WELLS Counter Point

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THE ELECTRONIC, DIAGNOSTIC AND DRIVEABILITY RESOURCE.

A Compelling Case Study

When faced with an unfamiliar problem, it pays to collect as much information about the problem as possible.

This issue's case study was contributed by Jim Gehl.

This case study concerns a 1997 Pontiac Gran Prix that has a 3.8L engine and about 100,000 miles on it. The problem with the vehicle is very intermittent. The engine may start and run fine all day. But at other times, the engine may not start on the first attempt of the day, or it may take several tries before it will start and run. The engine also may die while driving, but restart immediately. Or it may die while driving and not restart until allowed to cool down.

About the only thing we have to start with is a diagnostic trouble code (DTC) P0560 (System Voltage) stored in the PCM's memory. The DTC indicates that the PCM has lost voltage on one or both of its supply voltage circuits. But the engine is running fine right now. Figure 1 on page 3 is the schematic that is to be used with the diagnostic procedure for this DTC.

We could assume the DTC is the answer to the vehicle's problem, but it sure doesn't seem that way. First, let's check the system that causes the most concerns on this type vehicle: the ignition system. I like to start checking an ignition system by testing the four most important circuits (the inputs and outputs) and get a scope pattern for each while the engine is running normally. This gives me a baseline for the system, and I might get lucky and find the problem in one of the scope patterns. This may seem like a hassle, but it took only five minutes to connect the scope and get the information.

By connecting to pins H and D of the ignition control module (ICM), I got the ignition system's 3X signals. Pin H is the input from the crankshaft position sensor (CKP) 3X reference signal and pin D is the 3X output signal from the ICM to the powertrain control module (PCM).

If your shop doesn't have an oscilloscope, a digital multimeter (DMM) capable of reading frequency in hertz (Hz) can also be used. One hertz is equal to one cycle per second, 100 Hz is equal to 100 cycles per second, and so on. This unit of measurement can be applied to any periodic event. For example, a clock ticks at 1 Hz and a human heart beats at (approximately) 1.2 Hz.

In automotive usage, a frequency reading gives us an indication of the number of signal transitions per second. The accuracy of the 3X and 18X sensors can be verified by comparing their readings to other known values, like engine RPM. If the engine idle is steady, the ignition control module frequency reading also should be relatively steady. Here's the Hz conversion equation for the 3X sensor:

(Engine RPM ÷ 60) x 3 = 3X Sensor Signal in Hz

We'll insert some real values to verify sensor accuracy.

Engine idle = 725 RPM

725 ÷ 60 = 12.08

12.08 x 3 = 36.24

36.24 = 3X Sensor Signal in Hz

36.24 Hz was the DMM reading for the 3X sensor (Figure 2), so it checked out okay. Pins G and C at the ICM send and receive the ignition system's 18X signal. Pin G is the input from the CKP and pin C is the ICM output to the PCM. I found nothing abnormal with either the 3X or 18X inputs and outputs, but the vehicle suddenly decided it didn't want to start during the test. I quickly determined the ignition was still working, but there was no fuel pressure during the no-start. Now what?

Let's check the fuel pump and its circuit next to see if the fuel pump can function. I need to prove the fuel pump is not responsible for the no-start condition. What circuit controls the fuel pump relay? What circuit supplies the power for the fuel pump? Looks like it's time to get out the wiring diagram and component locator (Figure 3).

I found the fuel pump relay in the underhood fuse panel, and the manufacturer was kind enough to supply a nice diagram on the side.

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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, L.P., 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 1993 Ford Tempo with a 2.3L engine and a manual transmission. The engine runs great until the shifter is moved to any gear, and the clutch pedal is released. The engine will stumble but keep running if I release the clutch pedal and quickly push it back to the floor while in gear.

I noticed that when I disconnected the clutch pedal position switch and depressed the clutch pedal, the engine would die as soon as I shifted into any gear. I tried disconnecting the park/neutral switch also, but then the engine would not crank. Both the clutch pedal position and park/neutral switches were replaced twice, with no change. I disconnected the park/neutral switch and connected a headlight in the circuit. The headlight lit as soon as the engine started and when I put it into gear and released the clutch pedal the engine kept running. What could be wrong? Is the ECM defective?

Steve Roberts
Howell Tire
Howell, MI

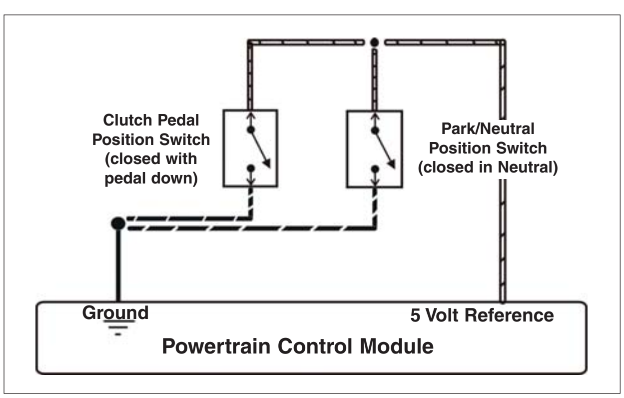
A: If this problem doesn't get you thinking, nothing will. Let's begin with the wiring diagram. The first thing you will notice is the Clutch Pedal Position Switch (CPPS) and Park/Neutral Position Switch (PNS) are on a parallel circuit and share a common voltage feed and ground. When the clutch pedal is depressed, the CPPS is closed. And when the transmission is in neutral, the PNS is also closed.

Internally, the ECM reads a voltage drop on the pink/yellow 5 volt reference wire that feeds both switches. The PCM does this to determine when the transmission is in gear and the clutch is disengaged (clutch pedal is released) to adjust timing, fuel mixture, etc.

By disconnecting the CPPS, you created an open in that portion of the parallel circuit — simulating a released clutch pedal. When you put the shifter into a gear, the ECM thought the clutch pedal was released and the transmission was in gear and tried to make adjustments accordingly. Placing the light in the circuit didn't allow the voltage drop level read by the ECM to reach the needed 5 volts and fooled it into thinking either the transmission was still in neutral and/or the clutch pedal was on the floor.

Because the light lit where a 5 volt input should be, I suggest checking the ECM voltage at pin 30. If the voltage is above 5 volts, the current limiter in the ECM is defective, and it needs to be replaced. If this is the case, higher voltage can feed back through the ECM, skewing other sensor readings and causing this failure.

Results: Steve found a steady 12 volts at pin 30. He replaced the ECM and the engine is running fine.



Wow! I never expected that a 1998 Pontiac Grand Prix would generate such a strong response from *Counter Point* readers. Thank you to all who sent in answers and comments. I commend those readers who reminded me that the VIN code should have been included in the description of the vehicle complaint. This Grand Prix is a supercharged vehicle (VIN 1), utilizing a dual-speed fuel pump. Remember, the vehicle would start, but not run unless the engine speed was very high.

At idle and at low RPM and light loads, the PCM on this vehicle directs current through the fuel pump relay and a ballast resistor located on the right inner fender well. This reduces the fuel pump speed. When engine load and RPM increase, the PCM redirects current to the fuel pump via the fuel pump relay and fuel pump speed control relay – supplying 12 volts and allowing full fuel pump speed.

When the ballast resistor fails (open), the fuel pump will receive power only during cranking and high RPM operation. It can be tested either by jumping the green and grey wires to the ballast resistor or checking the ballast resistor's resistance.

The first *Counter Point* readers to submit a correct answer to this diagnostic problem were:

Scott Davidson
Dayton, OH

Roger Aultz
Wheeler Bros. Inc
Sipesville, PA

Gary Smalley
Smalley Auto
Wichita, KS

Diagnose The Problem Win A Shirt

I am working on a 2000 Honda Odyssey EX that is really starting to get to me. It has a 3.5L engine and about 92,000 miles on it. The engine runs great at idle. However, while driving at speeds between 40 and 50 MPH the following codes will set: P0172 (rich condition), P0300 (random cylinder misfire), P0301 (misfire cylinder 1), P0302 (misfire cylinder 2), P0303 (misfire cylinder 3).

The long term fuel trim bounces from -8% to -11%. The fuel pressure is good both in the shop and on the road. The valves were adjusted about 10,000 miles ago, and they are not currently making any noise. The front oxygen sensors are both switching in a range from 150 to 850 mV. According to the manufacturer's diagnostic tree, the next step is to replace the fuel injectors. This job will cost about $1,000. Do you have any other ideas?

George Breitengross
Canton, OH

If you have the answer, use the following contact information:
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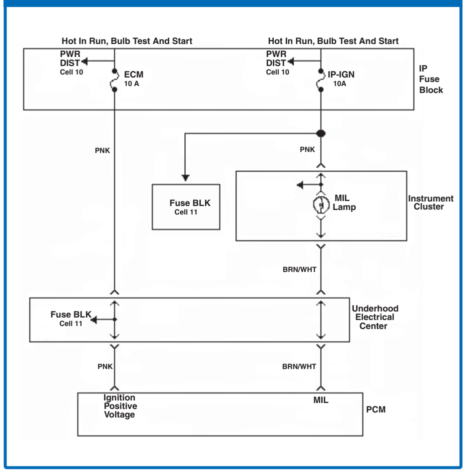
A Compelling Case Study

If I compare the information from the wiring schematic to the relay schematic, I'll be able to determine the fuel pump circuit's current path. The relay manufacturer was also nice enough to label the pins.

Figure 1: This wiring diagram illustrates the power supply from the fuse block to the PCM.



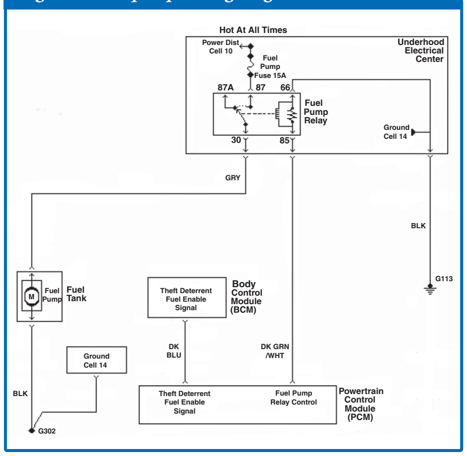
Using my DMM's amp test function, I removed the relay and bypassed it to activate the pump and measure its current requirement. My DMM says the fuel pump is using 5.37 amps while running. That sounds about right. Not too high and not too low.

Figure 2: The ignition system's 3X signal was verifed by attaching a DMM, set to measure frequency (Hz).

The next step is a voltage drop test on the ground side of the fuel pump relay circuit. I like to place a headlight in series in the circuit to load the wiring. This technique is very helpful in flushing out hidden wiring problems. The fuel pump relay on this vehicle is controlled by a constant ground and the PCM sends a regulated voltage to activate it. I connected one headlight terminal to the power feed side of the relay, and the other terminal to the voltmeter lead. The other voltmeter lead is connected to ground. Even after adding the headlight, the indicated voltage drop was 45.8 mV, or .045 volts. Once again, nothing out of the ordinary.

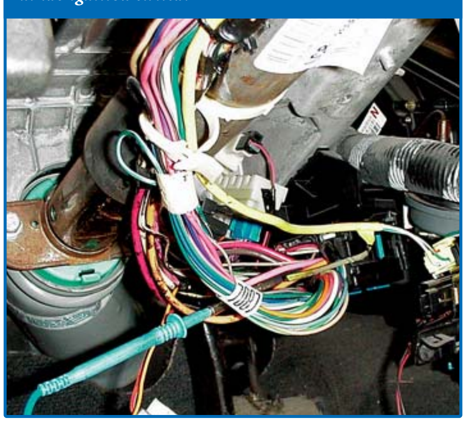
The PCM also must supply adequate voltage to energize the fuel pump relay windings. When I checked the voltage at fuel pump relay terminal 85, my DMM only indicated 3.67 volts. Something doesn't seem right here. The PCM has to supply more than 3.67 volts to the fuel pump relay coil windings. There must be a very large voltage drop before this part of the circuit.

Figure 3: Fuel pump wiring diagram.



The wiring diagram in Figure 1 indicates the circuit goes inside the vehicle to the instrument panel (IP) fuse block. My DMM showed the same voltage inside as outside the fuse block. Imagine that. The wiring diagram also indicates that the PCM supply voltage originates at the ignition switch, so I checked there next (Figure 4). The voltage at the ignition switch feed to the fuse was only 3.91 volts (Figure 5). The rest of the circuits from the ignition switch were working properly, so right then I knew I had found the cause of the intermittent stalling and no-starts.

Figure 4: Voltage feed to the fuel pump relay, measured at the ignition switch.



After replacing the ignition switch, the PCM fuel pump relay control voltage was 10.6 volts. Now, that's more like it!

Figure 5: 3.91 V won't energize the fuel pump relay. Time to identify the source of the voltage drop.

What have we learned from this case study? Perhaps the most important lesson learned is to collect as much information about the problem as possible, including wiring diagrams and operating strategy. Take what the vehicle will give you and use that information to form a diagnostic strategy. You'll find the problem a lot quicker if you use an organized and systematic approach to troubleshooting, even if it means starting with known trouble areas.

We know that when an engine dies or won't start, it's usually because its supply of fuel or ignition has been removed. The presence of DTC P0560 indicated that the PCM had lost its supply voltage at some point. This could have caused either fuel or ignition, or both to be interrupted, at least temporarily. So our diagnostic strategy was to find the source of that interruption.

The search led us to the ignition switch. The ignition switch had not failed completely, but was failing intermittently. The failure also seemed to have a temperature component, because the vehicle would always restart when allowed to cool down. Although this failure caused a loss of fuel pressure, the fuel pump was not to blame. **WELLS**

Jim Gehl is an ASE Master and L1 certified technician and has been employed by the Wells Technical Services department for the past six years. Jim fields calls from customers on the tech line, as well as writing and instructing driveability training classes. He has 23 years of experience in the field, specializing in steering/suspension and driveability repairs. Prior to joining Wells, he managed a successful auto repair business for five years, with three of those years working solo.

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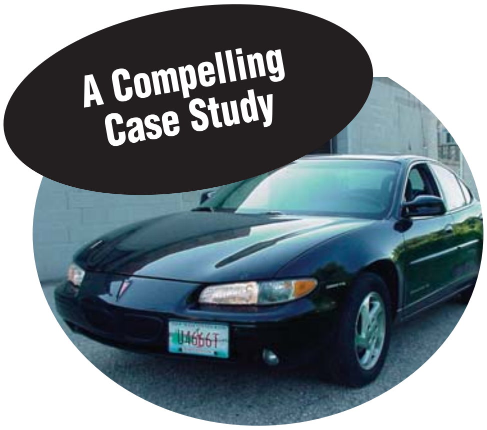
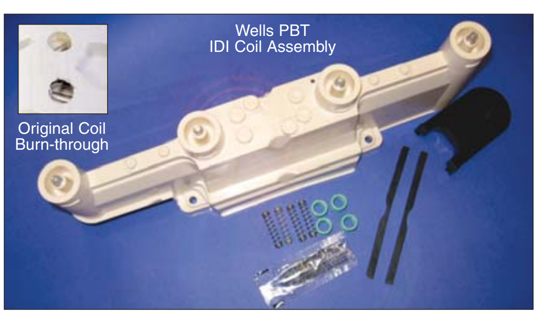


Quality Points

Ignition System Improvements

In 1987, GM introduced the DIS system called the Integrated Direct Ignition (IDI) system and incorporated it into the popular Quad IV engine. Some techs named it a "cassette ignition system" because of the appearance of the module under the cover. A common problem with this system was the occurrence of a two-cylinder misfire that was often accompanied by a no-start condition, especially in cold climate areas.



Pockets of air or bubbles can be trapped in the plastic between the DIS coil towers during the injection molding process. These air pockets weaken the unit's dielectric strength, and eventually cause the coil towers to burn through and short to each other. An example of this type of damage can be seen in the inset photo.

Wells has developed a precise two-step injection molding process to prevent air from being trapped in the Polybutadiene–Terephthalate (PBT) plastic (main photo). This unique process eliminates these failures.

Once again, Wells takes on the challenge and bursts another trouble bubble. WELLS

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