
**WORDS** by Paul West **PHOTOGRAPHY** by Will Neill & Rich Sams

# TECH TALK ECU MAPPING PT1

## INTRODUCTION

The element of car tuning that most people find the most confusing is ECU Mapping and 'tuning', given that there are few tangible items, things to hold, shiny metal things and the like, it can be hard to see where your money is going. In reality however, everything is controlled by computers, from your most humble of household appliance to your car, some of the most important elements are controlled by electronics.

We here at Honda Tuner like to think we know a thing or two about Hondas, however we're far from experts in ECU Mapping, thankfully we know a few people who know everything that is needed and then some, one such man is Paul West, of TDi North, here's an introduction from Paul, explaining what qualifies him to explain mapping and then into part one of a two part article that will hopefully tell you everything you need to know about ECU (engine control unit, if you didn't know) Mapping. Paul has done his upmost to make this article as accessible as possible, but in reality it is pretty complex.

"I have always been around cars. My father ran a busy workshop in Maidstone, Kent so I was often in and around oily engines and petrol fumes from a very young age. After leaving school I served a 5 year apprentice in electrical/electronic engineering specialising in control systems and programming high speed machine systems and robotics but still played with cars in my spare time modding, tuning etc but got more involved when I started working part time at TDi North in 2004 doing most of the big powered cars and any electrical work eventually taking over full time ownership in 2010

## BASICS OF ENGINE MANAGEMENT.

### BEFORE YOU START

Engine cycle - one complete cycle of the engine, from the intake of air to expelling of waste gas.

Ignition event angle - refers to the number of degrees before top dead centre that the spark will ignite the air-fuel mixture

Ignition coil - transforms the battery's low voltage to the thousands of volts needed to create an electric spark in the spark plugs to ignite the fuel

The primary job of the engine control unit (ECU) is to provide the engine with sparks at the right time and fuel in the right quantity but also at the correct time. The engine management system lives life at a frantically fast pace, it lives life from just one engine cycle to the next and its entire world is the current engine cycle.

The job that the ECU must complete for each engine cycle is to first measure all of the controlling variables which control its internal look-up tables (or maps, we'll explain that later) as it is required to make a firm decision quickly on the ignition event angle which is to be used for the current cycle, then it must also make a firm decision on fuel delivery and decide on an injector opening duration.

Once the ECU has weighed up the variables and has settled on both an ignition event angle and an injector opening time it now has to begin to charge the ignition coil in preparation for the ignition event, also it must decide when in the engine's cycle to begin the opening of the fuel injectors.

Whilst injecting the estimated required amount of fuel the ECU waits for exactly the right time to cease charging the ignition coil.

At the critical point the ECU cuts the electrical feed to the ignition coil causing the nicely contained and highly charged electrical field which has built up inside the coil to collapse and desperately search for an escape route.

This newly homeless energy tries to tunnel its way out of the coil the easiest way it can which should be down through the spark plug, the energy courses down through the spark plugs core eventually jumping through a compressed mix of fuel and air in the combustion chamber of the engine and over to the spark plug's earthing strap, by doing this we start the combustion process for this engine cycle.

At 6000rpm the ECU has just 20 milliseconds maximum to complete this entire process, a good quality modern ECU will do all of this and more with plenty of time to spare.


## ECU TYPES

### BEFORE YOU START

Reflashing - Updating or changing an ECUs original map

Boost Control - Controls the boost level produced by a turbo or supercharger

Traction Control - Prevents loss of traction of driven road wheels

2-Step launch Control - Is a two step rev limiter. One step is used to control launch RPM and the second is a fail safe for max engine RPM.

Wideband - is an air-fuel sensor that measures that measures the ratio of air to fuel

Knock (detonation) - Occurs when excessive heat and pressure in the combustion chamber causes the air/fuel mixture to auto ignite.

Datalogging - Records important data over time for analysis

There are basically two types of ECU systems available to us which give similar control over the parameters we need to give effective operation. The first and most widely used is what is termed a "Stand Alone" system. This is a system that uses a dedicated ECU which is directly programmed and connects to the car's harness or a modified harness in the case of race cars. These include the very popular Hondata systems that utilise the stock ECU, systems like AEM, DTA, Syvecs and Motec to name but a few. Systems such as chip reflashing stock ECU's would also be described as stand-alone although don't offer the flexibility of an easy accessed system through say USB, OBD or Ethernet ports.

Many of these stand alone systems offer many functions which stock ECU's don't such as Boost Control, Traction Control, Multiple Injectors, 2-Step launch Control, Wideband and Knock control as well as full Datalogging capabilities and in the newer systems the possibilities to add further sensors and systems that can interact with the operation of the ECU directly to effectively safeguard the operation of the motor if predetermined critical levels are reached.

The other systems that we see quite often are what are termed "Piggy back". A "Piggy back" system still uses the stock ECU but the new system will connect into the loom and manipulate the outputs from the ECU in such a way as to give control of fuel, ignition and VTEC operation. The best way to describe it is like a puppeteer pulling the strings of a puppet to make it do what you want. These systems don't tend to offer anywhere near the functionality of the "Stand Alone" systems but can offer an economic alternative. Popular systems seen quite often are the Dastek range of products and the AEM FIC (Fuel and Ignition Controller)

There is also a very good system which technically is a piggy back system but does function like a Stand Alone system offering very good control and that is the HKS range of ECU's



## TOOLS FOR TUNING ROAD OR DYNO

### BEFORE YOU START

Lambda feedback - Lambda or oxygen sensor is an electronic device that measures the proportion of oxygen in the gas or liquid being analysed.

Knock or pre-detonation - Occurs when excessive heat and pressure in the combustion chamber causes the air/fuel mixture to auto ignite.

There is always a lot of debate as to how effective tuning should take place and this is backed by advocates of "Road" tuning stating that cars are driven on the road therefore the best place to tune is on the road and those which state a dyno is the only way. I'm really not going to get into this debate, the majority of people saying that road tuning is the correct way don't actually have access to dyno facilities, so I will sit on the fence and say effective tuning requires a combination of the two but it is for different tasks within the actual tuning process.

The bottom line is you cannot effectively calibrate ignition and in the newer cars with variable intake cams, correct cam angles and VTEC points without measuring the changes in tractive effort in a repeatable fashion and the dyno facility also offers a safe controlled environment to apply the sort of speeds and loads that on the road could result in losing your licence or even life as happened a few years ago with a colleague who was datalogging a high powered GTR when the driver lost control. People familiar with the aftermarket tuning and drag racing scene will know who I am talking about and he is still very much missed.

As well as the dyno which measures the tractive effort and records other data during the tuning process you also require accurate calibrated Lambda feedback to measure the AFR's (Air Fuel Ratio) of the exhaust gasses, some form of detection system to measure the knock or pre-detonation, vacuum lines connected to the dyno computer to measure manifold pressure and sometimes also a pressure sensor in the exhaust manifold to measure back pressure and Exhaust gas temperature monitoring.

Most software used on modern ECU's have the facility to monitor the majority of on-board sensors and systems but they can often misread so it's always good to have calibrated external sensors hooked up you can trust.

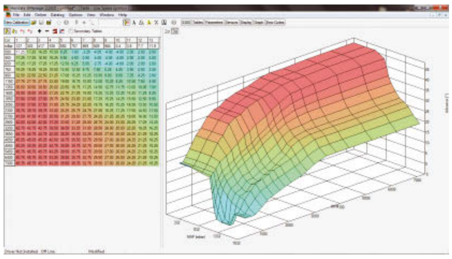
## CONSTRUCTION OF TUNING TABLES

Before we cover the methods used for actually "Tuning" an engine its worth showing how the actual "Fuel" and "Ignition" tables where the changes are made are constructed.

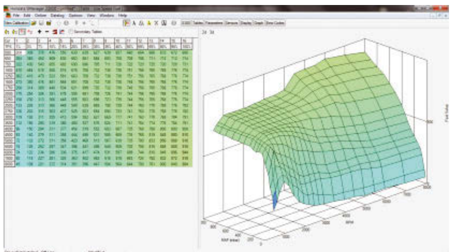
A Table is simply made up of a cross reference where preset values are input during tuning to tell the ECU what values to use at any specific engine speed and load measuring system which is either Manifold Pressure (MAP), Mass Air Flow (MAF) or AlphaN which is a term given normally to a Throttle Position Sensor (TPS) input predominantly on ITB (independent throttle body) equipped cars.

On an AEM EMS system you just have one table for fuel and one for ignition. On the Hondata S300 systems you get a low and high cam fuel table and low and high cam ignition table. With the Hondata Kpro and Flashpro systems you get Low and high tables but you now also have extra tables on both low and high of different intake cam angles totalling 12 fuel and 12 ignition tables plus high and low intake cam tables so as you can see there is quite a lot of work to do on a full tune.

Next is an example of a low cam Ignition table on an S300 showing load which is Manifold pressure on the horizontal axis vs RPM on the vertical axis. This is described as a "Speed Density Table".



A Low cam Fuel table on S300 showing load which is this time a Throttle Position Sensor % value vs RPM. This type of calibration table is described as AlphaN.



With the basics now explained we'll leave it until next issue to further breakdown the (now hopefully not so) black art of ECU mapping and tuning. In the next and final installment we will explain which 'load system' to use and why, Tuning Methodology and approach, Tuning VTEC and much more. We also hope to have some real world examples of how mapping effects a car as we set about having a Honda mapped to show just what a good tune can do for a car. Until next time…


**WORDS** by Paul West

# TECH TALK
# ECU MAPPING PT2

### INTRODUCTION

Last time round we explained (when I say we, I mean Paul West of TDi North explained) the basics of engine management, ECU types, tools for tuning and the construction of tuning tables. With that out of the way this issue we're going to build on that and explain the more technical aspects of how a car is tuned, how this affects various elements and how it's achieved. If you didn't pick up the last issue then this might all seem a bit confusing, you can still pick up a copy online from the Honda Tuner shop at www.hondatuner.co.uk (shameless plug!)

### WHAT LOAD SYSTEM TO USE AND WHY?

#### MAF – Mass Air Flow

These systems are far and away the most popular in the world, at least in terms of numbers. This method is also used by 90% of the world's OEM vehicle manufacturers.

This system will employ some type of sensor to take direct real time measurements of the air mass consumption of the engine. Modern MAF sensors sit in direct airflow normally after the air filter and use hot wires or hot films to try to gauge the air mass movement over the sensor. One common feature across all MAF sensors is that they must interfere to some extent with the engines intake airflow and so can hinder efficiency.

**HOW DOES IT WORK?** - This system estimates the engines volumetric efficiency by knowing in one hand the engines physical capacity and in the other hand it knows how much air mass it's just eaten. It is possible from this information to estimate the required fuel delivery and to a less certain extent the required ignition advance for any given engine cycle.

**WHY MAF?** – If you're a high volume car manufacturing company then it's a very logical choice. The big problem for major OEM's is that it is logistically impossible to build an accurate ECU calibration of every single individual engine that rolls off of the production line. It goes without saying that not all production engines are equal, manufacturing tolerances will always give rise to some differences from the best engines to the worst and therefore the engine management system must be able to "see" the differences between these engines and effectively roll with the punches. So an engine management system which constantly measures the engines efficiency is a handy tool, albeit not perhaps the ideal solution from an engineering point of view.

**PRO'S –**

• Robust and easy to calibrate in a way that allows one ECU calibration to be copied across many vehicles.

• Copes well with dynamic changes in the engines efficiency throughout the vehicles life, for instance blocked exhaust systems, etc.

**CON'S -**

• The system must make the assumption that all of the measured air mass does in fact go through the engine and also that the engine can get air from nowhere else other than through the MAF sensor, this assumption does make these systems extremely vulnerable to leaks.

• These systems are unable to assess the exact intake charge density where it really matters which is directly behind the intake valves, unfortunately it is this highly localised density that really does affect the combustion dynamics and so with it the required ignition event angle, meaning that the ignition control is not so good with a MAF system.

• MAF sensors do tend to have a fairly limited shelf life and rarely last the entire operational life of a vehicle, as and when they do start to fail the results can vary from a fairly harmless reduction on output and increased fuel consumption right across the spectrum to a spectacular total engine failure.

### Alpha-N

The most complex and mysterious sounding name within our load systems actually describes the simplest engine control system, the Alpha part of the name refers to an "Alpha" variable, this variable can technically be any relevant variable but most commonly its the voltage reading from the throttle position sensor (TPS) which is used. And the N part of the name would normally refer to the engine speed (RPM), I'm pretty sure there would be a lot less confusion in our world if it were to be referred to as just TPS vs RPM.

**HOW DOES IT WORK?** - In this system the look up tables (maps) are driven by engine speed along one axis and throttle plate position along the other. This system relies very heavily on the engineer calibrating the system accurately as the system itself is blind to a lot of critical sub-variables such as the mass air flow and the intake manifold pressure, the chosen alpha variable tenuously controls these as long as everything else remains equal. The calibration engineer must visit every single area of the look up tables and set each to the ideal ignition timing values as well as the ideal fuel delivery values, this must be carried out on an engine by engine basis and the calibration will only ever be correct for as long as the engines volumetric efficiency profile remains exactly as it was on the day of the actual calibration, a consistent performance from the exhaust and intake systems are also blindly assumed.

**WHY ALPHA-N?** – Alpha-N is simple for the ECU to manage, the burden is on the calibration engineer not on the ECU so the actual hardware is often quite basic in nature and therefore quite low cost. This method of load sensing is extremely flexible and can be quickly applied to almost any design of engine, it's especially good at dealing with very hectic harmonic environments such as very short individual throttle body set-ups on smaller engines using very long duration camshafts.

**PRO'S –**

• Straight forward to understand and calibrate
• Low cost
• Low parts count
• Good at dealing with large amplitude intake system harmonics.

**CON'S –**

• The system is vulnerable to post throttle air leaks
• The system cannot self adjust for dynamic changes in the engine's volumetric efficiency
• The system cannot cope with forced induction applications whilst only using TPS vs RPM
• Throttle position sensors have a relatively short shelf life and this system absolutely relies on having an accurate TPS signal at all times.

### Speed Density

This is the system you will find controlling most motorsport engines especially those utilising forced induction. The name refers to the two major drive variables for the strategy engine, SPEED and the intake charge DENSITY.

**HOW DOES IT WORK?** – To know the density of a gas we need two essential pieces of information, pressure and temperature. The pressure would be monitored by a Manifold Absolute Pressure (MAP) sensor whilst the temperature of the intake charge is measured normally with a thermister which is nothing more than a resistor that changes resistance as it's temperature changes.

It's probably worth mentioning at this point that MAP in this instance is an acronym for Manifold Absolute Pressure, the absolute part refers to the fact that in the world of engineering and science it's useful for us to talk about pressure in a slightly different way to the generally accepted norm. In absolute terms zero pressure is what you might commonly call a total vacuum, and in absolute terms as you sit reading this you are most likely sitting in air which has a pressure of approximately 1000mbars.

**WHY SPEED DENSITY?** – When accuracy of engine control is the most important factor then speed density is about as good as it gets, by accurately measuring intake charge density in real time behind the intake valves we can cater for the real life, cycle by cycle combustion environment precisely. This system will look up the right ignition and fuel numbers regardless of any leaks whether pre or post throttle body so it is highly robust.

**PRO'S**

• Highly relevant assessment of the intake charge conditions which results in highly relevant ignition event timing and fuel delivery look up.
• Robust against common real world faults like intake system air leaks.
• Highly adaptable to variable running conditions.
• Very suitable for forced induction applications.

**CON'S**

• These systems still rely very heavily on the calibration engineer to program the tables accurately as the system cannot see VE.
• Correct positioning, plumbing and mounting of MAP and intake air temp sensors are critical for accurate operation.
• More time consuming to calibrate than other engine management types.

## LOAD SYSTEMS CONCLUSION

For ultra accurate engine control we can combine aspects of the various systems, for instance speed density systems can be combined with Alpha-N control so that layers of pressure driven 3D look-up tables can be cycled through in a fourth dimension by an Alpha variable such as TPS. This might be useful when controlling a turbocharged application with throttle plates mounted very close to the intake valves, as in this instance a different throttle plate angle might well change the eventual combustion environment in the cylinder by altering the local aerodynamics in the intake port but without necessarily changing the measurable charge air density.

Most of the Honda's we see from day to day have MAP sensors onboard which makes tuning relatively easy but this isn't the norm as most modern cars are still equipped with MAF sensors.

## TUNING METHODOLOGY AND APPROACH

I'm going to explain the methodology I use for working with the Hondata systems which the majority of readers will be able to associate with. Other systems are pretty much the same in the way we would approach the task as you are really only doing the same thing but it's the interfaces that change.

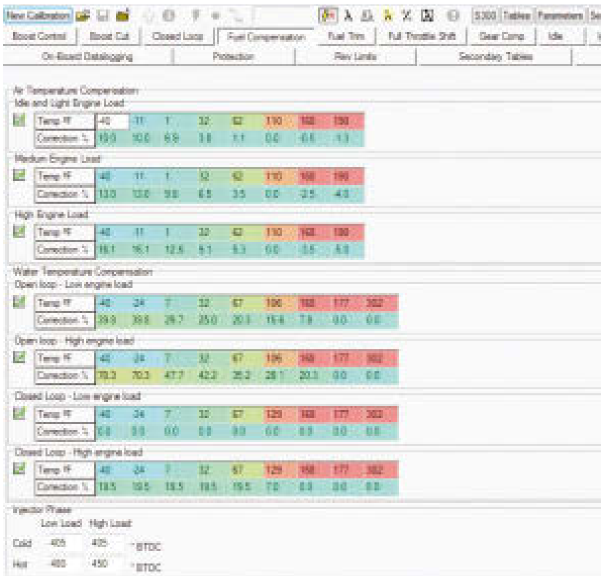
The way I approach any tuning work is to first get the car onto the dyno and carry out some basic checks like oil, coolant, tyre pressures and condition. Once we are happy that everything is OK the ECU is totally wiped. The reason for doing this is a lot of functionality for the ECU and correct operation of the software requires a clean upload which will also carry with it any firmware changes. Sometimes in the case of the Hondata FlashPro systems as soon as you connect if the FlashPro detects a conflict it will auto update. This doesn't happen with the older systems so it is always good practice if you're struggling to upload or get the ECU to communicate correctly.

I have a series of starting calibration files I upload which are preset with safe ignition and fuelling for the type of car I am looking at with cam angles all zeroed out and limiters set low and VTEC high to save me time and I can get straight on with the tuning.

First thing is to setup any different sensors and valves that are critical to operation such as aftermarket pressure sensors, injector sizes with deadtimes, TPS sensors and VTEC activation and deal with any check codes that come up on initial power up. We should be ready then to start the car.

It's important to get the car to operational temperature and to maintain the parameters during tuning and ensure that no compensation tables are having an effect on the data we are measuring. Put simplistically if all compensations are zeroed out the engine will run off the values we input into the fuel and ignition tables. The compensation tables are there to allow for things like cold starts as well as high and low water and intake temperatures and the tables assign a value to add or subtract preset % values of fuel or true ignition advance value in degrees. These are a protection system for the engine and effective measurement and positioning of the coolant and intake air temperature sensor is critical.

Below is a typical Hondata S300 Fuel compensation table




With the car started and fully warmed up we start to adjust the fuelling to get correct values for idle and free revving. One of the tables we have on the newer cars is for intake cam angles and this I set to start with at "0'" which is critical and often ignored as when a car goes into limp mode the intake cam sets itself at "0'" and just runs in that so it's of the utmost importance that this part of the fuel and ignition tables are fully and correctly setup.

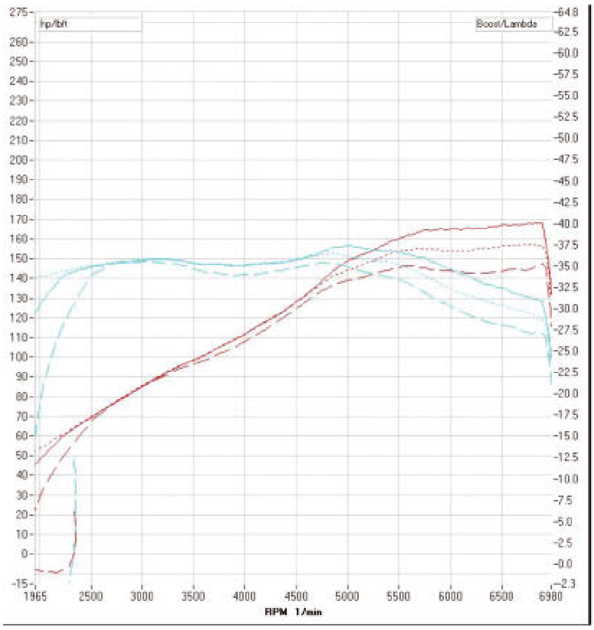
Happy with the idle I can then start the car rolling and applying load I can effectively setup fuelling at the different manifold pressures through the rev range. Slowly increasing the load raises the manifold pressure or airflow so it enables me to start constructing the fuel map.

One of the good features with the new FlashPro system is the addition of live tuning. This means we can make adjustments in real-time and monitor the effects straight away.

Happy with the part throttle fuelling I will move onto the full throttle part of the tables of the low cam. Once happy I have achieved optimum fuelling I copy the whole table into the next cam angle fuel table and repeat the process. With the older S300 systems there is only the one table so it's less time consuming but with the newer systems I have to go through this procedure until all cam angle tables are complete.

With the fuelling correct now at full throttle up to around 7000rpm (No VTEC at this point) I carry out consecutive power runs at 10, 20, 30, 40 and 50' cam angles. At this point I have identical ignition values in each table and what you see when you overlay the runs is what cam angles make best power at exactly what rpm. This is something you cannot do on the road and why it's so important when trying to extract optimum power you need a repeatable dyno.

The next plot shows the overlay of 20, 30 & 40' intake cam angles which in this case were the ones I was interested in as making best power. From this I am able to extrapolate the data required to build up the composite low cam table. With the cam table built up I now do a full power run on the low cam.




Below shows a typical Low cam composite table. The way this works is the same as the fuel and ignition tables. At any given engine speed and load input the value cross referenced is the target cam command so the intake cam should rotate to this value.

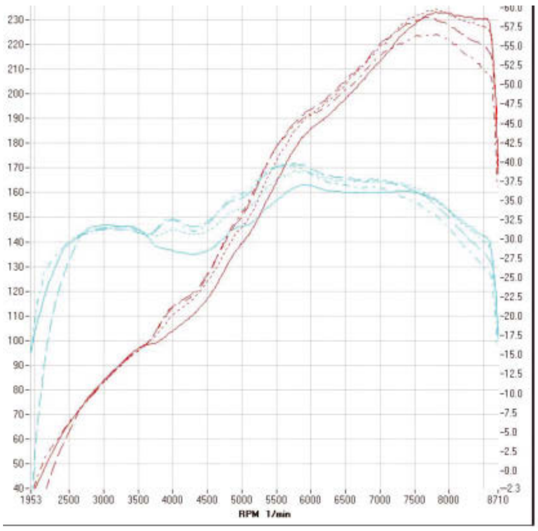
New Calibration — Edit All Tables — 0 degrees — Cam angle low speed

| Col | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| " | -25.8 | -23.2 | -20.7 | -17.3 | -13.9 | -10.5 | -7.2 | -3.8 | -0.4 | 0.5 |
| 500 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 800 | 0 | 0 | 0 | 0 | 7 | 7 | 7 | 7 | 7 | 7 |
| 1000 | 0 | 0 | 0 | 7 | 26 | 33 | 40 | 40 | 40 | 40 |
| 1250 | 0 | 0 | 0 | 6 | 25 | 32 | 38 | 45 | 45 | 45 |
| 1500 | 0 | 6 | 8 | 14 | 24 | 30 | 36 | 50 | 50 | 50 |
| 1750 | 0 | 6 | 11 | 17 | 23 | 29 | 35 | 50 | 50 | 50 |
| 2000 | 0 | 5 | 11 | 16 | 22 | 27 | 33 | 50 | 50 | 50 |
| 2250 | 0 | 5 | 10 | 15 | 21 | 26 | 31 | 50 | 50 | 50 |
| 2500 | 0 | 5 | 10 | 15 | 19 | 24 | 29 | 49 | 49 | 49 |
| 2750 | 0 | 4 | 9 | 14 | 18 | 23 | 27 | 48 | 48 | 48 |
| 3000 | 0 | 4 | 8 | 13 | 17 | 22 | 26 | 45 | 45 | 45 |
| 3500 | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 36 | 36 | 36 |
| 4000 | 0 | 4 | 7 | 11 | 15 | 19 | 22 | 30 | 30 | 30 |
| 4500 | 0 | 3 | 7 | 10 | 14 | 17 | 20 | 30 | 30 | 30 |
| 5000 | 0 | 3 | 6 | 9 | 12 | 15 | 19 | 30 | 30 | 30 |
| 5500 | 0 | 3 | 6 | 8 | 11 | 14 | 17 | 50 | 50 | 50 |
| 5800 | 0 | 2 | 5 | 8 | 10 | 13 | 15 | 20 | 20 | 20 |
| 6000 | 0 | 2 | 4 | 7 | 9 | 11 | 13 | 10 | 10 | 10 |
| 7000 | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 10 | 10 | 10 |
| 8000 | 0 | 2 | 3 | 5 | 7 | 8 | 10 | 10 | 10 | 10 |

Next step is to set the VTEC point at a low point like 3000rpm then run to the limiter to now calibrate all high cam fuel tables.

Again the cam table is reset to "0" but this time on high cam and we repeat the process of running through part throttle slowly increasing the loads until we are ready to start the power runs. With the high cam fuelling now finished and again the same values on all ignition tables I run through consecutive runs at the different cam angles then overlay them all to see optimum angle for given rpm.

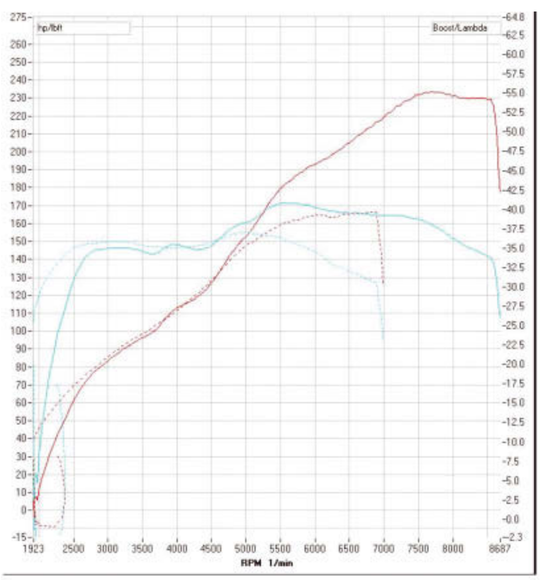
The plot below shows the plots of 20, 30, 40 and 50' overlaid with the VTEC activation point from 3500rpm. With the High speed cam table now complete we do another power run giving the composite of optimum cam movement for the high cam.




## TUNING FOR VTEC

"I want to lower my VTEC" is something we get pretty much every day! You try and explain that it's not as simple as just lowering the activation point as you need to have the correct fuelling and cam angles to support a different activation point and just lowering it without proper calibration normally results in loss of power. VTEC controllers were the old way to do it and work pretty well on the older B-Series motors and some also offered a small amount of fuel control but they still didn't affect the intake cam rotation and were overall a pretty crude system but on the later cars they just throw up a check light and go into limp as the ECU knows something's happened it's not expecting. This is how you do it properly... You overlay the composite low cam and high cam plots and where you see the high cam making greater power than the low cam, that is your optimum VTEC point.

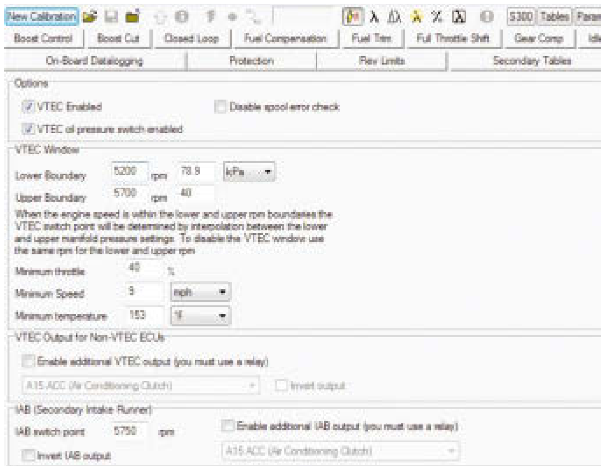
In the plot below the solid line is the high cam that you can see starts to make more power from around 4600rpm.




Now you can't just set your activation point at that and use the same values you have been using as optimum as it takes time to switch from low to high, plus rotate the intake cam. The correct settings to achieve a nice smooth changeover is to have the cams change about 100rpm before optimum but also on the intake cam table you need to try and synchronise the low to high cam so it's not having to move far after activation as that will cause a significant drop in power. This needs often quite a while to get dead right and to optimum and again something you can never do on the road.

Another thing that worries people is VTEC coming in too early which although might be optimum, when cruising on the motorway you don't want to be constantly in VTEC and resulting in a lot of noise and poor fuel economy. This really isn't something to worry about as with the ECU's we have the possibility to create a window that works on manifold pressure and in some cases road-speed as well as engine speed. The result of this is optimum performance when you want at full throttle but at part throttle when cruising VTEC isn't activated until manifold pressure increases where the throttle is pressed harder. The real life difference is that you don't need to shift down gears to try and overtake.

Below is a typical setup of the VTEC window as setup on a Hondata S300 system.




Note that there is also an activation temperature setting which means you can't push the engine hard until it's fully warmed up.

So, with low and high cams all tuned correctly for correct fuelling and the VTEC point set at optimum its time to move onto the ignition settings. With most Honda engines we aren't knock limited. What this means is that you can advance the ignition timing past MBT without encountering knock, which actually loses power and increases the mechanical stress on the engine components.

With an accurate and repeatable dyno you can slowly alter the ignition timing and measure the tractive effort to find MBT. We do this through the whole rev range for high and low cam making adjustments where necessary until the optimum settings are achieved. Without accurate dyno tuning of this critical function, performance and engine reliability is compromised.

With ignition now set as well as the fuelling, cam angles and VTEC we are able to do the final power run. For the customers we have already done a before run, we can now overlay the before and after.

The next plot shows the car before tuning and after final calibration. The dotted line is tuned, red is power at fly, blue torque and orange is AFR's. One thing to note is that with the fuelling all setup correctly it's running far leaner on the high cam than before so one of the big things people see when a cars tuned correctly is returning better mpg. More power, better mpg. Win win!


With the dyno work now finished the car comes off the dyno to start the road tuning part of the process. What is important is the "feel" of the car. The transitions from low to high cam and back again. The way the car runs at slow speeds and reacts when slowing and pulling away. This is something you can't do on the dyno. You don't really get any conception of feel and they only start recording from 2-2500rpm so the low speed and throttle response is what we are looking at.

With the part throttle and dynamics of throttle response now complete its time to reset all the compensation tables, trims etc and hand the keys to the owner for the test drive.

For me this is the best bit. You expect to see significant changes to a car when boosted but the way these Honda engines react to a few good modifications and effective mapping people just can't believe. The stunned reactions on people's faces, people shaking and rushing off for a cigarette is a common sight.

Credit to Sam Borgman at Torque Developments International for providing the technical information above, and I hope this little article can answer some of the questions we get asked every day to explain and remove some of the smoke and mirrors from a very important part of your cars modification process.

Paul West
MD TDi North Ltd.

## HONDATA SYSTEMS

A Hondata system consists of additional components which are added to the standard ECU to allow the ECU to use a Hondata program (this modification is normally done by a dealer). An interface box is then connected to the ECU which contains circuitry for datalogging, stores rev limits and interfaces to switches in the vehicle. Optionally a clutch switch, push button and datalogging cable may be installed. Collectively all this is known as a Hondata system.

Below we will look in brief at some of the Hondata systems for both OBD1 applications and the newer K Series systems and break down what each product does and how it works.

### HONDATA OBD1 SYSTEMS

#### S100 (1992-2000 HONDAS)

The s100 is a small circuit which fits inside the ECU. It requires a dealer with an S200 for tuning and has the same features less datalogging, full throttle shift and launch control.

#### S300/S300J (1992-2000 HONDAS)

The s300/s300j is a circuit board which fits inside the ECU. A slot is cut in the side of the ECU for the USB connector. The ECU uses different connector pins than the s100 & s200 (male pins vs. a socket)

The s300 will only fit inside a rectangular US frame ECU. The s300j will only fit inside a square JDM frame ECU.

#### HONDATA CPR (1992-2000 HONDAS)

The Hondata Coil Pack Retrofit (CPR) allows the use of 'coil on plug' individual ignition coils on engines with distributor based ignition systems (D, B, F and H series Honda engines). It does this by replacing the stock coil and ignition with an electronic circuit which can drive igniter type individual ignition coils, such as used on later model Honda engines. A Hondata S300 system and US OBDI ECU are required.

### HONDATA K SERIES SYSTEMS

#### K100 (2001-2005 MODEL HONDAS)

The k100 is a circuit board that is installed in the ECU in a similar fashion to the K-Series programmable ECU (K-Pro) at a lower cost. It allows your Hondata dealer to install a custom flash program based off any of the programs supplied with the K-Pro or any program of their own design. A dealer can also custom tune, using their K-Pro, a map specifically tailored for the customers car.

Unlike the K-Pro, the k100 does not have datalogging nor does it have programming capability. Programming and installation are done by your Hondata dealer.

#### K PRO (2001-2005 MODEL HONDAS)

The K-Series Programmable ECU (K-Pro) consists of a hardware modification to any K-Series ECU, the installation of a circuit board into the stock ECU, plus Windows software which allows for re-programming of the ECU and datalog sensors.

#### FLASHPRO (DRIVE BY WIRE 2006 + HONDAS)

The FlashPro allows full user tuning and datalogging. It includes Windows based software called FlashProManager.

The FlashPro connects from your laptop's USB port to your vehicles diagnostic port to provide live tuning with a variety of calibrations, extensive real time and stored datalogging capabilities.

#### HONDATA TRACTION CONTROL

Traction Control for your s300, KPro or FlashPro. Hondata Traction Control works by monitoring the ABS wheel speed sensors and reducing engine output when excessive wheel-spin is detected. A dash mountable switch allows the selection of different target slip rates, and software allows the system to be tuned for your specific vehicle setup. More details will be available shortly.

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