OBD II GENERIC PID DIAGNOSIS

By Karl Seyfert

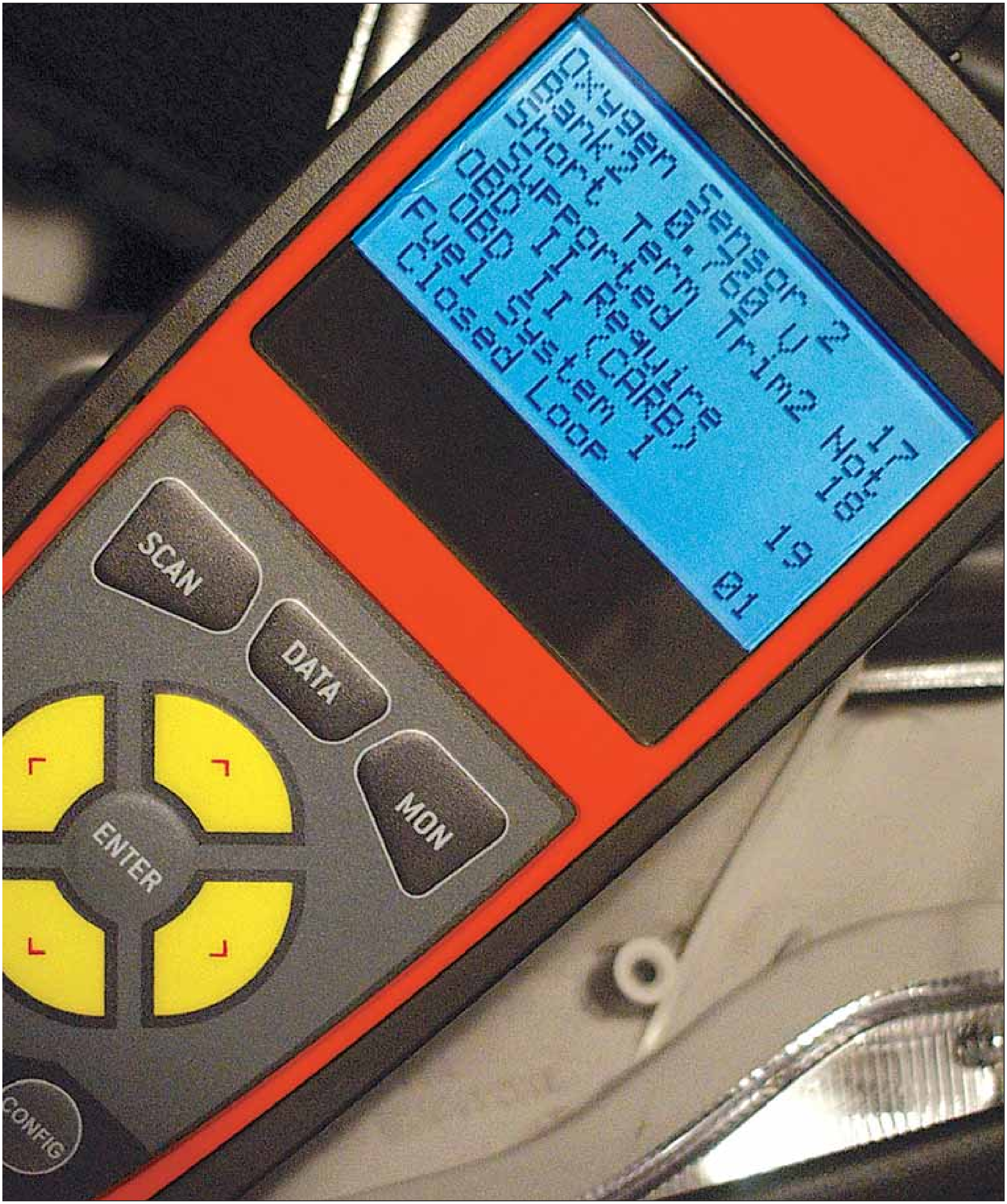
A wealth of diagnostic information is available on late-model OBD II-compliant vehicles, even when 'enhanced' or 'manufacturer-specific' PIDs are not accessible. It doesn't take much to use this information to its best advantage.

Photo: Karl Seyfert

Some scan tools call it the *global OBD II mode*, while others describe it as the *OBD II generic mode*. The OBD II generic mode allows a technician to attach his scan tool to an OBD II-compliant vehicle and begin collecting data without entering any VIN information into the scan tool. You may need to specifically select "OBD II Generic" from the scan tool menu. Some scan tools may need a software module or personality key before they'll work in generic OBD II test mode.

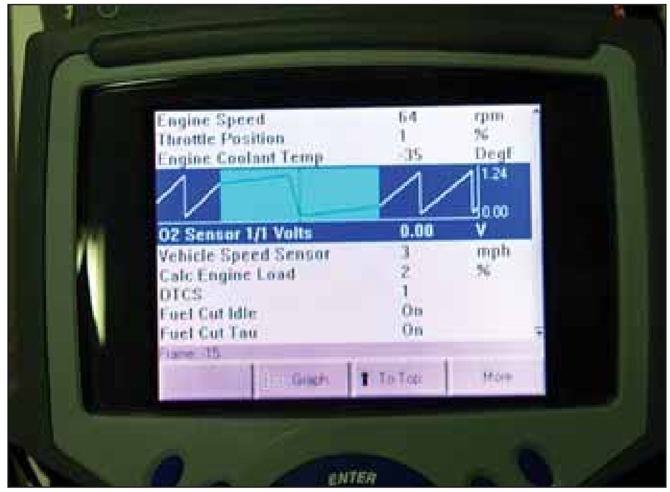
The original list of generic data parameters mandated by OBD II and described in SAE J1979 was short and designed to provide critical system data only. The useful types of data we can retrieve from OBD II generic include short-term and long-term fuel trim values, oxygen sensor voltages, engine and intake air temperatures, MAF or MAP values, rpm, calculated load, spark timing and diagnostic trouble code (DTC) count. Freeze frame data and readiness status also are available in OBD II generic mode. A generic scan tool also should be able to erase trouble codes and freeze frame data when commanded to do so.

Data coming to the scan tool through the mandated OBD II generic interface may not arrive as fast as data sent over one of the dedicated data link connector (DLC) terminals. The vehicle manufacturer has the option of using a faster data transfer speed on other DLC pins. Data on the generic interface also may not be as complete as the information you'll get on many manufacturer-


Oxygen Sensor 2 17
Bank2 0.760 V
Short Term Trim2 Not
Supported 18
OBD II Require
OBD II (CARB) 19
Fuel System 1 01
Closed Loop
SCAN
DATA
MON
ENTER
CONFIG

Photos: Karl Seyfert

Here's a basic scanner display showing OBD II generic PIDs. Slow-changing PIDs like IAT and ECT can be followed fairly easily in this format, but it's difficult to spot glitches in faster moving PIDs like Spark Advance.



This scan tool also allows the user to graph some PIDs, while continuing to display the others in conventional numeric format. Due to OBD II's refresh capabilities on some vehicles, it's best to limit your PID choices to those directly related to your diagnostic approach.

specific or enhanced interfaces. For example, you may see an engine coolant temperature (ECT) value in degrees on the OBD II generic parameter identification (PID) list. A manufacturer-specific data list may display ECT status in Fahrenheit or Celsius and add a separate PID for the ECT signal voltage. In spite of these and other limitations, OBD II generic mode still contains many of the trouble codes, freeze frame data and basic datastream information needed to solve many emissions-related issues.

There are nine modes of operation described in the original J1979 OBD II standard. They are:

Mode 1: Show current data
Mode 2: Show freeze frame data
Mode 3: Show stored trouble codes
Mode 4: Clear trouble codes and stored values
Mode 5: Test results, oxygen sensors
Mode 6: Test results, noncontinuously monitored
Mode 7: Show pending trouble codes
Mode 8: Special control mode
Mode 9: Request vehicle information

Modes 1 and 2 are basically identical. Mode 1 provides current information, Mode 2 a snapshot of the same data taken at the point when the last diagnostic trouble code was set. The exceptions are PID 01, which is available only in Mode 1, and PID 02, available only in Mode 2. If Mode 2 PID 02 returns zero, then there's no snapshot and all other Mode 2 data is meaningless. Vehicle manufacturers are not required to support all modes. Each manufacturer may define additional modes above Mode 9 for other information.

Most vehicles from the J1979 era supported 13 to 20 parameters. The recent phase-in of new parameters will make OBD II generic data even more valuable. The California Air Resources Board (CARB) revisions to OBD II CAN-equipped vehicles have increased the number of potential generic parameters to more than a hundred. Not all vehicles will support all PIDs, and there are many manufacturer-defined PIDs that are not included in the OBD II standard. Even so, the quality and quantity of data have increased significantly. For more information on the new PIDs that were added to 2004 and later CAN-equipped vehicles, refer to Bob Pattengale's article "Interpreting Generic Scan Data" in the March 2005 issue of MOTOR. A PDF copy of the article can be downloaded at *www.motor.com*.

Photo courtesy Snap-on Diagnostics

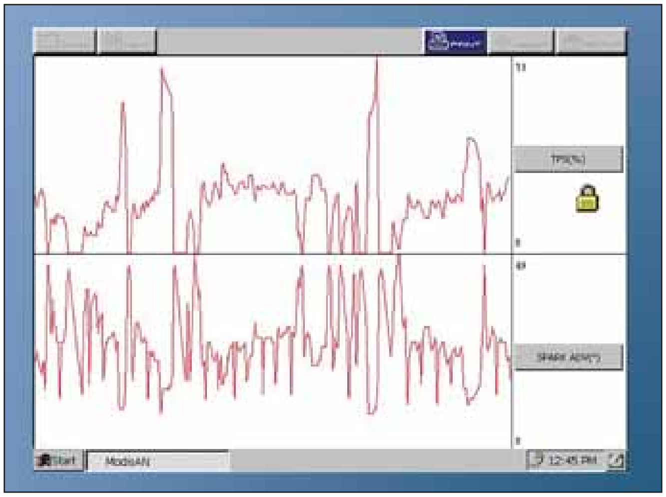
This photo illustrates how far PID data collection and display have come. Several hundred thousand techs are still using the original Snap-on "brick" (on the left), which displays a limited amount of PID data on its screen. Scrolling up or down revealed more PIDs. The color version on the right brought graphing capability to the brick, and extended the product's life span by several years.

Establish a Baseline

If you're repairing a vehicle that has stored one or more DTCs, make sure you collect the freeze frame data before erasing the stored codes. This data can be used for comparison after your repairs. The "before" freeze frame shot and its PID data establish the baseline.

As you begin your diagnosis, correct basic problems first—loose belts, weak batteries, corroded cables, low coolant levels and the like. The battery and charging system are especially important, due to their effect on vehicle electronics. A good battery, a properly functioning alternator and good connections at power and ground circuits are essential. You can't assume that OBD II will detect a voltage supply problem that can affect the entire system. If you have an intermittent problem that comes and goes, or random problems that don't follow a logical pattern, check the grounds for the PCM and any other controller in the vehicle.

If the basics check out, focus your diagnosis on critical engine parameters and sensors first. Write down what you find; there's too much information to keep it all in your head. Add any information collected from the vehicle owner regarding vehicle performance. Jot down the battery voltage and the results of any simple tests, such as fuel pressure or engine vacuum. Look at the Readiness Status display to see if there are any monitors that aren't running to completion.



Screen capture: Jorge Menchu

The Snap-on MODIS is a combination scanner, lab/ignition scope, DVOM and Troubleshooter. In scanner mode, MODIS can graph several parameters simultaneously, as seen in this screen capture. Remember, although these may look like scope patterns, the reporting rate for PID data on a scanner isn't nearly as fast.

Datastream Analysis

Take your time when you begin looking at the live OBD II datastream. If you select too many items at one time, the scan tool update will slow. The more PIDs you select, the slower the update rate will be. Look carefully at the PIDs and their values. Is there one line of data that seems wrong? Compare data items to one another.

Do MAP and BARO agree key on, engine off (KOEO)? Are IAT and ECT the same when the engine is cold KOEO? The ECT and IAT should be within 5°F of each other. ECT should reach operating temperature, preferably 190°F or higher. If the ECT is too low, the PCM may richen the fuel mixture to compensate for a (perceived) cold-engine condition. IAT should read ambient temperature or close to underhood temperature, depending on the location of the sensor.

Is the battery voltage good KOEO? Is the charging voltage adequate when the engine starts? Do the MAP and BARO readings seem logical? Do the IAC counts look too high or too low? Compare data items to known-good values you'd expect to see for similar operating conditions on similar vehicles.

Check short-term fuel trim (STFT) and long-term fuel trim (LTFT). Fuel trim is a key diagnostic parameter and tells you what the computer is doing to control fuel delivery and how the adaptive strategy is operating. STFT and LTFT are expressed as a percentage, with the ideal range being within ±5%. Positive fuel trim percentages indicate that the powertrain control module (PCM) is attempting to enrichen the fuel mixture to compensate for a perceived lean condition. Negative fuel trim percentages indicate that the PCM is attempting to enlean the fuel mixture to compensate for a perceived rich condition. STFT will normally sweep rapidly between enrichment and enleanment, while LTFT will remain more stable. If either STFT or LTFT exceeds ±10%, this should alert you to a potential problem.


Photo courtesy SPX/OTC

An on-screen description of the PID displayed below the graphing data may help you to understand what you're looking at, and avoid misunderstandings with measurement units.

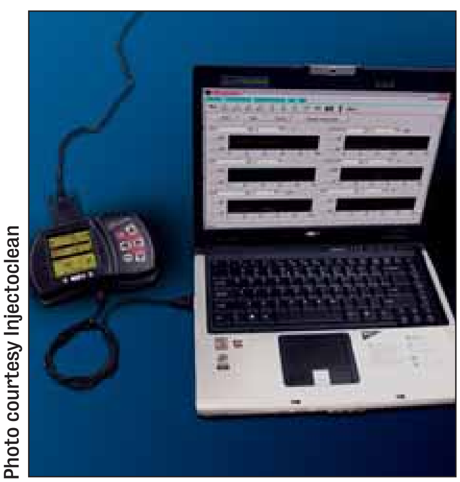
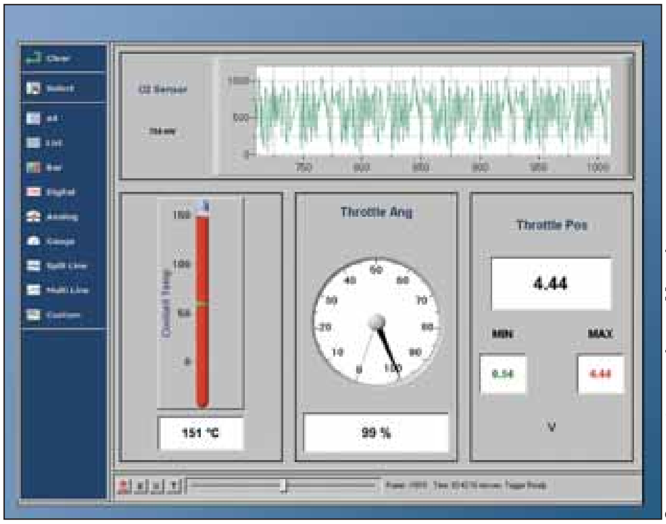


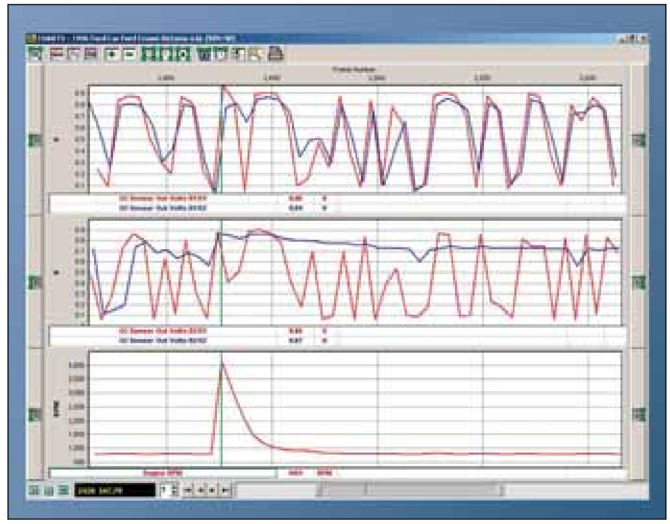
Photo courtesy Injectoclean

When scan tool screen real estate is limited, porting the scan tool into a laptop or desktop PC allows you to graph more PIDs simultaneously. The PC's much larger memory capacity also makes it possible to collect PID data in movie format for later playback and analysis.



Screen captures: Jorge Menchu

Graphs aren't the only way to display PID data. Once transferred to the PC with its greater screen real estate, PID data can be converted to formats that relate to the data. A red thermometer scale is much easier to follow than changing numbers on a scan tool.



PC-based scan tools excel at capturing and displaying large amounts of PID data for later analysis. Graphing the data, then analyzing it on-screen, may allow you to spot inconsistencies and provides an easy method for overlaying similar or related PID data.

Determine if the condition exists in more than one operating range. Check fuel trim at idle, at 1500 rpm and at 2500 rpm. If LTFT B1 is 20% at idle but corrects to 5% at both 1500 and 2500 rpm, focus your diagnosis on factors that can cause a lean condition at idle, such as a vacuum leak. If the condition exists in all rpm ranges, the cause is more likely to be fuel-related, such as a bad fuel pump, restricted injectors, etc.

Fuel trim can also be used to identify which bank of cylinders is causing a problem on bank-to-bank fuel control engines. For example, if LTFT B1 is −25% and LTFT B2 is 5%, the source of the problem is associated with B1 cylinders only, and your diagnosis should focus on factors related to B1 cylinders only.

The following parameters could affect fuel trim or provide additional diagnostic information. Also, even if fuel trim is not a concern, you might find an indication of another problem when reviewing these parameters:

Fuel System 1 Status and Fuel System 2 Status should be in closed-loop (CL). If the PCM is not able to achieve CL, the fuel trim data may not be accurate.

If the system includes one, the mass airflow (MAF) sensor measures the amount of air flowing into the engine. The PCM uses this information to calculate the amount of fuel that should be delivered to achieve the desired air/fuel mixture. Check the MAF sensor for accuracy in various rpm ranges, including wide-open throttle (WOT), and compare it with the manufacturer's recommendations.

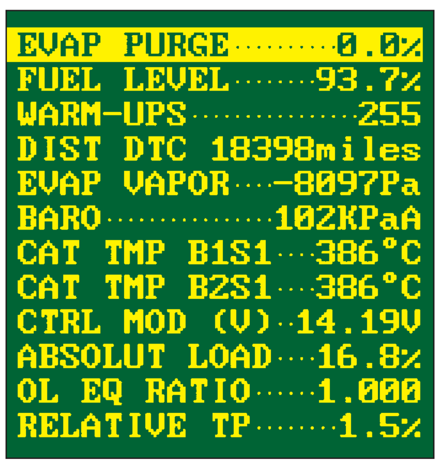
When checking MAF sensor readings, be sure to identify the unit of measurement. The scan tool may report the information in grams per second (gm/S) or pounds per minute (lb/min). Some technicians replace the sensor, only to realize later that the scan tool was not set correctly. Some scan tools let you change the units of measurement for different PIDs so the scan tool matches the specification in your reference manual. Most scan tools let you switch easily between Fahrenheit and Celsius temperature scales, for example. But MAF specs can be confusing when the scan tool shows lb/min and we have a spec for gm/S. Here are a few common conversion formulas, in case your scan tool doesn't support all of these units of measurement:

Degrees Fahrenheit − 32 × 5/9 = Degrees Celsius

Degrees Celsius × 9/5 + 32 = Degrees Fahrenheit

lb/min × 7.5 = gm/S

gm/S × 1.32 = lb/min



Screen capture courtesy Bosch Diagnostics

Here's a peek at some of the additional PID data that's available on late-model vehicles. This screen capture was taken from a CAN-enabled 2005 vehicle, and includes PIDs for EVAP PURGE, FUEL LEVEL and WARM-UPS, as well as familiar PIDs like BARO. This much PID data in generic mode should aid in diagnosis when manufacturer-specific PID data is not available.

The Manifold Absolute Pressure (MAP) Sensor PID, if available, indicates manifold pressure, which is used by the PCM to calculate engine load. The reading is normally displayed in inches of mercury (in./Hg). Don't confuse the MAP sensor parameter with intake manifold vacuum; they're not the same. Use this formula: barometric pressure (BARO) − MAP = intake manifold vacuum. For example, BARO (27.5 in./Hg) − MAP (10.5) = intake manifold vacuum (17.0 in./Hg). Some vehicles are equipped with only a MAF sensor, some have only a MAP sensor and some are equipped with both.

The PIDs for Oxygen Sensor Output Voltage B1S1, B2S1, B1S2, etc., are used by the PCM to control fuel mixture and to detect catalytic converter degradation. The scan tool can be used to check basic sensor operation. The sensor must exceed .8 volt and drop below .2 volt, and the transition from low to high and high to low should be quick. A good snap throttle test will verify the sensor's ability to achieve the .8 and .2 voltage limits. If this method doesn't work, use a bottle of propane to manually richen the fuel mixture to check the oxygen sensor's maximum voltage output. To check the sensor's low voltage range, simply create a lean condition and check the voltage.

Remember, your scan tool is not a lab scope. You're not measuring the sensor in real time. The PCM receives the data from the oxygen sensor, processes it, then reports it to the scan tool. Also, a fundamental OBD II generic limitation is the speed at which that data is delivered to the scan tool. In most cases, the fastest possible data rate is approximately 10 times a second, with only one parameter selected. If you're requesting and/or displaying 10 parameters, this slows the data sample rate, and each parameter is reported to the scan tool just once per second. You can achieve the best results by graphing or displaying data from each oxygen sensor separately. If the transition seems slow, the sensor should be tested with a lab scope to verify the diagnosis before you replace it.

The Engine Speed (RPM) and Ignition Timing Advance PIDs can be used to verify good idle control strategy. Again, these are best checked using a graphing scan tool. Check the RPM, Vehicle Speed Sensor (VSS) and Throttle Position Sensor (TPS) PIDs for accuracy. These parameters can also be used as reference points to duplicate symptoms and locate problems in recordings.

Most PID values can be verified by a voltage, frequency, temperature, vacuum or pressure test. Engine coolant temperature, for example, can be verified with a noncontact temperature tester, while intake manifold vacuum can be verified with an accurate vacuum gauge. Electrical values also should be tested with a DVOM. If the electrical value exists at the sensor but not at the appropriate PCM terminal, then the component might be experiencing a circuit fault.

Calculated Values

Calculated scan tool values can cause a lot of confusion. The PCM may detect a failed ECT sensor or circuit and store a DTC. Without the ECT sensor input, the PCM has no idea what the coolant temperature really is, so it may "plug in" a temperature it thinks will work to keep the engine running long enough to get it to a repair shop. When it does this, your scanner will display the fail-safe value. You might think it's a live value from a working sensor, when it isn't.

Also be aware that when a component such as an oxygen sensor is disconnected, the PCM may substitute a default value into the datastream displayed on the scan tool. If a PID is static and doesn't track with engine operating conditions, it may be a default value that merits further investigation.

Graphing Data

If you've ever found it difficult to compare several parameters at once on a small scan tool screen, graphing PIDs is an appealing proposition. Graphing multiple parameters at the same time can help you compare data and look for individual signals that don't match up to actual operating conditions.

Although scan tool graphing isn't equivalent in quality and accuracy to a lab scope reading, it can provide a comparative analysis of the activity in the two, three, four or six oxygen sensors found in most OBD II systems.

Many scan tools are capable of storing a multiple-frame movie of selected PIDs. The scan tool can be programmed to record a movie after a specific DTC is stored in the PCM. Alternatively, the scan tool movie might be triggered manually when a driveability symptom occurs. In either case, you can observe the data or download it and print it later. Several software programs let you download a movie, then plot the values in a graphical display on your computer monitor.

Make the Most of What You've Got

Take the time to learn what your scan tool will do when connected to a specific make or model. Do your best to gather all relevant information about the vehicle system being tested. That way you can get the most out of what the scan tool and PCM have to offer. The OBD II system won't store a DTC unless it sees (or thinks it sees) a problem that can result in increased emissions. The only way to know what the PCM sees (or thinks it sees) is to look through the window provided by the scan tool interface.

You have a DTC and its definition. You have freeze frame data that may help you zero in on the affected component or subsystem. PIDs have already provided you with additional clues about the operation of critical sensors. Keep your diagnosis simple as long as you can. Now fix the car. M

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