

# Scan tools, Technical insight.

*We all have used scan tools. There are many brands available, all with good features and all with gaps in the functionality.*

My history of working for a scan tool manufacturer as an application engineer has given me a unique insight in how the hardware, software and the politics behind such equipment works.

Part of the workings of such equipment is covered in the AECS Scan1 training course, as I believe that if you use such equipment you should have a basic understanding of the scan tool's capabilities and shortcomings.

This understanding increases the functionality of the scan tool for the enw2d user as it stops technicians over exposing themselves by making conclusions based on incorrect or incomplete information.

It is my belief that as technicians you should be having a higher level of background knowledge of such tools than what is actually present amongst most garages.

In this article I will try to explain some of the technical background without trying to make this too boring.

IDLE AIR CONTROL SOL	39.6 %
ENGINE SPEED	100 rpm
MANIFOLD PRESSURE	97.4 kPa
ECT SENSOR	-17.0°C
Data lines	Converted Values

You see here on the screen a normal random scan tool display with 4 lines of live data.

Serial communication is called serial data as

- packets of data get sent one after the other (in series),
- also each packet of data gets sent as a series of zero's and ones, one after the other.

## LAUNCH X-431 X3 Latest model SCAN TOOL

X431 GX3 scan tool is the new look **scan tool** developed by Launch. It's a perfect complete unit, it out performs all other diagnostic tools you have seen so far!



**\$4,990 + gst**

### Features:

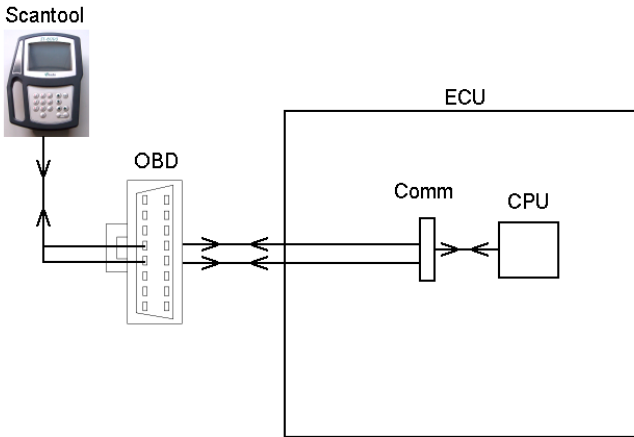
- ▶ Touch Screen PDA
- ▶ Inbuilt printer
- ▶ Able to be used on **58 car brands**
- ▶ Very simple to operate
- ▶ Many protocols are almost identical to factory software
- ▶ 1 year free updates and 12 month warranty
- ▶ Strong carry case for all connectors and tool
- ▶ **AECS** technical support.

Parallel import.  
New shipment arriving soon!

The communication is usually via one or two wires, depending on the communication protocol the manufacturer has chosen.

A communication protocol includes the communication speed, codes, the voltage height of the signals and the hardware.

**A short focus on 2 different types of communication layouts**

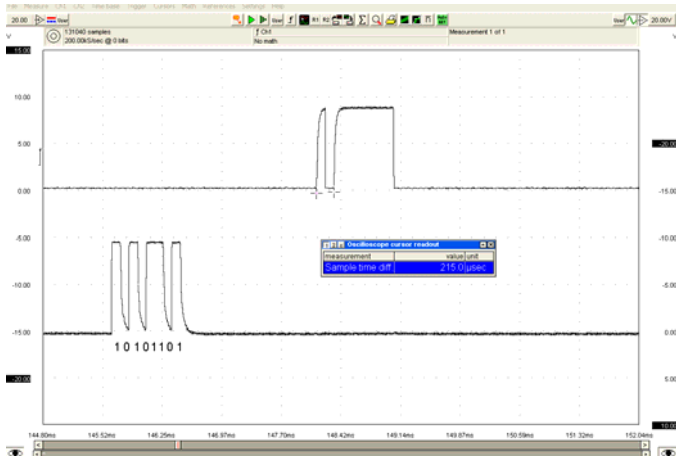


The scan tool is connected to a communication controller in the ECU. The communication controller in the ECU determines the communication speed (refresh rate) this has nothing to do with the tool.

In this picture the tool communicates with two wires. One of the dual wire communication systems is called K/L line communication system.

Simply explained one wire is used for the 'questions' of the scan tool and the other wire is used for the 'answers' from the ECU.

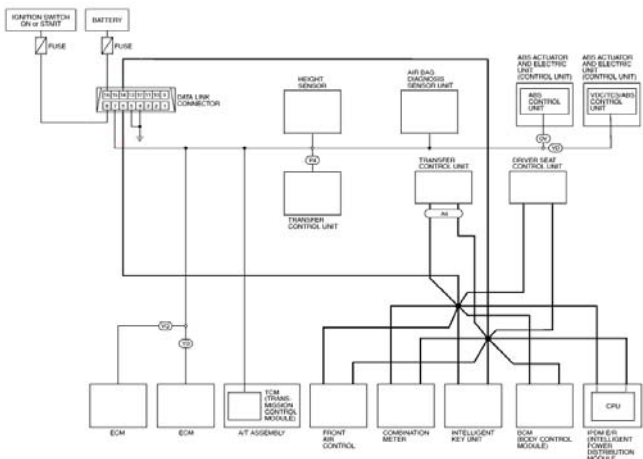
On a scope the communication recording looks as follows:



The 'pulses' are where one ECU switches the power supply provided by the other ECU to earth. The switching speed in this recording is 215 Micro sec for 2 pulses (high/low).

The bottom signal is the question, the top signal is the answer in this sample.

Each request is one data line on your scan tool's display.



In the next late model vehicle wiring diagram you see a combination of single wire communication (K line) and two wire CAN data bus communication.

**AVL  
DiX 450  
Petrol/ Diesel**

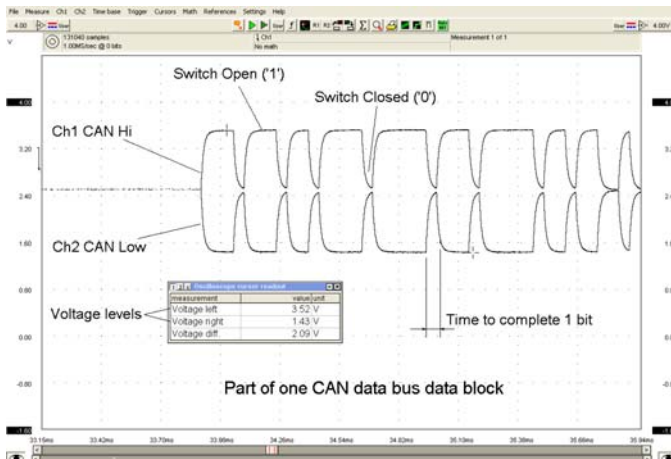


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+ gst**

- Modular Tester for conducting emission tests and engine diagnostics.
- Flexible system that can be added to suit your requirements.

The two wire can data bus communication works very different from two wire K/L line communication. In a CAN bus system both wires work in unison and are each other's mirror image.

In this system, if one wire is broken the communication will stop altogether; there are systems where parts of the communication system stays alive. Testing and in depth knowledge of CAN bus is covered in the AECS DMS1-2 training course.



The CAN system is very simple and requires very little skill to find faults and repair. It requires good understanding of basic electronic circuits.

You can basically think about two wires which are connected to earth and a 5 V power supply through a pull down and pull up resistor. These two wires are connected with each other via two capping resistors.

The ECU's linked to such a system measure the voltage on these two wires (Listening Rx) and can send messages by opening/closing a switch connecting the two wires (Send or Tx).

There are various languages which can be spoken via CAN data bus at various speeds, but there is a form of standardisation present in CAN data bus. Yet do not count that if you have a tool communicating with one CAN bus vehicle that it will talk to another brand or model also equipped with CAN.

### AECS Training systems

Mercedes benz ML320.  
 84 01 F2 22 11 07 01 B0 scantool  
 85 F2 01 62 11 07 64 00 D6 ECU  
 84 01 F2 22 11 01 01 AF scantool  
 85 F2 01 62 11 01 8B 00 EF ECU

The first data line (sent by the scantool) is built up as follows  
 byte #00 (84) is the header byte.  
 byte #01 (01) is the target address i.e. 01 is the ECU.  
 byte #02 (F2) is the source address i.e. F2 is the scantool.  
 byte #03 (22) is the question identification byte.  
 byte #04 (11) indicates live data streaming  
 Next 2 bytes #05 and #06 (07 01) are the actual question i.e. Airmass.  
 The last byte #07 is the checksum. The check sum is the sum of all the bites in Hex. minus the first digit in this example.

Please note how the various blocks of data are represented by a double digit hex code (1 byte). In the sample the scan tool asks 8 bytes of data before the ECU can answer (9 byte).

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# AGS-688 EXHAUST GAS ANALYSER FOR PETROL ENGINES

OIML R 99 - ISO 3930 CLASS 0

ELECTROMAGNETIC CLASS E2

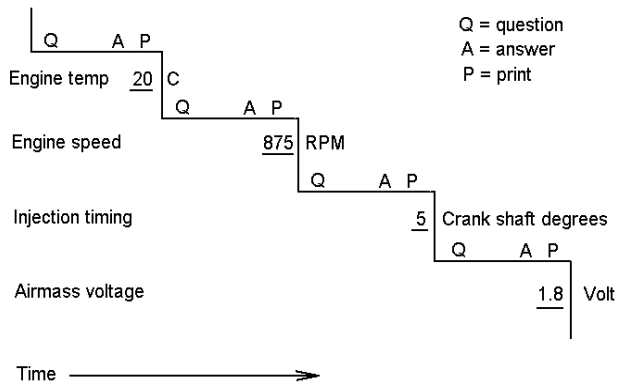
Integrated with the online database of ETNZ

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- PRINTER INCORPORATED
- PORTABLE and powered by 12volts
- CONNECTABLE TO ANY PC or LAPTOP for diagnostics
- ETNZ Approved (www.etnz.co.nz)
- The AGS-688 has a higher rating than the current LTNZ OIML class1 import inspection emission tester
- INTERGRATED WITH THE ONLINE DATABASE OF ETNZ





On the scan tool for example four live data lines are processed as follows:



Many serial communication protocols have a refresh rate of three times per second, this means that if three data lines are selected the refresh rate of each live data line is about once per second.

I can make this visible with the scope when the screen is fully zoomed out, but to go deeper into this now will take too long.

The staggered data explains why for example a shot of freeze frame data are never a series of events that happen all at the same time. It can give some really interesting reading which can confuse the best brains. Some of the explanations are really .... Well, Interesting.....

In our recently released Hybrid training seminar we came across some interesting data combinations in freeze frame mode:



The planetary gear set is a fixed unit, the gear ratio cannot change nor slip, so the ratio between the Petrol engine, electric motor/generator (MG) 1 and MG 2 is fixed.

In our aftermarket scan tool the following data lines were selected under various conditions:

Data table from scan tool (cycle 14)

Condition of drive		Engine start up, no VSS, foot on brake and in D, depress accelerator
Engine	(RPM)	1280
Vehicle speed	(Km/h)	0
MG2	(RPM)	-5
MG2 Torq	(Nm)	53.87
Regen brake torq	(Nm)	0
Required regen brake torq	(Nm)	0
MG1	(RPM)	-12
MG1 Torq	(Nm)	2
Request power	(Watt)	0
Target engine	(RPM)	0
Actual engine speed	(RPM)	0

Note: The engine rotates at the first line at 1280 RPM at the last line 0 RPM.

I will explain a number of the data lines which you see in this freeze frame shot:

- The data is retrieved from the HV ECU.
- The HV ECU receives the "Engine RPM" information from the Engine ECU,
- it receives the "MG1 speed" from the MG1 Controller inside the inverter,
- it receives the "MG2 speed" form the second ECU inside the inverter (NHW10, on NHW11 and 20 this is controlled by one ECU inside the inverter).
- It receives the "required regenerative torque" information from the ABS ECU (brake pedal force on the pressure transducer in the stroke simulator of the ABS actuator), and
- it receives the "Requested power" from the accelerator pedal.
- The requested power figure is the figure which is send to the engine ECU so it can control the throttle opening.

Data table from scan tool (cycle 4)

Condition of drive		Gentle drive, +/-20% throttle.
Engine	(RPM)	1152
Vehicle speed	(Km/h)	12
MG2	(RPM)	492
MG2 Torq	(Nm)	51.75
Regen brake torq	(Nm)	0
Required regen brake torq	(Nm)	0
MG1	(RPM)	3285
MG1 Torq	(Nm)	- 8.13
Request power	(Watt)	2270
Target engine	(RPM)	1245
Actual engine speed	(RPM)	1056

All in All a lot of data to deal with! This certainly does this leave the communication controller inside the HV ECU, and the various data busses a bit 'over worked'.

In real terms you need to consider that the communication is all on the same data bus inside the HV controller, all ECU's need to have an opportunity to talk and pause.

On top of this some ECU's just have a higher priority than others, the scan tool is always the lowest ECU in rank.

### Misconceptions

One of the biggest misconceptions technicians have is that if the car talks to the tool, then whatever comes out must be true! Consider the following when selecting a scan tool.

- Some scan tools have reverse engineered software which is expensive and very often incomplete, think about 'unknown error' etc. Some copy an OEM tool with all its flaws and ability.
- Also when the vehicle data list is incomplete the scantool manufacturer is still able to advertise that the car is in the tool.

OBD compatible vehicles are advertised as being covered by many tools while the amount of data is vastly lower than OEM data from a proper designed piece of scan tool software. Some good examples are:

- no Fault codes while there are codes stored in the system.
- or on the Toyota Hybrid vehicle NHW11 there are only 3 useful data lines under OBD, the rest is marked as not applicable. With the OEM copied software there are probably a thousand of live data lines in all ECU's combined.
- Some aftermarket scan tools let you read just OBD fault codes, some scan tools will come up

with an OBD code while the actual code is describing different fault area.

### New developments

There are many jobs that cannot be done without the aid of a scan tool, like configuring or coding new ECUs into a system, or programming key's and for example injectors in a common rail Diesel system.

A brand new development is "Pass through". A small number of scan tool manufacturers have this feature already build in to the tool.

"Pass Through" is a feature where the scan tool can upgrade the vehicle's software by software releases made by the manufacturer.

#### 2) What is Pass-through ?

Pass-through is a technology allowing for reprogramming of ECUs by using files provided by car makers, as outlined in the diagram below.



The reference regulation sets forth programming standards (J2534) that shall be employed by an API (Application programming interface) software that will be used by all car makers and that will enable the independent market, by means of an internet connection, to reprogram ECUs without the need to have an original tool.

This will only be able to be done with Euro 5 vehicles, build from the 1<sup>st</sup> of March 2010. The software can be downloaded by dealer networks and independent garages

### Conclusion

AECS have a large range of diagnostic equipment for sale, and we spend a lot of time researching which equipment does the job out there instead of generating quick sales. Our knowledge allows us to make sound judgements on what works and what doesn't.

I believe that, when you need to invest in equipment you have to spend some time researching what is available out there. Do not go by preconceived ideas or smooth sales talk, as a lot is changing very fast out there.

A great number of you have already attended multiple training seminars with AECS, as it is simply not practical for all garages to invest the same amount in researching the same repair and problem solving technologies. We from AECS are in the business to sell that research for your advantage through advanced training seminars.

## AECS

**Training coming up:**

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<b>AED</b>	29th & 30th June	New Plymouth
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Herbert

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