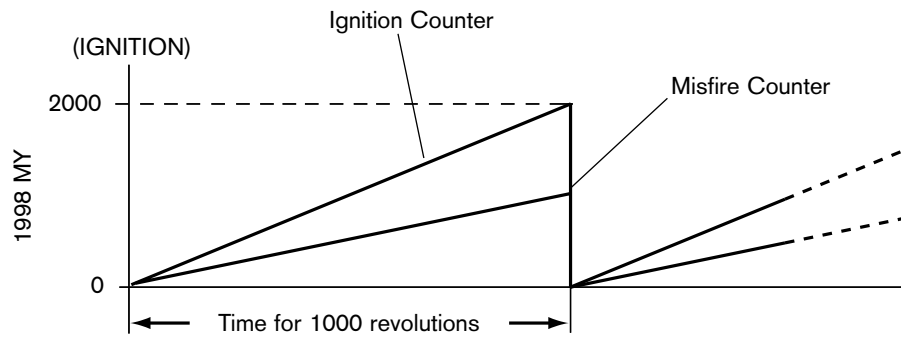


# Engine Misfire Diagnosis

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- Learning Objectives:**
1. Determine engine cylinder misfire through Enhanced Data, CARB Data and engine symptoms.

# Engine Misfire Diagnosis

**Overview** It used to be that engine misfire was primarily diagnosed with a variety of test equipment and a logical troubleshooting procedure using a process of elimination to determine the cause. With OBD II, an engine misfire monitor detection is part of the ECM's diagnostic program and the cylinder that is misfiring is reported on a scan tool. However, not all misfires can be detected in this manner. The misfire detection program is keyed towards engine emissions, not a smooth running engine.

Included in this section is an overview of engine diagnosis. This area provides explanations on no start and other engine conditions.

**Misfire Monitor** The misfire monitor serves two purposes. The first reason for the monitor is to determine if a misfire is severe enough to damage the catalytic converter. The second reason is to monitor for any misfire that would raise emission levels above the standard. The misfire monitor is a continuous monitor.

The ECM measures crankshaft acceleration via the crankshaft position sensor. The crankshaft will briefly accelerate each time a cylinder is on the power stroke. When the cylinder misfires, the crankshaft slows down instead of speeding up. The ECM detects the change in frequency in the crankshaft position sensor signal (NE). The ECM is able to identify the cylinder on the power stroke from the camshaft position sensor signal (G). Severe rough road conditions may temporarily suspend misfire monitor operation.

## Misfire Detection

*When the ignition counter is cycling, the misfire monitor is operating. A percentage above zero indicates the cylinder(s) that is misfiring.*

```

INJECTOR..... 2.9ms
IGN ADVANCE..... 7.0deg
CALC LOAD..... 17%
ENGINE SPD..... 715rpm
COOLANT TEMP..... 190.4°F
CTP SW..... ON
VEHICLE SPD..... 0MPH
STARTER SIG..... OFF
A/C SIG..... OFF
PNP SW [NSW]..... ON
ELECT LOAD SIG..... OFF
STOP LIGHT SW..... OFF
IGNITION..... 1697
CYL #1..... 0%
CYL #2..... 0%
CYL #3..... 0%
CYL #4..... 5%
CYL #5..... 0%
CYL #6..... 0%
CYL #7..... 0%
CYL #8..... 0%
MISFIRE RPM..... 775rpm
MISFIRE LOAD..... 0.90g/rev
# CODES..... 1
CHECK MODE..... OFF
MISFIRE TEST..... COMPL
  
```

Ignition Counter

Misfire Percentage

Fig. 4-1

TL874f401

The Diagnostic Tester will display the cylinder and the percentage of misfire. As you will see, misfire monitor operation varies with the model year and operating conditions.

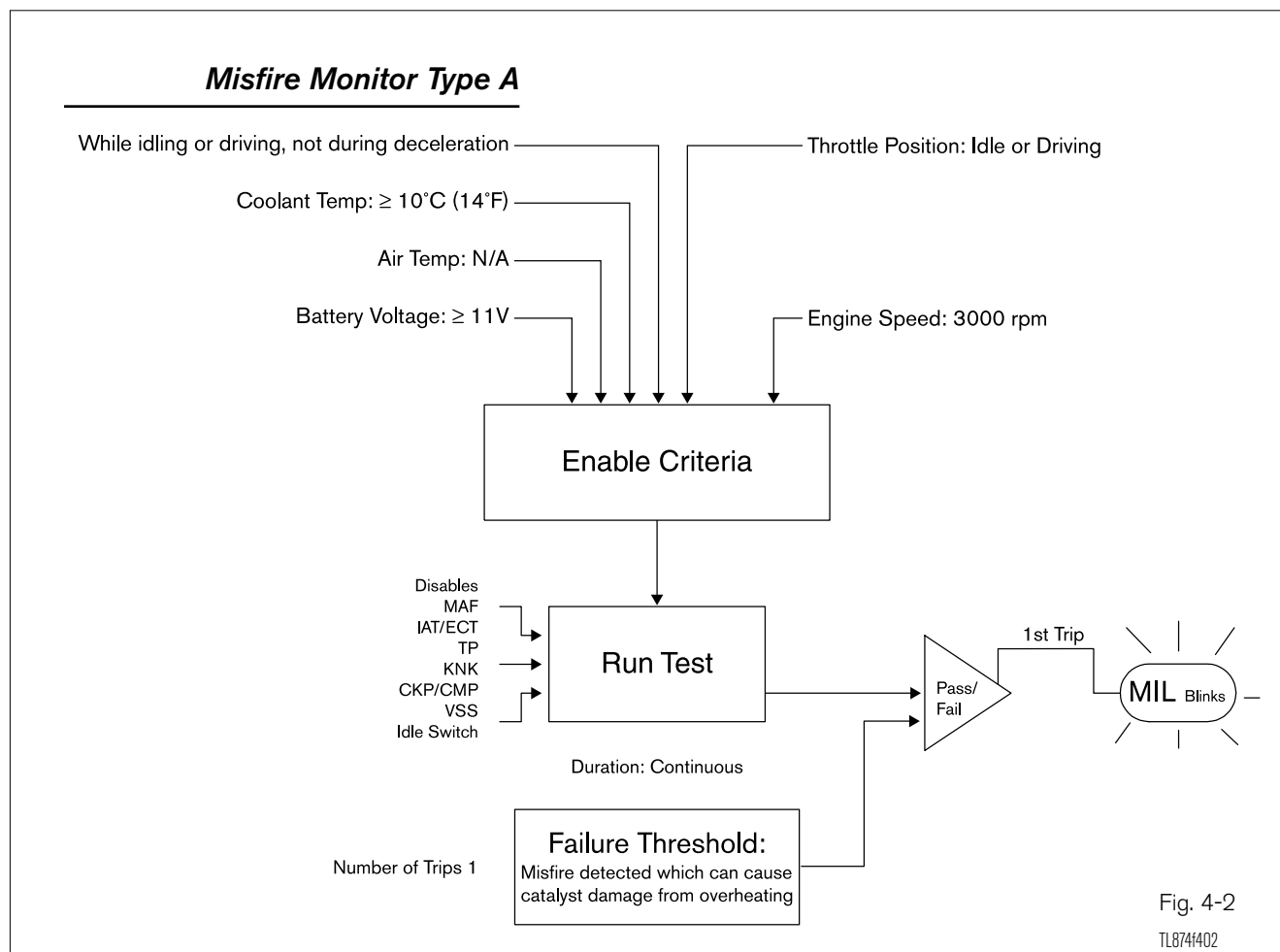
**Misfire Type A (One Trip)** The Type A misfire is a misfire severe enough to damage the catalytic converter. The MIL will blink if the misfire would result in catalyst temperatures of 1000°C (1832°F) or more.

The catalyst temperature is calculated by the ECM based on driving conditions and the percentage of misfire. The higher the percentage of misfire and engine load, the more likely the ECM will cause the MIL to blink.

The blinking MIL will warn the driver of pending catalyst damage and is the only condition that will cause the MIL to blink. The blinking will continue only when the misfire is severe enough to cause catalytic converter damage.

**NOTE**

A pending misfire DTC can be observed in CARB, Mode 7, Continuous Test screen or Pending Codes.



**Misfire Type B (Two Trip)** The type B misfire is less severe. It will increase emissions above standards, but will not damage the catalytic converter. This type of misfire is determined by the percentage of misfire compared to ECM emission specifications. If the percentage misfire causes the emissions to increase beyond a specified level, a DTC will set on the second trip. Type B misfire is a two trip monitor.

The MIL does not blink for these DTCs.

**NOTE** A pending misfire DTC can be observed in CARB, Mode 7, Continuous Test screen or Pending Codes.

### ***Misfire Monitor Type B P0300, P0308***

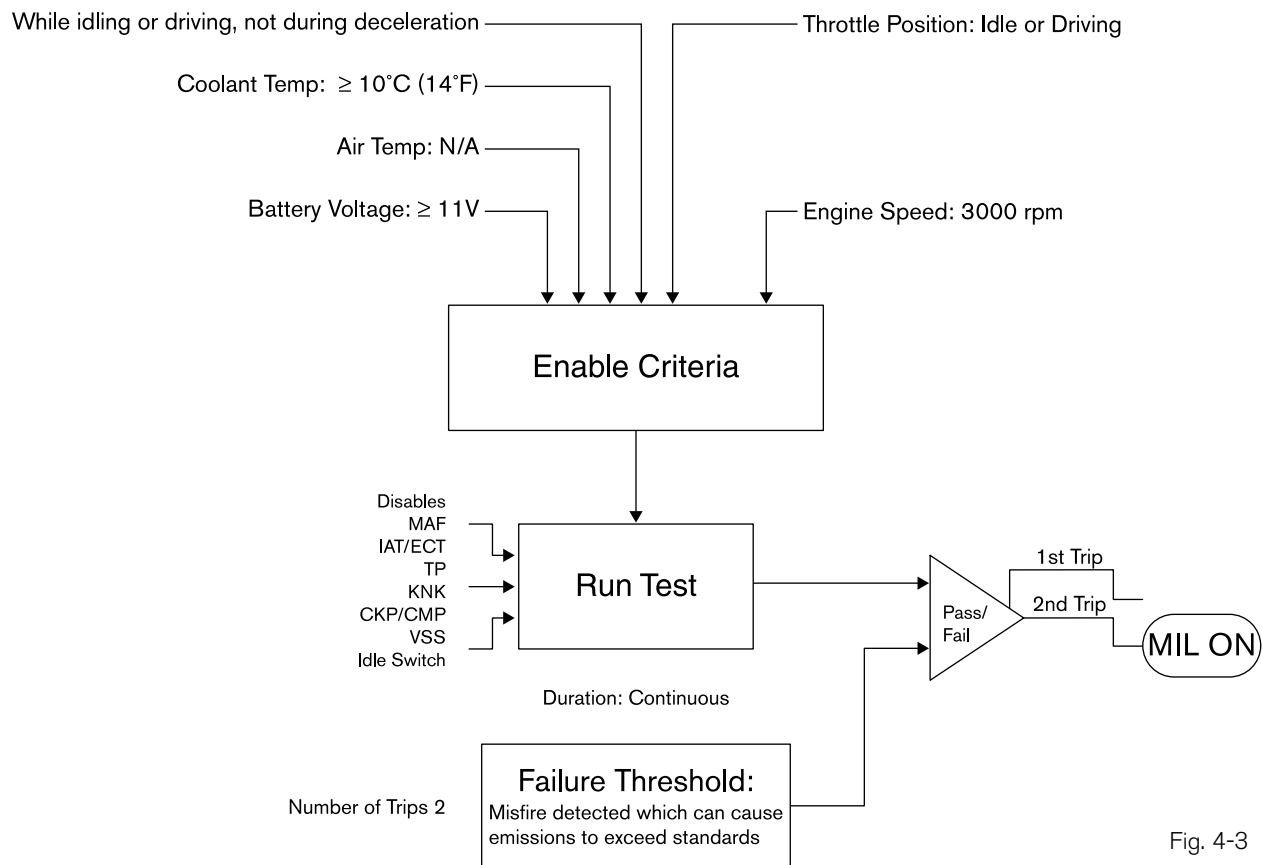


Fig. 4-3  
TL8741403

### ***Time Period to Duplicate Misfire Conditions***

*The Repair Manual provides a chart similar to the one shown. Use this chart along with the Freeze Frame data to reproduce misfire conditions.*

Engine Speed	Time
Idling	3 minutes 30 seconds or more
1000 rpm	3 minutes or more
2000 rpm	1 minute 30 seconds or more
3000 rpm	1 minute or more

Fig. 4-4

TL874f404

### **Ignition Counter (1000 Revolutions)**

1994 ~ 1998 and some 1999 MY OBD II vehicles: The Diagnostic Tester displays an Ignition Count that reflects the number of firing events that take place in 1000 engine revolutions. Each cylinder fires every other revolution, thus each cylinder will fire 500 times in 1000 revolutions.

### ***Ignition Count vs. Number of Firing Cycles per Cylinder***

*The Diagnostic Tester display will show the Ignition Counter recycling at a different count based on the number of cylinders.*

Number of Cylinders		Number of Firing Events per Cylinder in 1000 Revolutions		Ignition Count
4	x	500	=	2000
6	x	500	=	3000
8	x	500	=	4000

Fig. 4-5

TL874f405

### ***1000 Revolutions***

*Misfire counter repeats each 1000 revolutions or 2000 ignitions for a 4 cylinder engine shown here.*

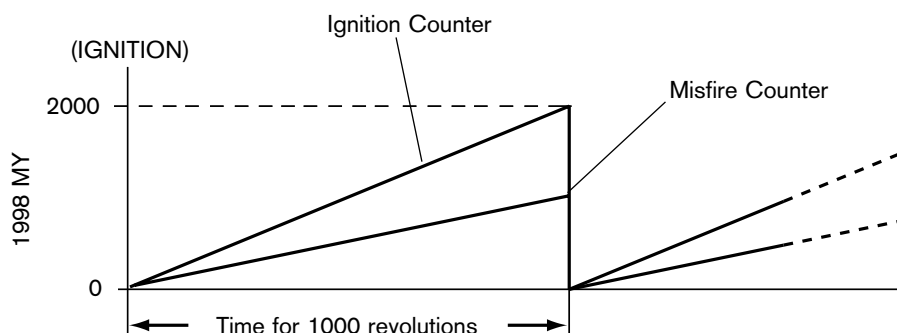


Fig. 4-6

TL874f406

**Ignition Counter (200 Revolutions)** Some 1999 and newer MY OBD II vehicles: The Diagnostic Tester displays an Ignition Count that reflects the number of firing events that take place in 200 engine revolutions. Each cylinder fires every other revolution, thus each cylinder will fire 100 times in 200 revolutions.

***Ignition  
Count Based on  
200 Revolutions***

*1999 and newer vehicles will display the Ignition Count based on 200 revolutions.*

Number of Cylinders		Number of Firing Events per Cylinder in 200 Revolutions		Ignition Count
4	x	100	=	400
6	x	100	=	600
8	x	100	=	800

Fig. 4-7

TL874f407

***200 Revolutions***

*Misfire counter repeats each 200 revolutions or 400 ignitions for a 4 cylinder engine shown here.*

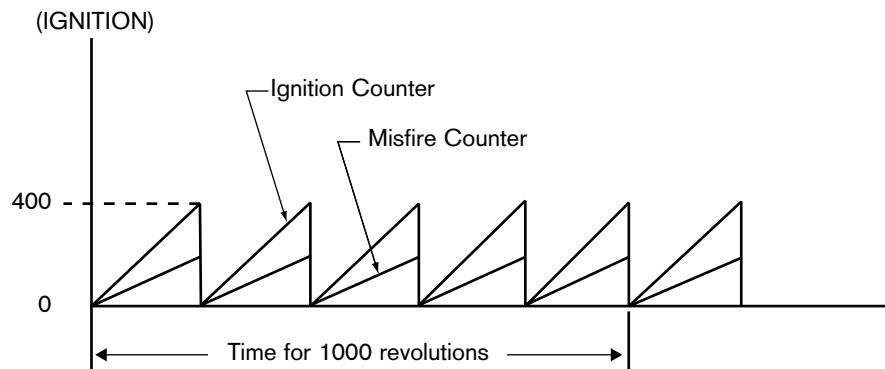


Fig. 4-8

TL874f408

Although the Diagnostic Tester only displays the 200 revolution ignition counter, the ECM monitors five multiples of the 200 counter to total 1000 revolutions for a misfire that would increase emissions above standards. Thus the internal logic uses 200 revolutions for a misfire that would damage the catalytic converter and 1000 revolution counter for an increase in emissions.

### ***Misfire Monitor Screens***

#### **CARB Screens**

```
CONTINUOUS TESTS
ECU:  #10 (Engine)
Number of Tests: 1
```

```
P0304
Cylinder 4 Misfire
Detected
```

#### **Enhanced OBD II Screens**

```
ECU:  #10 (Engine)
Number of DTCs: 1
MIL ON
```

```
P0304
Cylinder 4 Misfire
Detected
```

```
FREEZE FRAME  0
```

```
TROUBLE CODE..... P0304
ENGINE SPD..... 683RPM
COOLANT TEMP..... 190°F
VEHICLE SPD..... 0MPH
CALC LOAD..... 18.0%
FUEL SYS #1..... CL
FUEL SYS #2..... CL
SHORT FT #1..... 0.8%
LONG FT #1..... -5.4%
SHORT FT #2..... -0.7%
LONG FT #2..... 12.5%
```

```
TROUBLE CODE..... P0304
CALC LOAD..... 18%
ENGINE SPD..... 683RPM
COOLANT TEMP..... 190.4°F
INTAKE TEMP..... 125.6°F
CTP SW..... ON
VEHICLE SPD..... 0MPH
SHORT FT #1..... 0.7%
LONG FT #1..... -5.5%
SHORT FT #2..... -0.9%
LONG FT #2..... 12.4%
FUEL SYS #1..... CL
FUEL SYS #2..... CL
FC IDL..... OFF
STARTER SIG..... OFF
A/C SIG..... OFF
PNP SW [NSW]..... ON
ELECT LOAD SIG..... OFF
STOP LIGHT SW..... OFF
ENG RUN TIME..... 80
```

Fig. 4-9

TL874f409

## Misfire DTC(s)

- P0300: Random/ Multiple Cylinder Misfire Detected** Misfiring of random cylinders is detected during any particular 200 or 1000 revolutions (two trip detection logic). This code can be set from multiple cylinders randomly misfiring.
- P0301: Cylinder 1 Misfire Detected** Cylinder 1 misfire detected during any particular 200 or 1000 revolutions which can cause catalyst overheating or deterioration in emissions (two trip detection logic).
- P0302: Cylinder 2 Misfire Detected** Cylinder 2 misfire detected during any particular 200 or 1000 revolutions which can cause catalyst overheating or deterioration in emissions (two trip detection logic).
- P0303: Cylinder 3 Misfire Detected** Cylinder 3 misfire detected during any particular 200 or 1000 revolutions which can cause catalyst overheating or deterioration in emissions (two trip detection logic).
- P0304: Cylinder 4 Misfire Detected** Cylinder 4 misfire detected during any particular 200 or 1000 revolutions which can cause catalyst overheating or deterioration in emissions (two trip detection logic).
- P0305: Cylinder 5 Misfire Detected** Cylinder 5 misfire detected during any particular 200 or 1000 revolutions which can cause catalyst overheating or deterioration in emissions (two trip detection logic).
- P0306: Cylinder 6 Misfire Detected** Cylinder 6 misfire detected during any particular 200 or 1000 revolutions which can cause catalyst overheating or deterioration in emissions (two trip detection logic).
- P0307: Cylinder 7 Misfire Detected** Cylinder 7 misfire detected during any particular 200 or 1000 revolutions which can cause catalyst overheating or deterioration in emissions (two trip detection logic).
- P0308: Cylinder 8 Misfire Detected** Cylinder 8 misfire detected during any particular 200 or 1000 revolutions which can cause catalyst overheating or deterioration in emissions (two trip detection logic).

## Causes of Engine Misfire

- Troubleshooting** This type of diagnosis requires an understanding of engine basics and a working knowledge of the subsystems involved in getting the engine to start and keeping it running. The Basic Inspection and Problem Symptoms chart should be followed to locate the problem.



Fundamentally, there are four conditions that must be satisfied to prevent engine misfire:

- Engine compression - this procedure is found in the beginning of the EM section
- Fuel delivery – this procedure is found in the beginning of the SF section
- Ignition spark - this procedure is found in the beginning of the IN section
- Free breathing intake and exhaust system

Perform a preliminary inspection before any pinpoint troubleshooting takes place. Perform a Diagnostic Circuit Inspection, to narrow down the scope of your investigation. The Diagnostic Circuit Inspection includes:

Malfunction Indicator Lamp (MIL) Check:

- By confirming MIL operation, you eliminate power distribution and a grounded Vc circuit from your investigation

Diagnostic Code Check:

- If codes are stored, they could very possibly be the cause of the misfire condition.

Another important quick check to perform is an inspection of critical data parameters using the Diagnostic Tester. Abnormalities in any of the following signals may have an impact on engine misfire:

- Engine RPM (NE)
- Engine cranking signal (STA)
- Engine Coolant Temperature (ECT/THW)
- Injection duration
- Ignition timing (spark advance)

**NOTE**

Injection duration and ignition spark parameters may display normal values on serial data even when injection pulse or ignition trigger are not present. Use a DVOM or V-BoB oscilloscope to display real circuit voltage signals if pinpoint tests are necessary in these areas.

A specific series of events must occur in several engine control sub-systems for proper combustion. The following will address these sub-systems, their normal function, and specific checks to verify normal operation.

Basic Mechanical Functions - the following must be satisfactory:

- the engine must develop at least 80% of normal compression
- the air/fuel mixture must be in the correct proportion
- the intake and exhaust systems must be free of any abnormal restrictions
- the ignition secondary system must be in good condition without leakage to ground
- engine mechanical components must be in good condition and in the proper relationship to each other. For example, the crankshaft timing pulley must be in the correct location on the crankshaft and correctly timed to the camshaft timing pulleys

It is important to realize that the ratio of air to fuel needs to vary to meet engine operating conditions. A stoichiometric A/F Ratio is needed for efficient catalytic converter operation. During starting, acceleration, and under heavy load, the mixture needs more fuel. During light cruise and decel, less fuel is needed.

Engine symptoms can provide important clues. An extremely rich mixture fouls spark plugs. A mixture too lean typically causes a backfire (usually during cold weather). See Fuel System Diagnosis for more information.

**Primary Ignition Circuit (ESA)** When the engine is running, current flows to the ignition coil primary circuit and to the igniter +B terminal (to power the igniter electronics). As the crankshaft rotates, the crankshaft speed and position signals (NE and G) are sensed at the ECM supplying information necessary to calculate the Ignition Timing Signal (IGT). The ECM sends the IGT signal to the igniter firing the coil.

When the igniter detects the primary coil circuit current rise and fall, the igniter triggers an IGF signal (see Engine Control Systems I). When the ECM does not detect the IGF signal, the ECM goes into fail-safe mode. With no IGF signal, the ECM will store the P1300 series DTCs, depending on model year and number of cylinders affected. There are different fail-safe modes depending on type of ignition system, cylinder displacement and model year. The following is a general summary.

- If there is no IGF signal on engines before 1998 model year, the ECM will enter fuel fail-safe and turn off all the fuel injectors.
- Beginning with the 1998 model year, V-6 and V-8 engines equipped with direct ignition system with integrated ignition coil/igniter (1 ignition coil/igniter per cylinder), the engine will still run without the IGF signal, but the MIL will be ON.
- Beginning with the 2001 model year on 1 ignition coil/igniter per cylinder engines, the ECM fail-safe will turn off the fuel injector if there is no IGF signal for that cylinder and if engine conditions (such as load and temperature) are sufficient to damage the catalytic converter. If the IGF signal returns to normal while the engine is running, the injector may remain off until the next engine start.

**NOTE**

Regardless of the type of IGF fail-safe mode, the IGF DTCs must be diagnosed before attempting to diagnose a fuel system/injection problem. The IGF DTCs (P1300 series) are one trip DTCs.

**Quick checks** using a noid light on one of the injectors confirms if the ECM is pulsing the injector(s).

Check for spark as outlined in the Basic Inspection section of the Repair Manual. IG section of the Repair Manual contains more information on ignition system diagnosis.

**Circuit Inspection** using a DVOM or V-BoB: Inspect the following signals for behavior as indicated above; NE, G, IGT, IGF. Refer to the appropriate Repair Manual circuit inspection charts and to the Engine Control System schematic in the EWD for troubleshooting details.



## WORKSHEET 4-1 Misfire Detection Monitor

Vehicle	Year/Prod. Date	Engine	Transmission
---------	-----------------	--------	--------------

### Worksheet Objectives

Accurately interpret cylinder misfire data.

### Tools and Equipment

- Vehicle
- Vehicle Repair Manual, EWD, & NCF
- Diagnostic Tester
- TIS Access
- Hand Tools, Fender Covers, Floor Mats, and Shop Towels

### Section 1

1. Connect Diagnostic Tester to vehicle.
2. Disconnect a fuel injector connector.
3. Start the engine. Observe the MISFIRE DATA LIST under ENHANCED OBD II.
4. What cylinder is misfiring? \_\_\_\_\_
5. If the MIL is blinking, check CARB OBD, CONTINUOUS TESTS or PENDING CODES.

What DTC is displayed? \_\_\_\_\_

6. What do the following Data List parameters represent?

<b>MAF</b>	
<b>CALC LOAD</b>	
<b>MISFIRE RPM</b>	
<b>IGNITION</b>	

## Section 2

1. Why didn't a DTC set on the first trip? \_\_\_\_\_
2. Shut off the engine, wait 30 seconds, and restart. Wait approximately 3.5 mins. or until the MIL illuminates.
3. Is there a DTC and Freeze Frame? \_\_\_\_\_ Why? \_\_\_\_\_
4. Connect the fuel injector. Check for normal engine operation.