OBD-II PIDs

OBD-II PIDs (On-board diagnostics **Parameter IDs**) are codes used to request data from a vehicle, used as a diagnostic tool. SAE standard J/1979 defines many PIDs, but manufacturers also define many more PIDs specific to their vehicles. All light duty vehicles (e.g. less than 8,500 pounds) sold in North America since 1996, as well as medium duty vehicles (e.g. 8,500-14,000 pounds) beginning in 2005, and heavy duty vehicles (e.g. greater than 14,000 pounds) beginning in 2010, are required to support OBD-II diagnostics, using a standardized data link connector, and a subset of the SAE J/1979 defined PIDs (or SAE J/1939 as applicable for medium/heavy duty vehicles), primarily for state mandated emissions inspections.

Typically, an automotive technician will use PIDs with a scan tool connected to the vehicle's OBD-II connector.

- The technician enters the PID
- The scan tool sends it to the vehicle's bus (CAN, VPW, PWM, ISO, KWP. After 2008, CAN only)
- A device on the bus recognizes the PID as one it is responsible for, and reports the value for that PID to the bus
- The scan tool reads the response, and displays it to the technician

Modes

There are ten modes of operation described in the latest OBD-II standard SAE J1979. They are as follows (the 0x prefix indicates a hexadecimal radix):
0x01. Show current data
0x02. Show freeze frame data
0x03. Show stored Diagnostic Trouble Codes
0x04. Clear Diagnostic Trouble Codes and stored values
0x05. Test results, oxygen sensor monitoring (non CAN only)
0x06. Test results, other component/system monitoring (Test results, oxygen sensor monitoring for CAN only)
0x07. Show pending Diagnostic Trouble Codes (detected during current or last driving cycle)
0x08. Control operation of on-board component/system
0x09. Request vehicle information
0x0A. Permanent DTC's (Cleared DTC's)

Vehicle manufactures are not required to support all modes.

Each manufacturer may define additional modes above #9 (e.g.: mode 22 as defined by SAE J2190 for Ford/GM, mode 21 for Toyota) for other information (e.g.: the voltage of the Traction Battery [1] in a HEV).

Standard PIDs

The table below shows the standard OBD-II PIDs as defined by SAE J1979. The expected response for each PID is given, along with information on how to translate the response into meaningful data. Again, not all vehicles will support all PIDs and there can be manufacturer-defined custom PIDs that are not defined in the OBD-II standard.

Note that modes 1 and 2 are basically identical, except that Mode 1 provides current information, whereas Mode 2 provides a snapshot of the same data taken at the point when the last diagnostic trouble code was set. The exceptions are PID 01, which is only available in Mode 1, and PID 02, which is only available in Mode 2. If Mode 2 PID 02 returns zero, then there is no snapshot and all other Mode 2 data is meaningless.

Please, note that when using Bit-Encoded-Notation, quantities like C4 means bit 4 from data byte C. Each bit is numerated from 0 to 7, so 7 is the most significant bit and 0 is the least significant bit.

Mode (hex)	PID (hex)	Data bytes returned	Description	Min value	Max value	Units	Formula
01	00	4	PIDs supported [01 - 20]				Bit encoded [A7..D0] == [PID 0x01..PID 0x20] See below.
01	01	4	Monitor status since DTCs cleared. (Includes malfunction indicator lamp (MIL) status and number of DTCs.)				Bit encoded. See below.
01	02	2	Freeze DTC				
01	03	2	Fuel system status				Bit encoded. See below.
01	04	1	Calculated engine load value	0	100	%	A*100/255
01	05	1	Engine coolant temperature	-40	215	°C	A-40
01	06	1	Short term fuel % trim—Bank 1	-100 Subtracting Fuel (Rich Condition)	99.22 Adding Fuel (Lean Condition)	%	(A-128) * 100/128
01	07	1	Long term fuel % trim—Bank 1	-100 Subtracting Fuel (Rich Condition)	99.22 Adding Fuel (Lean Condition)	%	(A-128) * 100/128
01	08	1	Short term fuel % trim—Bank 2	-100 Subtracting Fuel (Rich Condition)	99.22 Adding Fuel (Lean Condition)	%	(A-128) * 100/128
01	09	1	Long term fuel % trim—Bank 2	-100 Subtracting Fuel (Rich Condition)	99.22 Adding Fuel (Lean Condition)	%	(A-128) * 100/128
01	0A	1	Fuel pressure	0	765	kPa (gauge)	A*3
01	0B	1	Intake manifold absolute pressure	0	255	kPa (absolute)	A
01	0C	2	Engine RPM	0	16,383.75	rpm	((A*256)+B)/4
01	0D	1	Vehicle speed	0	255	km/h	A
01	0E	1	Timing advance	-64	63.5	° relative to #1 cylinder	A/2 - 64
01	0F	1	Intake air temperature	-40	215	°C	A-40
01	10	2	MAF air flow rate	0	655.35	grams/sec	((A*256)+B) / 100
01	11	1	Throttle position	0	100	%	A*100/255
01	12	1	Commanded secondary air status				Bit encoded. See below.
01	13	1	Oxygen sensors present				[A0..A3] == Bank 1, Sensors 1-4. [A4..A7] == Bank 2...
01	14	2	Bank 1, Sensor 1: Oxygen sensor voltage, Short term fuel trim	0 -100(lean)	1.275 99.2(rich)	Volts %	A/200 (B-128) * 100/128 (if B==0xFF, sensor is not used in trim calc)

01	15	2	Bank 1, Sensor 2: Oxygen sensor voltage, Short term fuel trim	0 -100(lean)	1.275 99.2(rich)	Volts %	A/200 (B-128) * 100/128 (if B==0xFF, sensor is not used in trim calc)
01	16	2	Bank 1, Sensor 3: Oxygen sensor voltage, Short term fuel trim	0 -100(lean)	1.275 99.2(rich)	Volts %	A/200 (B-128) * 100/128 (if B==0xFF, sensor is not used in trim calc)
01	17	2	Bank 1, Sensor 4: Oxygen sensor voltage, Short term fuel trim	0 -100(lean)	1.275 99.2(rich)	Volts %	A/200 (B-128) * 100/128 (if B==0xFF, sensor is not used in trim calc)
01	18	2	Bank 2, Sensor 1: Oxygen sensor voltage, Short term fuel trim	0 -100(lean)	1.275 99.2(rich)	Volts %	A/200 (B-128) * 100/128 (if B==0xFF, sensor is not used in trim calc)
01	19	2	Bank 2, Sensor 2: Oxygen sensor voltage, Short term fuel trim	0 -100(lean)	1.275 99.2(rich)	Volts %	A/200 (B-128) * 100/128 (if B==0xFF, sensor is not used in trim calc)
01	1A	2	Bank 2, Sensor 3: Oxygen sensor voltage, Short term fuel trim	0 -100(lean)	1.275 99.2(rich)	Volts %	A/200 (B-128) * 100/128 (if B==0xFF, sensor is not used in trim calc)
01	1B	2	Bank 2, Sensor 4: Oxygen sensor voltage, Short term fuel trim	0 -100(lean)	1.275 99.2(rich)	Volts %	A/200 (B-128) * 100/128 (if B==0xFF, sensor is not used in trim calc)
01	1C	1	OBD standards this vehicle conforms to				Bit encoded. See below.
01	1D	1	Oxygen sensors present				Similar to PID 13, but [A0..A7] == [B1S1, B1S2, B2S1, B2S2, B3S1, B3S2, B4S1, B4S2]
01	1E	1	Auxiliary input status				A0 == Power Take Off (PTO) status (1 == active) [A1..A7] not used
01	1F	2	Run time since engine start	0	65,535	seconds	(A*256)+B
01	20	4	PIDs supported [21 - 40]				Bit encoded [A7..D0] == [PID 0x21..PID 0x40] See below.
01	21	2	Distance traveled with malfunction indicator lamp (MIL) on	0	65,535	km	(A*256)+B
01	22	2	Fuel Rail Pressure (relative to manifold vacuum)	0	5177.265	kPa	((A*256)+B) * 0.079
01	23	2	Fuel Rail Pressure (diesel, or gasoline direct inject)	0	655,350	kPa (gauge)	((A*256)+B) * 10
01	24	4	O2S1_WR_lambda(1): Equivalence Ratio Voltage	0 0	1.999 7.999	N/A V	((A*256)+B)*2/65535 or ((A*256)+B)/32768 ((C*256)+D)*8/65535 or ((C*256)+D)/8192
01	25	4	O2S2_WR_lambda(1): Equivalence Ratio Voltage	0 0	2 8	N/A V	((A*256)+B)*2/65535 ((C*256)+D)*8/65535
01	26	4	O2S3_WR_lambda(1): Equivalence Ratio Voltage	0 0	2 8	N/A V	((A*256)+B)*2/65535 ((C*256)+D)*8/65535

01	27	4	O2S4_WR_lambda(1): Equivalence Ratio Voltage	0 0	2 8	N/A V	((A*256)+B)*2/65535 ((C*256)+D)*8/65535
01	28	4	O2S5_WR_lambda(1): Equivalence Ratio Voltage	0 0	2 8	N/A V	((A*256)+B)*2/65535 ((C*256)+D)*8/65535
01	29	4	O2S6_WR_lambda(1): Equivalence Ratio Voltage	0 0	2 8	N/A V	((A*256)+B)*2/65535 ((C*256)+D)*8/65535
01	2A	4	O2S7_WR_lambda(1): Equivalence Ratio Voltage	0 0	2 8	N/A V	((A*256)+B)*2/65535 ((C*256)+D)*8/65535
01	2B	4	O2S8_WR_lambda(1): Equivalence Ratio Voltage	0 0	2 8	N/A V	((A*256)+B)*2/65535 ((C*256)+D)*8/65535
01	2C	1	Commanded EGR	0	100	%	100*A/255
01	2D	1	EGR Error	-100	99.22	%	(A-128) * 100/128
01	2E	1	Commanded evaporative purge	0	100	%	100*A/255
01	2F	1	Fuel Level Input	0	100	%	100*A/255
01	30	1	# of warm-ups since codes cleared	0	255	N/A	A
01	31	2	Distance traveled since codes cleared	0	65,535	km	(A*256)+B
01	32	2	Evap. System Vapor Pressure	-8,192	8,192	Pa	((A*256)+B)/4 (A is signed)
01	33	1	Barometric pressure	0	255	kPa (Absolute)	A
01	34	4	O2S1_WR_lambda(1): Equivalence Ratio Current	0 -128	1.999 127.99	N/A mA	((A*256)+B)/32,768 ((C*256)+D)/256 - 128
01	35	4	O2S2_WR_lambda(1): Equivalence Ratio Current	0 -128	2 128	N/A mA	((A*256)+B)/32,768 ((C*256)+D)/256 - 128
01	36	4	O2S3_WR_lambda(1): Equivalence Ratio Current	0 -128	2 128	N/A mA	((A*256)+B)/32768 ((C*256)+D)/256 - 128
01	37	4	O2S4_WR_lambda(1): Equivalence Ratio Current	0 -128	2 128	N/A mA	((A*256)+B)/32,768 ((C*256)+D)/256 - 128
01	38	4	O2S5_WR_lambda(1): Equivalence Ratio Current	0 -128	2 128	N/A mA	((A*256)+B)/32,768 ((C*256)+D)/256 - 128
01	39	4	O2S6_WR_lambda(1): Equivalence Ratio Current	0 -128	2 128	N/A mA	((A*256)+B)/32,768 ((C*256)+D)/256 - 128
01	3A	4	O2S7_WR_lambda(1): Equivalence Ratio Current	0 -128	2 128	N/A mA	((A*256)+B)/32,768 ((C*256)+D)/256 - 128

01	3B	4	O2S8_WR_lambda(1): Equivalence Ratio Current	0 -128	2 128	N/A mA	((A*256)+B)/32,768 ((C*256)+D)/256 - 128
01	3C	2	Catalyst Temperature Bank 1, Sensor 1	-40	6,513.5	°C	((A*256)+B)/10 - 40
01	3D	2	Catalyst Temperature Bank 2, Sensor 1	-40	6,513.5	°C	((A*256)+B)/10 - 40
01	3E	2	Catalyst Temperature Bank 1, Sensor 2	-40	6,513.5	°C	((A*256)+B)/10 - 40
01	3F	2	Catalyst Temperature Bank 2, Sensor 2	-40	6,513.5	°C	((A*256)+B)/10 - 40
01	40	4	PIDs supported [41 - 60]				Bit encoded [A7..D0] == [PID 0x41..PID 0x60] See below.
01	41	4	Monitor status this drive cycle				Bit encoded. See below.
01	42	2	Control module voltage	0	65.535	V	((A*256)+B)/1000
01	43	2	Absolute load value	0	25,700	%	((A*256)+B)*100/255
01	44	2	Command equivalence ratio	0	2	N/A	((A*256)+B)/32768
01	45	1	Relative throttle position	0	100	%	A*100/255
01	46	1	Ambient air temperature	-40	215	°C	A-40
01	47	1	Absolute throttle position B	0	100	%	A*100/255
01	48	1	Absolute throttle position C	0	100	%	A*100/255
01	49	1	Accelerator pedal position D	0	100	%	A*100/255
01	4A	1	Accelerator pedal position E	0	100	%	A*100/255
01	4B	1	Accelerator pedal position F	0	100	%	A*100/255
01	4C	1	Commanded throttle actuator	0	100	%	A*100/255
01	4D	2	Time run with MIL on	0	65,535	minutes	(A*256)+B
01	4E	2	Time since trouble codes cleared	0	65,535	minutes	(A*256)+B
01	4F	4	Maximum value for equivalence ratio, oxygen sensor voltage, oxygen sensor current, and intake manifold absolute pressure	0, 0, 0, 0	255, 255, 255, 2550	, V, mA, kPa	A, B, C, D*10
01	50	4	Maximum value for air flow rate from mass air flow sensor	0	2550	g/s	A*10, B, C, and D are reserved for future use
01	51	1	Fuel Type				From fuel type table see below
01	52	1	Ethanol fuel %	0	100	%	A*100/255
01	53	2	Absolute Evap system Vapour Pressure	0	327.675	kPa	1/200 per bit
01	54	2	Evap system vapor pressure	-32,767	32,768	Pa	A*256+B - 32768
01	55	2	Short term secondary oxygen sensor trim bank 1 and bank 3	-100	99.22	%	(A-128)*100/128 (B-128)*100/128
01	56	2	Long term secondary oxygen sensor trim bank 1 and bank 3	-100	99.22	%	(A-128)*100/128 (B-128)*100/128
01	57	2	Short term secondary oxygen sensor trim bank 2 and bank 4	-100	99.22	%	(A-128)*100/128 (B-128)*100/128

01	58	2	Long term secondary oxygen sensor trim bank 2 and bank 4	-100	99.22	%	(A-128)*100/128 (B-128)*100/128
01	59	2	Fuel rail pressure (absolute)	0	655,350	kPa	((A*256)+B) * 10
01	5A	1	Relative accelerator pedal position	0	100	%	A*100/255
01	5B	1	Hybrid battery pack remaining life	0	100	%	A*100/255
01	5C	1	Engine oil temperature	-40	210	°C	A - 40
01	5D	2	Fuel injection timing	-210.00	301.992	°	(((A*256)+B)-26,880)/128
01	5E	2	Engine fuel rate	0	3212.75	L/h	((A*256)+B)*0.05
01	5F	1	Emission requirements to which vehicle is designed				Bit Encoded
01	60	4	PIDs supported [61 - 80]				Bit encoded [A7..D0] == [PID 0x61..PID 0x80] See below.
01	61	1	Driver's demand engine - percent torque	-125	125	%	A-125
01	62	1	Actual engine - percent torque	-125	125	%	A-125
01	63	2	Engine reference torque	0	65,535	Nm	A*256+B
01	64	5	Engine percent torque data	-125	125	%	A-125 Idle B-125 Engine point 1 C-125 Engine point 2 D-125 Engine point 3 E-125 Engine point 4
01	65	2	Auxiliary input / output supported				Bit Encoded
01	66	5	Mass air flow sensor				
01	67	3	Engine coolant temperature				
01	68	7	Intake air temperature sensor				
01	69	7	Commanded EGR and EGR Error				
01	6A	5	Commanded Diesel intake air flow control and relative intake air flow position				
01	6B	5	Exhaust gas recirculation temperature				
01	6C	5	Commanded throttle actuator control and relative throttle position				
01	6D	6	Fuel pressure control system				
01	6E	5	Injection pressure control system				
01	6F	3	Turbocharger compressor inlet pressure				
01	70	9	Boost pressure control				
01	71	5	Variable Geometry turbo (VGT) control				
01	72	5	Wastegate control				

01	73	5	Exhaust pressure				
01	74	5	Turbocharger RPM				
01	75	7	Turbocharger temperature				
01	76	7	Turbocharger temperature				
01	77	5	Charge air cooler temperature (CACT)				
01	78	9	Exhaust Gas temperature (EGT) Bank 1				Special PID. See below.
01	79	9	Exhaust Gas temperature (EGT) Bank 2				Special PID. See below.
01	7A	7	Diesel particulate filter (DPF)				
01	7B	7	Diesel particulate filter (DPF)				
01	7C	9	Diesel Particulate filter (DPF) temperature				
01	7D	1	NOx NTE control area status				
01	7E	1	PM NTE control area status				
01	7F	13	Engine run time				
01	80	4	PIDs supported [81 - A0]				Bit encoded [A7..D0] == [PID 0x81..PID 0xA0] See below.
01	81	21	Engine run time for AECD				
01	82	21	Engine run time for AECD				
01	83	5	NOx sensor				
01	84		Manifold surface temperature				
01	85		NOx reagent system				
01	86		Particulate matter (PM) sensor				
01	87		Intake manifold absolute pressure				
01	A0	4	PIDs supported [A1 - C0]				Bit encoded [A7..D0] == [PID 0xA1..PID 0xC0] See below.
01	C0	4	PIDs supported [C1 - E0]				Bit encoded [A7..D0] == [PID 0xC1..PID 0xE0] See below.
01	C3	?	?	?	?	?	Returns numerous data, including Drive Condition ID and Engine Speed*
01	C4	?	?	?	?	?	B5 is Engine Idle Request B6 is Engine Stop Request*
02	02	2	Freeze frame trouble code				BCD encoded, See below.
03	N/A	n*6	Request trouble codes				3 codes per message frame, BCD encoded. See below.
04	N/A	0	Clear trouble codes / Malfunction indicator lamp (MIL) / Check engine light				Clears all stored trouble codes and turns the MIL off.
05	0100		OBD Monitor IDs supported ($01 – $20)				

05	0101		O2 Sensor Monitor Bank 1 Sensor 1	0.00	1.275	Volts	0.005 Rich to lean sensor threshold voltage
05	0102		O2 Sensor Monitor Bank 1 Sensor 2	0.00	1.275	Volts	0.005 Rich to lean sensor threshold voltage
05	0103		O2 Sensor Monitor Bank 1 Sensor 3	0.00	1.275	Volts	0.005 Rich to lean sensor threshold voltage
05	0104		O2 Sensor Monitor Bank 1 Sensor 4	0.00	1.275	Volts	0.005 Rich to lean sensor threshold voltage
05	0105		O2 Sensor Monitor Bank 2 Sensor 1	0.00	1.275	Volts	0.005 Rich to lean sensor threshold voltage
05	0106		O2 Sensor Monitor Bank 2 Sensor 2	0.00	1.275	Volts	0.005 Rich to lean sensor threshold voltage
05	0107		O2 Sensor Monitor Bank 2 Sensor 3	0.00	1.275	Volts	0.005 Rich to lean sensor threshold voltage
05	0108		O2 Sensor Monitor Bank 2 Sensor 4	0.00	1.275	Volts	0.005 Rich to lean sensor threshold voltage
05	0109		O2 Sensor Monitor Bank 3 Sensor 1	0.00	1.275	Volts	0.005 Rich to lean sensor threshold voltage
05	010A		O2 Sensor Monitor Bank 3 Sensor 2	0.00	1.275	Volts	0.005 Rich to lean sensor threshold voltage
05	010B		O2 Sensor Monitor Bank 3 Sensor 3	0.00	1.275	Volts	0.005 Rich to lean sensor threshold voltage
05	010C		O2 Sensor Monitor Bank 3 Sensor 4	0.00	1.275	Volts	0.005 Rich to lean sensor threshold voltage
05	010D		O2 Sensor Monitor Bank 4 Sensor 1	0.00	1.275	Volts	0.005 Rich to lean sensor threshold voltage
05	010E		O2 Sensor Monitor Bank 4 Sensor 2	0.00	1.275	Volts	0.005 Rich to lean sensor threshold voltage
05	010F		O2 Sensor Monitor Bank 4 Sensor 3	0.00	1.275	Volts	0.005 Rich to lean sensor threshold voltage
05	0110		O2 Sensor Monitor Bank 4 Sensor 4	0.00	1.275	Volts	0.005 Rich to lean sensor threshold voltage
05	0201		O2 Sensor Monitor Bank 1 Sensor 1	0.00	1.275	Volts	0.005 Lean to Rich sensor threshold voltage
05	0202		O2 Sensor Monitor Bank 1 Sensor 2	0.00	1.275	Volts	0.005 Lean to Rich sensor threshold voltage
05	0203		O2 Sensor Monitor Bank 1 Sensor 3	0.00	1.275	Volts	0.005 Lean to Rich sensor threshold voltage
05	0204		O2 Sensor Monitor Bank 1 Sensor 4	0.00	1.275	Volts	0.005 Lean to Rich sensor threshold voltage
05	0205		O2 Sensor Monitor Bank 2 Sensor 1	0.00	1.275	Volts	0.005 Lean to Rich sensor threshold voltage
05	0206		O2 Sensor Monitor Bank 2 Sensor 2	0.00	1.275	Volts	0.005 Lean to Rich sensor threshold voltage
05	0207		O2 Sensor Monitor Bank 2 Sensor 3	0.00	1.275	Volts	0.005 Lean to Rich sensor threshold voltage

05	0208		O2 Sensor Monitor Bank 2 Sensor 4	0.00	1.275	Volts	0.005 Lean to Rich sensor threshold voltage
05	0209		O2 Sensor Monitor Bank 3 Sensor 1	0.00	1.275	Volts	0.005 Lean to Rich sensor threshold voltage
05	020A		O2 Sensor Monitor Bank 3 Sensor 2	0.00	1.275	Volts	0.005 Lean to Rich sensor threshold voltage
05	020B		O2 Sensor Monitor Bank 3 Sensor 3	0.00	1.275	Volts	0.005 Lean to Rich sensor threshold voltage
05	020C		O2 Sensor Monitor Bank 3 Sensor 4	0.00	1.275	Volts	0.005 Lean to Rich sensor threshold voltage
05	020D		O2 Sensor Monitor Bank 4 Sensor 1	0.00	1.275	Volts	0.005 Lean to Rich sensor threshold voltage
05	020E		O2 Sensor Monitor Bank 4 Sensor 2	0.00	1.275	Volts	0.005 Lean to Rich sensor threshold voltage
05	020F		O2 Sensor Monitor Bank 4 Sensor 3	0.00	1.275	Volts	0.005 Lean to Rich sensor threshold voltage
05	0210		O2 Sensor Monitor Bank 4 Sensor 4	0.00	1.275	Volts	0.005 Lean to Rich sensor threshold voltage
09	00	4	mode 9 supported PIDs 01 to 20				Bit encoded
09	01	1x5	VIN Message Count in command 09 02				Returns 1 line/packet (49 01 05 00 00 00 00), where 05 means 05 packets will be returned in VIN digits.
09	02	5x5	Vehicle identification number (VIN)				Returns the VIN as a multi-frame response using the ISO 15765-2 protocol. This is typically five frames, with the first frame encoding the size and count.
09	04	varies	calibration ID				Returns multiple lines, ASCII coded
09	06	4	calibration				

In the formula column, letters A, B, C, etc. represent the decimal equivalent of the first, second, third, etc. bytes of data. Where a (?) appears, contradictory or incomplete information was available. Someone with a copy of the 2006 SAE HS-3000 should fact-check these.

Bitwise encoded PIDs

Some of the PIDs in the above table cannot be explained with a simple formula. A more elaborate explanation of these data is provided here:

Mode 1 PID 00: A request for this PID returns 4 bytes of data. The four bytes are giving information about which of the next 32 PIDs are supported. The response can be decoded like this: If the car response is BE 1F A8 13, then transform that in binary.

```
                B    E    1    F    A    8    1       3
               ---- ---- ---- ---- ---- ---- ----  ----------
supported?     1011 1110 0001 1111 1010 1000 0001   0  0  1  1
PID num        1234 5678 .... .... .... .... .... 29 30 31 32
```

0 = not supported

1 = supported

Mode 1 PID 01: A request for this PID returns 4 bytes of data.

The first two bytes are identical for both spark ignition (Gasoline) and compression ignition (Diesel) engines. The third and fourth bytes are to be interpreted differently depending on if the engine is spark ignition or compression ignition. In the second (B) byte, bit 3 tells you which way to interpret the C and D bytes, with 0 being spark and 1 (set) being compression.

The first byte contains two pieces of information. Bit A7 (the eighth bit of byte A, the first byte) indicates whether or not the MIL (check engine light) is illuminated. Bits A0 through A6 represent the number of diagnostic trouble codes currently flagged in the ECU. The second, third, and fourth bytes give information about the availability and completeness of certain on-board tests. Note that test availability signified by set (1) bit; completeness signified by reset (0) bit:

Bit	Name	Definition
A0-A6	DTC_CNT	Number of confirmed emissions-related DTCs available for display.
A7	MIL	Off or On, indicates if the CEL/MIL is on (or should be on)
B3	NO NAME	0 = Spark ignition monitors supported 1 = Compression ignition monitors supported
B7	RESERVED	RESERVED

Here are the common bit B definitions, they're test based.

```
                 Test available      Test incomplete
Misfire                B0                  B4
Fuel System            B1                  B5
Components             B2                  B6
```

The byte C and D spark ignition monitors:

```
                 Test available      Test incomplete
Catalyst               C0                  D0
Heated Catalyst        C1                  D1
Evaporative System     C2                  D2
Secondary Air System   C3                  D3
A/C Refrigerant        C4                  D4
Oxygen Sensor          C5                  D5
Oxygen Sensor Heater   C6                  D6
EGR System             C7                  D7
```

And the byte C and D compression ignition monitors:

```
                 Test available      Test incomplete
NMHC Cat               C0                  D0
NOx/SCR Monitor        C1                  D1
Boost Pressure         C3                  D3
Exhaust Gas Sensor     C5                  D5
PM filter monitoring   C6                  D6
EGR and/or VVT System  C7                  D7
```

NMHC *may* stand for non-methane hydrocarbons catalyst, but J1979 does not enlighten us.

Mode 1 PID 03: A request for this PID returns 2 bytes of data. The first byte describes fuel system #1. Only one bit should ever be set.

```
A0     Open loop due to insufficient engine temperature
A1     Closed loop, using oxygen sensor feedback to determine fuel mix
A2     Open loop due to engine load OR fuel cut due to deceleration
A3     Open loop due to system failure
A4     Closed loop, using at least one oxygen sensor but there is a fault in the feedback system
A5-A7  Always zero
```

The second byte describes fuel system #2 (if it exists) and is encoded identically to the first byte.

Mode 1 PID 12: A request for this PID returns a single byte of data which describes the secondary air status. Only one bit should ever be set.

```
A0     Upstream of catalytic converter
A1     Downstream of catalytic converter
A2     From the outside atmosphere or off
A3-A7  Always zero
```

Mode 1 PID 1C: A request for this PID returns a single byte of data which describes which OBD standards this ECU was designed to comply with. The hexadecimal and binary representations of the data byte are shown below next to what it implies:

```
0x01  00000001b    OBD-II as defined by the CARB
0x02  00000010b    OBD as defined by the EPA
0x03  00000011b    OBD and OBD-II
0x04  00000100b    OBD-I
0x05  00000101b    Not meant to comply with any OBD standard
0x06  00000110b    EOBD (Europe)
0x07  00000111b    EOBD and OBD-II
0x08  00001000b    EOBD and OBD
0x09  00001001b    EOBD, OBD and OBD II
0x0A  00001010b    JOBD (Japan)
0x0B  00001011b    JOBD and OBD II
0x0C  00001100b    JOBD and EOBD
0x0D  00001101b    JOBD, EOBD, and OBD II
```

Mode 1 PID 41: A request for this PID returns 4 bytes of data. The first byte is always zero. The second, third, and fourth bytes give information about the availability and completeness of certain on-board tests. Note that test availability signified by set (1) bit; completeness signified by reset (0) bit:

```
                  Test enabled       Test incomplete
Misfire                B0                  B4
Fuel System            B1                  B5
Components             B2                  B6
Reserved               B3                  B7
Catalyst               C0                  D0
Heated Catalyst        C1                  D1
Evaporative System     C2                  D2
Secondary Air System   C3                  D3
A/C Refrigerant        C4                  D4
Oxygen Sensor          C5                  D5
Oxygen Sensor Heater   C6                  D6
```

```
EGR System              C7                    D7
```

Mode 3: (no PID required) A request for this mode returns a list of the DTCs that have been set. The list is encapsulated using the ISO 15765-2 protocol.

If there are two or fewer DTC's (4 bytes) they are returned in an ISO-TP Single Frame (SF). Three or more DTCs in the list are reported in multiple frames, with the exact count of frames dependent on the communication type and addressing details.

Each trouble code requires 2 bytes to describe. The text description of a trouble code may be decoded as follows. The first character in the trouble code is determined by the first two bits in the first byte:

```
A7 A6    First DTC character
-- --    -------------------
 0  0    P - Powertrain
 0  1    C - Chassis
 1  0    B - Body
 1  1    U - Network
```

The four following digits are BCD encoded.

The second character in the DTC is a number defined by

```
A5 A4    Second DTC character
-- --    --------------------
 0  0    0
 0  1    1
 1  0    2
 1  1    3
```

The third character in the DTC is a number defined by

```
A3 A2 A1 A0    Third DTC character
-- -- -- --    -------------------
 0  0  0  0    0
 0  0  0  1    1
 0  0  1  0    2
 0  0  1  1    3
 0  1  0  0    4
 0  1  0  1    5
 0  1  1  0    6
 0  1  1  1    7
 1  0  0  0    8
 1  0  0  1    9
 1  0  1  0    A
 1  0  1  1    B
 1  1  0  0    C
 1  1  0  1    D
 1  1  1  0    E
 1  1  1  1    F
```

The fourth and fifth characters are defined in the same way as the third, but using bits B7..B4 and B3..B0. The resulting five-character code should look something like "U0158" and can be looked up in a table of OBD-II DTCs.

Hexadecimal characters (0-9,A-F), while relatively rare, are allowed in the last 3 positions of the code itself.

Fuel Type Coding

Mode 1 PID 0x51 returns a value from an enumerated list giving the fuel type of the vehicle. The fuel type is returned as a single byte, and the value is given by

```
01    Gasoline
02    Methanol
03    Ethanol
04    Diesel
05    LPG
06    CNG
07    Propane
08    Electric
09    Bifuel running Gasoline
0A    Bifuel running Methanol
0B    Bifuel running Ethanol
0C    Bifuel running LPG
0D    Bifuel running CNG
0E    Bifuel running Prop
0F    Bifuel running Electricity
10    Bifuel mixed gas/electric
11    Hybrid gasoline
12    Hybrid Ethanol
13    Hybrid Diesel
14    Hybrid Electric
15    Hybrid Mixed fuel
16    Hybrid Regenerative
```

Special PIDs

Some PIDs are to be interpreted specially, and aren't necessarily exactly "bitwise encoded"

Mode 1 PID 78

A request for this PID will return 9 bytes of data. The first byte is a bit encoded field indicating which sensors are supported:

```
                    Sensor Supported
EGT11                    A0
EGT12                    A1
EGT13                    A2
EGT14                    A3
Reserved                 A4
Reserved                 A5
Reserved                 A6
Reserved                 A7
```

The remaining bytes are 16 bit integers indicating the temperature in Degrees celsius in the range -40 to 6513.5 (scale 0.1) using the usual ((A*256)+B)-40 formula.

Mode 1 PID 79

A request for this PID will return 9 bytes of data. See Mode 1 PID 78 (above) for a description.

Non-standard PIDs

The majority of all OBD-II PIDs in use are non-standard. For most modern vehicles, there are many more functions supported on the OBD-II interface than are covered by the standard PIDs, and there is relatively minor overlap between vehicle manufacturers for these non-standard PIDs.

AutoEnginuity, who manufactures OBD-II scan tools, provides the following example on their website[2]:

> Although Ford does implement the largest subset of the OBDII standard, the typical vehicle only supports 20 - 40 [standard] sensors and is limited to the emissions powertrain. Using the enhanced Ford interface, a typical Ford vehicle will support 200 - 300 sensors within half a dozen systems; that's essential systems such as ABS, airbags, GEM, ICM, etc.
>
> Our enhanced Ford interface coverage is only matched by factory tools; we have support for 3,400+ [Ford] sensors selected from all 58 [Ford] systems.

There is very limited information available in the public domain for non-standard PIDs. The primary source of information on non-standard PIDs across different manufacturers is maintained by the US-based Equipment and Tool Institute and only available to members. The price of ETI membership for access to scan codes starts from US $7500[3]

However, even ETI membership will not provide full documentation for non-standard PIDs. ETI state[3]

> Some OEMs refuse to use ETI as a one-stop source of scan tool information. They prefer to do business with each tool company separately. These companies also require that you enter into a contract with them. The charges vary but here is a snapshot of today's per year charges as we know them:
>
> GM $50,000
> Honda $5,000
> Suzuki $1,000
> BMW $7,000 plus $1,000 per update. Updates occur every quarter. (This is more now, but do not have exact number)

CAN (11-bit) Bus format

The PID query and response occurs on the vehicle's CAN Bus. Standard OBD requests and responses use functional addresses. The diagnostic reader initiates a query using CAN ID 0x7DF, which acts as a broadcast address, and accepts responses from any ID in the range 0x7E8 to 0x7EF. ECUs that can respond to OBD queries listen both to the functional broadcast ID of 0x7DF and one assigned ID in the range 0x7E0 to 0x7E7. Their response has an ID of their assigned ID plus 8 e.g. 0x7E8 through 0x7EF.

This approach allows up to eight ECUs, each independently responding to OBD queries. The diagnostic reader can use the ID in the ECU response frame to continue communication with a specific ECU. In particular, multi-frame communication requires a response to the specific ECU ID rather than to ID 0x7DF.

CAN bus may also be used for communication beyond the standard OBD messages. Physical addressing uses particular CAN IDs for specific modules (e.g., 720 for the instrument cluster in Fords) with proprietary frame payloads.

Query

The functional PID query is sent to the vehicle on the CAN bus at ID 7DFh, using 8 data bytes. The bytes are:

Byte ->	_ 0 _	_ 1 _	_ 2 _	_ 3 _	_ 4 _	_ 5 _	_ 6 _	_ 7 _
SAE Standard	Number of additional data bytes: 2	Mode 01 = show current data; 02 = freeze frame; etc.	PID code (e.g.: 05 = Engine coolant temperature)	not used (may be 55h)				
Vehicle specific	Number of additional data bytes: 3	Custom mode: (e.g.: 22 = enhanced data)	PID code (e.g.: 4980h)		not used (may be 00h or 55h)			

Response

The vehicle responds to the PID query on the CAN bus with message IDs that depend on which module responded. Typically the engine or main ECU responds at ID 7E8h. Other modules, like the hybrid controller or battery controller in a Prius, respond at 07E9h, 07EAh, 07EBh, etc. These are 8h higher than the physical address the module responds to. Even though the number of bytes in the returned value is variable, the message uses 8 data bytes regardless. The bytes are:

Byte ->	_ 0 _	_ 1 _	_ 2 _	_ 3 _	_ 4 _	_ 5 _	_ 6 _	_ 7 _
SAE Standard 7E8h, 7E9h, 7EAh, etc.	Number of additional data bytes: 3 to 6	Custom mode Same as query, except that 40h is added to the mode value. So: 41h = show current data; 42h = freeze frame; etc.	PID code (e.g.: 05 = Engine coolant temperature)	value of the specified parameter, byte 0	value, byte 1 (optional)	value, byte 2 (optional)	value, byte 3 (optional)	not used (may be 00h or 55h)
Vehicle specific 7E8h, or 8h + physical ID of module.	Number of additional data bytes: 4to 7	Custom mode: same as query, except that 40h is added to the mode value.(e.g.: 62h = response to mode 22h request)	PID code (e.g.: 4980h)		value of the specified parameter, byte 0	value, byte 1 (optional)	value, byte 2 (optional)	value, byte 3 (optional)
Vehicle specific 7E8h, or 8h + physical ID of module.	Number of additional data bytes: 3	7Fh this a general response usually indicating the module doesn't recognize the request.	Custom mode: (e.g.: 22h = enhanced diagnostic data by PID, 21h = enhanced data by offset)	31h	not used (may be 00h)			

References

[1] http://www.eaa-phev.org/wiki/Escape_PHEV_TechInfo#PIDs
[2] "AutoEnginuity's Scan Tool - Enhanced interface for Ford" (http://www.autoenginuity.com/products-software.html#EI01). . Retrieved 30 September 2009.
[3] "ETI Full Membership FAQ" (http://www.etools.org/files/public/Full_Member_FAQ.htm). . Retrieved 30 September 2009.showing cost of access to OBD-II PID documentation

External links

- OBD-II Codes Definition (http://www.obd-2-codes.com/) OBD-II codes definition, description and repair information.
- (http://www.permoveo.ltd.uk/TechnicalResources.aspx) OBD code definitions, including manufacture codes.
- (http://www.motorstate.com.ua/a/31998L0069.htm) Directive 98/69/EC of the European Parliament and of the Council of 13 October 1998.
- CAN Bus Vehicles (http://www.auterraweb.com/aboutcan.html), make, model and year vehicles that support OBD II CAN bus
- Fault Code Examples (http://kbmsystems.net/files/Engine ECU Fault Code Reading with OBDKey.pdf) Sample fault code data read using the OBDKey Bluetooth, OBDKey USB and OBDKey WLAN vehicle interface units.

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