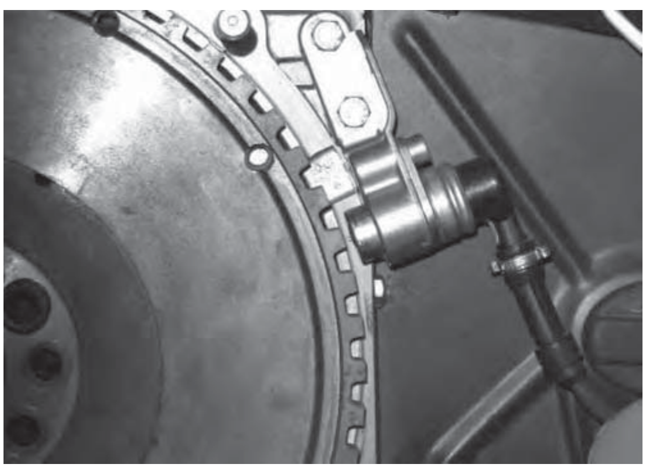
Misfire Monitor

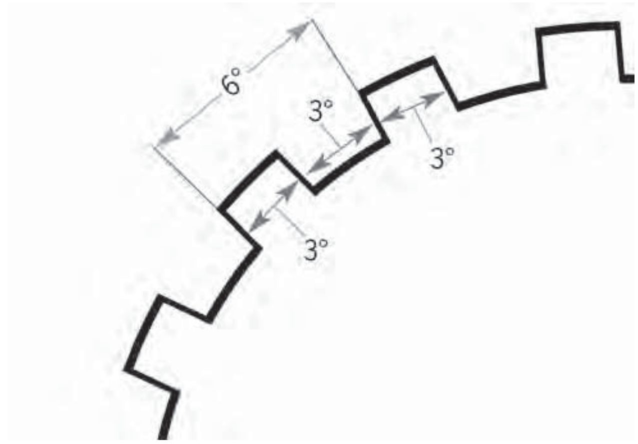
The misfire monitor detects any condition that causes the mixture in the combustion chamber not to ignite. When the hydrocarbons (fuel) in the combustion chamber do not ignite, they pass down the exhaust system into the catalytic converter where they cause overheating that will damage the converter. This is due to the oxidation process that takes place in the converter. Oxidation (burning) of the hydrocarbons is promoted by the platinum and rhodium catalyst. The relatively small amount of hydrocarbons that are normally in the exhaust flow will not overheat the converter. This makes it essential that misfire conditions that cause a rich mixture be detected by the OBD-II system and indicated by the malfunction indicator light.

The misfire monitor detects misfire by monitoring the acceleration of the crankshaft that occurs when a spark plug fires and the combustion process forces the piston down the cylinder, thereby accelerating the crankshaft. The system utilizes the speed and reference sensor that is part of the engine management system to detect the acceleration of the crankshaft caused by the combustion process.



Flywheel With Sensor Ring and Inductive Sensor

As you can see in the illustration the inductive sensor with coil and iron core is positioned to sense the teeth of the sensor ring. The frequency of this signal (number of teeth per second) is directly proportional to crankshaft speed. There is a reference point that is determined by removing two teeth. There would be 60 teeth if the two removed to make the reference signal were in place. This makes each tooth and the void next to it 6 degrees in length, each tooth is 3 degrees in length.



Sensor Ring Tooth Degree Diagram

With the flywheel divided into sixty segments and each segment divided into two 3-degree segments (the high section and the low section), the computer can determine crankshaft movement in less than a degree. Remember the processor is operating with a clock speed of 20 to 30 million cycles per second, so the processor can do a lot of math when the flywheel moves only a portion of a degree.

With a six-cylinder engine, the system divides a crankshaft rotation into three 120-degree segments and looks for acceleration in each segment. These segments are equal to the distance between two ignitions. From this it can determine not only that a cylinder has misfired or not, but identify the cylinder that has misfired. The program that evaluates misfire is complex. It has to be able to distinguish between deceleration caused by rough roads, potholes, shifting, and other non misfire causes, and deceleration caused by misfire.

In case of rough road detection, misfire detection must be deactivated. While driving on an extremely rough road surface, drive train vibrations can cause engine speed variations, which would lead to improper misfire detection. Additionally, engine start leads to unsteady crankshaft revolutions at low RPM that can be improperly diagnosed as a cylinder misfire. Therefore, misfire monitoring is enabled within 1 camshaft revolution after engine speed reaches 150 RPM below operating temperature idle speed.

When the fuel level is in the reserve range, it flags any misfire that occurs with the information that the misfire occurred when the fuel level was in the reserve range.

In order to determine if crankshaft deceleration is occurring, the misfire monitor must establish a baseline of crankshaft motion (what the crankshaft rotation looks like when there is no combustion).

We call this process flywheel adaptation and it has to take place the only time that there is no combustion, during deceleration.

In addition to establishing the flywheel adaptation, the misfire program can tell if there is damage to the sensor ring or flywheel. The misfire monitor is unique in that it is the one monitor that will turn on the malfunction indicator light immediately. All of the other monitors have some amount of time that the fault must be present before the light will be turned on. This is due to the damage that can happen to the catalytic converter if misfire occurs in a high RPM/load range or for too long of a period of time.

With catalyst damaging misfires, it is possible to switch off the injector of the affected cylinder to protect the catalyst (up to a maximum of two cylinders). If more than one cylinder misses, then in addition to the cylinder specific fault a fault for multiple misfire is set.

Mixture Control Monitor

The mixture control monitor utilizes the mixture adaptation system to detect mixture control system malfunctions. When the active mixture control FR (integrator), or the adaptive long-term fuel trim system moves out of a specified range, a fault is detected. If the fault is present for a specified time period and is outside the allowed range for two key cycles, the MIL (malfunction indicator light) is illuminated and a fault is stored. This monitor is part of the mixture control software and is active whenever the engine is running. When a fault is detected, the mixture adaptation system locks and makes no further corrections. The mixture control is already closely monitoring injection time and long term fuel trim, so modifying the software to detect when the fuel trim system has developed a malfunction does not require large changes to the system.

The mixture control monitor has a function that detects a low fuel level in the fuel tank. An empty fuel tank would cause the mixture adaptation system to appear defective and set a fault code. The monitoring time is extended in this case to prevent an incorrect detection of a mixture control fault.

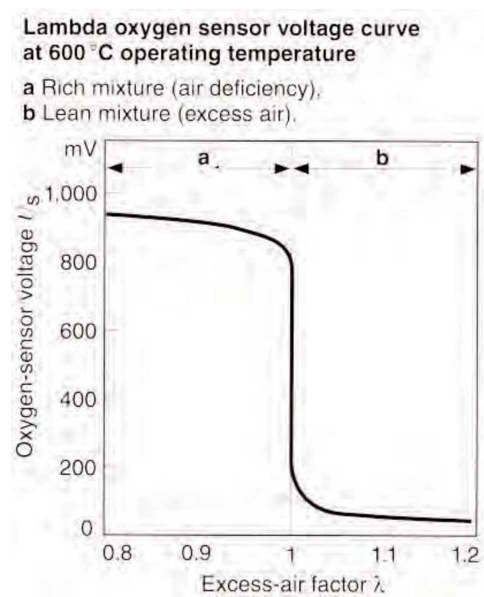
All of the monitors we have discussed so far are continuous monitors that operate all of the time in the background. They run from the time that the engine is started until the vehicle is shut down. These monitors are for the most part software modifications and require little or no additional hardware be added to the vehicle.

Oxygen Sensors

Before we continue with the Monitors run once per key cycle, we need to review oxygen sensor operation and theory. We need to do this because oxygen sensors are utilized by most of the once per key cycle monitors to check the function of the system that is monitored.

Narrow Band Oxygen Sensors (Lambda Sensor)

Narrow band oxygen sensors generate a voltage when a difference in oxygen concentration exist across them. This voltage is directly proportional to air fuel mixture as we can see in the Sensor Voltage vs. Lambda graph.



Sensor Voltage vs. Lambda

The oxygen sensor operates on the principal of a galvanic oxygen concentration cell with a solid-state electrolyte; this means that it is a lot like a battery.