X-Analyser 3 Xa^3 WARWICK CONTROL TECHNOLOGIES

Accessing the CAN bus – OBD or direct access.

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In past articles, we talked about the CAN frame, and how to interpret it. Here we will discuss ways of accessing the bus. The access architecture can vary greatly amongst the various makes and models of vehicles. In this article, we will show you how to access the CAN bus in some vehicles simply by accessing the OBD (On Board Diagnostic) port. As not all vehicle CAN buses are accessible via the OBD connector, we will also show you some examples on how to access the CAN buses by other means.

Accessing the OBD port

All modern cars have an OBD connector for garage access to determine diagnostic faults for emissions diagnostics. These are to allow access for diagnostic scan tools. Most cars utilise the CAN bus for diagnostics. There are many types of diagnostic tools on the market for garage use. Here we show how you can use this access to some of the vehicles to collect real time CAN data. The OBD-II connector is required to be within 2 feet (0.61 m) of the steering wheel (unless an exemption is applied for by the manufacturer, in which case it is still somewhere within reach of the driver). OBD-II is the latest OBD specification of which EOBD is based on.

Many vehicles (particularly Ford) located the connector just underneath the steering wheel. Sometime there will be a small drop down access door. Figure 1 illustrates the appearance of the connector.
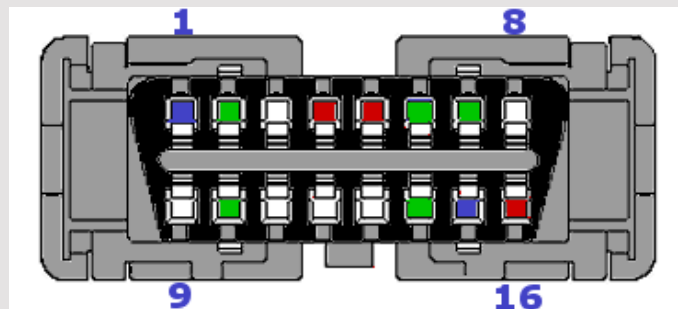

Figure 1. The OBD-II Connector

Note that on the plug side this D type 16 pin connector has a bar between the top row and the bottom row. This is on 12 volt applications, and it is to prevent technicians from plugging a 12 volt tool into a 24 volt system. If you are sure that your tools can handle 12 and 24 volt systems, you can remove this bar.

SAE J1962 defines the pinout of the connector as shown in Table 1.

J1962 OBD-II Connector Pin assignments

1	Manufacturer discretion - GM: J2411 GMLAN/SWC/Single-Wire CAN VW/Audi: Switched +12 to tell a scan tool whether the ignition is on. Ford: Infotainment CAN High	9	Manufacturer discretion - GM: 8192 bit/s ALDL where fitted. Ford: Infotainment CAN-Low
2	Bus Positive Line of SAE J1850 PWM and VPW	10	Bus Negative Line of SAE J1850 PWM only (not SAE J1850 VPW)
3	Manufacturer discretion - Ford: DCL(+) Argentina, Brazil (pre OBD-II) 1997-2000, USA, Europe, etc. Ford: Medium Speed CAN-High Chrysler: CCD Bus(+)	11	Manufacturer Discretion - Ford: DCL(-) Argentina, Brazil (pre OBD-II) 1997-2000, USA, Europe, etc. Ford: Medium Speed CAN-Low Chrysler: CCD Bus(-)
4	Chassis ground	12	Manufacturer discretion -
5	Signal ground	13	Manufacturer discretion - Ford: FEPS – Programming PCM voltage
6	CAN-High (ISO 15765-4 and SAE J2284)	14	CAN-Low (ISO 15765-4 and SAE J2284)
7	K-Line of ISO 9141-2 and ISO 14230-4	15	L-Line of ISO 9141-2 and ISO 14230-4
8	Manufacturer discretion - BMW: Second K-Line for non OBD-II (Body/Chassis/Infotainment) systems.	16	Battery voltage

Table 1. OBD Connector pinouts

CAN bus access the OBD port

The ODB port is provided to allow a standard access for garage service diagnostic tools. There are two scenarios for this access. Some vehicles allow direct access to the powertrain CAN bus from this connector. This is useful to allow other trouble shooting tools access to view the overall performance of the whole powertrain CAN bus. Figure 2 illustrates and example of this. Here you can see that it allows access of other tools as an oscilloscope, CAN analyser and voltmeter, along with the standard OBD scan tool.
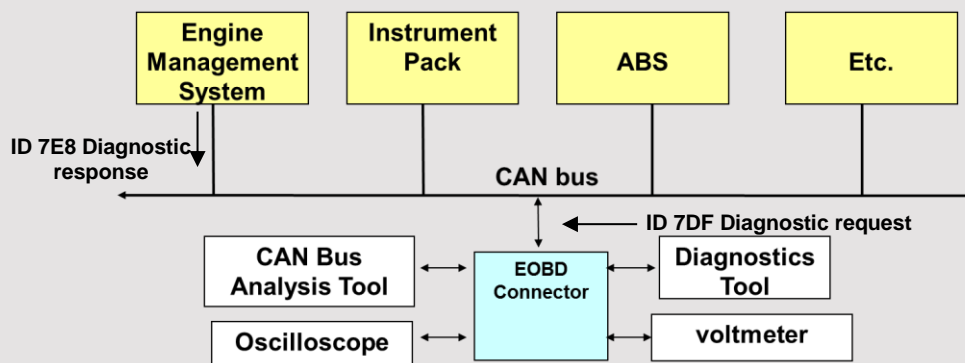

Figure 2. Direct access to the CAN bus via the OBD port

Of course this only allows direct access to the powertrain bus for emissions diagnostics. Many modern cars have multiple CAN buses that are connected together via Gateways. We will discuss later on how we can access these extra CAN buses.

The other typical scenario for access via the OBD port is through a diagnostic gateway ECU. Usually, this will be the Engine Control ECU. Figure 3 shows how this arrangement is typically

configured. Here the diagnostic scan tool connected to the OBD port is routed to the Engine ECU on a private CAN bus. The ECU acts as a gateway, where a standard diagnostic request message is sent to the gateway ECU, and the gateway ECU gathers the requested standard diagnostic parameters and sends this info back to the scan tool.
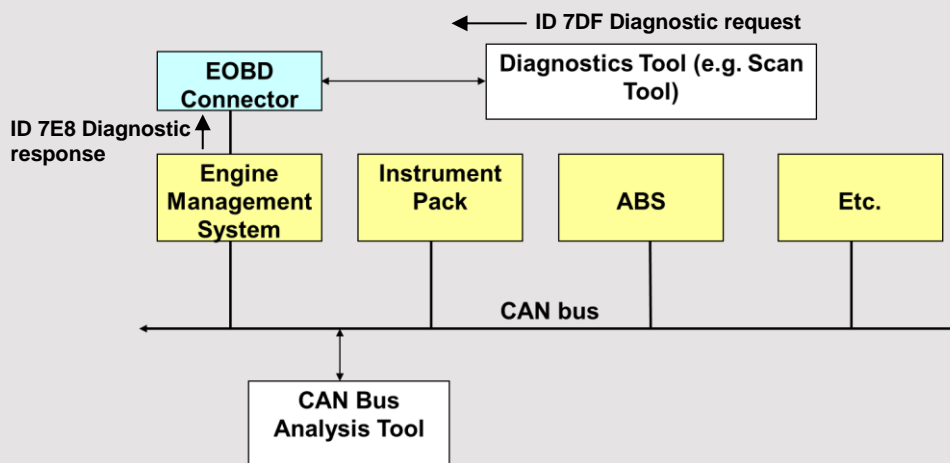

Figure 3. OBD access via a Diagnostic Gateway ECU

It should be noted that the scenario in Figure 2 utilises the same communication procedure, but it is done directly on the powertrain CAN bus, rather than a private diagnostic CAN bus. In both scenarios, the OBD diagnostic scan tool generates the Diagnostic Request messages (ID 7DF for Standard CAN or 18DB33F1 for extended CAN), and the Engine ECU generates the Diagnostic Response messages (ID 7E8 for Standard CAN or 18DAF110 for extended CAN). Table 1 reviews vehicles that are known to have direct access to the powertrain CAN bus from the OBD connector, and vehicles that access through the engine ECU gateway. Included are the figures for percent of market share in 2014 according to Car Magazine, January 2015: http://www.carmagazine.co.uk/car-news/industry-news/ford/uk-2014-car-sales-analysis-winners-and-losers/.

Direct access to the powertrain CAN bus from the OBD connector	Access through the engine ECU gateway
Citroen ~3%	Audi ~6%
Ford ~13%	BMW ~6%
Honda ~2%	Mercedes-Benz ~5%
Hyundai ~3%	Mini ~2%
Kia ~3%	Seat ~2%
Land Rover ~2%	Skoda ~3%
Mazda ~1%	VW ~8%
Nissan ~5%	
Peugeot ~4%	
Renault ~2%	
Suzuki ~1%	
Toyota ~3%	
Vauxhall ~10%	
Volvo ~1%	

Table 1. Car Manufacturers OBD access to powertrain CAN bus
Includes market share of sales

To illustrate the diagnostic request/response messages, observe the CAN messages in normal mode in our simple configuration in Figure 4, where we are collecting powertrain data on an early Ford Fiesta. Here you see just xxxx CAN frames being passed between the Engine ECU and the Instrument pack.
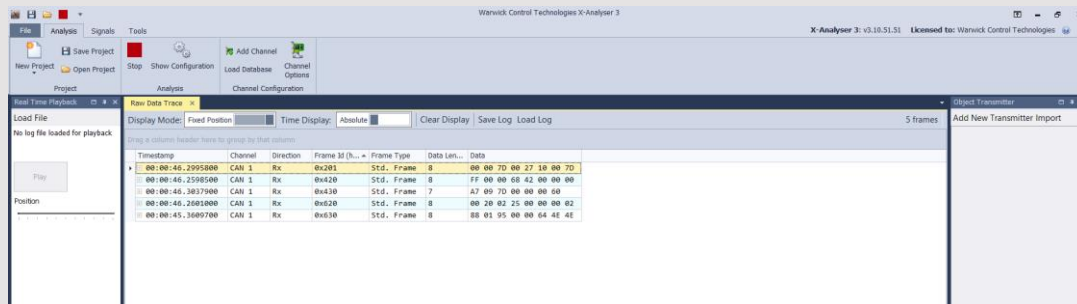

Figure 4. CAN analysis tool display before connecting Scan Tool

In Figure 5, we show the display after an OBD diagnostic scan tool is connected to it. Here you can see two new messages are added to the display (ID 7DF Diagnostic request and ID 7E8 Diagnostic response). This is the interaction between the diagnostic scan tool and the Engine ECU, which is the diagnostic gateway for the scan tool. The data contained in these messages are diagnostic related parameters, such as emissions parameters along with operational data such as engine speed, throttle position, inlet temperature, etc. Also, Diagnostic Trouble Codes (DTCs) – sometimes called Fault Codes - are relayed through these messages. This is discussed further in a later article.
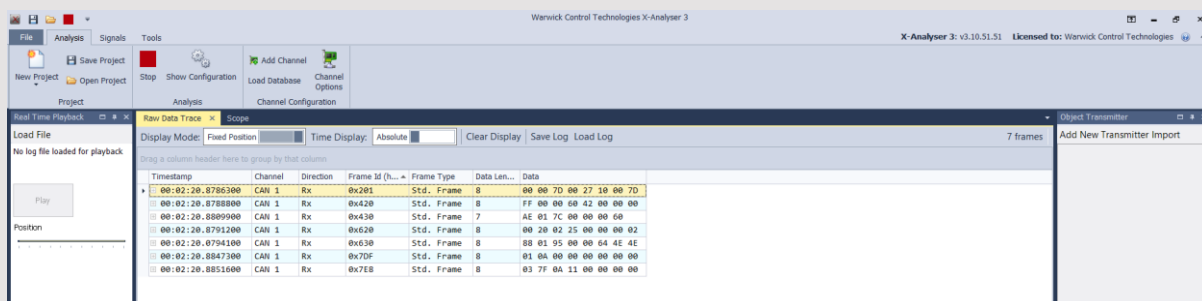

Figure 5. CAN analysis tool display after connecting Scan Tool

Direct Access to other CAN busses

As we know, some vehicle have several CAN buses gatewayed together. There will be occasions where access is need to check the health of these buses. There is no standard on how you can access these buses, so we will give a few examples here on a few cars on how this can be accomplished. As there are no standard interconnections on these extra CAN buses, we must be a bit more creative on we get access to the twisted pair CAN wires. The two main methods that can be utilised are:

- Vampire clips – insulation piercing method
- Induction pick up sensors

Use of Vampire clips is a positive but intrusive way of connecting to the twisted pair wires. These are insulation displacement piercing connections. There are precision clips available that cause minimal damage when piercing the insulation. A picture of one of these products is shown in Figure 6. These clips allow you to clamp onto the wire with a spring retainer, and you slowly screw the piercing pin in with precision to cause minimal damage. This type of connection is ideal for directly connecting to the wire for interfacing to an analysis tool or an oscilloscope.
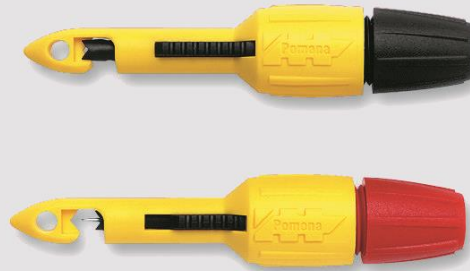

Figure 6. Insulation displacement connection – "Vampire clips"

The other method for accessing the CAN bus is less intrusive. It is an inductive pickup sensor, where the sensor is clamped onto the twisted pair CAN wires, and it senses transitions of data via an electrical induction pick up. An example of this method is a product known as CANcliq. Figure 7 show how this connects to the CAN bus. As you can see, it is un-intrusive. It does require a power supply to operate. As this method re-shapes the CAN signals, it is not suitable for viewing with an oscilloscope. It is useful for interfacing with a CAN analysis tool or a diagnostic scan tool.

Figure 7. Inductive pick from the CAN bus

Some methods used in the past have been via the back of an ECU connector using pins. This is not recommended, as it could cause damage to the connector.

Example CAN bus Locations

There is a lot of information out there showing how to get to the CAN bus on various vehicles. As stated before, there does not seem to be a standard to get to CAN buses other than the powertrain bus for emissions diagnostics. In the case of the access to the powertrain bus via a diagnostic gateway as shown in Figure 3, this will require some of the creative means described above. Here we will point out a couple of examples on particular vehicles.

For example, one can access the CAN bus wires of a VW Beetle behind the instrument pack as shown in Figure 8.
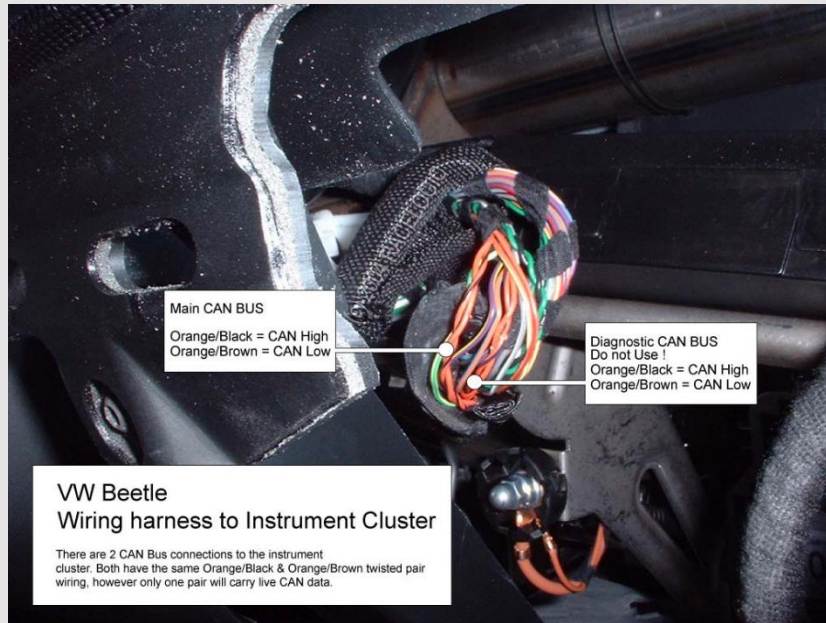

Figure 8. CAN bus access on a VW Beetle

Another Example is shown in Figure 9. Here we can see the access to the CAN bus in a Peugeot 407 behind the kick panel in the foot well.
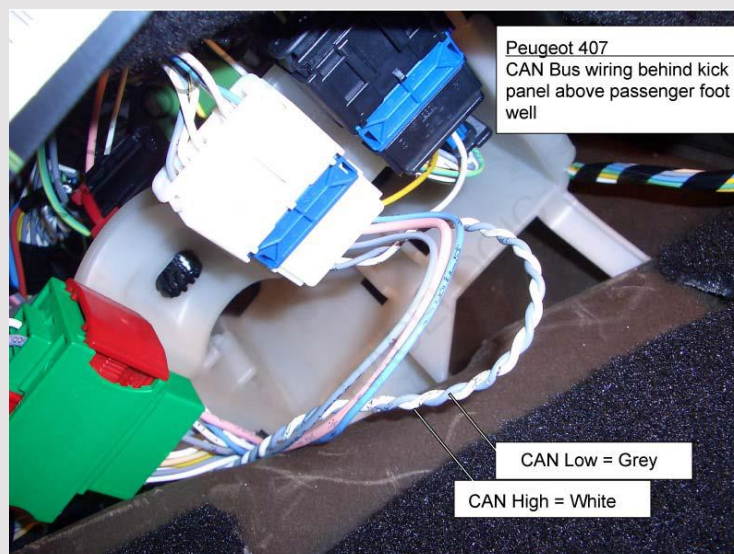

Figure 9. CAN bus access on a Peugeot 407

One more example to illustrate is shown in Figure 10 where the access to the CAN bus in a 2004 Vauxhall/Opel Astra can be found at the rear of the radio.
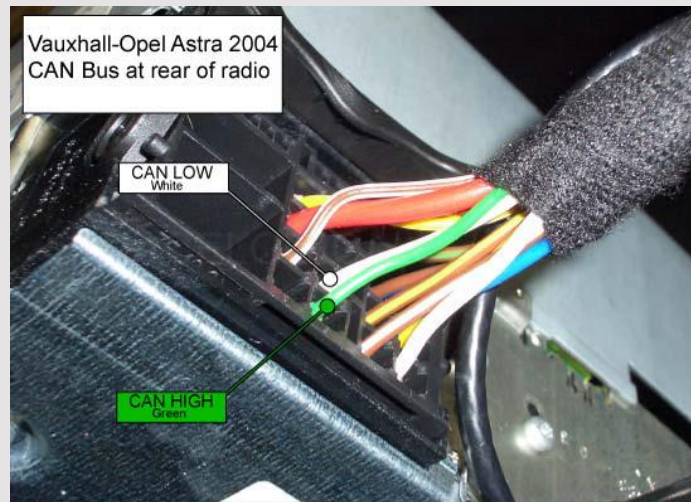

Figure 10. CAN bus access on a Vauxhall/Opel Astra

Here we showed a few examples of how to access the CAN bus where access is not readily known. There is much information from experience that many kind technicians have shared through open forums such as you find on the internet. Once access is made, there are several tools available to observe the bus once connected. In this article, we showed you how to look at the data via the CAN analysis tool X-Analyser 3. In a later article, we will show you how we use an oscilloscope to check the physical health of the CAN bus along with the electrical integrity.