



**OBD-II Diagnostic  
ScanTool  
*User Guide***

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## ***WELCOME***

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Thank you for purchasing AutoEnginuity's ScanTool for OBD-II vehicles. I hope that our tool saves you a considerable amount of time and money in vehicle repair and maintenance.

As an avid car fan, I love working on my cars; but before ScanTool, I was limited by my vehicle's computer which "hid" the information I needed to understand the problem. Sure computers make cars more efficient and lighter; but, they also hide all the information away in proprietary interfaces.

AutoEnginuity's ScanTool gives you access to the abundance of data that any 1996 and newer vehicle provides through the OBD-II and optional manufacturer interfaces. It will help you determine what repairs are necessary, and determine whether you can repair it yourself, or whether it's something that requires more assistance. What's more, AutoEnginuity's ScanTool allows you to verify that work you have done—was done *properly*. Whether you're an independent service shop, or simply a vehicle owner, now you can diagnose a broad range of vehicles, accurately and quickly, with just one tool.

Jay Horak

A handwritten signature in black ink, appearing to read 'Jay Horak', with a stylized, cursive script.

Principal Engineer

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## ***OBD-II HISTORY***

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### What is OBD-II?

OnBoard Diagnostics Version 2 (OBD-II) is in all passenger vehicles manufactured for sale in the U.S. beginning in 1996. It has three main purposes; it: 1) alerts the vehicle operator if the vehicle's emissions output rises in response to a system failure; 2) performs real-time analysis of the engine's performance to help manufacturers achieve regulated vehicle fuel economy; and, 3) standardizes the electrical and communications protocols for the automotive industry. OBD-II has allowed vehicle manufacturers to stay within the Environmental Protection Agency's (EPA) emissions guidelines, and made it easier to diagnose problems in a wide variety of vehicles using only one tool. OBD is more or less a sophisticated data-acquisition system for vehicle emissions and performance.

### What is the History Behind OBD-II?

In 1955 the government took notice of the detrimental effects that car emissions were having on the atmosphere. Early laws were passed that gave vehicle manufacturers strict guidelines to follow with regard to vehicle emissions. These laws were generally ignored until 1988 when the Society of Automotive Engineers (SAE) proposed several standards, and the Air Resources Board (ARB) mandated them on all 1988 and later vehicles. These mandates were, in effect, OBD-I.

The original OBD was a simple system that monitored the oxygen sensors, exhaust gas recirculation (EGR) system, fuel delivery system, and the engine control module (ECM) for excessive emissions. Unfortunately, different car manufacturers complied with the ARB's mandates in different ways. In fact, compliance was so varied that a new problem developed.

The problem was that manufacturers had equipped their vehicles with OBD systems that weren't standardized. Consequently, each manufacturer had its own set of fault codes and its own tools to interpret the codes. Independent repair facilities across the country were struggling to diagnose vehicles with such a

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wide variance in both fault codes and in the equipment necessary to interpret them.

The EPA stepped in and created an extensive list of procedures and standards based on the findings of the SAE and ARB. This list resulted in the second generation of onboard diagnostics, OBD-II. By 1994 manufacturers were to implement OBD-II unless a waiver was granted. Almost every manufacturer applied for, and received, a waiver. However, in 1996 all new passenger vehicles were required to be equipped with OBD-II—without exception.

Vehicle requirements for OBD-II are light trucks or passenger vehicles, manufactured for sale in the U.S. after January 1st, 1996. California requires OBD-II compliance for all gasoline (MY 1996+) and diesel (MY 1997+) vehicles up to 8500 lbs. Starting in 2010, the weight cut-off changed to 10,000 lbs. The National LEV program requires compliance for all vehicles that weigh 6,000 lbs or less. If the vehicle is not required to be OBD-II compliant, it will utilize an OBD-I system. For example, the Ford 7.3L and 6.0L Powerstroke uses hybrid OBD-I/II systems because the vehicles are over 8,500 lbs.

The idea behind OBD-II is simple: in vehicles manufactured in 1996 or later, no matter who the manufacturer is, there is a standard set of fault codes that use a standard tool to interpret them.

### OBD-II Today

As the years went on, some manufacturers improved upon their implementation of OBD-II. In addition to the basic standard, they implemented optional support (i.e., more sensors). Some manufacturers (Ford, GM, etc.) didn't stop with optional support, but saw the utility in going above and beyond. These enhanced implementations give access to more sensors and even more descriptive fault codes. Although they are vehicle specific, their value can be easily seen by any service shop that specializes in that make, or a tuner that wants to wring every ounce of performance from his vehicle.

The newest addition to the OBD-II specification is an electrical interface called CAN. CAN is short for Controller Area Network. All vehicles will standardize on the CAN electrical interface starting in the model year 2008. Some manufacturers have already

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begun the transition (Ford, GM, Jaguar, Nissan, Mazda, Mercedes, and Toyota to name a few.).

## EOBD

With the success of OBD-II, European countries adopted EOBD. EOBD IV is the European equivalent of the OBD-II standard.

All petrol cars sold within Europe since January 1st, 2001, and diesel cars manufactured from 2003 on, must have onboard diagnostic systems to monitor engine emissions. Some manufacturers (Ford and GM) who sold into the European market already had OBD interfaces prior to this requirement.

## The Future of OBD

The new OBD standard is already in development. It's to be called OBD-II Remote. What the new standard will contain is still a matter of speculation, but some things are certain: 1) more advanced support for sensors; and, 2) wireless interfaces. Some speculation is whether vehicle telemetry will be part of the standard. The transponders would be used to locate the vehicle in the case of faults or non-compliance with EPA regulations; and, possibly, whether or not you are in compliance with local traffic regulations. Whether consumers will ever allow their Congressman or Congresswomen to implement such a standard will have to be seen.

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## ***SECTION I: Installation***

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### ***Minimum Requirements***

<b>Operating System</b>	Windows® 7 / 8 / 10
<b>Processor</b>	Pentium® or AMD Athlon®
<b>Free Memory</b>	400 MB RAM (450 MB RAM recommended)
<b>Free Storage Space</b>	400 MB
<b>USB Port</b>	1.0 / 2.0 / 3.0



Do not use a power inverter without an “isolated ground” with any USB product connected to your vehicle. A ground loop may occur.



Note: The ScanTool OBD-II interface draws up to 350mA from the vehicle. Do *not* leave it plugged into your vehicle for long periods of time without turning over the engine to recharge the battery.

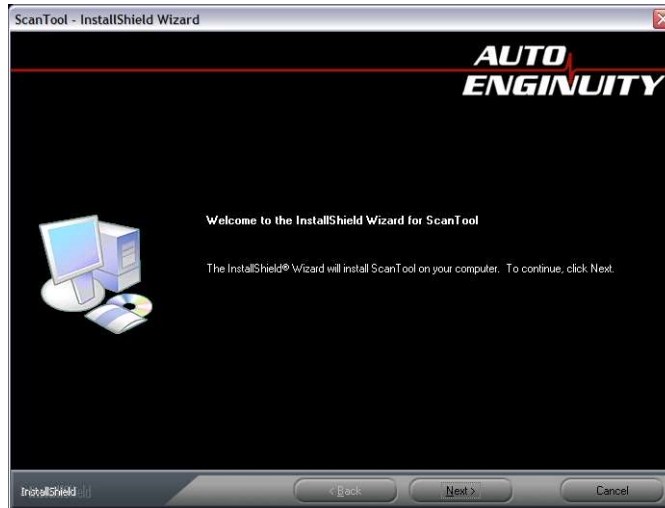
### ***Installation Instructions***

Follow the step-by-step instructions below to install AutoEnginuity's ScanTool onto your personal computer.

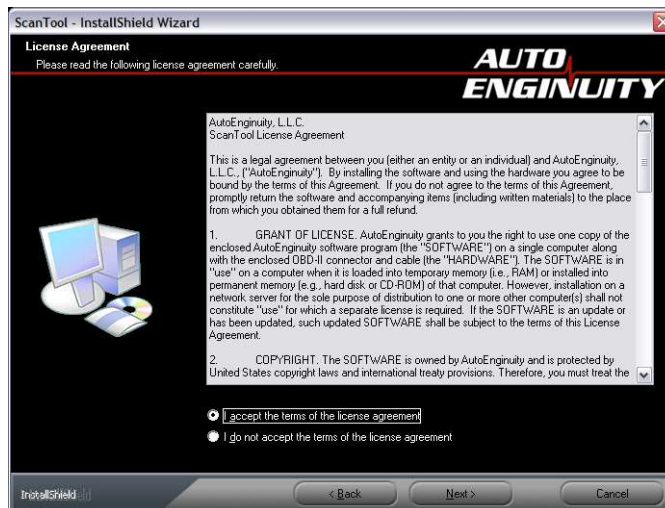
1. Place the AutoEnginuity USB drive into your computer's USB port.
2. The Setup program will begin the installation process automatically. (If this doesn't happen automatically, you will be required to manually navigate to the CD-ROM or DVD-ROM drive that contains the AutoEnginuity disc, then double-click on Install/Setup.exe.)



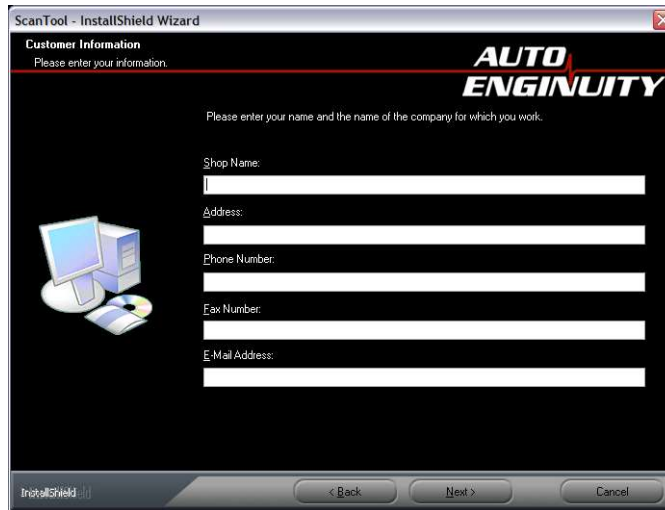
- 
3. Select *Next* to continue the installation process.



4. Carefully read the terms of the agreement. If you agree with the terms and wish to continue the installation, accept the terms of the license agreement by selecting *I accept the terms in the license agreement* and then select *Next* to continue. If you do not accept the terms of the agreement, select *Cancel* and contact AutoEnginuity or your reseller to discuss the return of the product.

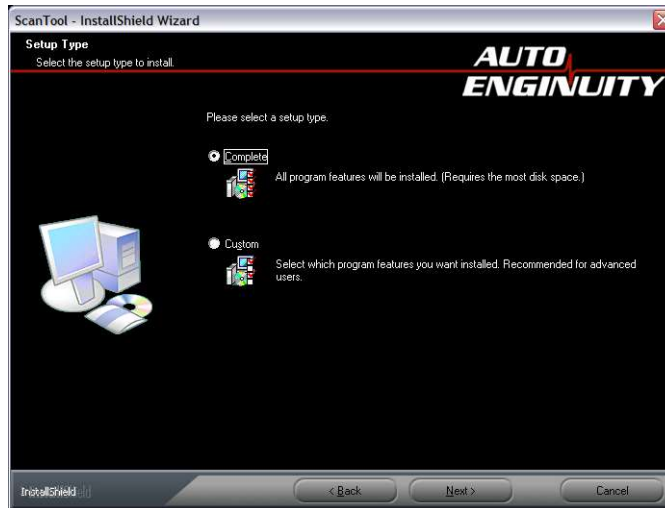


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5. Enter you or your shop's information in each of the fields. This information is used for the saved and printed reports.



The screenshot shows the 'Customer Information' screen of the ScanTool - InstallShield Wizard. The window title is 'ScanTool - InstallShield Wizard'. The header area includes the 'AUTO ENGINEUITY' logo. Below the header, it says 'Please enter your name and the name of the company for which you work.' There are five input fields: 'Shop Name:', 'Address:', 'Phone Number:', 'Fax Number:', and 'E-Mail Address:'. To the left of the fields is an icon of a computer monitor and a CD. At the bottom, there are three buttons: '< Back', 'Next >', and 'Cancel'.

6. Select *Complete* to install all of the required and optional components. This is the typical installation for most users. If you have used AutoEnginuity's ScanTool before, or do not require anything but the program itself, select *Custom*. The Custom option will allow you to choose individual components to install. Select *Next* when you are done.

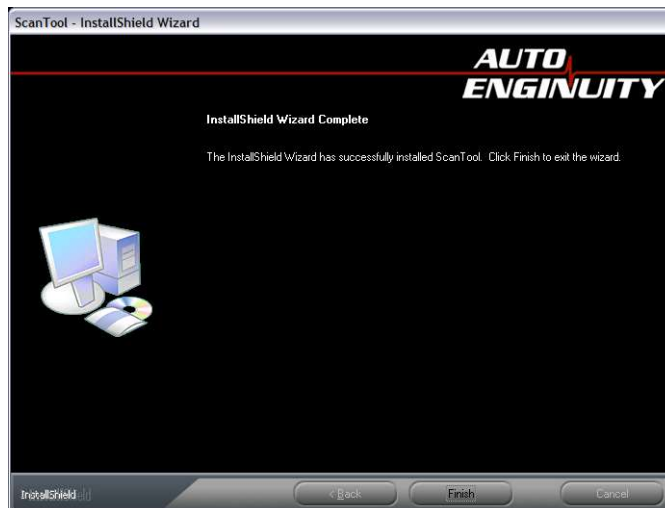


The screenshot shows the 'Setup Type' screen of the ScanTool - InstallShield Wizard. The window title is 'ScanTool - InstallShield Wizard'. The header area includes the 'AUTO ENGINEUITY' logo. Below the header, it says 'Select the setup type to install.' There are two radio button options: 'Complete' (selected) and 'Custom'. The 'Complete' option has a description: 'All program features will be installed. (Requires the most disk space.)'. The 'Custom' option has a description: 'Select which program features you want installed. Recommended for advanced users.' To the left of the options is an icon of a computer monitor and a CD. At the bottom, there are three buttons: '< Back', 'Next >', and 'Cancel'.

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7. If you have changes to make to your installation settings (such as a different Shop Information, etc.) now is the time to do so by selecting *Back*. If no changes are necessary, select *Install* to complete the installation process. Once *Install* is selected, a progress bar will reflect how far along in the installation your computer is.



8. Congratulations! You have successfully installed AutoEnginuity's ScanTool. Select *Finish*.



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## ***SECTION II: Using the Software***

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### ***Connecting to the Vehicle***

Connecting AutoEnginuity's ScanTool to the vehicle is a simple process. To begin you will need your AutoEnginuity ProLine VCI connector. You will be required to cable between your vehicle's DLC (Data Link Connector) and your computing device's communications port.

The first step is to connect the USB cable between the PC and the ProLine VCI connector. The red and amber LED on the ProLine VCI should illuminate.

Next locate the vehicle's DLC (Data Link Connector). Typically, the DLC is located in the driver's area, within reach of the driver's seat and visible by crouching (i.e., under the steering column or dash).



The DLC is usually exposed and accessible without a tool. (Notable exceptions being BMW which requires a flat-head screwdriver to remove a plastic cover, and Mercedes and MINI which hides the DLC under a cover.) Exceptions to the standard location include the ashtray/console area, or in the rear seat. If you have trouble finding the DLC, see *Appendix A* or consult your vehicle's Owner's Manual for more details. Once you locate the DLC, plug

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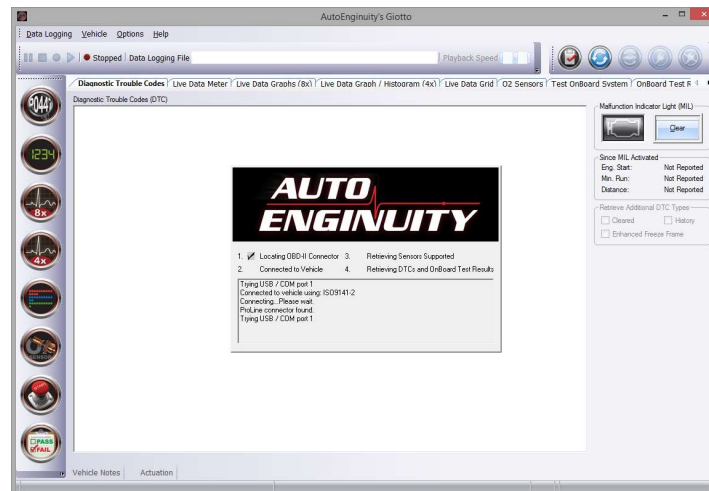
the AutoEnginuity ProLine VCI connector firmly into it.

Once the vehicle is physically connected to the PC, place the key in the ignition and turn it forward to the "ON" or "RUN" position. If you would like to monitor onboard test results or view vehicle sensor data in real-time, you can start your vehicle at anytime.



**Warning:** Never operate a vehicle within a confined area. Vehicle emissions are dangerous. Make sure that your work area is well ventilated.

Now you are ready to start AutoEnginuity's ScanTool program. The first screen that you will see is the *Connection Status* window. This window will remain until the vehicle and ScanTool have completed the "handshaking" phase of the connection process. You will see this window when your vehicle is connecting for the first time, or when reconnecting if the connection was lost. If this window is not present, press F2 or select *Vehicle | Connect* to manually initiate the connection process.



The *Connection Status* window will show whether your communications port has been opened by the software and what vehicle interface type is used to connect to the vehicle. If the *Connection Status* window doesn't go away, either the connector settings or the

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vehicle interface type is incorrect or cannot be discovered automatically. In either of those cases, you may be required to manually configure these settings to proceed. *See Communication Configuration below for more details on correcting connection settings.* For most applications the default settings are recommended.

You can also use the connection buttons to help connect (green button), disconnect (red button), and change system (purple).



A connection should not take longer than two minutes.

The *Connection Status* window will place a check next to each of the connection steps as it finalizes. As the connection is ongoing, the *Connection Status* window will also display any protocol or vehicle-related information discovered.

In the rare case that the connection could not complete, continue on to the *Communications Configuration* section below to determine the appropriate settings for your vehicle; otherwise you can skip to the *Vehicle Selection* section.

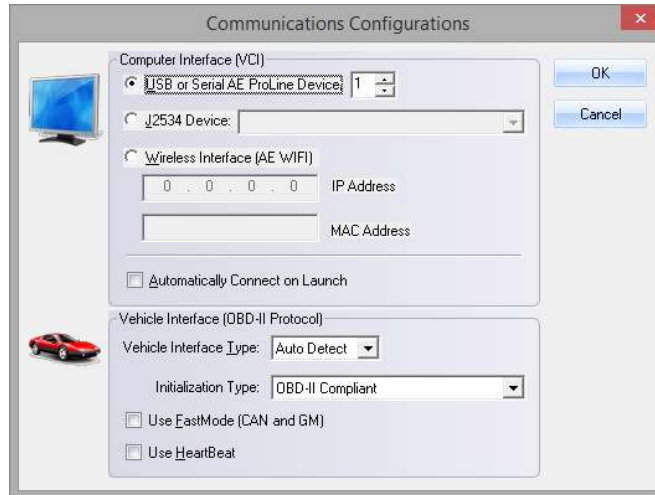
### **Communications Configuration**

Communications Configuration is where you will configure vehicle specific connection settings or set your computer interface settings.

To open the Communications Configuration window, click the AutoEnginuity logo on the *Connection Status* window, select *Vehicle | Communications Configuration*, or press F4.

#### **Computer Interface (VCI)**

This is the interface used to connect the DLC (diagnostic link connector) connector to your computing device. There are three ways to configure the computer interface: 1) USB or Manually Set Serial Port; 2) J2534 Device; and, 3) Wireless Interface.



*USB or Serial AE ProLine* is used to set that the software will be using a USB or serial connector. The USB connector will need no further settings as the USB port is determined automatically. However, in the case of a serial connector, you will need to set the serial/COM port as well. If you need help determining the serial/COM port See *Appendix D: Serial Port Troubleshooting*.

*J2534 Device* is used to set that the software will be using a J2534 hardware device. Any J2534 devices that are correctly installed on the computer will enumerate in the list. J2534 devices will require a special activation code to operate.

*Wireless Interface* is used to set that the software will be using the ProLine VCI WIFI connector. The wireless (i.e., WIFI) network can have a range of up to a 100' and maintain data rates as fast as a USB cabled solution.

The IP Address defaults to the values 0.0.0.0 which allows the software to automatically find the ProLine VCI WIFI interface. You will only be required to enter the IP Address and MAC Address if the computer sees multiple ProLine VCI WIFI devices.

To create a wireless connection you need to attach the ProLine

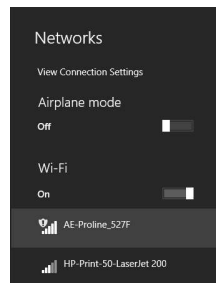
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VCI WIFI connector vehicle's DLC to drawing power and to allow it to start broadcasting wirelessly.

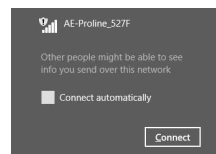
Next you will need to find your Network selection on your operating system. Usually this is available by selecting the WIFI five bar icon in the lower-right hand corner of your display.



Once the list of WIFI networks are listed, you will need to choose the one enumerated as AE-PROLINE xxxx. (The last four



digits will be the hardware ID for the device.) Once the AE-PRO-  
LINE xxxx is selected you will need to choose *Connect* to create a  
network. The option *Connect Automatically* may not work in some  
cases. For example, if the ScanTool software continues searching  
for the ProLine VCI WIFI connector it was previously connected  
to, but now won't find, uncheck this option and try *Connect* again.  
In this case, the computer cached the connection settings from the  
last time a network was made but those settings are now longer  
valid.



Once the Network selection is made and the *WIFI Interface*  
selection is set, close the ScanTool software to store the settings  
and relaunch the software. It will automatically discover the Pro-



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Line VCI WIFI once the software launches and begin a connection to the attached vehicle.

### Automatically Connect on Launch

The *Automatically Connect on Launch* option configures the software to start connecting to the vehicle automatically. This option is enabled by default and will need to be disabled if you want to Playback a data log. While connecting or connected to a vehicle, data logging play back is not possible.

### Vehicle Interface Type

The *Vehicle Interface Type* selection is used to determine how to communicate with the vehicle. Typically you won't have to change this as the *Auto Detect* entry will query the correct selection from the vehicle. OBD-II does define an order to auto detect the vehicle's protocol which the ScanTool complies with; however, the specification does not dictate how a vehicle manufacturer has to respond to protocols it doesn't support. Because of this lack of specificity, auto detecting can't be guaranteed. In those cases where the software can't complete a connection after a few attempts, we recommend selecting the vehicle's protocol manually.

Selecting the correct vehicle interface type depends on the make, model, and year of your vehicle. The *Vehicle Interface Type* drop-down menu has the following entries:

**TABLE 1. Typical Interface Type Per Manufacturer**

Interface Type	Manufacturer
J1850 PWM	pre-'04 Ford, Lincoln, Mercury, pre-'04 Jaguar SType and XType, Mazda, Panoz, Saleen
J1850 VPW	pre-'08 Buick, Cadillac, Chevrolet, Chrysler, Dodge, GMC, Hummer, Isuzu, Oldsmobile, Pontiac, Saturn
ISO 9141-2	pre-'08 Asian (Acura, Honda, Infinity, Lexus*, Nissan, Toyota*, etc.), European (Audi, BMW, Jaguar non-SType and XType, Mercedes, MINI, Porsche, etc.), and early Chrysler*, Dodge, Eagle, and Plymouth

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**TABLE 1. Typical Interface Type Per Manufacturer**

Interface Type	Manufacturer
KWP2000	pre-'08 Daewoo, Hyundai, KIA, Subaru STi, and some Mercedes
CAN	All '08+ and '04+ Ford, Jaguar, Mazda, Mercedes, Nissan, and Toyota*
*Exceptions	'98+ Concorde, Intrepid, LHS, 300M, 2000+ Neon use J1850 VPW '96-'98 some Toyota/Lexus use J1850 VPW '96, '97 Probe 2.5L, '96 Tracer 1.8L, '96 Escort 1.8L, Triumph, Geo, Catera, '97 Paseo use J1850 VPW

Once you have determined the correct vehicle interface type, select it. The connection process will now only attempt the protocol you have selected. This may correct the issue with a vehicle not being able to respond to protocols it doesn't support.

In some rare cases, such as '96 Toyota/Lexus vehicles, selecting the wrong protocol (i.e., auto detecting) can cause the vehicle's PCM to stop responding. Please select the proper protocol then disconnect the OBD-II connector from the vehicle. Cycle the vehicle's key and reconnect to the vehicle. This will reset the PCM to allow for a connection process that it knowingly supports.

#### Initialization Type

The *Initialization Type* option enables the user to select the startup packet formatting required to begin communications with the vehicle.

The *OBD-II Compliant* option will go through the standard initialization process of retrieving live data and freeze frame sensor coverage, Mode 6 coverage, Inspection/Maintenance monitor states, and whether there is an active MIL before completing a connection. This is a much more in-depth process than a simple code reader and can therefore take longer.

The *Non-OBD-II Only* option is used to bypass all OBD-II cov-

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erage and only use enhanced features. With this option no OBD-II support will function (specifically the O2 tab and OnBoard Test Results). That doesn't mean the OBD-II information isn't available, it may be obtained in other ways, such as with manufacturer specific sensors. **In some cases where the vehicle's enhanced support is based on the OBD-II protocol, this option won't work. As an example, Toyota, Nissan, and Hyundai/Kia early models use OBD-II-derived enhanced protocols that require normal OBD-II initialization steps to correctly operate.**

In some cases, not having any OBD-II support may be preferred. For example, Ford '96 - '97 Powerstrokes use the *Non-OBD-II Only* option because these vehicles have no OBD-II support at all.

The *KWP2000 ECM Forced Init* option is used to force a connection to very specific vehicle models. Use this only with direction from AutoEnginuity Technical Support.

The *CAN Physical Addressing* option is used to force a connection with a CAN controller that does not support the SAE default of functional addressing. Use this with any Nissan '08 and Subaru'08 models that fail to connect automatically.

The Initialization Type is set to *OBD-II Compliant* by default.

#### Use HeartBeat

The *Use HeartBeat* option sends a request through the vehicle bus at a regular interval if there is no other communication. This is used both as a "keep alive" request and to determine if a connection is lost. Should you run into an issue with a vehicle that loses connection after a brief period of time (i.e., Nissan vehicles), try selecting or deselecting this setting. This setting is deselected by default.

#### Use FastMode

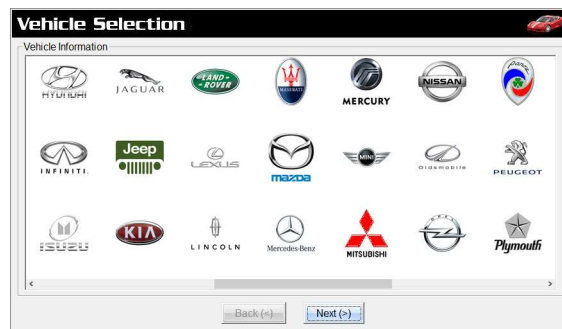
The *Use FastMode* option enables J1979 CAN 6x or GM DPID sampling rates. With this option selected, data rates will increase because each request will return up to six responses. This setting is deselected by default.

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## Vehicle Selection

Once the ScanTool has connected to the vehicle, the Vehicle Selection window will appear. Here is where you will select the connected vehicle's make, model, year, system, etc.

The first step is to select the Make of the vehicle. You will make the selection by double-clicking on the manufacturer's icon or simply selecting it and then click the *Next* button. If your connected vehicle's Make does not appear in the list, simply select *Generic OBD-II* for the Make.



Next, the model and associated selections will need to be determined.



You will be required to select each of the enabled fields. The fields will be enabled based on enhanced options and the make of the vehicle. For example, for GM- and Chrysler-brand vehicles you

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will have the option of selecting the engine, product, and transmission types.

Making sure you have the correct vehicle model selection will be the difference between getting no/bad data, and retrieving the correct information. To help you make the proper selections, the Vehicle Selection fields are color-coded. The color red is used to signify a *Not Selected* **but necessary** entry. Yellow is used to signify that the field is not required for this make or model. If the field is selected, matches an existing table entry, and does not conflict with other selections it will change to white.



Chrysler Body Codes can be found in tables in their service guide or in after-market content provider tables like Mitchell or AllData.

GM Product Line can be determined by the fourth digit of the VIN of a passenger vehicle and the fifth digit for vans and light trucks. GM vans and light trucks can't be completely decoded by the ScanTool due to overlapping VIN numbers, so they will require you to complete the model decoding manually.

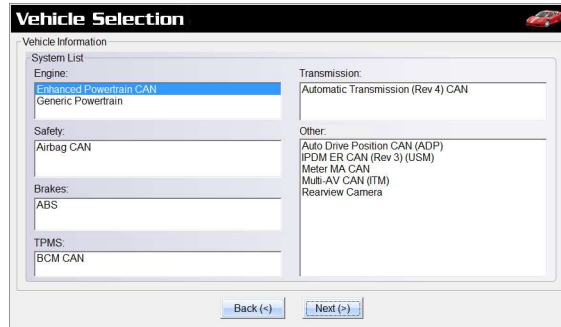
You may automate the vehicle selection process by retrieving the VIN from late model vehicles (i.e. 2004+ for OBD-II vehicles; EOBD vehicles have no such standard and typically will report no VIN). To retrieve the vehicle's VIN, click the *GetVIN* button. If the vehicle supports retrieving VINs electronically, the software will attempt to fill in the model information fields.

Even if the VIN is retrieved, don't assume that your job is done. For example, since GM overran VIN series for truck models, the software will not be able to complete the selection process for you. In these cases, you are required to verify the information or complete any fields that can't be automatically filled in using the VIN.

Once all the vehicle's model-specific fields are all resolved, click the *Next* button to continue to the System selection. System selection is where you will determine what controller on the vehicle

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you want to start a diagnostic session.



If the vehicle has no enhanced interface options available or your configuration doesn't have support for them, the vehicle will only support the Generic Powertrain system.

System support is not only determined by which of the optional enhanced interfaces you have purchased, but also the vehicle. Not every vehicle will be equipped with the same systems; even if the system is supported by the ScanTool.



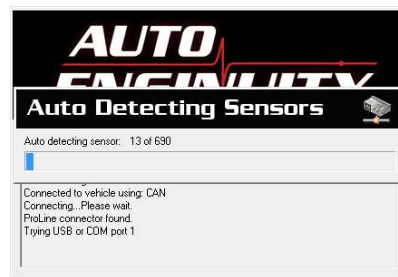
We update the vehicle databases frequently, but in the case that the vehicle is newer than our database, try selecting the previous model year.

Once you have finalized your System selection, click *Next*.

The ScanTool will now attempt to verify that a connection can be established with the selected system. If the selected system does not respond to initialization requests, a warning will appear to notify you that the system is not present or communicating.



Once connected to the system's controller and if you have selected an enhanced system, the system's sensors will be detected. This process can be slow on systems with hundreds of sensors. A progress window will appear to help you monitor the process.



Once the process is complete, the progress window will disappear and the Actuation, Test OnBoard Systems, and sensor lists will be updated to include the model-specific support detected for this vehicle.

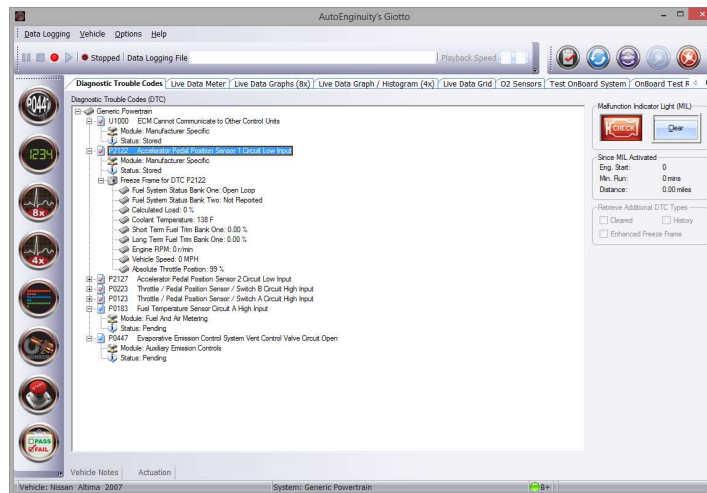
To change a system and return to this selection window, select *Vehicle | Change System* or press F7. This will immediately disconnect you from the vehicle system you are currently connected to and allow another system selection, without having to go through the initial connection steps.

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# Using the Software

## Diagnostic Trouble Codes

The Diagnostic Trouble Code window is probably the most important window in AutoEnginuity's ScanTool software; and it's the first window you'll see for just that reason.



During the connection phase, and every five minutes while connected, the software will attempt to retrieve trouble codes from the vehicle. Before it begins this process, the software will need to know if you want to retrieve from *All* systems, only the *Current* system, or *None* (bypassing trouble code retrieval entirely).



If you select *All*, a new window will appear showing you the



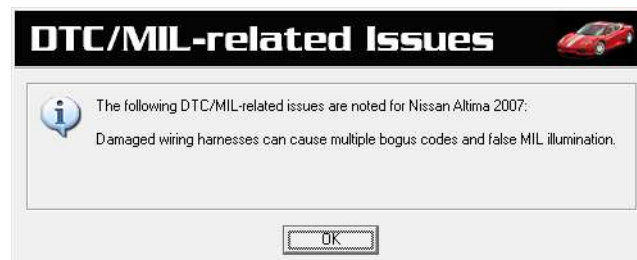
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progress of the trouble code retrieval process from each system available to the ScanTool. Selecting this option can take up to two minutes to complete as it may have to connect and retrieve codes from several dozen systems.



In the case of selecting *Current*, then only the selected system will have its trouble codes retrieved. In the case of selecting *None*, no trouble codes are retrieved and the step is bypassed.

If the vehicle connected to the ScanTool has any issues with displaying or generating false trouble codes, a built-in technical service bulletin (TSB) library is searched and any information available is displayed. This information comes right from the vehicle manufacturers, complete details should be researched at their respective service sites or with after-market content providers.



A flashing MIL means that there is a severe misfire occurring. See *Understanding Misfire in Appendix D* for further details.

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### **Origins of a Check Engine/Service Engine Light**

If you are experiencing issues with your vehicle, chances are you have a Check Engine or Service Engine Soon indicator light on (the OBD-II specification refers to these as MILs—Malfunction Indicator Lights). The MIL tells the driver that an issue has arisen that needs attention. The MIL will not always come on when a fault is first found. The decision to illuminate the vehicle MIL for any diagnostic trouble code (DTC) is based on the "Enabling Conditions" or, more generally, the test strategy.

OBD-II "Enabling Conditions" are based solely on the fact that the vehicle is operating at 1.5 times the normally allowable emissions level. The criteria to determine this is manufacturer-specific; it's based on their testing of how each system malfunction affects emissions. Most vehicle manufacturers post the OBD-II Enabling Conditions on their websites.

Whether you're diagnosing with OBD-II or enhanced expansions, understanding the test strategy used by a controller prior to setting a fault is very important to making correct service decisions.

The first step is to determine how and when the test is run that determines whether the fault occurred. Usually a fault must occur multiple times, and in separate drive cycles, before the vehicle's controller creates a stored fault and illuminates the MIL. Severe faults require only one drive cycle to illuminate the MIL indicator.

Finally, keep in mind that you can have a problem with your vehicle and not have the MIL illuminated. For example, the system test for misfire monitors will not run if the roads are rough or the fuel level is too low. Your vehicle could be misfiring and you would never know it if you waited for the MIL to illuminate. Don't count on the MIL being illuminated as the only means to determine your vehicle's condition.

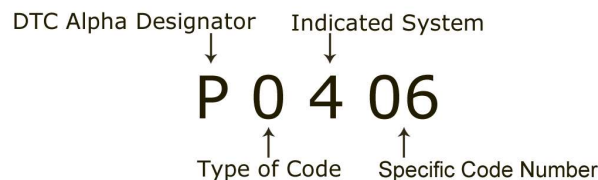
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The Diagnostic Trouble Codes list will enumerate any trouble codes that the ScanTool has retrieved from the vehicle. Each DTC will have a color-coded icon associated with it. The red DTC icon is used to denote those DTCs that are Stored or those that could cause the MIL to illuminate. The blue DTC icon is for those that will not illuminate the MIL. Below each DTC entry will be a list of its properties.



The vehicle is scanned for diagnostic trouble code changes in five minute intervals.

The DTC value will help you narrow down the specific component or module in question. A DTC has a standardized format that can be interpreted as follows:



The first part of the DTC is the Alpha Designator. The alpha designator can be:

- B - Body electronics (i.e., door and hood latches)
- C - Chassis (i.e., traction control or ABS)
- P - Powertrain (i.e., engine, transmission, or engine support components)
- U - Network communications for the different control models

The second part of the DTC, is a three or four-digit numerical series. The OBD-II specification has reserved the first 1,000 entries for a core set that are uniformly implemented across all vehicle manufacturers. DTCs after the core set are available for manufacturer specific uses. Type of Code will be 0 for the core set, or a value of 1 - 9 for manufacturer specific codes. The Indicated System and Specific Code Number further narrow down the code to a

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specific component or system.



Note: Some enhanced interface expansions use non-standard trouble code lettering conventions (i.e., BMW FC codes and Chrysler DTC sensors). Please refer to the BMW and Chrysler User Guides for more information.

Each DTC entry will have a detailed description of what the trouble code means. The descriptions are carefully written to be unambiguous and to give you as much information as possible about the specific fault. **In the case of manufacturer specific codes, selecting the proper make, model, and year is imperative to getting the correct description.**

In addition to having a DTC value and description, each DTC can also have an accompanying set of properties. These properties are accessed by clicking on the plus symbol to the left of the DTC entry.

The first property is the Status. In the case of generic OBD-II this will be either Stored or Pending. Stored DTCs are those that have failed their respective test several times and are considered faulty. Any DTCs enumerated as Pending are those that have failed their respective test at least once, but less than the number of times to be considered faulty. A DTC reported as Pending does not necessarily indicate a faulty component/system. If it continues to fail, it will be reported as Stored and the MIL indicator will be illuminated. If no fault is present on the next trip, the Pending DTC will eventually clear itself. (Except in the case of a severe Misfire Monitor fault.) Enhanced interfaces also use the Status to represent manufacturer specific states. An example is GM which denotes History, Cleared, Previously Stored, etc.

The intended use of the Status data is to assist the service technician after a vehicle repair and after clearing diagnostic information, by reporting results from a single drive cycle.

Next, any Freeze Frame information associated with the DTC

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will be enumerated. A DTC can have multiple Freeze Frame information. The first frame, Frame 0, is the only mandated Freeze Frame. Manufacturers are allowed to use their own Freeze Frame implementations after Frame 0.

Freeze Frame data is a snapshot of the vehicle's state within a second or two of when a DTC is stored. If a vehicle reports a Freeze Frame snapshot, all of the reported data is from the vehicle's components; they are not default values. Freeze Frame data gives you great insight into the conditions that the vehicle was operating under when the fault occurred. Don't overlook this information when determining the reason for a fault. Was it a faulty component? Or, could the fault have been due to excessive strain on the vehicle? Keep in mind that not all Freeze Frame sensors are supported by all vehicles.



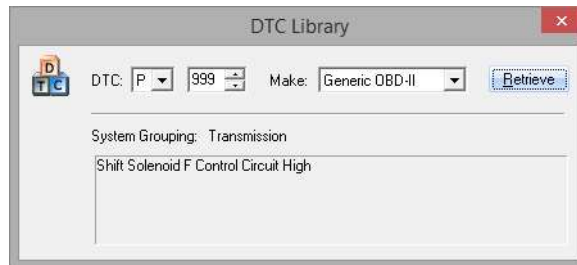
**Remember:** OBD-II reports in tenths of a second. If your vehicle is storing Freeze Frame data (under the best conditions) a full second will elapse. With this delay, some fast-changing sensors could be drastically different from when the first sensor and the last were stored.

The DTC that caused the MIL to activate will typically be the one to store the Freeze Frame 0 data. The manufacturer determines which DTC should store Freeze Frame data based on severity.

Finally, there may be Fault Frequency or SubType entries. The Fault Frequency will designate how many times the controller has flagged this trouble code. The SubType is a new addition to the SAE trouble code, it will designate the fault type, such as Electrical. This is used to help resolve the type of fault instead of what group the fault is in as the letter codes designate.

### DTC Library

The DTC description library is available off- or online at any time. Select *Help | DTC Library*. To retrieve the description of a trouble code simply enter the type, numerical value, and what database to query in. The retrieved grouping and trouble code description will be displayed.



### Clear

The ability to clear trouble codes and the MIL is just as important as it is to view the trouble codes. Clearing does more than turning off the indicator light on the vehicle. It can:

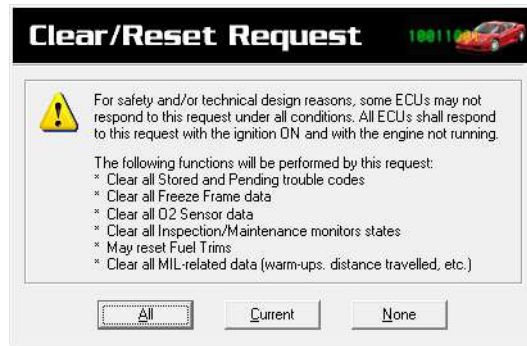
- Clears diagnostic trouble codes.
- Clears the Freeze Frame data.
- Clears oxygen sensor test data.
- Resets status of system monitoring tests.
- Clears OnBoard monitoring test results.
- Resets fuel trim stored values.

To clear the MIL and to perform the operations enumerated above, click the *Clear* button and select either *All*, *Current*, or *None*. Selecting *All* will perform this request on all supported systems on the vehicle. Selecting *Current* will perform these operations on only the currently selected system. Finally, *None* will cancel the operation entirely.

For safety and/or technical design reasons, some ECUs may not respond to this request under all conditions. All ECUs shall respond to this service request with the ignition "ON" and with the engine not running.



Warning: Clear DTCs without first determining if repairs are required may result in the DTC returning immediately or in a later drive cycle. If a repair is required, clearing a DTC is a short term fix.



If the MIL is cleared on the connected vehicle and the problem isn't fixed, the MIL will return. If there is a serious problem with the connected vehicle, more problems could arise, or the problem could worsen, if the appropriate action is not taken. It is not enough to clear the MIL, the fault that caused the MIL must be addressed.

Even after the MIL is cleared, DTCs will be stored in the engine computer's memory banks for 40 warm-up periods; 80 warm-up periods in the case of Misfire or Fuel System Monitoring. (Note: Generic scan tools won't have access to this part of the controller's memory. The enhanced expansions can, in some cases, access it with the *Cleared* or *History* option checked.)

#### Since MIL Activated/Cleared

Starting with the model year 2000, support was added to keep track of when a MIL was set and other MIL-related data. This optional support was primarily implemented to meet EOBD IV emissions requirements. It reports the time since, the number of warm-ups, and the distance traveled since the MIL was activated. Conversely, if the MIL was cleared, the time since, the number of warm-ups, and distance traveled since the clear occurred will be reported. It will reset to zero once another DTC is set or when the MIL is cleared.

#### Retrieve Additional DTC Types

The History and Cleared enhanced codes can be retrieved for some manufacturers. If your vehicle supports this feature it will be

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enabled. To retrieve History or Cleared codes, check the History or Cleared code options respectively. Each time the DTCs are retrieved, these additional DTC Types will be retrieved as well.

*History* codes are those that are stored in the vehicle's PCM but are not Stored or Pending codes. Each vehicle manufacturer designates how many and how long they will store History codes.



Warning: Hyundai / Kia can use History codes for trouble codes that illuminate the airbag indicator. If the airbag indicator is illuminated and no trouble codes are reported, retry with History selected.

The *Cleared* codes option can show those trouble codes that were previously present, but cleared by diagnostics equipment in a previous session.

*Enhanced Freeze Frame* is the option to show freeze frame entries that are manufacturer specific. In some cases, GM for example, this option can add a considerable amount of time to the trouble code retrieval process.

### Create Report

You can save all DTC and Freeze Frame information into a report for viewing or offline review and/or printing. All of the information will be stored in an XML format for universal viewing and printing in a web browser (i.e., Internet Explorer or Netscape).

The reports are viewed and displayed according to a provided XSL style sheet (AutoEnginuity DTC Results 2.0 XML Template.xsl). The reports layout can be changed to better suit your needs or show your company's logo. *See Data Logging Settings for more details on changing the style sheet.*

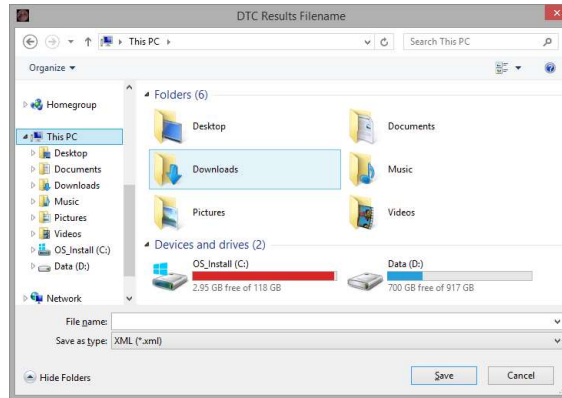
To create a report, click the *Print Data* button on the left of the Live Data Options toolbar or press F8.



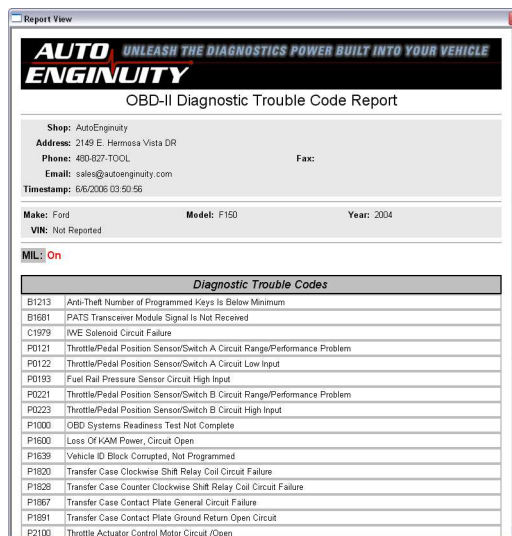


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Then enter the filename of the resulting DTC and Freeze Frame report.



Once you have named and saved the report, a screen will appear showing the final formatted report. You can navigate back and forth through previous reports or print it by right-clicking on the view and selecting your option.





### OBD-II Diagnostic Trouble Code Report

**Shop:** AutoEnginuity  
**Address:** 2149 E. Hermosa Vista DR.  
**Phone:** 480-827-TOOL  
**Email:** support@autoenginuity.com  
**Fax:** Call for #  
**Timestamp:** 6/9/05 11:56:27

**Make:** Ford  
**Model:** F150  
**Year:** 2004  
**VIN:** Not Reported

**MIL:** On

Diagnostic Trouble Codes	
P0122	ottle/Pedal Position Sensor/Switch A Circuit Low Input
P0193	l Rail Pressure Sensor Circuit High Input
P0223	ottle/Pedal Position Sensor/Switch B Circuit High Input
P0421	m Up Catalyst Efficiency Below Threshold (Bank 1)
P1000	Systems Readiness Test Not Complete
P1639	icle ID Block Corrupted, Not Programmed
P2100	ottle Actuator Control Motor Circuit /Open

Freeze Frame (Frame 0) for DTC P1639			
Abs. Throttle Pos.:	80 %	B1S1 O2 Fuel Trim:	-99.84 %
B1S1 O2 Voltage:	0.000 V	B1S2 O2 Voltage:	0.000 V
B2S1 O2 Voltage:	0.000 V	B2S2 O2 Voltage:	0.000 V
Calculated Load:	0 %	Control Module V.:	12.26 V
Coolant Temperature:	-40 F	Engine RPM:	0 r/min
Fuel Rail Pres. Rel.:	78.64 psig	Fuel System Status Bank One:	Not Reported
Fuel System Status Bank Two:	Not Reported	Ign. Timing Adv. C1:	-64.0 deg
Intake Air Temp.:	-40 F	Long Term FT B1:	-99.84 %
Long Term FT B2:	-99.84 %	MAF Air Flow Rate:	0.00 lb/min
Short Term FT B1:	-99.84 %	Short Term FT B2:	-99.84 %

### Refresh

This forces the screen to refresh before the normal five minute update interval.

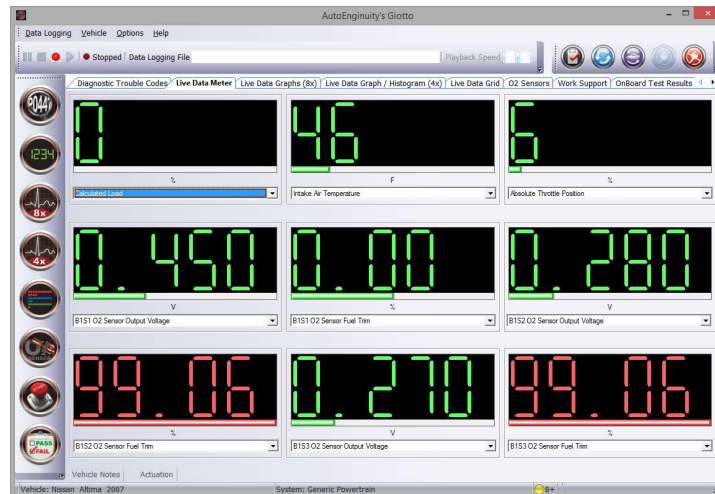
To refresh the DTC list and MIL status, click the *Refresh* button on the right of the Live Data Options toolbar or press F5.



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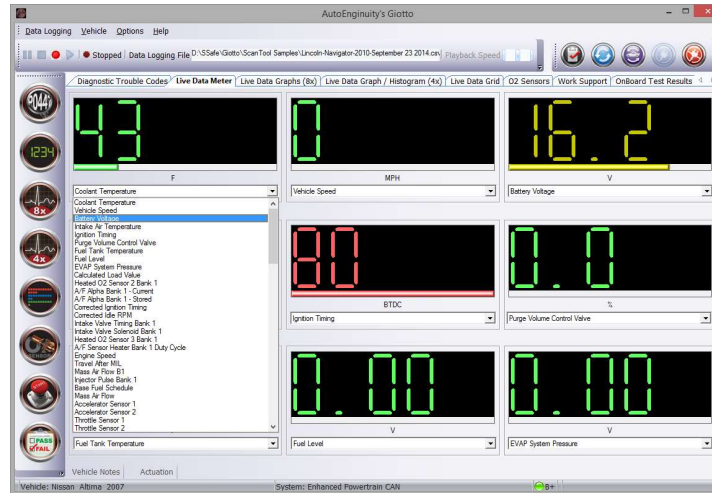
## Live Data Meter

The Live Data Meter gives you the ability to watch several sensors report from the vehicle in real-time. In the case that your vehicle reported a DTC and set the MIL, you'll want to use the DTC description to determine what sensors to watch. Sensors might also help you determine if a new component (i.e., free-flow exhaust or intake) is performing better than stock. The sensor data your vehicle reports provides a wealth of information of the real-time status of the vehicle's operating condition.



The number of sensors that you can view is determined by the vehicle make, model, and year. Typically, the newer the vehicle the more sensors it supports. Some sensors take longer to report back to the ScanTool (i.e., Intake Manifold Absolute Pressure) and will update slower. In the case of ISO 9141-2, four to six sensors is probably the most you'll want to have listed at one time. Newer protocols, such as CAN, can sustain more sensors without slowing down the bus.

To add a sensor to the Meter, select the sensor from a meter's respective drop-down list.



Before purchasing a used vehicle, bring your AutoEnginuity Giotto scan tool and verify the vehicle's condition.

If you no longer need to watch a sensor you can remove it from the list by selecting *Off* from the drop-down list.

Meters will report the current status of the sensor through color cues. If the sensor is functioning at 80 - 90% of its capacity, the meter will change its color to yellow. If the sensor is between 90 - 100%, the meter will change to red. Below 80%, the meter will display in green.

Along the bottom of each meter is a bar that shows the current position of the sensor in its range. The farther right it is, the farther along in the range the sensor is reporting.

Once a sensor is added, it can also be configured. To configure the minimum and maximum range, scaling value, units, sampling rate, and audible alert triggers select *Configure Sensor*. See *Configuring Sensor for more information*.

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## Printing

The Meter screen can be printed at any time. To do this, select the *Print Data* button or press F8. The software will then prompt you for a printer and allow you to make print specific settings before sending the screen capture to the printer. The area that is printed is only the tab window itself. At the top of the print will be the vehicle make, model, year, and VIN information.



## Refresh

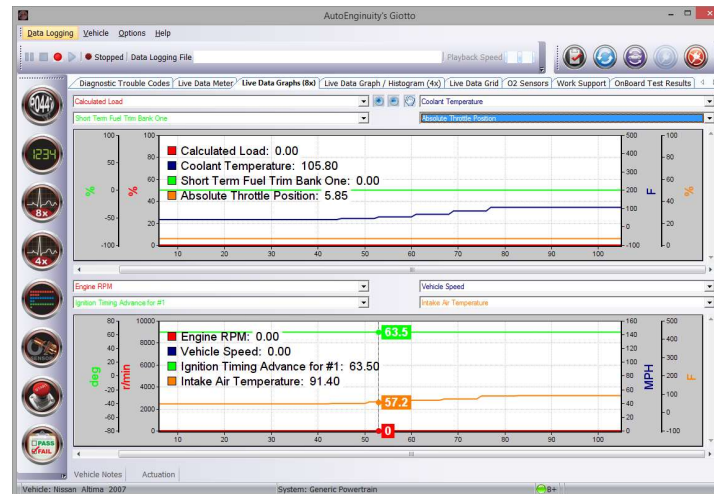
This forces the screen to refresh each of the meter controls. All data is discarded and once again retrieved from the vehicle. To refresh the meter controls, select the *Refresh* button or press F5.



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## Live Data Graph

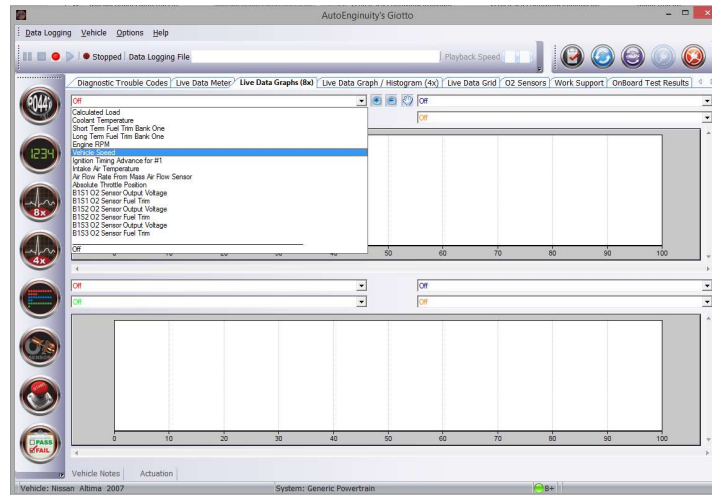
The Live Data Graph gives you the ability to plot four live sensors in each graph. There are two types of graphing capabilities with the ScanTool: 1) 4x plots on each of the two graphs; or, 2) 4x plots on a single graph. The graphed data is stored in a virtual buffer that can store data for several hours. Once stored in the virtual buffer, the plot data can then be panned or zoomed on to help view the data as you require. Also, since plot data is stored in a virtual buffer, you can switch between the graph tabs and the data is preserved.



The graphing layout is simple and productive. On the left and right are the color-coded units, and the domain and range that the plot is reported in. Color-coding the plot makes it easy to quickly identify which plot you are looking at. You can change the color of these graph properties by selecting *Options* and then selecting *Customize Display*. See *Customize Display for further details*. The plots are anti-alias to provide the sharpest image possible.

Plots on a graph will have their value reported in a legend at the top left of the graph while data is being updated. You can also mouse over a plot, and the current plot value nearest to the mouse position will be reported. Finally, at the bottom of the screen is the

sample count.



Adding a sensor to be viewed is as easy as selecting the sensor from the any of the drop-down lists above the respective graph.

Once a sensor is added, it can also be configured. To configure the minimum and maximum range, scaling value, units, sampling rate, and audible alert triggers, select *Configure Sensor* from the drop-down list from which the sensor combo box you would like to configure. *See Configure Sensor for more details.*

If you no longer need to watch a live sensor you can remove it from the graph by selecting *Off* in the Live Vehicle Sensor list, or by left- or right-clicking the graph area and selecting *Off*.

A plot can be zoomed in/out or panned. To do this, select the either of the Zoom or Pan icons at the top of the graph. By default the Pan icon is selected. Once a icon is selected it will stay in that mode until you select another mode.



The plot data can be panned also by left-clicking on the graph area and holding down the left-mouse button, if data is present but

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not visible, the graph's viewport will show the plot data stored in the virtual buffer from the direction in which you are moving the mouse. Release the left-mouse button to restore normal operations.

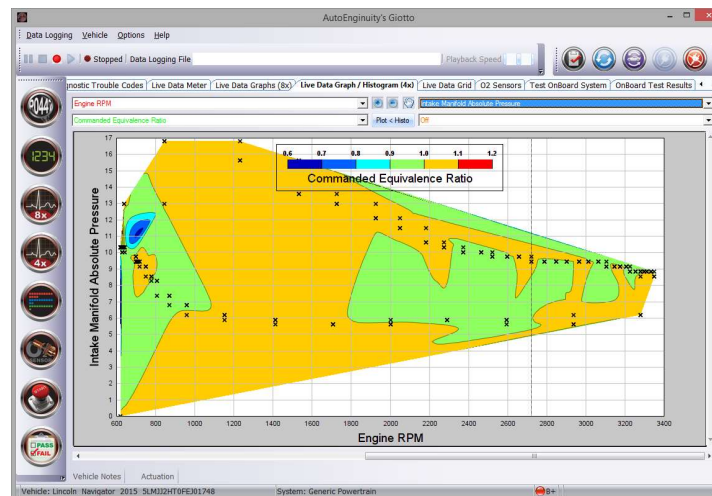
## Histogram

The Graph (4x) offers a way to plot the weight of a sensor against two other ranges. To change from the Live Data Graph to the Histogram functionality, you will simply click the Plot > Histogram button.



To create a Histogram you simply need to add three sensors to the graph. The first sensor selected is the X range. The second sensor selected is the plotted against sensor. Finally, the third sensor is the Y range.

The Y range entries will be marked on the histogram as Xs to mark their position against the X range. The color weighted area is the second sensor and the most important for the purposes of this function. Here you can see that the 0.9 and 1.1 Commanded Equivalence is almost the entire range. Only in the lower RPMs at the higher intake pressure is there a deviation from the normal range.





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### Save or Print

The Graph screen can be save in a graphics format (JPG, BMP, PNG, or GIF) or printed. To do either, select the *Print Data* button or press F8. The you will then be prompted whether you want to either save in to a graphics format or print the graph to a device. If the Save to a graphics format is selected, you are prompted to name the file and set the file format. Otherwise, if the Print to device option is selected, the printer dialog is displayed allowing you to make print specific settings before sending the graph data to the printer.

The area that is saved/printed is only the graph window. At the top-left of the saved/printed graph will be the shop information. On the top-right will be, if connected, the vehicle make, model, year, and VIN; if not, the play back filename will be used instead.



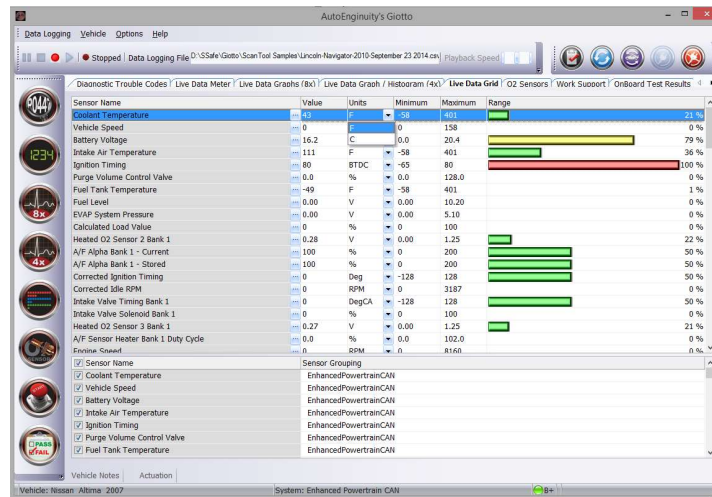
### Refresh

All data is discarded and once again retrieved from the vehicle. To refresh the graph controls, select the *Refresh* button or press F5.



## Live Data Grid

The Grid gives you the ability to view several sensors from the vehicle in a format that is most convenient for large amounts of data. The Grid combines both a spreadsheet-format and a color graphics meter to show sensor information. The Grid is probably the easiest way to add, view, and configure sensors then any other Live Data display method.

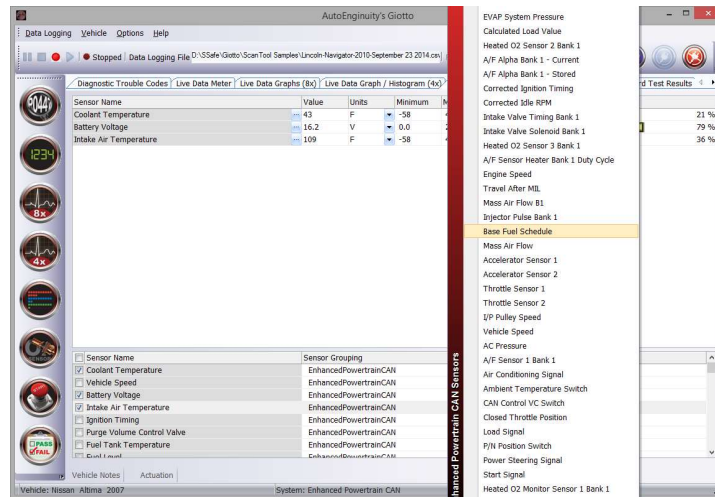


The Grid is made up of two lists: the top-most is the live sensors list; the bottom list is the complete sensor list from the currently active vehicle system. The lists are separated by a window splitter. To make either list larger or smaller, left-click and hold, on the window splitter. Now drag the window splitter up or down to change the respective sizes of the lists.

Once a sensor is added, the top-most live sensor list is where the sensor's sampled results will be reported. Its name, current value, minimum and maximum range are displayed. Also, on the right-side of the live sensor list is the percentage of the sensor's sampled value within the minimum and maximum ranges. This can be used as a visual clue to a sensor's load/state. The range color will change according to the sensor's maximum alert setting.

The supported sensor list is a list of the sensors supported by the active system. The left-most column is a check box which allows the sensor to be added/removed in the live sensor list above. The middle column is the name of the sensor. The right-most column is the group in which the sensor belongs. The grouping allows you to better associate sensors and trouble codes.

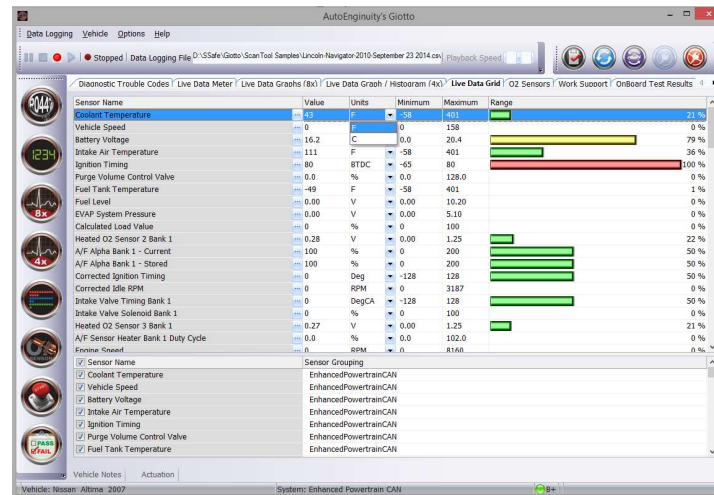
The Grid works the same way as the Live Data Graph when adding and removing sensors. To add a sensor, left-click on the Grid and select the sensor from the drop-down list. The Grid also has a unique feature which allows you to select multiple sensors quickly. Simply click the check box next to the desired sensor to add it to the Grid. You can remove a sensor by unchecking the check box, or by left-clicking on the sensor's column in the top-most list and selecting *Remove*.



Once a sensor is added, it can be configured. To configure the minimum and maximum range, scaling value, units, sampling rate, and audible alert triggers, right-click on the sensor name and select *Configure Sensor*. Or simply select the "..." button to the right of the sensor name.

The Grid also gives you the unique ability to change a sensor's units of measure right on the Grid's list. Simply select the sensor's

active units of measure and a drop-down list will appear with other possible other units of measure.



You can quickly find a sensor by merely pressing the first letter of the sensor name. The first entry beginning with that letter will be displayed.

The Grid font and font style can be configured in the *Customize Display* window. (See *Customize Display for further details*.)

## Printing

The Grid screen can be printed at any time. To do this, select the *Print Data* button or press F8. The software will then prompt you for a printer and allow you to make print specific settings before sending the screen capture to the printer. The area that is printed is only the tab window itself. At the top of the print will be the vehicle make, model, year, and VIN information.



## Refresh

This forces the screen to refresh each of the grid entries. All data is discarded and once again retrieved from the vehicle. To

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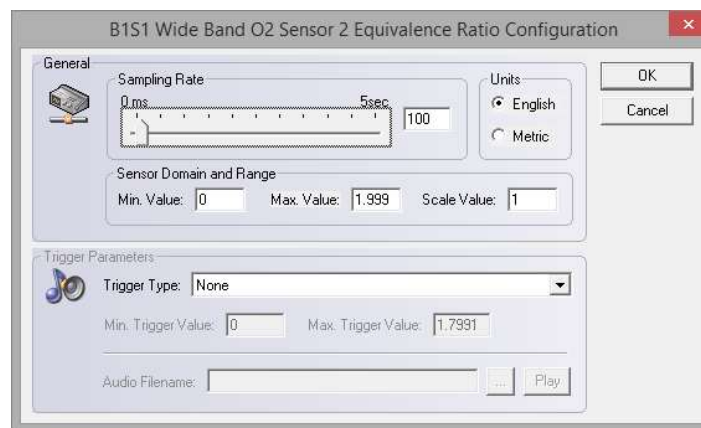
refresh the grid entries, select the *Refresh* button or press F5.



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## Sensor Configuration

Once a sensor is added to the Meter, Graph, or Grid tabs, it can also be configured. To configure the minimum and maximum range, scaling value, units, sampling rate, and audible alert triggers click on the sensor name field that you want configured and select *Configure Sensor*. A dialog box will appear with all of the sensor configuration options. These options are not permanent and the changes will be lost between vehicle connections.



### Sampling Rate

Sampling Rate is the rate that the software requests data from the sensor. If the time for the next sample has not expired and the meter, graph, or grid is ready to update the screen, the last sampled value is used.

In some cases, like coolant temperature, the sensor's value changes very slowly and sampling it rapidly is a waste of valuable bandwidth.

### Units

Units refers to the unit of measure that the sensor data is reported in.

### Sensor Domain and Range

Sensor Domain and Range lets you set the starting point of the

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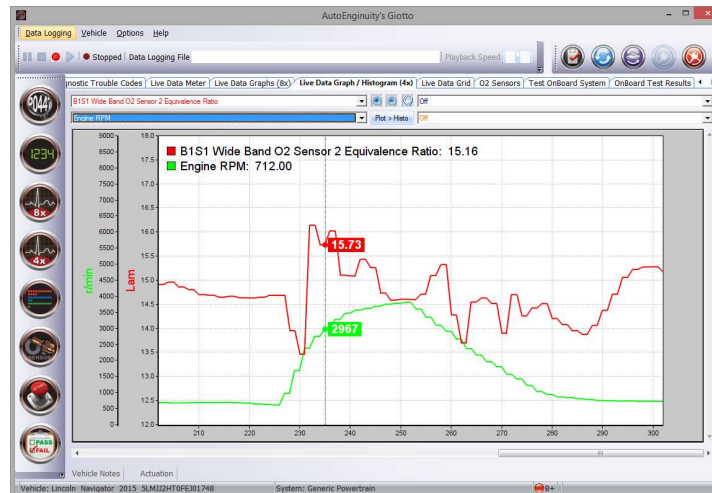
sensor and the maximum value that it can report. The domain and range are used to automatically range the meters and graphs. These values are used to determine whether the meter color should be green, yellow, or red.

### Scaling Value

Scaling value is the multiplier that is applied to the domain, range, and reporting sensor sample value. Scaling is used for a variety of reasons, such as converting Hz to counts, kPa to psi, etc. You only need to know the multiplier, let the ScanTool do the rest.

For example, if you want to see your air/fuel mixture in real-time and your vehicle supports wide-band O2 sensors, simply select the Wide-Band Equivalency Ratio you wish to work with. Then select *Sensor Configuration* from the same menu. Finally, change the scaling value to 14.7 and click *OK*. Now the sensor will report its percentage value multiplied times the stoichiometric value, creating real-time air/fuel mixture readings.

In the example below you can see the wide-band O2 sensor (B1S1 WB02 Ratio) showing real-time air/fuel mixtures from a Lincoln Navigator '15.

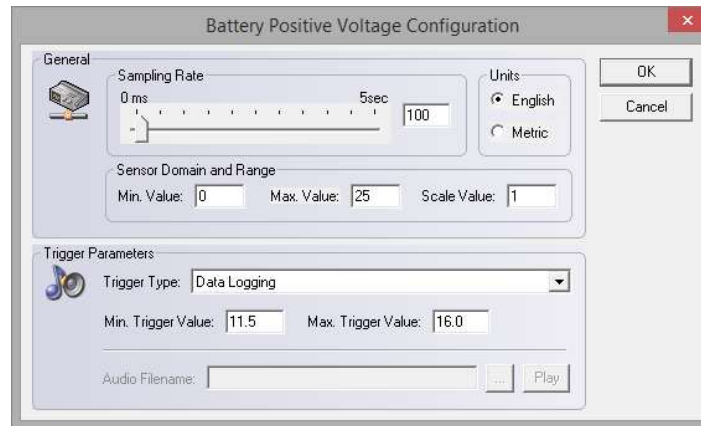


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## Trigger Parameters

Three types of sensor triggers are available: 1) trigger data logging; 2) play audio files; and, 3) visual marker trigger

To enable triggering for a specific sensor, change the Trigger Type from *None* and choose a trigger type. Now change the *Min. Trigger Value* and *Max. Trigger Value* to the range in which you'd expect the sensor to report within and click *OK*.



## Data Logging

Data Logging is a trigger type used to start a data log when a reporting sensor value is outside of the normal range. The benefit to using this feature is that you won't have to watch over the sensor. You can operate the vehicle until the condition arises and when the conditions are met the software will prompt you to begin logging. If you agree with the Data Logging requirement, click *OK* to begin the data logging or *Cancel* to ignore

If a filename is preset when the trigger event occurs, the data logging will begin without any further user interaction. Otherwise, you will be prompted to enter a filename once data logging is triggered. Data logging will continue until you manually stop it or change a sensor.





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The Trigger Type is automatically returned to *None* after data logging is started to prevent a second trigger event from writing over your first data log. You will be required to reset the trigger each time you'd like to trigger a data log.

### Play Audio File

Play Audio File trigger is an audible way to alert you when a sensor is out of range.

The Play Audio File trigger type will require you to select an audio file to be played. You can manually enter the full path to a filename or select the "..." button to the right of the Audio Filename text field and browse your computer's audio files. Select any .wav file. You can test the audio file that you selected by pressing *Play*.

Only three seconds of the audio file will be played. Multiple audio files can be played if multiple triggers from different sensors are being triggered. How well your computing device can handle audio files simultaneously depends on your audio hardware.

### Visual Marker

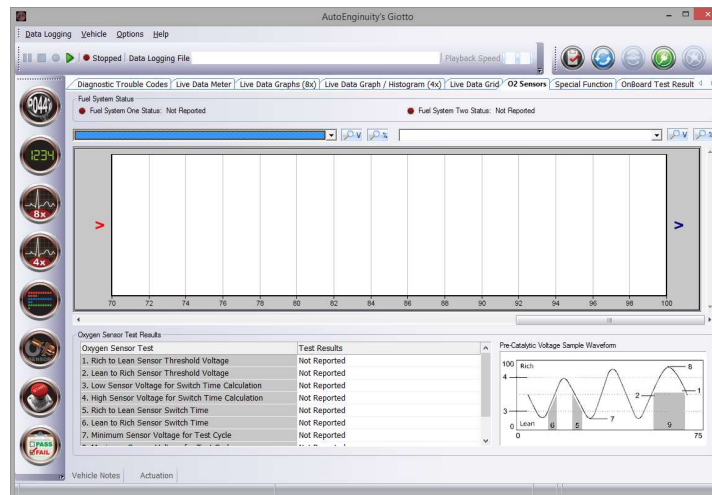
Visual Marker trigger is used with Live Data Graphs. When the minimum or maximum range is exceeded a horizontal line is drawn across the screen at the trigger range. Once the sensor's value crosses back within the allowable range, the visual marker is removed.

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## O2 Sensors

The O2 Sensors window is used to show oxygen sensor specific data and test results. Like the Live Data Graph, O2 Sensors allows you to show oxygen sensor voltage and fuel trim plotting. What O2 Sensors adds, is the ability (if supported by your vehicle) to look at the plotted data specifically scaled to the manufacturer's requirements and a sample of what the pre-catalytic oxygen sensor switching should look like.

This window will only report O2 sensor data from SAE OBD-II and EOBD IV Modes 1 and 5. So in the case of manufacturer specific O2 data, it will not be displayed here.



## Fuel System Status

At the top of the window is the Fuel System Status. Each fuel bank has a separate color-coded indicator and a text description of its state.

The Fuel System Status is used to determine if the O2 sensors are being used in the fuel loop. Common reporting conditions are:

- 
- |                          |   |
|--------------------------|---|
| • Not Reported (Red)     | The vehicle doesn't support the fuel bank.  |
| • Open Loop (Bright Red) | Fuel adaptation is not using the O2 sensors but is instead using the ECM's hard-coded internal presets. |
| • Closed Loop (Yellow)   | Fuel adaptation is operating from the O2 sensors input, but with a fault.                               |
| • Closed Loop (Green)    | Fuel adaptation is influenced by the O2 sensors. This is the normal state.                              |

See the Fuel Systems section in *Appendix D: Engine Management Systems* to better understand how O2 sensors affect engine management.

### Oxygen Sensor Test Results

In the lower-left corner of the window, the Oxygen Sensor Test Results are shown. This data is retrieved from your vehicle's PCM and used to determine the oxygen sensors' performance and in influencing the computation of fuel trim. If your vehicle doesn't support displaying these values, then *0.00* will be displayed. Reporting *0.00* doesn't mean that the test wasn't performed, it means that the test/threshold value isn't available to be read on this vehicle.



Some 2001 and newer vehicles will support this feature. Previous model years will not.

In the lower-right corner of the window, is a sample voltage plot showing a good pre-catalytic converter oxygen sensor. The Oxygen Sensor Test Results are numbered so that each test result can be matched to the part of the plot used as a threshold value in the testing process. *See the O2 Sensors section in Appendix D: Engine Management Systems to better understand how oxygen sensors affect engine management.*

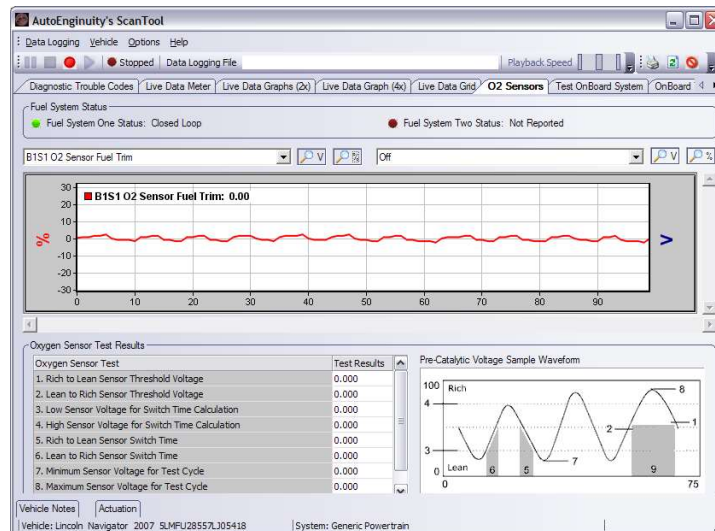
Like the Live Data Graph, adding a sensor to the graph is easy. Select the sensor from the O2 Sensors list above the O2 Sensors graph, or left- or right-click on the graph area and select the sensor from the drop-down list.

If you no longer need to watch a sensor you can remove it from the graph by selecting *Off* in the O2 Sensor list, or by right-clicking the graph area and selecting *Off*.

Zooming in on the O2 sensor voltage or fuel trim is done by selecting the zoom buttons next to the O2 sensor name.

The V zoom will set the ranges of the graph to the preset of 0.0 - 1.2V for normal-band and 0.8 - 1.2mA for wide-band O2 sensors. If the vehicle supports reporting normal-band O2 Test IDs for minimum and maximum O2 V, then those reported values are used (+.05V) as the minimum and maximum plot ranges. This allows you to quickly determine if the O2 sensor voltages are within manufacturer or known preset ranges.

The % zoom will set the range of the graph to the preset of -30 - 30%. This is used to range an O2 sensor's fuel trim to a typical threshold range.



You may restore the normal graph ranges for the O2 sensors by simply reselecting the O2 sensor from the sensor drop-down list. The default ranges will be restored.



Post catalytic converter O<sub>2</sub> sensors may not report fuel trim. It may report as 99.06. In this case, you will be required to use only the voltage.



Toyota A/F Sensors are not the same as normal O<sub>2</sub> sensors. They will report between .5V and .8V normally. Stoichiometric is .66V.

### Understanding O<sub>2</sub> Sensor Locations

Oxygen sensor locations are not universal for all vehicles. First, you must understand that you can have up to two banks (B1 and B2) on your vehicle. You will have an exhaust pipe for each bank; if your vehicle has two exhaust pipes, it will have two oxygen sensor banks. Sensors are designated with S1 - S4. Sensor S1 is always before the catalytic converter and considered a pre-catalytic converter (pre-cat.) oxygen sensor. Typically all oxygen sensors S1 and S2 will be pre-cat. and sensors S3 - S4 are post-cat. sensors. In the case where the vehicle only has oxygen sensors S1 and S2, S1 will be pre-cat. and S2 will be post-cat.

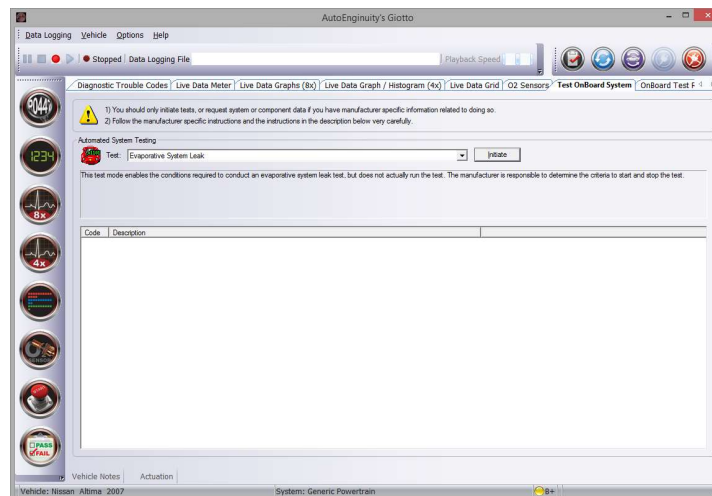
Pre-catalytic converter oxygen sensors should exhibit a waveform with switching similar to the example on the O<sub>2</sub> Sensor window. Post-cat. sensors should exhibit a low-amplitude, or semi-flat, waveform while the vehicle is at idle. Oxygen sensor readings will be inaccurate if the fuel system is "Open". Data will only be valid if the fuel system is "Closed". Depressing the gas pedal while sampling any oxygen sensor should increase the frequency of the switching.

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## Test OnBoard System

Test OnBoard System is used to send requests to specific components and/or modules, and to run system-level tests on the vehicle. The optional enhanced interfaces will also actuate system tests and components here. *Also see Actuation Tests for more on component-level controls.*

In the case of enhanced options, the label of this tab will change to reflect what the car maker uses to describe their similar functionality. For example, Mercedes and BMW will call this functionality *Special Functions*. While Nissan / Infiniti will call it *Work Support*. Only with Generic OBD-II will this tab consistently be labelled Test OnBoard Systems.

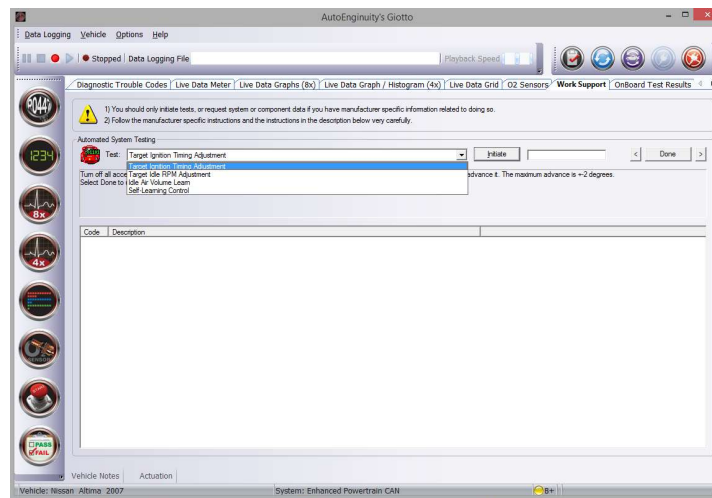


### Automated System Testing

The *Test* list will enumerate all of the system-level tests that your currently selected system has available. This list will change depending on the make, model, year and system selected.

A brief description of the test is given to clarify what the system-level test can do, and what the requirements may be for its operation. Please read this information carefully.

To initiate a system-level test, select the test from the *Test* drop-down list. Read the description to make sure the conditions required for the test to operate correctly are met. Finally, click the *Initiate* button. Below the description, an ongoing status of the test and the final results will be displayed. Changing tabs to any other part of the ScanTool during the test, will terminate the test.



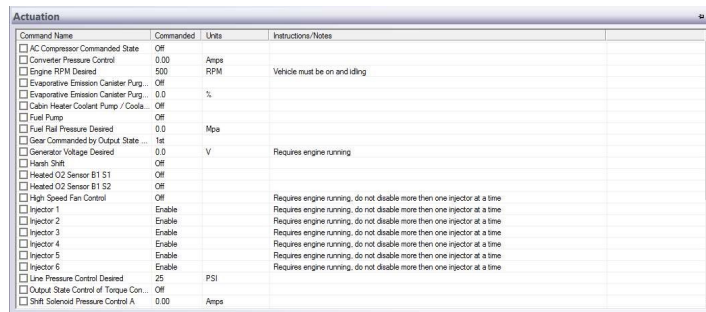
If a test requires inputs, the instructions will be enumerated in the *Description* field. Any buttons that are required for test operation will be displayed to the right of the *Initiate* button.

Test output results will vary depending on the test. For example, test results can be displayed as plot data. Such as in the case of the Ford Power Balance test from the enhanced Ford expansion. Some test results will report DTCs. They are read and interpreted just as in the DTC window. The ability to click the *Code* row and see a more detailed description is not available here. In this case, you can view the entire description by using the DTC Library. Select *Help | DTC Library* and enter the DTC and vehicle make.

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## Actuation

Actuation of individual vehicular components can be performed within the *Actuation* floating/dockable window. For example, with a Ford ABS controller, here is where you would actuate the ABS pump motor. The actuation command list typically is not vehicle specific, but system specific. In some cases, such as BMW and Ford, this means that not all vehicles will respond to all of the actuation commands listed. Check your vehicle manufacturer's service guide for specific actuation commands if you are unsure of what components and/or modules the vehicle supports. *Also see Test OnBoard System for system-level controls.*



Command Name	Commanded	Units	Instructions/Notes
<input type="checkbox"/> AC Compressor Commanded State	Off		
<input type="checkbox"/> Converter Pressure Control	0.00	Amps	
<input type="checkbox"/> Engine RPM Desired	500	RPM	Vehicle must be on and idling
<input type="checkbox"/> Evaporative Emission Canister Purge	Off		
<input type="checkbox"/> Evaporative Emission Canister Purge	0.0	%	
<input type="checkbox"/> Cabin Heater Coolant Pump / Control	Off		
<input type="checkbox"/> Fuel Pump	Off		
<input type="checkbox"/> Fuel Rail Pressure Desired	0.0	Mpa	
<input type="checkbox"/> Gear Commanded by Output State	1st		
<input type="checkbox"/> Generator Voltage Desired	0.0	V	Requires engine running
<input type="checkbox"/> Harsh Shift	Off		
<input type="checkbox"/> Heated O2 Sensor B1 S1	Off		
<input type="checkbox"/> Heated O2 Sensor B1 S2	Off		
<input type="checkbox"/> High Speed Fan Control	Off		Requires engine running, do not disable more than one injector at a time
<input type="checkbox"/> Injector 1	Enable		Requires engine running, do not disable more than one injector at a time
<input type="checkbox"/> Injector 2	Enable		Requires engine running, do not disable more than one injector at a time
<input type="checkbox"/> Injector 3	Enable		Requires engine running, do not disable more than one injector at a time
<input type="checkbox"/> Injector 4	Enable		Requires engine running, do not disable more than one injector at a time
<input type="checkbox"/> Injector 5	Enable		Requires engine running, do not disable more than one injector at a time
<input type="checkbox"/> Injector 6	Enable		Requires engine running, do not disable more than one injector at a time
<input type="checkbox"/> Line Pressure Control Desired	25	PSI	
<input type="checkbox"/> Output State Control of Torque Con...	Off		
<input type="checkbox"/> Shift Solenoid Pressure Control A	0.00	Amps	

The *Actuation* window is movable and dockable, so you can use this window from anywhere within the ScanTool program. This will allow you to view the actuation results in real-time.

When the *Actuation* window is docked, it will become a tab. **In case the Actuation window is closed and not docked, you can restore it by right-clicking on any menu item or toolbar. Selecting the menu entry *Actuation* to restore it to the default lower-left corner of the ScanTool workspace.**

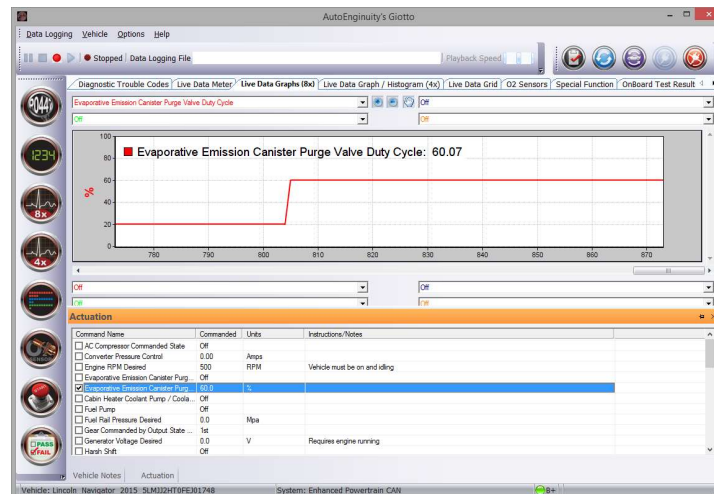


Only initiate actuations or system tests as per the vehicle manufacturer's instructions. Damage to your vehicle can occur from improper usage.



To initiate an actuation command, simply change the corresponding *Commanded* entry to a value that you would like the component and/or module to change to. Then enable the command by selecting the check box to the left, under the *Command Name* column. The actuation request will be placed in the queue for processing. If you are previewing a lot of live data sensors, the actuation may take a second before it begins.

In the example below, we changed the EVAP Purge Duty Cycle to 60% and the sensor changed instantly to reflect this.



Depending on your vehicle manufacturer, the ScanTool software may be capable of supporting multiple actuation commands simultaneously.

You may be required to disable the actuation for it to stop actuating. To disable the actuation, simply uncheck the command. All component and/or module settings are restored automatically if the ScanTool is disconnected or if the vehicle's key is cycled.

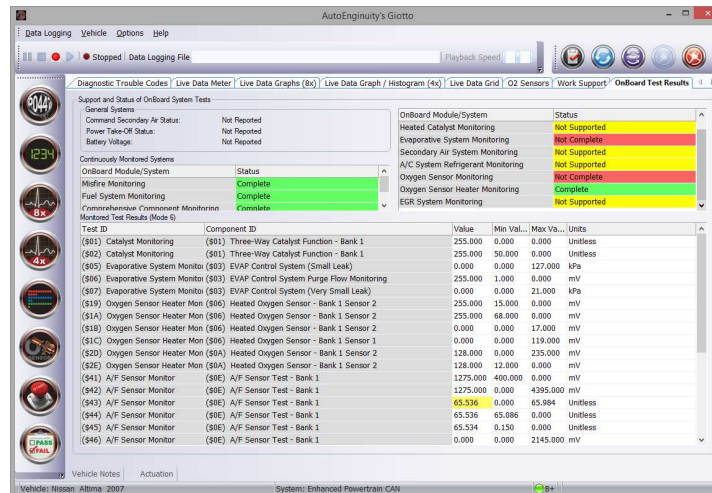
On the right-side of the Actuation window is the Instructions/Notes column. If the manufacturer has published notes for the operation of the actuation request, they will be documented here.

## OnBoard Test Results

The OnBoard Test Results window is used to display the results from the onboard diagnostic inspection/maintenance (IM) monitors and SAE OBD-II Mode 6 results. Three system values that are important to the completion of the IM monitors and Mode 6 results are also displayed.

### Continuously and Non-Continuously Monitored Systems

The engine computer monitors the status of up to 11 emission-control related systems by performing either continuous or periodic function tests. The first three testing categories—misfire, fuel system, and comprehensive components—are continuously running during the operation of the vehicle. The remaining eight run only once per drive cycle and only after a certain set of conditions are met. Typically, vehicles will have at least five of the eight remaining monitors (catalyst, evaporative system, oxygen sensor, heated oxygen sensor, and exhaust gas recirculation, or EGR, system) while the remaining three (air conditioning, secondary air, and heated catalyst) are not necessarily applicable to all vehicles.



Not all of the IM monitors are supported by all vehicles. The *Status* column in each of the standard lists indicates whether the

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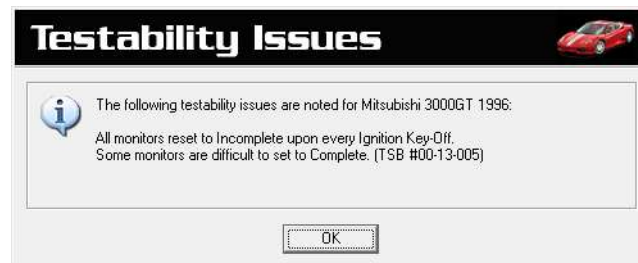
system supports being tested on this vehicle. If the system is not supported, "Not Supported" (shown in yellow) will be displayed in the column and the description will have a line striking through the IM monitor's name. If the system is supported, "Completed" (shown in green) or "Not Completed" (shown in red) will be displayed.

Most states now use the IM monitors to determine whether a vehicle passes their emissions requirements. Which IM monitors are used for testing is not standardized. If your vehicle doesn't have the necessary monitors in the "Completed" state, a tailpipe gas analysis might be used instead of allowing your vehicle to fail. Contact your local emissions facility to determine which IM monitors are used for testing and what the emissions requirements are for your state.



Make sure you verify that all of your required IM monitors have completed before the vehicle is emissions tested.

If the vehicle attached to the ScanTool has any issues with storing IM results or completing a system test, a built-in technical service bulletin (TSB) library will be searched and the information displayed the first time you view this window.



Continuously monitored systems are sampled by the vehicle every two seconds. The rate at which the non-continuously monitored systems are sampled is vehicle and manufacturer dependent.



The vehicle is automatically scanned for changes in continuous and non-continuous onboard system test results in five minute intervals.

Vehicle manufacturers were given liberal latitude in setting non-continuous IM monitoring strategies. A "drive cycle" is the name for the series of conditions required before all non-continuous IM monitors can begin and complete their tests. For example, sloshing of the fuel can prevent testing of the evaporative system because of false malfunction indications due to high vapor generation rates. (*See Appendix C for details about your vehicle's drive cycle.*) It is also possible that an IM monitor will not complete, even though its drive cycle criteria is met, because of a Pending DTC or a dependency on the completion of another IM monitor (i.e., a catalyst monitor waiting for the completion of the oxygen sensor monitor.).

A "trip" can also be used to verify work you do on any one system and its supporting components without having to complete the entire drive cycle.

#### **OBD-II IM-based Emissions Testing**

An OBD-IM check consists of two types of examinations: A visual check of the dashboard display function and status (also known as the MIL and/or bulb check), and an electronic examination of the OBD computer itself.

1. Visually examine the instrument panel to determine if the MIL illuminates briefly when the ignition key is turned to the "key on, engine off" (KOEO) position.
2. Locate the vehicle's data link connector (DLC) and plug a scan tool into the connector.
3. Start the vehicle's engine so that the vehicle is in the "key on, engine running" (KOER) condition. The MIL may illuminate and then extinguish during this phase. Continued illumination while the engine is running is cause for failure.
4. Check the vehicle's IM readiness states. (What constitutes failure is non-uniform; however, typically two IM monitors Not Completing is a failure. Some states won't allow any to be Not Complete.)

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## General Systems

The General Systems in the upper-left of the window shows the secondary air, the power-on takeoff status, and battery voltage. These system values are typically used to determine whether an IM monitor test can begin or complete.

You can also use battery voltage to help determine "no start" conditions and to make sure your alternator is charging the vehicle's battery. If the battery voltage, while the vehicle is running, is less than 12V, your alternator is not producing enough power to charge the battery.

## Monitored Test Results (Mode 6)

This table is a list of all of the IM monitors' component-level test results. This is commonly referred to as "Mode 6" because of its SAE J1979 designation. Manufacturers are supposed to allow the viewing of the test ID (TID), component ID (CID), component results, and ranges for each subsystem that make up an IM monitor's results. Should your vehicle support this feature, it can show you what results each system has at the component level.

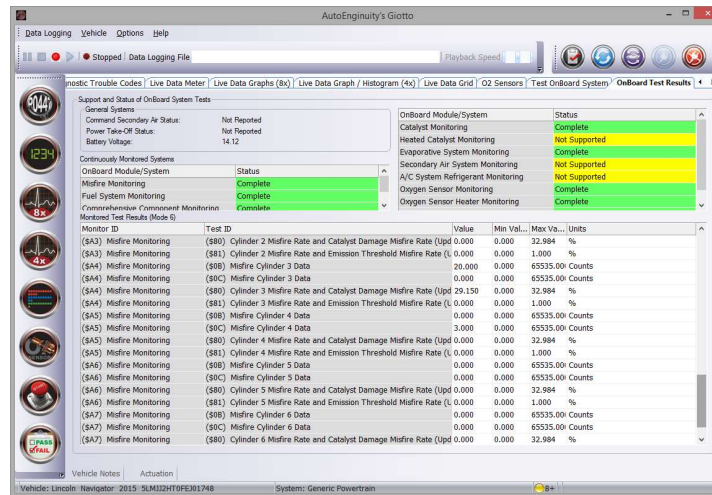
The ScanTool has a built-in database of descriptions and scaling values derived directly from the manufacturers. If the Mode 6 data reported from your vehicle is listed in the database, ScanTool will translate it for you. Keep in mind that not all Mode 6 data is documented by the manufacturer, and not all manufacturers even support Mode 6. We periodically update ScanTool to include more descriptions as they become available. If the Mode 6 data is not translated you can also try searching your manufacturer's service guides or other service information sources for complete descriptions and scaling values.

Mode 6 test values and limits are to be reported in a decimal format with a range of 0 - 65,535. However, some manufacturers have stored negative number test values and/or limits. Also, some manufacturers reset the Mode 6 information upon key off; as a result, only data from the current driving cycle can be accessed and must be obtained before engine shutdown.



Some manufacturers have developed a singular Mode 6 data sheet for all of their vehicles. Therefore, some vehicles may report TID/CIDs they don't support. Ignore results from components your vehicle doesn't support.

If your vehicle supports Mode 6, don't overlook the usefulness of this information. As an example, the Mode 6 data below is from a 2015 Lincoln Navigator.



For this vehicle, each individual cylinder misfire count is reported. In this case, cylinder three has been misfiring. The misfire count does not exceed what this vehicle allows before it would register it as a fault, so it was not flagged by the PCM. Even if the Misfire IM doesn't report the condition as an emissions violating misfire, the information can help diagnose this hard-to-find problem.

### Create Report

You can save all IM and Mode 6 information or DTC and IM information into a report for offline review and/or printing. All of the information will be stored in an XML format for universal

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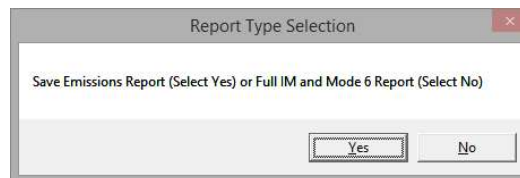
viewing and printing in a web browser (i.e., Internet Explorer and Firefox).

The reports are viewed and displayed according to a provided XSL style sheet (AutoEnginuity IM Results XML Template.xsl and AutoEnginuity Emissions Report XML Template.xsl). The reports' layout can be changed to better suit your needs or show your company's logo. *See Data Logging Settings for more details on changing the style sheet.*

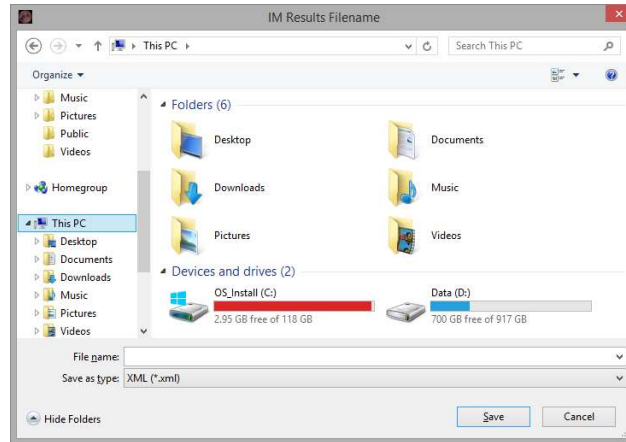
To create a report, click the *Print Data* button on the left of the Live Data Options toolbar or press F8.



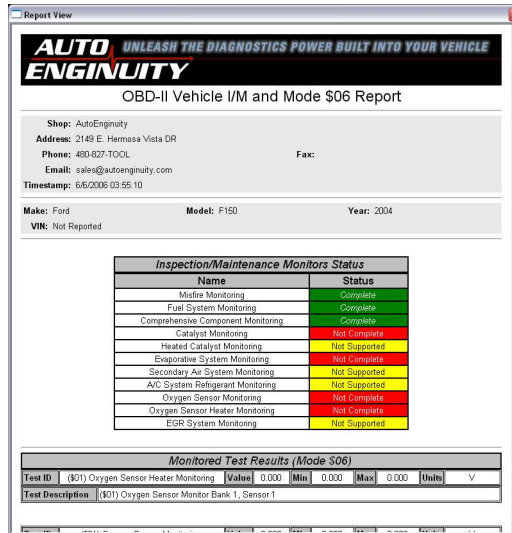
You will then be prompted to select which type of report you want. An Emissions Report is the DTCs (no freeze frame information) and the IM states. The Full IM and Mode 6 Report is just as the name describes.



Then enter the filename of the resulting report in the IM Results Filename dialog.



Once you have named and saved the report, a screen will appear showing the final formatted report. You can navigate back and forth through previous reports or print it by right-clicking on the view and selecting your option.







## OB2-II Vehicle I/M and Mode \$06 Report

Shop: Name	
Address: Address	
Phone: Phone	Fax: Fax
Email: Email	
Timestamp: 8/7/2004 1:40:10 AM	
Make: Ford	Model: Explorer
Year: 2004	
VIN: 1FMZU62KX4ZA05572	

Inspection/Maintenance Monitors Status	
Name	Status
Misfire Monitoring	Complete
Fuel System Monitoring	Complete
Comprehensive Component Monitoring	Complete
Secondary Air System Monitoring	Complete
A/C System Refrigerant Monitoring	Not Supported
Oxygen Sensor Monitoring	Complete
Oxygen Sensor Heater Monitoring	Not Supported
EGR System Monitoring	Not Supported
Catalyst	Complete
Heated Catalyst	Complete
Evaporative System	Complete

Monitored Test Results (Mode \$06)							
Test ID	Oxygen Sensor Monitoring	Value	0.495	Min	0.230	Max	2.816
Units	A						
Test Description	Heated O2 Bank 2, Sensor 1 Heater Current						

Test ID	Oxygen Sensor Monitoring	Value	0.495	Min	0.230	Max	2.816
Units	A						
Test Description	Heated O2 Bank 2, Sensor 1 Heater Current						

Test ID	Oxygen Sensor Monitoring	Value	0.495	Min	0.230	Max	2.816
Units	A						
Test Description	Heated O2 Bank 2, Sensor 1 Heater Current						

### Refresh

This forces the screen to refresh before the normal five minute update interval.

To refresh the IM states and Mode 6 information, click the *Refresh* button on the right of the Live Data Options toolbar or press F5.

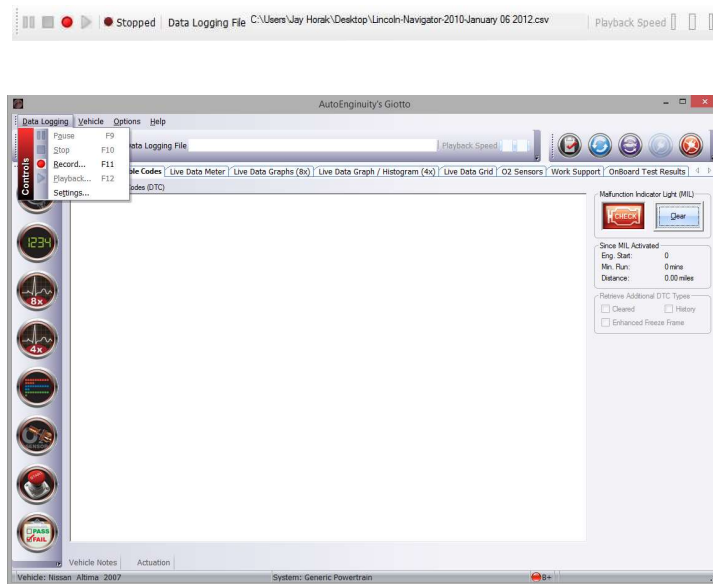


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## Data Logging

Data logging is a very useful and simple-to-use feature which can be used to find intermittent issues and/or examining data stream offline. Use the Record feature to create the data logs, and Playback feature to review the data log offline. Data logging controls are available in both menu and toolbar form.

The Data Logging toolbar is a floating window control and can be moved, docked, or removed. Although the toolbar is a graphical duplicate of the Data Logging menu, only the toolbar allows you to change the Playback rate and it also displays the active *Data Logging File*. Another unique feature of the toolbar is the Data Logging Status LED. It shows the data logging state in a colored LED with the text description or the state to the right of the LED.



All live data sensors are capable of being recorded. Data logs can be played back or recorded in the Live Data Meter, Live Data Graph, and Live Data Grid. You can switch between the tabs without interfering with the data logging. Recording will stop if a live

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data sensor selection changes.

Two methods for storing the logged data are: 1) CSV/delimited text file for traditional spreadsheet-like formatting; and, 2) XML for use with web browsers.

### Pause

You have the ability to pause the recording or playback. For example, if you are waiting for an oxygen sensor to warm up and don't need to record until it starts switching. Pausing can be done by selecting *Pause* from the Data Logging menu. Pausing keeps the current file active but suspends logging data until the logging state is changed to *Stop*, or until *Pause* is selected again to continue recording. The active sensors are still updated on the screen, but they are not being recorded.

To signify that *Recording* or *Playback* is being paused, a high-light color is applied to the *Pause* menu item and the Data Logging Status LED is shown in yellow. The Data Logging Status is changed to *Paused*.

### Stop

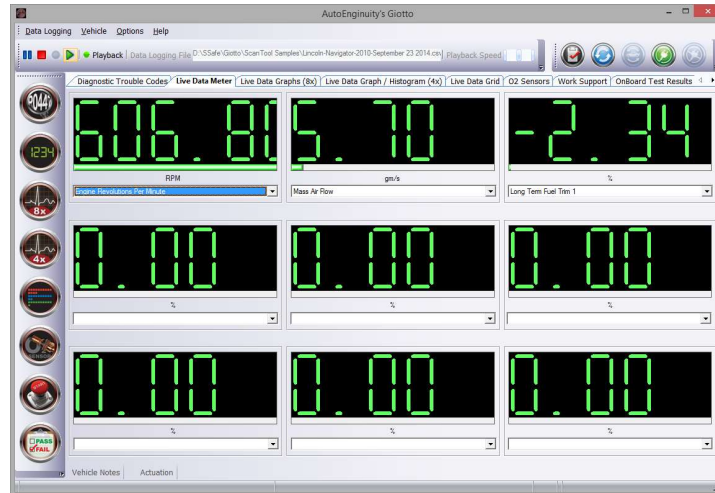
Once you are done recording or playing back, you can select *Stop* from the Data Logging menu. When you select *Stop*, a high-light color is applied to the *Stop* menu item, Data Logging Status LED is shown in bright red. The Data Logging Status is changed to *Stopped*. Finally, the data logging file is closed.

### Playback

If you have already recorded a data log and are not connected to a vehicle (*Disconnected*), you can select this option to play the file back in the Live Data Meter, Live Data Graph, or Live Data Grid.



You may be required to disable the ScanTool from trying to connect to the vehicle to use *Playback*. To do this, select *Vehicle Communications | Communications Configuration*. Finally, uncheck *Automatically Connect on Launch..*



You can playback both the CSV and XML data logs as long as both the units and sensor range options were selected during the recording of the data log. Without those options the meters and graphs won't know where to range the data.

To begin, select *Playback*. If a filename already exists in the *Data Logging File* field, then that data log will begin to play. You can remove or change the filename manually by entering any filename and destination in the *Data Logging File* field or by clicking the *Data Logging File* button. If *Data Logging File* field doesn't already have a filename or the *Data Logging File* button is selected, you will be given the chance to select a filename and path where the data log is stored.

Once a data logging file has been selected, a list of all the sensors in the file will be presented in a selection window. You can select individual sensors by clicking the check box next to the sensor name. Or you can select all the sensors supported by the data logging file by selecting the check box next to the column heading. Click *OK* when you are done and playback will begin.

To signify that Playback is being performed, a highlight color

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is applied to the *Playback* menu item. Also, the Data Logging Status LED is shown in green and the Data Logging Status is changed to *Playback*.

The data logging samples will show on the Live Data (Meter/Graphs/Grid) tab selected. If no Live Data tab is currently selected, then playback will default to using the Live Data Graph.

The Live Data Graph will load the entire data logging file and show it in a single graphing window. This viewing method can be useful to quickly view a data logging file for an intermittent sensor recorded during a drive cycle.

The Live Data Meter and Live Data Grid tabs will playback the file one sample at a time. Playback defaults to a 100ms update rate; you can change the update rate on the Data Logging Toolbar. Sliding the *Playback Speed* control to the left increases the pauses between updates, slowing down the playback speed as much as 200ms per update. Moving the slider to the right speeds up the playback rate by shortening the pauses.

## Record

If you are connected to a vehicle, you can start recording live data. If the intent is to playback the data log, then both the units and sensor range must be enabled in the *Data Logging Settings* prior to beginning recording. These settings are enabled by default.

To begin, select the sensors to data log in the Live Data Meter, Live Data Graph, or the Live Data Grid. After the sensors are selected, a filename for the data log must be chosen. If a filename already exists in the *Data Logging File* field, then that filename and destination directory will be used when you select *Record*; the previous file will be overwritten. You can remove or change the filename manually by entering any filename and destination in the *Data Logging File* field or by clicking the *Data Logging File* button. If *Data Logging File* field doesn't already have a filename or the *Data Logging File* button is selected, you will be given the chance to select the filename and path where the data log will be stored. By default the make, model, year, and today's date are used as the filename defaults. Once the filename is set, click *OK* to begin

data logging.

Make sure that you have enough space available on the drive you select; data logging doesn't take much memory, but it will add up if you record multiple sensors for long periods of time.

### Sample XML Data Log



OBD-II DataLogging

Time	Coolant Temperature (°F) [-40 - 419]	Time	Engine RPM (r/min) [0 - 9000]	Time	Air Flow Rate From Mass Air Flow Sensor (lb/min) [0.00 - 86.70]
09:40:33.406	135	09:40:33.734	2814	09:40:34.062	0.00
09:40:34.343	135	09:40:34.671	2814	09:40:35.000	76.29
09:40:35.312	135	09:40:35.640	2814	09:40:35.968	76.29
09:40:36.260	135	09:40:36.593	2814	09:40:36.921	76.37
09:40:37.203	135	09:40:37.546	2814	09:40:37.899	76.29
09:40:38.146	135	09:40:38.484	2820	09:40:38.836	76.37
09:40:39.109	135	09:40:39.437	2814	09:40:39.781	0.00
09:40:40.078	135	09:40:40.390	2814	09:40:40.734	0.00
09:40:41.031	135	09:40:41.359	2814	09:40:41.703	0.00
09:40:41.984	135	09:40:42.312	2814	09:40:42.666	76.29
09:40:42.937	135	09:40:43.265	2814	09:40:43.609	76.37
09:40:43.890	135	09:40:44.218	2814	09:40:44.593	76.37
09:40:44.959	135	09:40:45.171	2814	09:40:45.484	76.37
09:40:45.718	135	09:40:46.031	2814	09:40:46.359	0.00
09:40:46.593	135	09:40:46.906	2814	09:40:47.218	0.00
09:40:47.454	135	09:40:47.796	2814	09:40:48.125	76.37
09:40:48.359	135	09:40:48.697	2814	09:40:49.000	76.37
09:40:49.260	135	09:40:49.578	2814	09:40:49.890	76.37
09:40:50.125	135	09:40:50.437	2814	09:40:50.765	76.37
09:40:51.015	135	09:40:51.328	2814	09:40:51.640	0.00
09:40:51.890	135				

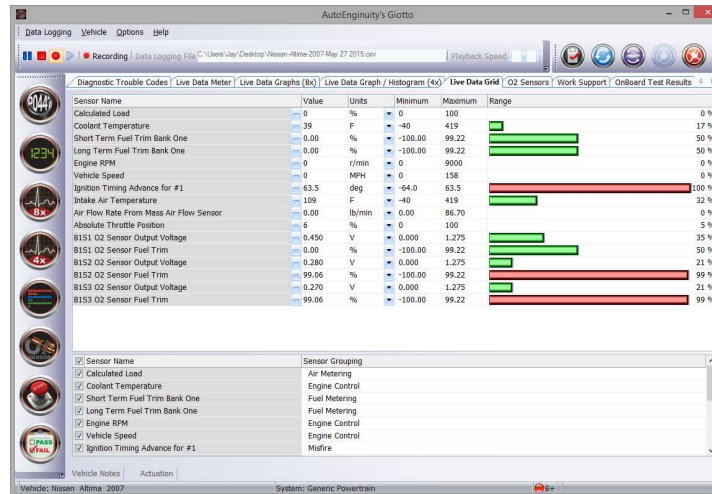
### Sample CSV Data Log

A	B	C	D	E	F
Time	Calculated Load (%) [0 - 100]	Time	Engine RPM (r/min) [0 - 9000]	Time	B1S1 Wide Band O2 Sensor Equivalence Ratio (Lam) [0.000 - 1.999]
01:22:11.932	14	01:22:12.172	700	01:22:12.943	0.986
01:22:14.036	14	01:22:14.266	781	01:22:15.407	1.037
01:22:16.588	15	01:22:16.849	815	01:22:17.710	1.001
01:22:18.892	15	01:22:19.122	822	01:22:19.993	0.991
01:22:21.175	15	01:22:21.415	843	01:22:22.277	1.004
01:22:23.448	15	01:22:23.689	830	01:22:24.570	1.013
01:22:25.902	15	01:22:26.042	830	01:22:26.923	0.989
01:22:28.236	16	01:22:28.465	832	01:22:29.307	1.086
01:22:30.588	14	01:22:30.819	1212	01:22:31.690	1.071
01:22:32.912	17	01:22:33.142	1632	01:22:34.013	1
01:22:35.265	23	01:22:35.496	1139	01:22:36.377	1.046
01:22:37.528	13	01:22:37.779	728	01:22:38.640	0.961
01:22:39.812	14	01:22:40.072	742	01:22:40.893	1.01
01:22:42.065	15	01:22:42.325	714	01:22:43.167	1.021
01:22:44.378	17	01:22:44.639	693	01:22:45.550	1.007
01:22:46.902	15	01:22:47.062	882	01:22:47.923	1.011
01:22:49.155	22	01:22:49.386	1646	01:22:50.267	0.95
01:22:51.448	15	01:22:51.679	636	01:22:52.530	1.006
01:22:53.795	26	01:22:54.026	499	01:22:54.345	0.995

When data logging is in the recording state, a highlight color is applied to the *Record* menu item to signify that recording is active. In the lower-left corner, the Data Logging Status will read *Recording* and the Data Logging Status LED will illuminate bright red. The *Data Logging File* field will reflect the output filename and path that you set earlier.



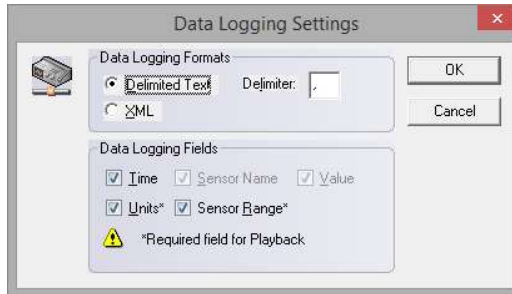
While Recording, vehicle disconnection detection is disabled. A sensor that has multiple communication failures will not trigger a disconnect, but report as 0.0 instead.



If the connection to the vehicle is lost, or if a sensor is changed, data logging is stopped and the file is closed as if *Stop* had been selected from the Data Logging menu.

## Data Logging Settings

Selecting the format in which the data is logged is as simple as selecting the *Data Logging* menu item, and then *Settings*. You can choose either *Delimited Text* or *XML* as the format to log data. Which you choose depends largely on where you would like to view the resulting data. In the case that you would like to import the data into a spreadsheet program, select *Delimited Text*. If you would like to view the resulting data with a standard Internet browser or would like to customize the recording style to include your company's information, select *XML*.



A delimited text file is the most common way to log data for spreadsheets. A delimiter is a character used to separate each of the data fields. The delimiter can only be one character. The default character is a comma (hence the formatting technique commonly called "comma-delimited").



A delimiter should be a character that is not alphanumeric (1 - 10 or A -Z). Otherwise, regular data will be confused with the delimiter.

An XML file can be viewed with web browsers such as Netscape and Internet Explorer. XML is the acronym for Extensible Markup Language, and is best described as a means of structuring data. XML provides rules for placing text and other media into structures and allows you to manage and manipulate the results. This formatting method is more sophisticated than delimited text files because of the power and control that a user has over the resulting document. With XML there is no need for a single delimiter to separate fields. Each field will have an individual tag to denote its start and end.

XML uses a file called a style sheet to help format the data in a web browser. The *AutoEnginuity DataLogging.xml* is the default style sheet for XML output installed with AutoEnginuity's ScanTool. By default, the style sheets are all installed in the Program Files/Common Files/AutoEnginuity directory. These style sheets can be modified to suite your purposes.



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XML also gives you the unique ability to create your own custom style sheets to format the logged data. For example, in the case that you will show the resulting data to your customers, you might want to add your company's logo at the top.

The fields that can be logged are listed with a check box so that they can be enabled and disabled. The fields that cannot be disabled are grayed out and the check box cannot be unchecked.

Once you have determined which fields will be logged, click *OK*.

---

## Customize Display

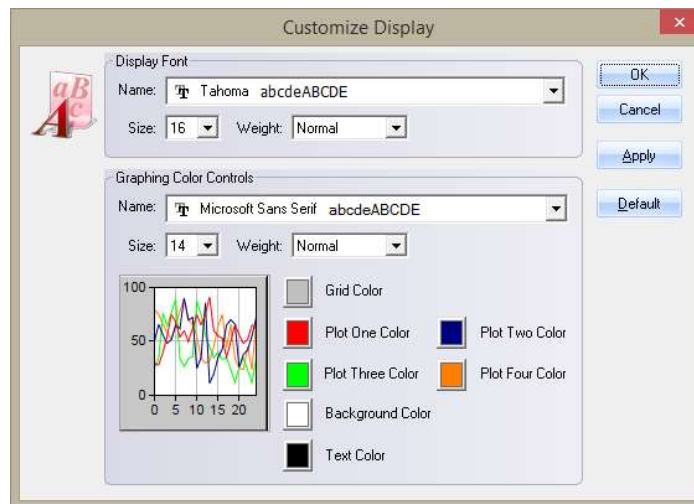
The user interface font and Live Data Graph, Grid, and O2 Sensors windows, color schemes and font styles can be changed to better suit your tastes or needs. The default colors and font styles were chosen to best suit the needs of the graph and the grid with respect to contrast and visual clarity.

### Display Font

The Display Font is used in all of the menus and screen text items. You can change the display font by selecting a new font from the *Name* drop-down list. This list will show all of the active fonts on your system in their respective font style. You can also change the size and the weight to make the display font more or less prominent.

### Graphing Color Controls

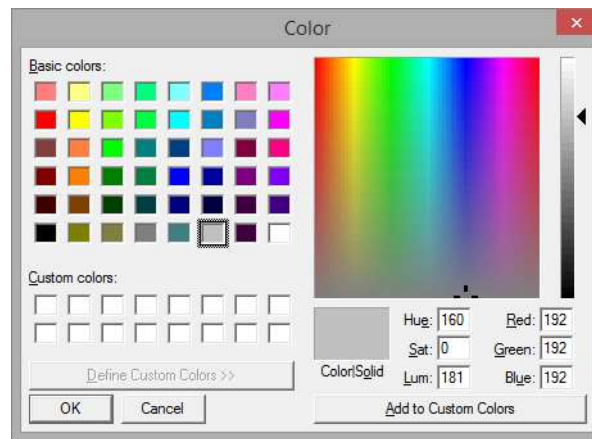
You can change the graphing font using the same procedure described above in *Display Font*.



To the right of the graph are the color icons and the control parameter that uses the color. By clicking on the color icon, a color selector will appear. You can choose a color that views better on

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your screen or that fits your computer's color scheme. Basic colors are provided for simple color selection. If you require a custom color you can "mix" the color manually by entering the values which represent the color, or by moving your cursor over a specific color you would like and left-clicking. Selecting *Color | Solid* will show you the color that is currently selected and how the Windows operating system will display the color on your screen.



Choose a new color and click *OK*. The graph colors will change immediately when *OK* is selected. This color scheme will be saved and reused when the ScanTool is started again.

If, after changing the colors, you don't find them usable or would prefer to stay with the default color scheme, you can restore the default colors by clicking *Default Colors* in the *Customize Display* window.

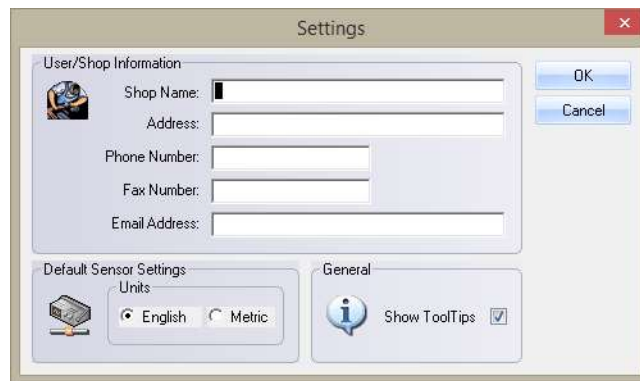
---

## Settings

The Settings window is used to change overall ScanTool parameters. This window allows you to change the report information, default sensor units, and whether ToolTips are shown.

### User/Shop Information

The User/Shop Information is used to fill in the first section for the DTC/Freeze Frame and IM/Mode 6 reports. This information should have been entered during the ScanTool installation. If you need to change any of the information, you can do it here.



### Units

This is the default unit of measure for all sensors and the MIL-related data. Each individual sensor can be overridden by using *Configure Sensor*. English is the default setting.

### Show ToolTips

This option will disable or enable the showing of the helper information displayed when you mouse over a section of the user-interface. Enabled is the default setting.

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## Vehicle Information

Vehicle information shows the make, model, year, VIN, vehicle interface type, OBD-II type, CAL, and CVN information. If any enhanced interface options are active, then you may see more module specific information in the Vehicle Module Information list.



The ECM Information is where you can determine the ECM ID the ScanTool is communicating with and the CAL and CVN IDs for it. Only late model vehicles will report CAL and CVN IDs.

The ECM ID will help you determine which control module your vehicle uses in some cases. For example, Chrysler will use different ECM IDs for different ECMs. The ScanTool will display this information if available.

The CAL ID is the Calibration ID of the ECM. Simply put, it's the binary fingerprint of the ECM's current program. Dealers can use this information to determine what revision of the ECM you are using for possible reflashing recalls.

The CVN ID is the Calibration Verification ID of the ECM. This is used to determine who installed the CAL program. Emis-

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sions testing centers and dealers will use this information to determine if the vehicle's program was reflashed privately or by a factory tool.

Enhanced interface options will also show module specific configuration information as in the examples below. This can vary for each vehicle model and year.

**Vehicle Information** 

Vehicle

Make: Lincoln Year: 2007

Model: Navigator

VIN: 5LMFU28557LJ05418

Interface Type: CAN

OBD-II Type: Not Reported

Vehicle Module Information

- [-] Software ID Block
  - PCM Part #: 7U7AHCA\*
  - Software Level: INBHCLB.HEX
  - Copyright: Copyright Ford Motor Co. 2008
- [-] Vehicle ID Block
  - Octane Adjust: Disabled
  - Fuel Octane: Disabled
  - Fuel Type: Unleaded
  - Tire Size: 643

**Vehicle Information** 

Vehicle

Make: Chrysler Year: 1998

Model: Concorde

VIN: 2C3HD46R8WH104247

Interface Type: J1850 VPW

OBD-II Type: Not Reported

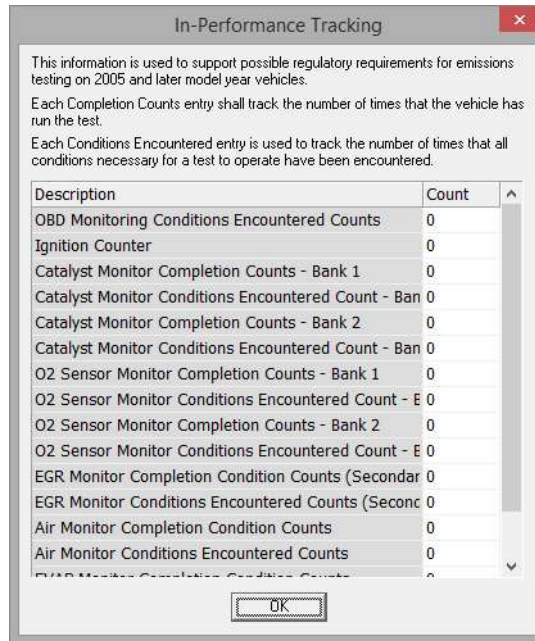
Vehicle Module Information

- [-] Engine Control Module
  - Part Number: 04606460AQ
  - Module Hardware Type: SBEC3A
  - Body Style: LH
  - Engine Displacement: 2.7 Liter V6
  - Engine Aspiration: Naturally Aspirated
  - Fuel Injection: Multi-Point Injection (MPI) Seq
  - Fuel Type: Unleaded Fuel
  - Fan Control: Two Fans, Two Speeds

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## In-Performance Tracking

In-Performance Tracking is a new effort to monitor the number of times a component test encounters condition suitable to run and complete. Vehicles starting in the model years of 2005 may implement this feature. This feature is required starting with the 2006 model year vehicles.



OBD Monitoring Conditions Encountered counts the number of times that the vehicle has been operated in the specified OBD monitoring conditions.

The Ignition Counter tracks the number of times that the vehicle's engine has been started.

The remaining component tests are simply tracking the conditions suitable for a test to run and complete.

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## Feature Activation

AutoEnginuity's ScanTool has the ability to be expanded, often without receiving new hardware or adaptor cables. Optional features can be activated by purchasing enhanced interfaces from an authorized reseller or directly from AutoEnginuity.

To view a list of optional features currently supported, select *Help | Feature Activation*. Enhanced Interfaces that you have purchased support and completed the activation process for, will show a status of "Activated". Those Enhanced Interfaces that you do not have support for will show a status of "Not Activated".





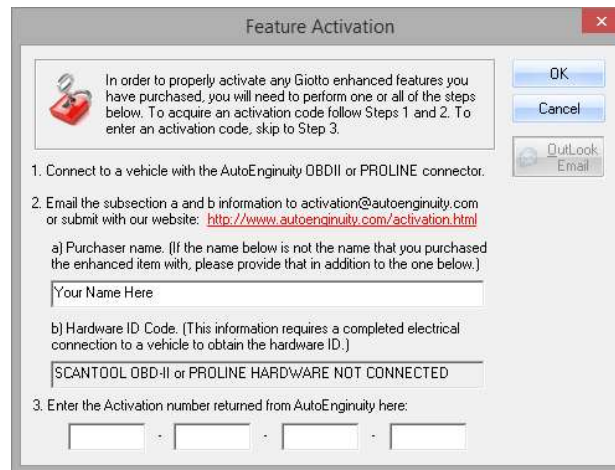
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### What do the Enhanced Interfaces do?

Enhanced Interfaces are, in most cases, software-only updates that allow you to access non-OBD-II systems, sensors, and actuations. For example, with generic OBD-II, Ford only supports 30 - 40 sensors. However, with the enhanced Ford interface, a typical Ford vehicle will support 200 - 300 sensors from 65 systems, and a dozen system tests. The Enhanced Interfaces allow you to access the vehicle with the manufacturers' proprietary protocols while still using the standard hardware; thus giving you dealer-like capabilities using the ScanTool.

### Activating Enhanced Options

If you would like to activate an enhanced feature that you have purchased, click the *Activate* button on the *Supported Features* window. Feature Activation is a two part: 1) submitting the purchaser name and hardware ID to the activation server to acquire an activation code; and, 2) entering the activation code. If the product was purchased with enhanced interface options, your activation codes should have been in the package. In that case, skip to *Entering Activation Codes*.



The image shows a 'Feature Activation' dialog box with a title bar and standard window controls. It contains a message box with a red key icon and instructions. Below the message are three numbered steps. Step 1 is a simple instruction. Step 2 involves email or website submission and includes a text input field for the purchaser's name. Step 3 involves entering an activation code, which is currently blocked by a message indicating that the hardware is not connected. The dialog also features 'OK', 'Cancel', and 'Outlook Email' buttons.

**Feature Activation**

In order to properly activate any Giotto enhanced features you have purchased, you will need to perform one or all of the steps below. To acquire an activation code follow Steps 1 and 2. To enter an activation code, skip to Step 3.

1. Connect to a vehicle with the AutoEnginuity OBDII or PROLINE connector.
2. Email the subsection a and b information to [activation@autoenginuity.com](mailto:activation@autoenginuity.com) or submit with our website: <http://www.autoenginuity.com/activation.html>
  - a) Purchaser name. (If the name below is not the name that you purchased the enhanced item with, please provide that in addition to the one below.)
  - b) Hardware ID Code. (This information requires a completed electrical connection to a vehicle to obtain the hardware ID.)
3. Enter the Activation number returned from AutoEnginuity here:  
 -  -  -

OK  
Cancel  
Outlook Email

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### Acquiring Activation Codes

1. **Connect the ProLine or OBD-II connector** to your computing device and the other end to any vehicle's DLC.
2. **Start the ScanTool program.** The software should automatically begin trying to connect to the vehicle, if not, select *Vehicle | Connect* or press F2.
3. Once connected to the vehicle, the ScanTool will require you to select the vehicle model information. **Select the correct make, model, and year.**
4. **Select Generic OBD-II** as the System.
5. **Click OK** once the vehicle model information and the system are selected.
6. The software will now finalize the connection and ask you if you want to retrieve trouble codes; please **select None** to bypass the trouble code retrieval phase in this case.
7. Select **Help | Feature Activation.**
8. Select **Activate.** With a completed connection, subsection 2b is filled in with the Hardware ID.

9. **Email both the full Purchaser Name and Hardware ID to activation@autoenginuity.com.** You can create a new email or use our website at <http://www.autoenginuity.com/activation.html>. Though you must provide the full Purchaser Name and Hardware

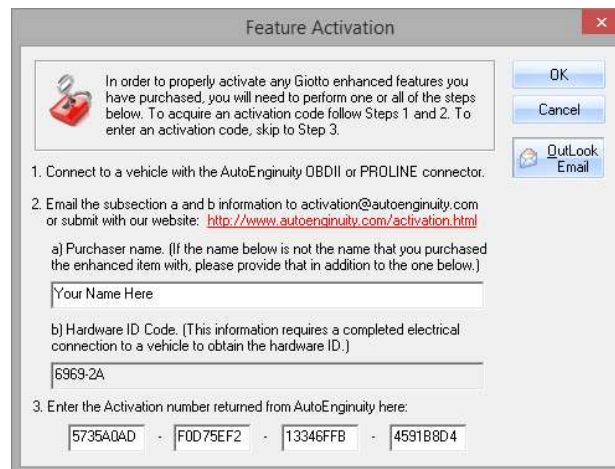
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ID through email, you do not have to use the same computing device that you will use to operate the software to send the email. The email can be sent by any computing device that sends and receives emails.

It's very important that the Purchaser Name match that of the name on the original invoice. The server will match up the information in the database before responding with an activation code. If any information is not accurate or does not match with an entry in the database, the server will respond with an automated message asking you to correct the submission and try again. **If the submission is correct, an activation code will be returned during business hours.** The activation code will be emailed as a response to the email you sent. The activation code will be at the top of the email and will be a large number broken into four parts.

### Entering Activation Codes

Activation codes are four segments of hexadecimal codes. Enter all hexadecimal segments into the text entry fields of the Feature Activation window at Step 3. The text entry fields are not case-sensitive. Unlike acquiring activation codes, no connection to a vehicle is necessary during this step.

A screenshot of the 'Feature Activation' window. The window has a title bar with 'Feature Activation' and a close button. Inside, there's a message box with a red key icon and text explaining the activation process. Below this, there are three numbered steps. Step 1 mentions connecting to a vehicle. Step 2 involves emailing or submitting information to activation@autoengenuity.com or a website. It includes sub-steps 'a) Purchaser name' with a text field containing 'Your Name Here' and 'b) Hardware ID Code' with a text field containing '6969-2A'. Step 3 is 'Enter the Activation number returned from AutoEngenuity here:' and shows four text fields with the values '5735A0AD', 'F0D75EF2', '13346FFB', and '4591B8D4'. On the right side of the window, there are 'OK', 'Cancel', and 'OutLook Email' buttons.

Feature Activation

In order to properly activate any Giotto enhanced features you have purchased, you will need to perform one or all of the steps below. To acquire an activation code follow Steps 1 and 2. To enter an activation code, skip to Step 3.

1. Connect to a vehicle with the AutoEngenuity OBDII or PROLINE connector.

2. Email the subsection a and b information to [activation@autoengenuity.com](mailto:activation@autoengenuity.com) or submit with our website: <http://www.autoengenuity.com/activation.html>

a) Purchaser name. (If the name below is not the name that you purchased the enhanced item with, please provide that in addition to the one below.)

Your Name Here

b) Hardware ID Code. (This information requires a completed electrical connection to a vehicle to obtain the hardware ID.)

6969-2A

3. Enter the Activation number returned from AutoEngenuity here:

5735A0AD - F0D75EF2 - 13346FFB - 4591B8D4

OK  
Cancel  
OutLook Email

You will be required to restart the software for the new activa-

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tion codes to take effect. Please *do **not** restart your computer*, you may lose your activation codes if the software is not closed first. Once you restart the software, your new enhanced coverage will be highlighted in green and show a status of "Activated."

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## Appendix A: Hard-to-Find DLCs

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**TABLE 2. Hard-to-Find DLCs**

Make	Model	Year	Location */Access	Comments
Acura	CL	1996-1998	7/open	under shifter
Acura	CL	1999	8/cover	above shifter
Acura	NSX	1996-2001	7/cover	under passenger dash
Acura	RL	1996-1998	7/open	passenger side center console
Acura	RL	1999-2001	8/cover	in front of shifter behind ashtray
Acura	TL	1996-1998	8/open	behind ashtray
Acura	TL	1999-2003	6/cover	below radio next to seat heater
Audi	Cabriolet A6	1996, 1997	9/cover	rear ashtray
Bentley	All	1996-2000	9/cover	in glove box
BMW	3 Series (also M3)	1996-2003	2/cover	1/4 turn slot head screw to expose
BMW	5 Series	1996-2003	2/cover	1/4 turn slot head screw to expose
BMW	7 Series	1996-2003	6/cover	under stereo controls
BMW	X3/M Roadsters	1996-2000	7/cover	passenger side of console
BMW	Z3 Series	1996-2001	9/cover	under passenger dash
BMW	Z8	2000-2002	2/cover	
Daewoo	Lanos	1999-2000	6/open	
Ferrari	All	1996-2000	3/open	up high under dash
Ford	Bronco	1996	7/cover	

**TABLE 2. Hard-to-Find DLCs**

Make	Model	Year	Location */Access	Comments
Ford	F Series	1996	7/cover	
Ford	Thunder- bird/Cou- gar	1996, 1997	7/cover	
Ford	Thunder- bird / Cougar	1996, 1997	7/cover	
Ford	Power- stroke	1995-1998	9	under passenger dash
Honda	Accent	1996-1998	2/open	in coin box
Honda	Accord	1996, 1997	6/cover	behind ashtray
Honda	CR-V	1997-2003	7/open	under passenger dash
Honda	Del Sol/ Hybrid	1996-1999	7/open	under passenger dash
Honda	Odyssey	1996-1998	7/cover	console under passenger dash
Honda	Prelude	1996	8/open	above shifter
Honda	Prelude	1997-1998	7/open	passenger side dash
Honda	S2000	2000-2003	7/open	under passenger dash
Land Rover	Defender 90	1997	8/cover	behind fuse box
Land Rover	Range Rover	1996-2001	7/open	next to console
Lexus	ES300	1996	2/cover	behind fuse box panel
Lexus	LS400	1996-2003	2/cover	above parking brake
Lotus	Esprit	1997-2003	7/open	above passen- ger dash
Mazda	Miata	1998, 1999	2/cover	behind fuse box panel

**TABLE 2. Hard-to-Find DLCs**

Make	Model	Year	Location */Access	Comments
MINI	MINI	2002-2003	2/cover	pull cover away to expose
Mitsubishi	Expo	1996	2/open	behind fuse box
Porsche	All	1996	6/cover	driver's side of console
Rolls-Royce	All	1996-2003	9/cover	glove box
Rover	Defender	1997	6/cover	under parcel tray
Rover	Range Rover	1996-2003	7/open	under passenger dash
Subaru	Legacy	1996-2003	2/cover	behind plastic hinged cover
Subaru	SVX	1996, 1997	1/cover	right side of steering column
Toyota	Avalon	1996	2/cover	behind fuse box panel
Toyota	Camry	1994-1996	2/cover	behind coin box
Toyota	New Hybrid	2000	7/open	
Toyota	Previa (2/4WD)	1996, 1997	6/cover	top instrument panel
Toyota	Tercel	1996-1998	2/cover	behind fuse box panel
Volvo	850	1997, 1998	8/cover	in front of shifter coin tray
Volvo	All (except S80)	1998, 1999	9/cover	hand brake area
Volvo	S60	2001	2/cover	
Volvo	C/S/V 70	2000-2003	8/cover	
Volvo	S/V 40	2000-2003	6/cover	
Volkswagon	Cabrio, Golf, Jetta	1996-1998	7/cover	right side of ash-tray

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**TABLE 2. Hard-to-Find DLCs**

Make	Model	Year	Location */Access	Comments
Volkswagon	Eurovan	1996-1999	4/cover	on dash behind wiper lever
Volkswagon	Golf, Jetta	1999	7/cover	
Volkswagon	Passat	1996, 1997	4/cover	on dash behind wiper lever

\* DLC Locations.





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## ***Appendix B: Engine Terminology***

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### **Absolute Throttle Position Sensor**

A sensor that reads the throttle opening. Throttle position at idle will usually indicate greater than 0%. Throttle position at wide open throttle (WOT) will usually indicate less than or equal to 100%.

### **Air Conditioning System Refrigerant Monitor**

This non-continuous monitor checks the functioning of R-12 air conditioning systems. Note: air conditioning systems that use R-134 are not required to implement this monitor.

### **Air/Fuel Ratio**

The ratio, by weight, of air to gasoline entering the intake in a gasoline engine. The ideal ratio for a complete combustion is 14.7 parts of air to 1 part of fuel.

### **Ambient Temperature Sensor**

A sensor that measures the temperature of the air outside the engine compartment.

### **Bank**

The group of cylinders which feed an oxygen sensor. Bank 1 contains the number 1 cylinder.

### **Calculated Load Value**

An indication of the current airflow divided by peak airflow, where peak airflow is corrected for altitude, if available. Mass airflow and barometric pressure sensors are not required for this calculation. Calculated Load Value provides a unitless number that is not engine specific, and provides the service technician with an indication of the percentage of engine capacity that is being used (with wide open throttle being 100%).

### **Cam Position Sensor**

The position of a specific camshaft. This can be determined directly by using magnetic or optical sensors, or indirectly by computing it

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from the crankshaft. *See also Crankshaft.*

### **CAT or Catalytic Converter**

Burns off any unburned fuel (hydrocarbons-HC) or partially burned fuel (carbon monoxide-CO) through simple chemical reactions before sending it through the rest of the exhaust. Two common catalytic converters used today are: 1) Oxidizing; and, 2) Three-way. An Oxidizing Catalytic Converter uses extra oxygen (*See Secondary Air*) to increase the rate of the chemical reaction. The Three-Way Catalytic uses special materials (platinum, palladium, rhodium, alumina, and cerium) to increase the rate of the chemical reaction.

### **Catalyst Monitor**

This monitor tests the performance of the catalytic converter. Before the monitor will run, certain criteria must be met: 1) the engine must be warm; 2) the throttle must be open; 3) the fuel status must be in a closed loop; 4) the engine RPM must be within a certain range; and, 5) the MAP must be at a specified voltage. This does not guarantee that the monitor's test will run (i.e., an O2 sensor DTC is stored, or a Fuel Trim to Rich/Lean is stored). The actual test is accomplished by comparing the pre-CAT oxygen sensor's switching frequency, and the post-CAT oxygen sensor's readings. If the ratio between the oxygen sensor's switches is outside of a manufacturer specific threshold, the catalytic converter is considered faulty. Catalytic converters generally don't go bad. If the vehicle's catalytic converter is considered faulty, an effort should be made to determine if something else is at fault. Typically, if an engine misfires excessive heat or fuel contamination (i.e., blown head gasket, or ring blow-by, etc.), oil or coolant can bond with the catalytic converter's materials and cause premature failure. This is a "Two-Trip" monitor. *See also Catalytic Converter.*

### **Closed Loop**

When the monitored sensors feed back into the system the actual and desired values, the engine computer can use the difference as an input to reduce the error to zero. Typically when a vehicle is at operating temperature, the fuel system is operating in a closed loop.

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### **Continuously Monitored**

A monitor that runs continuously during normal operations. This monitor looks at a set of components that could make the engine run out of its emissions range. The sampling rate for OBD-II, under this definition, is no less than two samples per second.

### **Comprehensive Component Monitor**

A continuously run monitor that performs checks on the OBD-II sensors, actuators, and switches. The current values are compared against "known-good" values to determine if the sensor, actuator, or switch is functional and is rationally operating.

### **Crankshaft Position Sensor**

The crankshaft position sensor has many other tasks besides telling the engine computer what position the crankshaft is in. This sensor is also used to determine the speed of the engine, and it is used to determine if the engine misfired.

### **DLC or Data Link Connector**

The OBD-II standard physical connector on the vehicle side. This 16-pin female connector mates to the scan tool.

### **DTC or Diagnostic Trouble Code**

Diagnostic Trouble Codes are how OBD-II identifies and communicates to technicians what on-board problems exist. The first number in the DTC indicates whether the code is an SAE standard code (applies to all OBD-II systems) or is specific to the vehicle manufacturer. The remaining three numbers provide information regarding the specific vehicle system and circuit.

### **Drive Cycle**

A series of conditions required before all non-continuous system monitors can complete their tests. Some drive cycle requirements are manufacturer specific and involve such things as ambient temperatures, as well as driving conditions. *See Appendix C for further details. See also Trip.*

### **ECM or Electronic Control Module**

An onboard computer controlling a specific system. Most vehicles will have several ECM units for different systems.

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## **Emissions**

By-products of the combustion engine that are regulated by the Environmental Protection Agency (EPA). Modern vehicles must be able to reduce emissions to a federally regulated level to be able to operate on United States roadways. Three exhaust gases are specifically regulated: HC, CO, and NO.

There are three types of emissions: 1) crankcase; 2) evaporative; and, 3) exhaust. Crankcase represents 25%, evaporative is 15%, and exhaust is 60% of all vehicular emissions.

Crankcase emissions are created when gases escape past the piston rings and into the crankcase. The Positive Crankcase Ventilation (PCV) System is used to recirculate these gases back into the combustion chamber to be reburned.

Evaporative emissions are gas vapors that escape from the fuel tank. These vapors are trapped in a canister to be released into the combustion chamber to be burned.

Exhaust emissions are the single largest contributor of vehicle emissions. The process by which exhaust emissions are reduced is by allowing the catalytic process to burn away the excess fuel before releasing the remaining exhaust gases into the environment.

## **Enabling Conditions**

The criteria used to determine when a system test can run, or a set of conditions that can cause a trouble code to be stored.

## **ETS or Engine Temperature Sensor**

Measure of the engine's internal temperature.

## **EVAP or Evaporative Emissions System**

This system works to prevent the escape of fuel vapors into the atmosphere. The system works by drawing fumes from the fuel tank into the engine for combustion. Several components can make up this system, including charcoal canisters, a purge solenoid, fuel cap, and connecting tubes.

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### **Evaporative System Monitor**

This non-continuous monitor checks the proper fuel vapor flow to the engine and pressurizes the system to check for leaks. If you have an EVAP fault, or the system has failed its test, the gas cap should be the first place you check. This is a "Two-Trip" monitor. *See also EVAP.*

### **EGR or Exhaust Gas Recirculation Valve**

The EGR valve recirculates small amounts of exhaust gas back into the intake manifold where it is mixed with the incoming air/fuel mixture. This process reduces combustion temperatures by up to 500°F. By reducing the temperature in the combustion chamber, NOx emissions can be reduced.

### **Exhaust Gas Recirculation (EGR) Valve Monitor**

This non-continuous monitor checks the EGR valve for low and high flow rates among other parameters. The components of the EGR Valve Monitor are EGR Valve, EGR solenoid, EGR back pressure transducer, and connecting hoses. This is a "Two-Trip" monitor. *See also EGR.*

### **Freeze Frame**

A snapshot of the vehicle's sensor data when the engine computer determined that a fault had occurred. Freeze frame reveals the state of the engine when the DTC responsible for the fault was triggered. This extra insight can help determine what conditions contributed to creating the fault.

### **Fuel Injector**

A solenoid-type actuator which is controlled by the ECM to deliver the correct quantity of finely atomized fuel with the incoming air charge.

### **Fuel System Monitor**

A continuously run monitor that checks the short- and long-term fuel trim. Should either fuel trim stay in or reach their limits for too long, a stored DTC will record and the MIL will illuminate. The severity of the fault determines whether this is a "One-Trip" or "Two-Trip" monitor.

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### **Fuel System Status**

This system status indicates whether the fuel system is open or closed. Typically, when the vehicle starts, the fuel system is open. When the oxygen sensors warm up and start reporting stably, the fuel system is closed.

### **Fuel Trim**

Feedback adjustments to the base fuel schedule. Short-term fuel trim refers to dynamic or instantaneous adjustments. Long-term fuel trim refers to much more gradual adjustments to the fuel calibration schedule than short-term adjustments. Long-term adjustments compensate for vehicle differences and gradual changes that occur over time. Short-term and long-term are added together to make the total fuel adaptation for that fuel bank.

### **General Circuit Malfunction**

Fixed value or no response from the system.

### **Heated Catalyst Monitor**

A non-continuous monitor that checks the efficiency of the way the catalytic converter heats up. If this monitor does not complete, check the oxygen sensor heaters, air injection system, and the catalytic converter. This is a "Two-Trip" monitor.

### **H02S or Heated Oxygen Sensor**

An oxygen sensor that is electrically heated to decrease the time it takes for the oxygen sensor to reach operating temperature. *See Oxygen Sensor.*

### **High Input**

Circuit voltage, frequency, or other signal measured at the control module input terminal, or pin, that is at or near full scale for the particular signal being measured. It is measured with the external circuit, component, or system connected.

### **IAC or Idle Air Control Motor**

This is a motor, or sometimes a valve, that controls how the engine idles.

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### **IAT or Intake Air Temperature**

Ambient temperature taken from as far away from the engine as possible to get an accurate reading. It is used to help determine the fuel mixture and manifold pressure.

### **Intake Manifold**

Is the final conduit for getting the air, and sometimes the fuel, to the intake valve. The design of the intake manifold has a great deal to do with the creation and control of horsepower and torque.

### **Knock Sensor**

Measures how each cylinder is firing. If one cylinder is firing too soon or too late, or even if it fires twice, a knock or ping is produced. The sensor sends a signal to the computer, which will adjust either the timing on the ignition or the camshaft. “Knocking” is not common, but the special conditions under which it will most commonly occur are with high manifold pressure, bad fuel, bad spark advance, or improper engine cooling.

### **KOEO**

Key On Engine Off; a specific state of the vehicle where the ignition key is turned to the “ON” position but the engine is not started.

### **KOER**

Key On Engine Running; a state of the vehicle where the engine has been started and allowed to run. OBD-II system download and a visual check of the MIL occurs during the KOER state.

### **Low Input**

Circuit voltage, frequency, or other signal measured at the control module input terminal or pin that is at or near zero. It is measured with the external circuit, component, or system connected.

### **LTFT or Long-Term Fuel Trim**

The engine computer is always learning how your vehicle is being driven. If you drive slowly, it stores that information; and, if you drive fast, it also stores that. In addition, the engine computer will compensate or adapt for a part of the engine that has become defective. This is called Adaptation or Fuel Trim. LTFT values represent

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the average of Short-Term Fuel Trim fuel corrections.

### **Manufacturer Specific Codes**

Non-standardized OBD-II diagnostic trouble codes that are individually assigned and defined by each vehicle manufacturer. These DTCs do not have uniform definitions or code numbers, and are identified by a “1” as the second digit.

### **MAF or Mass Air Flow Sensor**

Normally mounted as part of the air cleaner assembly, it measures air flow into the intake manifold. The MAF sensor generates a continuous signal that varies nearly linearly with true mass air flow.

### **MAP or Manifold Absolute Pressure Sensor**

Senses the difference between the atmospheric pressure and the pressure (or vacuum) inside the intake manifold. It is also used to calculate the engine load.

### **MIL or Malfunction Indicator Light**

Check Engine or Service Engine Soon indicator light is used to alert the vehicle operator that a fault has occurred. The MIL is only used to indicate problems in the emissions control system. It is not intended to be used as a maintenance reminder, e.g., change oil.

When the vehicle’s engine computer senses that a part or component is operating outside of the normal range or not reporting at all, a fault is recorded in the stored DTC area of memory.

When a severe misfire occurs that could damage the catalytic converter, the MIL will flash once per second. A flashing MIL is intended to discourage vehicle operation until repairs have been performed.

### **Misfire**

A miss in the ignition firing process of cylinder combustion due to the failure of the fuel/air mixture to ignite.

### **Misfire Monitor**

A continuously run monitor that checks for a miss in the ignition firing process of cylinder combustion. If the misfire is small, a



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Pending DTC will be recorded. If the misfire is large enough to cause damage or allow emissions to exceed 1.5 times the EPA standard, a Stored DTC is recorded immediately and the MIL is illuminated. If the misfire is severe and capable of causing damage to the catalytic converter, the MIL will flash once per second as long as the misfire is detected and then illuminate normally. This is a "One-Trip" monitor. *See also Misfire.*

### **Non-Continuous Monitor**

A monitor that runs a specific test at the manufacturer's designated interval. *See also One- or Two-Trip Monitor.*

### **One-Trip Monitor**

A non-continuous monitor that requires only a single fault to be detected before the engine computer illuminates the MIL and places a DTC in the stored DTC area of the engine computer's memory. *See also Two-Trip Monitor or Trip.*

### **Open Loop**

When some or all of the components of the engine computer are not in their normal operational condition, the engine computer will use pre-determined, or default, values to regulate the fuel mixture and spark advance. Typically, this happens when a vehicle starts as certain components are not yet up to operating temperature (i.e., oxygen sensors).

### **O2 or Oxygen Sensor**

The oxygen sensor is the heart and soul of the fuel system. It is sometimes referred to as the Exhaust Gas Oxygen or Lambda sensor. Typically oxygen sensors are positioned before and after the catalytic converter in the exhaust pipe. The oxygen sensors sample the exhaust and report back a value in terms of voltage. The engine computer looks at the voltage to determine if the fuel/air mixture is lean or rich, and adjusts the amount of fuel entering the engine accordingly. Because of the time delay for the engine computer to correct the fuel mixture, and the time it takes for the oxygen sensor to report, the oxygen sensor switches from lean to rich frequently. Oxygen sensors located before the catalytic converter will exhibit the most switching (cross-counts). The oxygen sensors located after the catalytic converter should exhibit flat or relatively low signal

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amplitude. The OBD-II standard allows oxygen sensors that do not influence the lean to rich fuel trim to not report their data. A good pre-catalytic oxygen sensor should switch between the values of 1 volt for a rich mixture, and .1volt for a lean mixture.

### **Oxygen Sensor Heater Monitor**

This non-continuous monitor evaluates the working state of all oxygen sensor heaters in the vehicle. A vehicle will operate in an open loop until the oxygen sensors are up to operating temperature. It will use the default parameters stored in the engine computer to regulate fuel trim. When an oxygen sensor heats up to around 600° F the engine computer switches to a closed loop and uses the values from the oxygen sensor to influence the fuel trim. To allow for a quick transition between the open and closed loop state, oxygen sensors are heated. This is a "Two-Trip" monitor. *See also Oxygen Sensor.*

### **Oxygen Sensor Monitor**

This monitor evaluates the working state of all oxygen sensors in the vehicle. It monitors the minimum and maximum voltage levels, switching frequency (cross-counts), the response rate of each oxygen sensor, etc. The testing threshold and ranges can be exported to the ScanTool and viewed in the Oxygen Sensor Test Results area of the O2 Sensor window. This is a "Two-Trip" monitor. *See also Oxygen Sensor.*

### **PCM**

See ECM.

### **PID or Parameter Identification**

An OBD-II standard term for a sensor and its respective functionality.

### **Secondary Air System**

This system is used to assist the catalytic converter in burning off emissions related gases. When a cold engine is started, several components necessary for emissions regulation will not be up to operating temperature. The engine computer operates in an open loop. In this case, the catalytic converter has oxygen forced into the

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exhaust stream by way of the secondary air system to assist in burning off all of the unburned or partially burned fuel. The secondary benefit of the oxygen being injected into the catalytic converter is that the catalytic converter heats up quicker.

### **Secondary Air System Monitor**

This non-continuous monitor checks the air pump and all its components. This is a "Two-Trip" monitor. *See also Secondary Air System.*

### **STFT or Short-Term Fuel Trim**

Like the LTFT, STFT adapts the fuel inputs to keep the engine performing to the current style of driving.

### **Stoichiometric**

Used to describe the ideal air/fuel mixture entering the intake. The point at which the production of emissions is at a minimum and catalytic conversion of emissions is most efficient. The stoichiometric air/fuel ratio is 14.7 to 1.

### **TPS or Throttle Body**

Monitors the throttle valve position (which determines how much air goes into the engine) so that the engine computer can respond quickly to changes, increasing or decreasing the fuel rate as necessary.

### **Trip**

A specific series of steps required in order to have a single monitor run its test and complete. If your vehicle manufacturer details the specific requirements to initiate and complete a single monitor test, then a repair technician can prevent a lengthy drive cycle. Sometimes a monitor is referred to as a "One-Trip" or "Two-Trip". A "One-Trip" monitor means that if a fault is detected the engine computer will illuminate the MIL and a DTC will be placed as a stored DTC. A "Two-Trip" monitor means that if a fault is detected on the first trip, the engine computer will temporarily save this fault in its memory as a Pending DTC (the MIL will be off). If the fault is detected again on a second consecutive trip, the engine computer will illuminate the MIL and a DTC will be placed as a Stored DTC. The Fuel System Monitor and Misfire Monitor are the only "One-

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Trip" monitors. *See also Drive Cycle.*

### **Two-Trip Monitor**

A non-continuous monitor that requires a fault to occur in each of two consecutive trips before the engine computer illuminates the MIL and places a DTC in the Stored DTC area of the engine computer's memory. *See also One-Trip Monitor or Trip.*

### **WOT or Wide-Open Throttle**

Throttle depressed to its fully extended position.

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## ***Appendix C: Drive Cycles, Trips, and Inspection/Maintenance Readiness***

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### **Ford:**

#### **Vehicle Preparation for OBD-II Drive Cycle**

Note: Vehicles with Power-Take Off (PTO) must have this system disengaged before proceeding. Verify by viewing the PTO sensor for the Off Status.

1. Attach AutoEnginuity's ScanTool and verify that the Intake Air Temperature is between 50-100° F (10-38° C). Verify that the Fuel Level Indicator sensor is reading between 15% and 85% (only available on EVAP Running Loss systems).
2. Warm the vehicle until the Engine Coolant Temperature reaches a minimum of 130° F (54° C).
3. With the engine Off, use the ScanTool to clear all DTCs with the ScanTool. P1000 will remain. Leave the key in the ON position, and start the vehicle.
4. Wait for the vehicle to connect and for the Connection Status window to disappear. Then select the *OnBoard Test Results* tab to view the status of the monitors.
5. Proceed with the OBD-II drive cycle or the specific trip.
6. Note: Once started, the engine must not be turned off or the monitors will not complete their respective tests.

#### **OBD-II Drive Cycle**

Note: The Intake Air Temperature sensor must read between 50-100° F (10-38° C) during the entire OBD-II drive cycle to enter into all of the OBD-II monitors. The Fuel Level Indicator sensor must be between 15% and 85% at all times.

1. Drive in stop-and-go traffic with at least four idle periods (30 seconds each), while safely observing the status of the OBD-II monitor on the ScanTool. If the exhaust gas recirculation (EGR), heated oxygen sensor (HO2S), evaporative emission

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(EVAP), secondary air (AIR-if applicable), or catalyst efficiency monitor have not completed, drive on the highway at a constant speed over 40 mph (64 km/hr) not to exceed 65 mph (104 km/hr), for up to 15 minutes. Heavy accelerations, sudden decelerations, and wide-open throttles are not recommended.

2. Bring the vehicle to a stop and retrieve pending DTCs to verify that the P1000 DTC has been erased.

### **Comprehensive Component Monitor Repair Verification Trip**

1. Complete the Vehicle Preparation for OBD-II Drive Cycle.
2. Complete the OBD-II Drive Cycle.

### **EGR Monitor Repair Verification Trip**

1. Verify that the Intake Air Temperature is reading a minimum of 32° F (0° C) to initiate the EGR monitor.
2. Complete the Vehicle Preparation for OBD-II Drive Cycle.
3. Start the engine and drive the vehicle for six minutes.
4. Drive in stop-and-go traffic for five minutes with at least two idle periods.
5. Accelerate to 45 mph (72 km/h) (56 km/h for Escort/Tracer at more than one half WOT). Maintain speed for one minute.

### **EVAP Running Loss System Repair Verification Trip**

1. Complete the Vehicle Preparation for OBD-II Drive Cycle.
2. Drive the vehicle at a constant speed between 35 mph (56 km/hr) and 65 mph (104 km/hr) with throttle as steady as possible. Observe the Heated Oxygen Sensor Monitor on the ScanTool until it completes.
3. Bring the vehicle to a stop and read the following sensors with the ScanTool: Intake Air Temperature, Fuel Level Indicator, FTP, FTP V, EVAPPDC, and EVAPCV. Measure the duty cycle of the EVAPCV circuit with a multimeter and breakout box if it is reading not available.
4. Verify the following EVAP monitor entry condition: Intake Air Temperature is reading between 50-100° F (10-38° C).

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5. Drive the vehicle on the highway with a constant speed over 40 mph (64 km/hr) with throttle as steady as possible. During this time, verify the following EVAP monitor entry conditions: Fuel Level Indicator stable  $\pm 5\%$  between the limits of 15% and 85% tank full. FTP (FTP V) stable with  $\pm 0.5$  in-H<sub>2</sub>O ( $\pm 0.175$  volts).
  6. Prior to running the EVAP monitor, when EVAPPDC is less than 75%, the canister vent solenoid is open and the system is unsealed. To initiate the EVAP monitor, the EVAPPDC sensor reading must increase to at least 75%. At this time, the EVAP-PCV sensor will then read 100% (canister vent solenoid closed to seal the system and the monitor will begin to run. Continue to drive at a steady throttle with light steering until the EVAP-PCV sensor reads 0% (canister vent solenoid open, system unsealed.) If this step does not occur as described, fuel vapors may be keeping the test from starting.
  7. Bring the vehicle to a stop. With the ScanTool, read the EVAP monitor results.

#### **Catalyst Monitor Repair Verification Trip**

1. Make sure that the Intake Air Temperature is above 0° F (-18° C).
2. Complete the Vehicle Preparation for OBD-II Drive Cycle.
3. Drive in stop-and-go traffic for 20 minutes, include six different constant speeds between 25 and 45 mph (40 and 72 km/hr). Drive on the highway for an additional five minutes.

#### **Fuel Monitor or HO<sub>2</sub>S Repair Verification Trip**

1. Complete the Vehicle Preparation for OBD-II Drive Cycle.
2. Drive in stop-and-go traffic for six minutes, include one idle. Accelerate to 45 mph (72 km/hr)[35 mph (56 km/hr) for Escort/Tracer at more than 1/2 throttle.]. Maintain speed for one minute.

#### **Misfire Monitor Repair Verification Trip**

1. The Misfire Monitor can only be tested if the fuel gauge reads above one quarter full, or the Fuel Level Input is above 15%.

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2. Start the engine and drive the vehicle to a location where speeds can reach 55 to 60 mph (88 to 97 km/hr) and coast down to 40 mph (64 km/hr) without traffic interference.
  3. Accelerate at wide-open throttle to allow vehicle to shift at red-line (if equipped with a tachometer). Immediately return to normal speeds.
  4. Perform the following drive procedure three consecutive times. Accelerate on the highway to 60 mph (97 km/hr). Maintain speed for 20 seconds. Coast down with your foot off the accelerator pedal from 60 mph to 40 mph (97 km/hr to 64 km/hr).

### **Secondary Air Monitor Repair Verification Trip**

1. Complete the Vehicle Preparation for OBD-II Drive Cycle.
2. Complete OBD-II Drive Cycle.



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## **GM:**

### **Vehicle Preparation for OBD-II Drive Cycle**

1. **Cold Start.** In order to be classified as a cold start the engine coolant temperature must be below 122° F (50° C) and within 11° F (6° C) of the ambient air temperature at startup. Do not leave the key on prior to the cold start or the heated oxygen sensor diagnostic may not run.
2. **Idle.** The engine must be run for two and a half minutes with the air conditioner on and rear defrost on. The more electrical load you can apply the better. This will test the O2 heater, Passive Air, Purge "No Flow", Misfire and if closed loop is achieved, Fuel Trim.
3. **Accelerate.** Turn off the air conditioner and all the other loads and apply half throttle until 55 mph (88 km/hr) is reached. During this time the Misfire, Fuel Trim, and Purge Flow diagnostics will be performed.
4. **Hold Steady Speed.** Hold a steady speed of 55 mph (88 km/hr) for 3 minutes. During this time the O2 response, Air Intrusive, EGR, Purge, Misfire, and Fuel Trim diagnostics will be performed.
5. **Decelerate.** Let off the accelerator pedal. Do not shift, touch the brake, or clutch. It is important to let the vehicle coast along gradually slowing down to 20 mph (32 km/hr). During this time the EGR, Purge, and Fuel Trim diagnostics will be performed.
6. **Accelerate.** Accelerate at 3/4 throttle until 55-60 mph (88-96 km/hr). This will perform the same diagnostics as in step 3.
7. **Hold Steady Speed.** Hold a steady speed of 55mph (88km/hr) for five minutes. During this time, in addition to the diagnostics performed in step 4, the catalyst monitor diagnostics will be performed. If the catalyst is marginal or the battery has been disconnected, it may take 5 complete driving cycles to determine the state of the catalyst.
8. **Decelerate.** This will perform the same diagnostics as in step 5. Again, don't press the clutch or brakes, or shift gears.

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## **Nissan:**

1. Start the engine when the engine coolant temperature gauge is not in the normal operating range (usually between C and H).
2. Accelerate the vehicle to 55 mph (88 km/h), then quickly release the accelerator pedal completely and keep it released for at least 6 seconds.
3. Quickly depress the accelerator pedal for a moment, then drive the vehicle at a speed of 52 to 60 mph (85 to 97 km/h) for at least 5 minutes.
4. Stop the vehicle.
5. Accelerate the vehicle to 35 mph (55 km/h) and maintain the speed for 20 seconds.
6. Repeat steps four through five at least three times.
7. Accelerate the vehicle to 55 mph (88 km/h) and maintain the speed for at least 3 minutes.
8. Stop the vehicle and turn the engine off.
9. Repeat steps one through eight at least one more time.

## **BMW**

1. Start the engine and allow it to idle for 3 minutes.
2. Drive the vehicle for 5 minutes between 20 and 30 MPH. Do not allow the RPMs to exceed 3000 RPMs.
3. Drive the vehicle for 15 minutes between 40 and 60 MPH. Do not allow the RPMs to exceed 3000 RPMs.
4. Stop the vehicle and allow to idle for 5 minutes.
5. Check IM Monitor status with the ScanTool. Repeat steps 1 - 5 if necessary.

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## Appendix D: Serial Port Troubleshooting

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### Verifying Your Serial Port Settings

Typically the ScanTool software will programmatically change the serial port settings to what is required. In some rare cases this may not be possible because the device driver doesn't allow software to change its settings. In this case you'll be required to manually change the serial port settings.

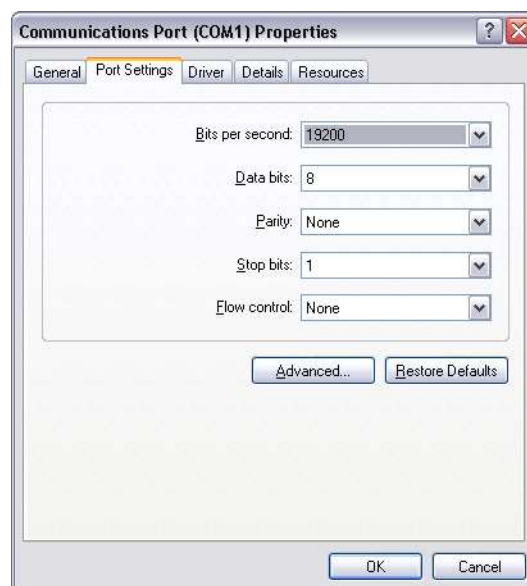
1. Select *Start | Settings | Control Panel*.
2. Click the *System* icon.
3. Select the *Hardware* tab.
4. Select the top-most option: *Device Manager*.



5. Expand the Ports section of the Device Manager.



6. Double-click the serial port you wish to use the ScanTool hardware with.
7. Select the *Port Settings* tab.



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8. Change your serial port settings to 19200, 8 - N - 1 and None.
  9. Click *OK* and close the Device Manager.
  10. Rebooting your computing device may be necessary.

### How to Enable the External Serial Port on Your ThinkPad

By default, currently available ThinkPads come with the external serial port disabled and Infrared enabled on COM 1. To use the serial port on COM 1 you must either disable infrared or change infrared so that it uses alternate resources. If you are not using infrared for printing or file sharing, it is recommended that it be disabled.

1. Double-click your ThinkPad Features or ThinkPad Configuration icon located in the ThinkPad folder on your desktop.
2. Locate the infrared button located on the left-hand side of this configuration screen and click once.
3. Change infrared from "Enable" to "Disable" and click *OK*.
4. Locate the serial port icon and click it once.
5. Select serial port "Enable", ensure that the COM Port setting is "COM 1", and click *OK*.
6. Restart the computer.

### How to Disable the Palm HotSync Software

If you have a Palm handheld device and have the Palm HotSync software installed, it might prevent the ScanTool from having access to the serial port. To disable the Palm HotSync software while you use the ScanTool:

1. Click the HotSync tray icon and select *Local Serial* to uncheck it.



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## ***Appendix E: Engine Management Systems***

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### **Understanding Misfires**

A misfire is an incomplete combustion event that will cause an increase in emissions or catalyst damage. There are two types of misfires: 1) Type A - Catalyst Damaging; and, 2) Type B - Emissions Threatening. The difference between the two is only the frequency at which the misfire occurs. The OBD-II standard has gotten progressively more stringent on what are considered Type A and Type B misfires.

A misfire can be in an individual cylinder or multiple cylinders. Some vehicles do not have the ability to differentiate between individual cylinder misfire and multiple misfires and may consider them a random misfire.



Did you know that gas doesn't explode--it burns! The flame speed is 20-100 ft/sec. Cylinder design directly affects the speed by affecting the air's turbulence and the position of the spark front.

Detecting a misfire is a very complex process. A very common technique is to monitor crankshaft rotation. The crankshaft vibrates slightly when each cylinder fires. If a misfire occurs, the crankshaft rotation speed changes rapidly. The ECM monitors the crankshaft rotation speed based on the output pulses from the crankshaft position sensor. By monitoring changes in the crankshaft rotation speed, the ECM counts the number of misfires and attempts to determine which cylinder is misfiring. Since the normal rotational frequency of a motor is known by the ECM, it only has to detect subtle variations. Since a lot of things can influence the crankshaft rotational frequency, the ECM must have a way to ignore false misfires. Therefore, the enabling conditions to run the misfire monitor are chosen specifically to mitigate the detection of a false misfire.

Common enabling conditions are sufficient fuel (at least 10 - 15%), a learned crank position sensor (GM), no accessories run-

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ning, vehicle at operating temperature, and the crankshaft rotating at so many RPMs.

Several notable reasons why the misfire monitor will be temporarily disabled are: 1) fuel delivery issues such as fuel starvation and sloshing of the fuel; 2) rough road conditions or deceleration which causes the crankshaft to vibrate or be driven from the drivetrain; 3) accessories driven off the accessory belt (A/C systems); and, 4) fuel delivery changes such as wide-open throttle or heavy acceleration.

Because of the complexity of detecting misfires with such low resolution systems, manufacturers are constantly changing their detection algorithms. The need to check for TSBs in the case of a misfire code is imperative to prevent wasted time tracking down a false misfire detection.

A scan tool is one of many tools that you'll need to track down a misfire. We recommend starting with examining the Freeze Frame data if your vehicle provides it. The context of the misfire is a great place to get an idea of the driving conditions the vehicle was under when it detected the misfire. (Don't forget Freeze Frame information is slow-updating on most vehicles and can have a full second between the first stored sensor value and the last.)

Check the Mode 6 data for Fords or misfire sensors for GM and Toyota. In the case of Ford, a generic scan tool that reports Mode 6 data can actually report individual cylinder misfire counts and the maximum threshold before a code will be triggered. With the GM and Toyota enhanced interfaces you can access the proprietary sensors used to count individual cylinder misfires.

Isolate fuel delivery issues by examining the Freeze Frame fuel trims and the fuel trims at idle. Don't forget to check fuel trims across the fuel banks if you have a multiple bank vehicle. You can reproduce the conditions by taking the vehicle for a test drive and putting the vehicle in fuel enrichment mode by going wide-open throttle.

To find out if it's spark related, check the condition of the

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spark plugs. Look for oil, carbonizing, or cracks. Also, if your vehicle uses coil packs, try relocating them and see if the misfire relocates.

### **Fuel Loops (Open or Closed)**

Fuel loops are actually states that the fuel system enters. Either the ECM is reading preset values in its built-in tables, or it is using O2 and other sensors to influence the fuel trims. The latter case being a feedback loop.

Open loop operation occurs when the fuel adaptation components or systems are not sufficiently warmed up, ready for operation, or not working properly. In this case, the ECM uses internally stored default values.

Closed loop operation occurs when the O2 sensor is used for feedback to adjust the air/fuel ratio. Under most circumstances, when a preset coolant temperature is reached and the O2 sensor heats up sufficiently to provide a good signal, the ECM goes into closed loop mode.

### **Fuel Trim (Short- and Long-Term)**

As fuel system components age or otherwise change over the life of the vehicle, the adaptive fuel strategy learns deviations from stoichiometry while running in a Closed fuel loop. The baseline value for both short- and long-term fuel trims is 0%. Rich conditions are represented by -1 to -99%, and lean from 1 to 99.

Fuel trims operate in two states: 1) closed; or, 2) open. In an open loop the ECM determines fuel delivery based on inputs from pre-determined tables stored inside the ECM. In a closed loop, the vehicle sensors are used in a feedback loop.

Short-term fuel trim is an ECM erasable memory register. When the fuel system for a bank closes, the O2 sensors are being used to create the short-term fuel adaptation. Short-term fuel trims are based on the upstream O2 sensor voltage only. As an O2 signal



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voltage increases, indicating a rich mixture, the short-term fuel trim influences the ECM to reduce the fuel injectors pulse width, thereby correcting the fuel mixture.

Long-term fuel trim is the learned corrections from the short-term fuel trim over time. The long-term fuel trim is stored in the ECM memory and is used to determine when fuel metering components are failing. This is like the macro fuel adaptation variable and short-term is the micro fuel adaptation. As short-term fuel trim changes its value, the long-term fuel trim changes in sync to allow the short-term fuel trim to neutralize back to zero.

When the short-term and long-term fuel trim are added together they create the total fuel adaptation for that bank. The total adaptation is the percentage of the increase or decrease in the fuel injector pulse width. Ultimately the fuel injector pulse width is matched to the ratio of air in the combustion chamber to create the most efficient mixture for complete combustion (14.7:1). This optimal mixture is referred to as being called stoichiometric.

Fuel trims are typically considered good if they are +/-10 when totaled (short-term plus long-term fuel trim). Most manufacturers will set a trouble code when fuel trims either, or individually, achieve 20% or greater for a prolonged period of time.

### **MAF (Mass Air Flow Sensor)**

The MAF is a key component in the fuel management of your modern engine. By monitoring the flow of air into the intake manifold, air/fuel mixture can be adjusted as necessary to achieve complete combustion. A typical MAF works by heating a thin wire or film. As air passes over the wire or film, the air cools it causing a difference in the resistance of the circuit. The resistance is sampled by the ECM to determine the air flow. A contaminated MAF or "dirty" MAF can cause problems because it can under-sample the air coming into the intake manifold and the ECM will not apply enough fuel; thus creating a lean condition.



If a vacuum leak develops in a MAF system, the idle may deteriorate severely because the ECM does not recognize the unmetered air entering the system.

### **Oxygen Sensor (Narrow Band)**

An oxygen sensor measures the amount of oxygen present in the exhaust gas. The oxygen sensor "element" is coated with a catalyst metal that produces a small voltage from 0 to 1V at temperatures in the range of 600F when exposed to oxygen. The stoichiometric air/fuel mixture for optimum fuel economy and emissions occurs at approximately 0.5V. When the oxygen sensor output signal is above .5V, the air/fuel mixture is considered rich; when the signal is under .5V it is considered lean. The ECM only monitors oxygen sensors when the fuel system is in a closed loop or when the purge solenoid is operating.

The "upstream" (front) oxygen sensor is located in the exhaust stream before the catalytic converter. The front sensor provides feedback to the ECM that is used to identify if the air/fuel mixture supplied to the cylinders is rich or lean. Under normal operating conditions, the front oxygen sensor signal will fluctuate from 0 to 1V. The front sensor signal should fluctuate, crossing the .5V center about seven times in 5 seconds with the engine held at 2,500 RPMs (with vehicle in a closed fuel loop and at operating temperatures).

The "downstream" (rear) oxygen sensor is located after the catalytic converter in the exhaust stream. The rear sensor provides feedback to the ECM to "fine tune" the air/fuel ratio and to monitor catalytic converter efficiency. The rear sensor is primarily used for catalytic converter efficiency monitoring. The rear sensor signal will also fluctuate in the 0 to 1V range, but the pattern is less predictable than for the front oxygen sensor because of its position. Once the catalyst has reached operating temperature, the rear sensor signal should change very little, if at all. If the rear sensor signal fluctuates at approximately the frequency of the front sensor, it is

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an indication that the catalytic converter is not at operating temperature or is malfunctioning.



Although oxygen sensors are designed to work in a hostile environment, they are very fragile and can be easily damaged by oil, silicone, and other

A good oxygen sensor may have unusual signal characteristics that are a result of other components. The following components should be checked:

- Fuel injectors
- Mass air flow sensors
- Evaporative emission systems
- Intake air temperature sensor
- Barometric pressure sensor
- Engine coolant temperature sensor
- Throttle position sensor
- Intake system vacuum leaks
- Low battery voltage
- Spark plugs

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## *Appendix F: Known Connectivity Issues*

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Make	Model	Year	Comments
BMW	E46 M3	2002-2007	Older "ScanTool OBDII" connectors will have no OBD-II support. Requires BMW Enhanced support.
BMW	E39 M5	2000-2002	Older "ScanTool OBDII" connectors will have no OBD-II support. Requires BMW Enhanced support.
BMW	740i / 740iL	2001	Enhanced DME may not communicate. Cycle the ignition key and retry to complete a connection.
Nissan	ALL	2008+	Older "ScanTool OBDII" connectors running software version 9 or earlier require forcing Initialization Type to "Force CAN Physical Addressing" to communicate with Generic OBD-II.
Toyota	Truck	1996-1998	"Auto Detect" Vehicle Interface will not work. Requires manually setting J1850 VPW.
Jaguar	XJ / XK	1994-2004	No Generic OBD-II support. Damage to ProLine or ProLine VCI can occur with Generic OBD-II selection. <b>Use Jaguar Enhanced support option only.</b>
Porsche	Cayenne	2003-2007	Older "ScanTool OBDII" connectors will have no Generic OBD-II support. Requires Porsche Enhanced support.
Ferrari	All	1996+	Older "ScanTool OBDII" connectors requires a special Ferrari cable due to crossing of ground pins on vehicle.

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Make	Model	Year	Comments
VW	Tourage	2003-2007	Older "ScanTool OBDII" connectors will have no Generic OBD-II support. Requires Porsche Enhanced support.
Subaru	STi	2000-2007	Requires manually setting to KPW2000.
Audi	A4 1.8T	2002-2007	DTCs may require several attempts to retrieve codes.
GM	Various	1996-1998	May not "Auto Detect" the Vehicle Interface type. May require manually setting to J1850 VPW.
Ford	Escape	1999-2002	Alternator issue may make connections unstable with our interface (Powered off the vehicle's DLC).
Nissan / Mercury	Quest/ Villager	1996-2003	Not compatible with our product because an OBD-II pin has excessive power and can damage SAE compliant diagnostics equipment.
Cadillac	CTS	2001-2008	May not Auto Detect the vehicle interface type. May require manually setting to KWP2000.
Saturn	Vue	All	Generic OBD-II support not functioning correctly. This vehicle is a Vauxhall rebadge brought into US and utilizes EOBD IV.

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