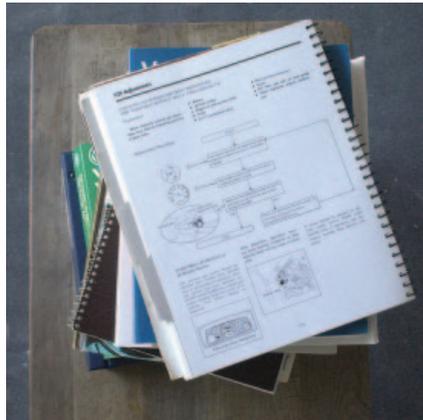


Beyond the Diagnostic Trouble Tree

Service information is valuable, but not infallible. It helps to recognize the difference.



Certainly you've been reminded many times before, both here and elsewhere, to always consult your service information sources before attempting a vehicle diagnosis. Nobody can dispute the importance and necessity of accurate service information. But did you ever stop to realize that the very same service information that you rely on can also lead you astray? Yes, it's true, and here's why.

Most service information, and especially diagnostic trouble trees dealing with engine driveability problems, is constructed under the assumption that the basic engine mechanical functions (engine compression, valve timing, spark timing, etc.) are within normal specifications. This is usually correct when the vehicle was relatively new; but it may no longer be true several years later, when the vehicle is parked in your service bay.

Perhaps this has happened to you in the past. You've followed the diagnostic trouble tree, carefully performing each test as instructed.

The results of those tests have led you to the end of the trouble tree at the bottom of the page, where you're confronted with the daunting instruction to "Replace the PCM."

Is the PCM really bad? You're not really confident that it is, so you repeat all of the trouble tree tests, exactly as instructed. The results are the same, so you take the next step and order a replacement PCM. Following a brief road test, the Check Engine light comes back on and the PCM stores the same diagnostic trouble code (DTC). What now? Do you try to return the PCM as 'defective'? Or do you try to convince yourself (and your customer) that the vehicle really 'needed' the PCM? Remember, the original problem still hasn't been repaired, and you've just blown the customer's auto repair budget.

Situations like this crop up too frequently. That's why we've decided to investigate just such a problem here. The owner of a 1997 Olds Aurora with a 4.0L engine complained that his Check Engine light (CEL) was on. There were no other driveability issues. After attaching a scan tool, it was determined that DTC P0340 (Cam Sensor Circuit Condition) was stored in the PCM's memory.

Like most DTC diagnostic work, the first step is to go to your reference material and follow the diagnostic tree for DTC P0340. The diagnostic tree asks if you have

performed a powertrain OBD system check. This consists of checking the scan tool, battery and starter integrity. If the scan tool and starting system are working properly, you are returned to the DTC diagnostic tree, where you are taken through what seems to be a complete diagnosis of the system. You are asked to use your DVOM to check resistances and perform several voltage drop tests. If no problems are found during any of these tests, the final step is to, you guessed it, check the connections and/or replace the PCM. Since this is a relatively new vehicle, the PCM must also be flashed before you can install it.

There's one large hitch: The PCM had already been replaced twice before by other shops. Also, the cam sensor and ignition control module both had been replaced several times. In fact, no fewer than three shops had performed diagnostic work on this vehicle and it still wasn't fixed. The inaccurate diagnosis can't be entirely blamed on the technicians who worked on this vehicle. After all, they were following a road map that led them to a dead end.

A vehicle's onboard computer is programmed to function correctly on a mechanically sound engine. When the integrity of the engine weakens, the PCM does not always recognize it. Yes, if the compression drops far enough to cause a misfire, the PCM will pick this up and illuminate the Check Engine light. But when the timing chain or belt stretches or compression drops slightly, if it's not enough to cause a misfire, the PCM has no way to completely understand the failure.

All of the problems on the Aurora were caused by things the engine management system was not equipped to recognize. The timing chain had stretched and the cam and crankshaft gears were off by about one tooth. This was just enough to throw them out of synchronization. The PCM knew there was something wrong with the signals it was receiving from the cam sensor, but it wasn't sophisticated enough to figure out why.

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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 Wells shirt if your question is published. So please include your shirt size with your question.

Q: I am working on a 1999 Chevrolet Silverado that has approximately 50,000 miles on it. The owner has no driveability concerns, but the malfunction indicator light (MIL) keeps coming on. My scanner showed a diagnostic trouble code (DTC) P0440, indicating an EVAP system problem. I cleared the code, but the customer returned with the same DTC in memory. I normally work only on Asian vehicles, and got myself involved in this because it belongs to a friend. The electrical wiring and hoses look okay. Are there any pattern failures associated with this DTC? Do I need to purchase a special GM scan tool to complete the repair?

Paul Kroll
Reliant Auto Repair
Boston, MA

A: Paul, one of the most common OBD II DTCs is a P0440. In fact, we recently were able to help a customer with a complaint very similar to yours. Regarding pattern failures: vent solenoid failures are common on GM vehicles. However, it would be a gamble to recommend replacing the vent solenoid on your customer's vehicle without first conducting a complete diagnosis. In the next *Counter Point*, we will examine EVAP systems more closely and provide several tips to use when diagnosing P0440 codes. We will also help you decide whether you need a smoke machine to diagnose EVAP problems.

Results: Paul decided to roll the dice. He changed the vent solenoid and the MIL has not come back on.

In the last *Counter Point*, we were working on a 1996 Mazda Millenia with a 2.5L engine that was intermittently setting a code P0400. So far, we have checked voltage from the integrated EGR valve position sensor. At idle, it was near 1 volt and jumped to 4 volts upon acceleration. These are normal readings indicating full EGR pintle movement.

I believed that from the 1996 model year onward, all vehicles sold in the United States were required to confirm EGR flow to remain in compliance with OBD II regulations. This is not necessarily true. Some earlier import vehicles and some later domestic vehicles are not required to verify EGR flow. This 1996 Mazda Millenia *does* verify EGR by confirming MAP change, and it's a good thing it does. The P0400 was appearing because the PCM did not detect a change in the MAP sensor reading with EGR pintle movement.

Plugged EGR passages are a recurring problem on these vehicles. The normal procedure is to open the EGR and listen for a drop in RPM.

Hot off the Wire

New Counter Point Delivery Options

How would you like to receive an early *Counter Point* edition? Wells Manufacturing Corp. now offers exclusive *Counter Point* access to its subscribers, via the Internet. Participants in this new program will download the latest issue of *Counter Point* in portable document format (PDF), before printed copies are mailed to other subscribers.

The *Counter Point* Internet edition won't be limited to a four-page newsletter format. This will allow us to offer content not included in the printed *Counter Point*. Other features may be added, based on feedback from you.

If you sign up for the *Counter Point* Internet edition, you will no longer receive a printed copy by mail. If you prefer to continue receiving the newsletter by mail, no further action is required.

Go to the Wells website at www.wellsmfgcorp.com, then click on the "Diagnostics" button for further information on how to register. You'll need the identification number printed on the mailing label of this *Counter Point* issue.

National Catalog Managers Award

Wells Manufacturing Corp. recently received the President's Award for Electronic Data Excellence at the National Catalog Managers Association (NCMA) annual conference, held in Orlando, Florida. The award was presented to Wells Catalog Manager Dave Teifke by NCMA President Roger Gerite.

Wells Manufacturing Corp. has been a NCMA member since 1981 and received its first President's Award for Electronic Data Excellence in 2003 (*Counter Point* Volume 7 Issue 3, July 2003). Prior to that, Wells received nine President's Awards for Catalog Excellence for paper catalogs (*Counter Point* Volume 4 Issue 4, October 2000). We have earned more NCMA awards than any other ignition/emissions parts manufacturer.

The President's Award for Electronic Data Excellence is given to the top companies supplying electronic data that is used in the electronic catalogs for AutoZone, Activant (formerly CCI/Triad), DST MacDonald and Wrenchhead. Judging criteria include, but are not limited to:

- Information format,

- Compliance with Automotive Aftermarket Industry Association (AAIA) standards, established by the NCMA,
- Timeliness of data submission,
- Data accuracy,
- Ease of cross platform data transmission,
- Supersession and obsolescence information.



As this *Counter Point* issue was going to press, we were saddened by the unexpected passing of Dave Teifke, on June 17, 2004. The many NCMA awards Wells received were due in large part to Dave's efforts. We will greatly miss the man, as well as the expertise he brought to Wells. We extend our heartfelt condolences to his family. **WELLS**

If there is no drop or if only a slight drop is heard, it's assumed the EGR passage is restricted. If the engine dies during the test, it's normally considered to indicate an unrestricted passage.

This is not the case with this vehicle and several others out there. The correct procedure for testing the EGR is as follows: Connect a vacuum gauge to the intake manifold and idle the engine. The vacuum reading should be approximately 20 inches at this time, depending on engine integrity and elevation. Raise the RPM to around 2500 and take note of the vacuum reading before activating the EGR. The vacuum reading should drop 6 to 8 inches when the EGR is activated. If there is no vacuum drop or it is less than spec, it means there is a restriction in the EGR passage that must be cleared out.

The passage for EGR flow on this vehicle ends under the throttle body. To properly clear the ports, remove the throttle body and EGR valve. After removing the throttle body, look for two EGR port openings on the floor of the intake manifold (the most common area for carbon buildup). By removing the EGR valve, most of the dislodged carbon can be forced out through the EGR cavity.

Results: Since Ron cleared the EGR ports, P0400 has not returned.

This quarter's winners are:

Ray Gribble
AutoZone #2034
Warrenton, VA

Doug Kreil
AV Auto Diagnostic & Smog
Lancaster, CA

Diagnose The Problem Win A Shirt

A 2002 Toyota Camry with California emissions was referred to my shop by a neighboring body shop. After making the exterior repairs, the body shop technician noticed the MIL was illuminated. He retrieved the codes (P0103 and P0133), then found the O₂ sensor had been broken in the accident. The O₂ sensor has been replaced three times since then, with the same result. The MIL is still illuminated and P0103 and P0133 are still stored in the PCM's memory.

All tests *still* indicate the O₂ sensor needs to be replaced. But how could three O₂ sensors be defective? I've checked the rest of the system and everything seems to be in good shape. Any ideas?

Dave Courtney
Courtney Auto Repair
Reedsport, OR **WELLS**

continued from page 1

Beyond the Diagnostic Trouble Tree

We're not suggesting that you tear all the diagnostic trees out of your reference material. Just remember that an internal combustion engine must be diagnosed in its entirety. When the diagnostic tree fails to direct you to the source of the problem, take the blinders off and think about what could be wrong if the engine had no management system. *Don't miss the forest for the trouble trees.*

Ford Distributor Ignition Diagnosis - Part Two

Part One of this article (*Counter Point* Spring, 2004) ended with a bit of a cliffhanger. We apologize for leaving it that way, but we couldn't fit the entire story into a single issue. Just like any good mystery that keeps you in suspense until the stunning conclusion, some important clues were included in Part One. We didn't even bother to hide them. In fact, they were out in plain sight where a sharp diagnostic detective could spot them. Let's pick up where we left off last time.

At the beginning of this diagnosis, we mentioned that the PIP sensor had two PIP terminals — one for the PCM and the other for the ICM. Were both the PCM and ICM receiving the same PIP signal? We reattached the GMM to both PIP terminals, then watched the signals when the engine would not start. The PIP sensor produces a digital square wave signal, meaning it's either producing a voltage or it's not. The ICM and PCM look at how fast the PIP turns ON and OFF to determine engine speed. They then make engine management decisions, including timing. In order to determine when the PIP signal is ON, the signal voltage must exceed a set threshold. If the signal voltage is below the threshold, the computer receiving it will completely ignore it.

The spec you won't find in any service manual is the threshold voltage the ICM and PCM must see before each will recognize the PIP signal. We used a signal generator to simulate the PIP signal, then adjusted the output voltage to find out how much was required before the ICM and PCM would recognize the signal. It turns out it's two different values. The PCM needed to see a PIP square wave with a peak amplitude of **6.5** volts or more, while the ICM only needed **5.75** volts to recognize the signal.

This is where the clue from Part One comes in. Refer to the scope patterns shown in Figure 1 on this page. This is the same illustration we showed you the first time around, also identified as Figure 1. Notice that the SPOUT signal (bottom pattern) starts out okay, but then begins to drop out. Now take a look at

when the dropout starts. The dropout occurs immediately after the PIP signal (upper pattern) drops below the required threshold voltage.

The intermittent no-start was caused by a failing PIP sensor that was only able to manage a peak amplitude of about 6.0 volts after a hot soak. This was still enough to satisfy the ICM, but not the PCM. When the PIP sensor's peak signal voltage dropped below the 6.5 volt threshold, the PCM couldn't recognize it. The best the PCM could do was to produce the weak SPOUT signal we had observed during the Mustang's no-start episodes.

Figure 1: This screen capture shows PIP (top) and SPOUT (bottom) during no-start cranking. SPOUT began dropping out as soon as PIP dropped below the threshold voltage.



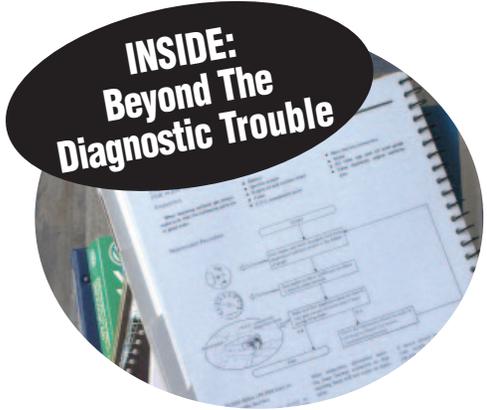
Things were back to normal after a new PIP sensor was installed. The new sensor produced a healthy square wave with a peak amplitude of over 9.0 volts — more than enough to satisfy the minimum threshold requirement of both the ICM and the PCM. And the sensor was completely unaffected by changes in temperature and hot soaks.

It might be easy to say, "Why didn't you just replace the PIP sensor in the first place?" It may seem obvious at the end of the story to recognize that it was the source of the problem all along, but it wasn't that simple in the beginning. We had a PIP signal at all times, although its voltage level was not always consistent. Who knew there were times when it wasn't strong enough to satisfy the minimum threshold voltage required by the PCM?

The point of all this is to remind you to test everything and trust nothing until you are absolutely certain that the results are right and valid. Never assume that a sensor is good, just because it appears to be producing a signal. Refer to printed specifications whenever possible. When no specs are available, start collecting "known good" specs of your own. Buy yourself a notebook and write things down. Keep your notes on a computer if that's more to your liking. Learn from your mistakes, as we have (write them down), and use your experiences to keep from making the same mistakes twice. You can bet we'll never be misled by another sickly PIP sensor that can't stand the heat. **WELLS**

WELLS

WELLS MANUFACTURING CORP.
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Quality Points

Selective Soldering System

Wells Manufacturing Corp. has accomplished another first by designing, fabricating and programming a new Selective Soldering System. The system solders precise printed circuit board (PCB) areas, in a blink of an eye.

The first step in this automated process is the application of flux material to the PCB. This is accomplished with a two-axis Cartesian system, which sprays the flux over specific solder joints.

Next, a Scara robot picks and places the PCBs onto an index table, where they are preheated in preparation for soldering. After passing through the four separate stations, the PCBs are ready for the soldering process. Separate stations ensure uniform heat distribution across the entire PCB — critical to the soldering process. A custom nozzle allows six specific joints to be soldered in unison.

In the final step, the PCBs are returned to the conveyer belt to continue the remainder of the assembly process. The entire soldering operation takes approximately five seconds to complete.



Senior Product Engineer Steven Sauvey prepares the Wells selective soldering system for operation.

Wells again leads the way with faster and more progressive technology. **WELLS**

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