VEHICLE Counter Point

Volume 11 Issue 1, Winter 2007

THE ELECTRONIC, DIAGNOSTIC AND DRIVEABILITY RESOURCE.

Present and Future Vehicle Powertrains - Are You Ready?

The over 100 year-old internal combustion engine has company on the road, with other new power-trains yet to come.

Concerns over dwindling oil reserves, seemingly ever-increasing fuel costs and tightening emissions standards have caused vehicle engineers to look beyond the internal combustion, gasoline engine as the primary propulsion source for the vehicles of today, and tomorrow. On today's roads, we see growing numbers of hybrid gas/electric vehicles, alternative fuel vehicles and diesel vehicles. In the not-so-distant future, we should also expect to see diesel/electric hybrids, plug-in hybrids, as well as hydrogen fuel cell-powered vehicles leave the laboratory and enter the ranks of everyday vehicles.

What will these changes mean to the service technicians of today and tomorrow? This is the first part of an overview of new and emerging vehicle power systems that is designed to give you an understanding of this new technology and provide a starting point to safely and effectively work on these vehicles.

Hybrid Vehicles

Gasoline/electric hybrids have been grabbing the headlines in recent months. Honda, Toyota, Ford and GM now offer hybrids in a variety of configurations and models. Sales of hybrid vehicles rose 28% in 2006, but growth in the segment was dominated by Toyota Motor Corp.'s Prius. Prius sales accounted for almost 43% of new hybrid sales for the year. Overall, U.S. consumers bought over 250,000 hybrids in 2006, up from nearly 200,000 a year earlier, as gasoline prices spiked to over $3 per gallon last summer.

In 2006, three California cities — Los Angeles, San Diego and San Francisco — together accounted for over 20% of all U.S. hybrid sales. Los Angeles, the country's second-largest city by population, accounted for over 12% of hybrid sales — more than any other market. California led Florida, Texas, New York and Virginia (in that order), when last year's state-by-state hybrid vehicle sales were tabulated.

If you don't live in one of those five states, is it safe to say that you won't need to worry about hybrids? The easy answer is "No." Although hybrids may still be a relative rarity in many parts of the country, their growing sales numbers would indicate that they will be around for several years. Now would be an excellent time for you to get the training you need, so your shop can hang out its "Hybrid Specialist" sign. These vehicles are going to be around at least until hydrogen-fueled vehicles are ready for primetime, and probably longer.

Hybrids offer vehicle manufacturers a relatively inexpensive way to increase fuel economy and reduce emissions, without having to ditch the familiar gasoline internal combustion engine. Current hybrid vehicles use a secondary power source to supplement a conventional gasoline engine. A *parallel hybrid* has a fuel tank that supplies gasoline to the engine and a set of batteries that supplies power to an electric motor (the secondary power source). Both the engine and the electric motor can power the vehicle at the same time, or independently. Depending on the manufacturer, the vehicle may use only the electric motor during low speed operation. When additional power is needed, output from the electric motor and the gasoline engine are combined. The gasoline engine is designed to work efficiently and cleanly at cruising speeds or during periods of low load, without extra help from the electric motor.

Some of the gasoline engine's energy is also devoted to keeping the batteries charged, via the hybrid charging system. Hybrid vehicles also use regenerative braking to recapture electrical energy during deceleration and braking. These systems keep the batteries charged at all times, without the need to plug the vehicle into an external battery charger when it is not in use.

Some manufacturers are also experimenting with *diesel/electric hybrids*. The concept is the same as a gasoline/electric hybrid, but the result may be an even more efficient vehicle due to the diesel engine's greater fuel efficiency and torque. Another hybrid variation is called a *plug-in hybrid*. These vehicles are powered by electric motors a greater percentage of the time, which

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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 have a 1998 Pontiac Grand Prix with a 3.8L engine (VIN 1) that has a misfire on cylinder #3. The misfire occurs all the time, but it is extremely noticeable on acceleration. The PCM reports thousands of misfires on #3 at the same time.

We first replaced all the spark plugs and the ignition control module, with no change. I compression-tested the #3 cylinder and it had 148 lbs of compression. Next, I put the spark tester on all of the cylinders, and guess what? Cylinder #3 was the only one that did not show a consistent spark. I then replaced the coil with a known-good part, with the same results. Next, I replaced the ignition wire on cylinder #3, and it still misfired.

What am I missing? I have replaced all of the secondary components and the control module, but I still have no spark on #3.

Tim Matthews
Richmond, VA

When you replaced the control module and coil first, without replacing the ignition wire, the #3 cylinder would still misfire and the control module and coil would be in danger of another failure. When a dielectric path is established in the coil, it could be an easier path back to the secondary winding, rather than firing the #3 spark plug on the compression stroke. This is one of the reasons it is always a good idea to replace the control module and coils at the same time and thoroughly check all other secondary ignition components before a restart.

Results: Tim again replaced the ignition coil for the #3 and #6 cylinders and the misfire was cured.

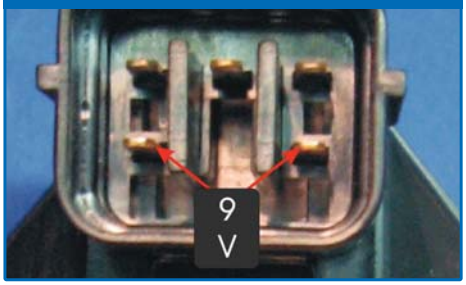
Perhaps you remember the problems George Breitengross wrote to us about in the last issue of *Counter Point*. Based on the information he'd received from the manufacturer's diagnostic tree, George was ready to replace the fuel injectors. Our advice to George is not to change those injectors just yet. One of the worst feelings in this business is when you have to call a customer to let them know that an 'educated guess' diagnosis didn't work out (I'm sure we all have been there). In this case, a mistake could end up costing the customer an extra $1,000.

Granted, the symptoms on the '00 Honda Odyssey George is working on could lead you to suspect bad injectors, but let's not jump to any conclusions. The best way I have found to deal with a manufacturer's diagnostic tree is to use it as a guide or as a way to gain a better understanding of the system, but not as a definitive answer.

Let's begin by looking at the facts, then we'll use them to figure out the cause of the problem. The Odyssey has a 3.5L engine with 92,000 miles. It has set codes P0172 (rich condition), P0300, P0301, P0302 and P0303 (misfires on cylinders 1, 2 and 3). The valves were adjusted 10,000 miles ago, the O_2 sensors seem to be working properly and the fuel trim is taking away 8 to 11% of the fuel. Most importantly, the engine runs great until the vehicle reaches 40 to 50 mph.

Okay, the first conclusion we can safely reach is that the engine is running rich. There are many things that can make an engine run rich. But how does the PCM know when this is happening? Of course, the O_2 sensors tell the PCM what is happening by sensing a lack of oxygen in the exhaust stream. What can cause a lack of oxygen in the exhaust stream? Either the cylinders are receiving too much fuel, which is taking the place of the oxygen, or sufficient oxygen is not available.

Apply 9 volts to the EGR valve's terminals shown to manually activate the valve and check EGR flow.



Back to our existing driveability information — what turns on or changes when a vehicle reaches 40 to 50 mph? This is when the EGR valve normally activates. On this engine, it's possible for the EGR to cause a misfire on some cylinders and not others because it utilizes an orifice setup similar to a 3.8L Ford engine.

If the EGR system is causing the problem, is there a way we can prove it? How about if the EGR valve is opened while the engine is idling? This can be accomplished through some scan tools, or you can simply jumper the two terminals shown in the photo in the previous column with a 9-volt battery.

Results: After receiving the information, George grabbed the first available 9-volt battery (it just happened to come from his wife's hearing aid). He energized the EGR and cylinders 1,2 and 3 began misfiring, but the engine continued to run. If the EGR passages are fully open and free of carbon deposits, applying full EGR at idle should kill the engine. George cleaned the EGR ports and the engine is running great again.

The first readers with the correct answer were:

Gordon Pocock
Highland Service Center
Newton, MA

Kevin Sorensen
Auto Diagnostics, Inc.
West Allis, WI

Diagnose The Problem Win A Shirt

I have a problem with a reoccurring diagnostic trouble code (DTC) P0410 (secondary air system performance) on a 2001 Chevrolet Blazer, equipped with a 4.3L, VIN W engine. I checked the related hoses and vacuum lines and they all looked healthy. Next, I found a service bulletin for the secondary air pump. After reading the bulletin, I replaced the pump because it had ice in it and did not rotate. I tried to run the pump with my scan tool and it would not turn ON. After some intense checking, I found and replaced the pump fuse under the battery tray. I can now turn the pump ON using my scan tool. The pump seems to be running fine. The problem is that after about five days of driving the Check Engine light comes back on and a code P0410 is again stored in the PCM. What else could be causing this code to return?

Tom Stephanie
Plymouth, MN

If you have the answer, please use the following contact information:

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Present and Future Vehicle Powertrains

increases fuel economy, but depletes the onboard battery charge more quickly. To make up for this deficit, a plug-in hybrid must be plugged into a battery charger when it is not in use.

Hybrid vehicles, like this Honda Civic, are becoming an increasingly common sight on the nation's roads. Adequate training is essential to assure safe and effective hybrid repair and service.

Page 1, 3 and 4 photos: Wieck Media.

Chevrolet recently introduced its Volt hybrid at the 2007 Detroit International Auto Show. The Volt uses its gasoline and electric motors in a unique manner. The vehicle is propelled by a battery-powered electric motor at all times. The gasoline engine's only job is to run a generator that keeps the electric motor's batteries charged, so it's tuned to run at a fixed speed for maximum efficiency and minimum emissions. The Volt is a plug-in hybrid, with a limited range on a single battery charge if the gasoline engine is not used to charge the batteries. In commuter use with nightly recharges, it may be unnecessary for the gasoline engine to start up and recharge the batteries. Fuel mileage for the Volt could be phenomenal under these circumstances, but the vehicle owner would have the additional expense of electricity used for the nightly recharges.

Perhaps the biggest question mark regarding hybrid vehicles of any sort is the high voltage battery pack. Hybrid critics have questioned how long these battery packs will last and how much they will cost the vehicle owner if they fail after the vehicle is out of warranty. So far, there have been no reported hybrid battery pack failures. The hope is that as the hybrid population grows, battery production costs will fall and the cost of battery replacement (if and when necessary) will follow.

What do you need to know if one of the current generation of gasoline/electric hybrids pulls into your shop? First of all, standing too close to a hybrid isn't going to turn you into a pillar of salt. But it is necessary to use proper caution when working on or around a hybrid. The high voltage battery pack that powers the three phase A/C electric motor is rated at anywhere from 144 to 330 volts, depending on the vehicle manufacturer. That kind of voltage is strong enough to kill you, with plenty left over. All hybrid vehicle manufacturers have gone to great lengths to build redundant safety systems into their vehicles, but caution still is in order. Before you begin, we recommend attending a hybrid training course, along with the purchase of the necessary test and safety equipment.

Flex Fuel Vehicles

At this time, conventional gasoline fuel is sold in a mixture of 90% gasoline and 10% ethanol. E85 refers to a special blend of fuel that's a mixture of 85% ethanol and 15% gasoline. In this country, corn is the primary basis for ethanol fuel production. In Brazil it's sugar cane.

Flex fuel vehicles (FFV) can run on E85, conventional gasoline fuel, or any combination of the two. From the outside, E85 vehicles don't look much different from other vehicles on the road. The manufacturer may put a "flex fuel" badge somewhere on the outside of the vehicle, but that's usually it. The National Ethanol Vehicle Coalition estimates that five million E-85 compatible vehicles have been sold in the United States, and more than 1200 service stations (mostly in the Midwest) offer E85.

E85's backers point to the fact that corn is a renewable resource, and oil is not. Substituting ethanol for gasoline reduces our dependence on oil, and imported oil in particular. It's backers also stress that E85 gasoline has the highest oxygen content of any fuel available today. It contains 80% less gum-forming compounds, like olefins found in gasoline. Production and use of E85 is claimed to result in a 35% reduction in greenhouse gas emissions.

In accordance with Corporate Average Fuel Economy (CAFE) regulations, automakers are currently required to achieve a "fleet average" of 27.5 mpg for cars and 21.5 mpg for trucks or face "gas-guzzler" taxes. To encourage vehicle manufacturers to produce E85-compatible vehicles, the EPA uses a special formula to determine the fuel mileage credit these vehicles receive for CAFE purposes. This formula means that flex fuel vehicles are credited with a much higher miles-per-gallon capability than they actually deliver. For example, an E85 SUV like the GMC Yukon is rated at 33 mpg for CAFE purposes, when it actually gets about 15 mpg in city driving and 20 mpg on the highway. The E85 Yukon and vehicles like it get even lower fuel mileage when running on fuels containing large concentrations of ethanol, because ethanol-based fuels contain less energy per gallon than conventional gasoline fuels.

A distinctive yellow gas cap identifies a vehicle that can run on E85 fuel, or a mixture of E85 and conventional gasoline. Service of these vehicles involves few surprises for a well-trained tech.

Making an E85-compatible vehicle requires changes to the fuel system because ethanol is more corrosive than gasoline and has different combustion characteristics. Onboard sensors monitor the fuel mixture and automatically adjust spark timing and fuel flow to optimize performance for gasoline with up to 85% ethanol. Other changes are made to the fuel system to protect it from potential corrosion damage. Adapting an existing gasoline vehicle to run on E85 is prohibited by the EPA, and no licensed aftermarket conversion companies exist to perform the service.

From a service standpoint, the primary difference on an E85 vehicle is the fuel sensor in the fuel line. The fuel sensor's job is to determine the presence and concentration of ethanol in the tank, and it accomplishes this in a very simple and straightforward manner – using temperature. Ethanol's temperature relative to the ambient temperature is different from conventional gasoline at the same ambient temperature. So if it's 70° outside, a tank of E85 will always register a lower temperature than an equivalent amount of conventional gasoline at the same ambient temperature. The temperature difference or offset would be greatest with a tank that contains 100% E85, and the offset would decrease as the mixture is diluted with the addition of conventional gasoline. The control unit makes engine management adjustments based on the fuel sensor's observed temperature offset.

In this first installment, we've given you an overview of two alternative powertrain systems that are already on the road. We intend to return to this subject in future *Counter Point* issues. WELLS

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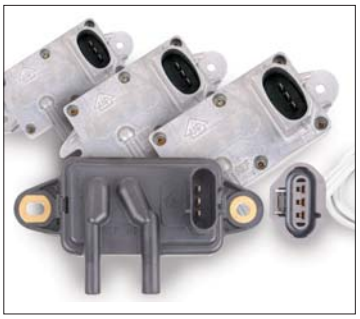
Return Service Requested

Quality Points

Great Customers... Great Manufacturers

In two previous *Counter Point* issues (Spring 2005 and Summer 2006), we reported the advantages of Wells Delta Pressure Feedback (DPFE) EGR sensors. Since then, several of our valued customers have expressed concern about potential problems with these sensors.



It was immediately determined that one of our DPFE sensor designs received elevated circuitry as an improvement modification. The elevation left a pressure sensor connection exposed after the epoxy potting process. During EGR monitoring, it was found that these terminals were exposed to very small amounts of exhaust gases. These gases interact with moisture, and highly corrosive sulfuric and nitric acids are formed. After prolonged exposure, the terminals deteriorate and open-circuit, causing a component failure. The terminals were, and still are, made of a top-grade copper with gold plating.

Mistakes are sometimes made, even with the best of intentions. It is at these times that we especially appreciate the candid and knowledgeable feedback we receive from the technicians who specify and install Wells products. It really is true: Great customers make great manufacturers!

The component was recalled during December 2006, and a new potting process was implemented to eliminate the possibility of further failures. It is important to note that only one of many Wells DPFE sensors was affected by this problem. All others continue to perform at the premium design level. Once again, thanks for the help! WELLS

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