WELLS Counter Point

Volume 9 Issue 2, Spring 2005

THE ELECTRONIC, DIAGNOSTIC AND DRIVEABILITY RESOURCE.

Misfire Diagnosis Case Study

You can expect to see many vehicles with misfire-related DTCs, in need of repair. This case study will help you get a jump on fixing them.

This issue's case study was contributed by John Thornton.

A main function of OBD II is to make sure that a vehicle's emissions stay within established limits. One of the ways this is accomplished is by keeping a close, protective eye on the vehicle's catalytic converter. If the converter becomes damaged, it won't be able to properly process the engine's exhaust gasses, and emissions will consequently increase to an unacceptable level. OBD II will do everything it can to protect the converter and prevent the increase in emissions.

Misfire can easily damage a converter, as the incomplete combustion sends unburned fuel and oxygen downstream to the converter. Heat already present inside the converter can cause the previously unburned fuel to ignite, increasing temperatures to the point where converter damage is inevitable.

To keep this from happening, OBD II closely monitors the engine for signs of misfire. Misfire is detected by observing very slight variations in engine rpm. Each time a cylinder misfires, the engine slows for a brief moment. OBD II observes these misfire events, using the crank position sensor. When too many misfires occur in a set period of time, OBD II flags a misfire diagnostic trouble code (DTC). The sophistication of OBD II also allows it to identify which cylinder or cylinders are misfiring and assign a cylinder-specific DTC in response. OBD II systems from all manufacturers also have a general misfire DTC (P0300) to indicate that an unacceptable level of random or multiple cylinder misfire has occurred, without assigning the blame to a specific cylinder.

Misfire DTCs have been particularly troublesome for many technicians to diagnose and repair. There are many possible causes for cylinder misfire. However OBD II does not assign a cause when it observes a misfire. It's up to the technician to determine if the misfire was due to an ignition system fault, a lean fuel mixture, a rich fuel mixture, low fuel pressure, faulty injectors or possibly a bump in the road. Proper troubleshooting techniques are necessary to quickly eliminate the factors that *did not* cause the misfire, and zero in on those that are more likely to be responsible. To illustrate proper misfire diagnostic techniques, we'll use an actual vehicle case study.

Our case study concerns a 2003 Chevy pickup truck with a 6.0L engine (VIN U) and a coil-near-plug ignition system. The customer complained of a misfire and surging. Diagnostic trouble codes (DTCs) P0300, P0351 and P0357 were retrieved. All are misfire-related.

With the engine running, a scan tool was then used to monitor the misfire counters. Misfires for cylinder #1 immediately started accumulating. A scope was attached to the #1 plug wire and the secondary ignition pattern was consistent with the misfire. The signal dropped to 0 volt when the engine missed. The #1 and #7 coils were replaced due to the miss and because cylinder #7 had also triggered a misfire code.

The engine ran well after the parts were installed, but a recheck with the scan tool revealed DTCs P0351 and P0357 had returned. Power and ground to both coils was verified, as well as the signal wires to the computer for these coils. The tech working on the vehicle theorized that one of the original coils might have damaged a driver in the PCM, or done some other internal damage. A new PCM was installed. The engine ran well with the new PCM, but both misfire DTCs had returned by the next day.

A scope was used to monitor the trigger signals from the PCM to the #1 and #7 coils with the engine running. Once captured, they were compared to the six known-good trigger signals from the PCM to the other coils. The trigger signals produce a simple square wave when viewed on a scope. The six known-good trigger signals had a "high" voltage of 4.25 volts at the top of the square wave. The #1 and #7 trigger signals had a "high" voltage of only 4.0 volts.

The P0351 and P0357 DTCs appeared to be legitimate. There was a 0.25 volt difference between the good trigger signals and the two suspect trigger signals. Could the two new replacement coil/module assemblies be excessively loading the trigger signals supplied by the PCM?

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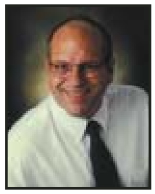
Fine Tuning



Fine Tuning questions are answered by Mark Hicks, Technical Services Manager. Please send your questions to: Mark Hicks c/o ***Wells Manufacturing Corp., P.O. Box 70, Fond du Lac, WI 54936-0070*** *or e-mail him at* ***technical@wellsmfgcorp.com.*** *We'll send you a very nice Wells golf shirt if your question is published. So please include your shirt size with your question.*

Q: I am working on a 2000 Cadillac Escalade with a 5.7L engine. The engine has a bad hesitation and at times will cut out and almost stall. It is setting a MAP sensor code. I have changed the MAP sensor, PCM, spark plugs, cap and rotor, but I am still only getting a 1.6 volt reference at the MAP sensor. Any idea what's happening? Could there be a bad ground on the circuit?

Jerry Parsons
Jim's Auto and Tire
Birmingham, AL

A: Jerry, as with most electrical problems, the first step in your diagnosis is to look at a wiring diagram. In fact, that is the first thing I did after receiving your letter. While doing so I noticed the five volt reference from the PCM to the MAP sensor also feeds two other components – the fuel tank pressure sensor and the EGR valve.

It's a common misconception that a defect in the grounding portion of the circuit may cause low voltage on the supply side of the circuit. If the ground portion of this circuit were open or even shorted, the supply voltage would remain constant, unless it was shorted to the supply circuit itself. The odds of this happening are very long.

It is more likely you have a supply wire shorted to ground. Perhaps the protective plastic coating has chafed through or a sensor in the circuit has internally shorted. The short is drawing the available voltage away from the other two sensors. My suggestion is to unplug the sensors in question, then check the voltage supply to each one. If everything checks out, monitor the available voltage to the MAP sensor while plugging the other two sensors back in one at a time. When the supply voltage to the MAP sensor drops, you have found the defective component.

Results: While performing the test above, the supply voltage dropped back to 1.6 volts as soon as the fuel tank pressure (FTP) sensor was plugged in. The FTP sensor was replaced and all is well again.

In the last ***Counter Point***, you may recall one of our readers was having difficulty with a Toyota Tacoma with an audible spark knock upon acceleration. Some of my comrades told me they felt this problem is too complicated. They were doubtful that we would receive any correct replies. I have news for them: we received many answers to the diagnostic question, and nearly all of them were correct. I believe some of the sharpest techs in the industry read *Counter Point*, and your response reinforces that opinion.

Yes, this Tacoma was a bit of a headache until we looked at the fundamentals of how the system functions. Spark knock can be caused by a variety of things, including low octane fuel, over-advanced ignition timing, too much compression, a defective EGR valve and always by too much heat in the combustion process. As the reader stated, adding octane booster to the fuel would eliminate the spark knock. He also stated that the knock would occur upon normal acceleration and the vehicle would stumble and hesitate.

What could cause high combustion chamber temperatures and a hesitation? Our first thought was a lean fuel mixture. On this vehicle, the primary component influencing the PCM's fuel mixture decisions is the mass air flow sensor (MAF). The first step in checking a MAF system is to look for cracks in the intake duct that could let in any unmetered air. No cracks were found.

We then found a specification for TPS voltage versus MAF sensor voltage. At a TPS voltage of .63 volts, the MAF voltage should be nearly equal to 1.06 volts. Ours was reading 1.44 volts at the MAF. Is this close enough to the specification?

We then removed the MAF to inspect the hot wire and found that it was completely contaminated. After installing a new MAF, we again took a reading of the MAF output. With .63 volt at the TPS, the MAF read 1.35 volts. Still out of specifications, but the vehicle ran great. The hesitation was gone and so was the spark knock.

Your scan tool can be used to conduct a more accurate check of MAF accuracy. As a rule of thumb, the MAF's key on, engine off barometric pressure reading should not be below 150 hz or less than 29.92 inches of mercury (in-Hg), depending upon elevation and vehicle type. If the reading is in kPa instead of inches of mercury, 103 kPa is the approximate barometric reading at sea level. For every additional 100 feet in altitude, barometric pressure drops .10 in-Hg. For the best results in this type of testing, you need to become familiar with normal barometric pressure readings for your area. Look at the reading on your scan tool using different vehicles during various weather conditions to improve your diagnostic accuracy.

The first correct answer was submitted by:
Catarino Torrescruz
Auto Diagnostics, Inc.
West Allis, WI

Second and third were submitted by:
James Wilkes
Central Georgia Technical College
Milledgeville, GA

Geoff Emmett
Auto Care by Kenely
Orangevale, CA

Diagnose The Problem Win A Shirt

Q: I am working on a 2001 GMC truck with a 4.3L engine (VIN W). It has set codes P0300 (Random Misfire), P0420 (Bank 1 Catalyst Low Efficiency) and P0430 (Bank 2 Catalyst Low Efficiency). I have already replaced the catalytic converters and the front O_2 sensors, as well as the spark plugs, ignition wires, distributor cap and rotor. The P0300 is still being set. I scoped the ignition system and it looks great. The fuel trim readings are between -2% and 0%. The fuel pressure holds a steady 61 psi while the engine is running but drops to about 30 psi with the engine off.

Could this drop in fuel pressure cause the misfire problem? I suspect an internal engine problem, like a sticking valve, carbon buildup or the camshaft lobes have flattened. How can I verify that the engine is mechanically sound without investing a lot of time? And if the engine is in good shape, what else could be wrong and how do I test it?

Kevin Messer
Downtown Auto Repair
Los Angeles, CA

If you have the answer, we'd like to hear from you. Use the following contact information:

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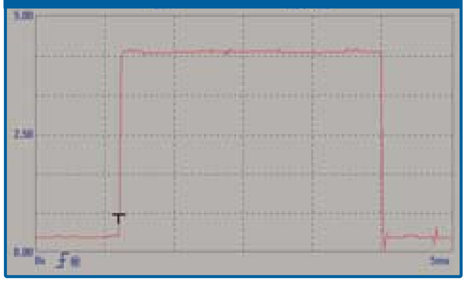
Misfire Diagnosis Case Study

The second step in the diagnosis was to scope the #1 and #7 trigger signals with the harness connectors removed from the coil/module assemblies. This test would eliminate the coils as a possible source of excessive circuit loading. The expected voltage signal is a 0-5 volt square wave. To establish a baseline, the test was first used on the known-good cylinder coils for trigger signals. The six known-good trigger signals had a “high” voltage of 5.0 volts. Both the #1 and #7 trigger signals had a “high” voltage of only 4.75 volts.

A backprobe allows you to tap into the wiring between the PCM and the coil, without causing damage. Brace the alligator clip to avoid accidental shorts.

Even when open-circuited from the coil/module assemblies, the suspect trigger signals were still 0.25 volt lower than the known-good trigger signals. Either something else in the circuit was loading down these two trigger signals or there was a PCM issue. Since the PCM was already replaced, chances were good there was something else in the circuit causing the problem.

This screen capture reveals a normal square wave control signal from the PCM to the coil primary. Our defective signal was only .25 volt below normal.



The third step in the diagnosis was to cut (open circuit) the #1 trigger wire somewhere close to the PCM. An alligator clip also could be used for this portion of the test. The idea was to remove any external load from the trigger circuit. The #1 trigger signal was then measured and a good 0–5 volt signal appeared. The PCM was capable of producing a no-load 0–5 volt trigger signal for the #1 cylinder, so the PCM received a clean bill of health. An external load had to be pulling down the #1 trigger circuit by the measured difference of 0.25 volts.

The fourth step was to measure resistance between the open #1 trigger wire and ground. Resistance was observed. Resistance was also observed between the #7 trigger wire (disconnected PCM connector) and ground. Resistance was also measured between the #1 and #7 trigger wires. The resistance between the #1 and #7 trigger wires, and between both wires and ground, was due to moisture in the PCM harness. Moisture had entered the PCM harness, attacked the copper wire and created a high resistance. This was enough to load the circuit by 0.25 volts and the difference was enough to flag the P0351 and P0357. After a wire and harness repair, this vehicle was fixed.

You'll need to follow a focused approach (like the one documented here), to provide an accurate diagnosis, while increasing your shop's efficiency and billable hours. **WELLS**

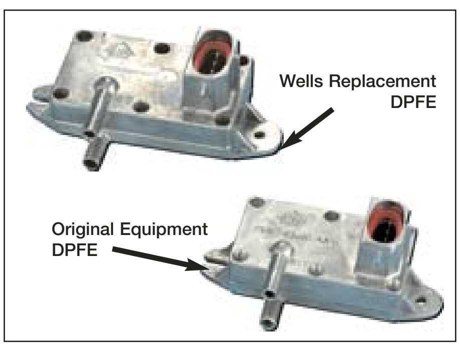
This case study was provided to *Counter Point* by John Thornton. John is a nationally-known and respected driveability instructor who also operates an independent repair shop. He is also a regular contributor to several automotive trade magazines. *Counter Point* looks forward to future contributions from John, as well as other driveability instructors. Thanks, John for this great case study.

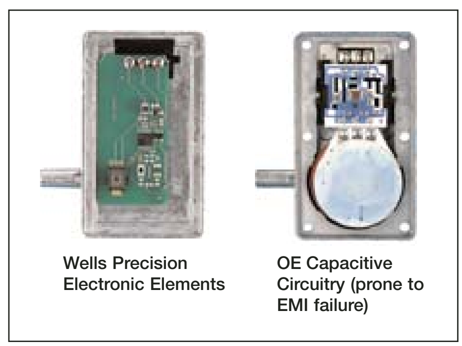
Quality Points

DPFE Sensors

For a sensor that's been around for at least 15 years, very little is known about the DPFE sensor and its function. DPFE is an acronym for *delta pressure feedback EGR*. It's also called an EGR pressure sensor by some manufacturers. Delta pressure is the *difference* in pressure, over time, or from one point to another. The DPFE sensor monitors the differential pressure drop across a sharp-edged orifice in the EGR flow and reports directly to the PCM. The PCM controls EGR flow based on signals it receives from the DPFE sensor.

The original equipment (OE) DPFE sensor functions by exposing a pressure sensor to the exhaust gasses. These gasses are harmful to the sensor's gasket and diaphragm, which can result in premature sensor failure. The OE sensor is also vulnerable to electromagnetic interference (EMI), due to its capacitive circuitry.





The first step in the Wells solution to these shortcomings is a precision electronic element that is highly resistant to EMI. Next, we incorporate a small but very accurate pressure sensor. To visualize how it works, imagine a bass drum. EGR pressure presses on the outside of the drum skin. The pressure sensor on the opposite side of the drum skin very accurately reads the changes in EGR pressure. The outside of the skin is exposed to exhaust gases, but the Wells sensor is treated with a special silicone coating that will virtually never deteriorate. The differences in the internal DPFE technology are shown here and on the “Editor's Notes” page at www.wellsmfgcorp.com. These improvements lead to greater sensor accuracy and longevity.

Wells is the source when you want to repair the problem the first time. **WELLS**

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Hot off the Wire

National Automotive Service Professionals Week

The countdown has begun, and six states have already issued proclamations for National Automotive Service Professionals Week in June. The National Institute for Automotive Service Excellence (ASE) declared June 11-17, 2005 as National Automotive Service Professionals Week based on the success of last year's Automotive Service Professionals Day.

In 2001, ASE established National Automotive Service Professionals Day on June 12th to honor the commitment and dedication of automotive, truck and collision technicians, along with parts specialists and other support professionals who serve the motoring public. For 2005, ASE has expanded this recognition to a full week.

"Twenty-seven states issued proclamations honoring National Automotive Service Professionals Day in 2004," said Trish Serratore, ASE Group VP, Industry Relations. "We will push to have all fifty states recognize the outstanding work done by automotive professionals all across the nation in 2005."

"We established National Automotive Service Professionals Week to recognize the men and women who service and maintain the highly complex vehicles upon which we depend so much for our day-to-day transportation," said Ron Weiner, ASE President.

Wells Manufacturing Corp. encourages professionalism through technician certification.

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