WELLS Counter Point

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THE ELECTRONIC, DIAGNOSTIC AND DRIVEABILITY RESOURCE.

Scan Tool Diagnostics

In spite of its limitations, scan tool data can be an effective aid to diagnosis, as long as it is used properly.

The Fall 2005 ***Counter Point*** included a case study where the information provided by the powertrain control module (PCM) lead a diagnosis astray. This can happen because the information the PCM supplies to your scan tool is *inferred* or *second-hand* information. In other words, the PCM takes in sensor data, then interprets that information before passing it on to your scan tool.

It is also possible for a late model vehicle to have a driveability or other running problem before the PCM detects it, and long before it illuminates the malfunction indicator lamp (MIL). How many times have you found a problem in a system that was missed by the PCM? Or perhaps the PCM registered a DTC that directed you to a sensor failure when an entirely different part of the system was the real culprit.

The PCM assumes the engine has normal compression in all cylinders. If compression is low in one or more cylinders, this assumption will be incorrect. On OBD II-compliant vehicles, the PCM may attempt to compensate for mechanical deficiencies by altering its commands to the fuel injectors, the ignition system and other components. This may mask the underlying mechanical problem for a while, until it's gone beyond the range of compensation that's available to the PCM. At this point, a DTC should store and the PCM will default to learned values.

Unless it receives sensor information to the contrary, the PCM also assumes the vehicle has a properly functioning cooling system, a free-flowing exhaust system, correct fuel system operation, suitable secondary ignition system operation and mechanical emissions control systems in working order, to name a few. That's an awful lot of assumptions.

The PCM also requires a reliable power supply and good system grounds, and assumes it has them. Connections may be corroded or loose, which will cause incorrect information to be fed to the PCM — information it will then also *assume* to be correct.

Do these built-in limitations mean you should throw away your scanner and start testing every system and component by hand, with test leads and a DMM or lab scope? No, but it's important to remain aware of where scanner information comes from and how it got there.

In other words, take what the scanner gives you and use that information to its greatest advantage. Used properly, a scanner can be used for the critical *first steps* in a successful diagnosis.

OBD II Diagnostic Strategies

Let's trace the first steps of an OBD II fault diagnosis. Even if the MIL is not on, plug your scan tool into the diagnostic link connector and check for pending DTCs. For some DTCs, the PCM must see evidence of a problem on two consecutive trips before it will turn on the MIL and store a DTC. But the first time the problem occurs, the PCM will set a pending code. So even though the MIL isn't on at this time, you may be able to retrieve information about a problem in the making. On some vehicles, the PCM will also capture freeze frame data for the pending DTC. This will help you to determine the conditions under which the problem is most likely to occur. This information can then be used to attempt to force a recurrence during a subsequent road test.

If there are no pending codes, look at the other information reported to the scan tool by the PCM. It will help your diagnosis if you select only the parameter identification (PID) data that is related to the problem at hand. This lets your scan tool update the PID data faster. The following PIDs will yield the most useful information and will relate to many engine management problems. Start with them first, before widening your search.

Short and long term fuel trim data (STFT and LTFT) provide a window into the operation of the engine management system and allow us to observe the fuel adaptive strategy. STFT reflects the PCM's efforts to keep the engine hovering around the best overall air/fuel ratio.

STFT and LTFT are expressed as a percentage, with the ideal range being within ±5%. Positive fuel trim percentages indicate the PCM is

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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 enjoy reading your articles. Here's a puzzler for you. I have a customer with a 1999 Jeep Cherokee that has a 4.0 engine in it. He has a trouble code P0123, which means a high voltage signal from the TPS. The vehicle has already been to the dealership. They replaced the PCM to correct the problem, but it was no help.

I have connected my scan tool and the voltage does read 5 volts for the TPS, regardless of the position the TPS happens to be in. I get about one volt when I read the voltage at the TPS signal pin with a DVOM, which is normal.

I asked the customer if anything unusual happened before this problem originally occurred. He said he couldn't remember anything, except that he had spilled some water on the steering wheel that same day because he had to make an unexpected quick stop.

I took the cover off the steering column and disconnected the clock spring for the air bag. The high signal from the TPS returned to normal. I replaced the clock spring and everything now works fine. No one here knows how this could happen. How could the clock spring set a TPS code? Do you have any ideas?

Gordon Pocock
North Attleboro, MA

A: Gordon, what a confounding problem you have! I have done some research on this subject and here is what I found. On JTEC (Jeep Truck Powertrain Control Module System) computers, the cruise control input and TPS signals are multiplexed in the computer. This means their signals run simultaneous through the same circuit.

The clock spring is used to maintain a continuous electrical circuit to the airbag and several other components that rotate on the steering wheel. These rotating components include the driver's side airbag, horn switch, vehicle speed control and possibly the radio controls. When the clock spring becomes electrically shorted, it allows the horn relay to bleed 12 volts into the cruise control circuit, which is connected to the PCM.

The cruise control and TPS on this vehicle normally operate at 5 volts. When the PCM receives this added voltage, it becomes confused and thinks there is 5 volts (max voltage) on both the cruise and TPS lines. This is why you see it on your scan tool, but not when you isolation test the component.

In the last *Counter Point*, we were working on a 2001 Chevy Impala with a 3.8L engine. The problems were a loss of power, an audible sucking noise from the engine and difficulty getting above 20 MPH. The vacuum was around 14 inches of mercury at idle, and the PCM had stored a P0410 code.

The P0410 code means the PCM detected a flow problem with the air injection system when it was running a monitor test. When running the monitor test, the PCM activates the AIR pump and the vacuum control solenoid and monitors the airflow by using the pre-catalyst heated oxygen sensor voltage and short-term fuel trim.

Looking at the entire picture is the key to this diagnosis — not just focusing on the trouble code. What can cause the loss of power, the vacuum to drop to nothing on light acceleration and the sucking noise?

In order to have good vacuum, the engine must be in good shape mechanically. The engine ran well at idle, so this was not our first concern. But the engine also needs a clear exhaust path to have good vacuum.

Using a pressure tester in the O_2 sensor hole is a quick way to check backpressure. A reading of anything over 1-2 psi just above idle indicates a problem. The backpressure on this vehicle was way out of specs and a plugged catalytic converter was the cause. The transmission would not shift, because the engine behaved like there was always a heavy load on the vehicle. The P0410 set because the air pump could not generate any flow through the exhaust.

Congratulations to the many readers who wrote to us with the correct response. The first correct answers we received came from:

Tim Forah
Tim's Import Sales and Service
Hutchinson, KS

LeRoy Maser
Alliant Energy
Fond du Lac, WI

Diagnose The Problem Win A Shirt

Because *Counter Point* is mailed to so many different locations across the country, some readers may receive their issues before others. We have found the most equitable method to award the first reply for a correct answer is to divide the country into regions, with a winner chosen from each region.

This time we are going to give everyone an equal opportunity to receive a great Wells polo shirt. We are looking for the best or most complete answer. In other words, tell us the steps you would take to diagnose the following problem.

Q: I do not do much driveability diagnostics, so I need a little help on this one. I am working on a 1988 Chevy S10 with a 2.8L TBI engine. It does not idle very well. It also hesitates, stalls at times and misfires. The only thing I have noticed that will make a change in the way the engine runs is to disconnect the alternator. When I do this the engine runs pretty good. I have replaced the alternator. What elso could be causing this situation?

Jerry Boden
Jerry's Repair
Milford, NE

Hint: The problem is in the fuel system.

If you have the answer, use the following contact information:
E-mail: technical@wellsmfgcorp.com
Fax: (920) 922-3585
Postal: *Counter Point* Editor,
c/o Wells Manufacturing Corp.
P.O. Box 70
Fond du Lac, WI 54936-0070 WELLS

Important Dates To Remember

The National Institute for Automotive Service Excellence (ASE) will offer its Spring 2006 (paper and pencil-based) certification tests on May 9th, May 11th and May 16th.

ASE also has announced the continuation and expansion of its computer-based testing (CBT) format. The Winter 2006 CBT administration will include all regular and recertification tests for the Automotive (A1-A8 and L1), Parts, Collision and Truck series, including the Advanced Level Truck (L2) test.

Wells Manufacturing Corp. encourages professionalism through technician certification. WELLS

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Scan Tool Diagnostics

attempting to richen the fuel mixture to compensate for a perceived lean condition. Negative fuel trim percentages indicate that the PCM is attempting to lean the fuel mixture to compensate for a perceived rich condition.

STFT values are erased as soon as the ignition key is switched off. LTFT is a learned value that is determined by trends in short term fuel correction. LTFT values are stored in the PCM's keep alive memory (KAM) and stay there unless reset with a scan tool or erased when the battery is disconnected. If STFT or LTFT exceed ±10%, this should alert you to a potential problem.

Suppose the STFT and LTFT numbers indicate the PCM has been adding fuel (positive STFT). The engine could be running lean due to a weak fuel pump. To compensate, the PCM adds more fuel by holding the injectors open longer. This general trend shifts the short term fuel trim corrections to a richer starting point. LTFT goes richer as well because LTFT will follow trends in STFT.

Determine if the condition exists in more than one operating range. Check fuel trim at idle, at 1500 rpm and at 2500 rpm. If LTFT B1 is nearly maxed out at 25% at idle but corrects to 4% at both 1500 and 2500 rpm, your diagnosis should focus on factors that might cause a lean condition at idle, such as a vacuum leak. If the condition exists in all rpm ranges, the cause is more likely to be fuel supply-related, such as a bad fuel pump, restricted injectors, etc.

On bank-to-bank fuel control engines, fuel trim can also be used to identify which bank of cylinders is causing a problem. If LTFT B1 is a very lean -20% and LTFT B2 is close to a normal ±3%, it's safe to say the source of the problem is associated with B1 cylinders and your diagnosis should focus on factors related to that side of the engine only.

Both STFT and LTFT can compensate for a rich or lean condition, but only up to a point, which is called the adaptive limit. When either STFT or LTFT have reached their adaptive limits (normally about ±25%), the PCM will store a DTC. But a driveability problem can develop long before the adaptive limit is reached. If you can interpret the scan tool data, you might be able to see it coming.

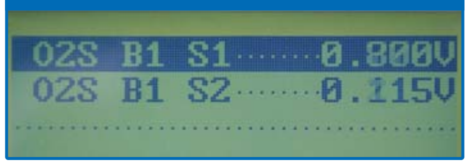
Refer to the October, 2002 *Counter Point* for additional information on short and long term fuel trim. If you've misplaced your printed copy, a PDF of that issue can be downloaded from the Wells Manufacturing Corp. website at www.wellsmfgcorp.com.

The following PID data could reflect changes in fuel trim and/or provide additional diagnostic information. Also, even if fuel trim is not a concern, you might find an indication of another problem when reviewing these parameters.

The Fuel System 1 Status and Fuel System 2 Status PIDs should indicate closed loop (CL). If the PCM is not able to achieve CL, the fuel trim data may not be accurate.

Engine coolant temperature (ECT) should reach an operating temperature of 190° F or higher. If the ECT reading is too low, the PCM may richen the fuel mixture to compensate for a (perceived) cold engine condition and the system may never achieve closed loop.

Some PIDs change rapidly and have a very fast update rate. With only two PIDS displayed, this oxygen sensor data was changing faster than it could be displayed by the scanner (note the blurred digits). A scanner with graphing capability could follow sensor behavior, and would be a better choice in this situation.



The intake air temperature (IAT) PID should reflect the ambient temperature or be close to the underhood temperature, depending on the location of the sensor. In the case of a Key On Engine Off (KOEO) cold engine check (an engine that has not been started in at least 12 hours), the ECT and IAT PID data should be within 5° F of each other.

If the system includes a mass airflow (MAF) sensor, the PCM uses this information to calculate the amount of fuel that should be delivered to the engine to achieve the desired air/fuel mixture. Check the MAF sensor for accuracy in various rpm ranges, including wide-open throttle (WOT), and compare it to the manufacturer's specifications.

Be sure to identify the unit of measurement when checking MAF sensor readings. Your scan tool may report the information in grams per second (gm/s) or pounds per minute (lb/min). For example, if the MAF sensor specification is 4 to 6 gm/s and your scan tool is reporting .6 lb/min, change the scan tool from English units to metric units to obtain accurate readings. More than a few technicians have mistakenly replaced the sensor, only to realize later that the scan tool was set for the wrong unit of measurement.

Also check the BARO PID data on MAF-equipped systems. With the key on engine off (KOEO), the BARO sensor should indicate the average barometric pressure for the elevation in your area.

On speed density fuel systems, the manifold absolute pressure (MAP) sensor measures manifold pressure, which is used by the PCM to calculate engine load. The MAP PID in English units is normally displayed in inches of mercury (in/Hg). Don't confuse the MAP sensor PID with intake manifold vacuum; they're not the same.

A simple formula to use is: barometric pressure (BARO) – MAP = intake manifold vacuum. For example: BARO 26.8 in/Hg – MAP 11.3 = intake manifold vacuum of 15.5 in/Hg.

The Oxygen Sensor Output Voltage PIDs B1S1, B2S1, B1S2, etc., are used by the PCM to control fuel mixture and to detect catalytic converter degradation. A scan tool with graphing capability can be used to check basic sensor operation. Use the data grid if graphing is not available on your scanner.

The sensor will normally sweep between a high of about .8 volt and a low of about .2 volt. The transition from low to high and high to low should be very quick. A snap throttle test can be used to verify the sensor's ability to achieve the .8 and .2 voltage limits. If this method does not work, check the oxygen sensor's maximum output by using a bottle of propane to manually richen the fuel mixture. To check the low oxygen sensor range, create a vacuum leak simulating a lean condition and check the voltage.

Checking the oxygen sensor response time is where a graphing scan tool really helps. Remember, your scan tool is not a lab scope. You're not measuring the sensor in real time. The PCM receives the data from the oxygen sensor, processes it, then reports it to the scan tool. Because of the speed of an O_2 sensor, you can achieve the best results by graphing or displaying data from each oxygen sensor separately. If the transition seems slow, the sensor should be tested with a lab scope to verify the diagnosis before you replace it.

To speed up the diagnostic process, select only the PIDs that will keep your diagnosis on course. Is it an engine management problem? A fuel supply problem? An ignition problem? Display only those PIDs that can be connected or related to the problem at hand. There are many roads that will take you where you need to go. None of them is really the wrong way, but some will get you there quicker than others, leading to more billable hours and a satisfied customer. WELLS

WELLS MANUFACTURING CORP.
P.O. Box 70
Fond du Lac, WI 54936-0070

Hot off the Wire

Confidence Earned

Webster's dictionary describes the meaning of the word confidence as: *trust, faith or a feeling of assurance.*

Do you have confidence when you are replacing an ignition or emission component? Are you confident the component you are using will work as well or better than the original? In today's automotive repair world, this can be a challenging problem.

Previous *Counter Point* articles informed you that Wells has earned and maintained the QS9000 certification developed by the Big Three, as well as the prestigious Ford Q-1 award. Wells is proud to announce that we've taken our manufacturing qualifications to the highest level in automotive manufacturing by earning the ISO/TS-16949-2002 certification. This certification is required by many auto manufacturers to remain one of their Tier 1 suppliers.

The ISO/TS-16949-2002 certification was developed by members of the IATF (International Automotive Task Force). The IATF consists of auto manufacturers BMW, Daimler Chrysler, Fiat, Ford, General Motors, Peugeot, Volkswagen and several others.

The bottom line: This is all about quality assurance – the assurance you need to feel confident when you are selling or installing a Wells product. You can be confident that you have sold your customer the best part available today. WELLS

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Wells' President ....William Allen
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