AUTOMOTIVE ELECTRONICS

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An introduction to automotive data scanners — 1

If you haven't struck one yet, a 'scanner' in the automotive electronics context is a hand-held device that allows the user to access the vehicle's control processor and retrieve diagnostic information from it. I predict that in the future, 75% of the world's cars will be fixed using them.

Virtually all vehicles that have an electronic control module (ECM) for engine management control offer some form of retrieving diagnostic data from it. This also applies to vehicles with electronic controlled transmissions (ECT). This data may be in the form of fault codes, a data stream (active data), or both.

Some systems allow *interaction* — meaning control signals can be sent *to* the ECM, as well as data retrieved from it. The original purpose of providing this access to ECM information is as an aid in troubleshooting. Some systems require special equipment to access the information. The hand-held scanner (Fig.1) performs this function, and often rather more besides.

Another use

It used to be an assumption (at least by Americans) that the way North America goes, in motoring, so goes the world. But as far as emission and pollution controls are concerned, the world tends to go the way *California* goes...

California's emission standards exceed all federal standards in North America. Many vehicles sold, and even manufactured, in North America, cannot be registered in California. As this is being written, California is planning to 'outlaw' leaded fuels and introduce methanol-mixed fuels. It's about time, as there are over 28 million motor vehicles in southern California.

What does all this have to do with scanners? To answer that question, you need to understand the purpose and usage of the scanner. The purpose is to provide all information available from the ECM. The usage, of course, is by motor mechanics. Independent mechanics fix 75% of the world's vehicles. Data may be retrieved from the ECM by other means, of course, but the scanner is the least expensive. So a fair statement is, most cars will be fixed using a relatively low cost hand-held device — i.e., a scanner.

Needless to say the car manufacturers, through their dealers, use not only scanners but other sophisticated equipment as well. But their equipment is generally dedicated to their own particular models, and is often very expensive anyway.

Keeping all this in mind, what is California up to? Here are just a few aspects of what is planned:

1. All vehicles must be fitted with the same diagnostic connector;
2. Diagnostic data should be accessed in serial format, with 'active high' logic polarity;
3. There must be a visual indication for emission or pollution control failure;
4. There must be an oxygen sensor;
5. All failure information must be stored in a memory, to allow later retrieval; and finally...
6. The diagnostic codes must be standardised.

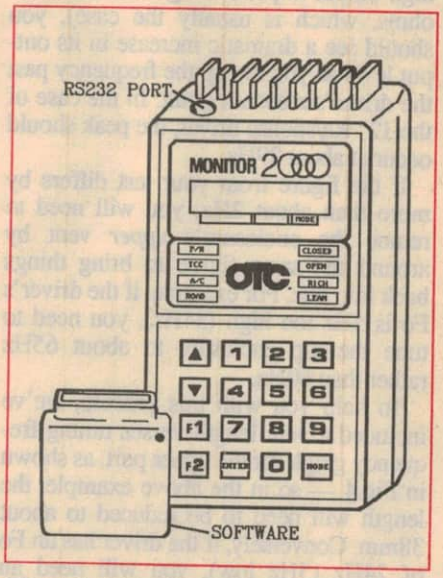


Fig.1: A typical handheld scanner has a keyboard and display, and plug-in software (firmware) modules.

There's more, but you can probably see where they're heading. Ultimately all vehicles are going to have the same serial interface and connector, using a standard diagnostic code and memory storage of failure information. So a scanner will be able to be used not just for diagnostics, but for monitoring a car's emission performance.

Yes, the day is fast approaching when you'll be stopped and your vehicle is connected to a machine to see if it meets the pollution specs. How much information will be accessed, is a matter of the legal system. Since some ECM's even store the vehicle's highest speed achieved, there's even the potential for your ECM to be used for 'self incrimination' if you have exceeded the speed limits.

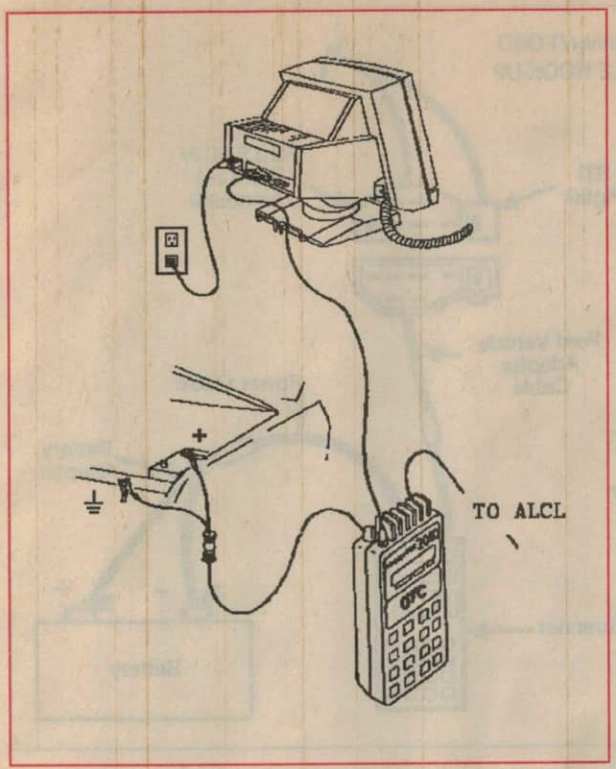
So now we can see the basic requirements for a scanner. In a nutshell, it must be capable of obtaining all data available from the ECM, storing it and providing a convenient means of displaying it. I like to describe this as 'hooking up to the ECM so that it can talk to the world'.

The sophistication of today's automotive electronics demands this kind of fast, convenient access to the ECM's internal 'brain', if servicing and adjustment are to be carried out economically.

Background history

None of the first ECM's provided access to the outside world, which meant that they couldn't be serviced in the field. Luckily this phase didn't last long.

Even when diagnostic connectors were provided, the scanner manufacturing industry took years to get its act together. Needless to say a scanner is itself a small computer, and it requires software — or more strictly, *firmware* (software in a ROM chip). And this



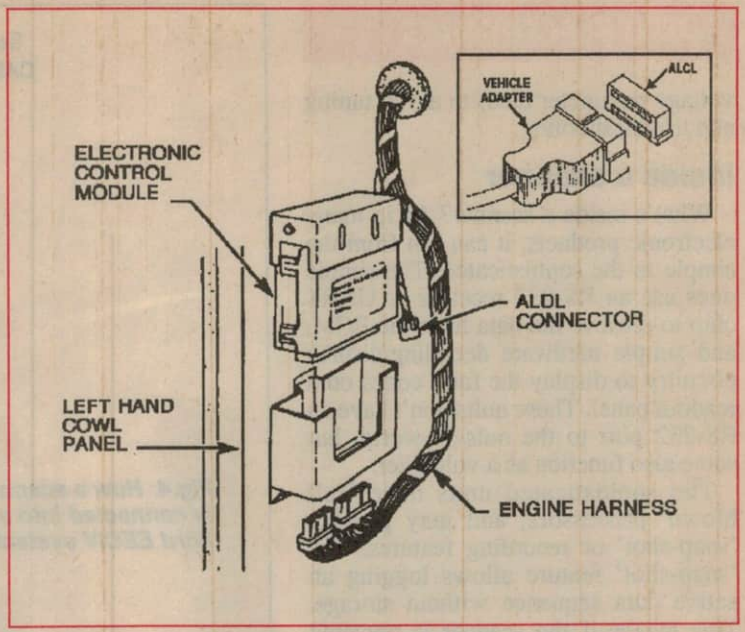


Fig.2 (above): In VN Holdens, the 'ALDL' (assembly line diagnostic link) connector is at the side of the ECM, behind the left kick panel.

Fig.3 (left): The more sophisticated scanners have an RS-232 serial port, so the data can be accessed and examined using a PC.

firmware generally needs to be updated pretty often, to cope with new models (on some cars, the ECM software can change yearly).

The first scanners also required a return to the factory for updating their firmware. After a few manufacturers went broke, plug-in firmware became available. The pioneer in this field was Superior Electric, an old manufacturer of electrical test meters. Their interest in scanners was sold to OTC (Owatonna Tool Company), a division of Sealed Power (of piston ring fame). Nowadays both are under the new banner of SPX.

As scanners proliferated, so did the competition. Not only did price wars develop, but also features. The industry, by now, had decided that the units must not become obsolete, because of a factory system or model change.

Soon the modular or system approach was taken. One could purchase a 'bare bones' scanner and add on options later. Then another approach was taken, which found features built in — such as the ability to record. When OTC introduced its System 2000, with an RS-232 port, many companies folded or changed owners.

But the industry still had a problem — simplicity. Some scanners were not very 'user friendly', and required extensive training. One button pushed out of sequence would either lock up the scanner or worse yet, give bad data.

The smart companies provided step by step visual instructions for operations, on the scanner's own display. So nowadays, just reading the display guides one through a procedure.

Does that mean everything is done for you? No — the hardest part is still there: interpreting the information.

The vehicle

So how are scanners used? First off, it depends upon the vehicle and its manufacturer. Some do not provide data, while others provide data, but have no access for a scanner. On some, the fault codes are read on the 'check engine' lamp or those for other functions. And some manufacturers don't provide retrieval data.

If you do not know what is applicable to your vehicle, ask your mechanic. There are too many models and systems to list here. Part of using a scanner is knowing what cars it will hook up to.

Every year more vehicle manufactures incorporate the data stream system, where the ECM delivers a constant stream of information. In 1991 Toyota's Cressida and Lexus models joined this group. It aids the manufacturer in assembly line final testing, allows collection of functional data on the road (the real world), aids diagnostics, and will soon be required by law — at least in California.

How they're used

ECM vehicles that accept a scanner are provided with a diagnostic connector. In shop talk it is the 'diagnostic lead' or the 'ALDL' (assembly line diagnostic link) connector. The latter name is GM-Holden terminology. The same company also talks about an 'ALCL' (assembly line communication link) — it's the same connector. The names used depends upon the function.

Finding the ALDL is another matter. On early Holdens it's under the instrument panel; on VNs it's behind (above) the left kick panel (Fig.2). On Fords and most others, it's under the bonnet.

The data retrieved consists of *fault codes* and *active data*. Fault codes are basically numbers, each representing a particular sensor or system fault. If no fault code appears, most scanners will indicate a pass code. Some ECM systems store previous fault codes, allowing logging of an intermittent failure. If an ECM system fails to give any kind of fault codes, there is a problem.

For cars with ECMs that also deliver active data, suitable diagnostic software will also assist the mechanic in tracking down problems. The mechanic will simply feed the data into the diagnostic program, which will analyse it and compare it to reference information in the scanner's memory. It will then tell what is in error and where to look (component or system).

On some vehicles, diagnostic programs are now being built into the ECM itself. The Chrysler 'Deluxe CDR' is the most sophisticated system manufactured in North America. It has built-in (software) diagnostics (engine sensor

voltage parameter data) to aid in tuning and troubleshooting.

Inside a scanner

What's inside a scanner? As in many electronic products, it can run from the simple to the sophisticated. The simple ones use an RS-232 receiver or UART chip to retrieve the data from the ECM, and simple hardware decoding/display circuitry to display the fault codes on a readout panel. These units don't have an RS-232 port to the outside world, but some also function as a voltmeter.

The sophisticated units have 'full blown' processors, and may provide 'snap-shot' or recording features. The 'snap-shot' feature allows logging an active data sequence without storage. This means if the scanner is powered down, all data is lost.

The recording feature allows data to be saved in solid state memory until you erase it. This provides greater flexibility and is the preferred choice.

The more sophisticated units have an RS-232 port for external data access (Fig.3), and generally offer many accessories such as modems, additional solid state memory, terminals, and software that allow interfacing to a PC or terminal. Matching PC software is available for graphing, more extensive diagnostics and storing/retrieval of information in a database.

Many of the sophisticated scanners use the modular or system concept. This allows one to purchase a 'bare bones' unit and expand it later, as the need arises and your finances allow.

Fault codes

At this stage the fault or trouble codes, their meanings and significance are not standardised; they vary by manufacturer and even from model to model. Trying to memorise them all is therefore futile.

Working with a particular vehicle, one will soon remember the critical sensor or circuit fault codes. It's the same as working on other electronic equipment — once you become familiar with a particular unit, you know where to look. Certain circuits fail or act up more often than others, and you soon learn by symptom where to look.

Unfortunately car manufacturers treat fault code meanings in much the same way that they treat sensors. Just as different companies use different names like 'throttle position sensor' (TPS) and 'throttle angle sensor' (TAS) for the same device, so with fault codes we can find different meanings for terms like hard, soft, fault, trouble, maintenance, slow, fast, on-demand, continuous, KAM (keep alive memory), history, past, etc. Generally you must work with the codes to understand the usage.

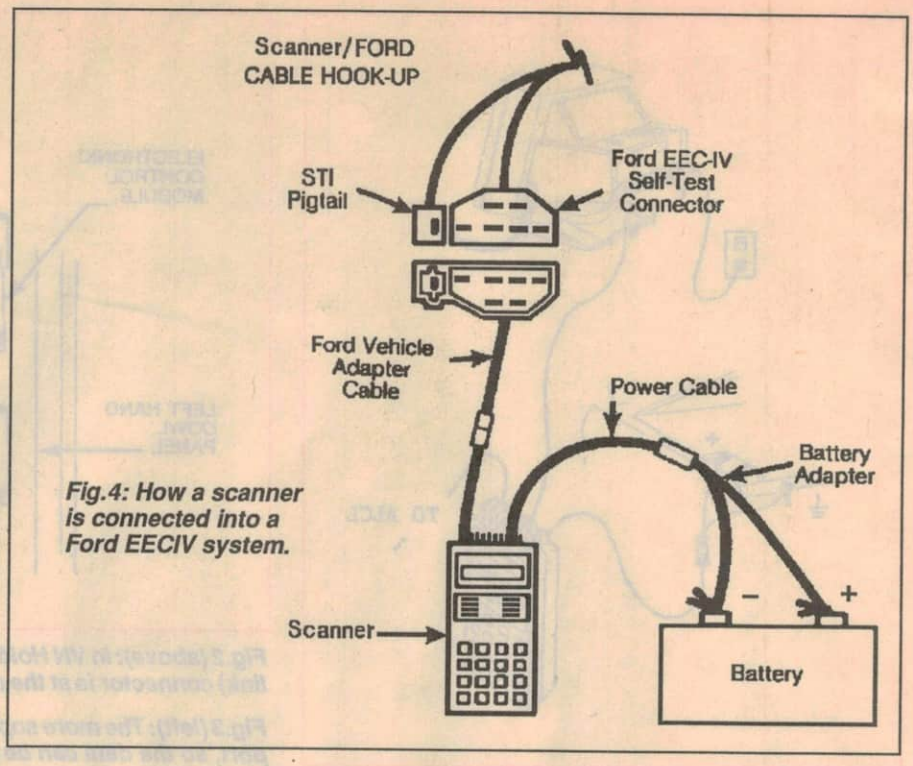


Fig.4: How a scanner is connected into a Ford EECIV system.

A scanner is not the only way to retrieve fault code data. A manual called *The Code Book* is available, which has all vehicle codes as well as other retrieval methods. Further information is available from the author, care of *EA*.

Incidentally the car's ECM system is often not the only source of diagnostic codes, in a modern vehicle. Some vehicles have more than one processor. There may be a separate processor for the anti-lock brake system (ABS), the cruise control, the transmission control system (CTS), the power control module (PCM) — and it goes on. Often different connectors are required for each system, making retrieval more difficult or costly.

A typical example

In Fig.4, the scanner is connected to a Ford EECIV system. This system provides self-diagnostics testing — a series of tests to aid in faultfinding. This system may have fault codes stored in KAM (really battery-backed or 'flash' RAM), indicating an intermittent or a past failure. If a particular test passes or fails, a code will so indicate.

Once the scanner is connected, it will request vehicle information. The information is then entered: Ford, year of manufacture and engine data. The scanner will then request what function or test is to be performed. On some scanners a menu will appear, like this:

1. Wiggle test
2. KOEO test (key on, engine off)
3. Computed timing check
4. KOER test (key on, engine running)
5. Clear memory
6. Output state test
7. Code library
8. Switch test

When the selected menu code is entered, the scanner display then directs the user on the correct sequence. At the completion of a test the scanner automatically goes to the code library, and the scanner indicates:

Review codes
Press: 1 - Codes
2 - Codes/Description
3 - Exit

The user selects his choice by entering 1, 2 or 3. For example if you enter '2' the display may indicate:

'26: MAF out of range'

(the MAF is the mass air flow sensor)

We'll look at the meanings of the fault codes next month, when we'll also discuss serial (active) data and the features provided in different scanners. We'll also look at the present and future requirements for a scanner.

In the meantime, if you need further information on scanners, I suggest that you call Neville on (02) 708 3360. ❖