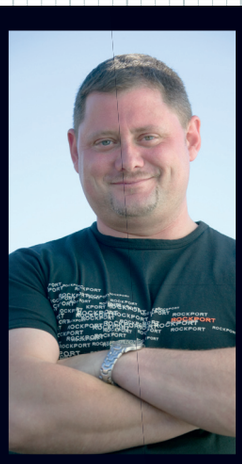


THE EXPERT STEWART SANDERSON

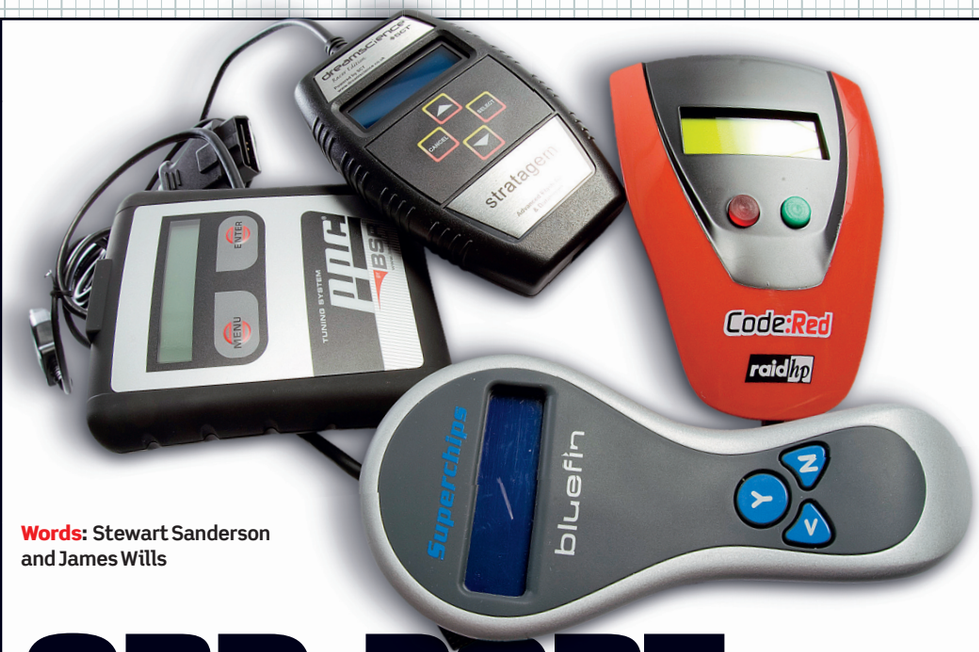
Having worked as a tuner for over 20 years, Stewart 'Stu' Sanderson is one of the most-respected names in the business.

A Level 5-trained fuel-injection technician, Stu has worked for a Ford Rallye Sport dealer, a well-known fuel-injection specialist and various tuning companies.

11 years ago he joined forces with Kenny Walker and opened up Motorsport Developments near Blackpool (01253 508400, www.remapping.co.uk), specialising in engine management live remapping, as well as developing a range of Evolution chips which are now sold all over the world.

He is the creator and administrator of www.passionford.com, which he started in 2003. It has grown rapidly from a few friends contributing, to one of the biggest Ford communities on the web.

Stu's enviable knowledge of the workings of modern-day Ford performance engines means that every month he's just the man to explain how and why things work, and importantly how they can be improved.



Words: Stewart Sanderson and James Wills

OBD PORT REMAPPING

This issue, Stu delves into the world of remapping your ECU – how it's done and why it's not 'chipping'...

This month I thought it was time that we revisited the ECU mapping stable, but I want to look more specifically at remapping modern Ford ECUs via the OBD port, or in the case of 'live mapping', via the expansion ports found on many Ford EEC ECUs.

WHAT'S AN OBD PORT?

I am sure most of you have seen an OBD port on a car at some point, all modern vehicles are fitted with one to allow diagnostic equipment and various other devices to be plugged in and used. The OBD port allows several key functions, many of which are legal requirements now and it is basically a doorway into the ECU. OBD is an abbreviation of 'On Board Diagnostics'.

In this feature we will take a look at how this port can be used to remap the vehicle. We'll look at why we call it remapping and not chipping, and how this process takes place plus what is actually done when you get an OBD remap.

WHAT IS AN EXPANSION PORT?

Most Ford EEC ECUs have a port on the back that allows us to access the memory directly and in fact completely override it with a correctly programmed module. It's often referred to as the J3 port and many of you will associate it with the blue Superchips modules that you may have seen that plug into the side of most EEC vehicles. Any correctly programmed module plugged in here can override the program that is inside the ECU, so that chip module is traditionally how we used to remap the Ford EEC vehicles.

SO WHAT'S THE DIFFERENCE BETWEEN CHIPPING AND REMAPPING?

When it comes to the crunch, any form of remap, chip or tuning module for older EECs is simply a matter of changing the ECU calibration data within the ECU memory. This is the memory location that an ECU will reference in order to know how much fuel to add and when to add it, when to spark, and on the modern ECUs it will even look here to see how loud the stereo should be at any given road speed!

The main difference between a chip and a remap is simply how the data is stored within the ECU. Some older ECUs like the Weber Cosworth units have a microchip known as an EPROM (commonly called a chip) which can simply be removed and a new item holding new data fitted in its place.

In more modern ECUs the same fundamental storage exists, the data is still in an EPROM, but nowadays that EPROM does not need to be removed from its circuit board in order to reprogram it. Think of it as a USB flash drive that we all use on our PCs at home, because in effect that's exactly what we have: a flash EPROM that is connected to the OBD port! So in order to remap a vehicle we are going to re-write, or 'flash' new data onto the memory inside the ECU itself. This can be done in most cases via the OBD port and no physical change or chips are needed. I say in most cases as some cars are still locked down by the manufacturer and cannot easily be accessed via OBD so we

still have to remove the ECU and do it a different way, but that hopefully is just a matter of time. So this in a nutshell is how the term 'chip' has changed to 'remap' because there is no physical changing of chips involved nowadays and all we are doing is changing the maps, or 're-mapping'.

HOW IS A REMAP PERFORMED?

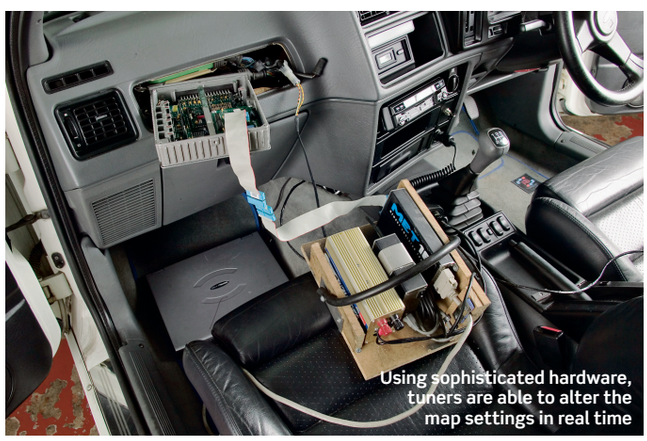
There are different stages of remapping available for most cars. The majority of garages that offer a remapping service do not actually get involved in the very complex job of decompiling and reverse engineering the ECU calibration files, they quite rightly leave that part to the professionals. In reality, the actual task of recalibrating the ECU maps is done by someone miles away, sat in an office at a computer wearing slippers! If you were to take your car into a local garage that offers a remapping service, the usual procedure would normally cover 10 steps.

WHY DO WE NEED TO READ THE ECU CALIBRATION FIRST NOWADAYS?

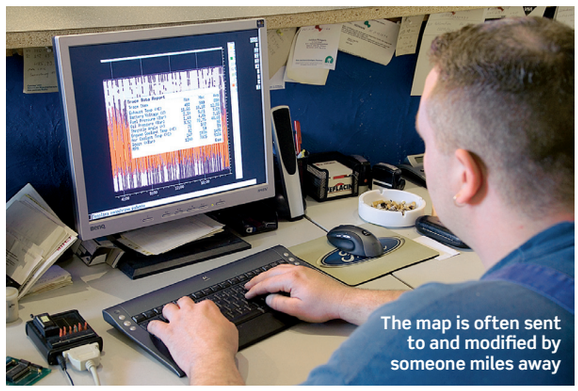
Are you wondering why your tuner can't just send you a chip for you to replace your exitsting one with, like you did back in the Cosworth tuning era? Well done, you spotted one of the main things that has changed since the good old days of simply changing EPROMS. This is simply because the ECU holds a lot more information about the vehicle than you might think nowadays! In amongst the engine's calibration data you will often find the vehicle registration number, the chassis number, the model codes and the comfort programming, not to mention the equipment coding. This data is all specific to your own personal vehicle.

From a security point of view, most ECUs also now hold most, if not all, of the immobilization codes and data, so your ECU can actually be coded to your car and to your ignition key! If you were to get a mail order remap for that type of vehicle that was originally based on someone else's car, your car would at worst not even start but at best would be programmed with info for the wrong car, so expect air conditioning to stop working, other keys to fail, and things like that! Secondly, but every bit as important is the fact that the firmware on modern ECUs is almost always updated during servicing within the first few years of the car's life. These changes can be as simple as ironing out a glitch when cold or something quite serious like a CANBUS problem with the braking system's data stream. Now, if we start with the exact calibration file that was on your car when it came in and only change the maps we need to change to improve the way the car performs, there is no fear of inadvertently changing the firmware to an older version and introducing bugs that you had previously already had ironed out by your dealer via ECU updates.

Unfortunately, a great many so-called professional tuning companies are still using the firmware from when the car was first produced, because the suppliers out there get them on CDs from eBay and the like for small change, but along with these historic files come all the car's historic problems! Be careful out there... you get what you pay for in remapping as it's a high technology business requiring constant development and reinvestment.



Using sophisticated hardware, tuners are able to alter the map settings in real time



The map is often sent to and modified by someone miles away

TEN STEPS TO OBD REMAPPING:

1 Pop your car into the garage and leave it with them for a few hours while you go shopping.

2 The garage will put various forms of diagnostic equipment on the car to check it is suitable for the remap to be carried out - you should never remap a car with existing faults, it's just not the thing to do and can cause severe damage!

3 If the car passes the above diagnostic check, then a simple road test will be carried out to assess the current performance and check for any smoke or signs that things are not as they should be. Then the car will be returned to the workshop.

4 The bonnet is opened and a stabilised power supply will be fitted to the battery. Some vehicles will put headlights and fans on during the read/write process and if a battery goes flat during this process it can corrupt or kill the ECU. Also some ECUs will not allow the read/write process unless a battery voltage of more than 14v is achieved. So a stabiliser (not a charger) is fitted to increase the voltage in the battery and keep it there during the following work.

5 A hand-held unit will be plugged into the ECU's OBD port. This will allow the tuner to select the correct protocol to read the ECU with. Think of a protocol as a language, and we need to tell the hand-held unit which language the ECU will speak in order for us to be able to understand the data that will come from it. The unit will then take a read of the ECU memory, all data will be copied and held in the unit's own memory. This may take up to 25 minutes depending on the file size!

6 The hand-held unit will then be plugged into a computer which will grab the information from the hand-held unit and send it via email to the person who will actually do the remapping procedure. We will look at this in more detail later!

7 In a short time the file will return from the remapping company, this file has now been modified and is ready to write back to the ECU. This new file is loaded onto the hand-held unit and the tuner returns to the car with it.

8 The hand-held unit is again plugged into the OBD port, and the file is written to the ECU memory, again this can take up to 25 minutes depending on the file size, and if the whole file has to be written back or just a portion of it.

9 Once the write-back is complete, the equipment will all be removed and the car will be started and allowed to idle for a short period. This will allow the ECU to complete any adaptation process it may need to do in order to idle correctly.

10 A final road test and diagnostic check will be carried out to assess the new performance, and see if all is as expected. Hopefully on the vehicle's return to the workshop you will get a phone call saying all is well and the car is now ready for collection!

WHAT MAPS DOES A MODERN FORD ECU CONTAIN?

Let's look at the main 500 or so of the calibration tables and switch points contained with a Focus RS Mk1 ECU as an example as we live map a lot of those...

Engine Fuelling	130+ Maps & Switches
Adaptive Fuelling	20+ Maps & Switches
Transient Fuelling	10+ Maps & Switches
Over run fuelling	10+ Maps & Switches
Cranking Fuelling	10+ Maps & Switches
Spark	70+ Maps & Switches
Adaptive Spark	10+ Maps & Switches
Transient Spark	10+ Maps & Switches
Closed Loop	40+ Maps & Switches
Boost Pressure	30+ Maps & Switches
Torque Limiters	10+ Maps & Switches
Idle Control	30+ Maps & Switches
MAF	20+ Maps & Switches
Fuel Injectors	10+ Maps & Switches
02 Sensors (per sensor)	30+ Maps & Switches
Cooling Fans	10+ Maps & Switches
Alternator	10+ Maps & Switches

And that's in a pretty basic machine from almost 10 years ago and before EGT monitoring and per cylinder detonation detection became the norm, and before we start looking at fault code programming!

HOW IS THE ACTUAL MAP CHANGED?

When your standard calibration file arrives at the computer of whoever is going to perform the remap, the data must first be loaded into a complex computer program which will allow this data to be changed and, importantly, to be presented in a usable format.

Only then can the task of finding and recalibrating the various maps begin. The modern ECU can hold massive amounts of data and over 500 maps and switch points are the norm on your average Ford: 8 megabyte files are very common (to put this into perspective, the Sierra Cosworth's ECU calibration file is only 8 kilobytes). As well as skilfully recalibrating the various fuel/spark/boost/valve timing/torque limiters and other tables within the file, we also have to deal with the various types of encryption and checksum algorithms that are present in the calibration and were put in place to ensure data integrity. All of these things have to be worked out and sometimes totally reverse-engineered to allow the engine to ever start again once the data has been tweaked and changed.

WHAT DIFFERENT TYPES OF REMAP ARE THERE?

These are usually broken down into three categories as follows.

1. OFF THE SHELF MAP

Option one is to have what we call an off the shelf program. This is a performance calibration for your management system that will remove various compromises written into the software by the manufacturer and has basic performance mods. These include leaning off excessively rich mixtures that the OEMs use and running a little more advance due to the fact that as an enthusiast you will be using better fuel than the garbage the manufacturer had to program it for on the off chance you put it in there after you bought the car. Often gearbox torque limiters are raised to increase performance in lower gears and sometimes the rev or speed limiters are increased or removed.

These files are basically programmed all the same for each type of car/ECU and engine combination. It's a large compromise but one that should do exactly as it says on the tin. It won't be perfect for every engine due to the simple fact that all engines tend to vary somewhat. This scenario covers all DIY type boxes that you may come across that you can buy mail order.

2. CUSTOM MAP

Option two is a custom map. This is a performance calibration for your management system that is far better than the simple off the shelf calibration but not quite as accurate as a live map, so still a compromise. With custom mapping, you basically start with an off the shelf calibration uploaded to your ECU as explained above, but it is then tested and adjusted time and time again to get the best out of your engine. The tuner would test drive the car, make notes on paper as to what rpm, throttle and so on that a problem arises, and then modify the calibration on his computer (or request the changes from his supplier), program the new calibration to the handset and upload this to the ECU, then go out again and see what difference it has made. This is basically repeated until the tuner is happy with the outcome.

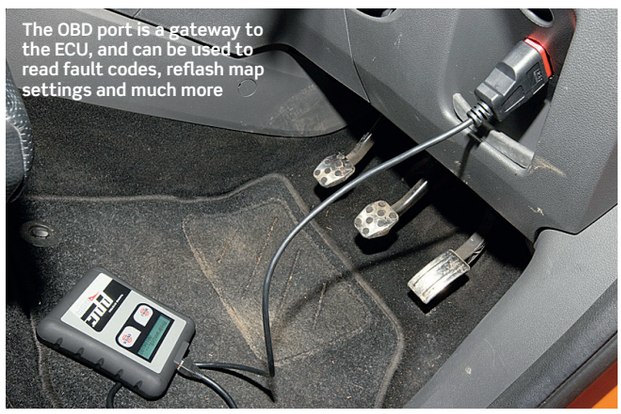
This is the option normally chosen by people who don't really need to get the car mapped live, but want more than an off the shelf program for their cherished chariot. Of course this is also the best option for people with cars that cannot be live mapped, such as the Focus ST225 and Focus RS Mk2. In fact, a great many modern OBD equipped systems cannot be live mapped due to hardware restrictions so it is lucky that great results are possible from custom mapping. It is hard and time consuming to perfect the calibration this way but the results can be excellent.

3. LIVE MAP

Option 3 is a live map - the daddy of the mapping world. Live mapping is a little like custom mapping but on a far grander scale. With a live map you have your ECU's chip completely removed and a laptop is connected in its place via a piece of hardware called an emulator. Once this system is installed the maps can be accessed live and altered at the same time as the ECU is asking for the information.

This means if for example you have a hesitation at 50mph in fourth gear, you can drive the car to that speed and easily see and access the point in the map that is wrong so you can correct it there and then, while driving the car using that current data. This allows you to literally feel the result of map changes as you perform them while simultaneously watching the fuelling on your wide-band fuel monitor, watching boost levels and so on and listening for detonation. There is no substitute for live mapping. It is the ultimate way to tune an ECU, period. Many Ford vehicles can still be live mapped, such as the Focus RS Mk1, the small turbo Escort Cosworth and of course the Fiesta RS Turbo. But a lot of the more modern vehicles are locked down in manufacture and sadly cannot be emulated.

"THE OBD PORT ALLOWS SEVERAL KEY FUNCTIONS, AND IS A DOORWAY INTO THE ECU."



The OBD port is a gateway to the ECU, and can be used to read fault codes, reflash map settings and much more

NEXT MONTH
WE'LL TAKE A LOOK AT CLUTCH TECHNOLOGY