WELLS Counter Point

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THE ELECTRONIC, DIAGNOSTIC AND DRIVEABILITY RESOURCE.

OBD II. . . An Introduction

The OBD II system is always on the lookout for anything that may cause an increase in vehicle emissions.

Previous *Counter Point* articles have examined the operation of key engine management system sensors and actuators. We've also provided the information needed to diagnose and repair these components in the field. At this point, you should have a solid understanding of the inner workings of a modern engine management system. We will next consider the engine management system's internal monitoring capabilities. We call these capabilities *on board diagnostics*, or OBD. These capabilities allow the engine management system to monitor its operation, and determine when a fault exists or system operation has deteriorated. Early OBD and feedback systems also included a means of retrieving diagnostic trouble codes (DTCs), to aid the service technician in repairing the system fault.

The first OBD systems were introduced in California in 1988, in response to emission control regulations enacted by the California Air Resources Board (CARB). These OBD systems were only capable of monitoring a few system inputs. If the signal from any of these inputs happened to become electrically open or shorted, due to a failure of the component or its wiring, the system's control unit could store a DTC and light the vehicle's Check Engine Light (CEL). If the failure happened to be an intermittent, the CEL might turn off as soon as the fault disappeared, possibly taking any stored DTCs along with it. Some system failures would never light the CEL.

These early OBD systems had some value, but they could be difficult to understand. Because no industry-wide standards existed, the OBD systems from every manufacturer could be (and often were) entirely different from the OBD systems from other manufacturers. Diagnostic codes, diagnostic methods, diagnostic connectors, diagnostic connector locations and diagnostic equipment were for the most part entirely manufacturer-specific. Some systems allowed access to serial diagnostic data, while others did not. Both the shape and the location of the diagnostic connectors varied from manufacturer to manufacturer and vehicle to vehicle. This required repair technicians to constantly add to their specialized tools, adapters and training, to extract the meager amount of diagnostic information these early OBD systems supplied.

OBD II (or On Board Diagnostics Version II) was introduced to address the shortcomings of the earlier systems. Some OBD II-compliant vehicles were introduced as early as 1994. By 1996, all vehicles sold in the United States were required by law to be equipped with an OBD II system. One of the *intentions* of OBD II was to eliminate the confusion of manufacturer-specific OBD systems, and replace them with standardized OBD II systems and a one-size-fits-all data link connector (DLC), like the one shown to the left.

While most would agree the OBD II regulations were an improvement over what preceded them, implementation of these new standards by the vehicle manufacturers has been something less than universal.

Why OBD II?

The primary goal of the OBD II system is to detect system or component problems that may cause vehicle emissions greater than 1.5 times the Federal Test Procedure (FTP) standard. Early OBD systems were passive systems that waited until engine management system problems occurred before they did anything. OBD II has added active diagnostic tests to the standard array of passive OBD tests. An OBD II system constantly monitors and performs functional tests on the engine management system operation, and is always on the lookout for anything that may cause an increase in vehicle emissions.

Because it is an active system, OBD II is also equipped to take action when it detects a fault that may increase vehicle emissions. Simply alerting the driver by turning on the Malfunction Indicator Light (MIL) is just part of the strategy. The OBD II system also has the ability to capture freeze frame data from the system at the moment the problem occurs (**Figure 1 on page 3**). The OBD II system can also control the operation of individual engine management system components, to limit the potential environmental and system damage until the vehicle can be properly repaired.

What OBD II Is Not

Even though its primary goal is to make sure that vehicle emissions stay within established limits, the OBD II system does not measure emissions directly. The OBD II system does not include an

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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: I have been working on a 1998 Pontiac Grand Am equipped with a 2.4 liter engine. The vehicle has 228,000 miles on it. The generator is not charging. I have replaced the generator twice and have also replaced and reprogrammed the PCM (at great expense). The generator still does not put out any current. What next?

Phil Kluskin, Phil's Service, New York, NY

This vehicle is equipped with a CS130D generator. The voltage regulator inside this generator has two wires running to it. Both wires are in circuit with the PCM. The L (Lamp) wire in this circuit conveys a 5 volt signal from the PCM to the voltage regulator, telling the generator to start charging. For example, during a cold/hard starting situation, the PCM will control when the generator activates through the L wire. The F (Field) wire is used to send a duty cycle signal back to the PCM, indicating the generator is charging.

We recently ran into the same symptoms on a similar vehicle. Several generators had been installed, and the PCM had also been replaced and reprogrammed. Here are the tests we conducted and the results we found:

- With the connector attached to the voltage regulator (KOEO), we read 3.7 volts at both the L and F wires.
- When we removed the connector from the regulator, we read 5 volts on the L wire and 0 volts on the F wire.
- The 5 volt reference indicated the PCM was operating normally and was trying to turn the generator on.
- We did a voltage drop test and checked for circuit shorts on both wires and found they were sound.
- Next we installed another generator.
- Before starting the engine, we checked voltages at the regulator harness connector with the connector removed (KOEO). We still had 5 volts at the L wire and 0 volts at the F wire.
- With the regulator connector plugged in and the engine off (KOEO), we read 2.6 volts at the L wire and 0 volts at the F wire.
- With the regulator connector plugged in and the engine running (KOER), we read 5.0 volts at the L wire and a pulse width modulated duty cycle input from the F wire. The generator was operating normally.
- After further investigation, it was learned the rebuilder who supplied the previous generators was applying 12 volts from an automotive battery through the L terminal to excite the generators during bench testing. The excess voltage damaged the generators *before they were installed.*

Results: After installing a generator from another source, the charging system functioned normally.

Diagnose The Problem Win A Shirt

I have been working on a 1996 Nissan Altima with about 70,000 miles on it. The 2.4 liter engine has a dead miss in cylinder number 3. I have checked the engine mechanical condition and everything is sound. I have replaced the distributor cap, rotor, ignition wires, coil and spark plugs. I don't get any fire with a spark tester on the number 3 ignition wire. I have good spark when I test the other cylinders. What could be wrong?

The first reader to respond with the most accurate answer via e-mail or fax, and the first reader to respond with the most accurate answer via snail-mail, will receive a Wells golf shirt. The answer will appear in the next issue.

Here's the answer to last issue's question regarding a 1994 Chevrolet Lumina with a number 5 cylinder miss.

With the information we have, we can be reasonably sure the ignition and fuel systems are working normally. Does a compression check mean the valves are working properly? Not necessarily. In this case, the exhaust cam lobe for the number 5 cylinder was worn. This cylinder would intake some air/fuel mixture, but it would be rich. This would cause an incomplete burn, explaining the black spark plug.

Remember, the vehicle's computer system *assumes* the engine is working properly. Run all engine mechanical tests *first* to make certain that assumption is correct, before you go through the 'high tech' checks.

Bruce Cook of Cook's Automotive of Bartow, Inc., Bartow, FL submitted the first correct e-mail or fax answer. The first correct regular mail answer was submitted by Ray Sherman, New Port Richey, FL.

Congratulations and thank you all for the many responses we received.

Quality Points

Wells Develops Advanced Knock Sensor Testing Procedure

Wells has recently implemented an advanced knock sensor testing procedure. Engineers at Wells have specifically programmed and modified PC-based testing equipment typically used to analyze electroacoustic transducers (microphones, loudspeakers, earphones and hearing aids) to assure conformance to specification. Once again, Wells is an innovator when it comes to quality assurance.

The testing procedure works as follows. Because a knock sensor is an electroacoustic transducer, it converts an acoustic input (engine vibration) into an electrical voltage signal that is sent to the vehicle's computer.

During the test, each sensor is excited with a programmed vibration to simulate the actual engine vibration range. The sensor's natural frequency and voltage output are measured and compared to specific limits.

The extra effort Wells puts into maintaining a benchmark of quality says a lot about how much we value our customers. Like all our parts, if a knock sensor doesn't pass our rigorous inspection process, it's history. We promise the knock sensors you buy from Wells will perform as designed. That means no customer complaints, less hassles and more profit for you.

Knock Sensor

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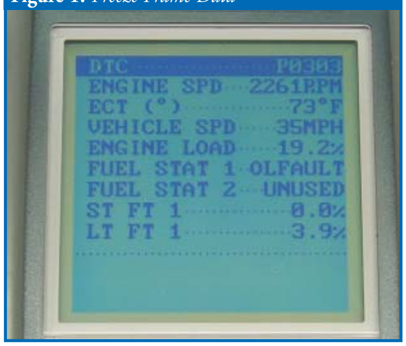
OBD II...An Introduction

on-board exhaust analyzer with the ability to directly measure the emissions produced by its host vehicle. Rather, it is constantly watching for problems that *could* cause an increase in vehicle emissions. If the OBD II system detects an emissions-related component or system failure that could cause tailpipe emissions greater than 1.5 times the FTP standard, it swings into action to limit the potential damage to the environment, as well as to the vehicle's catalytic converter.

Figure 1: *Freeze Frame Data*



Although it can alert the driver, reduce emissions and preserve the catalytic converter, OBD II is not an engine management system. It's integrated with the vehicle's engine management system, but it would be incorrect to consider them to be one in the same. The engine management system does its job, and as long as it is doing it correctly, the OBD II system stays out of its way.

Diagnostic Trouble Codes

The number of available DTCs in an OBD II system is much greater than in earlier OBD systems. This increase was also accompanied by an improvement in the *quality* of the information. OBD II DTCs tell us more about the nature of a particular fault, rather than simply pointing us in the general area of the fault.

For example, most early OBD systems had just one DTC to signal a TP sensor circuit problem. An OBD II system may have as many as five separate DTCs to define the nature of the fault. Using a generic vehicle as an example, DTC P0120 signals a basic TP sensor circuit malfunction. P0121 signals the TP sensor range or performance does not agree with the sensor data received from the MAP or MAF. P0122 indicates TP sensor voltage is low, and P0123 indicates TP sensor voltage is high. And finally, P0124 indicates an intermittent TP sensor circuit problem.

DTC Numbering System

OBD II also tried to bring standardization to the DTC numbering system, so each part of the alphanumeric OBD II DTC has a specific meaning. While the basic DTC definitions are supposed to be the same, there still may be subtle variations from manufacturer to manufacturer and from model to model. Let's break an OBD II DTC down, character by character:

• The first character is a letter of the alphabet which identifies the subsystem of the vehicle that is affected. P is a Powertrain DTC, B is a Body DTC, C is a Chassis DTC and U indicates a problem in the vehicle Network Communications System.

• The second character is a number indicating whether the DTC is a code assigned by the SAE (0), or by the vehicle manufacturer (1). 0 codes are generic, and the basic code definition for DTCs in this category should apply to all vehicles. However, this is one area where the implementation of the OBD II regulations has drifted from the original intent. You can expect to find variations in 0 code descriptions from manufacturer to manufacturer and from model to model. 1 codes are manufacturer-specific, and their meanings are defined by the individual vehicle manufacturers. 1 codes are necessary because vehicles from one manufacturer may have systems or features that are not present on vehicles produced by another manufacturer. There are also differences in 1 code definitions from model to model within a manufacturer's product line.

• The third character is a number from 1 to 9 which defines the affected vehicle subsystem. Looking at the third character in a TP sensor DTC P0121, we know the Air/Fuel Control system is the affected system. This is very helpful for zooming in on the problem.

• The fourth and fifth characters are a pair of numbers, similar to the old two number trouble codes that were used in early OBD and feedback systems. Because there are so many more possible DTCs in an OBD II system, it's difficult to find a direct DTC correlation between a DTC from an early OBD system and OBD II systems.

Because OBD II DTCs are five digits long, there are literally hundreds of possible DTC character combinations and definitions — too many for any one person to remember. Consult your service information sources for the precise DTC definitions and diagnostic procedures for the vehicle in your workbay (**Figure 2**).

Code Set Parameters

Each OBD II DTC has a set of conditions that must be satisfied before that particular DTC will set. These conditions are called code set parameters. Code set parameters are very precise, and they are also vehicle make and model specific. So the parameters that must be satisfied to set a DTC on one vehicle won't necessarily set the same DTC on a different vehicle, even if they were built in the same year and by the same manufacturer.

One of the functions of code set parameters is to keep the OBD II system from setting DTCs unnecessarily or prematurely, but the parameters also provide information that can be helpful in diagnosis. If you know the conditions that were present when the DTC was set, this information can be used to guide the tests you conduct during your diagnosis.

Figure 2: *DTC Descriptions*

Rationality Tests

OBD II retained the passive monitoring features of earlier OBD systems. The big improvement is that OBD II can also evaluate the validity of the readings it is receiving from individual sensor inputs. This is called rationality testing and it is accomplished by comparing sensor readings to one another, then evaluating the results based on what the OBD II system believes the readings *should be* under the circumstances. For example, there is no rational reason why the TP sensor should indicate the throttle is closed while the MAP or MAF and speed sensor are indicating the engine is under load. The operating conditions that would normally produce these sensor readings should not happen simultaneously. The OBD II system has been programmed to recognize this fact, and identify it as a fault.

By evaluating the data received from other input sensors, the OBD II system may be able to determine which of the sensors (TP, MAP or MAF) is producing the questionable data. The data received from all of the OBD II system's inputs must make sense in order to satisfy these OBD II rationality tests. Based on what we know about OBD II rationality tests and DTC descriptions, we might expect the vehicle in our example to set a DTC P0121.

We're Just Getting Started

It may seem there is an awful lot to learn about OBD II, but much of the new information is actually based on knowledge you already possess. The next *Counter Point* feature article will give you more OBD II information you can use to successfully diagnose and repair engine management system faults on late model OBD II-compliant vehicles. See you then.

WELLS

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CERTIFIED QS-9000 COMPANY

INSIDE:
OBD II

Hot off the Wire

Wells Manufacturing Corp. Adds New PNC Machine

With the automotive industry constantly demanding smaller and more accurate components, Wells sets the standard by acquiring a state-of-the-art Parallel Numerically Controlled (PNC) machine.

Wells PNC Machine

The Wells computerized dual axis mounting headstock PNC machine is capable of handling all grades of steel, brass, aluminum and stainless steel. It uses any size stock, up to ½-inch in diameter, to manufacture the complex pieces the industry demands. The PNC machine produces pieces that fit into many of the components Wells manufactures.

Wells PNC-machined parts

With a repeatable accuracy of between 0.00015 and 0.0002 inch, PNC machinery is also used extensively in the manufacturing of precision instruments for the dental and medical professions.

Wells is a QS9000-certified manufacturer of control modules, voltage regulators, starter solenoids, coils and sensors, just to name a few product categories.

Wells, again, steps forward to lead the industry by providing you with automotive components that are second to none.

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