WELLS Counter Point
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THE ELECTRONIC, DIAGNOSTIC AND DRIVEABILITY RESOURCE.

# OBD II...Part Two

Many OBD II-compliant vehicles are finding their way into independent repair shops. Could there be a better time to learn what makes OBD II tick?

Our previous *Counter Point* gave you a brief introduction to OBD II. In it we explained why the system was introduced and what it was intended to accomplish. We also gave you some basic information on diagnostic trouble codes (DTCs) and how (and when) the PCM decides to set them.

OBD II represents a new technology and a new language. Even though we were first exposed to OBD II in the middle of the last decade, many of us are struggling to understand what it all means. At the same time, many OBD II-compliant vehicles have completed their emissions warranty period and are finding their way into independent repair shops. Could there be a better time to learn what makes OBD II tick?

In this issue, we'll begin with some additional DTC information. From there, we'll increase your understanding of some new terms and concepts, including freeze frame data, monitors, enabling criteria and trips.

## More DTC Discussion

Perhaps you've heard the terms 'One-Trip' and 'Two-Trip' used to describe the different kinds of DTCs. They may also be referred to as Type-A or Type-B DTCs.
A trip begins with a warm-up cycle. A warm-up cycle consists of a key-on, followed by an engine start-up that allows the engine temperature to reach at least 160 degrees, with an increase in temperature of more than 39 degrees.

A One-Trip DTC signals a fault that requires immediate attention. If the PCM detects a One-Trip fault, the DTC and freeze frame data are stored and the MIL is turned ON instantly.
A One-Trip DTC is prompted by a condition that may cause immediate damage to the catalytic converter, or raise the emission level more than 1.5 times the EPA standard. Since OBD II's main goal is to maintain low emissions, anything that might damage the converter gets prompt attention from the PCM and the OBD II system.

A Two-Trip DTC represents a possible problem that has been detected by the PCM, but it has reserved judgement on the importance of the fault until it can review more information. Two-Trip DTCs fall into two sub-categories: those involving fuel or misfire problems and those that don't.

If the PCM detects a Two-Trip fuel or misfire fault during the first trip, it will set a pending DTC and store freeze frame data at that moment. If the fault reoccurs, the MIL will illuminate. Because fuel and misfire faults are so closely related to maintaining low emissions, the PCM will test the affected circuit repeatedly for the next 80 trips. If the PCM detects a fault during *any* of these 80 trips that is within 375 rpm, 10 percent of engine load and near the engine temperature of the first failure, it will keep the freeze frame data from the first occurrence and turn the MIL on.

Detected Two-Trip problems that do not involve fuel or misfire faults are handled a little differently. The PCM stores freeze frame data when a problem occurs during the first trip. If the same problem repeats within the next 40 trips, the PCM will then turn the MIL on. If nothing out of the ordinary happens during the next 40 trips, the PCM starts over.

Once a DTC has been stored (both One-Trip and Two-Trip), it remains in memory until it is erased by a command from a scan tool or by removing power to the PCM until the Keep Alive Memory (KAM) has been erased. The PCM may also conduct further tests to see if the component will pass a later test. If the component passes the monitor tests during three consecutive trips, the MIL will be turned off, but the DTC will still remain in memory.

## Freeze Frame Data

A freeze frame is a single frame snapshot of key parameters, recorded at the moment a fault occurs and a DTC is stored by the PCM. This information can be retrieved by most OBD II-compliant scan tools. A freeze frame may include some or all of the following information:
- DTC description,
- Engine speed,
- Engine temperature,
- Vehicle speed,
- Engine load,
- MAP (or MAF) value,
- Fuel status (open or closed loop),
- Short and long term fuel trim status.

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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 a 1992 Buick Lesabre with a 3800 V- 6 engine. I have replaced the Crankshaft Position Sensor several times. Each lasts a few months before it fails. When I remove the defective sensor, it has rub marks from where the harmonic balancer blades have rubbed through it. How do I install the sensor so the blades won't rub through the sensor?**

*Marvin Hisel, Dependable Repair, Philadelphia PA*

Remove the balancer and inspect the interrupter ring blades. One or more of the blades may be bent. The ring may also come loose from the balancer. Replace the harmonic balancer if any of the blades are distorted or loose. A tool is available to align the sensor and blades. If this tool is not readily available, cut a strip of plastic 1/2-inch wide and 2-3 inches long. A milk container works well — the thickness of the plastic just fits over the blades on the balancer and between the grooves on the sensor. Bend the plastic strip in half and hang it over a blade on the balancer, then slide the balancer onto the crankshaft. Carefully adjust the sensor to fit over the plastic-covered blade. Tighten the pedestal pinch bolt to 26-44 in. lbs. Overtightening the pinch bolt will damage the sensor. Remove the plastic strip and slowly rotate the crankshaft with a wrench while observing the gap. There should be an even gap on each side of the blades while they are in the sensor groove.

**Here's the answer to last issue's question regarding the 1996 Nissan Altima with a #3 cylinder misfire.**

This vehicle has an optical camshaft position sensor (CMP) inside a horizontally-mounted distributor. A worn distributor bushing allowed oil into the outer portion of the housing, where it found its way to a few adjacent trigger slits and one 90° slit on the rotor plate. This blocked the signal between the light-emitting diodes and the photo diodes of the CMP — shutting down the trigger signal to the ECM for the #3 cylinder.

**Results:** Removing the oil with a shot of carburetor cleaner restored the missing CMP signal. However, to prevent any reoccurrence, the distributor was replaced to correct the worn bushing.

*Al Olivarez from Firestone in Dallas, Texas, sent the '96 Nissan question last quarter. Remy Ashley of Remy's Garage in Ingleside, Texas, faxed or e-mailed the first correct answer. Steve Collelo of Envirotest in Oak Creek, Wisconsin, snailmailed the first correct answer. All three readers will receive Wells golf shirts.*

## *Diagnose The Problem* Win A Shirt

**Q: I've been working on a 1993 Dodge Dakota with a 3.9L engine. About five minutes after a cold start, the engine will begin to run very rough, backfire through the throttle body and occasionally die. The symptoms almost always disappear after the engine has completely warmed up. I've checked fuel pressure and volume when the engine was running poorly, and they are right at spec. I've replaced the distributor cap, rotor, wires, spark plugs and computer with no improvement. 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.*

# *Hot off the* Wire

## ISO 14001 Certification

Wells Manufacturing Corp. is currently working toward ISO (International Standardization Organization) 14001 certification. We are one of the first automotive aftermarket companies to do so. General Motors, Daimler Chrysler Corporation and Ford Motor Company have announced they will require their suppliers to be ISO 14001 certified by December 31, 2002.

ISO 14001 certification requires Wells Manufacturing Corp. to monitor and control the effects on the environment of its activities, products and services. All materials entering our plants will be evaluated as to their potential environmental effects (positive or negative). ISO 14001 also considers the final disposition of a company's products when the useful life has ended. The buildings and manufacturing equipment are also being evaluated to ensure all drains and ventilation systems are properly installed and maintained.

Wells Manufacturing Corp. will be using ISO 14001 to identify and improve energy usage, waste creation, disposal and general environmental awareness. ISO 14001 certification is your assurance that the Wells part or component you install is of the highest quality, is the most reasonably priced and is friendly to the environment.

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## OBD II...Part Two

While these freeze frame records may not tell you exactly what caused the fault that triggered the DTC, combining them with the diagnostic procedure for the DTC set should be enough to get you pointed in the right direction. You can use this data to recreate the problem when it occurred. (**Figure 1**)

**Figure 1:** *Freeze Frame Data*


Freeze frame data can be overwritten if another fault of a higher priority is detected and stored later. Remember, all freeze frame data is lost when DTCs are erased using your scan tool, or when battery power is removed long enough from the PCM to erase KAM. This is why it is so important to always review all freeze frame data before you erase DTCs. Once it's gone, there's no way to retrieve the information, until the next time a fault is detected.

### *Monitors*

A monitor is an organized means of testing a specific part of the system. Individual monitors are designed to test components and subsystems. If a component or subsystem failure is detected while a monitor is running, a DTC will be stored and the MIL illuminated by the second trip. There are two types of monitors: continuous and non-continuous.

### *Continuous Monitors*

As required conditions are met, continuous monitors begin to run. These continuous monitors will run for the remainder of the vehicle drive cycle. The three **Continuous Monitors** are:

**Comprehensive Component Monitor** – This monitor watches the sensors and actuators in the OBD II system. Sensor values are constantly compared to 'known-good' values stored in the PCM's memory.

These tests are designed to make sure the components are performing properly. For example, is the component open or shorted? These basic *functionality tests* are a carryover from OBD I and the feedback system, but they are supplemented by *rationality tests* in an OBD II system. Rationality tests determine whether the data received from the various system sensors makes sense to the PCM or seems rational as compared to other sensor outputs.

**Misfire Monitor** – This monitor looks at engine misfire. If a small misfire is detected, the PCM will make a note of it, then check to see whether the misfire repeats. If the misfire is deemed serious enough to cause immediate damage to the catalytic converter, or emissions to exceed 1.5 times the EPA standard, the PCM will illuminate the MIL immediately.

**Fuel Monitor** – The PCM continuously monitors short and long-term fuel trim. Constantly updated adaptive fuel tables are stored in long term memory (KAM), and used by the PCM for compensation due to wear and aging of the fuel system components. The MIL will illuminate when the PCM determines the fuel trim values have reached and stayed at their limits for too long a period of time.

## Non-Continuous Monitors

Non-continuous monitors run (at most) once per vehicle drive cycle. A monitor is really just another word for 'test,' and each non-continuous monitor has a beginning, middle and end. A monitor may be paused or stopped before completion due to a variety of factors.

The **Non-Continuous Monitors** are:

**Oxygen Sensor Monitor**
**Oxygen Sensor Heater Monitor**
**Catalyst Monitor**
**EGR Monitor**
**EVAP Monitor**
**Secondary AIR Monitor**
**Transmission Monitor**

Once a non-continuous monitor has run to completion, it won't be run again until the conditions are met during the next vehicle drive cycle. Also after a non-continuous monitor has run to completion, the Readiness Status on your scan tool will show *Complete* or *Done* for that monitor. Monitors that have not run to completion will show up on your scanner as *Incomplete*.

## Enabling Criteria

With so many different tests (monitors) to run, the PCM needs an internal director to keep track of when each monitor should run. Different manufacturers have different names for this director — some call it the Diagnostic Executive, while others call it the Task Manager. Each monitor has *enabling criteria*. These criteria are a set of conditions that must be met before the Task Manager will give the go-ahead for each monitor to run. Most enabling criteria follow simple logic. Two examples:

- The Task Manager won't authorize the start of the Oxygen Sensor Monitor until the engine has reached operating temperature and the system has entered closed loop.
- The Task Manager won't authorize the start of the EGR Monitor when the engine is at idle, because the EGR is always closed at this time.

Because each monitor is responsible for testing a different part of the system, the enabling criteria can differ greatly from one monitor to the next. It's up to the Task Manager to decide when each monitor should run, and in what order, to avoid confusion.

There may be a *conflict* if two monitors were to run at the same time. The results of one monitor might also be tainted if a second monitor were to run simultaneously. In cases like this, the Task Manager decides which monitor has a higher priority, and should be run first. Some monitors also depend on the results of other monitors before they can run.

A monitor may be classified as *pending* if a failed sensor or other system fault is keeping it from running on schedule.

The Task Manager may *suspend* a monitor if the conditions are not correct to continue. For example, if the catalyst monitor is running during a road test and the PCM detects a misfire, the catalyst monitor will be suspended for the duration of the misfire.

## Monitors and Stored DTCs

If a pending DTC is held in memory, this may keep the system from running all of its monitors. For example, if a failed oxygen sensor DTC is stored in memory, the oxygen sensor monitor will not be able to run. The catalyst monitor depends on the completion of the oxygen sensor monitor, so if the oxygen sensor monitor hasn't run due to an oxygen sensor DTC, the oxygen sensor and catalyst monitor readiness status will remain pending or incomplete.

It's also possible that a monitor won't run during a given vehicle drive cycle simply because the enabling criteria weren't met or there were too many other interruptions during that cycle. The Task Manager will make an electronic note of this and will watch for an opening when the appropriate enabling criteria are met during the next vehicle drive cycle.

## Trips

One of the problems technicians have run into with OBD II diagnosis and repair is the ability to verify the success of a repair with certainty. How can you be absolutely sure the vehicle has been successfully repaired if you are unable to duplicate the driving conditions necessary for the appropriate monitor to run to completion?

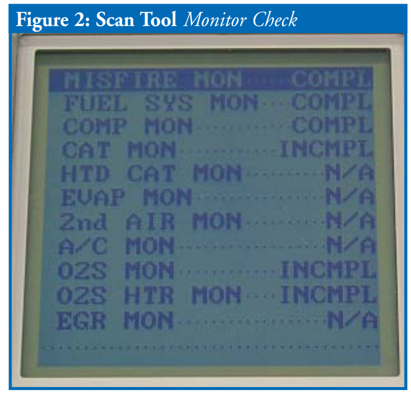
This situation has improved as we have learned more about the enabling criteria each monitor needs to see before it will run. When all of the enabling criteria are combined in the proper order and at the proper time, this series of events is called a *trip*. A trip is a set of driving conditions that are tailor-made to provide the enabling criteria necessary for a particular monitor to run. Since each monitor has its own set of enabling criteria, the definition of a trip is also different for each monitor.

If the vehicle manufacturer provides us with full information on enabling criteria for each monitor, it is possible to drive the vehicle in a manner that duplicates the trip requirements for individual monitors. A carefully planned trip which includes all of the necessary enabling criteria should allow the selected monitor to run to completion in a reasonable length of time.

## Monitors and Emissions Testing

Some states are performing emission test procedures via the OBD II data link connector. During the test, the operator will check whether the monitors have run to

**Figure 2: Scan Tool** *Monitor Check*




completion and passed (**Figure 2**). Each testing area in the country has the right to rule whether or not all monitors must pass or be completed. Due to special conditions in certain areas some tests may not be able to run to completion. If the correct number of monitors have not passed, the testing facility will revert to a tailpipe gas analysis.

## OBD II Case Study

We've familiarized ourselves with the basic language and technology of the OBD II system, and we're ready to tackle an OBD II diagnostic problem. In the next issue of the Wells *Counter Point* we will examine some of these real-world problems.

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INSIDE:
OBD II

# Quality Points

## Wells Clean Room

Today's marketplace demands high-quality products at competitive prices. Direct control of the manufacturing process assures these needs are satisfied. To that end, Wells Manufacturing Corp. has produced ceramic substrates in its state-of-the-art Clean Room for the past several years.

The Clean Room environment is maintained at 70°F, and a relative humidity of 45 percent. Before entering the Clean Room, all personnel must cross an electrostatic mat and wear a lint-less smock, hair net and finger cots. Lint and hair are electrically conductive and will short a circuit board.

The ceramic substrate manufacturing process begins as the screen printer deposits the palladium/silver conductor onto substrate blanks. To remove any solvents on the ink screen-print, a conveyer moves the substrates to the dryer/furnace, where they are heated to a temperature of 170°C (338°F). Substrates are next heated in a large furnace to 850°C (1562°F) for 10 minutes, then slowly cooled. This

Wells
Clean Room

permanently attaches the conductor metal to the ceramic substrates. Resistors next complete another screen printer procedure. The substrates then revisit the dryer/furnace, to repeat the heating/cooling process described earlier and permanently attach the resistors to the substrates. The last printing process applies a green overglaze to the substrates — protection from the harsh underhood environment. Finally, a laser trims the resistors to a very tight tolerance.

The Wells Manufacturing Corp. self-contained Clean Room is unmatched by any manufacturer of engine management components in the automotive aftermarket. *It comes down to controlling our own destiny.*

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