Setting up X-Analyser 3 to perform as a Scan Tool in Mode 1 Polling PIDs supported and Display Live Data

The concept is to utilise the X-Analyser 3 CAN analysis tool in OBD Mode 1 – Live Data. I.e. the X-Analyser is performing as an OBD Scan Tool. Here we show how you can utilise the Transmit function to ascertain which PIDs (Parameter Identifiers) are supported under Mode 1. Once this is determined, a Signal/CANdb file can be constructed to show the live data. We will start with how we built up a project to include the transmit files to poll for which PIDS are supported, and transmit PID request messages of the PIDs that are supported. Also, we will show how we built up the Signals/CANdb file to view the PID values. The reference for this is the ISO 15031-5, ISO 15765-4 and SAE J1979. Also, there is a very good review on http://en.wikipedia.org/wiki/OBD-II_PIDs.

Setting up X-A 3 to transmit Diagnostic Request messages for supported PIDs

In X-A 3 in the Object Transmitter area, we insert transmitters by selecting Add new Transmitter, and setting up the transmit function as shown in Figure 1.

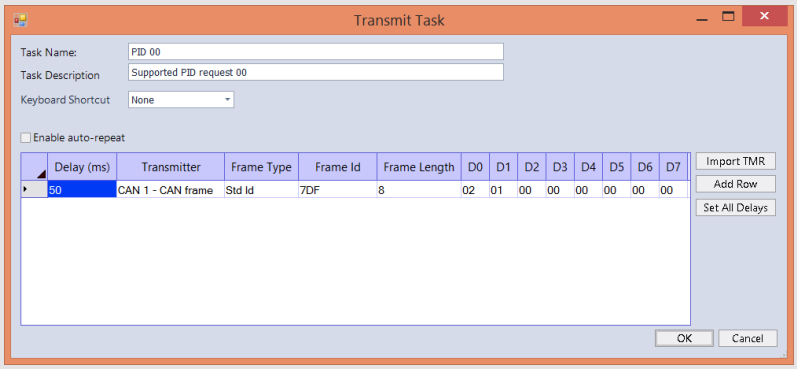


Figure 1. Setting up PID 00 Request message

Here we are creating a message to be transmitted onto the vehicle that requests PIDs supported between 0 and 20 Hex. The Diagnostic Request message has the CAN ID of 7DF (Standard 11 bit CAN ID). Always set the Frame Length to 8, even though all bytes are not used. As per the OBD standard, the first Byte (D0) indicates the number of bytes following, i.e. 2. The next byte (D1) indicates that this is a Mode 1 request, and the next byte (D2) is the request for PIDs supported up to 20. The rest of the bytes are not used. So the byte sequence is 02 01 00.

Once the transmit message is built, we connect the X-Analyser to the vehicle and transmit this Diagnostic request message. In our test we use a 2008 Ford Focus. When this request message is sent, we received a response from the vehicle that appears as in Figure 2 below.

Timestamp	Channel	Direction	Frame Id (hex)	Frame Type	Data Length	Data
00:00:06.4730574	CAN 1	TxReq	0x7DF	Std. Frame	8	02 01 00 00 00 00 00 00
00:00:06.4730574	CAN 1	TxReq	Diagnostic_Response (0x7E8)	Std. Frame	8	06 41 00 98 3B 00 17 00

Figure 2. Diagnostic Request and Response messages 00

You can see that the response message is the OBD standard ID of 7E8 Hex. Note that the Data field shows a value of 06 41 00 98 3B 00 17 00. The first byte indicates the number of bytes to follow (6), the second bytes indicates that it is a Mode 1 response message (41). Byte 3 indicates the PID 00 response. This is the response from the Engine ECU to say which PIDs from 1 to 20 are supported. Bytes 4, 5, 6 and 7 are the values that indicate which PIDS are supported. To visualise what this value indicates, see the table below. As we stated the PIDs supported value is 98 3B 00 17. If we convert this to binary and put into a table, it will appear as in Table 1.

Hexidecimal	9				8				3				B				0				0				1				7			
Binary	1	0	0	1	1	0	0	0	0	0	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1
Supported	Yes	No	No	Yes	Yes	No	No	No	No	No	Yes	Yes	Yes	No	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	Yes	No	Yes	Yes	Yes
PID Number	1	2	3	4	5	6	7	8	9	0A	0B	0C	0D	0E	0F	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	20

Table 1 PIDs supported (01 to 20) on 2008 Ford Focus

So, you can see which PIDs are supported from the Table 1. As a review, PIDs supported are:

- 1 - (MIL) status and number of DTCs
- 4 - Calculated engine load value
- 5 - Engine coolant temperature
- 0B - Intake manifold absolute pressure
- 0C - Engine RPM
- 0D - Vehicle speed
- OF - Intake air temperature
- 10 - MAF air flow rate
- 1C - OBD standards this vehicle conforms to
- 1E - Auxiliary input status
- 1F – Run time since engine start
- 20 - PIDs supported [21 - 40] – this means that the next group of PIDs are available up to 40.

The full table of PIDS can be obtained from SAE J1979 standard, or from the table mentioned in Wiki - http://en.wikipedia.org/wiki/OBD-II_PIDs.

Once this is done, we will create further messages to request PID support for:
21 to 40
41 to 60
61 to 80
81 to A0
A1 to C0
C1 to E0
E1 to FF

Once the next PIDs support request message is sent, you will get a response as shown in Figure 3.

Timestamp	Channel	Direction	Frame Id (hex)	Frame Type	Data Length	Data
00:00:06.4730574	CAN 1	TxReq	0x7DF	Std. Frame	8	02 01 00 00 00 00 00 00
00:00:06.4730574	CAN 1	TxReq	Diagnostic_Response (0x7E8)	Std. Frame	8	06 41 00 98 3B 00 17 00
00:00:09.3940084	CAN 1	TxReq	0x7DF	Std. Frame	8	02 01 20 00 00 00 00 00
00:00:09.3940084	CAN 1	TxReq	Diagnostic_Response (0x7E8)	Std. Frame	8	06 41 20 A0 03 A0 01 00

Figure 3. Diagnostic Request and Response messages 20

Here you can see that the Diagnostic request message 7DF was sent again with a slight difference. Note that the request has the byte sequence of 02 01 20, indicating the request for which PIDs are supported from 21 to 40. As you can see in Figure 3, the response is 7E8 - 06 41 20 A0 03 A0 01. This would translate to the supported PIDs as shown in Table 2.

Hexidecimal	A				0				0				3				A				0				0				1			
Binary	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Supported	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	Yes
PID Number	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F	40

Table 2. PIDs supported (21 to 40) on 2008 Ford Focus

So, you can see which PIDs are supported from the Table 2. As a review, PIDs supported are:

- 21 - Distance travelled with malfunction indicator lamp (MIL) on
- 23 - Fuel Rail Pressure
- 2F - Fuel Level Input
- 30 - # of warm-ups since codes cleared
- 31 - Distance travelled since codes cleared
- 33 - Barometric pressure
- 40 - PIDs supported [41 - 60] - this means that the next group of PIDs are available up to 60.

Since the 40 bit was set to 1, the next message to be sent will be the Diagnostic Request for PIDS supported above 40. Figure 4 shows the request sequence of 02 01 40, indicating the request for which PIDs are supported from 41 to 60. As you can see in Figure 4, the response is 7E8 - 06 41 40 C0 CC 00 00. This would translate to supported PIDs as shown in Table 3.

Display Mode: Chronological | Time Display: Absolute | Clear Display | Save Log | Load Log | 11 frames

Drag a column header here to group by that column

Timestamp	Channel	Direction	Frame Id (hex)	Frame Type	Data Length	Data
00:00:06.4730574	CAN 1	TxReq	0x7DF	Std. Frame	8	02 01 00 00 00 00 00 00
00:00:06.4730574	CAN 1	TxReq	Diagnostic_Response (0x7E8)	Std. Frame	8	06 41 00 98 3B 00 17 00
00:00:09.3940084	CAN 1	TxReq	0x7DF	Std. Frame	8	02 01 20 00 00 00 00 00
00:00:09.3940084	CAN 1	TxReq	Diagnostic_Response (0x7E8)	Std. Frame	8	06 41 20 A0 03 A0 01 00
00:00:11.6937084	CAN 1	TxReq	0x7DF	Std. Frame	8	02 01 40 00 00 00 00 00
00:00:11.6937084	CAN 1	TxReq	Diagnostic_Response (0x7E8)	Std. Frame	8	06 41 40 C0 CC 00 00 00

Figure 4. Diagnostic Request and Response messages 40

Hexidecimal	C				0				C				C				0				0				0				0			
Binary	1	1	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Supported	Yes	Yes	No	No	No	No	No	No	Yes	Yes	No	No	Yes	Yes	No	No	No	No	NO	No	No	No	No	No	No	No	No	No	No	No	No	No
PID Number	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	50	51	52	53	54	55	56	57	58	59	4A	4B	4C	4D	4E	4F	60

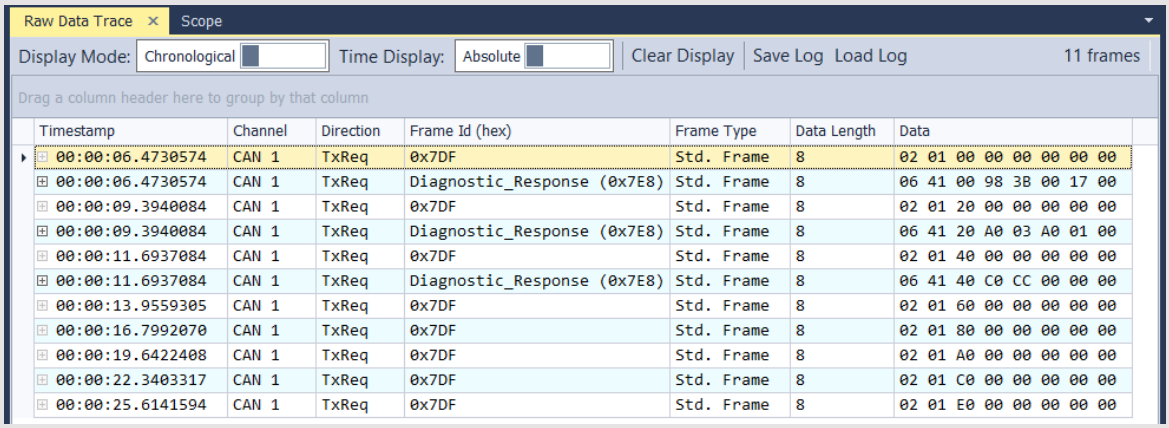
Table 3. PIDs supported (41 to 60) on 2008 Ford Focus

Here you can see the following PIDs are supported on this vehicle are:

- 41 - Monitor status this drive cycle
- 42 - Control module voltage
- 49 – Accelerator pedal position D
- 4A – Accelerator pedal position E
- 4D – Time run with MIL on
- 4E – Time since trouble codes cleared

Note that the table indicates that PID 60 is not supported. This means that there are no more PIDs supported on this vehicle. Therefore, there is no need to send a message asking for PIDs supported above 60. For experimental purposes we sent messages anyway requesting PIDs supported for:
61 to 80
81 to A0
A1 to C0
C1 to E0
E1 to FF

Figure 5 shows that there is no response to these Request messages, as there are no PIDs above 60 supported.



Timestamp	Channel	Direction	Frame Id (hex)	Frame Type	Data Length	Data
00:00:06.4730574	CAN 1	TxReq	0x7DF	Std. Frame	8	02 01 00 00 00 00 00 00
00:00:06.4730574	CAN 1	TxReq	Diagnostic_Response (0x7E8)	Std. Frame	8	06 41 00 98 3B 00 17 00
00:00:09.3940084	CAN 1	TxReq	0x7DF	Std. Frame	8	02 01 20 00 00 00 00 00
00:00:09.3940084	CAN 1	TxReq	Diagnostic_Response (0x7E8)	Std. Frame	8	06 41 20 A0 03 A0 01 00
00:00:11.6937084	CAN 1	TxReq	0x7DF	Std. Frame	8	02 01 40 00 00 00 00 00
00:00:11.6937084	CAN 1	TxReq	Diagnostic_Response (0x7E8)	Std. Frame	8	06 41 40 C0 CC 00 00 00
00:00:13.9559305	CAN 1	TxReq	0x7DF	Std. Frame	8	02 01 60 00 00 00 00 00
00:00:16.7992070	CAN 1	TxReq	0x7DF	Std. Frame	8	02 01 80 00 00 00 00 00
00:00:19.6422408	CAN 1	TxReq	0x7DF	Std. Frame	8	02 01 A0 00 00 00 00 00
00:00:22.3403317	CAN 1	TxReq	0x7DF	Std. Frame	8	02 01 C0 00 00 00 00 00
00:00:25.6141594	CAN 1	TxReq	0x7DF	Std. Frame	8	02 01 E0 00 00 00 00 00

Figure 5. Diagnostic Request – showing request for 60, 80, A0, C0 and E0

Visual Display of PIDs Supported

Here we utilised the X-Analyser CANdb editor to show a quick visual display of which PIDs are supported. These were set up as mode dependant signals. The mode dependency is set by bytes 2 and 3 of the Diagnostic Response messages. For example, in Figures 2 thru 5, the first Diagnostic Response message is CAN ID 7E8 with a data field of 06 41 00 98 3B 00 17 00.

The first byte is the number of bytes following indicator. Bytes 2 and 3 (41 00) indicate a Mode 1 Response for PIDs 1 to 20. Bytes 4, 5, 6 and 7 are the values of the PIDs supported (each bit represents a PID). Byte 8 is an extra and it is ignored. From this information, we were able to build up a CANdb to show each bit as a PID supported bit via a mode dependant indicator of Bytes 2 and 3.

As we said Bytes 2 and 3 are the mode dependant indicators. In this example, the values are 41 00 (16640 Decimal). In the CANdb editor (X-Editor or Kvaser's CANdb Editor) we indicate the first signal as the Mode dependency place and value. For example, for Mode value of 41 00 in bytes 2 and 3, this would translate to Start bit of 40, and a length of 16 in Motorola Backward format. In the editor the Signal Type is set to Mode.

In each Signal, the start bit will vary of course, but each one will be one bit in length, and it will be set a Signal Type of Mode Dependant, with the Mode value of 16640 decimal in this example (41 00 Hex). As an example, the signal for PID 05 (Engine coolant temperature). In Figure 6 you can see the visualisation of the CAN data layout in the X-Editor. Here we are showing the location of the Mode signal and each of the mode dependant signals to indicate PIDs supported from 01 to 20. The bit arrangement is in Motorola Backward format, the bits are arranged from right (01) to left (20), i.e. 01 is start bit of 39, and 20 is start bit of 8.

Figure 6. X-Editor showing PIDs supported request message for PIDs 01 to 20

In our example of the signal for PID 05 (Engine coolant temperature), the Start bit is 35 and length is 1 bit. PID 04 is Start bit of 36 and length of 1. To illustrate the Mode Signal for the mode dependency, Figure 7 shows the set up for setting the mode signal for mode dependency. Here you can see the start bit is 40, and the length is 16 bits. Signal Type is set to Mode. This will be used to ascertain the PIDs supported from 01 to 20. The multiplier is set to 1 and there is a default setting of Maximum and Minimum of 0. Of course the Bit Format is set to Motorola Backward. Hint – Always set the Bit Format before configuring the signal.

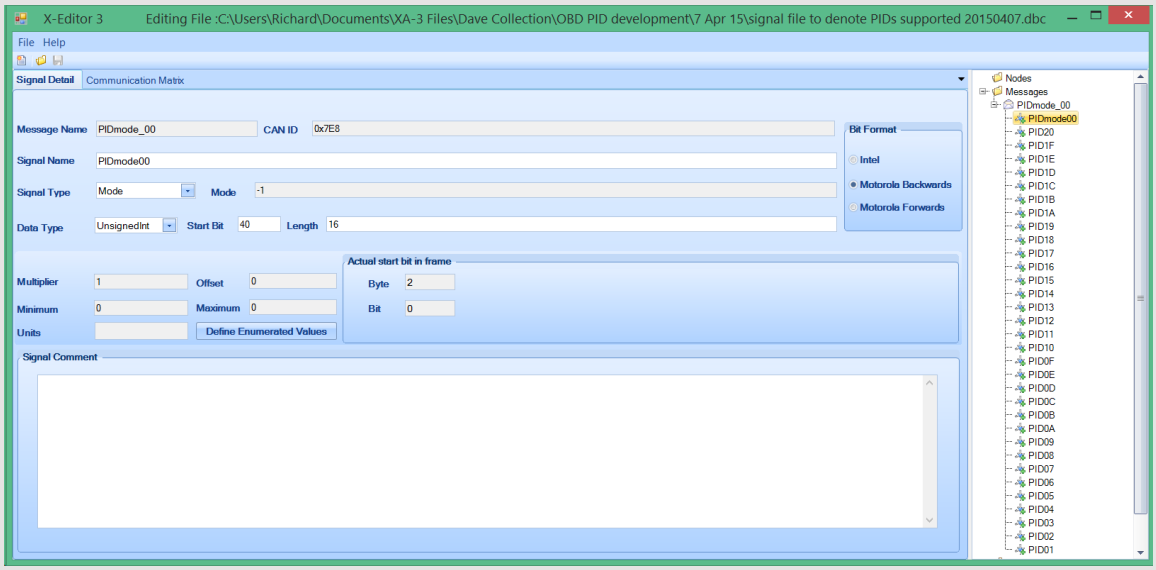


Figure 7. X-Editor showing the configuration of the Mode Signal set-up

Now, looking at our example of PID 05 (Engine coolant temperature), the configuration is illustrated in Figure 8. This illustrates how to build a Signals/CANdb file to obtain the "Live Data" of the PIDs supported (CompletePIDs). Here you see that PID 05 signal is set to Mode Dependant with a Mode value of 16645 decimal (41 05 Hex), you can also see the Offset (-40), the multiplier (1), Min and Max values (-40,215), the start bit (32) and Length (8). These values can be obtained via ISO-15031-5.

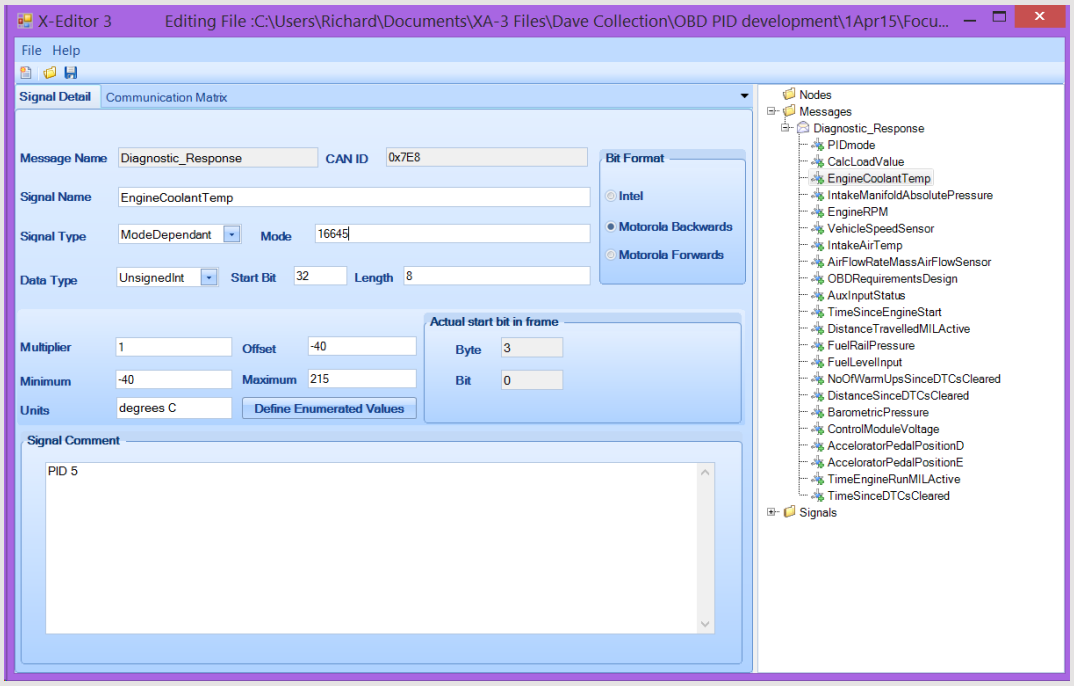


Figure 8. Configuration for interpreting PID 05 (Engine coolant temperature)

Warwick Control have built up a configuration project for X-Analyser where you can:

- Set up transmit functions to Request PIDs supported in OBD Mode 1.
- Display PIDs that are supported within a particular vehicle
- Display the parameters within each PID, such as engine speed, coolant temp, etc.

This type of configuration is shown in Figure 9, where we have made up signal file displays based on ISO-15031 and SAE J1979. Here we sent the Diagnostic Request Transmit Messages as described in the earlier section, and the Signals panels are set up to display which PIDs are supported based on the Diagnostic Response Messages.

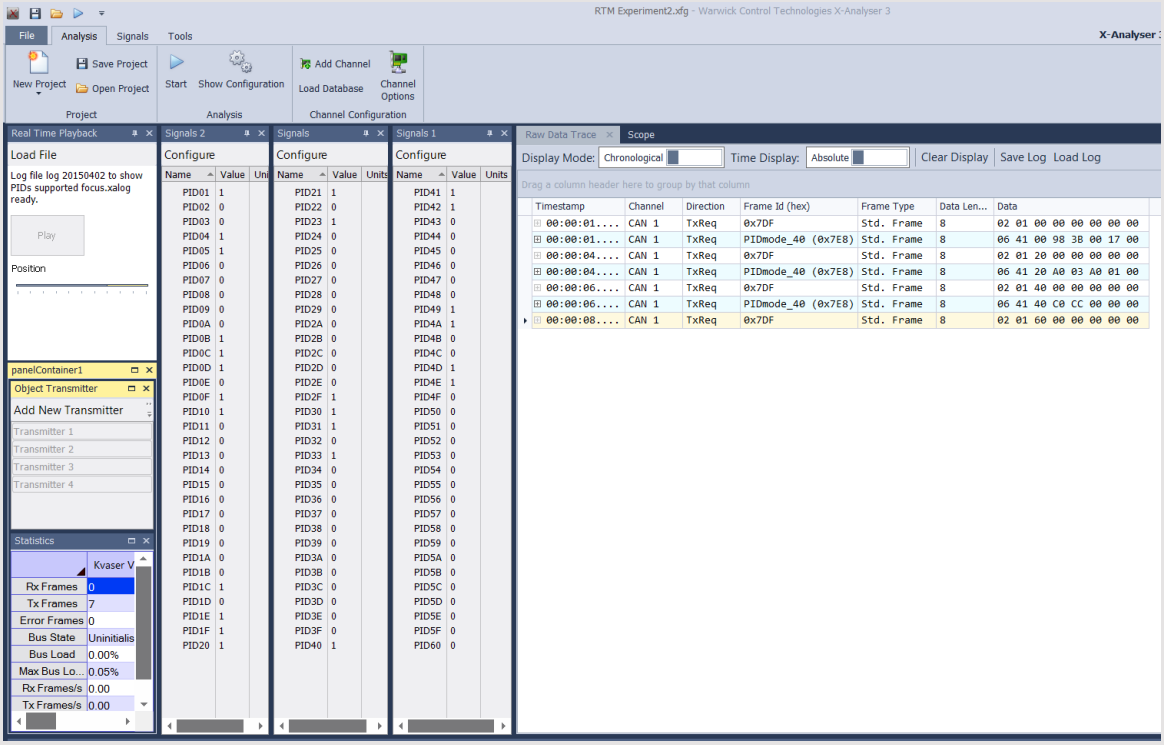


Figure 9. Transmitting to find PIDs supported of Ford Focus

Now we know which PIDs are supported. In the next section, we will show you how X-Analyser can be used to set up a Scan Tool function of requesting and collecting live data from the OBD software within the Engine ECU.

Emulating OBD Mode 1 – Displaying Live Data (PIDs)

Within the X-Analyser project file, we will add the CANdb/Signals file that allows you to select the PIDs supported, and display them in the Signals Panel in X-Analyser. Referring to Figure 10, we have added another Signals file called CompletePIDs to show “Live Data”, and another Transmit file of the same name. First step is to click on Configure in the CompletePIDs Signal Panel, and compare the PID requested Signals Panel results with the CompletePIDs configure panel. Select the PIDs that have a Value of 1 in the PID requested Signals Panels.

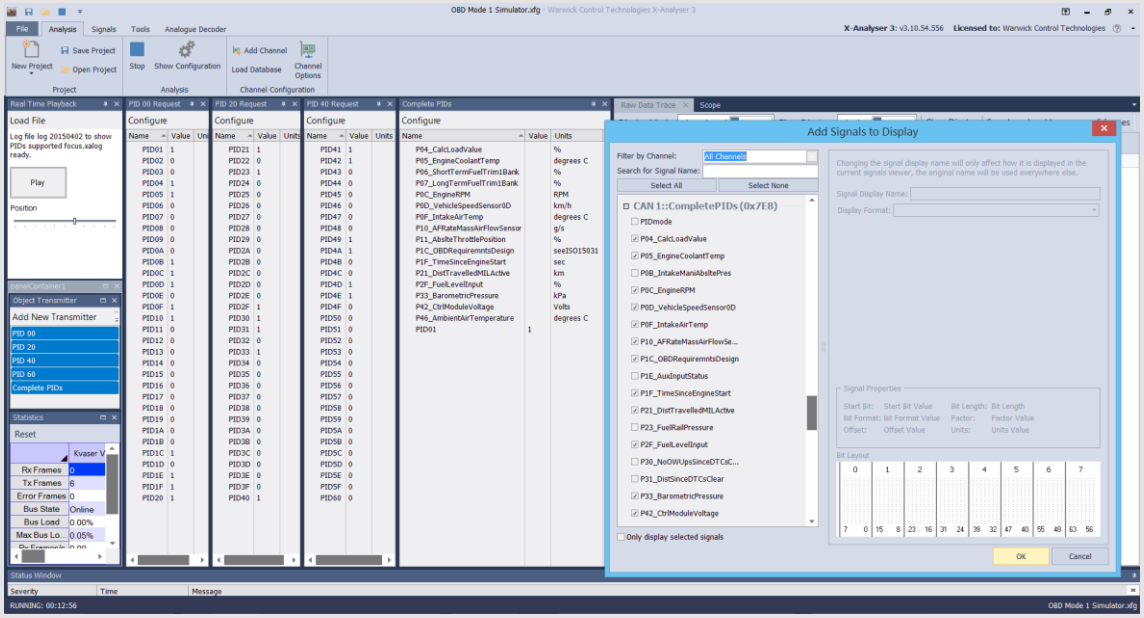
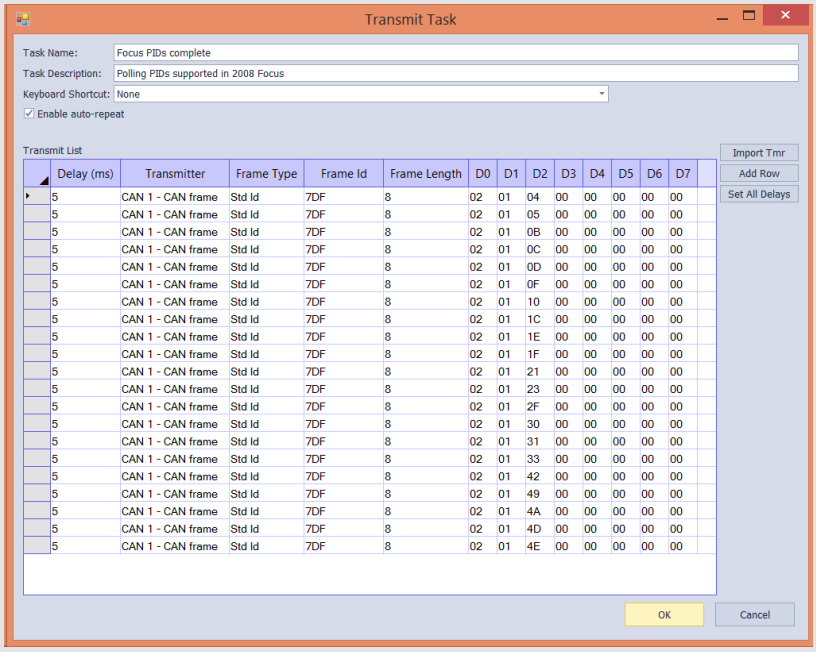


Figure 10. “Live Data” Selection

Once these are selected, you can see the list of PIDs for “Live Data” display in the Complete PIDs Signal panel. In the Object Transmitter panel, we have added another transmitter (Complete PIDs). This transmit object contains the series of diagnostic request messages that will set up the response from the engine ECU all the PID data supported. In this transmitter, there is a series of request messages similar to the one used in Figure 1. We show some of the Diagnostic request messages for transmit in Figure 11. Considering our PID 5 (Engine_Coolant_Temp) example, note that the transmit message highlighted in Figure 11 shows the standard message format of CAN ID 7DF with data D0 of 02 indicating number of Bytes to follow. D1 of 01 indicates this is a Mode 1 PID request. D2 is the number of the actual PID requested – 05 in this case.

As you can see from the list of transmit messages in Figure 11, this transmit routine sends a series of Diagnostic request messages for each PID. Each message will be responded to from the engine ECU with the Live Data for each Mode 1 PID request. Note that the messages are set to transmit 5 milliseconds apart. So, utilising these transmit routines, and with the addition of the Complete PIDs CANdb/Signals file, the X-Analyser 3 CAN emulate the Mode 1 functions of and OBD Scan tool. Figure 12 shows the result of the Diagnostic Request transmit messages with the responses (CAN ID 7E8) shown in raw CAN data and the Complete PIDs Signal panel.



Delay (ms)	Transmitter	Frame Type	Frame Id	Frame Length	D0	D1	D2	D3	D4	D5	D6	D7
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	04	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	05	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	0B	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	0C	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	0D	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	0F	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	10	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	1C	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	1E	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	1F	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	21	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	23	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	2F	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	30	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	31	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	33	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	42	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	49	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	4A	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	4D	00	00	00	00	00
5	CAN 1 - CAN frame	Std Id	7DF	8	02	01	4E	00	00	00	00	00

Figure 11. Transmit set up for requesting PID Live Data

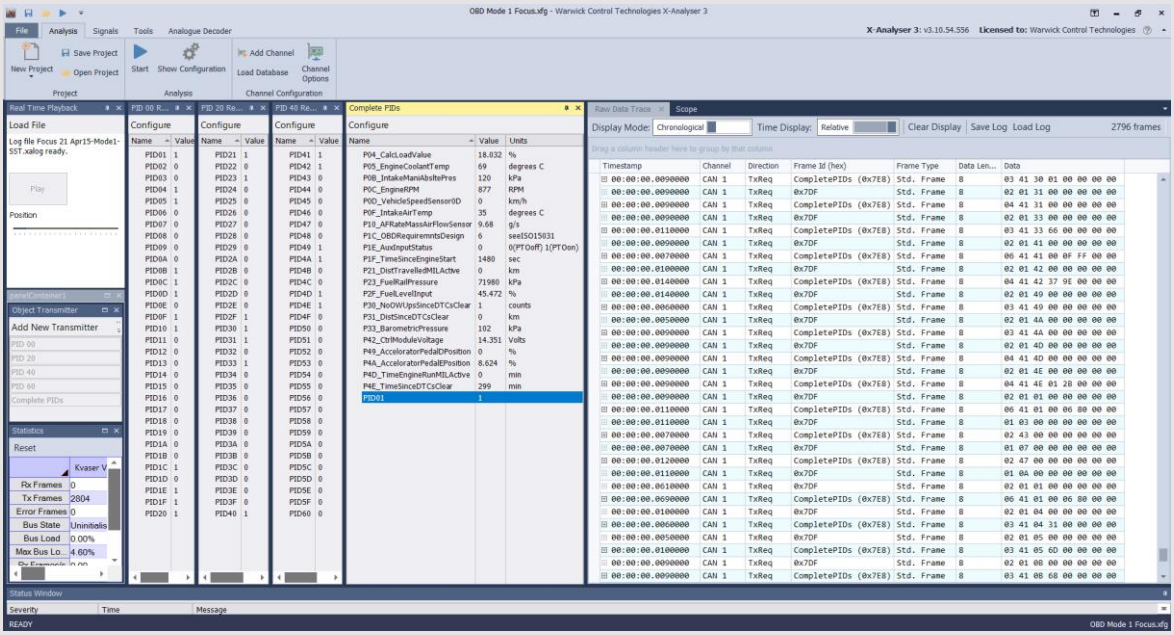


Figure 12. X-Analyser display with PIDs supported, PID values and CAN raw data display.

Further work in progress to emulate the other OBD Modes in X-Analyser. The next chapter will show how to use X-Analyser to emulate Mode 3 (Read DTCs) and Mode 4 (Clear DTCs).