WELLS Counter Point
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THE ELECTRONIC, DIAGNOSTIC AND DRIVEABILITY RESOURCE.

Ford Distributor Ignition Diagnosis

Even a carefully considered diagnosis can go astray. Our recent experience proves the point.

In previous *Counter Point* issues we've stressed the importance of forming a diagnostic strategy before tackling difficult engine starting or driveability problems. Without a strategy to direct your efforts, it's very easy to get blown off course. At the very least, you may end up spending more time than necessary on the job. Perfectly good parts may end up being replaced in the bargain. This makes for embarrassing situations that are very difficult to justify to your customers.

A recent experience with a 1994 Ford Mustang 5.0L HO at our shop illustrated the perils that can still come about, even when you think you're proceeding carefully with an orderly diagnosis. The vehicle in question had 104,000 miles on it. The customer complained that the engine either would not start or would crank for a very long time before starting, always following a hot soak of at least 10 minutes. If the vehicle was allowed to sit long enough for the engine to cool down completely, it would always restart.

Once the engine did start, it never died and had no other driveability issues.

This sounded like an intermittent hot soak-related failure of an ignition or fuel system component, but which one? We decided to begin by verifying the engine had spark when it would not start. The Mustang has a conventional distributor electronic ignition system, something you don't see that often anymore. Ford built this type of ignition system in two flavors: push start and computer-controlled dwell. A brief description of the differences between the two is in order before we proceed.

Push start (PS) systems are so-named because they are designed to allow the engine to start following a push start on manual transmission-equipped vehicles. PS systems can be identified by their *gray* ignition control module (ICM). The PS system allows for increased dwell (coil on-time) when starting the engine. After the engine starts, the ICM determines coil on-time based on engine rpm, previous spark position and coil charge time.

The powertrain control module (PCM) calculates spark timing and outputs a rising edge of the spark output (SPOUT) signal at the appropriate time. The ICM turns off the coil whenever it sees the rising edge of the SPOUT signal. The falling edge is ignored. On this system, SPOUT only controls when the ICM fires the coil. Excess dwell of either 17% or 32% is provided to ensure adequate coil saturation under engine acceleration conditions.

Computer-controlled dwell systems use both edges of the SPOUT signal. The PCM calculates the correct ignition timing for conditions and outputs a rising edge SPOUT signal at the appropriate time. The ICM turns off the ignition coil in response. The ICM then waits for the falling edge of the SPOUT signal to determine when to turn the coil back on. The coil on-time is entirely controlled by the PCM-generated SPOUT signal. The PCM determines the correct dwell by measuring how long it takes the coil to reach a predetermined current level. Excess dwell is limited, which reduces unnecessary heat inside the ICM. The ICM on computer-controlled dwell systems are *black* in color.

To begin our test of the Mustang's PS ignition system, a graphing digital multimeter (GMM) was attached to both terminals at the Hall effect PIP (profile ignition pickup) sensor. One terminal leads from the Hall effect sensor to the powertrain control module (PCM), and the other leads from the PIP sensor to the ignition control module (ICM). During cranking, we had what looked like good square wave signals from both PIP terminals and the engine started immediately.

When the engine would not restart following a hot soak, we attached a timing light while continuing to monitor the PIP signal. The timing light confirmed that we had an intermittent spark, but the PIP signal to the ICM still looked normal. At this time, we thought we were dealing with a PS ignition system, so we believed the ICM only needed to see a PIP signal during cranking to start the engine. Since the PIP signal never quit, we were reasonably confident that a heat-sensitive ICM was the source of the problem. Maybe you can guess what happened next. After installing a new ICM, the engine started from

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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: My 1990 Mitsubishi Montero 3.0 liter V6 quit while I was driving it. The engine cranks over but it will not restart. The fuel pump seems to be pumping okay (I can hear it running when I turn the key to the RUN position). However, with the key in the RUN position (engine not running), the dash tachometer indicates 1500 rpm. A check with a spark gap tester on the coil wire shows a steady stream of sparks with the switch ON. Is this a failed distributor igniter (inside the distributor) or could it be something else? This engine also has a small black box labeled "Power Unit" mounted on the coil bracket. Could this unit be causing the problem?

Miles Schofield
Tarzana, CA

A: Miles, I will assume the box labeled Power Unit is the power transistor or ignition control module. If I understand you correctly, the coil is firing a constant stream of current whenever the ignition key is turned to the ON or RUN position. It sounds to me like you have a coil primary transistor that is bouncing back and forth between ground and power and, in turn, triggering the secondary ignition to fire. After looking at the wiring diagram, I have determined this problem is originating from either the power transistor in the control module or the PCM. Try disconnecting the optical crankshaft position sensor in the distributor from the PCM, then turning the key to the ON position. If it continues to fire the coil, check the wiring at the PCM. If the wiring checks out okay, I would consider replacing the PCM.

Results: Miles installed a replacement PCM and the Montero's stalling, no restart problems were corrected.

In the last *Counter Point*, we presented a question about a 2000 Chevrolet Silverado with a 4.3L Vortec engine that had 46,000 miles on it. The Check Engine light was coming on and the PCM was storing two codes: P0171 and P0174. Both of these codes indicate a lean running condition in each of the banks. We also knew that long term fuel trim was at or near its maximum correction limit at +24.2%. There were no vacuum leaks, fuel pressure was perfect and there were no driveability complaints.

We received many correct answers to the next diagnostic step. Although many were worthy, prizes are awarded to the first two correct answers we receive. With that said, keep trying and better luck next time.

Looking at the information at hand, we know that both banks are reporting lean conditions. The PCM receives this information from the O_2 sensors. In response to the lean condition, the PCM tried to compensate by increasing injector pulse width. It appears to be at or near its maximum level of correction. You must ask yourself, what could affect both banks equally? Could it be a vacuum leak? Could the exhaust pipe be cracked? Either of these faults could cause a lean condition, but when they do, you would expect to see a difference in the O_2 sensor readings between the banks. One O_2 sensor will always report a mixture that is more lean than the other.

We need to look at possibilities that are common to the entire engine. Begin by checking the areas around the EGR and PCV for vacuum leaks. If no problems are found there, look at the calculated barometric value and MAF grams per second with your scan tool. Abnormal readings for either are indications of a dirty or defective MAF sensor.

There is no published specification for the barometric value, as it will vary in response to changes in altitude. Compare the reading on the problem vehicle to other known-good vehicles in your lot for a rule of thumb value. Next, while the engine is at a normal idle, take a look at the MAF reading. The specification is between 5 and 7 grams per second. If the value on the test vehicle is lower than your

Quality Points

Tech Services Department

The Wells Manufacturing Corp. Technical Services Department is staffed by highly experienced technicians. Each has an extensive background in the automotive and light truck field and is ASE Master and L1 certified.

Job One for Technical Services is maintaining the Technical Assistance Hotline. Most days are spent fielding calls from customers, answering requests for assistance with product knowledge, dispensing part specifications and offering technical assistance with driveability and emissions problems.

The department also designs and conducts training classes for our technician, counter personnel and sales associate customers. Training classes assure continued success in the sale and use of the Wells product line.

The tight compartments in today's vehicles mean fit and function are a very important step in the replacement part manufacturing process. This is why the engineering department calls upon the Technical Services Department for hands-on shop skills and product knowledge during product development and testing.

Assembling the quarterly *Counter Point* publication is also a Technical Services responsibility. Locating problem vehicles, learning how systems function from the inside out, mapping out sound diagnostic procedures, then clearly conveying the information in written form takes perceptive technicians with the desire to be the best in their chosen field. All involved enjoy and take great pride in creating the ideas necessary to keep this periodical fresh. We hope you enjoy the results.

Technical Services staff member Jim Gehl assists a Wells customer by telephone, while consulting printed and computer-based reference material.

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estimate on the barometric and/or lower than 5 grams per second on the MAF reading, the PCM interprets this as less air entering the intake than actual. It will then lean the fuel injector pulse width in response.

Results: Using his scan tool, Tim checked the MAF grams per second flow. The reading of 3 grams per second at idle was lower than normal. He replaced the MAF and the DTCs have not returned.

The first and second correct answers were both received via e-mail. Each will receive a Wells golf shirt. The winners are:

Daniel McMahon
East Meadow, NY

Robert Goodwill
Hayward, CA

Diagnose The Problem Win A Shirt

Q: "I am working on a 1996 Mazda Millenia with a 2.5L engine that intermittently sets a code P0400. When I monitor the EGR, the voltage is 1.05V. The voltage then will jump to 4.0V upon acceleration. These numbers seem correct to me. Does the PCM watch any other sensor on this vehicle to verify EGR flow? What else could be wrong?"

Ron McCarty
Pro Import Service
Orlando, FL

If you think you have the answer to this diagnostic problem, we'd like to hear from you. We accept correspondence via e-mail, fax or regular mail. Please use the following contact information for all correspondence.

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Important Dates To Remember

The National Institute for Automotive Service Excellence (ASE) will offer certification tests for repair professionals and parts specialists on May 4th, 6th and 11th. If you've already registered for the tests, be sure to mark your calendar with these important test dates. Wells Manufacturing Corp. encourages professionalism through technician certification. WELLS

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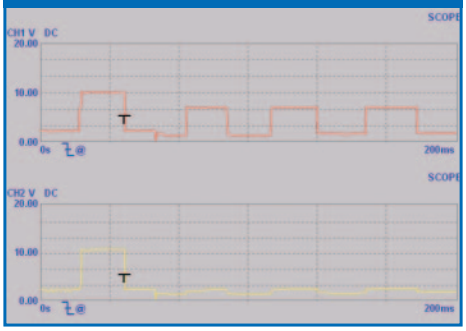
cold and ran normal. But a hot soak after warm-up caused the same no-start/long-crank symptoms we'd seen before. What next?

After consulting a wiring diagram, we learned a couple of things. First, we learned this was not a PS system, because it had a black module. We also determined that the ICM *does* need to look at the SPOUT signal during cranking to decide when to fire the coil. Our earlier assumption that only PIP was needed to start the engine was incorrect. We attached the GMM to the SPOUT terminal, then attempted to start the engine. When the engine would start, the SPOUT signal looked normal. When it wouldn't start, SPOUT was very weak with just a slight ripple above ground visible in the GMM trace.

As another test, we decided to disconnect the SPOUT connector. With the SPOUT wiring between the PCM and the ICM disconnected, the engine would always start. It didn't matter whether the engine was hot, cold or somewhere in between. In the complete absence of a SPOUT signal, the ICM went into a default mode and started the engine based on the PIP signal alone. But with no SPOUT signal, the ICM was forced to maintain the timing at a limp-home value. The engine would run, but not as well as it was intended to.

Figure 1: *This screen capture shows PIP (top) and SPOUT (bottom) while cranking during the no-start. Notice SPOUT is dropping out. This is why we decided to replace the ICM.*



We also monitored the ignition diagnostic monitor (IDM) signal during this test. The IDM is a signal from the ICM to the PCM that verifies spark function. IDM is based on the flyback voltage (up to 400 volts) created by the ignition coil primary discharge. The IDM signal consists of a single pulse for each successful ignition event. If the IDM signal is missing, it's an indication of intermittent or missing spark events. When we had no spark indicated by the timing light, the IDM signal was also missing. The PIP sensor signal continued to look normal.

The intermittent weakness of the SPOUT signal seemed to point to the PCM, so we ordered up a replacement. Our jubilation was short-lived, however. After the replacement of two non-returnable electronic components, the hot soak no-start symptoms returned all too soon.

During our GMM tests, we had noticed that some of the signals were riding above ground. Data collected via scan tool looked fishy, too. This often indicates the presence of a bad ground or a voltage drop somewhere in the engine management system wiring. We consulted a wiring diagram to learn the location of the system grounds, then performed a voltage drop test on each of them. Sure enough, our tests revealed a poor ground connection at G104, located near the battery. We cleaned and tightened it along with the other system grounds, then retested.

The engine started and ran from cold. The GMM patterns (especially SPOUT) looked better, and were riding closer to ground. Perhaps we'd found the source of the problem at last. No such luck! The no-start/ long-crank symptoms returned as soon as the engine was allowed to hot soak. Time to re-evaluate the information we'd collected thus far.

Figure 2: *The coil primary pattern is at the top of this GMM screen capture. The IDM pattern, which mirrors the primary and confirms each ignition event to the PCM, is at the bottom. The engine was running at this time.*

Why would the engine always start with the SPOUT terminal disconnected, regardless of the engine temperature or how long it had been sitting? We assumed it was because the system went into fail safe mode when the SPOUT signal was completely missing. We decided to look more closely at SPOUT when the engine would not start. During no-start cranking, the very weak SPOUT signal appeared to mirror the PIP signal, as if the PCM was trying to output a signal but was unable to do so for some reason. Our voltage drop tests had confirmed that the PCM was getting a good voltage supply and that all grounds were up to snuff.

Something was weakening the SPOUT signal, but what was it? Sorry to leave you hanging, but the answer to that question will have to wait until the next *Counter Point.* WELLS

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Spring 2004 ASE Tests

The Spring 2004 tests will be administered on May 4th, 6th and 11th.

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Hot off the Wire

National Car Care Month

April is National Car Care Month. During the voluntary check-lane vehicle inspections conducted during last year's National Car Care Month, nine out of every 10 of the inspected vehicles needed service or a part replaced. Each year there is an estimated $62 billion in unperformed vehicle maintenance and repair.

As a professional technician, you can play a vital role in educating your customers and informing them of how regular maintenance checks and a few simple service tips can greatly reduce the cost of car ownership and improve the environment. Some basic service tips include:

• Keep engine in tune for maximum fuel efficiency and cleaner air.

• When the CHECK light comes on or remains on, have the vehicle's engine analyzed immediately, as there may be an emissions or sensor related problem.

• For safe driving, keep brakes, steering and suspension systems in good working condition.

• Correct tire inflation is important; check it regularly. Rotate and inspect tires periodically.

• Be able to see and be seen with properly working lights, windshield wipers and washers.

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Every month is car care month as far as Wells is concerned. April is a time when we all need to draw special attention to the benefits of proper vehicle care and maintenance.

"Be Car Care Aware"

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