WELLS Counter Point
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THE ELECTRONIC, DIAGNOSTIC AND DRIVEABILITY RESOURCE.

Case Study: No Snap Decisions

If you're willing to look *closely* before you leap, most diagnostic mistakes can be avoided, and satisfied customers assured.

This issue's case study was contributed by Dave Heinzen.

We've all had to deal with a "diagnose lack of power" complaint before. You head out to road test the vehicle, scanner in hand, hoping it will act up. Well, this '95 Windstar with a 3.8 L engine may not be a rocket when it's healthy, but "lack of power" was an understatement. With the pedal to the floor, it would go from 0 to 25 mph in about six hours. For obvious reasons, we chose not to road test this one any further than the parking lot. Amazingly, the customer had driven it to us.

We checked for codes. Why not? We already had the scanner out. No codes, and the PIDs looked reasonable. That's okay. With this symptom, this thing should be a piece of cake to fix anyway.

What can cause an engine to have a severe lack of power, and no apparent misfire? In other words, what was affecting all cylinders equally? Our short list of possible causes included restricted exhaust, air intake restriction and/or fuel delivery.

Back pressure and fuel pressure are easy to check on this vehicle. You can tap into the exhaust right at the DPFE with a pressure gauge to test exhaust system backpressure, and the fuel rail has a service port for attaching a gauge to check fuel pressure.

One of my students put the van up in the air and banged on the cat. It rattled noticeably. We were really thinking this thing had an exhaust restriction. How often would a shop have replaced the cat before any further testing? Not that it didn't need one, but was it the cause of the complaint?

Backpressure was 0 psi at idle and less than 1 psi during power braking. If an exhaust restriction were causing this severe lack of power, the gauge would easily peg while power braking (10+ psi). I've had cars that ran great with 4 psi, even though "rule of thumb" specs say no more than 2 psi is acceptable. Be careful. Some backpressure specs are unreasonable.

We checked fuel delivery next. With my left foot on the brake pedal and my right foot pushing the accelerator to the floor, the engine sounded sick, but fuel pressure stayed well within specs. Now what? Could we have the pressure, but not the volume? In my experience, it's very rare to see a vehicle that has adequate fuel pressure while the symptom is occurring, and not have the volume.
If this thing was not going lean when the symptom was occurring, that would tell us that the fuel volume must be there and would also tell us that injectors, vacuum leaks, MAF probably were not to blame, either. During a gas analysis we had a lambda reading of 1.1. That's 10% lean, but 10% would not cause this vehicle to run this bad. Just to be safe, we added propane while power braking. We got lambda to go to 1 and lower, but the engine was still sick. Fuel delivery was not the problem. What gives? This thing was acting up in the bay! How tough could it be?

Lambda represents the ratio between the amount of oxygen present in a combustion chamber versus the amount that should have been present in order to obtain "perfect" combustion. When a mixture contains the exact amount of oxygen required to burn all of the fuel present, the ratio is balanced and lambda equals 1.00. If the mixture contains too much oxygen for the amount of fuel (a lean mixture), lambda is greater than 1.00. A rich mixture (one containing too little oxygen for the fuel) is represented by a lambda value of less than 1.00.

A positive change of .1 (lambda 1.1) indicates the mixture is 10 percent lean. Lambda 1.2 is 20 percent lean, and so on. The same rule applies for rich mixtures. Lambda .9 indicates a mixture that is 10 percent rich, lambda .8 is 20 percent rich, and so on.

It was time to consider the less likely things that can cause a lack of power of this sort. Timing was next on the list. This is a "waste spark" system, so ignition timing is not adjustable, not likely to be off and not easy to check. The crank sensor on this engine has a reluctor wheel on the harmonic balancer. A quick visual inspection of the balancer and sensor revealed no problems. The next thing to consider was cam timing. It's not the easiest to check either, at least not visually.

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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 having a problem with a 1997 Ford Taurus that keeps setting trouble codes P0420 and P0430 — Catalyst Efficiency Low. This car has a 3.0L VIN U engine code and has about 90,000 miles on it. Before I throw an expensive set of converters at it, I want to be sure I understand what could cause a catalytic converter failure. The engine does not burn oil, the owner purchases his fuel from a reputable supplier and no other trouble codes have been set in the system.

Past history has been a consistent light ping while cruising. About six months ago I cleaned the mass air flow sensor because I am about 700 feet above sea level and the BARO reading was 146 Hz. After cleaning the sensor, I had a reading of 151 Hz but the ping was still present. I think it's probably just carbon in the engine. What do you think it could be?

Ben Fuller
A-1 Repair
Chicago, IL

A: Catalytic converter failure is not a normal occurrence on an engine that is operating normally. The unit would need to be overheated or contaminated by chemicals. Sulphur and lead from fuel and fuel additives will destroy a converter. Also, motor oils containing too much zinc or phosphorus are hard on the active chemicals in catalytic converters.

Overheated converters are a more common occurrence than most technicians realize. A rich or very lean air/fuel ratio will cause the converter to run hot. For every 1% rise of CO in the air/fuel ratio, the catalyst temperature will increase 212° F. With normal operating temperatures at the core of the converter of around 900° F and a damaging temperature around 1650° F, you can see we have a very narrow window to work in.

The BARO numbers you are recording concern me. 151 Hz is a low number for the area where you are located. I would like to see that number somewhere in the 156 – 157 Hz range. As some technicians have learned, cleaning a MAF sensor can be a good diagnostic tool, but replacement is a more reliable way of keeping the customer happy. Cleaning a MAF sensor is usually a short-term fix.

Results: Ben reported that with a MAF sensor replacement and a computer system reset, the BARO numbers instantly went to 156.4 Hz. He replaced the catalytic converters and reports the customer has been on the road for four weeks with no trouble code resets and that annoying pinging is gone. *Remember, when a catalytic converter fails, more often than not an engine management condition caused the failure.*

Q: A customer with a 1996 Saturn equipped with a 1.9L 4-cylinder engine came into our shop with the MIL on. When I pulled the codes, it showed a P0341 was stored in the PCM. This code means the camshaft position sensor (CMP) either is out of synchronization or has too many or too few signals. I checked the engine over, but I could not find a cam sensor to test. I also checked the catalog, and it does not show a CMP for this vehicle. Is the PCM bad? Could my scan tool be lying to me?

Brian Osmolinski
AutoZone
Riverdale, MI

A: Your scan tool is not lying, but don't jump into condemning the PCM just yet. This system uses a capacitive device inside the ignition control module (ICM) and under the 1-4 coil to determine when cylinder 4 fires on a compression stroke. This device is similar to an inductive pickup used on engine analyzers and oscilloscopes to view ignition patterns. By monitoring the secondary voltage spikes, the ICM can determine when cylinder 4 is on a compression stroke. Theoretically, the cylinder that needs the most voltage to fire its spark plug is on the compression stroke.

When the ICM determines number 4 cylinder fired on a compression stroke it will then pull the cam signal voltage from the PCM to ground. This signal, along with the double pulse received from the crankshaft position sensor (CMP), allow the PCM to synchronize spark and fuel timing. The system is called compression sense ignition (CSI).

Let's get to the diagnostics. *Too few* cam sensor pulses can be caused by defective spark plugs, ignition wires, coil, the ICM or the PCM. Something in the secondary ignition system has shorted to ground, the ICM has failed to drop the cam signal voltage to ground or the PCM is unable to read or send the signal voltage. Or, if number 1 cylinder has high ignition secondary resistance, it will need more voltage to fire its spark plug and the ICM will think number 4 cylinder is never on a compression stroke.

It's very common for the system to produce *too many* cam sensor pulses. Whenever an open circuit or high secondary ignition resistance occurs on cylinder 4, the PCM will think this cylinder is on a compression stroke every crankshaft revolution.

Corrosion on the coil secondary towers is very common on this system.

In the last ***Counter Point***, a reader asked for help with a 1988 Chevy S-10 with a 2.8L TBI engine. It did not idle very well, also hesitated, stalled at times and misfired. The only thing that would make a change in the way the engine ran was to disconnect the alternator, so it was replaced but the problem remained.

My first thought was the alternator was allowing too much AC voltage into the electrical system. However, it had already been replaced, so we have to take a different plan of action.

What happens when the alternator is disconnected? The available voltage drops, right? Think about what types of component functions could be affected by a change in voltage. The first place to look would be something with a winding.

Voltage can be thought of as the pressure on the electrical circuit. Electricity can be compared to water flowing through a garden hose. Let's say the hose has a small leak that is revealed when the water valve is turned all the way on, under full pressure. Turning that valve down a little, and the leak might decrease or go away all together.

This is what I think is happening on this engine. Something has a small electrical leak or short to ground that is lowering the pressure on the system. Disconnecting the alternator makes the leak go away. Remember, electricity will always use the easiest path available to ground. I would suggest looking at the ignition coils and fuel injectors first.

While observing the fuel injectors with a timing light, Jerry noticed that one of the injectors stopped working when the alternator was reconnected. This is the tricky part — the injector that stopped working was the good one. The injector that was working was shorted. While the shorted injector continued to function, it also robbed anything else in the circuit of ample voltage, just like the leak in a garden hose would.

The first correct answers we received came from:

Pedro Talavera
Miami, FL

John P. Costello
Costello Automotive
Cleveland, OH

Diagnose The Problem Win A Shirt

I am working on a 1996 Jeep with a 4.0L that came in with a lack of power under acceleration. It feels like the exhaust system is restricted. It has also stored a code P0121, which mean the TPS voltage does not agree with the MAP sensor voltage. I have checked the fuel pressure and it stays steady at 40 PSI at all times.

The exhaust system has been dropped, but it made no difference. I have replaced the MAP and TPS sensors, which also made no difference. I checked the timing chain and the valve timing is right on and the chain is tight.

The barometric reading is the only signal I noticed that is a little weird. It reads about 29 in Hg at idle. But when I accelerate heavily, the reading drops to about 17 in Hg. It will not return to normal until I do a key off key on. What the heck is going on?

Rick Star
Gary, IN

Hint: The BARO calculation is done by the PCM using the MAP sensor. It is calculated when the key is turned on and at wide open throttle. What is the missing element to make this calculation?

If you have the answer, use the following contact information:
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Quality Points

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common TPS failure. To make the connection, we have designed a V-shaped spring clip. This allows the internal board to breathe through any temperature change. It always maintains a perfect connection no matter how harsh the environment.

Does your professional integrity matter? Think Wells. WELLS

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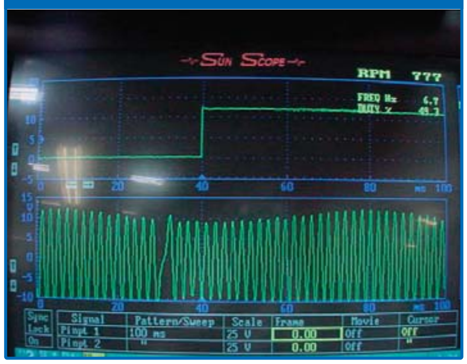
Case Study: No Snap Decisions

We pulled out a lab scope. A dual trace of the cam and crank sensors revealed the waveforms shown in Figure 1. You can see the sync pulse of the crank sensor and its relationship to the cam sensor, but this information means nothing if you don't know how it's supposed to look. So we hopped on the Internet, hoping that someone had saved a "known-good" cam/crank relationship waveform for one of these 3.8's. We got lucky and found a '95 Mustang 3.8 known-good.

Figure 1: Bad cam and crank sensor SYNC waveforms.



The cam sensor is a different design on the Mustang. But assuming nothing is different with the logic on these shaft sensors from one platform to another, it appeared we were off by 50 degrees. The crank sensor reluctor has a tooth every 10 degrees, with one missing for the sync — for a total of 35 teeth. It looked like it was time to pull the front cover.

Now is the time when you might start to question a diagnosis. What if we went through the work of pulling the timing cover and the chain were right on? After all, there was no chain noise. We decided to pull the front valve cover first, then watch the valves in relation to the crank. If the valve timing was off by 50 degrees, we should be able see it there. We had to unbolt the upper plenum to get the valve cover off, but this was still a lot easier than removing the timing cover. We created our own TDC mark on the balancer, then turned the engine over by hand while watching the valves. The valve timing was right on!

What was going on? Were we going down the wrong road? We put our heads together and brainstormed. We also began to doubt our known-good waveforms.

What if we flashed a timing light on the TDC mark we made? It may not be very accurate, but if the timing were way off, it would support the direction we were heading. So we did, and the timing was about 50 degrees off.

Think about it; the cam and crank sensors are inputs. The sensors report the position of the cam and crankshaft to the PCM, but they don't know if the information they send is *normal* or *abnormal* — it's just data. If the PCM can't tell the difference, either, it uses the data to calculate timing, etc. The timing light did tell us that the known-good waveforms appeared to be correct.

Now what? It was time for another brainstorming session. It looked like we were on the right track, but we didn't know what was causing the apparent timing error. One of my students suggested pulling the harmonic and having a look-see. So we removed it.

Figure 2 says it all. The hub of the balancer had broken off, allowing the balancer to spin in relation to the crank, then grab again. It probably stopped where it did because the engine could not develop enough torque to spin it any further. This is not a case of a balancer spinning on the rubber insulator. That would not have caused this problem since the reluctor is bolted to the center of the balancer.

Figure 2: Broken crank balancer and reluctor.

After a new balancer and an oil change, the Windstar ran great, rattling cat and all. But with the engine's normal torque restored, we could clearly hear a nasty rod knock. Good thing we didn't throw a bunch of parts at it.

Solving a tough one like this is very rewarding for everyone involved. It reminds me of the reasons why I enjoy fixing cars. WELLS

Dave Heinzen is the Automotive Program Director and a Driveability Instructor at Madison Area Technical College in Madison, WI. He has been at the college for five years. Prior to becoming an instructor, Dave spent 12 years as a technician and later a service manager at independent shops. He is an ASE Master, L1 and Service Consultant certified technician. Dave is also a member of ASA, iATN, NACAT and serves on the National Automotive Service Task Force.

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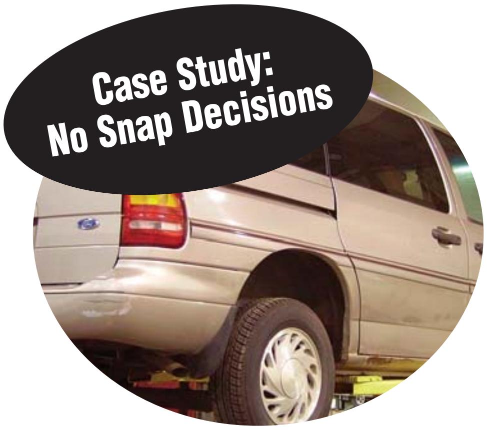

Quality Points

TPS Design Improvements

A good customer steps into your office and says his vehicle has a momentary hesitation when he accelerates at more than ¼ throttle. The engine also surges when cruising down the highway, but the surging stops upon a slight acceleration.

You grab your trusty lab scope to test the throttle position sensor (TPS). Sure enough, the TPS has a voltage dropout during a sweep test. Next, you inform the customer that the sensor needs to be replaced. The next decision you make is where to purchase the replacement TPS. Your customer has no idea what part is good; he's putting his trust in you. Do you replace the TPS with one that is prone to fail in the same manner or replace it with something better?

The majority of TPS failures are caused by one or more of the following: the circuit board cracks, the resistive ink wears through or the circuit board loses electrical connection. Wells uses a flexible circuit board that will not crack, even under the cruelest temperature conditions.

Dither and sweep tests are used by most manufacturers to verify TPS durability. Wells TPS's are laboratory tested to more than *two million* dither and sweep cycles — twice the OE specification. Our resistive ink is the best available in the automotive world.

A fracture in the solder connection between the circuit board and terminals is the most

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