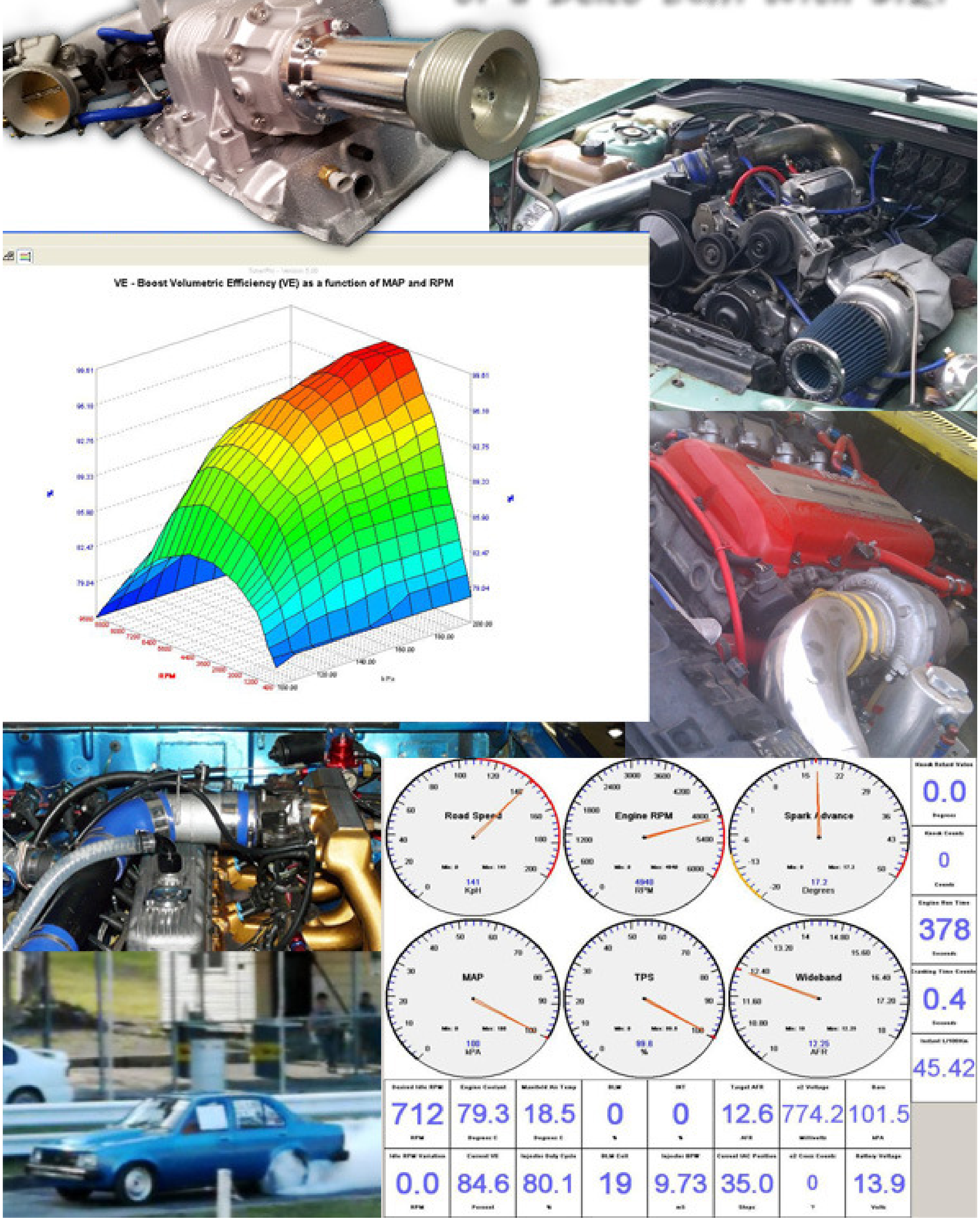
Advanced Tuning
of a Delco ECM With $12P



ADVANCED TUNING OF A DELCO ECM - v1.02
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ADVANCED TUNING OF A DELCO ECM - $12P

Disclaimer: This document is based around tuning $12P code and as such is intended as a general guide only as different code bases have subtle differences and different models require different tuning techniques, this is also by no means a full manual for tuning a delco! This is a guide only, and any attempt to tune any vehicle is done at your own risk.
This also assumes the user has the ability to log data from the ECM through Tuner Pro V5 and has a wideband oxygen sensor installed on the motor with an analog input into the ECM.

Abbreviations:

VE – Volumetric Efficiency
AFR – Air fuel Ratio
AE – Accelerator Enrichment
DE – Deceleration Enleanment
PWM – Pulse Width Modulation
WOT – Wide Open Throttle
BPW – Base Pulse Width
IAC – Intake Air Control
mS – MilliSeconds
BARO – Barometric Pressure
RDSC - RPM Derivative Spark Control
BKRTD – Burst Knock Retard
ISA - Idle Spark Adjustment
ID - Idle Drive
DC – Duty Cycle
TP5 – Tuner Pro v5
TIBS - Tip In Bump Spark

Understanding Map Switch Functions:-

$12P supports switching between two sets of data for common variables. This can be useful when you wish to have 2 tunes on the same memcal, for example running with dual fuel.

Not all items can be switched, but the ones that are supported can be easily identified because they are listed twice and labels are prefixed with MAP A and MAP B.

To use the map switching option you need to connect a wire from pin B9 on the ECM through a switch and then to ground – there is no pin in the standard wiring loom so you will need to find a spare one from another loom and put it into the wiring harness plug.
By default if there is no switch connected then the code will use MAP A settings.

All the dual options will usually be populated with the same thing in both MAP A and MAP B by default, but if you are planning to use this feature just double check them all before you go switching and driving!

There are many reasons why you might want to use the map switching feature, a few are listed below:-

- High and low octane spark maps to allow using 91 octane or 98 octane fuel.
- Dual fuels – for example a race car that is driven on the street, you can use pump fuel for the street then flick the map switch and use race fuel at the track – some fuels like methanol or E85 generally like a lot more timing than you can run on petrol.

Please note, this is not the same as the NVRAM bank switching, as the bank switching actually changes to a separate part of the NVRAM memory space and this needs to be fully populated to be used properly too.

Map Switch:

- Can switch maps on the fly.
- Can be copied on to a 256kbit or larger eprom and retain the functionality.
- Requires $12P code.

NVRAM Switch:

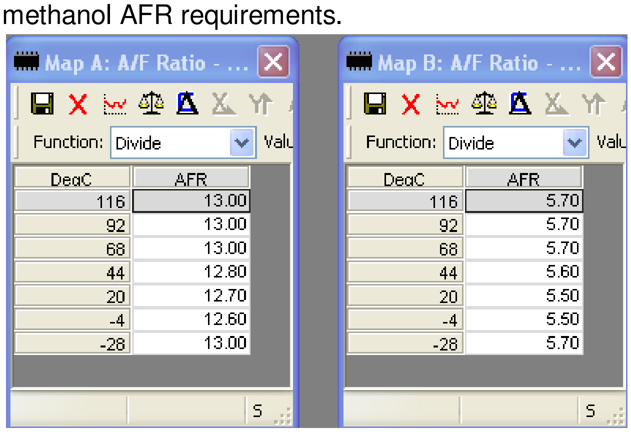
- Operates outside of the tune.
- Requires delcohacking.net NVRAM hardware.
- Cannot be switched while car is running or ignition is on.
- Does not require $12P.

So let's analyze the high/low octane option, now this is a simple setup which generally will have nothing changed from a standard tune other than spark tables. One of the most common reasons for using this is if you increase the compression of a standard motor say from 9.5:1 to 10.5-11:1, now the 9.5 from the factory has been tuned to work in all conditions on 91 octane fuel without knocking. Now going to 10.5:1 works fine on 98 octane fuel but on anything less it will knock, so what you can do is use the map switch to make MAP B your high octane table, so when you put 98 octane fuel in the car, flick the switch and you get more power, but then if you can't afford 98 or there's none at the outback servo you happen to pull into then you can flick the switch back and use 91 safely.

So generally in this case you would tune the 98 octane map on a dyno to get the most power out of it you can, then you put 91 fuel in the car, flick the switch and you would need to probably remove anywhere from 2-10 degrees of timing to get the 91 octane map to work without knocking. Obviously this is not something that can be easily done on the street as excess knock could kill the motor faster than you can tune it, but a dyno would allow you to get the timing spot on for both fuels.

The second example which is far more in depth would be if you were using say 98 octane petrol on the street and methanol at the track. Now the biggest issue here is that an engine running on petrol will use a lot less fuel than on methanol, so there are a lot of things that need to be changed, so in this case you would leave all the MAP A options set for petrol, then start adjusting the MAP B options to work for methanol.

So one of the biggest differences straight away for methanol is that the open loop air fuel ratio tables need to be adjusted for methanol Stoichiometric value difference (14.7 parts of air for every 1 part of petrol compared to methanol's 6.4 parts of air for every 1 part of fuel).
Now this is where it gets a bit more complicated – not only do we need to change the main AFR table but we also need to change the cold AFR and idle AFR tables, basically, any MAP B table that had 14.7 references in it needs to be changed to 6.4 AFRs.
Example below on left is MAP A petrol AFR table compared to MAP B which has been offset to suit methanol AFR requirements.



Note: These are idle AFR tables so they show values richer than 14.7 and 6.4 but basically we started with the petrol AFR's in both and to offset the MAP B table do the following:

14.7 / 6.4 = 2.3

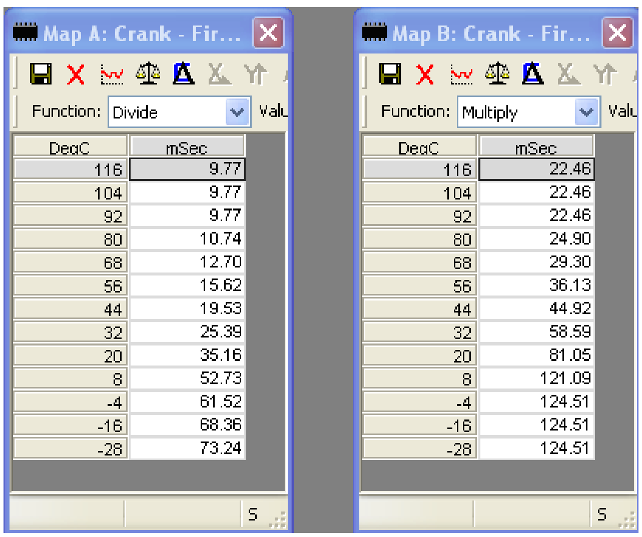
So then we select all the cells in MAP B table, use the function up the top to divide the table values by 2.3 and this will give you the values you see in the above example.

The same dividing method can be applied to all AFR tables to convert from one fuel to another as long as you know the stoichiometric value for each fuel being used.

AFR tables are by far the most critical tables to change when switching between fuel types, but another very important set of tables to change is the cranking fuel BPW tables as these tables don't use a multiplier or anything like that, they use a number in milliseconds (mS) of how long to open the injector.

To put this into context, if you have a V6 commodore motor, totally stock, and you want to use MAP B for methanol you need to supply 2.3 time more fuel than on petrol, so for a given mS time the injector is open you need to multiply these values by 2.3.

As you can see in the below tables, on the left is the stock cranking BPW values and on the right is the same values multiplied by 2.3 to give the required mS opening time needed to supply the engine with enough fuel to start on methanol.



Map A: Crank - Fir...

Function: Divide

DegC	mSec
116	9.77
104	9.77
92	9.77
80	10.74
68	12.70
56	15.62
44	19.53
32	25.39
20	35.16
8	52.73
-4	61.52
-16	68.36
-28	73.24

Map B: Crank - Fir...

Function: Multiply

DegC	mSec
116	22.46
104	22.46
92	22.46
80	24.90
68	29.30
56	36.13
44	44.92
32	58.59
20	81.05
8	121.09
-4	124.51
-16	124.51
-28	124.51

It is worth noting that a lot of this is not always as easy as just multiplying a table as above. For instance, if you have injectors that are twice as big as stock then you will probably need to roughly halve these tables before even thinking about adjusting them to suit a different fuel.

Before you go too far, have a good look through the variables that are available for dual maps. Anything with MAP A or MAP B in front of the description can be used to customise the settings and there are a lot of them in the Scalars, Flags and Tables sections.

Flex Tables:-

There are a few parts to using the flex tables in $12P. First and foremost, you need to have the pins connected on the wiring harness as follows:-

A4 ; Flex Output A
A3 ; Flex Output B
D12 ; Flex Output C
A7 ; Flex Output D - Works as TCC solenoid if Automatic Transmission, Flex table if Manual Transmission.

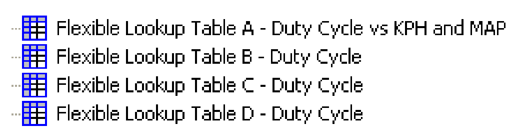
All the flex outputs are the ground side of any circuit, so if you wanted to use a flex table to activate a relay, you would supply power to the relay from the battery on pin 85, and then on pin 86 you would connect it to the above listed flex output pin and when active this will ground the output and complete the circuit.

Some examples of this will be explained below to show you how to setup a few different flex table configurations.

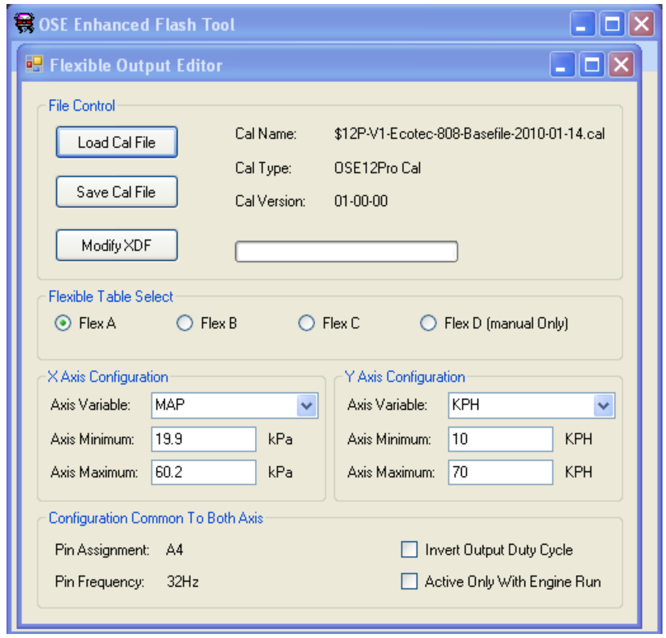
First example is a pretty straight forward use for a flex table.
In the case of running an Ecotec motor on an 808 ECM the biggest issue I came across was trying to use the Ecotec charcoal canister. How it works is that it uses a solenoid to open/close the vacuum line to the canister, this is what is used to regulate when the fuel vapours are sucked from the canister and how fast. In the Ecotec PCM there is a fairly complex bit of code to run this solenoid which takes into account things like road speed, engine load, coolant temperature and various others.

To get this to work as best as possible on an 808 ECM the flex table was setup to activate the original Ecotec canister solenoid.

So as you can see I used flex table A and its axis are KPH and MAP.



So to set this up firstly you need to open the OSE Enhanced Flash Tool, go to the “binary functions” menu and select “flexible output editor”, then you need to load your current tune file with “load cal file” button.



Now you need to select which output you want to edit (A, B, C, D) then below it you get the option to configure the X & Y axis parameters.

In the case of the canister solenoid we want to setup the MAP variable as the X axis and KPH variable as the Y axis.

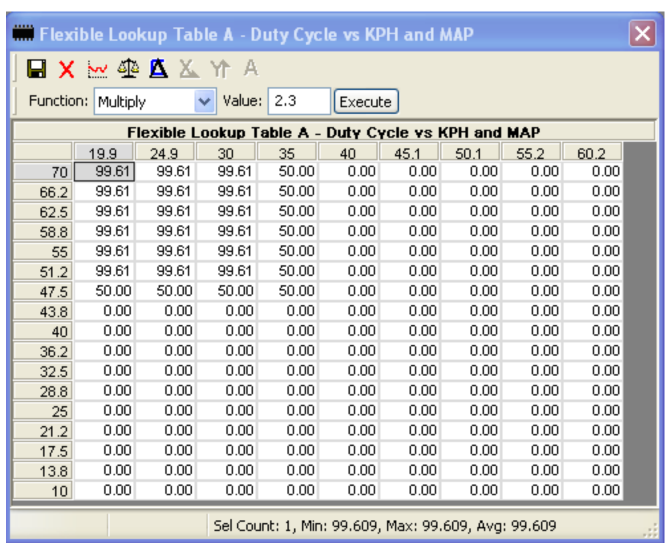
Also you will note that the min/max settings are definable, this allows you to have more resolution in adjustment between the min/max ranges. This is handy to allow you to define on/off points more specifically if required.

Once the axis are setup there are some other options down the bottom that can be adjusted, inverting output means whether 100% duty cycle is on or off, and active only with engine running is fairly self explanatory.

Once you are happy with the configuration of the flex table settings you need to do two things:

1. Save the cal file - This will populate the cal file with the required settings you have just defined above.
2. Modify the XDF – this will populate the XDF with the information required to display your settings in the table with the right axis and update the description of the table to reflect the axis as per picture on previous page.

Note: It’s a good idea to save the newly created files as a different name so if you have any issues you can go back to previously working files.



Flexible Lookup Table A - Duty Cycle vs KPH and MAP

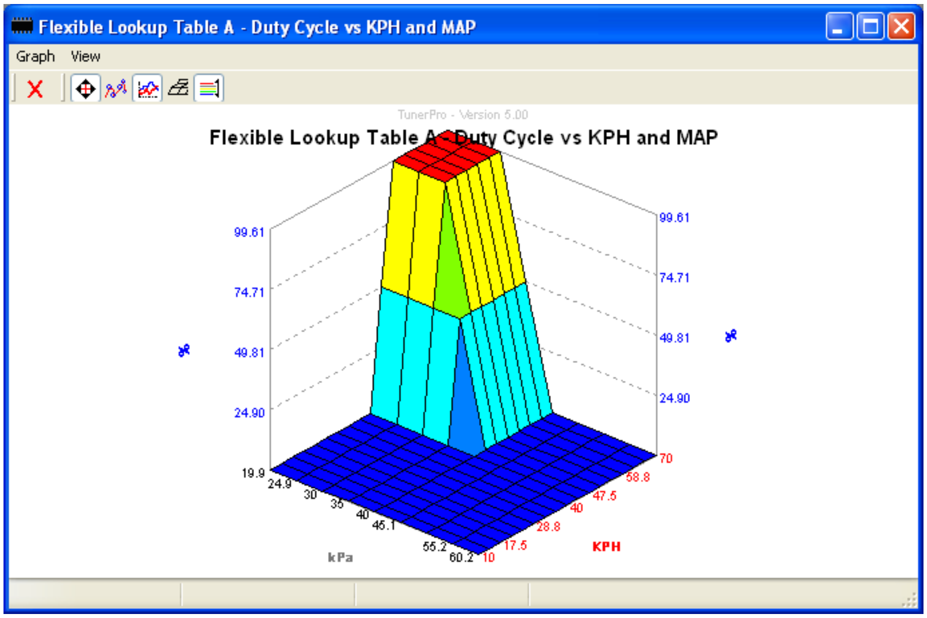
	19.9	24.9	30	35	40	45.1	50.1	55.2	60.2
70	99.61	99.61	99.61	50.00	0.00	0.00	0.00	0.00	0.00
66.2	99.61	99.61	99.61	50.00	0.00	0.00	0.00	0.00	0.00
62.5	99.61	99.61	99.61	50.00	0.00	0.00	0.00	0.00	0.00
58.8	99.61	99.61	99.61	50.00	0.00	0.00	0.00	0.00	0.00
55	99.61	99.61	99.61	50.00	0.00	0.00	0.00	0.00	0.00
51.2	99.61	99.61	99.61	50.00	0.00	0.00	0.00	0.00	0.00
47.5	50.00	50.00	50.00	50.00	0.00	0.00	0.00	0.00	0.00
43.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
36.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
32.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
28.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13.8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

So with all that completed you now need to open TP5 and load the new cal and xdf so you can start populating the table. This table is the setup I decided on for the canister solenoid.

As you can see i have everything above 51.2kph having the solenoid fully open, whereas 47.5kph is pulsing the solenoid at 50% DC and also the solenoid is only active from 40 kpa map and below.

It is worth noting that the edges of the table are what will be used above that point, so anything above 70kph will use 100% DC as long as it’s in the 0-35kpa map range. Likewise, anything out of that rang above 70kph will be 0% DC.

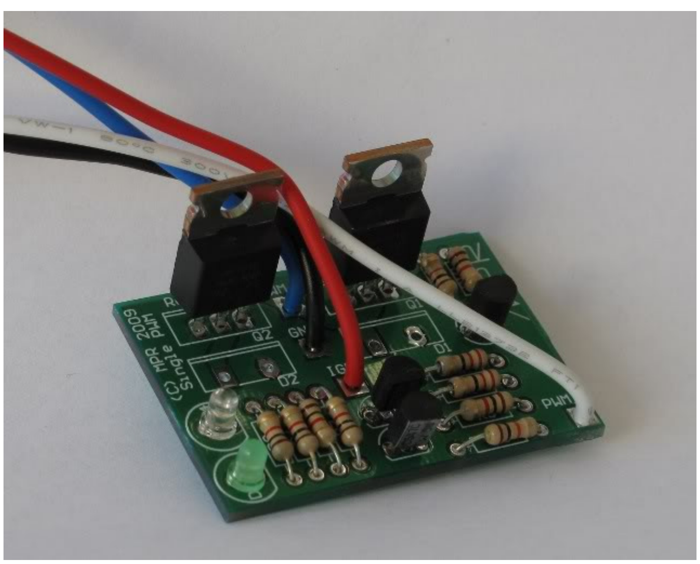
This graph is just the 3D version of the previous page table.



Another use for the above solenoid would be to use as a boost solenoid and the axis could be rpm's v's MAP to allow control over boost levels etc.

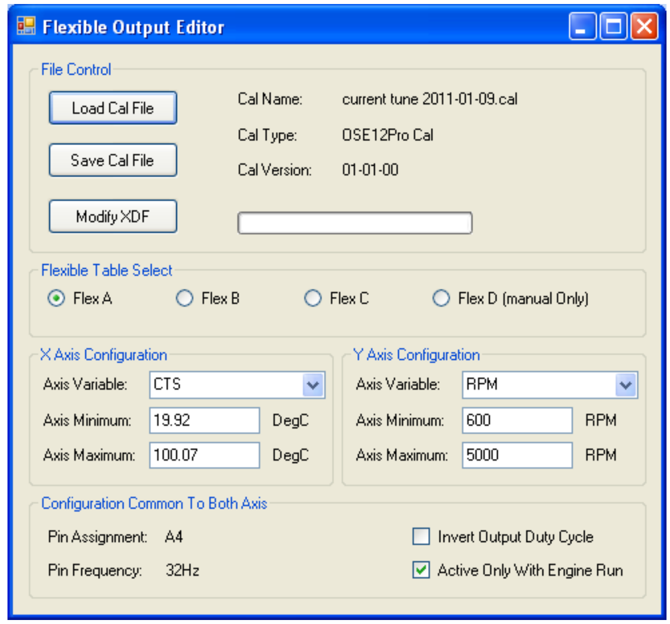
Now a slightly more complex use for the flex tables requires more than just a basic solenoid. This next example is going to describe how you can setup a PWM Controller to control an electric water pump or something similar.

To do it you need one of VL400's PWM Driver interface boards which can be bought from here:-
(http://delcohacking.net/forums/viewtopic.php?f=14&t=397#p4379)



This device is a voltage controller which works in conjunction with the flex tables output to speed up/slow down a 12v motor.

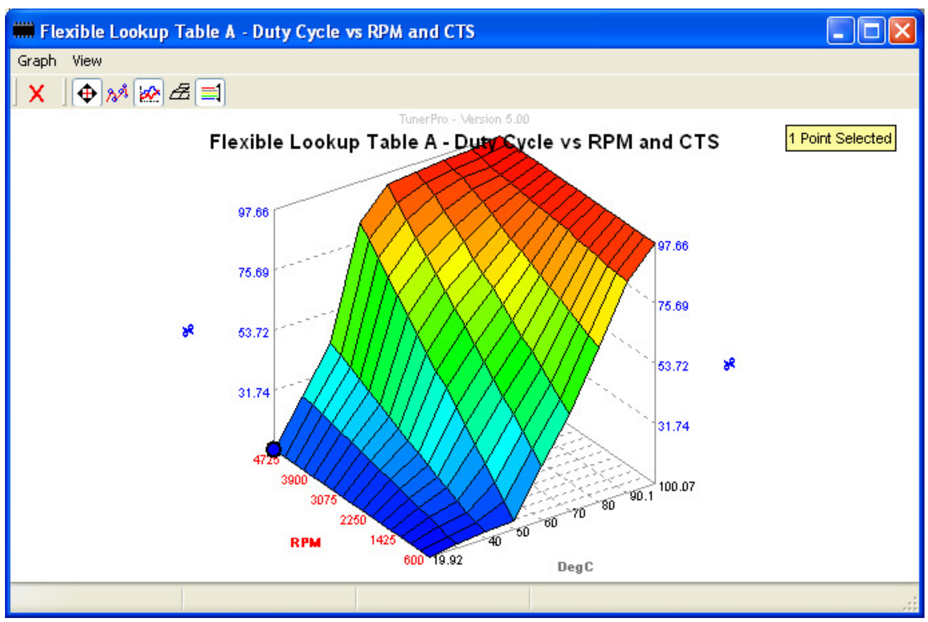
With the PWM Driver installed you then need to setup a flex table to drive it, and again this can be done with various sensors on each axis depending on your requirements. In this example it is being setup to run the water pump slowly when the engine coolant is colder and engine rpms lower, but as both rise so does the pump speed, this is to roughly mimic a normal mechanical water pump as closely as possible with the added advantage of being able to slow the water flow through the radiator when the engine is cold to the point of not flowing at all to allow the engine to warm up without requiring a thermostat to be fitted.
The only real difference in this table to the previous one is that the tick box is selected so when the engine stops/stalls the water pump also stops.



Now as you can see in the below graph the table slowly increases DC as the rpms and coolant temperature increase.

This could be done on a 2D table with just DC v's Coolant or something similar but it could also be mapped as a 3D table with any other sensor of your choosing.

Also note that outside of the table boundaries it will use the last value in the table, so if the coolant temperature exceeds 100 Degrees C then it will use the 100% DC value regardless of engine RPM's.



Likewise if the engine is stone cold and revved to 6000rpm it will use the low temperature values of the left hand side of the graph.

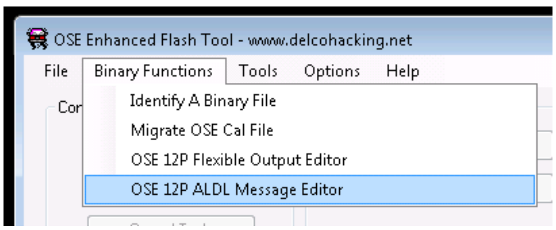
Another thing you can do with the flex tables is to have the DC % output from one table can be the axis for a second flex table, this obviously gives you endless options as to how you can have it configured.

Message 6 Customisation:-

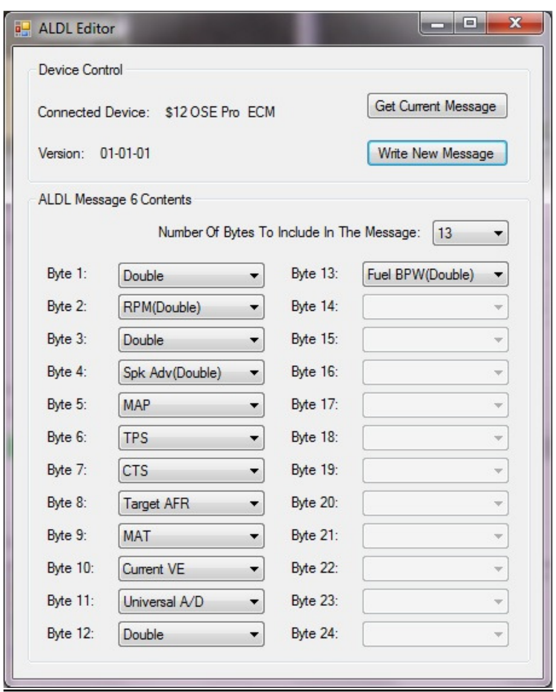
Custom Message 6 allows you to have data in your logs collected at faster sampling rates by removing items that you don't need to log. This is done by defining a custom message, for example, if you were drag racing and only wanted, RPM, TPS, CTS, MAT, Target AFR, Wideband AFR and Knock Retard, you could create a custom message for only these items and you may be able to get 2-3 times more samples per second than if you were using the complete message logging – but this is also very much dependant on the ability of your laptop, some older machines just don't have the performance to keep up with faster logging.

It will depend on what you are doing as to whether this can be useful or not, another example would be if you were on a dyno and only wanted to see the stuff specific to your dyno changes but also want to get the fastest responses so it gives you an accurate account of what your trying to change.

So to setup a custom message 6 configuration firstly you need to connect your laptop to the car and have the ignition on, then use the OSE Enhanced Flash Tool to connect, and then pull up the current configuration, this can be found in the Binary Functions menu of the flash tool.



Hit the "Get Current Message" button and it should display something similar to this, then all you need to do is set the length of the message to the amount you need to display. Then pull down each byte and fill in the fields you require, as per below, 10 bytes but only 8 items as 2 of them are 16 bit and need 2 bytes.



Once you are happy with this hit the "Write New Message" button to commit the changes to the ECM.

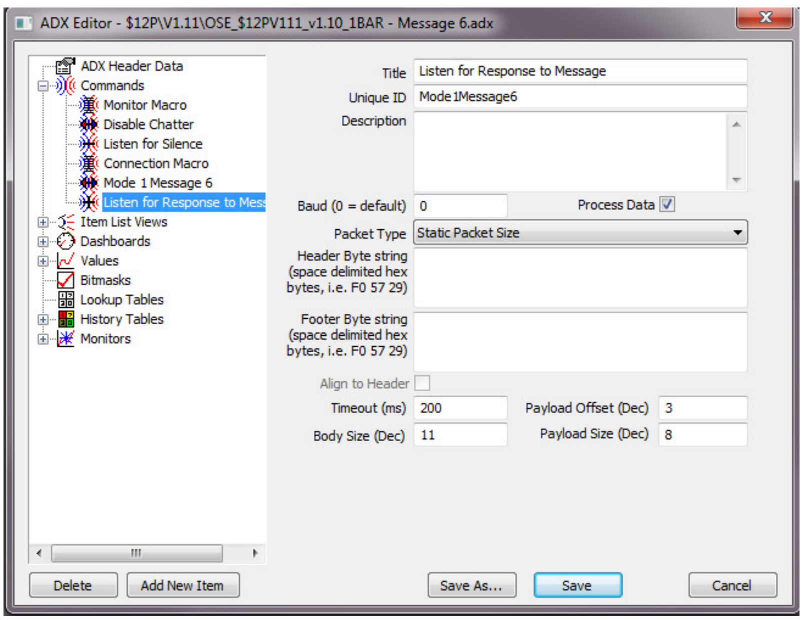
It is worth noting at this point, if you upload a complete bin to the NVRAM it will overwrite this information and similarly if you download a CAL only file it WILL NOT have the custom message information in it, so if you want to get a backup then do a "Get Bin" and save somewhere so you have a copy if you need to re-apply it.

If you want to confirm that you have applied this properly, turn the ignition off for 10 seconds, then back on, re-connect and go back in and get the message information again and make sure it brings back the info you configured above.

Now that the ECM side of this is completed all that is left to do is modify an adx to reflect the changes you have made so it shows the right information and right amount of bytes etc.

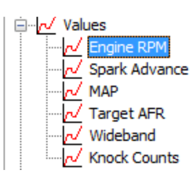
To begin we will use the message 6 adx that comes in the OSE $12P v1.11 zip file which is called ose_$12pv111_v1.00_1bar – message 6.adx but you do not have to use this you can use any adx you like, I am only using this one as its already a message 6 adx so a lot of the hard work is done in it.

First thing to look at is the configuration:



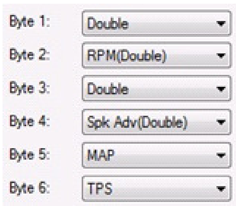
The main items that need changing are body size and payload size, and these change dependant of how many items you have selected above. For the above message 6 configuration we have 13 bytes of data to collect so we need to increase the payload size to 13 and increase the body size to 16.

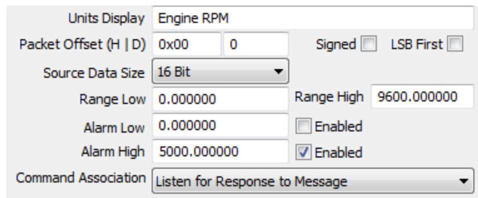
The next thing we need to do is to setup the values that we are logging so they are the right offsets and have the right configuration and conversions.



So the default settings of this adx are a good starting point, but we need to make sure they have the right offsets and to do this click on each, so Engine RPM is offset 0x00 and 16 bit, so this is fine.

Please note in the flashtool configuration if an item is a double value then it will be a 16 bit data size in the adx configuration.





So as you can see in the first 6 bytes of the message 6 settings we have byte 1 & 2 and byte 3 & 4 are both doubles and the byte 5 and byte 6 are both singles. So we set the adx to use 16 bit for 0x00 offset (engine rpm) and 16 bit for 0x02 offset (spark advance) and then 8bit for 0x04 offset (map) and so on.

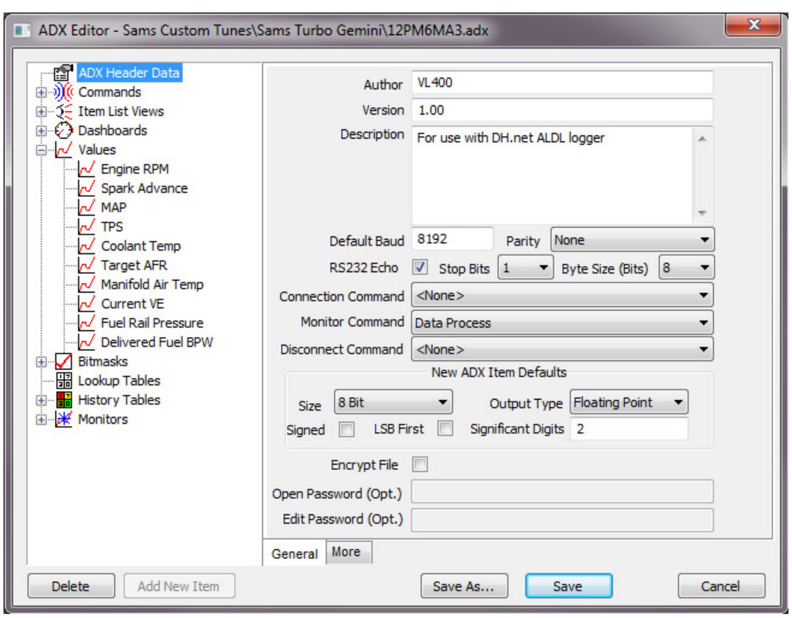
As far as offsets go, they go in order of the message 6 configuration, and increment 1 offset per each 8 bit item. Also note that once you get to 0x09 offset you go 0x0A, 0x0B, 0x0C, 0x0D, 0x0E, 0x0F, and then 0x10, 0x11, etc, but also as you can see above there is an option to use the Hex value or to the right of it decimal value, so if you were to put an offset in the decimal value of 15, it will automatically fill in the hex value for you with 0x0F.

Aside from setting this stuff up specific to message 6 logging, you can usually just reference a OSE $12P full message adx and get the calculations and range/alarm etc info from them and put them into the message 6 values.

If you want to add more items to an adx you select the last value in this case, knock counts, and then hit the "add new item" button and it will put the new item at the end of the list, if you have a middle item selected it will put the new item in between it and the next one in the list.

Once you have everything setup make sure you press the SAVE AS… button so you don't overwrite the original file.

If you have done everything right you should end up with something looking like this (for the above example).



Tuning Boost:-

My best suggestion before tuning boost on any motor is the make sure you have the non-boosted section of the tune pretty well spot on, i.e. Make sure the 100kpa column of your tune is spot on, because this will have a bearing on how the rest of the boost map turns out.

First things first: a quick list of the main flags/tables needed for boost tuning.

- Map A: MAP Sensor Type Selection A \ A:B Clear = 1Bar
- Map A: MAP Sensor Type Selection B / A Set = 2Bar, B Set = 3Bar
- Map A: EST - 20-100kPa Main Spark Advance vs MAP and RPM
- Map A: EST - Boost Main Spark Advance vs MAP and RPM
- VE - 20-100kPa Volumetric Efficiency (VE) as a function of MAP and RPM
- VE - Boost Volumetric Efficiency (VE) as a function of MAP and RPM
- Boost - Boost Multiplier Vs MAP (100-200kPa or 100-300kPa)
- Map A: A/F Ratio - Cold Engine A/F Ratio vs Coolant Temp and MAP
- Map A: A/F Ratio - Boost Cold Engine A/F Ratio vs Coolant Temp and MAP
- Map A: A/F Ratio - Idle A/F Ratio vs Coolant Temperature
- Map A: A/F Ratio - 20-100kPa Air Fuel ratio vs RPM and MAP
- Map A: A/F Ratio - Boost Air Fuel ratio vs RPM and MAP

So obviously you need to set your flags to suit weather you have 2 or 3 bar map sensor, In my case with a 2 bar map sensor I ticked the “Map Sensor Type Section A” and left “Map Sensor Type Section B” un-ticked.

Next thing to do is to make sure the boost main spark table is setup for a starting point. To do this you want to get the 100kpa column from the 20-100kpa main spark table and copy it into every cell of the boost spark table.

As can be seen below, the 100kpa column has been replicated into all columns of the boost table.

...nd RPM

90	95	100
33.40	33.75	33.05
33.40	33.75	33.05
33.40	33.75	33.05
33.40	33.75	33.05
33.40	33.75	33.05
33.40	33.75	33.05
33.40	33.75	33.05
33.05	33.40	32.70
31.99	32.70	31.99
31.99	32.70	31.99
31.99	32.70	31.99
31.99	32.70	31.99
30.59	32.34	31.64
29.88	31.29	30.59
29.53	29.88	29.18
29.53	28.48	27.77
29.53	28.48	27.42
29.53	28.48	27.42
29.18	28.13	27.07
27.77	27.42	26.72
27.07	26.72	26.37
27.07	26.72	26.37
27.07	26.72	26.37
27.07	26.72	26.37

Map A: EST - Boost Main Spark Advance vs MAP and RPM

Function: Multiply Value: 1.05 Execute

Map A: EST – Boost Main Spark Advance vs MAP and RPM

	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00	180.00	190.00	200.00
9600	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05
9200	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05
8800	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05
8400	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05
8000	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05
7600	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05
7200	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05	33.05
6800	32.70	32.70	32.70	32.70	32.70	32.70	32.70	32.70	32.70	32.70	32.70
6400	31.99	31.99	31.99	31.99	31.99	31.99	31.99	31.99	31.99	31.99	31.99
6000	31.99	31.99	31.99	31.99	31.99	31.99	31.99	31.99	31.99	31.99	31.99
5600	31.99	31.99	31.99	31.99	31.99	31.99	31.99	31.99	31.99	31.99	31.99
5200	31.99	31.99	31.99	31.99	31.99	31.99	31.99	31.99	31.99	31.99	31.99
4800	31.64	31.64	31.64	31.64	31.64	31.64	31.64	31.64	31.64	31.64	31.64
4400	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59	30.59
4000	29.18	29.18	29.18	29.18	29.18	29.18	29.18	29.18	29.18	29.18	29.18
3600	27.77	27.77	27.77	27.77	27.77	27.77	27.77	27.77	27.77	27.77	27.77
3200	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42
2800	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42	27.42
2400	27.07	27.07	27.07	27.07	27.07	27.07	27.07	27.07	27.07	27.07	27.07
2000	26.72	26.72	26.72	26.72	26.72	26.72	26.72	26.72	26.72	26.72	26.72
1600	26.37	26.37	26.37	26.37	26.37	26.37	26.37	26.37	26.37	26.37	26.37
1200	26.37	26.37	26.37	26.37	26.37	26.37	26.37	26.37	26.37	26.37	26.37
800	26.37	26.37	26.37	26.37	26.37	26.37	26.37	26.37	26.37	26.37	26.37
400	26.37	26.37	26.37	26.37	26.37	26.37	26.37	26.37	26.37	26.37	26.37

Sel Count: 1, Min: 33.047, Max: 33.047, Avg: 33.047

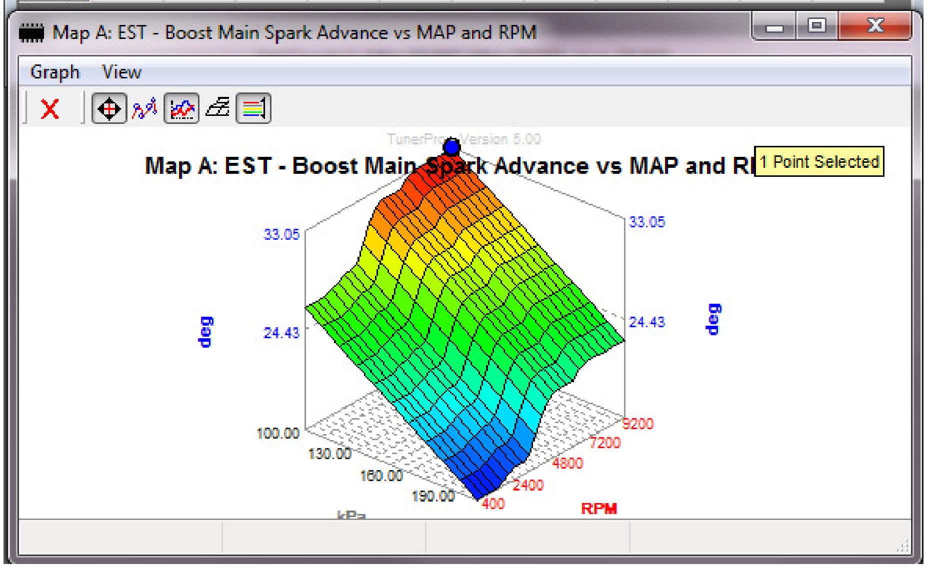
Next thing to do is select 110-200kpa all cells, then subtract 1 degree of timing, then select 120-200kpa all cells and then subtract 1 degree of timing, and continue this dropping 1 degree for every 10kpa to the end of your table.

Map A: EST - Boost Main Spark Advance vs MAP and RPM

Function: Offset (+/-) Value: -1 Execute

Map A: EST – Boost Main Spark Advance vs MAP and RPM

	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00	180.00	190.00	200.00
9600	33.05	31.99	30.94	29.88	28.83	27.77	26.72	25.66	24.61	23.55	22.50
9200	33.05	31.99	30.94	29.88	28.83	27.77	26.72	25.66	24.61	23.55	22.50
8800	33.05	31.99	30.94	29.88	28.83	27.77	26.72	25.66	24.61	23.55	22.50
8400	33.05	31.99	30.94	29.88	28.83	27.77	26.72	25.66	24.61	23.55	22.50
8000	33.05	31.99	30.94	29.88	28.83	27.77	26.72	25.66	24.61	23.55	22.50
7600	33.05	31.99	30.94	29.88	28.83	27.77	26.72	25.66	24.61	23.55	22.50
7200	33.05	31.99	30.94	29.88	28.83	27.77	26.72	25.66	24.61	23.55	22.50
6800	32.70	31.64	30.59	29.53	28.48	27.42	26.37	25.31	24.26	23.20	22.15
6400	31.99	30.94	29.88	28.83	27.77	26.72	25.66	24.61	23.55	22.50	21.45
6000	31.99	30.94	29.88	28.83	27.77	26.72	25.66	24.61	23.55	22.50	21.45
5600	31.99	30.94	29.88	28.83	27.77	26.72	25.66	24.61	23.55	22.50	21.45
5200	31.99	30.94	29.88	28.83	27.77	26.72	25.66	24.61	23.55	22.50	21.45
4800	31.64	30.59	29.53	28.48	27.42	26.37	25.31	24.26	23.20	22.15	21.09
4400	30.59	29.53	28.48	27.42	26.37	25.31	24.26	23.20	22.15	21.09	20.04
4000	29.18	28.13	27.07	26.02	24.96	23.91	22.85	21.80	20.74	19.69	18.63
3600	27.77	26.72	25.66	24.61	23.55	22.50	21.45	20.39	19.34	18.28	17.23
3200	27.42	26.37	25.31	24.26	23.20	22.15	21.09	20.04	18.98	17.93	16.88
2800	27.42	26.37	25.31	24.26	23.20	22.15	21.09	20.04	18.98	17.93	16.88
2400	27.07	26.02	24.96	23.91	22.85	21.80	20.74	19.69	18.63	17.58	16.52
2000	26.72	25.66	24.61	23.55	22.50	21.45	20.39	19.34	18.28	17.23	16.17
1600	26.37	25.31	24.26	23.20	22.15	21.09	20.04	18.98	17.93	16.88	15.82
1200	26.37	25.31	24.26	23.20	22.15	21.09	20.04	18.98	17.93	16.88	15.82
800	26.37	25.31	24.26	23.20	22.15	21.09	20.04	18.98	17.93	16.88	15.82
400	26.37	25.31	24.26	23.20	22.15	21.09	20.04	18.98	17.93	16.88	15.82



Note: if you use a 3 bar sensor you will want to drop at a rate to suit 100-300kpa instead of 100-200kpa range.

Now that your spark table is completed its time to sort out the boost ve table. This is similar to the spark table in that you need to use the 100kpa ve table column to copy over into the boosted ve table. One thing to note is that the boosted ve table is shorter than the 20-100kpa ve table so you need to take that into account when copying. This part of the tune is where it pays to have the 100kpa cells all accurate for your engine as they will reflect into the boosted section if the numbers are out.

Notice below in the boost table I haven't copied the top row of the 20-100kpa ve table as its 9600rpm.

MAP and RPM

…tion of MAP and RPM

90	95	100
49.61	49.61	49.61
50.00	50.00	50.00
50.39	50.39	50.39
50.78	50.78	50.78
50.78	50.78	50.78
51.17	51.17	51.17
51.56	51.56	51.95
52.34	53.13	51.95
53.13	54.69	53.13
54.69	56.64	57.03
55.86	60.16	60.16
50.78	62.50	63.28
53.52	61.72	64.06
57.03	70.31	61.72
61.33	70.31	62.89
58.98	60.55	64.84
67.97	47.66	55.86
60.16	60.55	46.48
56.25	75.78	73.44
57.03	99.61	99.61
63.67	99.61	99.61
64.84	99.61	99.61
53.91	96.48	99.61
44.53	49.22	49.22
39.06	42.19	42.19
36.33	38.67	38.67
34.38	37.50	37.50
33.59	35.55	35.55
30.47	33.20	33.20

VE - Boost Volumetric Efficiency (VE) as a function of MAP and RPM

Function: Offset (+/-) Value: -1 Execute

VE – Boost Volumetric Efficiency (VE) as a function of MAP and RPM

	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00	180.00	190.00	200.00
9200	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
8800	50.39	50.39	50.39	50.39	50.39	50.39	50.39	50.39	50.39	50.39	50.39
8400	50.78	50.78	50.78	50.78	50.78	50.78	50.78	50.78	50.78	50.78	50.78
8000	50.78	50.78	50.78	50.78	50.78	50.78	50.78	50.78	50.78	50.78	50.78
7600	51.17	51.17	51.17	51.17	51.17	51.17	51.17	51.17	51.17	51.17	51.17
7200	51.95	51.95	51.95	51.95	51.95	51.95	51.95	51.95	51.95	51.95	51.95
6800	51.95	51.95	51.95	51.95	51.95	51.95	51.95	51.95	51.95	51.95	51.95
6400	53.13	53.13	53.13	53.13	53.13	53.13	53.13	53.13	53.13	53.13	53.13
6000	57.03	57.03	57.03	57.03	57.03	57.03	57.03	57.03	57.03	57.03	57.03
5600	60.16	60.16	60.16	60.16	60.16	60.16	60.16	60.16	60.16	60.16	60.16
5200	63.28	63.28	63.28	63.28	63.28	63.28	63.28	63.28	63.28	63.28	63.28
4800	64.06	64.06	64.06	64.06	64.06	64.06	64.06	64.06	64.06	64.06	64.06
4400	61.72	61.72	61.72	61.72	61.72	61.72	61.72	61.72	61.72	61.72	61.72
4000	62.89	62.89	62.89	62.89	62.89	62.89	62.89	62.89	62.89	62.89	62.89
3600	64.84	64.84	64.84	64.84	64.84	64.84	64.84	64.84	64.84	64.84	64.84
3200	55.86	55.86	55.86	55.86	55.86	55.86	55.86	55.86	55.86	55.86	55.86
2800	46.48	46.48	46.48	46.48	46.48	46.48	46.48	46.48	46.48	46.48	46.48
2400	73.44	73.44	73.44	73.44	73.44	73.44	73.44	73.44	73.44	73.44	73.44
2200	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61
2000	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61
1800	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61
1600	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61	99.61
1400	49.22	49.22	49.22	49.22	49.22	49.22	49.22	49.22	49.22	49.22	49.22
1200	42.19	42.19	42.19	42.19	42.19	42.19	42.19	42.19	42.19	42.19	42.19
1000	38.67	38.67	38.67	38.67	38.67	38.67	38.67	38.67	38.67	38.67	38.67
800	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50	37.50
600	35.55	35.55	35.55	35.55	35.55	35.55	35.55	35.55	35.55	35.55	35.55
400	33.20	33.20	33.20	33.20	33.20	33.20	33.20	33.20	33.20	33.20	33.20

Sel Count: 1, Min: 50.000, Max: 50.000, Avg: 50.000

Now this table will probably eventually change as you would with a normal ve table in boosted areas, but there is also another table which is "Boost Multiplier Vs MAP"

Boost - Boost Multi...

Function: Offset (+/-) Va

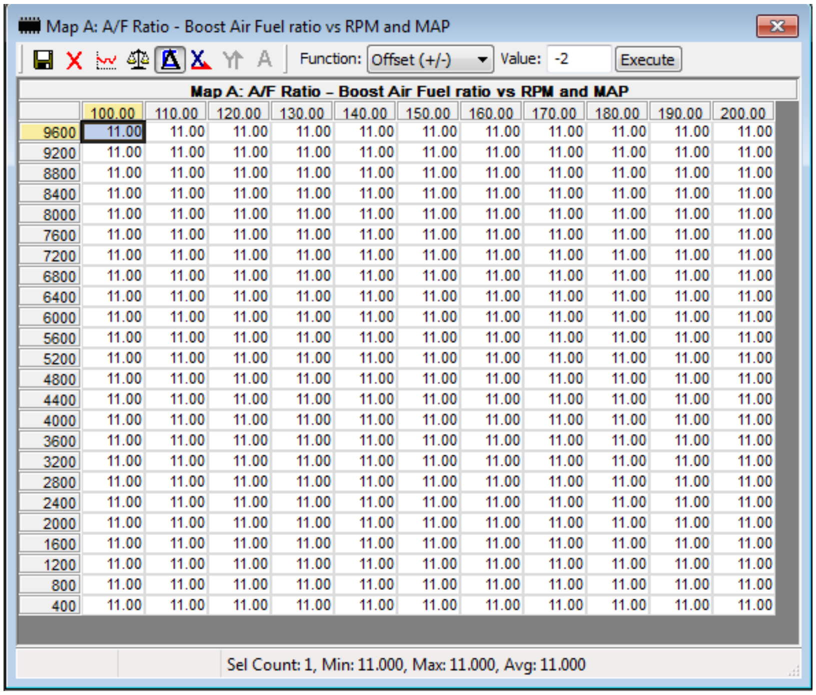
kPa	%
200.00	99.61
190.00	88.28
180.00	78.13
170.00	68.36
160.00	58.59
150.00	48.83
140.00	39.06
130.00	29.30
120.00	19.92
110.00	9.77
100.00	0.00

How this table works is it uses the numbers in the boosted ve table at the load point you are at and multiplies it, i.e. if you are at 2000rpm 130kpa then the number is 99.61, but then the multiplier will make it (99.61 x 1.2930) = 128.80.

This is how the ecm achieves a value of higher than 100% ve for boosted applications.

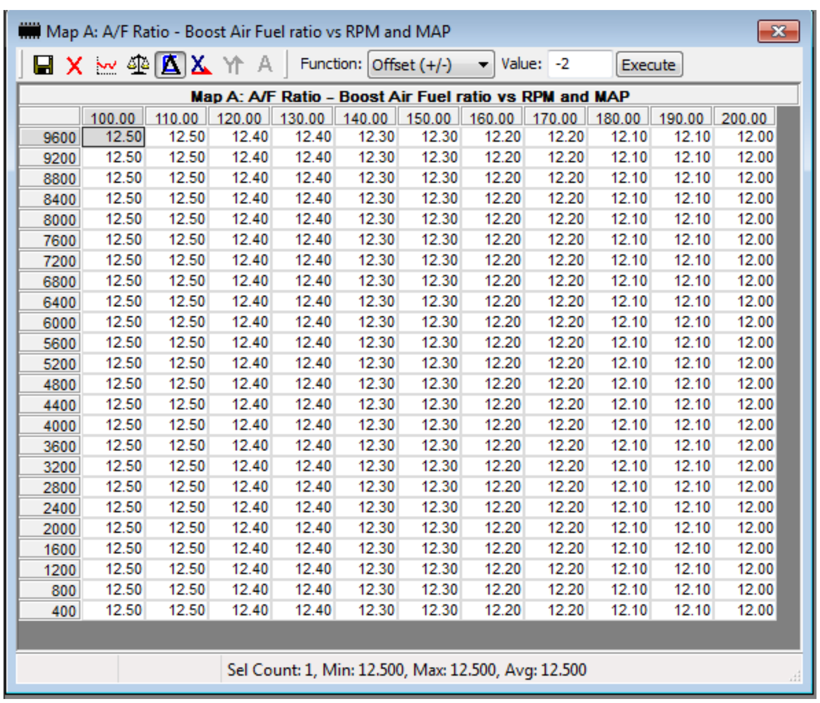
Generally you should be able to leave this table as it is and just offset the boosted ve table depending on data log histogram results, but it also allows more or less multiplier to be used if you found you needed a different value.

The final thing you need to do to make sure you have a reasonable starting tune for boost is to setup the "MAP A: A/F Ratio – Boost Air Fuel Ratio Vs RPM and MAP" and to do this you need to fill the table with a nice safe number, as can be seen below.



	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00	180.00	190.00	200.00
9600	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
9200	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
8800	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
8400	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
8000	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
7600	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
7200	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
6800	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
6400	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
6000	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
5600	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
5200	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
4800	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
4400	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
4000	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
3600	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
3200	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
2800	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
2400	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
2000	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
1600	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
1200	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
800	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
400	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00

This will probably use a lot of fuel and be pretty rich out the exhaust but it will also mean if your fuelling is on the lean side it will still be pretty safe to start off with. Once you have done a bit of tuning and can confirm the boost AFR (from wideband) matches the commanded AFR then you can look at changing the boost AFR table to something more like this one below.

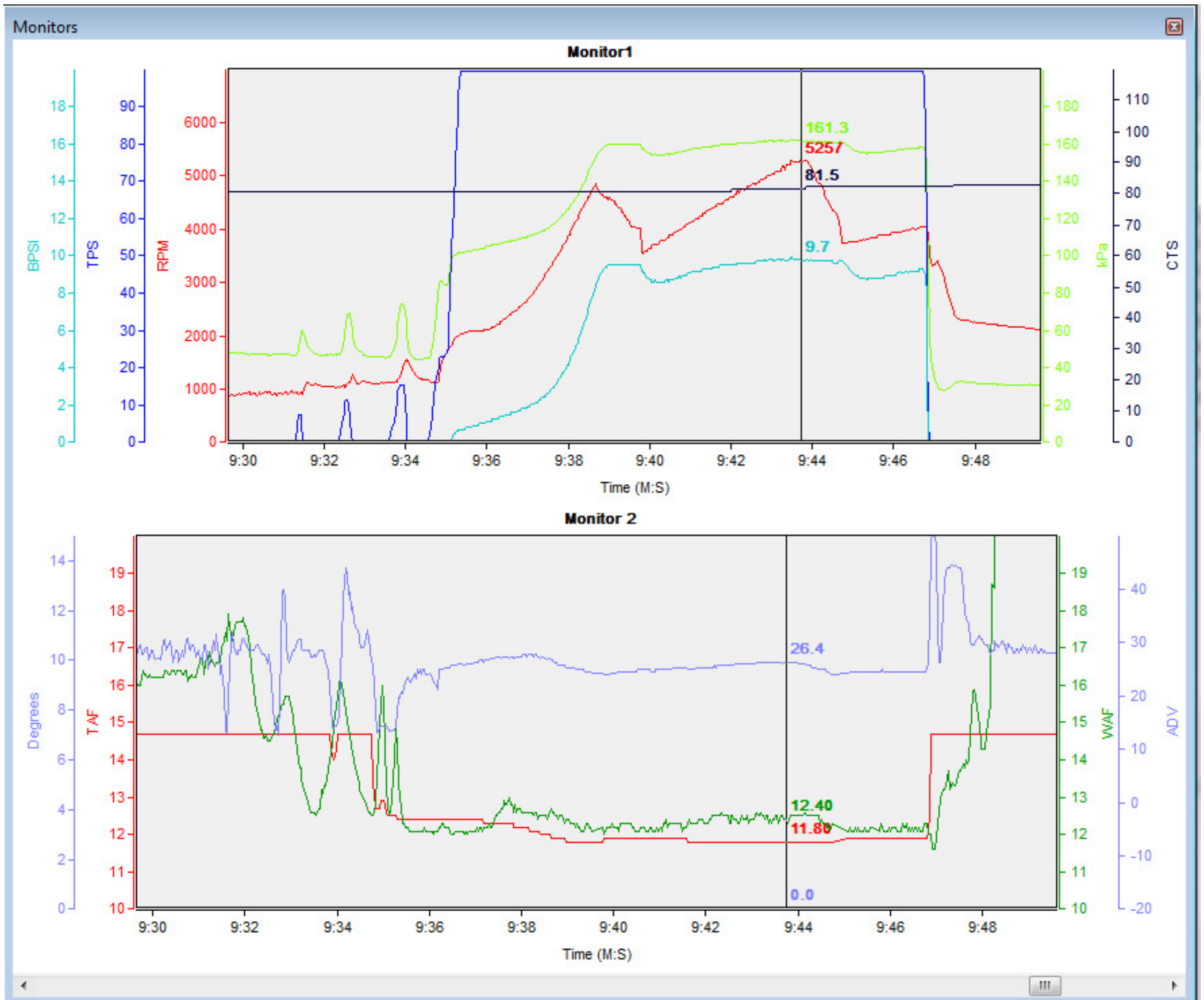


	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00	180.00	190.00	200.00
9600	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
9200	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
8800	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
8400	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
8000	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
7600	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
7200	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
6800	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
6400	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
6000	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
5600	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
5200	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
4800	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
4400	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
4000	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
3600	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
3200	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
2800	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
2400	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
2000	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
1600	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
1200	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
800	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00
400	12.50	12.50	12.40	12.40	12.30	12.30	12.20	12.20	12.10	12.10	12.00

It is worth noting that it doesn't really appear that there is a hard and fast rule on what is the best boost AFR to run. Some people say use 12.00 for the entire boost AFR table, others like to have it like the above table, with 20-100kpa numbers in the first boost column then slowly richening as boost pressure increases. Also keep in mind here if you are running 3 bar map sensor all these tables are from 100-300kpa instead of 100-200kpa so take that into account with number scaling!

With all the above setup it's really just a matter of going for a drive and logging and seeing what happens.

Below is an example of a boost test run, please note this is not the first drive and I don't recommend going full throttle on the first drive, just slowly increase throttle to get into boost and watch AFR's, make sure it's not going too lean before you go too hard or you'll melt things. You can see in the screen shot that the wideband AFR (green line in bottom window) is fairly closely following the target AFR (red line in bottom window)



Just for reference in the top window the aqua line (BPSI) is boost PSI and is a calculation of map kpa converted into PSI and is used to ensure waste gate is set right.

So use logs like this and make AFR log histograms to get the numbers right and also keep a close eye on knock retard on boost and hopefully all you will be doing is enjoying the power as to you tune it more.

As far as spark timing on boost goes, it’s no different to a naturally aspirated motor, but the above tables are made to be probably on the conservative side and most setups will be able to handle more timing and you will get good results, but it’s also best to tune this side of it on a dyno where you can get it right, nothing will kill your motor quicker than too much timing on boost!

Rev Limiting with $12P:-

One of the big issues with the way the rev limiter works in an 808 ecm is that it cuts fuel, and the problem with this is if you have 14psi of boost going into your motor and you hit the rev limiter, engine parts might not be too happy with that for too long, but there is a way you can get around some of these possible issues by using the different soft touch limiting that is built into $12P code.

How this works is you are able to set a hard limiter of say 7000rpm, and then set the soft touch limiter to start at 6000rpm, and it will gradually remove timing advance as per its settings and if set properly this can mean the engine will never see the rev limiter instead it will just hold the revs just below 7000rpm, you can also set soft fuel cut.

To do this you need to know a bit more about the settings and what each do.

- π Map A: Rev Limit - RPM Below Upper Threshold To Start Soft Fuel-Cut
- π Map A: Rev Limit - Soft Fuel Cut Upper RPM Threshold - Above This Is Hard Fuel Cut
- π Map A: Rev Limit - Multiplier For Soft Fuel Cut Time
- π Map A: Rev Limit - RPM Below Upper Threshold To Start Ignition Retard
- π Map A: Rev Limit - Soft Touch Rev-Limit Advance Reduction
- π Map B: Rev Limit - RPM Below Upper Threshold To Start Soft Fuel-Cut
- π Map B: Rev Limit - Soft Fuel Cut Upper RPM Threshold - Above This Is Hard Fuel Cut
- π Map B: Rev Limit - Multiplier For Soft Fuel Cut Time
- π Map B: Rev Limit - RPM Below Upper Threshold To Start Ignition Retard
- π Map B: Rev Limit - Soft Touch Rev-Limit Advance Reduction

Rev Limit - RPM Below Upper Threshold To Start Soft Fuel-Cut - So this is the amount of rpm below "Map A: Rev Limit - Soft Fuel Cut Upper RPM Threshold - Above This Is Hard Fuel Cut" to start applying the soft touch rev limiting. So in the case above the hard cut is at 7000rpm, and then set this one as 200rpm, which means at 6800rpm it will start soft touch rev limiting (cutting injection events) and if the engine continues to rev to 7000rpm it will then hit the complete fuel cut limiter, set this to same as hard cut if you don't want it to do anything.

Rev Limit - Soft Fuel Cut Upper RPM Threshold - Above This Is Hard Fuel Cut - As per above this is the hard cut, ie. total fuel cut at this rpm.

Rev Limit - Multiplier For Soft Fuel Cut Time - This is a multiplier for how long and often it cuts the fuel while in the soft touch limiter mode. Think of the difference between the two thresholds as an RPM window, as you enter the window only the occasional event is dropped but the further you get in to this window the more frequent the injection events are dropped. The default setting does not need to be changed.

Rev Limit - RPM Below Upper Threshold To Start Ignition Retard - So there is also ignition retard settings, so if you set this as 1000rpm, and your hard limiter is 7000rpm, then at 6000rpm the timing will start being retarded which if set correctly will make the engine feel like it's starting to nose over and hopefully you'll pull another gear before hitting the hard cut limit!

Rev Limit - Soft Touch Rev-Limit Advance Reduction - This is the amount of advance to pull out of the timing when the advance reduction setting is used, can be zeroed if you don't want this feature. To get this one set right will probably take a few trial and error runs, depending on the motor you might need to remove double the timing of the default settings, shouldn't be too hard to see what works for your motor.

Barometric Pressure Settings:-

The barometric pressure adjustment is used to compensate for the changes in exhaust back pressure and air density when driving at different altitudes. As altitude increases the MAP kPa will reduce, this causes the ECU to start using lower MAP cells when looking up the VE. However due to the reduced exhaust back pressure the VE has actually increased above the value that will be selected from the VE table. To counteract this barometric compensation is required.

In 12P there are a few ways to have barometric adjustment. The factory method reads the MAP sensor before the engine starts to get an initial baro reading, then while driving the MAP sensor and baro are compared and under certain conditions can update, however this is not suitable in forced induction applications where the MAP sensor can easily exceed the baro pressure.

Some additional options have been added to correct this:

- Option to only use the baro reading at key on and not update it while running.
- Added a Baro vs VE multiplier table.
- Option to choose a baro adjusted load variable or MAP load variable when looking up VE.

The Cal data you'll need to find for this is as per below:

- Baro params - Maximum MAP offset for baro adjustment
- Map A: set=Update Baro During Run, clear=Only Update Baro When Engine Off
- Map A: set=Use VE Multiplier Table For VE Baro Adjustment, clear=Use Altitude Adjusted MAP For Vacuum VE Lookup (Boosted No Baro Comp)
- Map B: set=Update Baro During Run, clear=Only Update Baro When Engine Off
- Map B: set=Use VE Multiplier Table For VE Baro Adjustment, clear=Use Altitude Adjusted MAP For Vacuum VE Lookup (Boosted No Baro Comp)
- Baro params - Baro Adjustment offset to MAP A/D reading vs RPM & TPS
- Baro params - Baro Vs VE Mult
- EST - Altitude Advance(Deg) vs Baro & Vacuum

Naturally Aspirated 1 Bar – The factory baro adjustment works very well in this application and can make changes while driving. It should not be changed unless you have good reason to do so.

The ECU takes a MAP sensor reading as soon as the key is turned on and before the engine starts, this becomes the initial baro reading. While driving any time the MAP sensor reading exceeds the initial baro reading it will increase the baro. It can also update (both increase and decrease) if the RPM is 1200-3600RPM and TPS is greater than 37.5%.

When the ECU looks up the VE value it uses an Altitude Adjusted MAP Load Variable (AAMLV) instead of just pure MAP. The AAMLV is calculated using..
AAMLV = MAP / Baro * 100
This scales the value to 100kPa and ensures the VE table value will always be from the correct cell regardless of the reduced MAP and baro kPa.

As an example, if the engine is tuned at sea level with 100kPa baro, WOT should see 100kPa MAP and the 100kPa column of the VE table will be used. If the vehicle is driven to a high altitude and baro is 80kPa, WOT will also show 80kPa. The engines fuel requirements are no different from sea level WOT however using just MAP the VE lookup would be from the 80kPa column. While the air density is lower the exhaust back pressure has decreased proportionally resulting in a higher VE. Using the AAMLV (80kPa/80kPa * 100 = 100) to lookup the VE table the correct 100kPa column will be still used.

Forced Induction 2/3 Bar – Using a single MAP sensor it is not easily possible to have the baro update while the engine is running.

The baro is still read at key on however it should not be allowed to update while the engine is running. To stop this the flag “Update Baro During Run” should be cleared.

The Altitude Adjusted MAP Load Variable discussed in the 1 bar section above can no longer be used with 2/3 bar MAP sensors. This can only scale the MAP sensor over the vacuum range. Instead the flag “Use VE Multiplier Table For VE Baro Adjustment” should be set and the table “Baro params - Baro Vs VE Mult” used for VE correction. This then uses MAP for the lookup but after the lookup scales the VE according the multiplier to allow for the baro reading.

As an example if the the baro is 80kPa, the 80kPa VE multiplier is the default value of 1.08 and the VE table value from the 160kPa column is 85%...
Actual VE = Lookup value * VE Multiplier
Actual VE used = 85% * 1.08 = 91.8%

Burst Knock Retard:-

Burst Knock Retard is a form of pre-emptive engine knock control. BKRTD does not require a knock sensor to operate, it does not actually detect any engine knock and then retard timing, but instead tries to prevent it in the first place. On sharp throttle applications, and particularly at low RPMs, the engine has a tendency to knock or ping. BKRTD detects the fast throttle movement and will instantly remove some spark advance, the removed advance will then slowly be returned.

If the BKRTD calibration is set too aggressively, that is the BKRTD active spark retard value is set too high, the result will be a large flat spot when the throttle is quickly applied. Conversely if it is set to conservatively the engine may knock (which will be detected on knock sensor equipped vehicles) and cause damage.
In most $12 factory calibrations BKRTD is disabled.

In order for BKRTD to be active the following conditions need to be met:

- Coolant temp higher than “Burst Knock Retard - If coolant < This then skip Burst Knock Retard”
- RPM less than “Burst Knock Retard - If RPM > Cal then Zero BKRTD”
- TPS position less than “Burst Knock Retard - dTPS Detection For Entering BKRTD”
- TPS delta greater than “Burst Knock Retard - TPS Delta threshold to activate BKRTD”

The Cal data you’ll need to find for this is as per below:

π Burst Knock Retard - If coolant < This then skip Burst Knock Retard
π Burst Knock Retard - If RPM > Cal then Zero BKRTD
π Burst Knock Retard - TPS Delta threshold to activate BKRTD
π Burst Knock Retard - If REFS in BKRTD <= Cal then Zero BKRTD
π Burst Knock Retard - If REFS in BKRTD >= Cal then Zero BKRTD
π Burst Knock Retard - Burst Knock Retard active value
π Burst Knock Retard - BKRTD decay value
π Burst Knock Retard - dTPS Detection For Entering BKRTD

When all the conditions are met BKRTD will become active. Spark is not removed instantly, it is possible to delay the spark removal using “Burst Knock Retard - If REFS in BKRTD <= Cal then Zero BKRTD”. The ECU will wait for this many crank/dizzy reference pulses before the spark advance will be modified.
Spark Advance = Spark Advance – “Burst Knock Retard - Burst Knock Retard active value “

With BKRTD active the spark removed will be steady for a period of time and then gradually decayed back to 0. The time that the retard is steady for is the number of reference pulses determined by “Burst Knock Retard - If REFS in BKRTD >= Cal then Zero BKRTD”. Once the reference pulse counts exceeds this the retard value is reduced using “Burst Knock Retard - BKRTD decay value” every 12.5ms.

On manual vehicles RPM Derivative Spark Control (RDSC), Tip In Bump Spark (TIBS) and Idle Drive (ID) are used to help make low speed driving easier and throttle applications smoother by dampening driveline oscillations. They are both spark modifiers, RDSC adjusts the spark advance based on the RPM rate of change (derivative) and TIBS adjusts spark advance based on throttle application and a change in MAP.

RPM Derivative Spark Control:-

RDSC as the name suggests is a spark modifier based on a change in RPM. It operates only when certain criteria are met. The first of these is that either the throttle change has exceeded the tip-in (throttle application) or tip-out (throttle release) thresholds. Other criteria must also be met such as the vehicle is moving, engine RPM is between a lower and upper threshold and coolant temp exceeds a set point. If all criteria are met RDSC will start adjusting spark advance to try and smooth out any RPM changes – if the RPM is rising too quickly advance will be reduced while if it is falling advance will be increased. Setting the gain of how much spark is added or subtracted in relation to the RPM derivative needs to be done carefully. Too much gain and RDSC will add to driveline oscillations.

The ECU uses RPM/KPH to determine the current gear and can apply different Tip-In and Tip-Out gain values for each gear. A sliding filter is used to store 10 previous RPM samples at 12.5ms intervals which are then used to calculate a moving average of RPMs. The sliding filter value defines the number of samples prior to the current to check for RPM increasing or decreasing.

When RDSC is active a maximum positive and negative spark change limit is also used to prevent overly large changes.

Idle Drive:-

ID is a form of RDSC but is only active at low speeds and while in 1st and 2nd gear. The RPM must also be less than "Idle Drive – Idle RDSC Enable RPM Threshold". It operates exactly the same as RDSC above except it allows for a different gain to be used at only low speeds.

Tip-In Bump Spark:-

TIBS adjusts the spark advance to reduce the initial driveline bump as the throttle is applied. For this reason throttle Tip-In must be active before any spark modification is made. The table "Tip-In Bump Spark vs TPS and RPM" is used as the amount of spark modification. The value cannot exceed "Tip-In Bump – Upper Bump Spark Limit".

When TIBS is active the spark advance is removed instantly and then constantly recalculated, but when returning the advance it is done slowly. The time that TIBS is active uses the scalar "Tip-In Bump – Time Bump Spark is Active" and "Tip-In Bump – Time Bump Spark is held steady before decay". When the active time is completed the TIBS no longer recalculates the required spark value, it is then held steady at the last value.

After both timers have expired TIBS is decayed using the table "Tip-In Bump Spark Decay Table – Decay rate Vs TPS".

Idle Spark Adjustment:-

Idle Spark Adjustment (ISA) is used to smooth out idle RPM variations. The ECU is constantly trying to maintain the desired idle RPM using IAC steps. This is a relatively slow moving idle speed adjustment and in order to stabilize idle speed using a faster adjustment, using spark advance/retard is used – if RPM is above desired, advance is removed, and below desired it is increased. This is done every 12.5ms.

The engine must be operating at idle and in closed loop idle mode (this is not closed loop fuel, but instead closed loop idle speed control). The ECU monitors desired and actual RPM, if the error between them is less than “Idle Spark Adjustment Params – RPM error limit for spark adv correction” the spark advance will be modified. If the RPM is greater than desired “Idle Spark Adjustment Params – High RPM correction Multipler” is used to remove advance, if below then “Idle Spark Adjustment Params – Low RPM correction Multipler” is used to add advance. The cal items are in spark degrees / RPM error – that is for every RPM error between actual and desired X degrees will be added/subtracted to the spark advance.

The spark correction limit is controlled using “Idle Spark Adjustment Params – Idle Spark Correction Limit”. If the calculated figure from the multiplier is greater, the limit item will override this and become the spark correction.

This applies to both spark advance and retard.