

Global OBD Vehicle Communication Software Manual

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Safety Information

For your own safety and the safety of others, and to prevent damage to the equipment and vehicles upon which it is used, it is important that the accompanying *Important Safety Instructions* be read and understood by all persons operating, or coming into contact with, the equipment. We suggest you store a copy near the unit in sight of the operator.

This product is intended for use by properly trained and skilled professional automotive technicians. The safety messages presented throughout this manual are reminders to the operator to exercise extreme care when using this test instrument.

There are many variations in procedures, techniques, tools, and parts for servicing vehicles, as well as in the skill of the individual doing the work. Because of the vast number of test applications and variations in the products that can be tested with this instrument, we cannot possibly anticipate or provide advice or safety messages to cover every situation. It is the automotive technician's responsibility to be knowledgeable of the system being tested. It is essential to use proper service methods and test procedures. It is important to perform tests in an appropriate and acceptable manner that does not endanger your safety, the safety of others in the work area, the equipment being used, or the vehicle being tested.

It is assumed that the operator has a thorough understanding of vehicle systems before using this product. Understanding of these system principles and operating theories is necessary for competent, safe and accurate use of this instrument.

Before using the equipment, always refer to and follow the safety messages and applicable test procedures provided by the manufacturer of the vehicle or equipment being tested. Use the equipment only as described in this manual.

Read, understand and follow all safety messages and instructions in this manual, the accompanying safety manual, and on the test equipment.

Safety Message Conventions

Safety messages are provided to help prevent personal injury and equipment damage. All safety messages are introduced by a signal word indicating the hazard level.

DANGER

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury to the operator or to bystanders.

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury to the operator or to bystanders.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in moderate or minor injury to the operator or to bystanders.

Safety messages contain three different type styles.

- Normal type states the hazard.
- **Bold type states how to avoid the hazard.**
- *Italic type states the possible consequences of not avoiding the hazard.*

An icon, when present, gives a graphical description of the potential hazard.

Example:



Risk of unexpected vehicle movement.

- **Block drive wheels before performing a test with engine running.**
A moving vehicle can cause injury.

Important Safety Instructions

For a complete list of safety messages, refer to the accompanying safety manual.

SAVE THESE INSTRUCTIONS

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1.1 Global OBD and What it Means

As a result of increasing emission levels around the world, many countries have enacted strict emission related regulations that will drive increased technology into the modern automobile in order to reduce the exhaust emissions. European and North American countries lead the way by adopting technology that will standardize the way these vehicles can be checked for compliance.

The OBD-I (On-Board Diagnostics I) system was introduced in the early 1980s and by 1988 all new cars and light trucks sold in California had to have OBD-I. The fundamental elements of the OBD-I are the electrical components (which influence exhaust emissions) that are monitored by the engine management system. An optical warning signal is given in the event of an OBD-I relevant failure. This fault can be read out by way of a flashing code.

OBD-II has been compulsory on all vehicles in the US market since January 1996. EOBD (European On-Board Diagnostics) is the European equivalent to OBD-II. It was introduced in 2000 and became effective in January 2001. There are a few differences between EOBD and OBD-II but none that will affect the generic scan tool operation. All the communication protocols for both programs are identical. Vehicle emission strategies and certification procedures vary between countries, states and regions. Always use the vehicle factory service information specific to the country and emission certification.

EURO-3 is a continuation of the emission regulations known as EURO-1 and EURO-2. In addition to introducing stricter emission limits, the directive now also covers the monitoring of emission related components and functions during operation, i.e. EOBD.

The OBD-II and EOBD system must show the failure of an emission related component or system to the driver using a MIL (Malfunction Indicator).

What does OBD-II and EOBD mean for the Repair Shop?

A universal or Generic OBD-II/EOBD scan tool can now be used on any OBD-II 1996 and newer and EOBD 2001 and newer vehicle, giving the shop more diagnostic coverage that was not previously possible.

1.1.1 OBD-II Start-up Phase

About 40% of the vehicles of model year 1995 sold in the USA were OBD-II prepared. Beginning in 1996, all vehicles sold in the USA were supposed to comply with OBD-II standards.

However, some 1996 and 1997 vehicles were not fully OBD-II compliant. This means that some early OBD-II vehicles may:

- Not have the standardized diagnostic connector location or
- Have missing or only partially implemented OBD-II monitors.

1.1.2 EOBD Start-up Phase

The European vehicle manufacturers also needed time to phase in and develop EOBD tests and software in their electronic control modules (ECMs). Some of the manufacturers already had experience with the USA OBD-II. Others may still have to improve their most recent software versions. This means that EOBD is experiencing similar phase in problems as OBD-II, with some 2001 and 2002 vehicles having limited EOBD functionality.

1.2 OBD-II/EOBD Limitations

Generic OBD-II/EOBD data is currently limited to:

- Emission diagnostics or
- Problems related to the Malfunction Indicator.

Access to all available data in the ECM (other systems, other parameters, enhanced diagnostics) will still require a scan tool with manufacturer specific capabilities.

1.3 OBD-II/EOBD Advantages

The advantage of OBD-II and EOBD is the simple “Plug and Play” function:

- Unlike using a manufacturer specific scan tool or vehicle communication software, one does not have to select the vehicle make, year or model.
- The communication protocol can be automatically detected by the scan tool software.
- Depending on the ECM and amount of parameters selected, data update rates may vary. By using functions as Custom Data List and Manual Select PID in Service \$01, sometimes data update rates may be higher than with manufacturer specific software. This can be helpful in finding intermittent signal gulches.

Data and monitors that are not described in the OBD/EOBD standards are filtered out, although they are selectable.

1.4 Communication Protocols

A communication protocol is a standardized way of data communication between an ECM and a scan tool.

For vehicles that comply with OBD-II and EOBD, the following communication protocols are permitted:

- ISO 9141-2 (K-LINE)
- SAE J1850 PWM (Pulse Width Modulation)
- SAE J1850 VPW (Variable Pulse Width)
- ISO 14230-4 (Keyword Protocol 2000)
- SAE J2284/ISO 15765-4 (CAN)

The scan tool can be setup so it will automatically determine the communication protocol used in the vehicle under test:

- If none of the protocol tests succeeds, the scan tool will show a message with hints to solve the communication problem.
- The test can be redone or the user can choose to abandon the attempt.



NOTE:

The scan tool indicates the number of failed initialization attempts to the user.

1.4.1 What is CAN?

CAN stands for Controller Area Network and means that control units are part of a network and can interchange data. Although some car manufacturers have used CAN for some years for communication between electronic control modules (ECMs), it was not directly connected to the diagnostic connector. In approximately 2001/2002 for Europe and 2003 for North America, the first car manufacturers started to connect the CAN communication lines to the diagnostic connector. CAN will be the only required protocol in near future for OBD.

1.5 Diagnostic Services Introduction

The OBD program is divided into several sub programs, called 'Service \$xx'. This complies to the EOBD/OBD-II standards:

Table 1-1 *Diagnostic services*

Service	Description
\$01	System readiness test status display
	MIL (malfunction indicator) Status & Control
	Request current power train diagnostic data
\$02	Request power train freeze frame data
\$03	Request emission-related DTCs (Diagnostic Trouble Codes)
\$04	Clear/reset emission-related diagnostic data
\$05	Oxygen sensor monitoring test results ¹
\$06	Specific diagnostic monitored system test results
\$07	Emission related diagnostic trouble codes detected during current or last completed driving cycle (=Pending Codes)
\$08	Onboard system activation tests ²
\$09	Request vehicle information
\$09	In-use Performance Tracking
1. Manual selection of Test IDs is not supported.	
2. Service \$08 is currently not supported.	

1.5.1 Readiness Monitor Test Status

OBD-II/EOBD stipulates the monitoring (continuous or non-continuous) of the functions of the following emission control related subsystems):

Table 1-2 Continuous or Non-continuous monitors

Readiness Monitor	Remark
Misfire monitoring	Continuous
Fuel system monitoring	Continuous
Comprehensive component monitoring	Continuous
Catalyst monitoring	†
Heated catalyst monitoring	†
Evaporative system monitoring	†
Secondary air system monitoring	†
A/C system refrigerant monitoring	†
Oxygen sensor monitoring	†
Oxygen sensor heater monitoring	†
EGR system monitoring	†
† Will only be monitored if the correct conditions are met.	



NOTE:

Not all data is applicable or supported by all vehicles.

Each vehicle manufacturer has unique monitor test criteria. The Readiness Test Status indicates whether a particular diagnostic monitor or function passed its specific test criteria and was found to be within specification.

Usually the monitors should run and set the Readiness Test Status during normal vehicle operation. The OBD-II Drive Cycle (see Figure 1-1: 'Typical OBD-II Drive Cycle') can be used to drive the vehicle in a prescribed manner.

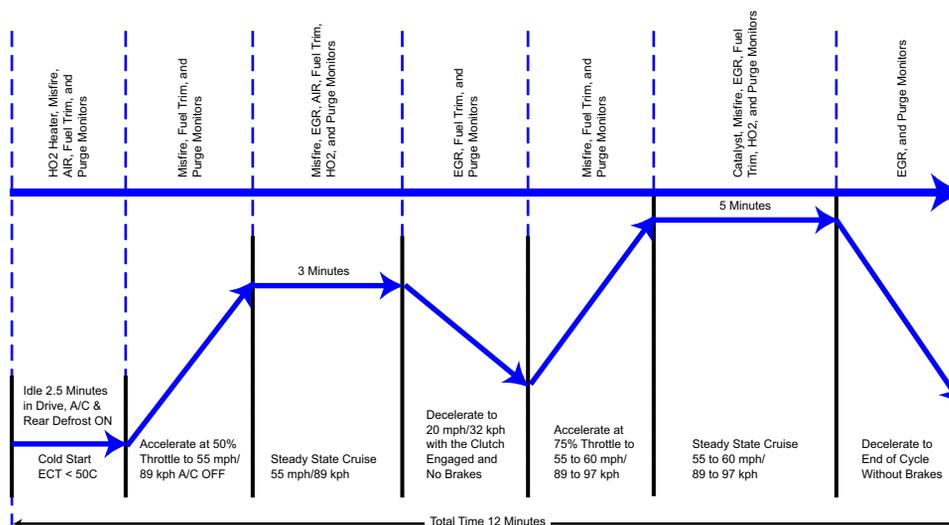


Figure 1-1 Typical OBD-II Drive Cycle

As this is a generic drive cycle, it may have limited results on some vehicles. If available, use the drive cycle information as supplied by the vehicle manufacturer.

System malfunctions that occur later and record a DTC (Diagnostic Trouble Code) will not change the Readiness Test Status. When the failure is repaired and the DTC is erased, all Readiness Test Status will be reset to a 'Not Completed' status.

Repair validation

Use the following procedure to validate a repair.



To validate the repair:

1. Perform a drive cycle (generic or vehicle specific).
2. Check Service \$07 (refer to 1.6.7: 'Service \$07: Emission-related DTCs detected during Current or Last Completed Drive Cycle (Pending Codes)' on page 16) and Service \$03 (refer to 1.6.3: 'Service \$03: Emission-related DTCs' on page 9).

If no DTCs are reported (that relate to the initial failure), it can be assumed that the fault has been repaired correctly.

1.5.2 MIL Status

Emission related malfunctions set failure specific DTC(s). The MIL (Malfunction Indicator Lamp) may light up as soon as the first emission related DTC has been stored and confirmed (stored a second time). Depending on the type of malfunction, it may take multiple drive cycles before the MIL turns on.

The MIL is located in the instrument panel. The MIL may display a symbol of an engine and should light up as soon as the ignition is switched on. Three different states are possible when the engine is running:

1. OFF: no emission limits exceeded.
2. ON: at least one OBD-II/EOBD emission limit exceeded.
3. Blinking: possibility of damage to the catalytic converter.

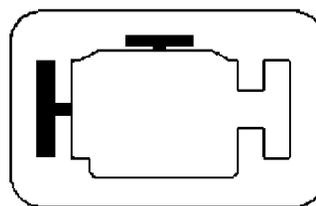


Figure 1-2 Example of Malfunction Indicator Lamp



NOTE:

The MIL may also be called the "Check Engine" lamp.

The ECM will transmit the status of the Malfunction Indicator including the identification of the ECM that commanded 'MIL ON'.

**NOTE:**

The MIL status will indicate "OFF" during the 'ignition key on, engine off' instrument panel bulb check unless the MIL has been commanded "ON" for a detected malfunction.

1.6 Diagnostic Service Definitions

1.6.1 Service \$01: Display Current Data

The ECMs will transmit the data value stored by the system. The data is commonly called PID (Parameter IDentification). All PIDs of sensors will show the actual readings. Not default or substitute values used by the system, because of a fault with that sensor.

Depending on the ECM and amount of parameters selected, data update rates may vary. Use Custom Data List to select the parameters to be displayed in Service \$01. The fewer data parameters were selected, the faster the update rate.

Only OBD/EOBD defined parameters will come up in the Current Data List. To view not supported parameters, select Manual Select PID (the last item of the Current Data List).

1.6.2 Service \$02: Power train Freeze Frame Data

Engine conditions are stored by the ECM at the time a Monitor detects an emission-related fault. A 'Freeze Frame' is such a group of captured information.

Using Freeze Frame for Diagnostic Purposes

Freeze Frame is useful for determining the exact conditions the vehicle was operating under when the DTC was set.

**NOTE:**

Freeze Frame is captured and stored when the DTC is set, not when the problem began.

For example, misfire is evaluated every 1,000 revs. A misfire DTC may be stored 60-90 seconds after the misfire initially occurred, at substantially different rpm and load conditions.

The Technician can duplicate these conditions to verify the complaint or the repair. In some cases the on-board tests for a specific DTC may report no problem found. But when the conditions match the Freeze Frame conditions, that same DTC would set with the MIL on.

**NOTE:**

Freeze Frame data is erased whenever codes are cleared.

Does a stored DTC change?

It can be overwritten by higher priority Emission DTCs. Misfire & Fuel System DTCs have the highest priority. A lower rated DTC may be overwritten by a higher priority DTC.

Only PIDs supported by the ECM will come up in the Freeze Frame data list.

1.6.3 Service \$03: Emission-related DTCs

The purpose of this service is to enable the scan tool to obtain stored DTCs from the power train ECMs that are emission-related.

The OBD-I ECM primarily identifies a faulty signal or a faulty sensor using three steps:

- Signal or component shorted to ground
- Signal or component shorted to battery positive
- No signal or component (open circuit)

For each of these tests, a specific trouble code is set.

With OBD-II/EOBD, expanded diagnostics now includes “rationality” testing. One input signal is compared against other input signals to determine if the reading is reasonable, given the current operating conditions.

Table 1-3 Diagnostic Trouble Code description

Position	Description
1	P = Power train
	C = Chassis
	B = Body
	U = Network
2	0 = Standardized emission-related trouble code
	1 = Manufacturer-specific trouble code
	2 = Standardized or Manufacturer-specific trouble code
	3 = Standardized or Manufacturer-specific trouble code
3	0 = Overall system
	1 = Secondary air system/Mixture preparation
	2 = Fuel system
	3 = Ignition system/Misfires
	4 = Additional exhaust gas monitoring
	5 = Cruise control/Idle speed control
	6 = Input/Output signals, Control units
	7 = Gearbox/Transmission
	8 = Transmission
	9 = Transmission
	A = Hybrid Propulsion
B = Reserved	
4 & 5	Serial numbering of individual components or systems

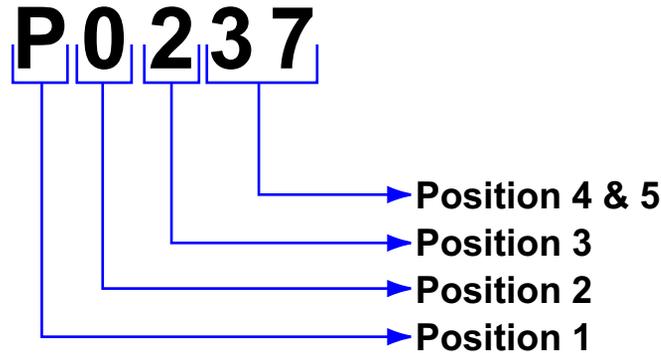


Figure 1-3 Example: DTC "P0237"

In this example, definitions listed for Position 3 are only valid for DTCs starting with "P". For codes (C, B, U) there are other definitions. Please refer to ruling OBD standards for more information.

Code Ranking

OBD-II/EOBD Codes have a priority according to their emission severity, with higher priority codes overwriting lower priority codes. The priority of the code determines the illumination of the MIL and the code erase procedure.

Vehicle manufacturers have implemented the ranking differently.

1.6.4 Service \$04: Clear/Reset Emission-related Diagnostic Data



NOTE:

It is recommended to perform the Clear Code/Reset function with the engine off and the ignition switched on.

The purpose of this service is to clear codes and turn off the MIL. It is recommended to print the DTCs before erasing them, for 'after repair comparison'.

Clearing the code memory will clear all diagnostic information stated in "Reset Information" below:

Table 1-4 Reset Information (sheet 1 of 2)

Service	Items to reset
\$01	Status of system monitoring tests
	Number of diagnostic trouble codes
	Distance travelled while MIL is activated
	Number of warm-ups since DTCs cleared
	Distance travelled since DTCs cleared
	Time run by the engine while MIL is activated
	Time since diagnostic trouble codes cleared
\$02	Diagnostic trouble code for freeze frame data
	Freeze frame data

Table 1-4 Reset Information (sheet 2 of 2)

Service	Items to reset
\$03	Confirmed diagnostic trouble codes
\$05	Oxygen sensor test data
\$06	Specific on-board monitoring test results
\$07	Pending diagnostic trouble codes

The following may occur as well:

- It may also erase engine management adaptive memory (some vehicle manufacturers only) when codes are cleared. Depending on the vehicle, adaptive memory may not correct itself without extensive driving.
- Other manufacturer specific “Clearing/Resetting” actions may also occur in response to this request message.
- Normally the MIL should automatically turn off after a successful repair, if emissions are normal. Refer to “: ‘Repair validation’ on page 7”.

IMPORTANT:

For safety and/or technical design reasons, some ECMs may not respond to this service under all conditions.

NOTE:

In most cases, once a MIL is deactivated, the original code will remain in memory until forty to eighty warm-up cycles are completed without the fault reappearing.

1.6.5 Service \$05: Oxygen Sensor Monitoring Test Results

The purpose of this service is to allow access to the on-board oxygen sensor monitoring test results (if implemented).

**NOTE:**

For CAN vehicles, Service \$05 is not supported. Oxygen sensor test results are implemented in Service \$06. For non-CAN vehicles, manufacturers can use Service \$06 as an alternative to Service \$05.

Different manufacturers may use many methods to calculate test results for this service. The scan tool converts test values and displays them in the standard units of measurement.

The ECM transmits the latest test results available from the system. Test results are retained by the ECM, even over multiple ignition OFF cycles, until replaced by the results of a more recent test. Test results are requested by Test ID. (See Test ID Table).

Test results can be reported either as a constant or as a calculated value, depending on the Test ID. Calculated values are reported with minimum and maximum limits.

**NOTE:**

Depending on the manufacturer, calculated values may be rounded off, which means that a test may fail despite the values reading within min. and max limits.

The scan tool checks if the readiness status of oxygen sensors is completed. If the test is not completed, the scan tool will display a warning.

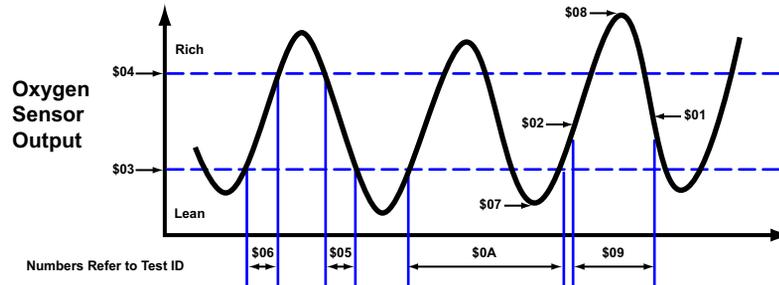


Figure 1-4 Test ID Values Example



NOTE:

Refer to Table 1-5: 'Test ID Table' for an explanation of the individual Test ID numbers.

Table 1-5 Test ID Table

Test ID No.	Description
\$01	Rich to Lean sensor threshold voltage (constant)
\$02	Lean to Rich sensor threshold voltage (constant)
\$03	Low sensor voltage for switch time calculation (constant)
\$04	High sensor voltage for switch time calculation (constant)
\$05	Rich to Lean sensor switch time (calculated)
\$06	Lean to Rich sensor switch time (calculated)
\$07	Minimum sensor voltage for test cycle (calculated)
\$08	Maximum sensor voltage for test cycle (calculated)
\$09	Time between sensor transitions (calculated)
\$0A	Sensor Period (calculated)
\$0B	EWMA (Exponential Weighted Moving Average) misfire counts for last 10 driving cycles (calculated) Calculation: $0.1 * (\text{current counts}) + 0.9 * (\text{previous average})$ Initial value for (previous average) = 0
\$0C	Misfire counts for last/current driving cycles (calculated)



NOTE:

Not all test values are applied on or supported by all vehicles. Only supported Test IDs will come up in the selection list.

Cylinder Bank & O2S Locations, Examples

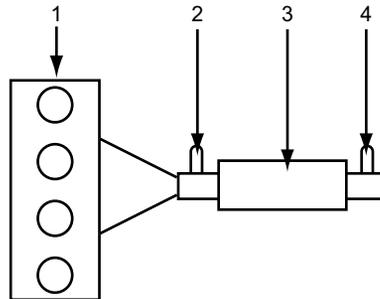


Figure 1-5 L4 Cylinder Engine with 1 exhaust bank and 1 Catalyst

- 1— Engine, exhaust bank
- 2— Sensor 1
- 3— Catalyst
- 4— Sensor 2, (heated)

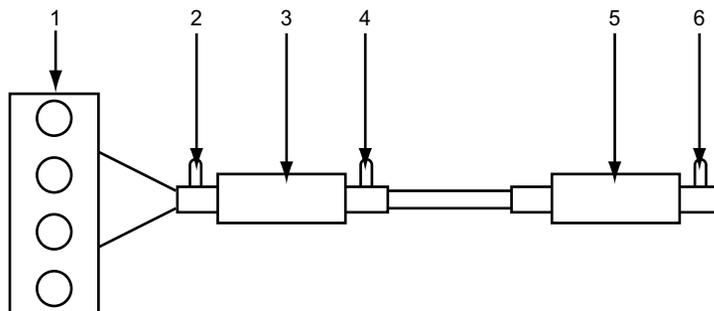


Figure 1-6 L4 Cylinder Engine with 1 exhaust bank and 2 Catalysts

- 1— Engine, exhaust bank
- 2— Sensor 1
- 3— Catalyst
- 4— Sensor 2, (heated), Bank 1
- 5— Catalyst
- 6— Sensor 3 (heated), Bank 1

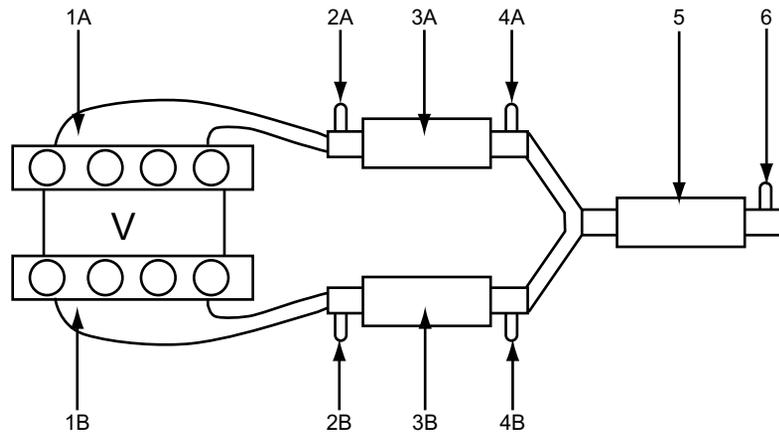


Figure 1-7 V8 Cylinder Engine with 2 exhaust banks and 3 Catalytic

- 1— Exhaust Bank X
- 2— Sensor 1, Bank X
- 3— Catalyst
- 4— Sensor 2, (heated), Bank X
- 5— Catalyst
- 6— Sensor 3 (heated), Bank X

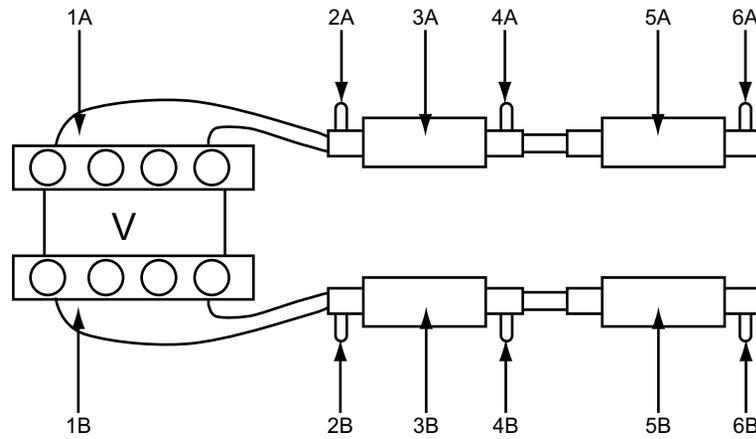


Figure 1-8 V8 Cylinder Engine with 2 exhaust banks and 4 Catalytic

- 1— Exhaust Bank X
- 2— Sensor 1, Bank X
- 3— Catalyst
- 4— Sensor 2, (heated), Bank X
- 5— Catalyst
- 6— Sensor 3 (heated), Bank X

1.6.6 Service \$06: Specific Monitored Systems

The purpose of this service is to allow access to the test results for on-board diagnostic monitoring tests of specific components or systems that are:

- Continuously monitored (CAN only)
- Not continuously monitored.

CAN Protocol

For CAN the Test ID Table from Service \$05 is used. The request message for test values includes an OBDMID (On-Board Diagnostic Monitor IDentification) that indicates the information requested. Unit information is given with the values. Test values (results) are always reported with the minimum and maximum test limits.

IMPORTANT:

The Test ID Table below is for CAN Protocol only:

Table 1-6 Test ID Table for CAN Protocol

Test ID No.	Description
\$01	Rich to Lean sensor threshold voltage, (Constant)
\$02	Lean to Rich sensor threshold voltage, (Constant)
\$03	Low sensor voltage for switch time calculation, (Constant)
\$04	High sensor voltage for switch time calculation, (Constant)
\$05	Rich to Lean sensor switch time, (Calculated)
\$06	Lean to Rich sensor switch time, (Calculated)
\$07	Minimum sensor voltage for test cycle, (Calculated)
\$08	Maximum sensor voltage for test cycle, (Calculated)
\$09	Time between sensor transitions, (Calculated)
\$0A	Sensor Period, (Calculated)
\$0B	EWMA (Exponential Weighted Moving Average) misfire counts for last 10 driving cycles (calculated) Calculation: $0.1 * (\text{current counts}) + 0.9 * (\text{previous average})$ Initial value for (previous average) = 0
\$0C	Misfire counts for last/current driving cycles (calculated)

If an OBDMID has not been completed at least once since Service \$04 or battery disconnect, then the following properties of the parameter are set to zero by the ECM:

- Test Value (Results)
- Minimum Test Limit
- Maximum Test Limit

Non CAN Protocol

The vehicle manufacturer is responsible for assigning Test IDs and Component IDs for tests of different systems and components. The latest test results are to be retained, even over multiple ignition OFF cycles, until replaced by more recent test results. Test results are requested by Test ID. Test results are reported only for supported combinations of test limit type and component ID and are reported as positive (unassigned) values. Service \$06 test values and limits are raw values that not scaled.

To date, only some manufacturers have provided conversion factors for technicians to utilize this data. See the example below for a US Ford version of Service \$06 Catalytic Converter test results.

Table 1-7 Service \$06 Catalytic Converter test results

Test ID	Comp ID	Test	Value	Min.	Max
\$10	\$11	Cat monitor Switch ratio Bank1	45	0	48
\$10	\$21	Cat monitor Switch ratio Bank2	42	0	48

Ford conversion factor: multiply the value by 0.0156 to get a value from 0 to 1.0.

Table 1-8 Calculated values

Item	Factor	Result
Bank 1	45 * 0.0156	0.702
Bank 2	42 * 0.0156	0.655
Threshold	48 * 0.0156	0.749

This catalyst is about to fail. Normal readings for a good catalyst should be approximately 0 to 0.1 (switch ratio).

Service \$06 Notes

Consider the following when performing this service:

- If in Service \$01 (Readiness Test Status) one of the tests is not completed, a warning message displays indicating that the values may be invalid or not available.
- Not all test values are applicable or supported by all vehicles. Only supported Test IDs appear on the selection list. To be able to select none supported Test IDs, the last item of the selection list is Manual Selection of Test ID.
- This service can be used as an alternative to Service \$05 to report oxygen sensor test results. The values are not converted and are displayed in standard units.

1.6.7 Service \$07: Emission-related DTCs detected during Current or Last Completed Drive Cycle (Pending Codes)

The purpose of this service is to enable the scan tool to obtain “pending” or maturing diagnostic trouble codes. These are codes for emission-related components or systems that are tested or continuously monitored during normal driving conditions that were detected during the current or last completed driving cycle.

Test results for these components or systems are reported in the same format as the DTCs in Service \$03; refer to 1.6.3: 'Service \$03: Emission-related DTCs' on page 9.

The intended use of this service is to assist the service technician after a vehicle repair and after clearing diagnostic information, by reporting test results after a single driving cycle.

- If a test failed during the driving cycle, the DTC associated with that test will be reported. If the pending fault does not occur again within 40 to 80 warm-up cycles, the fault is automatically cleared from memory.
- Test results reported by this service do not necessarily indicate a faulty component or system. If test results indicate a failure again after additional driving, then a DTC will set with Service \$03, indicating a faulty component or system. The MIL will be illuminated.

This service can always be used to request the results of the latest test, independent of the setting of a DTC.

1.6.8 Service \$08: On-board Activation Tests

The purpose of this service is to control the operation of vehicle components, tests or systems. These tests are also known as 'On-Board Activation Tests'. Service \$08 is not currently supported.

1.6.9 Service \$09: Vehicle Information

The purpose of this service is to enable the scan tool to request vehicle specific vehicle information such as:

- Vehicle Identification Number (VIN)
- Calibration IDs
- Calibration Verification Numbers (CVN, displayed as hexadecimal value)

Some of this information may be required by regulations and some may be desirable to be reported in a standard format, if supported by the vehicle manufacturer.

1.6.10 Service \$09: In-use Performance Tracking

This data is used to support possible regulatory requirements for "In-use Performance Tracking". Manufacturers are required to implement software programs that track in-use performance for each of the following components or systems:

- Catalyst Bank 1
- Catalyst Bank 2
- Primary Oxygen Sensor Bank 1
- Primary Oxygen Sensor Bank 2
- Evaporative Leak Detection System
- EGR System
- Secondary Air System

The completion value tracks the number of times that all conditions necessary for a specific monitor to detect a malfunction have been encountered. The condition value indicates the number of times that the vehicle has been operated in the specified conditions.

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

Engine Starts—displays the count of the number of times that the engine has been started.

Catalyst Monitor Completion Bank X—displays the number of times that all conditions necessary to detect a Catalyst System Bank 1 or 2 malfunction have been encountered.

Catalyst Monitor Conditions Bank X—displays the number of times that the vehicle has been operated in the specified Catalyst monitoring conditions.

O2 Sensor Monitor Completion Bank X—displays the number of time that all conditions necessary to detect an Oxygen Sensor Bank 1 or 2 malfunction have been encountered.

O2 Sensor Monitor Conditions Bank X—displays the number of times that the vehicle has been operated in the specified Oxygen Sensor monitoring conditions.

EGR Monitor Completion—displays the number of time that all conditions necessary to detect an EGR system malfunction have been encountered.

EGR Monitor Conditions—displays the number of times that the vehicle has been operated in the specified EGR system monitoring conditions.

Secondary Air Monitor Completion—displays the number of time that all conditions necessary to detect a Secondary Air system malfunction have been encountered.

Secondary Air Monitor Conditions—displays the number of times that the vehicle has been operated in the specified Secondary Air system monitoring conditions.

EVAP Monitor Completion—displays the number of time that all conditions necessary to detect an EVAP system leak malfunction have been encountered.

EVAP Monitor Conditions—displays the number of times that the vehicle has been operated in the specified EVAP system leak malfunction monitoring conditions.

2.1 Overview

A sequence of menu selections is used to access the OBDII/EOBD database. Menu selections vary slightly depending upon the make, year and model of the vehicle being tested.



To make a selection:

1. Select **OBDII/EOBD** from the vehicle make list.
2. Select the desired operating mode:
 - **OBD Diagnose**—accesses all OBD data, generic and enhanced.
 - **OBD II Generic**—accesses generic OBD data only.
 - **OBD Training Mode**—accesses simulated test data without connecting to an actual vehicle.
3. A communication menu displays once the database loads, select **Start Communication**.
4. A connection message that tells you which cable adapter to use and where the vehicle data link connector (DLC) is located displays.
5. Connect to the vehicle, then select **Continue**.
6. The ECM/Protocol Information screen, which shows the number of active vehicle electronic control modules (ECMs) and what communication protocol is being used, displays.
7. Select **Continue**.
The main menu displays, and you are ready to begin testing.

2.2 Connecting to the Vehicle

Connecting to the vehicle requires a data cable adapter, and a Personality Key for some models. Which adapter and key to use displays on the screen.

Most tests use the DLC, which is generally located under the dash on the driver side of the vehicle. Use the following procedure to locate a difficult to find DLC.



NOTE:

There maybe slight discrepancies in the connector location descriptions.



To locate the DLC:

1. Select Connector Information from the OBDII/EOBD menu to display the manufacturers.
2. Select the vehicle manufacturer to open the model list.
3. Select the model from the list.
The DLC location for that specific model displays, connect the data cable and adapter.
4. Select **Continue**.
The main menu displays, and you are ready to begin testing.

IMPORTANT:

Do NOT connect the adapter to a 24 V version OBD socket. This might damage the unit.

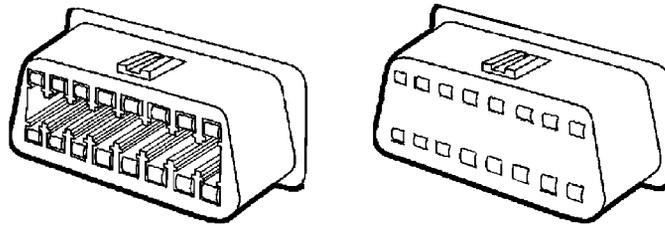
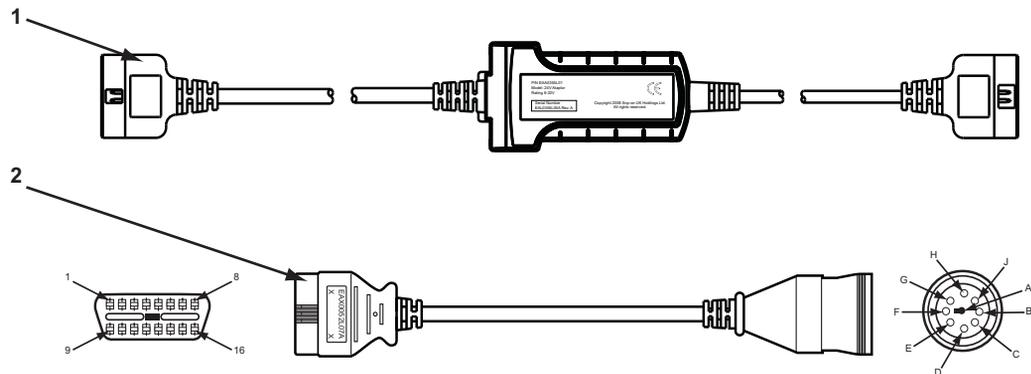


Figure 2-1 OBD sockets: 12 V (left) and 24 V (right)



1— 24V Adapter OBD-II/EOBD, Type B

2— 16 to 19 Pin Deutsch Adapter

Figure 2-2 Adapters, 24V

2.3 Main Menu

The main menu offer the following choices:

- Start communication
- Select communication protocol
- Connector information

2.3.1 Select Communication Protocol

Making this selection displays the following options:

- All Protocols (auto detect, recommended)
- ISO 9141-2
- SAE J1850 PWM (pulse width modulation)
- SAE J1850 VPW (variable pulse width)
- ISO 14230-4 (keyword protocol 2000)
- SAE J2284/ISO 15765-4 (CAN)

**NOTE:**

All Protocols, which automatically detects which protocol the vehicle communicates with, is the default selection. Use this setting unless you want to limit your testing to a specific communication protocol.

Select from the menu to continue.

2.3.2 Start Communication

This selection opens the communication network between the vehicle and the scan tool. Make the selection and one of the following results:

- An error message displays if communication can not be established. The scan tool continuously tries to establish communication with the vehicle. See “Troubleshooting” on page 36 for more information.
- A connection message that shows the number of ECMs and the active protocol displays. Select continue.

Once communication is established, select **Continue** to open the Select Service Menu.

2.4 Select Service Menu

This menu list all of the tests available on the identified vehicle. Menu choices any include:

- Readiness Test Status
- MIL Status
- Display Current Data (\$01)
- Display Freeze Frame Data (\$02)
- Display Trouble Codes (\$03)
- Clear Emissions Related Data (\$4)
- Display Test Parameter/Results (\$05, 06, 07)
- Request Control of On-Board System (\$8)
- Read Vehicle Identification (\$09)

Each of these selections is discussed in the following sections.

2.4.1 Readiness Test Status

Use this menu item to check the readiness of the monitoring system, such as the transmission controller components and the engine components. If a monitor system is not supported, it will not be displayed

Scroll to view the entire list of Readiness Monitors to ensure that all tests are complete. It is possible to print the Readiness Test Status.

2.4.2 MIL Status

This item is used to check the current condition of the Malfunction Indicator (MIL). Additional information, such as which ECM commanded the MIL on and also the distance travelled while the MIL is on (if supported), can also be displayed. It is also possible to print the MIL Status.

2.4.3 Display Current Data (\$01)

Use this item to display the current emission related data from the selected electronic control module (ECM) of the vehicle. Displayed data includes analog inputs and outputs, digital inputs and outputs, and system status information broadcast on the vehicle data stream.

2.4.4 Display Freeze Frame Data (\$02)

This item is used to display freeze frame data for any stored emission related diagnostic trouble codes (DTC). In most cases the stored frame is the last DTC that occurred. Certain DTCs, those that have a greater impact on vehicle emission, have a higher priority. In these cases, the highest priority DTC is the one for which the freeze frame records are retained.

Freeze frame data includes a "snapshot" of critical parameter values at the time the DTC set.

2.4.5 Display Trouble Codes (\$03)

This is used to display any stored emission related DTCs reported by the various ECMs.

The P0XXX codes are Society of Automotive Engineers (SAE) controlled and they display along with a description. These codes are the same for all manufactures.

The P1XXX codes are manufacturer controlled, refer to manufacturer data for information.

2.4.6 Clear Emissions Related Data (\$04)

This item is used to clear all emission related diagnostic data such as, DTCs, freeze frame data, and test results from the memory of the selected ECM.

2.4.7 Display Test Parameters/Results (\$05 to \$07)

This selection opens a submenu of test parameters and test results from various sensors, such as the oxygen sensor (O2S), monitor test results, and a record of DTCs detected during the last drive cycle. The menu includes:

- Oxygen Sensor Monitoring (\$05)
- Specific Monitored Systems (\$06)
- DTCs Detected During Last Drive (\$07)

Oxygen Sensor Monitoring (\$05)

This selection opens a menu with these choices:

- Rich to lean sensor threshold voltage
- Rich to lean sensor switch time
- Minimum sensor voltage for test cycle
- Sensor period

Making a selection displays and all of the pertinent O2S parameters for the specific test. The test identification (ID) displays at the top of the data list.

Specific Monitored Systems (\$06)

This selection opens a menu of available tests on monitored systems. These are data stream items, often a group of parameters, that the ECM evaluates to determine operational status and efficiency. There are two types of monitored systems:

- Continuously monitored systems—those that impact vehicle emissions, and are required to be monitored by OBD regulations.
- Non-continuously monitored systems—those that do not directly impact vehicle emissions, and are required to be monitored by OBD regulations.

Making a selection activates the test.

DTCs Detected During Last Drive (\$07)

This selection opens a record of any DTCs that set during the last completed drive cycle. Select to open the DTC list.

2.4.8 Request Control of On-board System (\$08)

This service enables bidirectional control of the ECM, that is the scan tool transmits control commands to operate the vehicle system. This function is useful in determining how well the ECM responds to a command.

Selecting opens a menu of test choices available on the identified vehicle. Options vary by make, model, and year of the test vehicle. Select a test and follow the on-screen instructions.

2.4.9 Read Vehicle Identification (\$09)

This selection displays the vehicle identification number (VIN), the calibration identification, and the calibration verification number (CVN) of the test vehicle.

2.4.10 In-use Performance Tracking (\$09)

This selection displays the “In-use Performance Tracking” of monitored data. It is basically a record of the number of times each of the monitor tests have been completed.

3.1 Service \$01 and \$02

These services involve evaluating the vehicle data stream parameter values. This section provides definitions for the values that display on the scan tool, along with diagnostic tips. The information is presented in three ways:

- “Long parameter names” on page 24—lists parameters by their complete names
- “Short parameter names” on page 28—lists parameters by their common acronym
- “DTC association” on page 32—lists parameter names by their corresponding diagnostic trouble code (DTC)

Depending upon the vehicle being tested and other variables, the scan tool may display either the long or short parameter names on the data list. The numeric definitions are based on the last three characters of the diagnostic trouble code. Refer to “Service \$03: Emission-related DTCs” on page 9 information on DTC structure.

3.1.1 Long Parameter Names

Table 3-1 lists data parameter definitions alphabetically by their complete name. The complete name typically displays when viewing data in text mode.



NOTE:

Counters (like cylinder bank or sensor position) in a parameter name are represented by a ‘y’ or ‘x’ in the table.

The vehicle ECM determines the parameter data list, not all parameters display on every vehicle.

Table 3-1 Long parameter names (sheet 1 of 4)

Parameter	Description for long parameter
ABSOLUTE LOAD VALUE	Value is presented as a percentage and ranges from 0 to 100 for naturally aspirated engines, and from 0 to 400 for boosted engines. On boosted engines the actual figure displayed is very much depending on how much boost is used. The higher the boost used, the higher Absolute Load Value will be.
ABSOLUTE THROTTLE POSITION–/B/C	Shows the absolute throttle position. The output signal is a proportional percentage to the input voltage (when proportional) or 100% minus the proportional percentage (when inversely proportional). See PID \$45 for the relative position.
ACCELERATOR PEDAL POSITION x	Shows the absolute pedal position. The output signal is a proportional percentage to the input voltage (when proportional) or 100% minus the proportional percentage (when inversely proportional).

Table 3-1 Long parameter names (sheet 2 of 4)

Parameter	Description for long parameter
AIR FLOW RATE	Shows the flow rate of the intake air as measured by the Mass Air Flow (MAF) sensor.
AMBIENT AIR TEMPERATURE	Can be obtained from an AAT sensor directly or deducted by the ECM from other sensor signals.
BAROMETRIC PRESSURE	Can be obtained from a BARO or MAP sensor directly or deducted by the ECM from other sensor (MAF) signals. If the value at 'ignition key on' and certain driving conditions is stored into a memory, clearing the memory may lead to inaccurate BARO values.
CALCULATED LOAD VALUE	The ECM calculates the engine load by dividing the actual manifold airflow volume (Otto engines) or actual fuel flow (Diesel engines) by the maximum possible volume with a factor for pressure and temperature compensation. Correlates with the engine vacuum. Value is presented as a percentage and ranges from 0 to 100.
CATALYST TEMPERATURE Bx-Sy	Shows the catalyst substrate temperature for the mentioned bank or the temperature of the mentioned bank and oxygen sensor. Can be obtained from a sensor directly or deducted by the ECM from other sensor signals.
COMMANDED EGR	Shows the status of the Exhaust Gas Recirculation system between 0% (no flow) and 100% (max. flow, max. duty cycle)
COMMANDED EQUIVALENCE RATIO	Shows the Air/Fuel ratio as commanded by the ECM. To obtain the actual Air/Fuel ratio, multiply the stoichiometric Air/Fuel ratio by the equivalence ratio. Conventional oxygen sensors shows the ratio when in Open Loop only. In Closed Loop '1.0' is shown. Wide range, or linear, oxygen sensors show the ratio in Open Loop and Closed Loop.
COMMANDED EVAPORATIVE PURGE	Shows the status of the Evaporative Purge Control Valve between 0% (no flow) and 100% (max. flow, max. duty cycle)
COMMANDED SEC. AIR STATUS	Shows the position of the Secondary Air system (upstream or downstream of the first catalytic converter) and/or its status.
COMMANDED THROTTLE ACT.CONTROL	Shows the status of the Throttle Actuator Control between 0% (closed throttle) and 100% (wide open throttle)
CONTROL MODULE VOLTAGE	Shows the power input to the ECM. This is not automatically equal to the battery voltage!
DISTANCE SINCE DTCs CLEARED	Accumulated distance since the DTCs were cleared. The maximum number is 65535. To set to 0, reset all DTCs
DISTANCE WHILE MIL ACTIVE	Conditions for this counter: 1. Resets to zero when MIL state changes from 'deactivated' to 'activated' by the ECM. 2. Accumulates counts in km if MIL is activated (ON). 3. Does not change value while MIL is not activated (OFF). 4. Resets to zero if diagnostic information is cleared either by service \$04 or 40 warm-up cycles without MIL activated. 5. Does not wrap to zero if value is maximum (65535).

Table 3-1 Long parameter names (sheet 3 of 4)

Parameter	Description for long parameter
EGR ERROR	The Exhaust Gas Recirculation system control and feedback devices differ, therefore no 'actual' or 'commanded' status can be shown. The value is (actual EGR - commanded EGR), commanded EGR. E.g. (5%-10%)/10%=-50%
ENGINE COOLANT TEMPERATURE	Shows the temperature as measured by either the engine coolant temperature sensor or the cylinder head temperature sensor. If neither of these sensors are available, the engine oil temperature may be shown instead.
ENGINE RUN WITH MIL ACTIVE	Conditions for this counter: 1. Resets to zero when MIL state changes from deactivated to activated by this ECM. 2. Accumulates counts in minutes if MIL is activated (ON) 3. Does not change value while MIL is not activated (OFF) 4. Resets to zero if diagnostic information is cleared either by service \$04 or 40 warm-up cycles without MIL activated 5. Does not wrap to zero if value is maximum (65535).
ENGINE SPEED	Engine speed as calculated by the ECM, based on various signals.
EQUIVALENCE RATIO Bx-Sy	Status of the oxygen sensor in V or as a ratio. Designed for linear or wide-ratio oxygen sensors. See also PID \$14 and up or \$34 and up.
EVAP SYSTEM VAPOR PRESSURE	Evaporative system vapor pressure, if used by the control module. Can be obtained from a fuel pressure sensor in the tank or in the evaporative system vapor line.
FUEL LEVEL INPUT	Shows the nominal fuel tank liquid fill capacity. For gaseous fuels the percentage of usable fuel capacity is shown. May either be obtained directly from a dedicated sensor, or calculated by the ECM based on other sensor signals.
FUEL PRESSURE GAUGE	Shows the fuel rail pressure at the engine relative to the atmosphere (gauge pressure).
FUEL SYSTEM x	Fuel System 'x' does not normally refer to injector banks. It is intended to represent different fuel systems (for multi-fuel vehicles) that can independently enter and exit 'Closed Loop'. 'Closed Loop' means the fuel control system uses the oxygen sensor signal. Banks of injectors on a V engine are generally not independent and use the same closed loop criteria.
IGNITION TIMING ADVANCE	Ignition timing spark advance for cylinder #1. If timing is retarded, the value will be negative.
INTAKE AIR TEMPERATURE	Shows the intake manifold air temperature as obtained from a sensor or as calculated by the ECM (using other inputs).
INTAKE MAP	Shows the absolute pressure in the intake manifold as measured by the MAP sensor.
LONG TERM FUEL TRIM BANK x	Shows the correction used by the Closed Loop and Open Loop fuel algorithm at the moment this parameter is requested. Negative values indicate a 'lean' condition, positive values a 'rich' condition. 0% correction will be shown if no correction is used in Open Loop.

Table 3-1 Long parameter names (sheet 4 of 4)

Parameter	Description for long parameter
NR OF WARM-UPS SINCE DTCs CLEARED	A warm-up cycle is valid if the coolant temperature rises, after starting the engine, at least 22 °C/40 °F and reaches at least 70 °C/160 °F (60 °C/140 °F for Diesel engines). The maximum number is 255. To set to 0, reset all DTCs.
O2S BANK x, SENSOR y	Shows the presence of oxygen sensor number 'y' per bank 'x' (group of cylinders). Sensor 1 is closest to the engine
O2S CURRENT BANK x, SENSOR y	Status of the oxygen sensor in mA or as a ratio. Designed for linear or wide-ratio oxygen sensors. See also PID \$14 and up or \$24 and up.
O2S VOLTAGE BANK x, SENSOR y	Shows the status of the oxygen sensor in V or percentages. Designed for conventional 0 - 1 V oxygen sensors. Sensors with a different full scale will be adapted. Negative percentages or 0 V indicate a 'lean' condition. Positive percentages or 1 V indicate a 'rich' condition. See also PID \$24 and up or \$34 and up.
OBD REQUIREMENTS	Shows the OBD requirements that the vehicle was designed for
POWER TAKE OFF (PTO) STATUS	Shows Power Take Off (PTO) status.
RELATIVE FUEL PRESSURE	Shows the fuel rail pressure at the engine relative to the manifold vacuum.
RELATIVE THROTTLE POSITION	Shows the 'learned' throttle position. Due to the 'closed throttle offset', Wide Open Throttle will be much less than 100%. See PID \$11, \$47 and \$48 for the absolute position.
SHORT TERM FUEL TRIM BANK x	Shows the correction used by the Closed Loop fuel algorithm. Negative values indicate a 'lean' condition, positive values a 'rich' condition. A 0% correction is shown if the fuel system is operating in Open Loop.
SHORT TERM FUEL TRIM Bx-Sy	Shows the status of the oxygen sensor in V or percentages. Designed for conventional 0 - 1 V oxygen sensors. Sensors with a different full scale will be adapted. Negative percentages or 0 V indicate a 'lean' condition. Positive percentages or 1 V indicate a 'rich' condition. See also PID \$24 and up or \$34 and up.
TIME SINCE DTCs CLEARED	Accumulated time since the DTCs were cleared. The maximum number is 65535. To set to 0, reset all DTCs
TIME SINCE ENGINE START	The incrementing counter starts when the engine runs. It freezes if the engine stalls. It resets if the ECM powers up and when the ignition key enters the 'key-on, engine off' position.
VEHICLE SPEED	Shows the vehicle speed as obtained from a sensor or as calculated by the ECM (using other inputs).

3.1.2 Short Parameter Names

Table 3-2 lists data parameter definitions alphabetically by their abbreviated name. As there is less display space available on a scan tool in graphing mode, short parameter names display.



NOTE:

Counters (like cylinder bank or sensor position) in a parameter name are represented by a 'y' or 'x' in the table.

The vehicle ECM determines the parameter data list, not all parameters display on every vehicle.

Table 3-2 Short parameter names (sheet 1 of 4)

Parameter	Description for short parameter
AAT	Can be obtained from an AAT sensor directly or deducted by the ECM from other sensor signals.
AIR_STAT	Shows the position of the Secondary Air system (upstream or downstream of the first catalytic converter) and/or its status.
APP_x	Shows the absolute pedal position. The output signal is a proportional percentage to the input voltage (when proportional) or 100% minus the proportional percentage (when inversely proportional).
BARO	Can be obtained from a BARO or MAP sensor directly or deducted by the ECM from other sensor (MAF) signals. If the value at 'ignition key on' and certain driving conditions is stored into a memory, clearing the memory may lead to inaccurate BARO values.
CATEMPx/y	Shows the catalyst substrate temperature for the mentioned bank or the temperature of the mentioned bank and oxygen sensor. Can be obtained from a sensor directly or deducted by the ECM from other sensor signals.
CLR_DIST	Accumulated distance since the DTCs were cleared. The maximum number is 65535. To set to 0, reset all DTCs
CLR_TIME	Accumulated time since the DTCs were cleared. The maximum number is 65535. To set to 0, reset all DTCs
ECT	Shows the temperature as measured by either the engine coolant temperature sensor or the cylinder head temperature sensor. If these sensors are not available, the engine oil temperature may be shown instead.
ECT_ERR	The Exhaust Gas Recirculation system control and feedback devices differ, therefore no 'actual' or 'commanded' status can be shown. The value is (actual EGR - commanded EGR), commanded EGR. Example; (5%-10%)/10%=-50%
ECT_PCT	Shows the status of the Exhaust Gas Recirculation system between 0% (no flow) and 100% (max. flow, max. duty cycle)
EQ_RAT	Shows the Air/Fuel ratio as commanded by the ECM. To obtain the actual Air/Fuel ratio, multiply the stoichiometric Air/Fuel ratio by the equivalence ratio. Conventional oxygen sensors shows the ration when in Open Loop only. In Closed Loop '1.0' is shown. Wide range or linear oxygen sensors show the ratio in Open Loop and Closed Loop.

Table 3-2 Short parameter names (sheet 2 of 4)

Parameter	Description for short parameter
EQ_RATxy	Status of the oxygen sensor in V or as a ratio. Designed for linear or wide-ratio oxygen sensors. See also PID \$14 and up or \$34 and up.
EVAP_PCT	Shows the status of the Evaporative Purge Control Valve between 0% (no flow) and 100% (max. flow, max. duty cycle)
EVAP_VP	Evaporative system vapor pressure, if used by the control module. Can be obtained from a fuel pressure sensor in the tank or in the evaporative system vapor line.
FLI	Shows the nominal fuel tank liquid fill capacity. For gaseous fuels the percentage of usable fuel capacity is shown. Can be obtained directly from a dedicated sensor or calculated by the ECM from other sensor signals.
FRP	Shows the fuel rail pressure at the engine relative to the atmosphere (gauge pressure).
FRP_REL	Shows the fuel rail pressure at the engine relative to the intake manifold vacuum.
FUELSYSx	Fuel System 'x' does not normally refer to injector banks. It is intended to represent different fuel systems (for multi-fuel vehicles) that can independently enter and exit 'Closed Loop'. 'Closed Loop' means the fuel control system uses the oxygen sensor signal. Banks of injectors on a V-engine are generally not independent and use the same closed loop criteria.
IAT	Shows the intake manifold air temperature as obtained from a sensor or as calculated by the ECM (using other inputs).
LOAD_ABS	Value is presented as a percentage and ranges from 0 to 100 for naturally aspirated engines, and from 0 to 400 for boosted engines. On boosted engines the actual figure displayed is dependant on how much boost is used. The higher the boost used, the higher Absolute Load Value will be.
LOAD_PCT	The ECM calculates the engine load by dividing the actual manifold airflow volume (Otto engines) or actual fuel flow (Diesel engines) by the maximum possible volume with a factor for pressure and temperature compensation. Correlates with the engine vacuum. Value is presented as a percentage and ranges from 0 to 100.
LONGFTx	Shows the correction used by the Closed Loop and Open Loop fuel algorithm at the moment this parameter is requested. Negative values indicate a 'lean' condition, positive values a 'rich' condition. 0% correction will be shown if no correction is used in Open Loop.
MAF	Shows the flow rate of the intake air as measured by the Mass Air Flow (MAF) sensor.
MAP	Shows the absolute pressure in the intake manifold as measured by the MAP sensor.

Table 3-2 Short parameter names (sheet 3 of 4)

Parameter	Description for short parameter
MIL_DIST	Conditions for this counter: 1. Resets to zero when MIL state changes from 'deactivated' to 'activated' by the ECM. 2. Accumulates counts in km if MIL is activated (ON) 3. Does not change value while MIL is not activated (OFF) 4. Resets to zero if diagnostic information is cleared either by service \$04 or 40 warm-up cycles without MIL activated 5. Does not wrap to zero if value is maximum (65535).
MIL_TIME	Conditions for this counter: 1. Resets to zero when MIL state changes from deactivated to activated by this ECM. 2. Accumulates counts in minutes if MIL is activated (ON). 3. Does not change value while MIL is not activated (OFF). 4. Resets to zero if diagnostic information is cleared either by service \$04 or 40 warm-up cycles without MIL activated. 5. Does not wrap to zero if value is maximum (65535).
O2SLOCxy	Shows the presence of oxygen sensor number 'y' per bank 'x' (group of cylinders). Sensor 1 is closest to the engine
O2Sxy	Shows the status of the oxygen sensor (O2S) in voltage or percentages. This parameter is designed for a conventional (0 to 1 V range) O2S. Sensors with a different full scale will be adapted. Negative percentages or below 0.5 V indicates a 'lean' operating condition. Positive percentages or above 0.5 V indicates a 'rich' operating condition. See also PID \$24 and up or \$34 and up.
O2Sxy	Status of the oxygen sensor in mA or as a ratio. Designed for linear or wide-ratio oxygen sensors. See also PID \$14 and up or \$24 and up.
OBDSUP	Shows the OBD requirements that the vehicle was designed for.
PTO_STAT	Shows Power Take Off (PTO) status.
RPM	Engine speed as calculated by the ECM, based on various signals.
RUNTM	The incrementing counter starts when the engine runs. It freezes if the engine stalls. It resets if the ECM powers up and when the ignition key enters the 'key-on, engine off' position.
SHRTFTx	Shows the correction used by the Closed Loop fuel algorithm. Negative values indicate a 'lean' condition, positive values indicate a 'rich' condition. A 0% correction is shown if the fuel system is operating in Open Loop.
SHRTFTxy	Shows the status of the oxygen sensor (O2S) in voltage or percentages. This parameter is designed for a conventional (0 to 1 V range) O2S. Sensors with a different full scale will be adapted. Negative percentages or below 0.5 V indicates a 'lean' operating condition. Positive percentages or above 0.5 V indicates a 'rich' operating condition. See also PID \$24 and up or \$34 and up.
SPARKADV	Ignition timing spark advance for cylinder #1. If timing is retarded, the displayed value is negative.
TAC_PCT	Shows the status of the Throttle Actuator Control between 0% (closed throttle) and 100% (wide open throttle)

Table 3-2 *Short parameter names (sheet 4 of 4)*

Parameter	Description for short parameter
TP/TP_B/TP_C	Shows the absolute throttle position. The output signal is a proportional percentage to the input voltage (when proportional) or 100% minus the proportional percentage (when inversely proportional). See PID \$45 for the relative position.
TP_R	Shows the 'learned' throttle position. Due to the 'closed throttle offset', Wide Open Throttle will be much less than 100%. See PID \$11, \$47 and \$48 for the absolute position.
VPWR	Shows the power input to the ECM. This is not automatically equal to the battery voltage!
VSS	Shows the vehicle speed as obtained from a sensor or as calculated by the ECM (using other inputs).
WARM_UPS	A warm-up cycle is valid if the coolant temperature rises, after starting the engine, at least 22 °C/40 °F and reaches at least 70 °C/160 °F (60 °C/140 °F Diesel). The maximum number is 255. To set to 0, reset all DTCs.

3.1.3 DTC Association

Table 3-3 lists parameter names (short and long) by their associated diagnostic trouble code (DTC) in numerically ascending order.



NOTE:

The value listed is the last three characters of the DTC, a "\$" indicates a variable value.

Table 3-3 DTC association (sheet 1 of 4)

DTC	Name, short	Parameter Name, long
\$03	FUELSYS1	FUEL SYSTEM 1
\$03	FUELSYS2	FUEL SYSTEM 2
\$04	LOAD_PCT (%)	CALCULATED LOAD VALUE (%)
\$05	ECT (°C)	ENGINE COOLANT TEMPERATURE (°C)
\$06	SHRTFT1 (%)	SHORT TERM FUEL TRIM BANK 1 (%)
\$07	LONGFT1 (%)	LONG TERM FUEL TRIM BANK 1 (%)
\$08	SHRTFT2 (%)	SHORT TERM FUEL TRIM BANK 2 (%)
\$09	LONGFT2 (%)	LONG TERM FUEL TRIM BANK 2 (%)
\$0A	FRP (kPa)	FUEL PRESSURE GAUGE (kPa)
\$0B	MAP (kPa)	INTAKE MAP (kPa)
\$0C	RPM (1/min.)	ENGINE SPEED (1/min.)
\$0D	VSS (km/h)	VEHICLE SPEED (km/h)
\$0E	SPARKADV (°)	IGNITION TIMING ADVANCE (°)
\$0F	IAT (°C)	INTAKE AIR TEMPERATURE (°C)
\$10	MAF (g/s)	AIR FLOW RATE (g/s)
\$11	TP (%)	ABSOLUTE THROTTLE POSITION (%)
\$12	AIR_STAT	COMMANDED SEC. AIR STATUS
\$13	O2SLOC11	O2S BANK 1 - SENSOR 1
\$13	O2SLOC12	O2S BANK 1 - SENSOR 2
\$13	O2SLOC13	O2S BANK 1 - SENSOR 3
\$13	O2SLOC14	O2S BANK 1 - SENSOR 4
\$13	O2SLOC21	O2S BANK 2 - SENSOR 1
\$13	O2SLOC22	O2S BANK 2 - SENSOR 2
\$13	O2SLOC23	O2S BANK 2 - SENSOR 3
\$13	O2SLOC24	O2S BANK 2 - SENSOR 4
\$14	O2S11 (V)	O2S VOLTAGE BANK 1 - SENSOR 1 (V)
\$14	SHRTFT11 (%)	SHORT TERM FUEL TRIM B1-S1 (%)
\$15	O2S12 (V)	O2S VOLTAGE BANK 1 - SENSOR 2 (V)
\$15	SHRTFT12 (%)	SHORT TERM FUEL TRIM B1-S2 (%)
\$16	O2S13 (V)	O2S VOLTAGE BANK 1 - SENSOR 3 (V)
\$16	SHRTFT13 (%)	SHORT TERM FUEL TRIM B1-S3 (%)

Table 3-3 DTC association (sheet 2 of 4)

DTC	Name, short	Parameter Name, long
\$17	O2S14 (V)	O2S VOLTAGE BANK 1 - SENSOR 4 (V)
\$17	SHRTFT14 (%)	SHORT TERM FUEL TRIM B1-S4 (%)
\$18	O2S21 (V)	O2S VOLTAGE BANK 2 - SENSOR 1 (V)
\$18	O2S31 (V)	O2S VOLTAGE BANK 3 - SENSOR 1 (V)
\$18	SHRTFT21 (%)	SHORT TERM FUEL TRIM B2-S1 (%)
\$18	SHRTFT31 (%)	SHORT TERM FUEL TRIM B3-S1 (%)
\$19	O2S22 (V)	O2S VOLTAGE BANK 2 - SENSOR 2 (V)
\$19	O2S32 (V)	O2S VOLTAGE BANK 3 - SENSOR 2 (V)
\$19	SHRTFT22 (%)	SHORT TERM FUEL TRIM B2-S2 (%)
\$19	SHRTFT32 (%)	SHORT TERM FUEL TRIM B3-S2 (%)
\$1A	O2S23 (V)	O2S VOLTAGE BANK 2 - SENSOR 3 (V)
\$1A	O2S41 (V)	O2S VOLTAGE BANK 4 - SENSOR 1 (V)
\$1A	SHRTFT23 (%)	SHORT TERM FUEL TRIM B2-S3 (%)
\$1A	SHRTFT41 (%)	SHORT TERM FUEL TRIM B4-S1 (%)
\$1B	O2S24 (V)	O2S VOLTAGE BANK 2 - SENSOR 4 (V)
\$1B	O2S42 (V)	O2S VOLTAGE BANK 4 - SENSOR 2 (V)
\$1B	SHRTFT24 (%)	SHORT TERM FUEL TRIM B2-S4 (%)
\$1B	SHRTFT42 (%)	SHORT TERM FUEL TRIM B4-S2 (%)
\$1C	OBDSUP	OBD REQUIREMENTS
\$1D	O2SLOC11	O2S BANK 1 - SENSOR 1
\$1D	O2SLOC12	O2S BANK 1 - SENSOR 2
\$1D	O2SLOC21	O2S BANK 2 - SENSOR 1
\$1D	O2SLOC22	O2S BANK 2 - SENSOR 1
\$1D	O2SLOC31	O2S BANK 3 - SENSOR 1
\$1D	O2SLOC32	O2S BANK 3 - SENSOR 2
\$1D	O2SLOC41	O2S BANK 4 - SENSOR 1
\$1D	O2SLOC42	O2S BANK 4 - SENSOR 2
\$1E	PTO_STAT	POWER TAKE OFF (PTO) STATUS
\$1F	RUNTM (s)	TIME SINCE ENGINE START (s)
\$21	MILL_DIST (km)	DISTANCE WHILE MIL ACTIVE (km or miles)
\$22	FRP_REL (kPa)	RELATIVE FUEL PRESSURE (kPa)
\$23	FRP (kPa)	FUEL PRESSURE GAUGE (kPa)
\$24	EQ_RAT11	EQUIVALENCE RATIO B1-S1 (:1)
\$25	EQ_RAT12	EQUIVALENCE RATIO B1-S2 (:1)
\$26	EQ_RAT13	EQUIVALENCE RATIO B1-S3 (:1)
\$27	EQ_RAT14	EQUIVALENCE RATIO B1-S4 (:1)
\$28	EQ_RAT21	EQUIVALENCE RATIO B2-S1 (:1)
\$28	EQ_RAT31	EQUIVALENCE RATIO B3-S1 (:1)

Table 3-3 DTC association (sheet 3 of 4)

DTC	Name, short	Parameter Name, long
\$29	EQ_RAT22	EQUIVALENCE RATIO B2-S2 (:1)
\$29	EQ_RAT32	EQUIVALENCE RATIO B3-S2 (:1)
\$2A	EQ_RAT23	EQUIVALENCE RATIO B2-S3 (:1)
\$2A	EQ_RAT41	EQUIVALENCE RATIO B4-S1 (:1)
\$2B	EQ_RAT24	EQUIVALENCE RATIO B2-S4 (:1)
\$2B	EQ_RAT42	EQUIVALENCE RATIO B4-S2 (:1)
\$2C	EGR_PCT (%)	COMMANDED EGR (%)
\$2D	EGR_ERR (%)	EGR ERROR (%)
\$2E	EVAP_PCT (%)	COMMANDED EVAPORATIVE PURGE (%)
\$2F	FLI (%)	FUEL LEVEL INPUT (%)
\$30	WARM_UPS	NR OF WARM-UPS SINCE DTCs CLEARED
\$31	CLR_DIST	DISTANCE SINCE DTCs CLEARED
\$32	EVAP_VP (Pa)	EVAP SYSTEM VAPOR PRESSURE (Pa)
\$33	BARO (kPa)	BAROMETRIC PRESSURE (kPa)
\$34	O2S11 (mA)	O2S CURRENT BANK 1 - SENSOR 1 (mA)
\$35	O2S12 (mA)	O2S CURRENT BANK 1 - SENSOR 2 (mA)
\$36	O2S13 (mA)	O2S CURRENT BANK 1 - SENSOR 3 (mA)
\$37	O2S14 (mA)	O2S CURRENT BANK 1 - SENSOR 4 (mA)
\$38	O2S21 (mA)	O2S CURRENT BANK 2 - SENSOR 1 (mA)
\$38	O2S31 (mA)	O2S CURRENT BANK 3 - SENSOR 1 (mA)
\$39	O2S22 (mA)	O2S CURRENT BANK 2 - SENSOR 2 (mA)
\$39	O2S32 (mA)	O2S CURRENT BANK 3 - SENSOR 2 (mA)
\$3A	O2S23 (mA)	O2S CURRENT BANK 2 - SENSOR 3 (mA)
\$3A	O2S41 (mA)	O2S CURRENT BANK 4 - SENSOR 1 (mA)
\$3B	O2S24 (mA)	O2S CURRENT BANK 2 - SENSOR 4 (mA)
\$3B	O2S42 (mA)	O2S CURRENT BANK 4 - SENSOR 2 (mA)
\$3C	CATEMP11 (°C)	CATALYST TEMPERATURE B1-S1 (°C)
\$3D	CATEMP21 (°C)	CATALYST TEMPERATURE B2-S1 (°C)
\$3E	CATEMP12 (°C)	CATALYST TEMPERATURE B1-S2 (°C)
\$3F	CATEMP22 (°C)	CATALYST TEMPERATURE B2-S2 (°C)
\$42	VPWR (V)	CONTROL MODULE VOLTAGE (V)
\$43	LOAD_ABS (%)	ABSOLUTE LOAD VALUE (%)
\$44	EQ_RAT	COMMANDED EQUIVALENCE RATIO
\$45	TP_R (%)	RELATIVE THROTTLE POSITION (%)
\$46	AAT (°C)	AMBIENT AIR TEMPERATURE (°C)
\$47	TP_B (%)	ABSOLUTE THROTTLE POSITION B (%)
\$48	TP_C (%)	ABSOLUTE THROTTLE POSITION C (%)
\$49	APP_D (%)	ACCELERATOR PEDAL POSITION D (%)

Table 3-3 DTC association (sheet 4 of 4)

DTC	Name, short	Parameter Name, long
\$4A	APP_E (%)	ACCELERATOR PEDAL POSITION E (%)
\$4B	APP_F (%)	ACCELERATOR PEDAL POSITION F (%)
\$4C	TAC_PCT (%)	COMMANDED THROTTLE ACT.CONTROL (%)
\$4D	MIL_TIME (min.)	ENGINE RUN WITH MIL ACTIVE (min.)
\$4E	CLR_TIME (min.)	TIME SINCE DTCs CLEARED (min.)

A.1 Start-up Problems

Refer to the relevant section in the manual for the specific diagnostic tool.

A.2 Internal Battery Voltage Low

Refer to the relevant section in the appropriate manual for the specific diagnostic tool.

A.3 Communication Problems

OBD-II/EOBD vehicles have few problems communicating with the scan tool. Nevertheless, an ECM may fail to communicate with the scan tool. Problems with the wiring or other circuit parts on the vehicle may prevent communication with the ECM. Also, a vehicle that fails to perform a test can be a symptom for diagnosing a driveability problem.

A.3.1 Check scan tool operation

If the scan tool works on other vehicles the problem is likely in the vehicle, not the scan tool.

If the display intermittently resets or goes blank, a wire may be opening in one of the cables or in a test adapter.

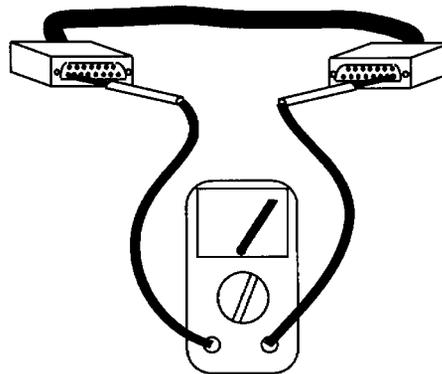


Figure A-1 Check the cable continuity

Check for pin-to-pin continuity between the D-shaped connectors at either end of the data cable with an ohmmeter.

If the display fails to light up, the scan tool may be at fault.

A.3.2 Testing the Diagnostic Connector — 16-pin DLC

Unfortunately, vehicle manufacturers have different interpretations of OBD-II requirements. This makes it rather difficult to define a specific approach to DLC problem diagnosis. For example, some manufacturers use the SAE J1850 BUS+ line but not the BUS-, while others use the ISO 9141 K-LINE, but not the L-LINE. See Table A-1: 'General contact allocations' below.

Ford has used 3 lines, the J1850 lines for powertrain tests, and the ISO 9141 line for the non-powertrain tests. There are also vehicles with no ground at pin 4. In addition, a pin location that is wired, does not necessarily mean it is wired based on the OBD-II requirements.

Table A-1 General contact allocations

Contact	General allocation
1	Discretionary ¹⁾
2	Bus positive line of SAE J1850 ²⁾
3	Discretionary ¹⁾
4	Chassis ground, (See Note below)
5	Signal ground, (See Note below)
6	CAN_H line of ISO 15765-4 ²⁾
7	K-LINE of ISO 9141-2 and ISO 14230-4 ²⁾
8	Discretionary ¹⁾
9	Discretionary ¹⁾
10	Bus negative line of SAE J1850 ²⁾
11	Discretionary ¹⁾
12	Discretionary ¹⁾
13	Discretionary ¹⁾
14	CAN_L line of ISO 15765-4 ²⁾
15	L-LINE of ISO 9141-2 and ISO 14230-4 ²⁾
16	Permanent positive voltage

¹⁾ Assignment of contacts 1, 3, 8, 9, 11, 12 and 13 in the vehicle connector is left to the discretion of the vehicle manufacturer.
²⁾ Note, for contacts 2, 6, 7, 10, 14 and 15 the related diagnostic communication assignments are shown. These contacts may also be used for alternate assignments in the vehicle connector.

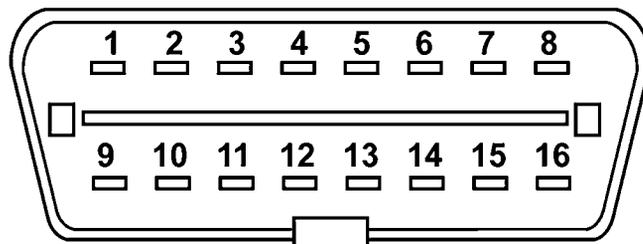


Figure A-2 Contact designation for vehicle connector mating end view

**NOTE:**

These point apply to pins 4 and 5:

- *The DL-16 Adapter with the S7 key, does not work for some vehicles. Most vehicles have “ground” (power and signal) connected to pin 4 of the 16-pin Diagnostic Connector. Key S7 connects pin 4 of the Diagnostic connector to ground pin of the scan tool. The same problem arises when the OBD-II connector is used with the K2A key.*
- *However, there are vehicles which have “ground” connected to pin 5 and do NOT communicate because the scan tool will not power-up. (No ground connection, therefore No power).*
- *According to ISO 15031-3:2001 the use of pin 4 of the Diagnostic connector is optional. Pin 5 of the Diagnostic connector should be used as signal ground and may be used as a power ground.*
- **Possible work around:** *Use a CAN adapter. This adapter shorts pins 4 and 5 of the Diagnostic connector.*

Use the following voltage tests at the diagnostic connector to help determine the reason that a vehicle will not perform diagnostic tests. Always use a high-impedance digital voltmeter.

**To test the DLC:**

1. **Ground** — Connect the voltmeter positive (+) lead to the ground terminal in the diagnostic connector. Connect the negative (-) lead directly to the battery negative (-) terminal.
Do not connect the voltmeter negative lead to an engine or chassis ground. This test measures the voltage drop across the ground side of the diagnostic connector. An ideal system ground should have a voltage drop of 0.1 V or less. An open ground can keep a fuel injected engine vehicle from starting. A high-resistance, or “dirty”, ground can cause overall poor operation.
2. **Battery Voltage** — Connect the voltmeter positive (+) lead to the battery voltage terminal at the diagnostic connector. Connect the negative (-) lead to the battery ground terminal.
The meter should read battery voltage. This tests the battery voltage supply to the ECM.
3. **ECM Communication Lines** — Remember, a stuffed pin does not necessarily predict the signal type. First determine if the vehicle uses J1850, ISO 9141, ISO 14230 or CAN (ISO 15765) and then determine if it uses both associated lines, or just one.
For ISO 9141 and ISO 14230 the K-LINE must be used, while the L- LINE is optional. For SAE J1850 the BUS + LINE must be used, while the BUS -LINE is optional.
For CAN (ISO 15765) both the H-LINE and L-LINE are used. Refer to a wiring diagram and use an ohmmeter to check continuity in the J1850, ISO 9141, ISO 14230 or CAN (ISO 15765) circuits to the diagnostic connector. The scan tool uses these lines to communicate with the ECM. If the circuit is open, the scan tool cannot transmit a request to the vehicle ECM nor receive data from it.

A.3.3 Check the Malfunction Indicator Lamp

On some vehicles, the lamp is labelled simply ENGINE, or has a symbol to indicate the ECM. Regardless of the label, they all can be referred to as the Malfunction Indicator Lamp.

Turn the ignition on and verify that the Malfunction Indicator Lamp lights with the ignition on and the engine off. If it does not, troubleshoot and repair the problem before going further. It could be as simple as a burned out lamp bulb or a blown fuse. Refer to the vehicle manufacturer shop

manual for the Malfunction Indicator Lamp troubleshooting procedure on the specific vehicle under test. Common causes of Malfunction Indicator Lamp circuit problems include:

- A blown circuit fuse, (GAUGES or other lamp fuse)
- A burned-out lamp bulb
- A wiring or connector problem
- A defective lamp driver
- A diagnostic connector problem

These vehicles can display a “No Communication” message when there is a communication problem. If the scan tool displays the message, “No Communication”, it means that the scan tool and the control module simply cannot communicate with each other for some reason.

Glossary

B

Bank

Specific group of cylinders sharing a common control sensor. Bank 1 always contains cylinder number 1.

C

CAN

Controller Area Network

D

DTC

Diagnostic Trouble Code

E

ECM

Electronic Control Module

EOBD

European Onboard Diagnostics

M

MIL

Malfunction Indicator Lamp

O

OBD

Onboard Diagnostics

OBDMID

On-Board Diagnostic Monitor IDentification