WIZARD AND CHIPS

PART 1

Pictures by Chris Graham

Re-chipping a modern performance car must surely be the most cost-effective way of significantly improving its performance. Chris Graham discovers what's involved.

In these days of heightened environmental consciousness the motor industry is taking a bit of a pounding. Vehicle exhaust emissions are a pretty hot issue right now and it's on the cards that ever-tightening controls in this area will be a major consideration for many years to come.

At present the best weapon in the vehicle manufacturer's armoury, for the fight against emissions, is the computer-controlled engine management system. When all is said and done the friendly old carburettor, even in its most advancd form, is a relatively crude mechanical device. Its function is to control the relative amounts of fuel and air being delivered to the engine to ensure correct and efficient running.

However, you may be surprised to learn that, in most cases, a carburettor can only be expected to be doing its job properly at half-a-dozen or so points across the rev range. At all other times the unfortunate truth is that it is delivering incorrect quantities leading to bad news on the emissions front. The answer, of course, was to develop a way of continually monitoring and adjusting the fuel and air supply which is exactly what we have today.

Good management

The thinking behind engine management was to produce a system that would overcome this inefficiency and create a way of controlling accurately both the fuelling, so that precisely the right amount of fuel was delivered, and the ignition timing throughout the whole rev range. In this way emissions of carbon monoxide and nitrous compounds could be kept to the absolute minimum and the engine could run at its peak performance at all times – everyone was happy!

However, the manufacturers soon cottoned on to the fact that they now had the means conveniently to tailor the performance of an engine to meet any particular market requirement if, for example, they were looking for high sales to company car fleet managers, then fuel economy was a vital consideration and the system could be programmed to produce excellent mpg figures.

This was obviously great news for the manufacturers themselves but it also had an interesting knock-on effect in the after-sales market too. This 'programmability' of the on-board computers proved to be an irresistible temptation to electronics wizards like Peter Wales. He immediately saw the potential for modifying the manufacturer's programmes to unlock the full potential of an engine's performance capabilities. The re-chipping industry was born!

Peter went on to form Detection Techniques Ltd (Buckingham Industrial Park, Buckingham MK18 1XJ, Tel: 0280 816781 or 815838, Fax: 0280 816764) who are now at the forefront of the industry. With his experience and expertise it was obvious that Peter was the man to talk to for an insight into the current state of play.

Detection and correction

My introduction began with an explanation as to how the management computer, which runs other vital systems such as ABS braking as well as the fuelling and ignition settings, exercises its control. Now, I'm no computer expert but, from what Peter said, it appears that the whole system stands or falls on the information held in one tiny memory chip. This is just a standard microchip, like those found in any personal computer, which is crammed full of figures. About 32,000 in fact!

These figures make up the programming instructions for all the computer's

Subtle badging is often the only way of telling that a car has been re-chipped.

functions and they can be displayed on a screen once the chip has been 'read' by a specially adapted computer. Peter loaded up a sample chip and, sure enough, the said figures appeared on the screen after a few seconds. I must admit that they meant very little to me but, within a moment or two, he was able to recognise important sequences of numbers which he explained were called maps.

The maps relevant for tuning purposes are the fuelling and timing maps which, in the case of the Bosch management system, take the form of 12 by 12 number grids. They contain the manufacturer's chosen performance settings for varying conditions. In addition the programming also allows the engine management system to take care of other variable factors such as air temperature, battery voltage and engine temperature. These are important too because they can all cause fluctuations necessitating changes in the fuelling and timing settings to maintain efficient running.

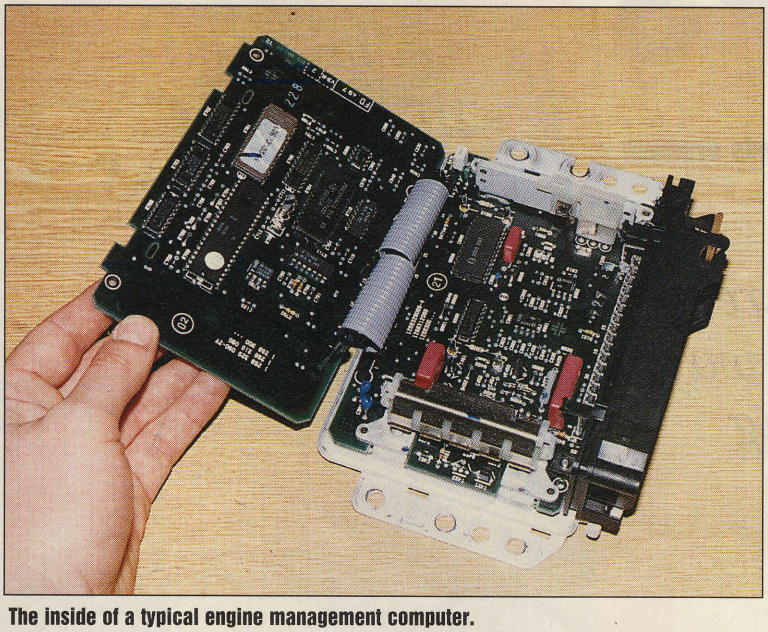
Peter picked out a fuel map and demonstrated how altering various figures could affect the running of the engine. Changes made to the maps will govern how lean or rich the engine is running at any one point in the rev range. Careful analysis will identify exactly when in the engine's power curve it starts to run lean or rich and corrective adjustments can be made.

On the cheaper management systems there are usually separate fuel maps for the engine at three different throttle settings – idle, part-throttle and full throttle – and two timing maps for each throttle setting. This makes a total of nine to be assessed although Peter added that he rarely fiddles with the idle maps because these are usually perfectly adequate.

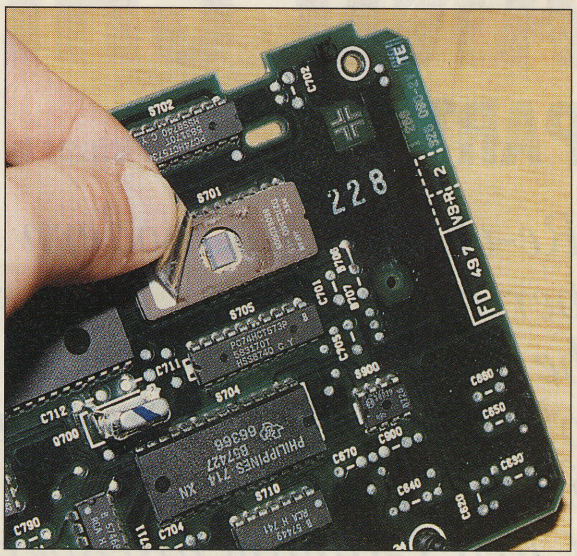
The more expensive systems, as found on BMWs for example, are rather more complicated with three maps for the part-throttle setting (light, medium and heavy), and there can be four or five completely different fuelling/timing map sets for use in different countries! In such cases Peter's first job is to find out which ones are actually controlling the engine at the time of the test. The manufacturers, of course, do not provide any help in this respect! Although the control box in a BMW 535 manual may look the same as the one in the auto version, the engine will be running on different maps. If the automatic is switched to the 'sport' mode then it will switch to yet another programme map to advance the ignition for greater performance. It's a very complex business.

So far, though, everything seemed to make reasonable sense but it got a good deal more involved when Peter went on to talk about cars fitted with catalytic converters. The management systems on these need to be more complex still. For the set-up to work at all there must be no unburnt fuel or air passing out of the system through the exhaust – it must be what's known chemically as stoichiometric! Only after complete combustion, with no air or fuel left over, will the catalytic converter function properly to convert the carbon monoxide (CO) into carbon dioxide and the nitrous compounds into nitrogen. Running on leaded petrol is a definite 'no no' with a

The staff at Detection Techniques are a cross between motor mechanics and electronics engineers. White coats abound!



The inside of a typical engine management computer.



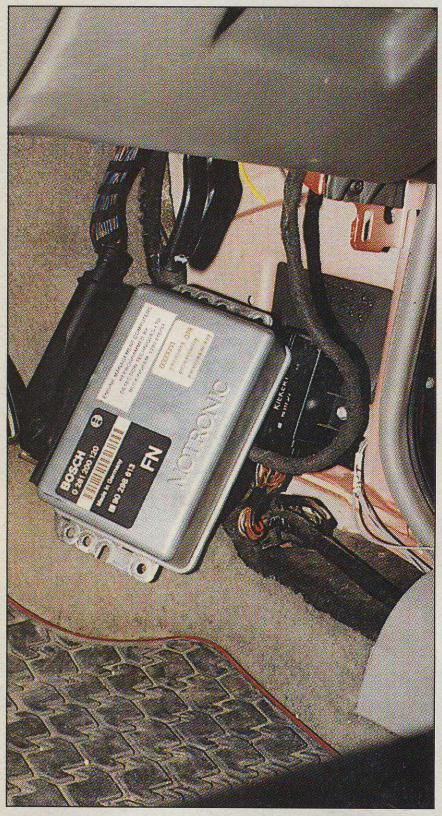
Beneath the protective tape hides the all-powerful memory chip. It's hard to believe that something this small can have such an influential effect on the performance of a motor car.

converter because the lead will simply clog it up.

To achieve stoichiometric combustion under all conditions the computer has an oxygen sensor placed in the exhaust pipe to measure the waste gases. Its recordings lead to changes in the amount of fuel being supplied and so the correct balance is maintained by continual adjustments which reflect changes in engine setting made by the driver.

Tweaking technique

As I've already mentioned, the motor manufacturers make full use of their ability to pre-programe an engine's performance levels to best suit their intended market. However, in many cases these limitations can lead to rather boring and even unsatisfactory performance if you are an enthusiastic driver.

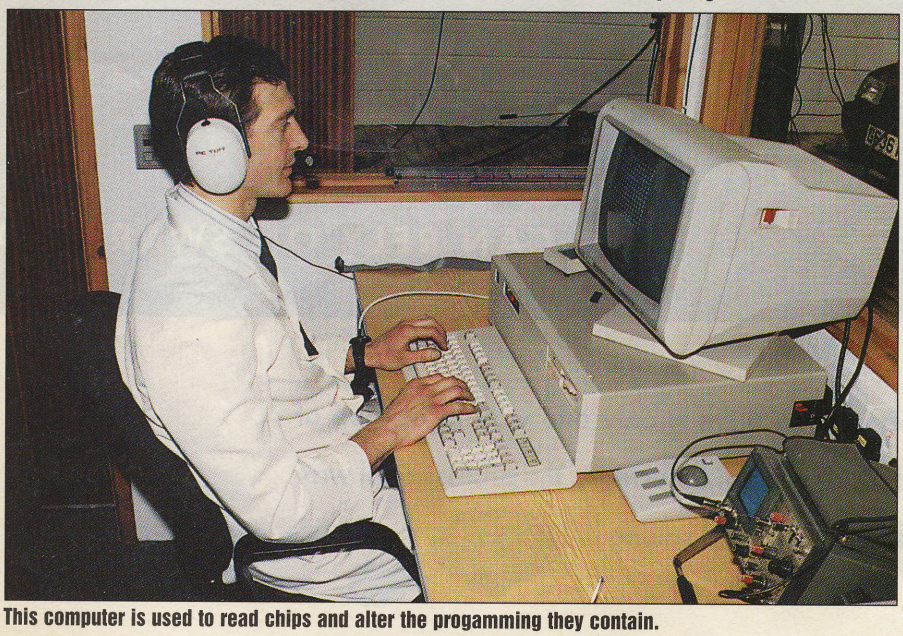


The engine management in the new Cavalier SRi is found behind the side panel in the driver's footwell. This convenient location means that the car can be made to perform significantly better without even opening the bonnet!

Often you will find that the engine has been set to run so weak in the mid-range (presumably to save fuel when cruising) that if you suddenly put your foot down there's nothing there! The solution is to re-programme the fuelling map so that the engine runs slightly richer in the mid-range. Because of the extra richness already there the mixture will not go too weak when more air arrives after you press the accelerator. The result will be instant response.

Another neat little trick the manufacturers adopt is to programme in an overrun cut-off which effectively switches off the engine when you take your foot off the accelerator. Although proving a good fuel saving device, the down side of this type of control is that it can often cause all sorts of lurching and hesitation problems, particularly when you're driving around town in heavy traffic. However, Peter says that by a simple alteration to just two figures in the memory chip the problem can be solved. The cut-off action is removed so that every time the accelerator or pedal is re-applied the engine responds instantly rather than having to switch itself back on again with the associated lurch.

Another point worth noting is that most performance cars are set up, by their manufacturers, to run fairly rich when on full throttle. This is not ideal but is done in a bid to aid mid-range acceleration. If it was not the case then sudden acceleration from the mid-range (which is set lean anyway) would weaken the mixture too much and the engine would falter. Therefore, by making the full-throttle map over-rich, the mixture strength is increased as soon as the throttle is fully opened and the engine is coaxed through the lean sport without hesitation. However, this is all very well until the engine is run for any time at full throttle. Under such circumstances the mixture quickly becomes too rich and performance suffers. This can be put right by leaning off the mixture with adjustments to the full-throttle fuel map.



This computer is used to read chips and alter the progamming they contain.

The proof of the pudding

There is no question that Detection Techniques are totally confident about all the conversion work they undertake. They fully appreciate the importance of what they are doing and the seriousness of the consequences should things go wrong. It's a business in which corners just cannot be cut although, unfortunately, there are those around today who are prepared to take the risk.

If a customer arrives in the Detection Techniques workshop with a car that is new to them then they will have to start from square one with a look at what's on the engine management's memory chip. The contents will be read and copied on to their computer to provide a working copy. From this the control maps will be identified, analysed and then the business of alteration will start.

The car is put on the rolling road and connected up to the main computer and the analysis machinery so that preliminary CO and timing measurements (taken at half-a-dozen points across the rev range) can be made. Then, by a complicated process of elimination, the function of each map is determined. This is done by making deliberately exaggerated alterations to each one in turn and noting the effects these have on the running of the engine.

Having established this then the fine tuning can start and it takes about six hours to completely re-tune an engine from scratch. After they have produced what's considered to be the definitive set of fuelling and timing maps, copies are made of the chip and they are tested extensively on other similar engines. If the reports on performance are unanimously good then the chip can be marketed. However, if there are just one or two that do not produce the same improvements as those seen on the original test car then more development work is done to find out why.

In Part 2, next month, we shall take a look at the practical results of Detection Techniques' tuning packages on both normally aspirated and turbo cars. Also we shall be considering the cost, to the owner as well as to the engine, of such modifications.