for non-continuously monitored systems

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- **Mode $07** - Request onboard monitoring test results for continuously monitored systems
- **Mode $08** - Request control of onboard system

Mode Six In GM

You may already be familiar with advantages of Mode 6 if you're using Failure Records to diagnose GM vehicles.

That's right, Mode 6 has been with us all along in the GM scan tool interface.

GM's **Diagnostic Test Status** scanner display tells us how well the non-continuous monitors are doing with their tests.

We don't have to wait for a pending code or DTC to be stored to know if we have a problem with a non-continuously monitored component or system.

We can simply go to the **Diagnostic Test Status** display in a GM scan interface and view the non-continuous monitor report cards.

DTC Monitor Report Card (Results sent to PCM)

Code	RUN	Grade
P0101	NO	-
P0102	NO	-
P0502	YES	PASS
P0400	NO	-
P0143	YES	FAIL
P0756	YES	INT

Notice that one column of the report card display tells us if the test for a given monitor has run — or if it hasn't run.

If the test has run successfully and gotten a passing grade, it is marked as a "**pass**." If it runs, but doesn't get a passing grade, it's marked as a "**fail**."

Finally, if the results of the test are inconclusive or questionable, the test gets an **INT** grade, indicating a questionable test condition that may be intermittent in nature.

A failing grade can alert us to a condition that **will** store a DTC if it isn't corrected. This is a good way to confirm the success of a repair without driving the car until a code is stored and the MIL illuminates.

Now you see why it's sometimes important to know the conditions needed to run a monitor.

If we don't get the monitor to run, it won't perform the test and we'll get a "NO" indication in the "RUN" column.

Viewing Mode 6 information

Not all scan tools will display Mode 6 information. Sorry about that.

Mastertech is one scan tool that will give us Mode 6 test data. Notice that the letters and numbers in the scan tool display are a little different from what we're used to seeing. More of those dollar signs!

Don't let those dollar signs annoy you. **TID** simply stands for a **Test ID** for a given monitor. Each Test ID (TID) is identified by its own number, such as $01 or $02.

The same thing applies to any **Component IDs** (**CID**) related to that test. This is especially important when a test of a system includes individual tests of multiple components.

A CID is just a manufacturer-defined component or test status identifier that helps you identify certain parts of test procedures.

Once we identify a Test and /or Component, we can simply look in this display window to see if it has passed or failed a test. This can give us an early warning about whether or not a monitor is likely to store a DTC.

TID = Test ID
CID = Component ID

How do we read this secret TID and CID code?

Some manufacturers have published TID and CID identifications, allowing us to match tests to monitors and perform Mode 6 diagnosis. Toyota and Ford have published this data on the web at i-ATN.

Mode Six In Generic OBD II

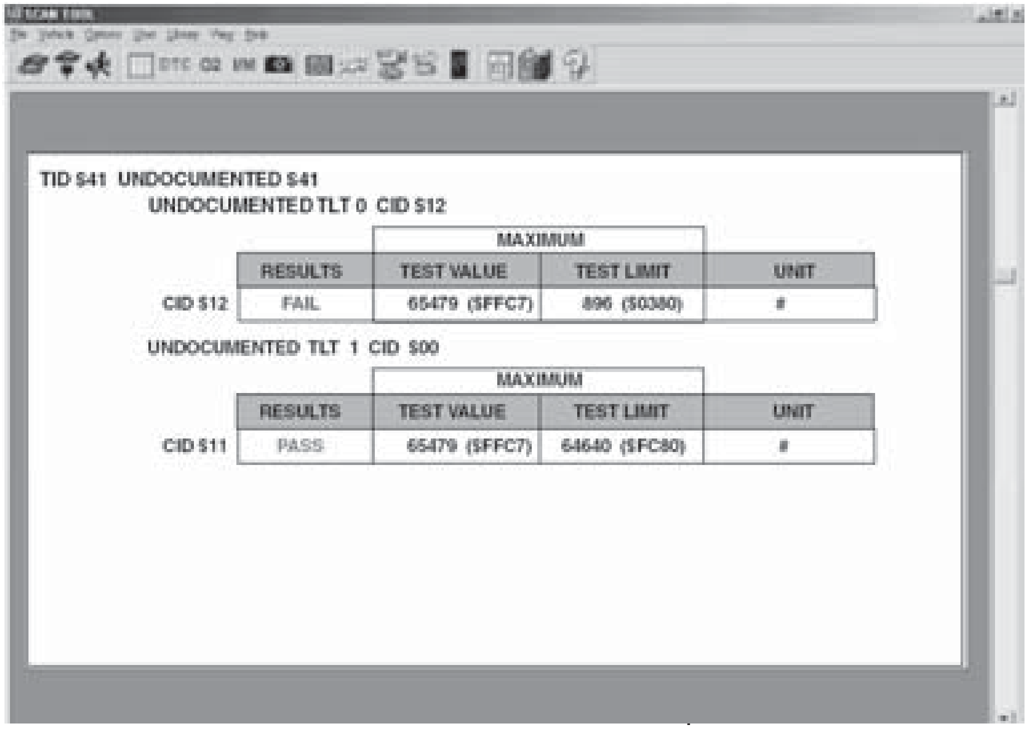
Here's a screen capture from a Ford Explorer displayed by EASE diagnostic software, a PC-based scan tool that can also display Mode 6 test results.

Note: We had already pulled a Pending Code P0401 for EGR insufficient flow.

Armed with the Pending DTC and Mode 6, we can tackle this problem.

First, refer to the two tests shown in the display to the right.

Note that of the two tests, one is a FAIL.



TID $41 UNDOCUMENTED $41

UNDOCUMENTED TLT 0 CID $12

	RESULTS	MAXIMUM TEST VALUE	TEST LIMIT	UNIT
CID $12	FAIL	65479 ($FFC7)	896 ($0380)	#

UNDOCUMENTED TLT 1 CID $00

	RESULTS	MAXIMUM TEST VALUE	TEST LIMIT	UNIT
CID $11	PASS	65479 ($FFC7)	64640 ($FC80)	#

• The Ford pages on the i-ATN (iatn.net) tell us that the TID and CID values shown in our test screen apply to the DPFE (Differential Pressure Feedback EGR). This is also referred to as the Delta Pressure Feedback EGR.

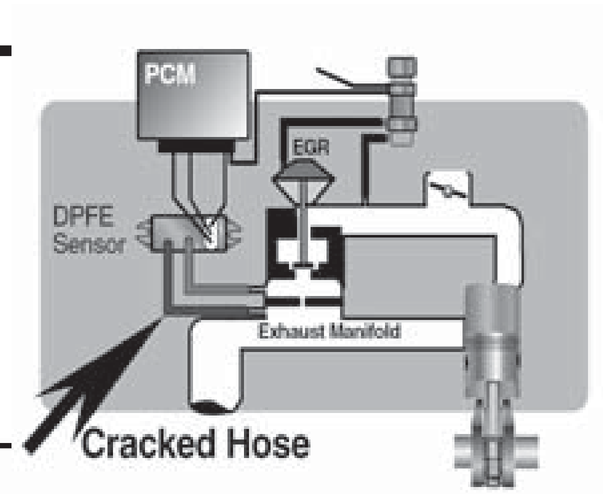
TIC CID Chart Ford DPFE

Next, we go to the Ford section on the i-ATN (www.i-ATN.net) and look up the test standards for the EGR system. The chart below lists the tests run by Ford. Notice that the TID and CID in the grayed-out box match the ones for the failed test in the EASE screen (TID$41 and CID$12).

We seem to be looking for a problem affecting the downstream DPFE hose. Note that the test spec is a pressure measurement (in H20). We have a pressure problem in the EGR.

Test ID	Comp ID	Description	Units
$41	$11	Delta Pressure for upstream hose test and threshold	in. H_20
$41	$12	Delta Pressure for downstream hose test and threshold	in. H_20
$42	$12	Delta Pressure for downstream hose test and threshold	in. H_20

Closer examination of the EGR hoses shows us that the heat-hardened downstream DPFE hose is indeed cracked and leaking. We repair the hose and return to Mode 6 to verify the repair. The Mode 6 screen verifies that the EGR test is now passing. We have a confirmation that the repair we made was the correct one without having to drive the vehicle on two trips to store a DTC.



Mode 6 Screen after Repair

TID $41 UNDOCUMENTED $41

UNDOCUMENTED TLT 0 CID $12

	RESULTS	MAXIMUM TEST VALUE	TEST LIMIT	UNIT
CID $12	PASS	65479 ($FFC7)	65320 ($0380)	#

UNDOCUMENTED TLT 1 CID $00

	RESULTS	MAXIMUM TEST VALUE	TEST LIMIT	UNIT
CID $11	PASS	65479 ($FFC7)	64640 ($FC80)	#

Things to consider about Mode 6

• Mode 6 is available through the **GENERIC OBD II** interface on scan tools that support it! You **DO NOT** need a factory level scan tool, just a generic scan tool that can access Mode 6, and trust us, they can't all do it!

• Even though our Ford test vehicle didn't store a manufacturer-specific code, Mode 6 helped us zero in on the area where the problem occurred (the cracked downstream DPFE hose). Admittedly, there are Ford-specific DTCs, but we didn't need them here because we had access to **1)** the Pending Code, **2)** Mode 6 test results, and **3)** Mode 6 definitions, available from the i-ATN for Ford and Toyota.

We suspect that Mode 6 test data for other makes will be more readily available in the near future. In the meantime, we suggest you visit the i-ATN and look more closely at the OE data for Ford and Toyota. Both manufacturers deserve credit for posting this information.

FORD

FORD

Silver Bullets

FORD

GENERAL MOTORS

Silver Bullets

GENERAL MOTORS

GENERAL MOTORS

IMPORTS

Silver Bullets

IMPORTS

Silver Bullets

IMPORTS

Chrysler/Jeep

Silver Bullets

CHRYSLER/JEEP

Glossary

Adaptive Memory
Adaptive memory is a long term data record of PCM control over adaptive system strategies used to maintain fuel control and adapt for vehicle wear and tear. This data is stored in Keep Alive Memory (KAM) and is not erased when the ignition is switched off.

AIR (Air Injection) system
The AIR system injects atmospheric air into the exhaust.

Alphanumeric
The OBD II trouble code numbering system is alphanumeric since it mixes numbers and letters of the alphabet.

Ambient Temperature or Pressure
Ambient refers to the air surrounding the vehicle. IAT measure ambient air temperature. BARO measures ambient atmospheric pressure.

Bidirectional
A diagnostic interface that allows the PCM and scan tool to both receive and transmit data.

Catalyst
A catalytic converter promotes a chemical action to clean exhaust gases.

Comprehensive Component Monitor (CCM)
The CCM tests inputs and outputs for functionality and rationality.

Conflict
A condition where the OBD II software can't run a monitor because another monitor is already running.

Continuous Monitor
A Continuous Monitor runs continuously during normal driving conditions.

Diagnostic Executive
This is the term used by GM and Ford to indicate the PCM software that schedules tests, stores test data, records DTCs, and turns the MIL on and off. Chrysler calls this the Task Manager.

DLC
Data Link Connector. This is the standard 16-pin scan tool test connection mandated for all OBD II vehicles.

Glossary

DPFE
Ford's Differential Pressure Feedback EGR (DPFE) system measures EGR flow rates and sends a variable voltage to the PCM.

DTC
Diagnostic Trouble Code

ECT
Engine Coolant Temperature sensor

Enabling Criteria
The exact test conditions required by the OEM to run a diagnostic test.

Enhanced EVAP
A diagnostic monitor that tests for both EVAP purge flow and also for EVAP system leaks.

EVAP
The Evaporative Emission system

Full-Range Misfire Detection
A misfire monitor that runs at any engine speed.

Functionality Test
Functionality Tests detect clear cut failures of sensors or actuators that can result in increased emissions.

Freeze Frame
A single-frame snapshot engine PIDs stored with the first, or highest priority DTC, You'll get at least one Freeze Frame, although some systems can store more than one of these snapshots.

FTP
The Federal Test Procedure (FTP) is a test procedure that sets the baseline for a vehicle's acceptable emission levels. It includes tests for both tailpipe and evaporative emissions.

HC
Hydrocarbons

IAC
Idle Air Control motor

IAT
Intake Air Temperature sensor

Inches of Water
One PSI is equal to 27.68 inches of water. This measurement standard is commonly used with EVAP system tests.

KAM
The long term data storage area of the PCM that is not erased each time the ignition is switched off.

LTFT
Long Term Fuel Trim (LTFT) is a record of fuel correction stored in the PCM to indicate long term trends in fuel correction.

MAF
Mass Air Flow sensors measure the mass of the air being drawn into the engine.

MAP
Manifold Absolute Pressure is the difference between atmospheric pressure (BARO) and the pressure/vacuum inside the intake manifold. MAP is also used as a shorthand reference for the MAP sensor.

MAP Sensor
The MAP sensor is used to measure intake manifold pressure as an indication of engine load based on manifold pressure.

MIL
The Malfunction Indicator Lamp.

Misfire
Anything that prevents complete combustion.

Monitor
The OBD II term for the test sequence used to check components and systems.

Glossary

Non-Enhanced EVAP
A system that tests purge flow but doesn't test for EVAP system fuel vapor leaks.

OBD I
On-board Diagnostics, Generation One.

OBD II
On-board Diagnostics, Generation Two. This on-board diagnostic system has been standard on passenger cars and light trucks sold in the U.S. since 1996, although there were a limited number of vehicles with some form of OBD II as early as 1994. OBD II tests for conditions that may lead to unacceptable vehicle emission levels.

OEM
Original Equipment Manufacturers. For our purposes here, the vehicle manufacturers.

Oxygen Sensor
A sensor used to measure the oxygen content in the exhaust. The signal from this sensor is used to control closed loop fuel correction and to perform a diagnostic function for several vehicle subsystems.

Oxygen Sensor Heaters
A resistance heaters that keeps an oxygen sensor at operating temperature regardless of exhaust temperature.

Pending Code
The first detection of a problem that may eventually mature into a DTC. Some faults must be detected by the PCM on two consecutive trips to store a DTC. A Pending DTC in the PCM memory indicates that something has failed once. Think of it as strike one!

PCM
Powertrain Control Module

PID
One item in scan tool datastream.

Glossary

Readiness Status
A scan tool menu that lists all monitors in a vehicle and indicates whether or not they have run to completion. If any fails, there should be a DTC stored.

Serial Data
Data that is transferred by voltage pulses.

Short Term Fuel Trim (STFT)
This is the fuel correction needed to keep the engine running in closed loop. STFT is reset each time the ignition is switched off.

Task Manager
Chrysler's term for the Diagnostic Executive.

Trip
A key cycle (Key-ON, start to-run, and Key-OFF) where driving conditions satisfy enabling criteria so a monitor can run.

Update Rate
This indicates how fast scan tool data is updated

VSS
Vehicle Speed Sensor

Warm-Up Cycle
The PCM may erase DTCs. The PCM can turn off the MIL if the monitor that originally stored the DTC runs again and passes on three consecutive trips. But the DTC won't be erased right away, even though the MIL is off. The DTC can eventually be erased by the PCM if it counts 40 warm-up cycles without seeing any recurrence of the problem. A warm-up cycle is a start-to-run where ECT begins below 160 degrees F and then increases above 160 degrees F. For a warm up to be counted, however, the ECT must also increase by at least 40 degrees.