教育部顧問室
資通訊科技人才培育先導型計畫
車載資通訊嵌入式系統
種子教師培訓研討會

•車上診斷系統

主講人:
南台科技大學資訊工程系
吳建中 教授

Outline

- Products
- On-Board Diagnostic
  - OBD, OBD-I, OBD-II, OBD-III
  - EOBD
- Support Protocol
  - CAN, VPW, PWM, ISO, KWP
    After 2008, CAN only
- Protocol
- Hardware
- Software
- Applications

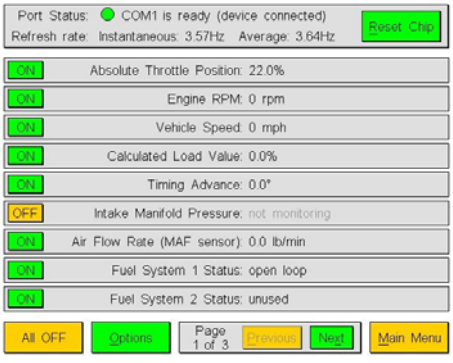
PC Type (USB)

ScanGaugeII by Linear-Logic

Ref ：http://www.scantool.net/products/product_info.php?cPath=8&products_id=32

PC Type (USB)

ELM 327 OBD2



Stand-alone Type

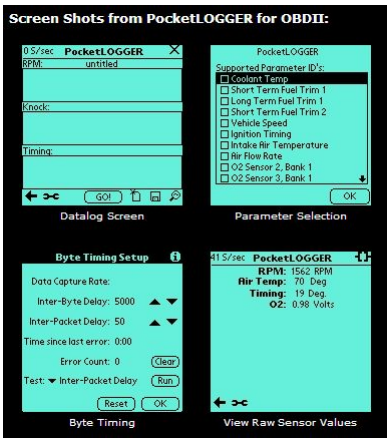
Ref ：http://www.scantool.net/products/product_info.php?cPath=8&products_id=32

PDA Type

Pocket LOGGER for OBDII

A Compatible Palm OS PDA

A Serial Hotsync cable for your PDA



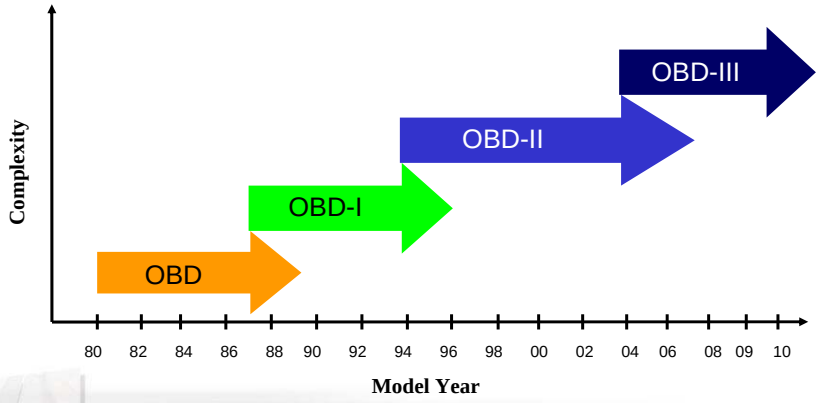
Ref ：http://www.pocketlogger.com/index.php?pid=plobdii_ss

CAN ODBII

D91汽車診斷儀器
BENZ BMW VW AUDI (AUTOLAND)

History of ODB

– On-Board Diagnostics (OBD) U.S. timetable



EOBD

- EOBD is a version of OBD-II required in Europe since Model Year 2004 for diesel vehicles and since 2001 for gasoline vehicles

OBD II Support Protocol

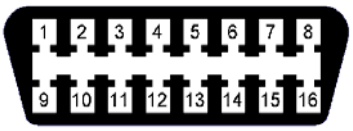
Protocol	Speed
J1850 PWM	41.6 kbaud
J1850 VPW	10.4 kbaud
ISO KWP	5 baud init, 10.4 kbaud
ISO KWP	fast init, 10.4 kbaud
ISO CAN	11 bit ID, 500 kbaud
ISO CAN	29 bit ID, 500 kbaud
ISO CAN	11 bit ID, 250 kbaud
ISO CAN	29 bit ID, 250 kbaud
ISO 9141-2	5 baud init, 10.4 kbaud

ISO 11898-x (road vehicles)

ISO 11898-1	data link, physical signaling
ISO 11898-2	high-speed medium access unit
ISO 11898-3	low-speed fault-tolerant medium-dependent interface
ISO 11898-4	time-triggered CAN
ISO 11898-5	relates to high-speed CAN and low-power applications

Pin definitions of OBDII Connector

OBDII Connector



Pin 2 - J1850 Bus+
Pin 4 - Chassis Ground
Pin 5 - Signal Ground
Pin 6 - CAN High (J-2284)
Pin 7 - ISO 9141-2 K Line
Pin 10 - J1850 Bus
Pin 14 - CAN Low (J-2284)
Pin 15 - ISO 9141-2 L Line
Pin 16 - Battery Power

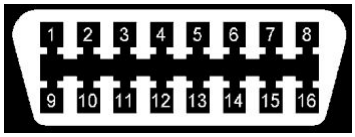
Software

Open Source Project

- ELM 323 / 327 Software Written by Lancastrian IT
- Software can download by : http://www.lancastrian-it.co.uk/component/option,com_jdownloads/Itemid,5/

Ref: http://www.lancastrian-it.co.uk/BMW/elm-323-327-software.html

ELM327 Universal Scantool OBD2



Interface ***ECUT327USB***

Free software

- Digimoto Lite
  EasyObd II 2005 **Version 1.0 by EasyObdII.com - Steve Duddridge**
  GM Mode 22 Scan Tool **by Terry**
  OBD Gauge **for PalmOS and Pocket PC by Dana Peters**

- OBD Logger **by Jonathan Senkerik**
  OBD-II ScanMaster **by Wladimir Gurskij**
  obd2crazy.com
  OBD2 Scantool **by Ivan Andrewjeski**
  OBDII for ELM322 **by David Huffman**
  pyOBD **by Donour Sizemore for MacOSX and Linux**
  RDDTC **for the PocketPC byPete Calinski**
  Real Scan **by Brent Harris**
  ScanTest **for Pocket PC by Ivan Ganev aka a-ser**
  Servertec ScanTool Communications Gateway (Java)
  wOBD **by WDT**

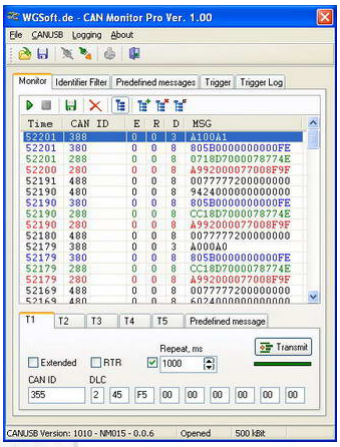
Ref: http://www.lancastrian-it.co.uk/BMW/elm-323-327-software.html

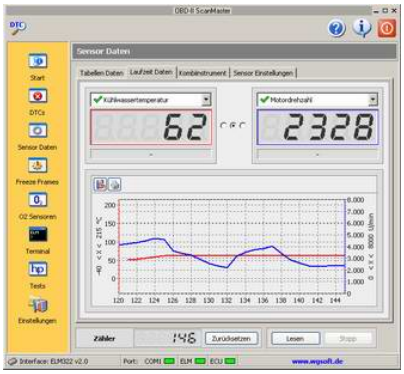
Non-free software

Digimoto
ElmOScan
OBD2Spy
PCMSCAN
ProScan
SoftDavid (in Spanish)
VitalScan

Ref: http://www.lancastrian-it.co.uk/BMW/elm-323-327-software.html

OBD-II ScanMaster



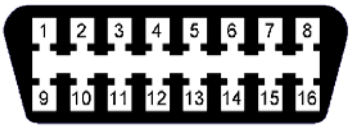


Ref ： http://www.wgsoft.de/

Hardware

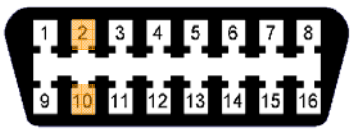
OBD-II Diagnostic connector

1. -
2. Bus positive Line of SAE-J1850
3. - Ford DCL(+) Argentina, Brasil (pre OBD-II) 1997-2000
4. Chassis ground
5. Signal ground
6. CAN high (ISO 15765-4 and SAE-J2234)
7. K line of ISO 9141-2 and ISO 14230-4
8. -
9. -
10. Bus negative Line of SAE-J1850
11. - Ford DCL(-) Argentina, Brasil (pre OBD-II) 1997-2000
12. -
13. -
14. CAN low (ISO 15765-4 and SAE-J2234)
15. L line of ISO 9141-2 and ISO 14230-4
16. Battery voltage



SAE J1850 PWM

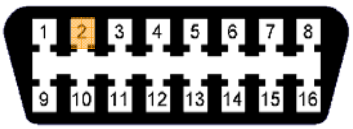
- SAE J1850 PWM (pulse-width modulation - 41.6 kbaud, standard of the Ford Motor Company)
- pin 2: Bus+
- pin 10: Bus–



- High voltage is +5 V
- Message length is restricted to 12 bytes, including CRC
- Employs a multi-master arbitration scheme called 'Carrier Sense Multiple Access with Non-Destructive Arbitration' (CSMA/NDA)

SAE J1850 VPW

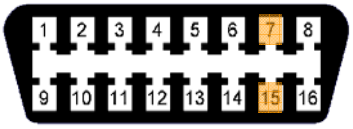
- SAE J1850 VPW (variable pulse width - 10.4/41.6 kbaud, standard of General Motors)
- pin 2: Bus+



- Bus idles low
- High voltage is +7 V
- Decision point is +3.5 V
- Message length is restricted to 12 bytes, including CRC
- Employs CSMA/NDA

ISO 9141-2

- ISO 9141-2. This protocol has a data rate of 10.4 kbaud, and is similar to RS-232. ISO 9141-2 is primarily used in Chrysler, European, and Asian vehicles.
- pin 7: K-line
- pin 15: L-line (optional)



- UART signaling (though not RS-232 voltage levels)
- K-line idles high
- High voltage is Vbatt
- Message length is restricted to 12 bytes, including CRC

ISO9141-2 on OBDII

- The ISO9141 standard
  - It specifies the requirements for setting up the *interchange of digital information* between *an on board ECU* and *a suitable diagnostic tester* to facilitate *inspection, test, diagnosis* and *adjustment* of vehicle's ECUs

ISO9141-2 on OBDII

- The ECU must have one (**K**) or two (**K** and **L**) communication connections
- Connecting lines **K** or **L** from *one or more ECUs together* results in a *bus system*
- Line **K** is defined as the line that provides information in a *serial digital form* from the *ECU to the diagnostic tester*
  - Line **K** may also be *bi-directional*, in which case it may *carry commands* or *data* form the diagnostic tester to the ECU

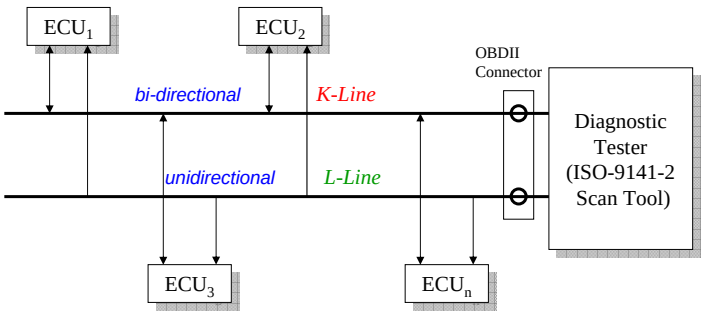
ISO9141-2 on OBDII

- Line **K** may also be used to *initialize* the serial communication
- The standard **K**-line is ISO9141 compatible for baud rates up to *250kbps*

– Line **L** is a *unidirectional* line from the diagnostic tester to the ECU
  - It may be used to *initialize* the serial communication and/or to carry commands and/or data

ISO9141-2 on OBDII

– ISO-9141-2 configuration (bus system)



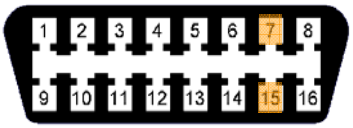
ISO9141-2 on OBDII

- ISO 9141-2 describes a subset of ISO9141
  - It specifies the requirements for setting-up the interchange of digital information between *on-board emission-related ECUs* or *road vehicles* and the *SAE OBDII scan tool*
  - It is limited to vehicles with nominal *12 V* supply voltage

ISO 14230 KWP2000

- ISO 14230 KWP2000 (Keyword Protocol 2000)

- pin 7: K-line
- pin 15: L-line (optional)

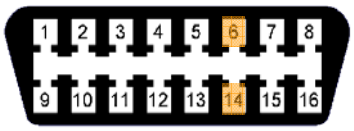


- Physical layer identical to ISO 9141-2
- Data rate 1.2 to 10.4 kbaud
- Message may contain up to 255 bytes in the data field

ISO 15765 CAN

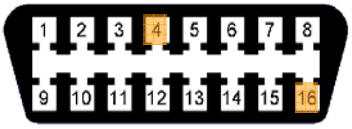
- **ISO 15765 CAN** (250 kbit/s or 500 kbit/s). The CAN protocol is a popular standard outside of the US automotive industry and is making significant in-roads into the OBD-II market share. By 2008, all vehicles sold in the US will be required to implement CAN, thus eliminating the ambiguity of the existing five signaling protocols.

- pin 6: CAN High
- pin 14: CAN Low



Ground pins

- pins 4 (battery ground) and 16 (battery positive) are present in all configurations.

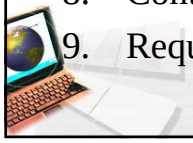


- ISO 9141 and ISO 14230 use the same pinout, thus the connector shape does not distinguish between the two.

Protocol

Nine modes of operation in ODB-II

1. Show current data
2. Show freeze frame data
3. Show stored Diagnostic Trouble Codes
4. Clear Diagnostic Trouble Codes and stored values
5. Test results, oxygen sensor monitoring
6. Test results, other component/system monitoring
7. Show pending Diagnostic Trouble Codes
8. Control operation of on-board component/system
9. Request vehicle information

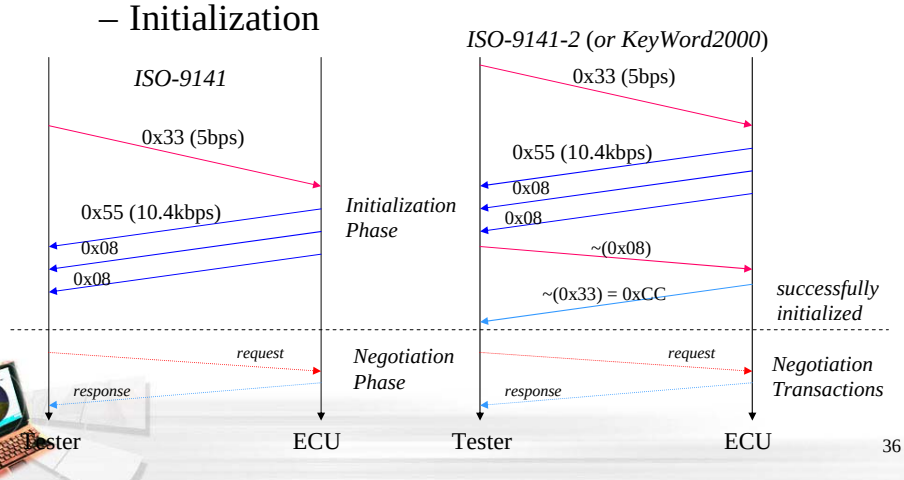


ISO9141-2 on OBDII

– Data rates
  - Wake-up (initialization) : 5 bps
  - Normal operation: 10.4kbps

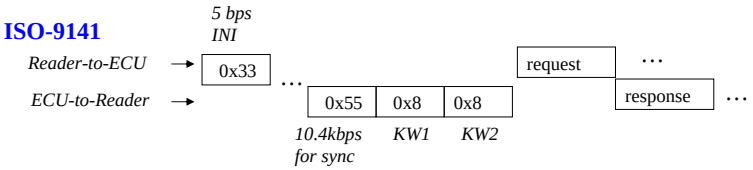
ISO9141-2 on OBDII

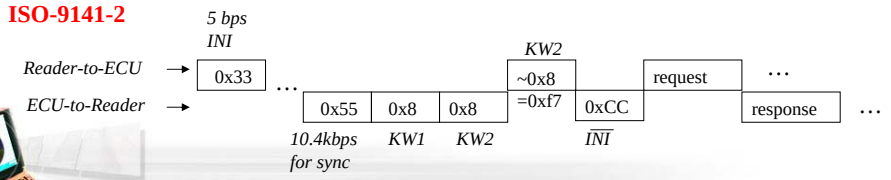
- Transactions of data link layer
  – Initialization



ISO9141-2 on OBDII

– Transaction timing





ISO9141-2 on OBDII

– Each **PID** was translated into meaningful parameter the predefined formula

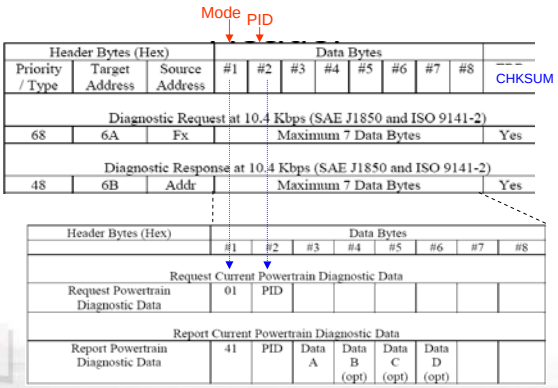
e.g., Vehicle Speed *PID* = 0x0D,

1 bytes is returned

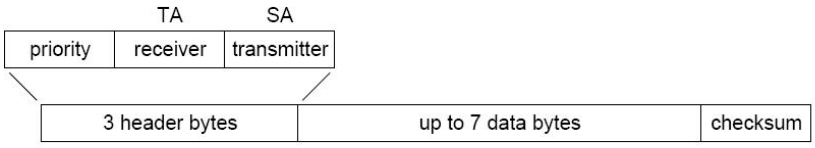
Units : *km/h*

ISO9141-2 on OBDII

- Negotiation phase
  - Request/Response packet formats

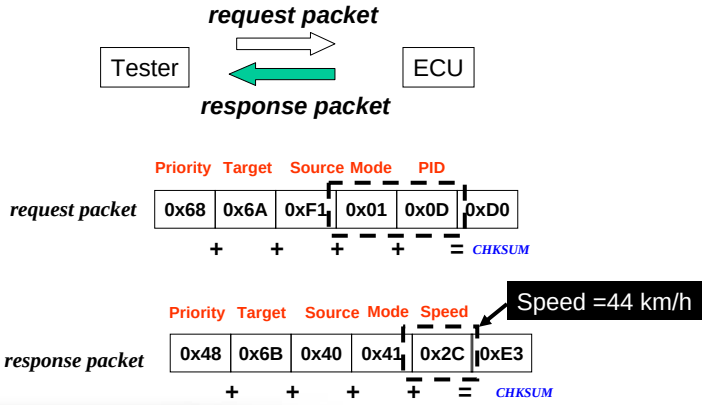


ODB-II Message



ISO9141-2 on OBDII

- Example: *request Vehicle speed*



J1939 on OBDII

- The particular characteristics of J1939
  - **29-bit** identifier (extended-identifier message)
  - Peer-to-peer and broadcast communication
  - Transport protocols for up to 1785 data bytes (255 packets)
  - Network management
  - Definition of parameter groups

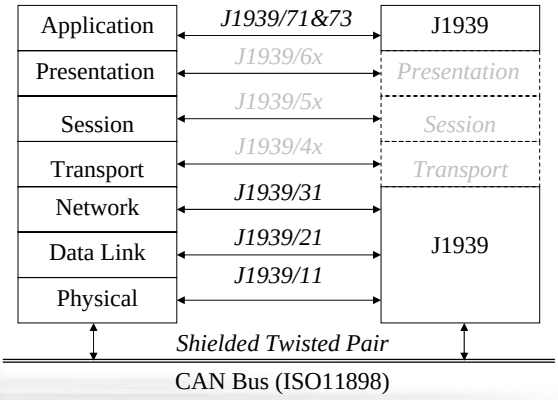
J1939 on OBDII

– Some SPN codes in *Caterpillar C7* engine

SPN-FMI	Diagnostic Code Description
100-03	Oil Pressure Sensor Open Circuit
100-04	Oil Pressure Sensor Short Circuit
100-11	Very Low Oil Pressure
102-01	Boost Pressure Reading Stuck Low
102-02	Erratic Boost Pressure
102-03	Boost Pressure Sensor Open Circuit
102-04	Boost Pressure Sensor Short Circuit
102-07	Excessive Boost Pressure

J1939 on OBDII

- OSI 7-Layer model for J1939

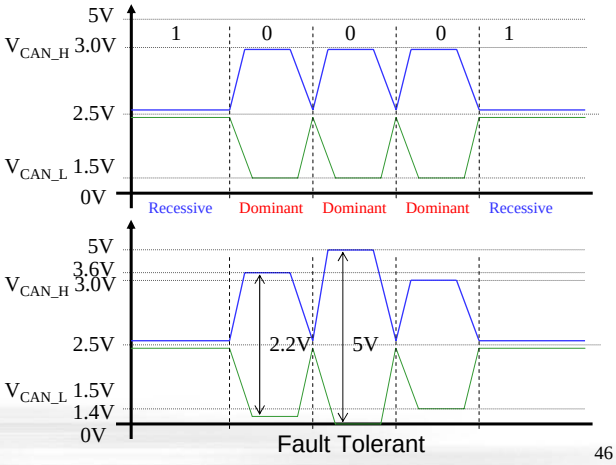


J1939 on OBDII

- J1939 main documents
  - SAE J1939 - Recommended Practice for a Serial Control & Communications
  - SAE J1939/11 - Physical Layer
  - SAE J1939/21 - Data Link Layer
  - SAE J1939/31 - Network Layer
  - SAE J1939/71 - Vehicle Application Layer
  - SAE J1939/73 - Application Layer Diagnostics – OBD
  - SAE J1939/81 - Network management Protocol

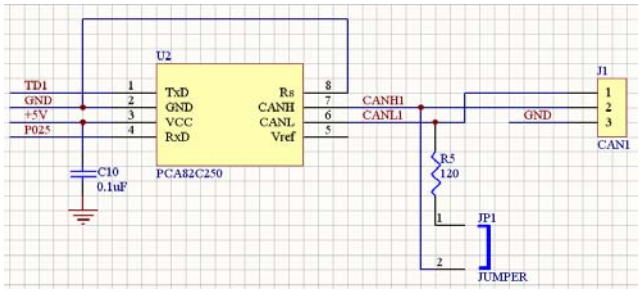
J1939 on OBDII

- The physical and data link layer
  - Signal levels



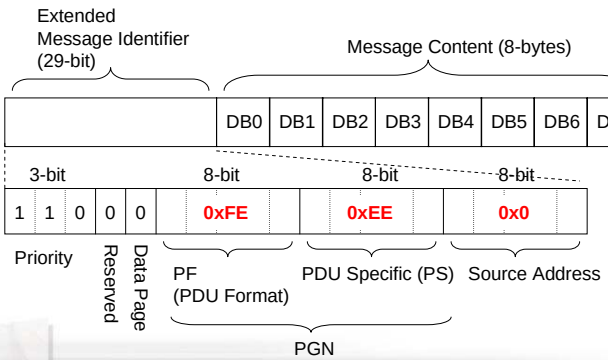
J1939 on OBDII

– Interface circuit

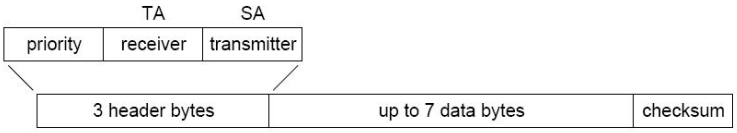


J1939 on OBDII

– CAN Message format on J1939 (extend-identifier messages)



ODB Message



J1939 on OBDII

- The PGN (Parameter Group Number) definitions
  - Parameter groups combine similar or associated *signals*
    - In the specification SAE J1939-71 the parameter groups are defined with the *signals* they contain
  - In addition, some *manufacturer-specific* parameter groups can be used

J1939 on OBDII

- Parameter groups with up to *8 data bytes* are transmitted in a CAN message
  - With more that 8 bytes, a *transport protocol* is used
- Each *parameter group* is addressed uniquely via a number (**PGN**)
  - For this number, a *16-bit value* is used that is composed of the *PDU format* and *PDU specific*

J1939 on OBDII

- There are two types of parameter group numbers:
  - **Global PGNs** for parameter groups that are sent to all (broadcast)
    - Here all 16 bits of the PGN are used ≥ *0xF0*
  - **Specific PGNs** for the parameter groups that are sent to particular devices (peer-to-peer)
    - With these PGNs, only the higher-value 8-bit (PDU format) are valid and the value must be smaller than 240 (*< 0xF0*)
    - The lower value byte (PDU specific) is always 0

J1939 on OBDII

– Sample of parameter group definition

Name:		Engine temperature (5.3.28)	
Transmission rate:		1s	
Data length:		8 bytes	
Data page:		0	
PDU format:		254 (0xEE)	
PDU specific:		238 (0xEE)	
Default priority:		6	
PGN number:		65262 (0xFEEE) → CAN Message ID = 0x18FEEE00	
Description of data:			
Byte:	**1**	Engine coolant temperature	(5.2.5.5)
	2	Fuel temperature	(5.2.5.14)
	3,4	Engine oil temperature	(5.2.5.15)
	5,6	Turbo oil temperature	(5.2.5.16)
	7	Engine intercooler temperature	(5.2.5.6)
	8	Engine intercooler thermostat opening	(5.2.5.242)

J1939 on OBDII

5.2.5.5 Engine coolant temperature –
Temperature of liquid found in engine cooling system

Data length:	1 byte
Resolution:	1 °C/bit gain, –40°C offset
Data range:	–40 to +210 °C (–40 to 410 °F)
Type:	Measured
Suspect parameter number:	110
Reference:	5.3.28

J1939 on OBDII

PGN $F004 (61,444) **Electronic Engine Controller #1 : EEC#1**

Source Address: $0 (0)
Repetition rate: 15 ms
Data Page: 0
SAE section: 5.3.7 (SAE – J1939-71)

Priority: 3
Data length: 8 Bytes
On request service: Yes

Byte	Bits	Parameter
3	8-1	Actual engine – percent torque (5.2.1.5) Resolution: 1%/Bit gain, -125% Offset Data Range: -125 – 125% $FF Not used
4-5	8-1	Engine speed (5.2.1.9) Resolution: 0.125 rpm/Bit gain, 0 rpm offset Data range: 0 – 8031.875 rpm $FFFF Not used

```
case 0xf004: // Actual engine percent torque and Engine speed
            Actual_Engine_Torque = receivedata[rx_head].MsgData.Data[2];
            Engine_Speed = receivedata[rx_head].MsgData.Data[4] * 0x100 + receivedata[rx_head].MsgData.Data[3];
```

J1939 on OBDII

- Transport protocols (for Specific PGNs)
  - Parameter groups that contain more than 8 data bytes are transmitted with a transport protocol
  - There are two special parameter groups available
    - *TP.CM* for connection management
    - *TP.DT* for the transmission of the data

J1939 on OBDII

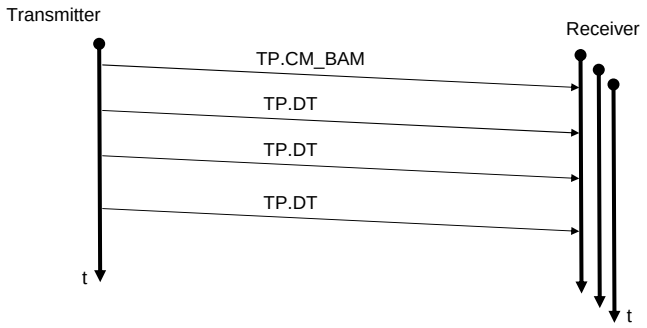
- There are two different protocols
  - Peer-to-peer
  - Broadcast transmission

J1939 on OBDII

- Broadcast transmission
  - For broadcast transmission, the **BAM** (Broadcast Announce Message) protocol (*TP.CM_BAM*) is used
  - Here, after a BAM-PGN (0xEC00) the transmitter sends all data PGs at a *minimum interval of 50ms*

J1939 on OBDII

– Transactions of broadcast transmission



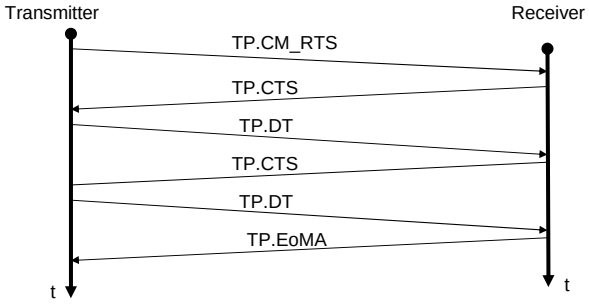
J1939 on OBDII

– Peer-to-peer transmission

- With the peer-to-peer transmission, the transmitter initiates the connection with a "request to send" (*TP.RTS*) message
- The receiver then controls the transport protocol with "clear to send" (*TP.CTS*) and "end of message acknowledge" (*TP.EoMA*)

J1939 on OBDII

– Transactions of peer-to-peer transmission



J1939 on OBDII

- The DTC (Diagnostic Trouble Code) definitions (SAE J1939-73)
  - A DTC is made up of 4 elements
    - Suspect Parameter Number (SPN) 19 bits
    - Failure Mode Identifier (FMI) 5 bits
    - Occurrence Count (OC) 7 bits
    - SPN Conversion Method (CM) 1 bit

J1939 on OBDII

DTC																													
Byte 3 (Least Significant Byte of SPN)								Byte 4 (Second Byte of SPN)								Byte 5 (3 Most Significant Bits of SPN)								Byte 6							
SPN																		FMI					CM	OC						
8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
1	0	1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0

SPN 1208 : Pre-filter oil pressure

SPN = 000 00000100 10111000 = 0x0040B8 = 1208
FMI = 00011 = 0x3 = 3
OC = 0001010 = 0xA = 10
CM = 0

```
tmp = (BAM[i+2] >> 5);
spn = tmp * 0x10000 + BAM[i+1] * 0x100 + BAM[i];
fmi = BAM[i+2] & 0x1f;
oc =  BAM[i+3] & 0x7f;
```


J1939 on OBDII

– **DM1**: Active Diagnostic Trouble Codes
  • The information communicated is limited to *the currently active DTC*

Data length:	variable
Data page:	0
PDU format:	254 (0xFE)
PDU specific:	202 (0xCA)
Default priority:	6
PGN number:	65226 (0xFECA)
Description of data:	
Byte: 1 & 2	Malfunction Indicator Lamp Status
3,4,5,6	SPN, FMI, CM, and OC

J1939 on OBDII

– Multiple DTCs
  • Broadcast Announce Message (*TP.CM_BAM*)

Data length: 8 bytes
Data page: 0
PDU format: 236 (0xEC)
PDU specific: Destination Address
Default priority: 7
PGN number: 60416 (0xEC00) →0xECFF in **Caterpillar C7**
Description of data:

Byte:		
	1	Control byte = 32
	2&3	Total message size (# Bytes)
	4	Total number of packets
	5	Reserved
	6-8	PGN of the packeted message (abcdbcdbcd…)

J1939 on OBDII

• Data Transfer (*TP.DT*)

Data length: 8 bytes
Data page: 0
PDU format: 235 (0xEC)
PDU specific: Destination Address (Global = 0xFF)
Default priority: 7
PGN number: 60160 (0xEB00) →0xEBFF in **Caterpillar C7**
Description of data:

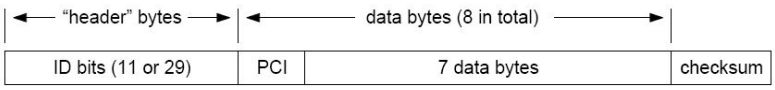
Byte:		
	1	Sequence number
	2-8	Packeted data (extra byte be filled 0xFF)

J1939 on OBDII

– Some SPN codes in *Caterpillar C7* engine

SPN-FMI	Diagnostic Code Description
100-03	Oil Pressure Sensor Open Circuit
100-04	Oil Pressure Sensor Short Circuit
100-11	Very Low Oil Pressure
102-01	Boost Pressure Reading Stuck Low
102-02	Erratic Boost Pressure
102-03	Boost Pressure Sensor Open Circuit
102-04	Boost Pressure Sensor Short Circuit
102-07	Excessive Boost Pressure

CAN ODB Message



PID query (Vehicle's CAN Bus)

- PID query ： ID=7DFh, 8 data bytes

Byte	0	1	2	3	4	5	6	7
SAE Standard	Number of additional data bytes:2	Mode	PID Code (ex:05)	Not used (maybe 55h)				
Vehicle specific	Number of additional data bytes:3	Custom mode:	PID Code (ex: 4980h)		Not used (maybe 00h or 55h)			

PID response (Vehicle's CAN Bus)

- PID response ： ID=7DFh, 8 data bytes

Byte	0	1	2	3	4	5	6	7
SAE Standard 7E8h and 7e9h or 7eah	Number of additional data bytes:2	Custom mode Same as query, except that bit 6 is set. 41: show current;	PID Code (ex:05)	Value, byte 0	Value, byte 1 (opt)	Value, byte 2 (opt)	Value, byte 3 (opt)	Not used (00h or 55h)
Vehicle specific 7e8h	Number of additional data bytes:3 to 6	Custom mode: same as query, except that bits 5 and 6 are set.(e.g.: 62 = response to mode 22 request)	PID Code (ex:4980h)		Value, byte 0	Value, byte 1 (opt)	Value, byte 2 (opt)	Value, byte 3 (opt)
Vehicle specific 7e9h	Number of additional data bytes:3	7fh	Custom code:	31h	Not used (maybe 00h)			

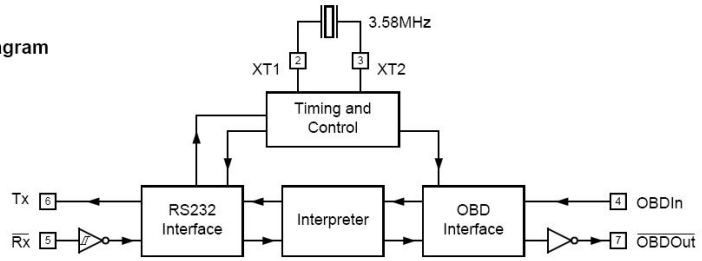
Open Source

- OBD II software ELM 327 USB is an open source project
- ELM320 : SAE J1850 PWM
- ELM322 : SAE J1850 VPW
- ELM323 : ISO9141
- ELM327=ELM320+ELM322+ELM323 interface + CAN BUS

ELM 320

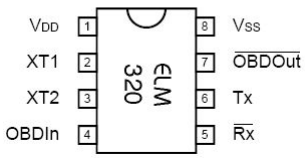
ODB (PWM) to RS-232 Interpreter

Block Diagram

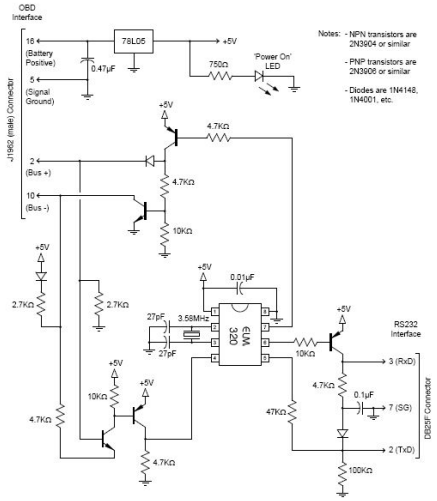


ELM 320 PINOUT

Connection Diagram
PDIP and SOIC
(top view)



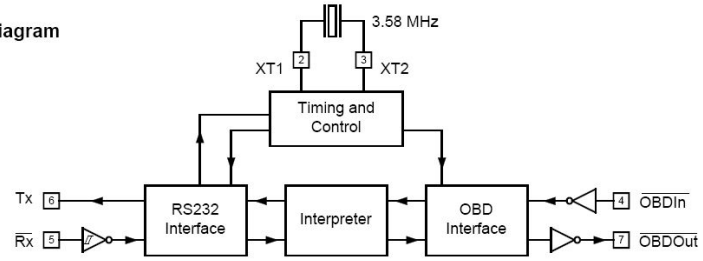
ELM320 to RS-232 Circuit



ELM 322

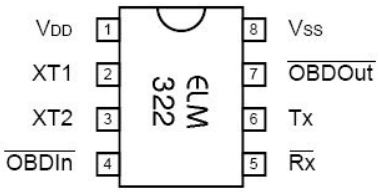
ODB (VPW) to RS-232 Interpreter

Block Diagram

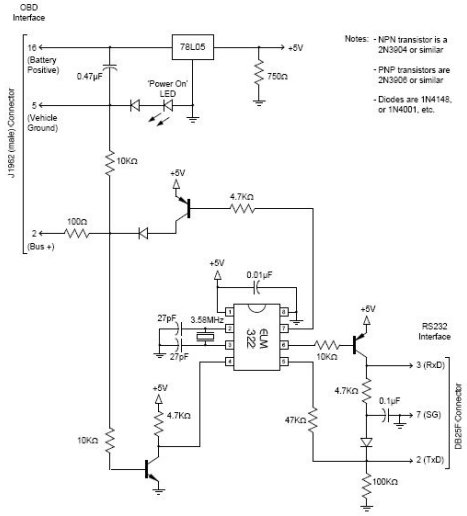


ELM 322 PINOUT

Connection Diagram
PDIP and SOIC
(top view)



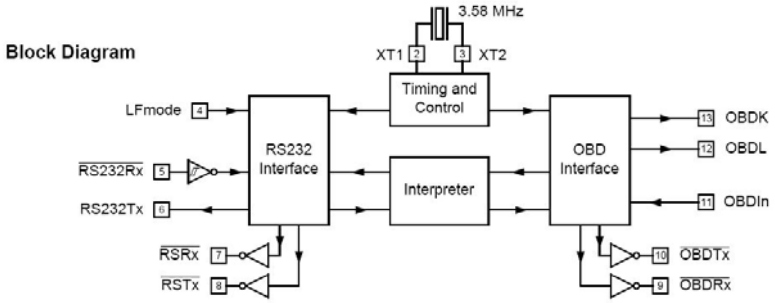
ELM322 to RS-232 Circuit



ELM 323

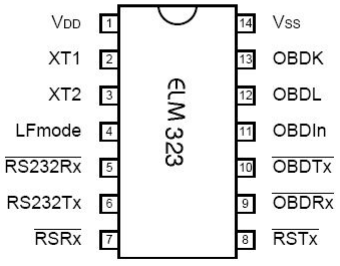
ODB (ISO) to RS-232 Interpreter

Block Diagram



ELM 323 PINOUT

Connection Diagram
PDIP and SOIC
(top view)



ELM323 to RS-232 Circuit

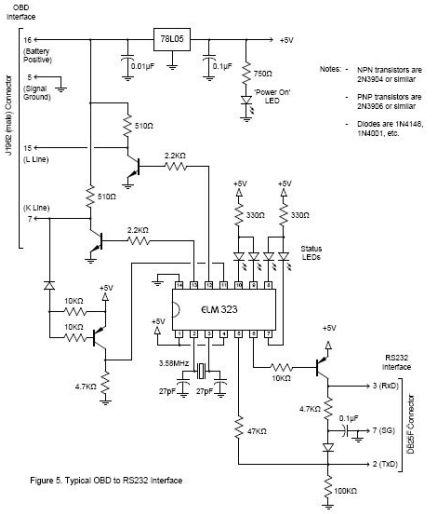


Figure 5. Typical OBD to RS232 Interface

A Simple ODB Monitor

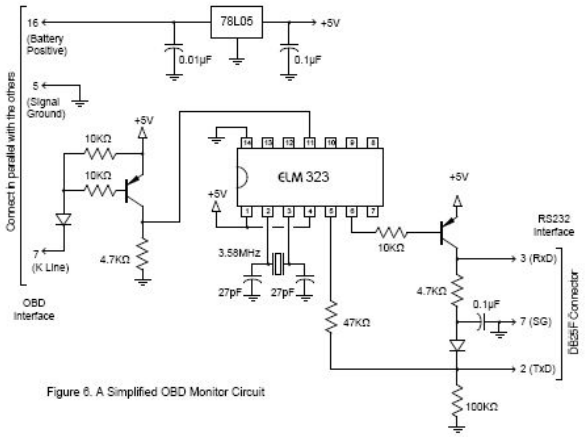
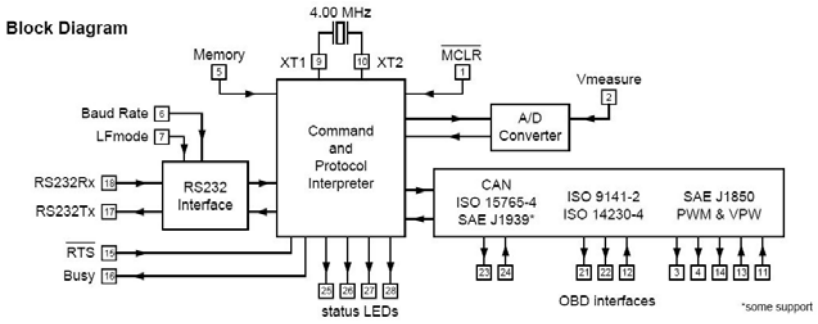


Figure 6. A Simplified OBD Monitor Circuit

ELM 327

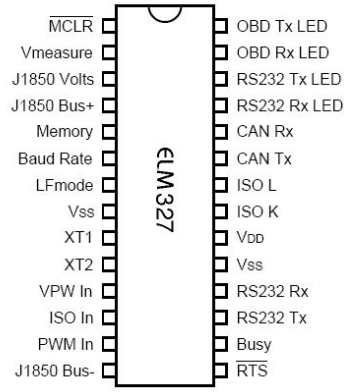
ODB to RS-232 Interpreter



ELM327 Block Diagram

ELM 327 package

Connection Diagram
PDIP and SOIC
(top view)



ELM 327 General AT Command

General Commands

<CR>	repeat the last command
BRD hh	try Baud Rate Divisor hh
BRT hh	set Baud Rate Timeout
D	set all to Defaults
E0, E1	Echo Off, or On*
I	print the version ID
L0, L1	Linefeeds Off, or On
M0, M1	Memory Off, or On
WS	Warm Start (quick software reset)
Z	reset all
@1	display the device description
@2	display the device identifier
@3 ccccccccccc	store the device identifier

Programmable Parameter Commands

PP xx OFF	disable Prog Parameter xx
PP FF OFF	all Prog Parameters Off
PP xx ON	enable Prog Parameter xx
PP FF ON	all Prog Parameters On
PP xx SV yy	for PP xx, Set the Value to yy
PPS	print a PP Summary

Voltage Reading Commands

CV dddd	Calibrate the Voltage to dd.dd volts
RV	Read the Voltage

ELM 327 ODB Command

OBD Commands

AL	Allow Long (>7 byte) messages
AR	Automatically Receive
AT0, 1, 2	Adaptive Timing Off, Auto1*, Auto2
BD	perform a Buffer Dump
BI	Bypass the Initialization sequence
DP	Describe the current Protocol
DPN	Describe the Protocol by Number
H0, H1	Headers Off*, or On
MA	Monitor All
MR hh	Monitor for Receiver = hh
MT hh	Monitor for Transmitter = hh
NL	Normal Length messages*
PC	Protocol Close
R0, R1	Responses Off, or On*
RA hh	set the Receive Address to hh
S0, S1	printing of Spaces Off, or On*
SH xyz	Set Header to xyz
SH xxyyzz	Set Header to xxyyzz
SP h	Set Protocol to h and save it
SP Ah	Set Protocol to Auto, h and save it
SR hh	Set the Receive address to hh
ST hh	Set Timeout to hh x 4 msec
TP h	Try Protocol h
TP Ah	Try Protocol h with Auto search

ELM 327 ISO Command

ISO Specific Commands (protocols 3 to 5)

IB 10	Set the ISO Baud rate to 10400*
IB 96	Set the ISO Baud rate to 9600
IIA hh	Set the ISO (slow) Init Address to hh
KW	display the Key Words
KW0, KW1	Key Word checking Off, or On*
SW hh	Set Wakeup interval to hh x 20 msec
WM [1 - 6 bytes]	Set the Wakeup Message

ELM 327 J1850 Command

J1850 Specific Commands (protocols 1 and 2)

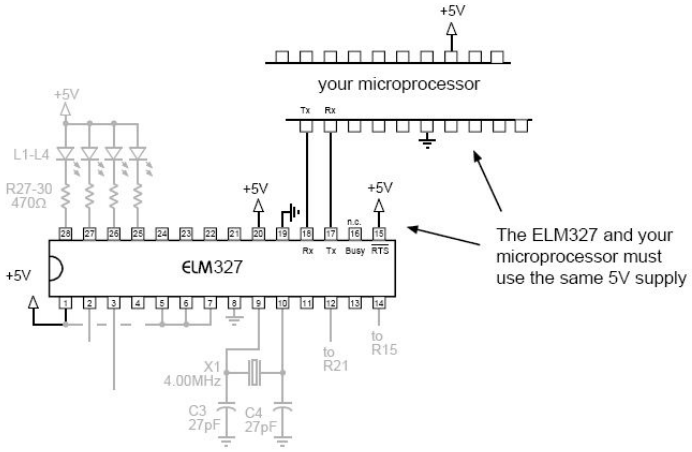
IFR0, 1, 2	IFRs Off, Auto*, or On
IFR H, S	IFR value from Header* or Source

ELM 327 J1939 CAN Command

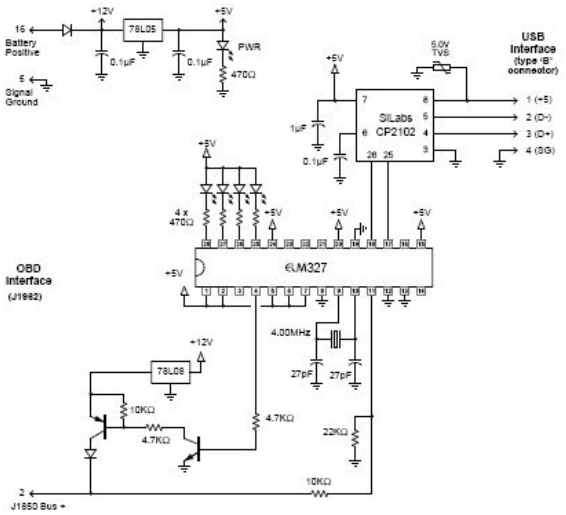
J1939 CAN Specific Commands (protocols A to C)

DM1	Monitor for DM1 messages
JE	use J1939 Elm data format*
JS	use J1939 SAE data format
MP hhhh	Monitor for PGN 0hhhh
MP hhhhhh	Monitor for PGN hhhhhh

Reference Design



J1850 VPW to USB interpreter



ELM 327 RS232 Interpreter

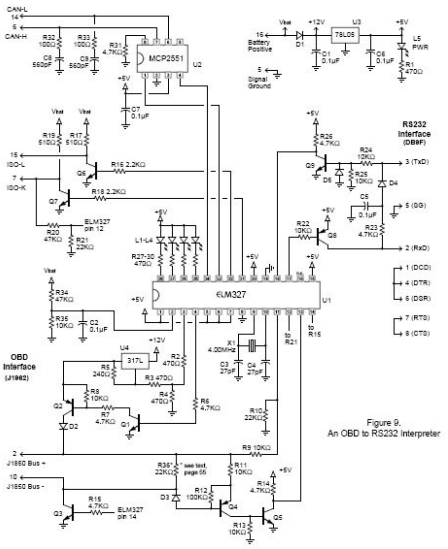


Figure 9.
An OBD to RS232 Interpreter

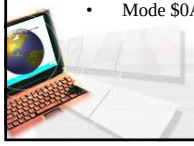
Tester

Mode of Operation

- Mode $01 is used to identify what Powertrain information is available to the scan tool.
- Mode $02 displays Freeze Frame data.
- Mode $03 lists the total number of powertrain or emission related DTC stored. It also displays exact numeric, 5 digit codes identifying the faults.
- Mode $04 is used to clear DTCs and Freeze Frame.
- Mode $05 displays the oxygen sensor monitor screen and the test results gathered about the oxygen sensor.

Ten numbers available for diagnostics

- $01 Rich-to-Lean O2 sensor threshold voltage
- $02 Lean-to-Rich O2 sensor threshold voltage
- $03 Low sensor voltage threshold for switch time measurement
- $04 High sensor voltage threshold for switch time measurement
- $05 Rich-to-Lean switch time in ms
- $06 Lean-to Rich switch time in ms
- $07 Minimum voltage for test
- $08 Maximum voltage for test
- $09 Time between voltage transitions in ms
- Mode $06 is a Request for On-Board Monitoring Test Results for Non-Continuously Monitored System. There are typically a minimum value, a maximum value, and a current value for each non-continuous monitor.
- Mode $07 is a Request for continuously Monitored Systems. This is used by service technicians after a vehicle repair, and after clearing diagnostic information to see test results after a single driving cycle to determine if the repair has fixed the problem.
- There are only three continuous monitors to be identified: fuel, misfire, and the comprehensive component.
- Mode $08 could enable the off-board test device to control the operation of an on-board system, test, or component.
- Mode $09 is used to deliver IUMPR. (In Use Monitor Performance Ratio)
- Mode $0A is required to store Permanent DTCs as per CARB.



ELM Series tester

- Using the AT command
- Using HyperTerminal

Ex:

SP h

(set protocol to h)

0 - Automatic
1 - SAE J1850 PWM (41.6 Kbaud)
2 - SAE J1850 VPW (10.4 Kbaud)
3 - ISO 9141-2 (5 baud init, 10.4 Kbaud)
4 - ISO 14230-4 KWP (5 baud init, 10.4 Kbaud)
5 - ISO 14230-4 KWP (fast init, 10.4 Kbaud)
6 - ISO 15765-4 CAN (11 bit ID, 500 Kbaud)
7 - ISO 15765-4 CAN (29 bit ID, 500 Kbaud)
8 - ISO 15765-4 CAN (11 bit ID, 250 Kbaud)
9 - ISO 15765-4 CAN (29 bit ID, 250 Kbaud)
A - SAE J1939 CAN (29 bit ID, 250* Kbaud)
B - USER1 CAN (11* bit ID, 125* Kbaud)
C - USER2 CAN (11* bit ID, 50* Kbaud)

* default settings (user adjustable)

Talking to Vehicle

- Reading Battery Voltage

>AT RV

12.5

Talking to Vehicle

EX: PID 00 is normally reserved to show which PIDs are supported by that mode.

PID=01 , mode =00

>01 00

+0x40

Respone :

41 00 BE 1F B8 10

01 - show current data
02 - show freeze frame data
03 - show diagnostic trouble codes
04 - clear trouble codes and stored values
05 - test results, oxygen sensors
06 - test results, non-continuously monitored
07 - show 'pending' trouble codes
08 - special control mode
09 - request vehicle information

1011 1110 0001 1111 1011 1000 0001 0000

Data：support BE,1F,B8,10

Talking to Vehicle

EX: requests the current engine coolant temperature (ECT).

PID=05 , mode =01

>01 05

+0x40

Respone :

41 05 7B

0x7B=7x16+11=123

123-40=83℃

01 - show current data
02 - show freeze frame data
03 - show diagnostic trouble codes
04 - clear trouble codes and stored values
05 - test results, oxygen sensors
06 - test results, non-continuously monitored
07 - show 'pending' trouble codes
08 - special control mode
09 - request vehicle information

PID, Mode

Mode (hex)	PID (hex)	Data bytes returned	Description	Min value	Max value	Units	Formula
01	00	4	PIDs supported				Bit encoded [A7..D0] == [PID 0x01..PID 0x20]
01	01	4	Monitor status since DTCs cleared. (Includes malfunction indicator lamp (MIL) status and number of DTCs.)				Bit encoded. See below.
01	02	8	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 (Rich)	99.22 (Lean)	%	(A-128) * 100/128
01	07	1	Long term fuel % trim—Bank 1	-100 (Rich)	99.22 (Lean)	%	(A-128) * 100/128

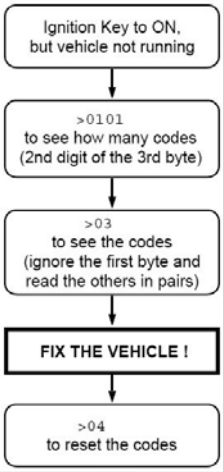
REF: http://en.wikipedia.org/wiki/OBD-II_PIDs

PID, Mode

Mode (hex)	PID (hex)	Data bytes returned	Description	Min value	Max value	Units	Formula
01	08	1	Short term fuel % trim—Bank 2	-100 (Rich)	99.22 (Lean)	%	(A-128) * 100/128
01	09	1	Long term fuel % trim—Bank 2	-100 (Rich)	99.22 (Lean)	%	(A-128) * 100/128
01	0A	1	Fuel pressure	0	765	kPa (gauge)	A*3
01	0B	1	Intake manifold 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

REF: http://en.wikipedia.org/wiki/OBD-II_PIDs

Quick Guide for Reading Trouble Codes



SAE standards documents on OBD-II

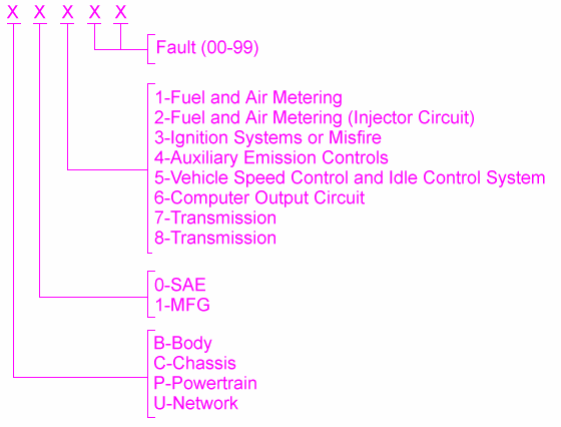
- J1962 - Defines the physical connector used for the OBD-II interface.
- J1850 - Defines a serial data protocol. There are 2 variants- **10.4 kbit/s (single wire, VPW) and 41.6 kbit/s (2 wire, PWM).** Mainly used by US manufacturers, also known as PCI (Chrysler, 10.4K), Class 2 (GM, 10.4K), and SCP (Ford, 41.6K)
- J1978 - Defines minimal operating standards for OBD-II scan tools
- J1979 - Defines standards for diagnostic test modes
- J2012 - Defines standards trouble codes and definitions.
- J2178-1 - Defines standards for network message header formats and physical address assignments
- J2178-2 - Gives data parameter definitions
- J2178-3 - Defines standards for network message frame IDs for single byte headers
- J2178-4 - Defines standards for network messages with three byte headers*
- J2284-3 - Defines 500K CAN Physical and Data Link Layer

ISO standards

- **ISO 9141: Road vehicles — Diagnostic systems**. International Organization for Standardization, 1989.
- Part 1: Requirements for interchange of digital information
- Part 2: CARB requirements for interchange of digital information
- Part 3: Verification of the communication between vehicle and OBD II scan tool
- **ISO 11898: Road vehicles — Controller area network (CAN).** International Organization for Standardization, 2003.
- Part 1: Data link layer and physical signalling
- Part 2: High-speed medium access unit
- Part 3: Low-speed, fault-tolerant, medium-dependent interface
- Part 4: Time-triggered communication
- ISO 14230: Road vehicles — Diagnostic systems — **Keyword Protocol 2000**, International Organization for Standardization, 1999.
- Part 1: Physical layer
- Part 2: Data link layer
- Part 3: Application layer
- Part 4: Requirements for emission-related systems
- **ISO 15765: Road vehicles — Diagnostics on Controller Area Networks (CAN).** International Organization for Standardization, 2004.
- Part 1: General information
- Part 2: Network layer services
- Part 3: Implementation of unified diagnostic services (UDS on CAN)
- Part 4: Requirements for emissions-related systems

Anatomy of the DTC

- **A DTC is made up of 5 digits. The figure below demonstrates the composition of a DTC. With this information it is easier to trouble shoot a DTC without knowing the description of the code.**



First Character — **System**

Interpretation of DTC's data bytes

Each DTC consists of five parts within a pair of data bytes (AB, CD, EF)

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

Second Digit –Code Type

A5	A4	Second DTC digit
0	0	Generic
0	1	Enhance (manufacturer specific)
1	0	undefined
1	1	undefined

Third Digit — **Sub-System**

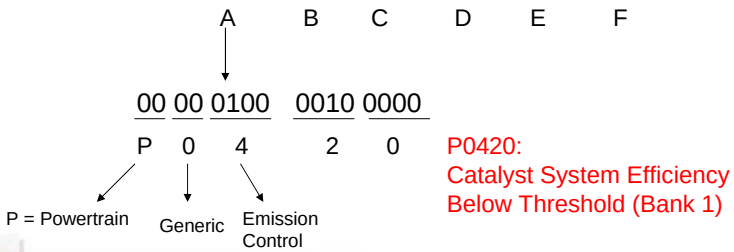
A3	A2	A1	A0	Third DTC digit
0	**0**	**0**	**0**	SAE Reserved
0	**0**	**0**	**1**	Emission Management (Fuel or Air)
0	**0**	**1**	**0**	Injector Circuit (Fuel or Air)
0	**0**	**1**	**1**	Ignition or Misfire
0	**1**	**0**	**0**	Emission Control
0	**1**	**0**	**1**	Vehicle Speed & Idle Control
0	**1**	**1**	**0**	Computer & Output Circuit
0	**1**	**1**	**1**	Transmission
1	**0**	**0**	**0**	Transmission
1	**0**	**0**	**1**	SAE Reserved

Fourth and Fifth — Digits

Fourth and Fifth — Digits are variable, and relate to a particular problem

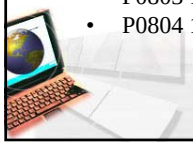
e.g., the response of Mode 3 request

0x04 0x20 0x00 0x00 0x00 0x00



OBD II Standard Fault Codes

- P01XX Fuel and Air Metering
- P0100 Mass or Volume Air flow Circuit Malfunction
- P0101 Mass or Volume Air flow Circuit Range/Performance Problem
- P0102 Mass or Volume Air Flow Circuit low Input P0103 Mass or Volume Air flow Circuit High Input P0104 Mass or Volume Air flow Circuit Intermittent
- P0105 Manifold Absolute Pressure/Barometric Pressure Circuit Malfunction
- P0106 Manifold Absolute Pressure/Barometric Pressure Circuit Range/Performance Problem
- P0107 Manifold Absolute Pressure/Barometric Pressure Circuit Low Input P0108 Manifold Absolute Pressure/Barometric Pressure Circuit High Input P0109 Manifold Absolute Pressure/Barometric Pressure Circuit Intermittent
- .....
- P08XX Transmission
- P080l Reverse Inhibit Control Circuit Malfunction
- P0803 1-4 Upshift (Skip Shift) Solenoid Control Circuit Malfunction
- P0804 1-4 Upshift (Skip Shift) Lamp Control Circuit Malfunction



ODB II Trouble Code

- http://www.obdii.com/codes.asp