

ProECU Subaru BRZ

Toyota GT86

Scion FR-S



Tuning Guide

2012-onward Model Year

v1.35

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1. Warning

!!! CAUTION !!!

EcuTek ProECU tuning tools should only be used by experienced tuners who understand the product and engine calibration.

If you do not fully understand this product then you WILL damage your engine, the ECU or your vehicle.

Please ensure you fully read all EcuTek manuals BEFORE attempting to use ProECU with your laptop or your vehicle.

Use with extreme caution and understanding at all times, if in doubt then do not proceed.

EcuTek accepts no responsibility for any damage to the engine, ECU or any part of the vehicle that results directly or indirectly from using the product.

** If you are in any doubt that you do NOT have the experienced required to use this product then you should NOT USE IT **

Retail customers

** If you have any doubt that you do NOT have the experienced required to use this product then you should NOT USE IT, you should simply contact your EcuTek Master Tuner shown clearly on the label on the top of your Programming Kit case or visit your preferred tuning shop to have a professional tuner to use it for you **

2. Introduction

2.1. RaceROM

RaceROM offers special custom written features for the BRZ, GT86 and FR-S, these are only available from EcuTek using ProECU.

RaceROM support for the BRZ, GT86 and FR-S is extensive and the exact details are covered in separate RaceROM and Custom Maps HELP manuals.

The current RaceROM features are listed below. Features marked ** are only available to trade customers, or retail customers that have purchased the optional RaceROM BRZ upgrade.

Launch Control – Stationary, driver adjustable rev limiter for fast takeoff.

Flat Foot Shifting – Allows you to change gear without lifting your foot from the throttle.

Throttle Auto-blip – Temporarily blips the throttle when downshifting to match engine speed to road speed.

Per Gear Rev Limits – Provides separate rev limits for each gear to aid acceleration or engine safety.

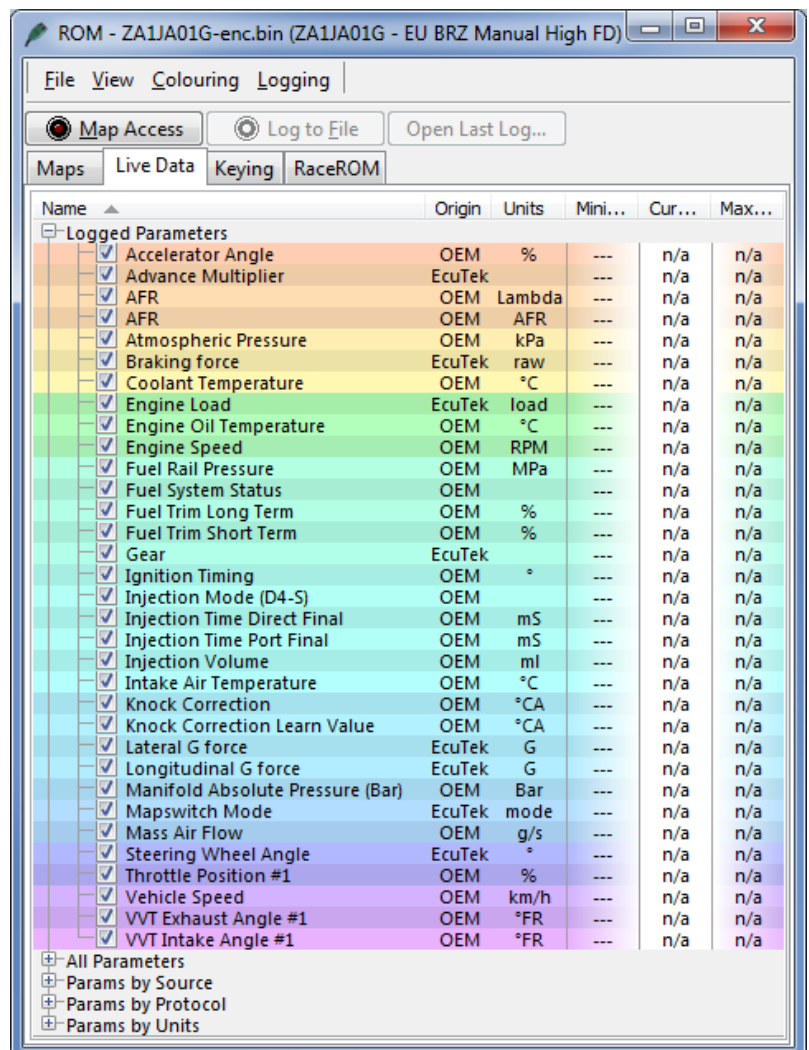
Accelerator Trim – Allows you to adjust the accelerator pedal response.

Map Switching** – Provides up to 4 sets of switchable maps with visual feedback on the current mode displayed on the tachometer.

Speed Density** – Replace the MAF system with a MAP based airflow reading.

Increased Engine Load Limit** – for high horsepower forced induction.

Custom Maps** – RaceROM Custom Maps provide completely adjustable user defined maps.



In addition, by using Custom Maps we are able to enter a whole new dimension of control.

Custom Maps enables us exciting new functionality and a few examples are shown below

- Boost Control including a fuel cut Boost Limiter
- Ethanol Flex-Fuel Tuning
- Traction Control

These examples are defined in more details in the Tuning section later in this training manual.

3. ECU Map Descriptions

Please note that map names are shown in **bold**. Live Data parameters can be used for Data Logging and are shown in *italic*.

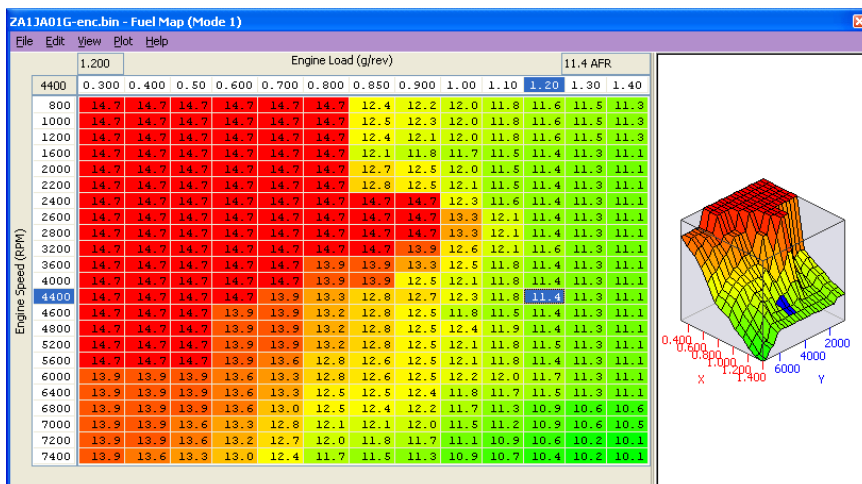
3.1. Fuelling

Live Data related parameters:

- *AFR*
- *A/F Sensor*
- *Fuel Pump Duty*
- *Fuel System Status*
- *Fuel Trim Long Term*
- *Fuel Trim Short Term*
- *Engine Load*
- *Mass Air Flow*

3.1.1. Fuel Map (Mode 1 to Mode 4)

The **Fuel Maps** contain target AFR based on Engine Speed (RPM) and Engine Load (grams/rev). These maps are used in both open loop and closed loop conditions. **Fuel Map (Mode 1)** will be used unless the ECU is Map Switched into another mode (Modes 2, 3 or 4). The X and Y axis scaling can be adjusted to suit higher RPMs or higher Engine Loads if required.



If the ECU is currently in Closed Loop mode (light load and below 4500rpm), then the *Short Term Fuel Trims* will be active. The target AFR in Closed Loop will be 14.7:1 AFR (Lambda 1), altering the fuel map values during closed loop control will not change the AFR (only the Fuel Trims will change to compensate for the deviation and will attempt to maintain Lambda 1 or 14.7 AFR).

If the ECU is in Open Loop mode (high load and high RPM), then the *Short Term Fuel Trims* will be inactive and set to zero. The AFR values shown in the **Fuel Map** in Open Loop are based on a stock intake and a known airflow amount, so the correct amount of fuel volume can be injected to deliver the indicated AFR.

If the Intake or Injectors have been replaced, then the MAF scaling or Injector scaling should be adjusted until the AFR value in the map is roughly achieved. Ensure that your actual engine load parameter shown in the data logging does not exceed the Engine Load Values shown in the X axis of the fuel map.

3.1.2. Injection Control

Live Data related parameters:

- *Direct Injection Timing*
- *Fuel Rail Pressure*
- *Injection Mode*
- *Injection Time Direct Final*
- *Injection Time Port Final*
- *Injection Volume*

Please note the following abbreviations will be used: **DI = Direct Injection** and **PI = Port Injection**

The Toyota developed Dual Injection system will operate in several different modes depending on the current engine conditions. The current Injection mode can be seen in the Live Data parameter called *Injection Mode (D4-S)*.

Injection Mode	Port Injection (PI)	Direct Injection (DI)
Mode 1 - seen after starting the engine	ON	OFF
Mode 2 - seen between 3000 to 5000rpm	OFF	ON
Mode 3 - seen below 3000rpm	ON	ON
Mode 4 – both Injectors off	OFF	OFF

The ECU will check the fuel map for a target AFR and then by using the current Mass Airflow amount (g/rev), it will deliver a required volume of fuel (ml) to achieve that AFR. The ECU will split the fuel delivery volume amount between the PI and DI injectors depending on the current *Injection Mode*.

Fuel Injection Ratio Port to Direct - Cold - Warm - Hot

The current *Injection Mode (PI/DI Ratio)* is determined by the maps named **Fuel Injection Ratio Port to Direct**.

There are 3 maps for engine cold, warm and hot conditions. These maps control the fuel delivery ratio between the PI and DI injectors.

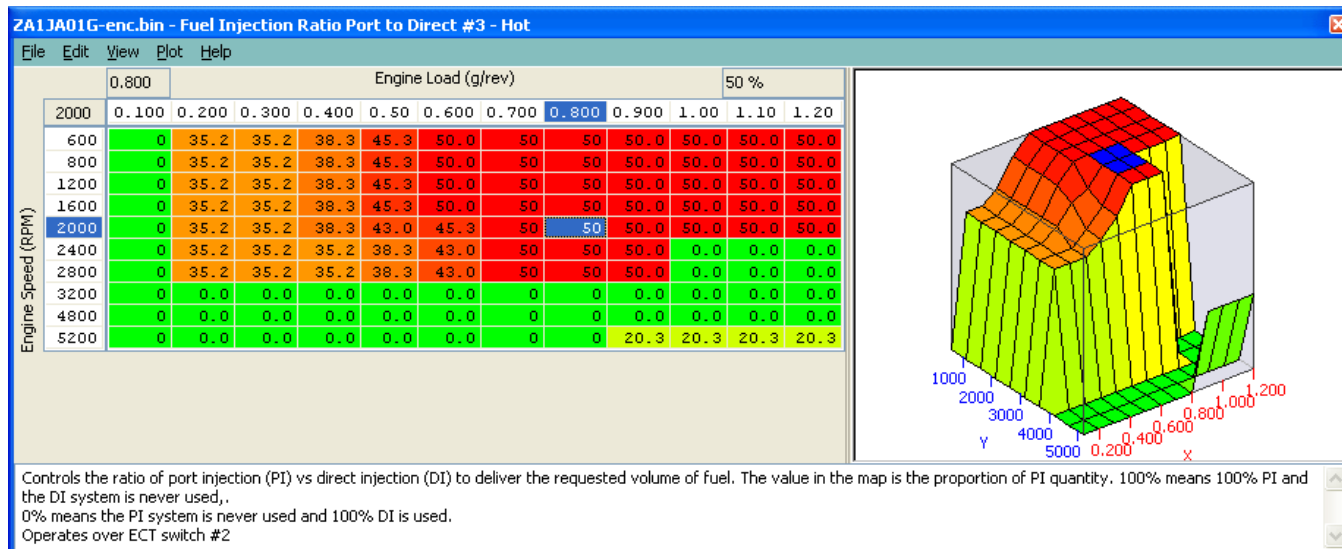
The values in the maps dictate the % ratio that a given volume of fuel will distribute between the PI and DI.

As shown in the screen shot of the factory map settings at 2000rpm and 0.8 Engine Load that the total Injection Volume amount (ml) will be split equally between the PI and DI (showing 50% in the map cell above).

The PI delivery ratio amount will then reduce between 2800rpm and 3200rpm where at 3200rpm the PI will have stopped completely injecting at all.

Please Note: Gasoline Direct injection Systems can only inject during the induction and compression phases of the engines cycle unlike the PI system which could also inject during the power and exhaust strokes, please keep in mind that the opening times for DI will be approximately half of what you would normally see when tuning a conventional port injection only engine.

The logging parameter called 'Fuel Injection End DI to Spark (ms)' is critical for DI tuning, it shows the time period left between the direct injector closing and the spark plug firing, critical to maximize the DI Open Time, see the tuning section for further information.



At 4800rpm, the PI will start to be phased back in and by 5200rpm the PI will deliver 20% of the required fuel volume. The PI ratio can be increased at higher RPM to provide more fuel delivery if required, especially on forced induction engines where the DI cannot supply the required amount of fuel that is needed.

This system has been extensively developed and tested by Toyota and you should consider this fact when making changes.

Fuel Injection Ratio ECT Switch Threshold #1

The engine coolant temperature at which the ECU will switch from "Fuel Injection Ratio Port to Direct #1" - "Cold to Fuel Injection Ratio Port to Direct #2 - Warm". The top value is the switch temperature to map #2, and the lower value is coolant temp that it would switch back to #1.

Fuel Injection Ratio ECT Switch Threshold #2

The engine coolant temperature at which the ECU will switch from "Fuel Injection Ratio Port to Direct #2 - Warm" - "Cold to Fuel Injection Ratio Port to Direct #3 - Hot". The top value is the switch temperature to map #3, and the lower value is coolant temp that it would switch back to #2.

NOTE: All 3 maps called "Fuel Injection Ratio Port to Direct" are set the same from the factory.

PI Ratio Threshold – Lower Limit / Upper Limit

If the fuel injection ratio Port to Direct #1, #2 & #3 maps are requesting values below the PI Ratio Threshold – Lower Limit (standard 35%) the ECU will automatically output 0% PI

If the fuel injection ratio Port to Direct #1, #2 & #3 maps are set above PI ratio Threshold – Upper Limit (standard 75%) the ECU will output 100% PI

PI Ratio Threshold – Load / RPM

These values will allow the ECU to ignore the PI Ratio Threshold - Lower / Upper limits if either PI Ratio Threshold - RPM or PI Ratio Threshold – Load are exceeded.

3.1.3. Direct Injection Maps

DI High Pressure Fuel Target #1 / #2

This is the requested fuel pressure that is supplied to the DI system, this is a mechanical pump and it has limitations for what it can deliver.

DI Quantity Maximum Allowed

This is the maximum allowed fuel volume to be delivered by the Direct Injection injectors. This is an absolute volume amount and will not change relative to fuel pressure or compensations. This map will need to be increased for engines making over 260bhp, but we recommend you do not exceed 1.0ml to avoid the risk of DI injection when the spark plug fires.

DI Quantity Minimum Allowed

This is the minimum fuel volume amount allowed to be delivered by the Direct Injection injectors. There should not be any need to change this value unless larger DI injectors are fitted.

DI Quantity Fuel Pressure Compensation #1 and #2

Related to the DI open time, these maps can be used to proportionally increase the DI (Direct Injection) volume amount, but should not be used for E85 tuning (use Custom Maps and see the example ROM and E85 Flex Fuel information).

DI Firing Angle

The angle at which the direct injection system opens the DI injector. The angle is measured before top dead centre on the compression stroke. E.g. 370 is 10 degrees inside the exhaust stroke, and 300 is 60 degrees inside the induction stroke. There are different maps for Low and High Engine Load with Engine Hot and Engine Cold conditions. Map #1 is used below 30 deg Coolant temp.

3.1.4. Port Injector Maps

Port Injector Scaling

The PI injector size in cc/min. Change this value when larger Port Injectors have been fitted so the ECU can accurately calculate the PI open time required to deliver a requested volume of fuel. Also ensure that you change the **Injector Opening Time Compensation** map as per the injector manufacturer specifications.

Injector Opening Time Compensation

Often called 'Injector Lag Time' / 'Injector Latency' or 'Injector Dead Time', this is the time period (ms) that is required for the injector to energise and fully open. If larger injectors have been fitted they often need a longer time period to open.

The Y-axis may be Manifold Relative Pressure (mmHg) on return-less fuel rail systems, but it is not calibrated at present. Ensure that you change the **Port Injector Scaling** to match the larger injectors that have been fitted.

PI Firing Angle

The angle at which the port injector will open. The angle is measured before top dead centre (spark plug firing).

PI Minimum Fuel Volume

The minimum time fuel volume that the Port Injectors are allowed to open for, this may need reducing if larger Port Injectors are fitted.

Port Injector Manifold Relative Pressure Comp

This map is used to adjust the opening time of the port injectors for a given manifold pressure. The factory settings do not account for any positive pressure, but when working on a forced induction engine this map must be profiled to provide PI open time compensation for positive pressure and therefore ensuring the correct volume of fuel is delivered.

3.1.5. Open and Closed Loop Control

Closed Loop is when the ECU is using the feedback control of the lambda sensors to maintain a steady 14.7:1 AFR (or Lambda 1). This closed loop target value cannot be altered from 14.7:1. The front 'widerange' AF sensor #1 is located before the Catalysers and allows the ECU to 'adjust or trim' the Fuel Injection volume amount very accurately so as to achieve the target AFR. This Fuel Trim can be seen under LIVE DATA as Fuel Trim Short Term and Fuel Trim Long Term. Closed Loop condition will be seen below 4000rpm and at light load conditions.

Open Loop is when the ECU is no longer using the feedback control of the lambda sensors to maintain a specific AFR but it will simply take an AFR value from the fuel map. This open loop AFR value will normally be lower (or richer) than 14.7:1 and as low as 10.5:1 depending on the exact model. The front 'widerange' AF sensor #1 can read to 12.2:1 AFR but has to be rescaled to read past 12.2AFR or 0.82Lambda, the accuracy is limited at richer AFR and it should not be completely trusted.

Open Loop Throttle Threshold Manual

Throttle angle for manual transmission above which fuelling goes open loop after the delay period expires.

Open Loop Per Gear RPM Thresholds Auto/Manual

Per gear RPM thresholds for AT/MT above which fuelling goes open loop. There is a pair of RPMs for each gear.

Open Loop Stationary RPM Threshold

When the vehicle is stationary the fuelling will go open loop above this RPM.

Open Loop Throttle Threshold High/Low Altitude Auto

Throttle angle for automatic transmission at high/low altitude above which fuelling goes open loop.

Fuel Trim Long Term Minimum and Maximum

These are the minimum and maximum allowed fuel trim to be applied in open loop. Set these to zero to avoid the closed loop fuel trims being applied in open loop.

Closed Loop AFR Adjustment #1 / #2

These 3D maps are used to fine tune the Injection amount during closed loop, they can also bias the AFR during transient conditions.

Closed Loop Max Vehicle Speed

This is the maximum allowed vehicle speed for the ECU to be in closed loop condition. Over this speed the ECU will switch to open loop but it may require other open loop conditions to be met before the transition to open loop.

Closed Loop Minimum Coolant Temperature

This is the minimum coolant temperature for the ECU to be in closed loop mode, below this value the ECU will be in open loop mode, used for emission control by manufacturers.

Closed Loop Delay Maximum Engine Load

The maximum allowed Engine Load for the Closed Loop Delay timer to work, the CL delay timer will prevent Open Loop until the timer has expired.

Closed to Open Loop Delay Periods

Delay periods when changing from closed to open loop fuelling. Reduce them to zero.

Delayed Open Loop Fuel Load Threshold

Injector load threshold, varying with RPM, above which fuelling will go open loop after a delay.

Delayed Open Loop Fuel Throttle Threshold

Throttle threshold, varying with RPM, above which fuelling will go open loop after a delay.

Throttle Delta Fuel Comp. (Delta) / (Delta) 2 / Coolant Temp.3

Base fuel enrichment factor applied during throttle movement, this can be increased and decreased to change the fuelling during transient conditions and sudden throttle movements.

AF Correction #3 Limit – Rear O2

These values should be set to zero if the rear O2 sensor is removed or repurposed along with the following map called AF Correction #3 CL Target Compensation Limits.

AF Correction #3 CL Target Compensation Limits

These Closed Loop Target Compensations values should be set to zero if the rear O2 is removed or repurposed along with the above map called AF Correction #3 Limit – Rear O2

3.2. Ignition Timing

Live Data related parameters:

- Ignition Timing (Deg)
- Ignition Correction – Coarse (Deg)
- Ignition Correction – Fine (Deg)
- Knock Correction (Deg)
- Knock Correction Learn Value (Deg)

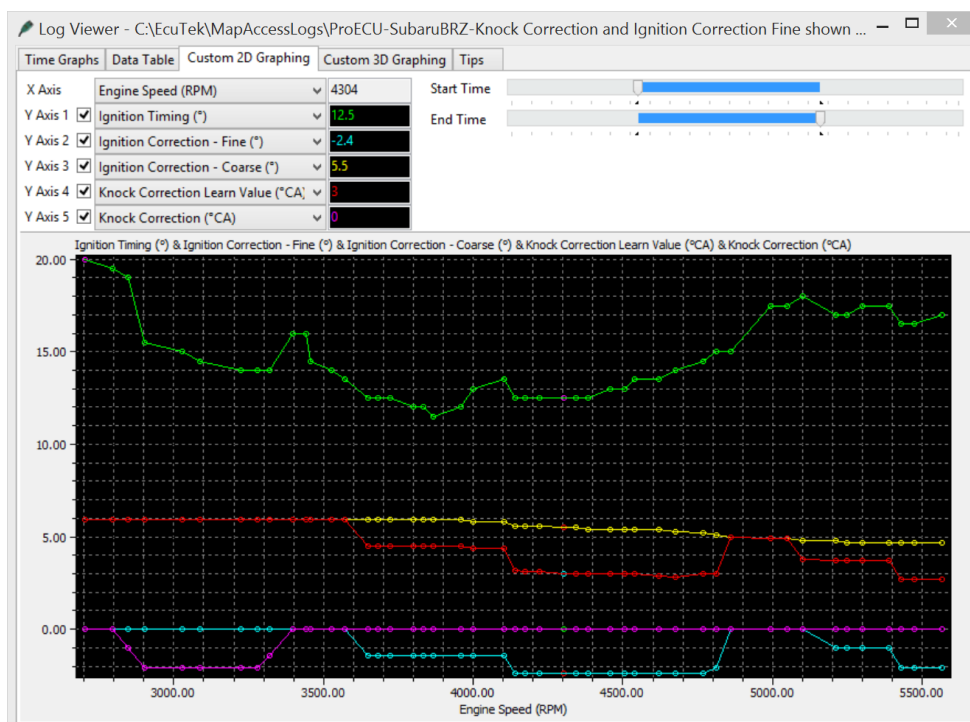
To help us understand the Ignition control we first need to define the ignition logging parameters. See below a brief description for each of the above Live Data parameters.

- Ignition Timing (Deg) – Displays the current Ignition Timing.
- Ignition Correction – Coarse – Shows the output of the Ignition Advance map multiplied by the current Advance Multiplier Value. If the Advance Multiplier value is 1 then the logging parameter will match the Ignition Advance map value (and the full value from the Advance Map is added to the Ignition Base map value). If the Advance Multiplier is 0.5 then the logging parameter will only be 50% of the Ignition Advance map value (and only 50% from the Advance Map is added to the Ignition Base map.
- Ignition correction – Fine -This is the Learned Knock Retard in the ECU's Memory.
- Knock Correction – This displays the Knock Correction Amount
- Knock Correction Learn Value – This is the Ignition Correction Coarse minus the Ignition Correction Fine value.

You can see below that the Ignition has learned some previous knock events (the Cyan line called Ignition Correction – Fine). This previous learned knock retard event is added during the Ignition calculation, you can see the Yellow line called Ignition Correction – Coarse has been reduced to the Knock Correction Learned Value (Red line).

The Yellow line is where the timing 'could be' and the Red line shows what's actually been added after the Ignition Correction Fine has been applied.

You can also see the Knock Correction (Purple line) was also active around 3000rpm.



3.2.1. Ignition Base Map (Mode 1 to Mode 4)

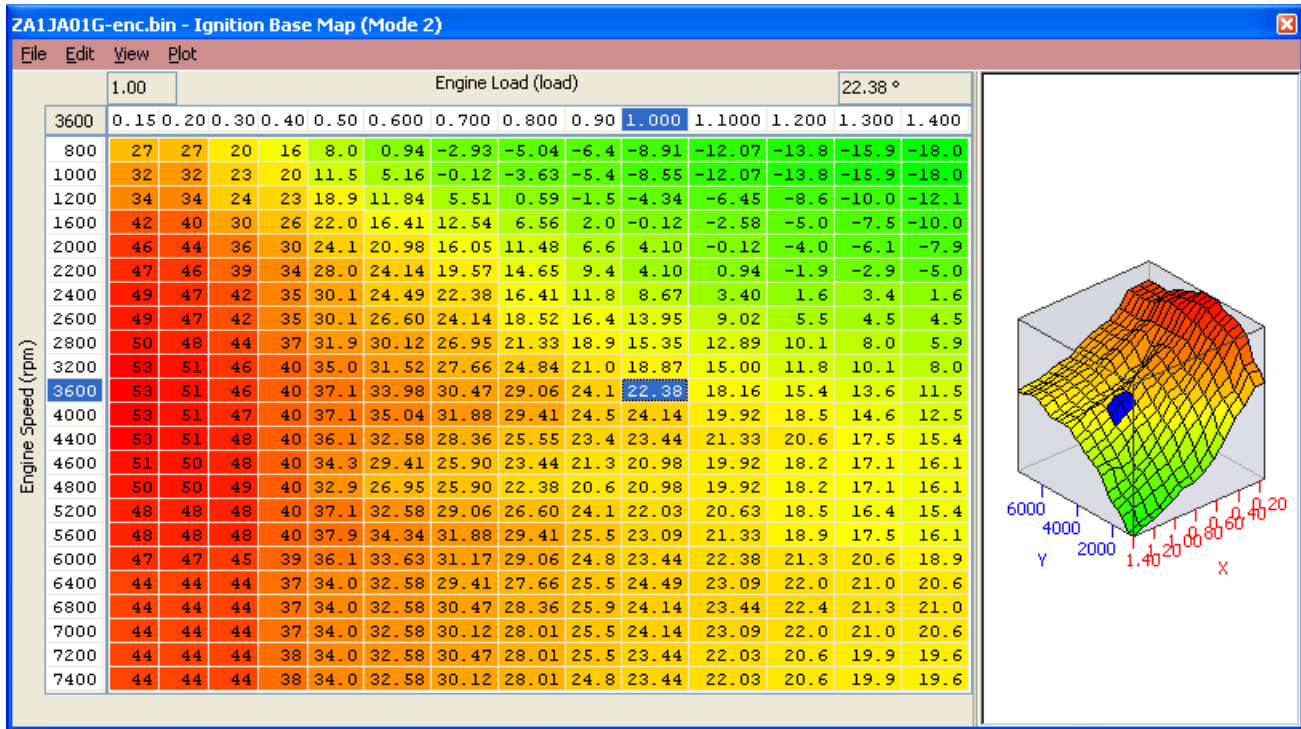
The ECU selects an **Ignition Base Map** depending on the current VVT status.

- VVT ON (Cam Timing working)
- VVT OFF (Cam Timing not working)

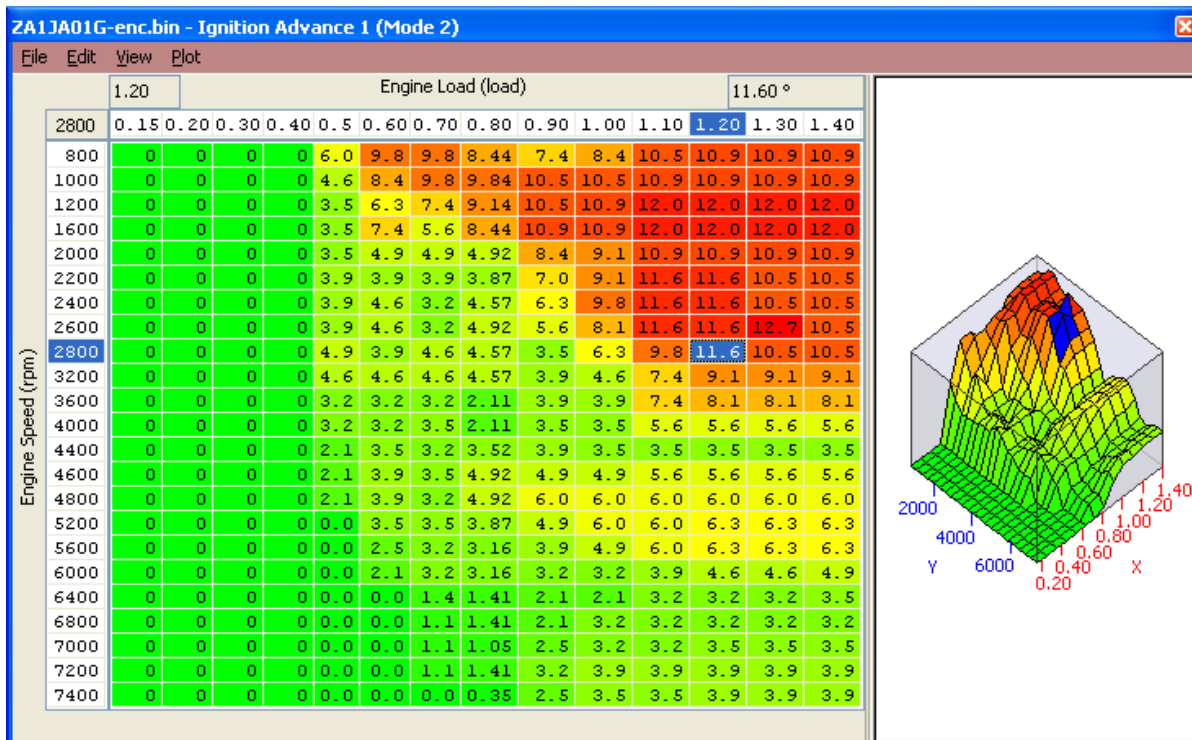
Under normal running the **Ignition Base Map VVT On (Mode 1)** will be used.

If the ECU is Map Switched into another RaceROM mode (for example Mode 3) then **Ignition Base Map (Mode 3)** will be used without consideration for the VVT status.

The X and Y axis scaling can be adjusted to suit higher RPM or higher Engine Loads if required.



3.2.2. Ignition Advance (Mode 1 to Mode 4)



The **Ignition Advance map** is added to the **Ignition Base map** relative to the LIVE DATA parameter called *Advance Multiplier (AM)*.

The **Ignition Advance map** is used as a coarse Ignition adjustment to advance and retard the Ignition timing for changing conditions like fuel quality, ambient temperature and altitude.

3.2.3. Advance Multiplier - Coarse Correction

The *Advance Multiplier (AM)* is dynamic and will change relative to the current amount of engine knocking (detonation). If the engine is knocking frequently and consistently then the AM will be low, if there is no knocking then the AM will be high. The AM moves between 0 and 1.

If the AM is 0 then NONE of the **Ignition Advance map** will be added to the **Ignition Base map**. If the AM is 1 then ALL of the **Ignition Advance map** will be added to the **Ignition Base map**. If the AM is 0.73 then 73% of the current **Ignition Advance map** value will be added to the **Ignition Base map**.

The factory **Ignition Advance map** is calibrated to advance and retard the ignition timing by a greater degree in certain areas of the map (as seen in the screen shot above).

This is to ensure when the engine is knocking (and the AM decreases) that more Ignition timing is removed from areas where the engine is more susceptible to detonation (like peak torque).

Areas where the engine is least likely to detonate the values are smaller (like light load).

The output of the **Ignition Advance map** is important and can be seen and logged in LIVE DATA as *Knock Correction Learn Value*.

So 'for explanation purpose only', if the **Ignition Advance map** was filled with 12 deg then the *Knock Correction Learn Value* would read 12 deg in LIVE DATA (assuming the AM is 1).

If the AM was 0.75 then the *Knock Correction Learn Value* would read 9 deg ($12 * 0.75 = 9$ deg).

3.2.4. Knock Correction

If the engine knocks then the ECU will immediately remove an amount of ignition timing (Knock Retard amount) and this will be shown in LIVE DATA as the *Knock Correction* parameter.

After a *Knock Correction* event has occurred and an amount of Ignition timing has been removed from the current Ignition Timing calculation then the ECU will store 50% of that *knock correction* event to pre-empt a similar knock event at the same RPM and same Load the next time round.

This is the long term 'Ignition Fine Learning' strategy.

3.2.5. Ignition Fine Learning

If the LIVE DATA parameter called *Knock Correction* shows a -4 deg has been removed from the current Ignition timing calculation then 50% of this *Knock Correction* amount (-2 deg) will be stored in memory for a given RPM and Engine Load range.

If a negative value is already stored for that RPM and Load then the value is simply added to stored 'Fine Learning value'

If -1 deg was already stored in memory for a given RPM and Load then a further -2deg would also be added making a total of -3 deg stored for the same RPM/Load memory location.

The next time the engine passes the same RPM and Engine Load then the Fine Learning value (-3 deg) would be recalled and subtracted from the Ignition Timing calculation at that point.

When the learned value is 50% or greater than the corresponding values in the **Ignition Advance map** then the AM will be decreased and all Fine Learning stored values are cleared and the process starts all over again.

In the event that no further knocking is experienced then the ECU will add positive Fine Learning values in +0.35 deg increments to build out the learned negative values.

When all negative values have been built out and the positive values are 50% or greater than the values in the **Ignition Advance map** then the AM will increase and therefore advance the whole ignition curve.

3.2.6. Ignition Compensations

There are many Ignition timing compensations that are added and subtracted to the Ignition calculation. Some are simple like Air Intake Temp (AIT) and after starting the engine, but others are more complex like transient conditions and overrun or during gear change etc.

3.2.7. Ignition Timing calculation

The final Ignition Timing calculation is computed like this:

Ignition Base Map
+
*(Ignition Advance Map * Advance Multiplier)*
+
Ignition Compensations
+
Ignition Fine Learning
+
Knock Correction

It's a very active and dynamic control strategy that will constantly adjust the ignition timing but it should not be fully trusted to 'control the ignition' especially on forced induction setups.

NOTE: The final Ignition Timing logging parameter will include any compensations or corrections that have been made by the above maps.

Advance Multiplier - The highest advance multiplier number obtainable is 1, this will be achieved when there is no engine knocking present. If the engine constantly knocks or reduces the AM then the Advance map or the Base map should be reduced in that region (excluding other factors like fuel, temps and cam timing etc).

Advance Multiplier – Initial

This is the base default setting for the advance multiplier after ECU Programming or ECU Reset. This can be increased to 1 for tuning purpose so that 100% of the **Ignition Advance map** is added to the **Ignition Base map**. It is advised to reset back to its default value on the final flash of the ECU.

Advance Multiplier – Increment amount

The amount that the Advance Multiplier will increase during its learning period like after programming the ECU or carrying out a CLEAR DTCs command (which will also reset the ECU learning).

Coarse Ign Learning Load Range

The engine load range in which the ECU is allowed to change the advance multiplier.

Coarse Ign Learning RPM Range

The RPM range in which the ECU is allowed to change the advance multiplier.

Ignition Compensation Coarse Cylinder #1 - #4

This is a per cylinder Ignition compensation that is added to the current Ignition timing when certain conditions are met, see the following maps. The Ignition Timing logging parameter will include any per cylinder ignition retard that has been applied.

Ignition Correction Coarse ECT Minimum

Minimum coolant temperature that must be exceeded before coarse ignition correction will be active.

Ignition Correction Coarse Engine Load Minimum

The minimum Engine Load to be exceeded before Ignition Coarse Correction will be active.

Ignition Correction Coarse RPM Maximum

The maximum RPM that Ignition Coarse Correction will be active.

Ignition Timing – Air Intake Temp Compensation

Ignition timing compensation for Intake Air Temp, this map will only work if the 3d map called 'Ignition Timing - Air Intake Temp Threshold' is enabled.

Ignition Timing – Air Intake Temp Threshold

Ignition timing compensation for Intake Air Temp, this map defines when the 2d map called 'Ignition Timing - Air Intake Temp Compensation' is allowed to work.

Ignition Timing Minimum Allowed during FFS

The minimum allowed ignition during gear change or a RaceROM Flat Foot Shifting.

Ignition Retard when the Clutch is down

The amount of retard that is subtracted from the current ignition timing when the clutch is depressed.

Ignition Timing After Starting

This is used immediately after starting to heat the Catalyst quickly, this map might not be used in all regions due to different emission requirements.

Knock Detection RPM Range

The engine RPM range in which the ECU is allowed to retard the ignition timing when the engine is knocking.

Knock Retard Decrement – Gamma F

This value controls the amount of timing cumulatively removed when each knock event is triggered.

Knock Retard Increment – Alpha F

This is the amount of timing cumulatively added when the ECU restores timing after a knock event.

Fine Ign Learning Advance Magnitude

The size of ignition learning advances after each 'Fine Ignition Learning Advance Time Interval'.

Fine Ign Learning Retard Magnitude

The size of ignition learning retards each time knock is detected.

Transient Ignition Retard

This map specifies the amount of timing to be removed during transient condition. The later ZA1JA01* and onwards have a serious map adjustment to help avoid transient knocking that has historically damaged DI combustion chamber seals. Base your tuning on the later A01 or B series ROMs.

Transient Ignition Retard RPM Threshold

Specifies the Engine Speed range under which Transient Ignition retard will be active. Make sure this is set at 8000+RPM.

Minimum CFP Delta for Transient Ignition Retard

Specifies the minimum change in Cylinder Fill Percentage for the transient ignition retard to be applied.

Transient Ignition Retard ECT Threshold

Specifies the minimum ECT for transient ignition retard activation.

Transient Ignition Retard Engine Load Threshold

Specifies the minimum Engine Load for transient ignition retard activation.

Transient Ignition Retard Temperature Compensation

This provides a multiplication factor for transient ignition retard for ECT.

3.3. Cam Timing

Live Data related parameters:

- *VVT Aim Angle #1 and #2*
- *VVT Exhaust Angle #1 and #2*
- *VVT Exhaust Angle Target #1 and #2*
- *VVT Exhaust OCV Duty #1 and #2*
- *VVT Intake Angle #1 and #2*
- *VVT Intake Angle Target #1 and #2*
- *VVT Intake OCV Duty #1 and #2*

3.3.1. Cam Timing – Exhaust & Intake

There are 3 maps to control each of the intake and exhaust cams. The base map interpolates against either the Low Det or High Det maps to control the cam angle. Which map is chosen depends on the current advance multiplier value.

3.3.2. Cam Timing - High/Low Det Threshold

This is the threshold that dictates which cam timing map will be chosen, below 0.1 Advance Multiplier (engine knocking) the High Det cam map will be used, above 0.4 Advance Multiplier the Low Det cam map will be used (engine not knocking). So 99% of the time the Low Det map will be used. We suggest that the values between the Base and Low Det maps are similar.

Important Cam Timing information

After starting the engine the Exhaust cam takes some time to become active, up to 30 seconds. If a power test is made whilst the Exhaust VVT is not active then a significant amount of power and torque will be lost.

There are also various issues with VVT control on the FA20 engine, see the Questions section for some of the issues and more specific information.

3.4. Torque, Accelerator and Throttle

Live Data related parameters:

- *Accelerator Angle*
- *Accelerator Pedal Position #1 and #2*
- *Accelerator Pedal Position Sensor #1 and #2*
- *Throttle Angle*
- *Throttle Position*
- *Throttle Position Commanded*
- *Throttle Position Relative*
- *Throttle Position Sensor #1 - #2*

Accel Pedal to Desired Torque

This map defines the desired engine torque output for a set Engine Speed and Accelerator Pedal angle.

Wide Open Torque Threshold

This map is used to calculate the percentage of maximum torque. The value in this map is divided by the value output from Accel Pedal to Desired Torque and is used as the X axis input into the Desired Torque to Throttle Opening map. Raising these values could stop you from getting full throttle butterfly opening. Reducing these values would mean the throttle butterfly would be open further for the same accel pedal angle (Torque Demand amount).

3.5. Other Maps

3.5.1. Engine Load

Live Data related parameters:

- *Engine Load (%)*
- *Mass Air flow (g/s)*

Engine Load Limiter #1 & #2

This is the maximum value of engine load that will be used in the ECU. If your engine load exceeds this value then the engine will run lean and advanced, these values should be raised especially with forced induction setups.

Calculated Engine Load Compensation #1 / #2

Calculated Engine Load Compensation factor based against MAP, used to correct Airflow/Engine Load as required. This map can also be used to correct Fuel Injector open time A/F Correction #1 errors at light load.

Calculated Cylinder Fill Percentage

Used internally by the ECU to calculate the amount of cylinder fill per stroke (CFP), as the engine has a large throttle butterfly then the maximum cylinder fill can be achieved at low RPM and small throttle opening (relatively low airflow). There is no need to adjust this map.

Engine Load Multiplier and Atmo Pressure compensation

These are used internally by the ECU and there should be no need to adjust these values.

3.5.2. Limiters

Speed Limiter – On & Off

This controls the vehicle speed that the fuel injectors will be cut to maintain a set vehicle speed or restored when the vehicle has decelerated.

Vehicle Speed based Throttle Angle Limiter #1 - #4

These maps control the maximum allowed throttle opening for a set Engine Speed. Either raise the values in the axis. Do NOT adjust the right hand side of these maps just adjust the left hand column with the vehicle speed shown.

Mass Air Flow Reading Limit

This is the maximum Mass Air Flow that the ECU will use. If your engine exceeds this value the ECU will incorrectly calculate engine load which means all the ignition and fuel maps will be inaccurate and the fueling will be very lean at high RPM. This map is often overlooked so please ensure you raise the values.

Rev Limit #1 and #2

This controls the engine speed that the fuel injectors will be cut to maintain a set RPM. The second value in each map is the hysteresis and is the Engine Speed when the injectors will restore.

Fuel Cut Resume

This is the manifold pressure at which the engine will restore the injectors after a fuel cut.

Engine Load Reading Limit

Engine Load Max Limit, this must be raised if your Engine Load exceeds this value.

3.5.3. Idle Control

Shown in Live Data as:

- *Engine Speed*

Controlling the Idle speed of an engine is a difficult task and the factory ECU has many targets and compensations to achieve this. The **Idle Target** maps set the target Idle speed for many different modes like drive, neutral, after starting, engine hot, load on (alternator or headlights etc). It is advised that you adjust all Idle maps by the same amount or simply set them all the same to avoid discrepancies in the idle engine speed.

Target Idle 1 to 9

Desired engine idle speed for a given coolant temperature.

Idle Air Flow Map – Cool. Temp Based

The mass airflow values in this map should be close to what the engine is running at Idle, this will help improve Idle stability.

Idle Engine Load Map – Cool. Temp Based

The engine load values in this map should be close to what the engine is running at Idle, this will help improve Idle stability.

Idle Stability Control #1 & #2

X axis is RPM idle error

Y axis is rate of change of engine speed

This map is used for Idle Speed error compensation, making the values bigger will make the Idle Speed error more aggressive for correction.

Radiator Fan Control

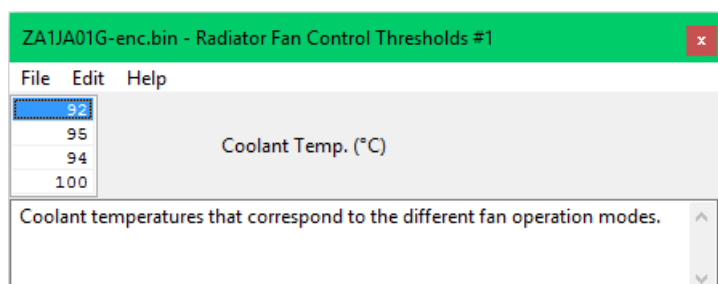
Shows the coolant thresholds where the each fan will switch ON and OFF, in our testing Rad Fan Threshold #1 maps are used, Threshold #2 maps may be used in different conditions so make a log file to verify your results like vehicle speed and with or without AC.

3rd Value (94deg C) is FAN No.1 ON

1st Value (92deg C) is FAN No.1 OFF

2nd Value (95deg C) is FAN No.2 OFF

4th Value (100deg C) is FAN No.2 ON



3.5.4. Boost Control

The CPC valve can be used as a Wastegate Solenoid valve on turbo models, see the Tuning section for further info.

CPC Control

Canister purge control solenoid valve target airflow map, no need to adjust.

If the CPC valve has been replaced with wastegate solenoid valve then use Custom Maps for boost control.

CPC Duty

Canister purge control solenoid valve duty map, no need to adjust this map.

If the CPC valve has been replaced with wastegate solenoid valve then use Custom Maps for boost control.

CPC Duty Multiplier

The operating frequency of the CPC solenoid valve.

On turbo BRZ/FR-S/GT86 models where the CPC valve is replaced with a fast switching wastegate duty solenoid valve then we suggest you set the frequency value to either 20% to 30%, some tuners report using 35 to 45% but we feel this is too high.

This will vary depending on the type of valve used.

3.5.5. Other Maps

Catalyst Warm-up Retard Drive & Idle

Ignition timing retard amount for a given coolant temperature and engine load. This can be used to speed up the heating of a catalytic convertor after starting from cold.

Gear Thresholds #1 & #2

The values are used to calculate the current gear position. The values are kmph for 1000 RPM.

E.g in first gear, if the value is 10.5 then it would mean your speedometer displays 10.5kmph at 1000RPM on the tachometer. Change these maps if you have different ratio gears in your gearbox than the standard vehicle.

3.6. Sensor Scaling

Shown in Live Data as:

- *Coolant Temp*
- *Air Temp*
- *Mass Air Flow*
- *Engine Oil Temperature*
- *AFR*
- *AFR Sensor*

AF Sensor heater duty limit

The maximum allowed AF sensor heater duty

Atmospheric Pressure Sensor Scaling Pressure Offset & Voltage Multiplier

This is an offset and multiplier sensor scaling. If you change the atmospheric pressure sensor on your vehicle please consult the manufacturer documentation for the correct values.

MAP Sensor Scaling – Pressure Offset

Manifold pressure sensor offset. Value is measured in bar.

MAP Sensor Scaling – Voltage Multiplier

Manifold Pressure Sensor multiplier in bar per volt.

Atmo Sensor Scaling – Pressure Offset

Atmospheric pressure sensor offset. Value is measured in bar.

Atmo Sensor Scaling – Voltage Multiplier

Atmospheric pressure Sensor multiplier in bar per volt.

Mass Air Flow Sensor Scaling

This map can be used to rescale the Mass Air Flow sensor relation between voltage and Mass Air Flow in g/s. Change this value if you have changed the MAF housing or intake system or if your AFR does not match what's in your fuel map.

Air Intake Temperature Sensor Scaling

This map can be used to rescale the intake air temperature sensor voltage to temperature scaling.

Coolant Temperature Sensor Scaling

This map can be used to rescale the coolant temperature sensor voltage to temperature scaling.

3.7. Diagnostic Trouble Codes & DTC Limits

This can be used to turn off any DTCs like catalyst efficiency and fuel tank pressure sensors.

Disabling DTCs should be done with care and understanding.

Example, if you disconnect the coolant sensor the engine will default to a 75 deg C coolant temp and run quite well, if you turn off the Coolant temp DTC then the ECU will use the Coolant temp sensor input and assume -40 deg C !

There are also DTC limits which control when the different DTCs are set.

DTC Enable Table

Enables/Disables the DTC from showing, the codes are listed in the ProECU HELP section.

C:\Ecutek\ProECUHelp\BRZ-FT86\ BRZ-FT86 - DTC List.pdf

DTC Limits

The Min and Max thresholds where certain DTCs are tripped. You may need to raise or lower certain sensor limits like MAF Sensor MAX Voltage on a Forced Induction model or lower the MAP Sensor MIN Voltage when you fit a 3 or 4bar MAP sensor

P0301 misfire detection

Misfire detection causing P0301 DTC.

Number in map is misfire counts in 200 revolutions.

4. Tuning

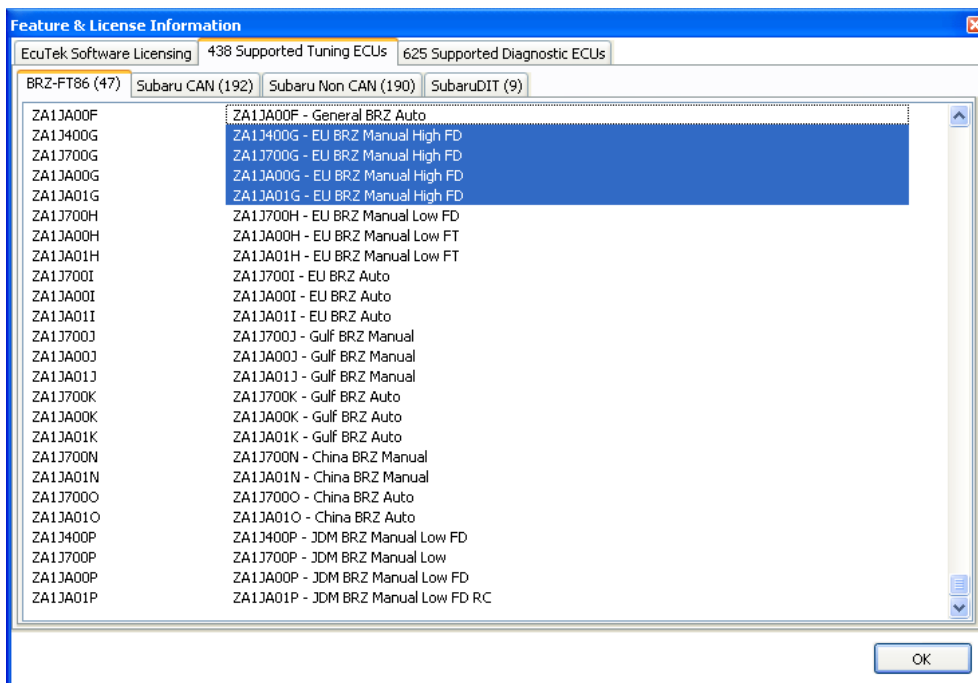
4.1. Tuning Questions – Hints and Tips

4.1.1. Which ROM version to use?

All ROM versions are shown under HELP, FEATURE & LICENCE INFORMATION and SUPPORTED ECUs. Only use the ROM that is specified for your region, USA ROM (C and D versions) share the Atmo pressure sensor with the fuel tank and these sensors are not fitted on Euro and Japan region vehicles, this causes the ATMO pressure to read incorrectly and causes tuning issues.

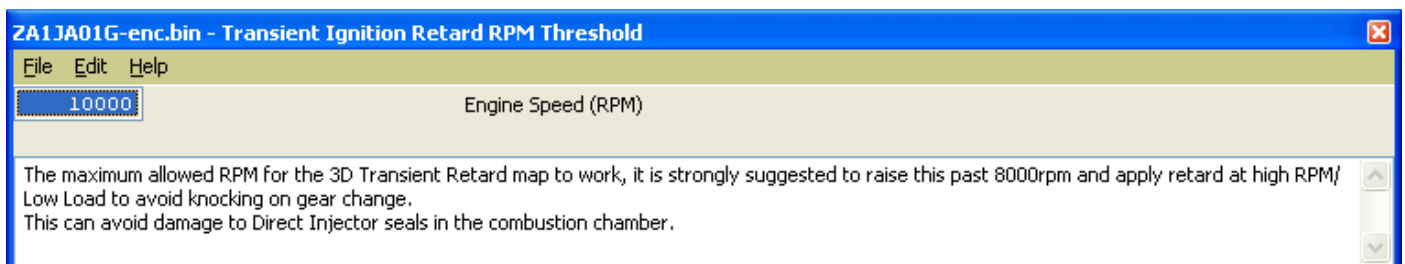
Make sure you base your tuning on the latest ROM revision that is available. Denso are constantly developing and improving and bug fixing so make the most of their hard work.

Here we can see the latest EURO region ECU ROM is the A01G (which replaces the 700G, 900G and A00G).

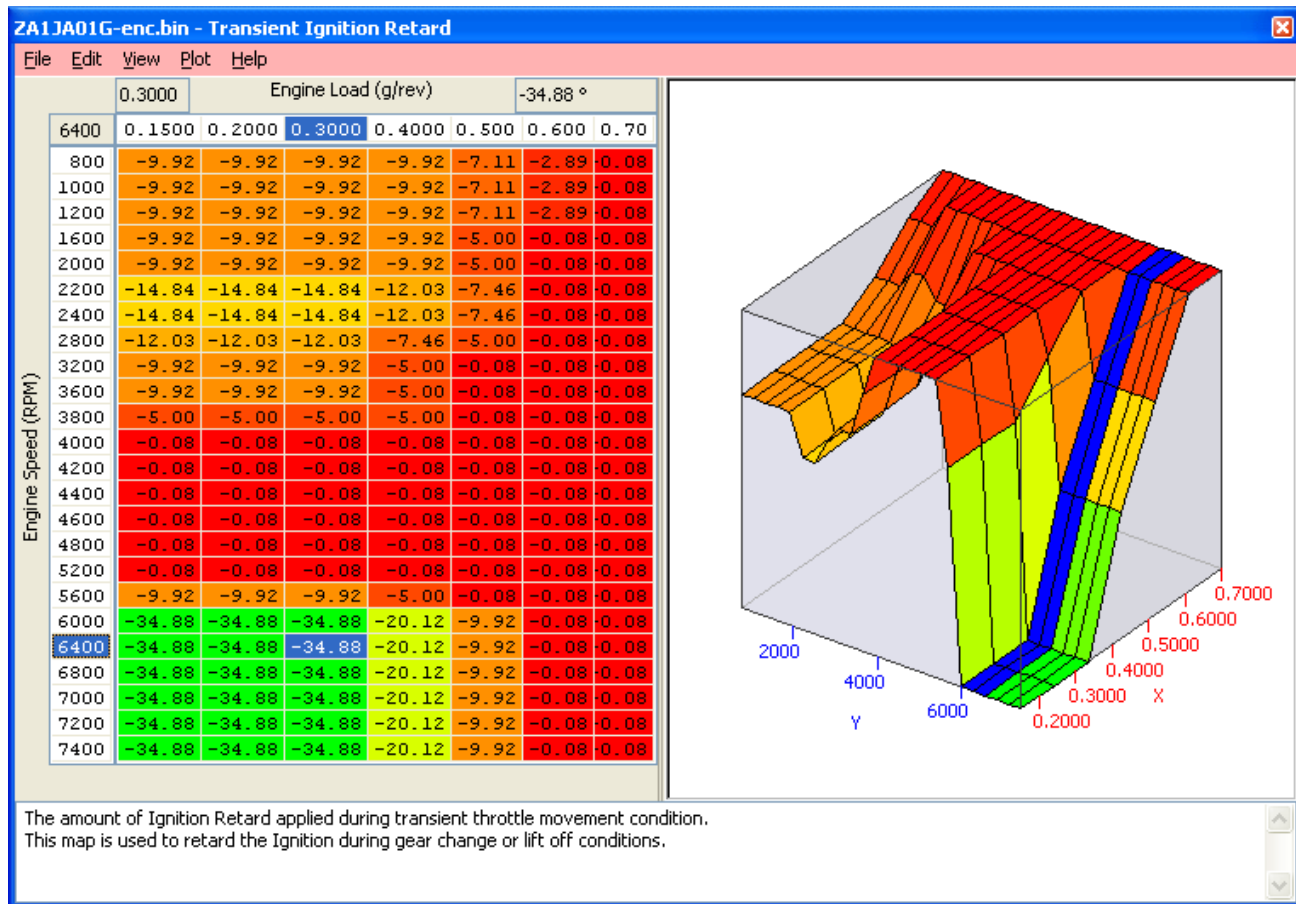


What's special about the A01* revisions or the latest B00* revisions?

The latest release is the ZA1JA01* , this 01 revision is the most important update since the vehicles release, it has a transient Ignition retard feature enabled that helps prevent damage of the Direct Injector seals that are in the combustion chamber. The 01 update allows transient retard to work past 5000rpm now, this is important for race cars.



The transient Ignition Retard amount has also been calibrated to remove -35deg of Ignition on lift off for a certain cylinder fill percentage, the map scaling value has also been changed to allow up to -50deg of retard over the previous limit of -30deg.



4.1.2. Is the VVT working?

Always make sure the Exhaust VVT is working!! After starting the engine the Exhaust cam takes some time to become active, up to 30 seconds. If a power test is made whilst the Exhaust VVT is not active then a significant amount of power and torque will be lost. After starting allow the vehicle to Idle for 20-30 seconds until Closed Loop is achieved and Fuel Trim Short Term becomes active, then gently lift the RPM and watch the Exhaust VVT angle in the LIVE DATA window, once it starts to move then you can make your tests.

4.1.3. My VVT is not working or I have a VVT CEL condition

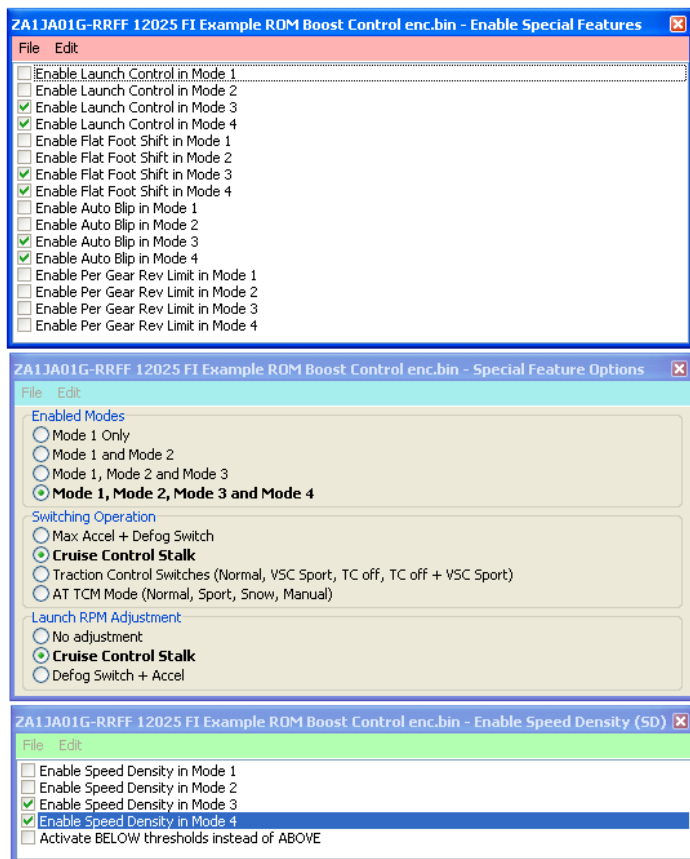
Apart from the time delay before the VVT will actually work, there is also a known hardware fault on the vehicles. There are several Technical Service Bulletins (TSB) available to help dealership technicians to decide if your ECU is faulty or not. The VVT related codes are: P000A, P000B, P000C, P000D, P0011, P0014, P0018, P0017, P0019, P0021 & P0024. There are also TSB and recalls for VVT shim issues

4.1.4. Can I tune for Ethanol E85 or Flex-Fuel?

Yes, using RaceROM Custom Maps** you can make calibrations in different map switch modes for pure E85 or E70 fuel (no mix ratios though). For true Ethanol tuning flexibility you can fit and import the Zeitronc Flex Fuel sensor and import the Zeitronc signal into the factory ECU, by setting up custom maps it's possible to turn the GT86/FR-S into a true Flex-Fuel vehicle. Expect around +20 to +25bhp power increase but be aware that you will use 25-35% more fuel.

4.1.5. Can I have Launch Control or Speed Density in certain modes?

Yes, Launch Control, Flat Foot Shift and Autoblip are all configurable in any of the 4 modes, along with Speed Density. 4-way map switching is only available to trade customers, or retail customers that have purchased the optional RaceROM BRZ upgrade package.



4.1.6. Can my current map switch mode be remembered?

Yes, ensure your tune is based on the latest RaceROM Feature File and the map switch mode will be remembered, older RRRF version do not always remember the current map switch mode though.

4.1.7. My engine doesn't start with my new map sensor fitted

Correct, the cranking fuelling is calculated from the MAP sensor, you MUST correctly rescale the MAP sensor scaling before trying to start the car, see the MAP sensor scaling section. You will also need to alter the DTC Limits for the MAP sensor voltage range.

4.1.8. Can I switch between MAF and Speed Density on the fly?

Yes, you can enable or disable SD in any of the 4 modes. You can also use the Hybrid SD function in any or all of the 4 map switch modes.

4.1.9. Can I return my tuned ECU to Stock?

Yes, Simply flash the 100% stock factory ROM file back into the ECU, this will then allow other tuning tools access to re-flash the ECU, the ECU will also appear stock to the dealer.

4.1.10. Will my CVN number be different after tuning?

Yes, to return the CVN (Checksum verification number) back to original the ECU must be flashed back to stock (see 4.1.9.).

4.1.11. Can the dealer over flash my “tuned” ECU?

No, the dealer re-flash tool (or other tuning tools) cannot over flash the ProECU tuned ROM, the ECU must first be flashed back to stock (see 4.1.9.).

4.1.12. How to recover a part-programmed ECU after a programming failure?

In the event the ECU programming sequence fails (like laptop power dies or vehicle interface becomes disconnected during programming) don't worry as ProECU can recover the ECU. The normal procedure of using *Tools >> Detect Vehicle* will not work at this point and you will need to click *Tools >> Manually Select Vehicle >> Subaru BRZ/Toyota FT-86 >> Program Engine ECU*. It is very important that you select the correct vehicle type. Once on the programming tool window, you must choose a 100% stock ROM file for the recovery sequence to work as expected. After successfully programming ECU with a 100% stock ROM file, you can then programme a tuned ROM file afterwards.

4.1.13. Why is my forced induction tune lean on full load?

Ensure you are using the latest version 9 RRFF (20479 or newer) which has improved for high power fueling calculation on big power engines.

Ensure you have increased the 1d map called 'Mass Airflow Reading Limit #1'

Ensure you have calibrated the 2d map called 'Port Injector Manifold Relative Pressure Compensation'

Ensure you have raised the 'Engine Load Limit' maps

Check the PI and DI setting and limiters in the How to Setup my Forced Induction Fueling' section and also see the Forced Induction Example ROMs found on EcuTek Update.

4.1.14. What happens when my MAF hits 5volts?

If you hit the maximum 5 volts then you will get a MAF fail safe condition based on MAP sensor calculation and P0103 DTC. This failsafe condition will occur even if you are running full time SD so ensure that P0103 is disabled so the MAF hitting 5 volt does not cause any issues.

See the Forced Induction section on the MAF Failsafe Load Calculation Multiplier for further important advice.

4.1.15. My forced induction engine misfires at high RPM

If your DI open time period is too long then the DI could still be open when the spark plug fires, check the logging parameter called 'Fuel Injection End DI to Spark (ms)' to see what time period is left, see the Forced Induction Tuning section for further information.

4.1.16. I can't see Custom Maps, Speed Density or Map Switching options.

If you have a retail programming kit then you will need to purchase the RaceROM BRZ product update from your Master Tuner.

4.1.17. Can ProECU open ROM files found on the various forums?

Yes, ProECU can open any Tuned or Stage xxx ROM files that are available on the various internet forums. The ROM file will need to be 1280KB in size and the file name extension may need to be changed to .bin for ProECU to open the raw ROM (as many free files are labelled as .hex or .org or .rom).

4.1.18. Can I use a wastegate duty solenoid to control my boost pressure?

Yes you can replace the Carbon Purge Canister solenoid valve with a conventional wastegate solenoid. You can then use Custom Maps to control the CPC valve, this can be used in a closed loop or open loop boost control. You should also alter the valve frequency to suit your chosen wastegate solenoid characteristics. See the tuning section for further information.

4.2. How to Setup...

4.2.1. How to setup an Intake or Induction Kit

It's very important that the ECU knows the true amount of mass airflow (grams per second) that is entering the engine so it can accurately calculate the correct volume of fuel to inject and therefore achieve the correct AFR that's shown in the fuel map.

The factory fuel map has been calibrated to a stock factory intake and the values in the fuel map are what the vehicle runs when the mass airflow entering the engine is accurate.

Generally when fitting aftermarket Intakes, induction kits or even replacement panel filters, the MAF sensor reading will be altered and the MAF sensor scaling will need adjusting.

Generally the Inside Diameter (ID) of an aftermarket MAF tube will be larger than the stock MAF tube ID. Most Intakes will change the way the air flows through the MAF tube and thus across the MAF sensor itself. This results in a lower MAF sensor voltage output that is given to the engine ECU for the same mass airflow. This lower mass airflow reading will lead to a lower engine load, more advanced Ignition timing and a leaner AFR. It's very important that the MAF scaling is adjusted (normally increased) to counteract this problem.

The preferred setup would be making a 'before and after' log file showing the MAF volts, mass airflow, engine load, AFR etc for the stock intake and then new intake, you can then cross reference the MAF Volts 'before and after' for each RPM and Manifold Pressure and increase the MAF Sensor scaling right hand column (grams) until the same mass airflow reading is achieved with the new intake compared to the old intake.

Now this doesn't always happen and quite often the car already has an Intake fitted so the Fuel Trims will be very important and can be used to make the MAF calibration.

Adjusting the MAF scaling in closed loop

At Idle and light load (Closed Loop condition) you should log Fuel Trim Short Term and Fuel Trim Long Term (FT), generally the MAF reading will be lower with a different Intake so the FT will be adding % to maintain closed loop 14.7AFR.

Typically the FT's will be adding +5% to +20% to maintain the closed loop target. So if we increase the whole MAF scaling by plus 5% this will make a coarse MAF scaling adjustment that will work quite well. Then continue to log and adjust the MAF scaling until the FT are within 10%, a good tuner will aim to have their Fuel Trims within plus or minus 5%.

Adjusting the MAF scaling in open loop

Now the Short Term Fuel Trims do not work in Open Loop so MAF scaling in Open Loop needs a slightly different approach.

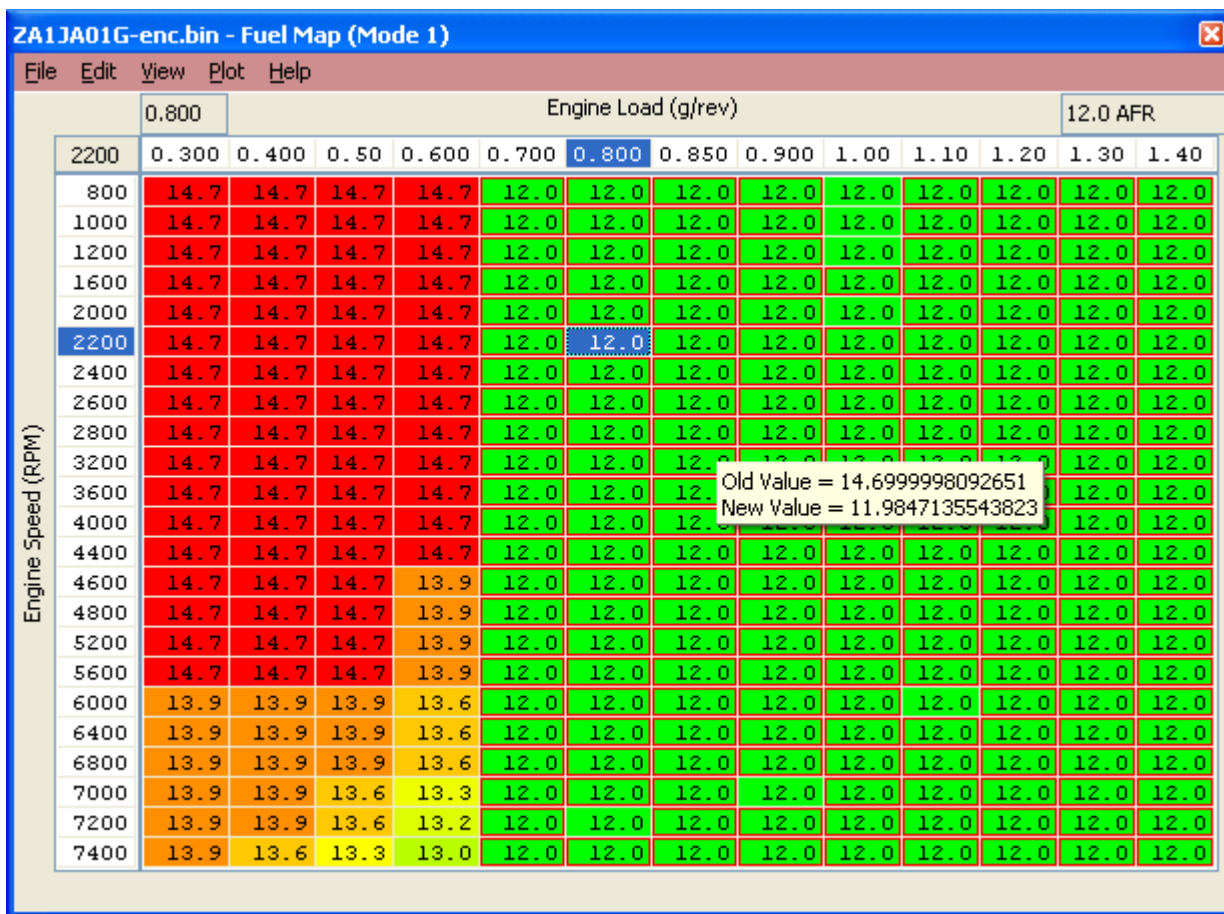
To make a good MAF scaling (and this applies to Forced Induction as well) we should fill the right hand side of the fuel map with a safe and friendly AFR, we will choose 12:1 AFR like shown below. Now make a power test and once the Engine Load exceeds 0.70 (r/rev) then the AFR should be 12:1.

If the AFR is 14:1 then increase the MAF scaling (g/sec) at that particular MAF voltage.

If the AFR is 10:1 then reduce the MAF scaling (g/sec) at that particular MAF voltage.

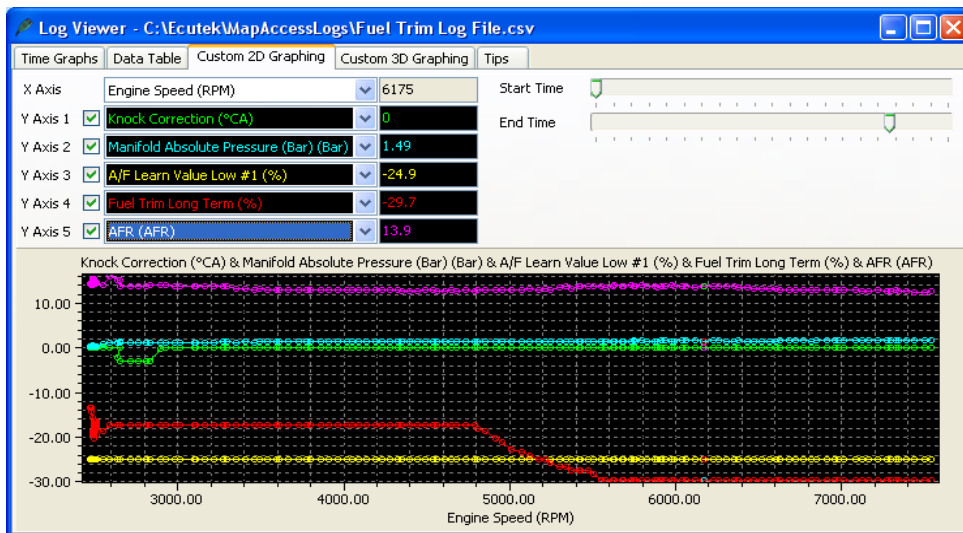
With a 12:1 Target then aim to get the AFR within 11.5:1 and 12.5:1 AFR across the board, good tuners will aim for 11.8 to 12.2 AFR but it depends on the time you have available. The first time you make a MAF scaling in this way, it may take a while but once you master it then in future you will be tweaking the MAF curve on every flash. Once the MAF scaling is good and smooth and you have 12:1 across the power curve, then you can profile the fuel map to your preferred AFRs.

MAKE SURE that your Engine Load does not exceed the X axis of the Fuel and Ignition maps, if it does then rescale the maps or use our Example Maps as your base file to start your tuning.



Now in Open Loop (high load), the fuel trim feedback does not work anymore (no Short Term Fuel Trim) but any Fuel Trim's that had been learned from Closed Loop can be applied in Open loop (shown as Long Term Fuel Trim and AF Learn Values), this is why it's very important to get your Fuel Trims tight so any Closed Loop Fuel Trims are not applied in Open Loop and therefore affect your Open Loop Fuelling.

The longer the Intake has been fitted then the better as the FT Long Term will show how the ECU uses the FT's to adjust for the MAF Scaling error, the FTLT that is applied can be used as a good indication of what to do with the MAF scaling. Here is a great example of how long term fuel trim are learned and applied.



The screen shot above shows the Fuel Trims working and actually removing -29% of the Injection Volume on fuel load, this vehicle actually had serious MAF scaling issue combined with a boost pipe air leak.

Adjusting the MAF scaling using SD **

One other option for creating the MAF scaling can be to enable SD mode, with SD enabled the mass airflow (g/sec) will come from the SD map and not the MAF sensor itself but LIVE DATA custom logging parameter called 'MAF Sensor' can still LOG the output of the MAF sensor (even though the MAF sensor is NOT used for the load input at all).

Though this can be confusing to start with it is great for MAF scaling on relatively stock cars. Simply enable SD and the engine should run reasonably well then make a power run and be sure to include the logging parameter called MAF Sensor (g/s).

As seen below the ECU is running on SD, the mass airflow input is coming from the SD map (the YELLOW line) and the engine is running well. We can also see the MAF Sensor reading below the YELLOW line (the RED line) but the ECU is NOT using the MAF Sensor.

So by enabling SD we are able to LOG and SEE the affect the new Intake has had and we simply increase the 2d MAF scaling until the RED line meets the YELLOW line.

Next we can turn OFF SD and we have a very close MAF scale. We can see at the highlighted point (4670rpm) that MAF scaling (Yellow line) is slightly higher than the SD calculated Mass Airflow (Red Line) so the MAF scaling could be reduced in this region.

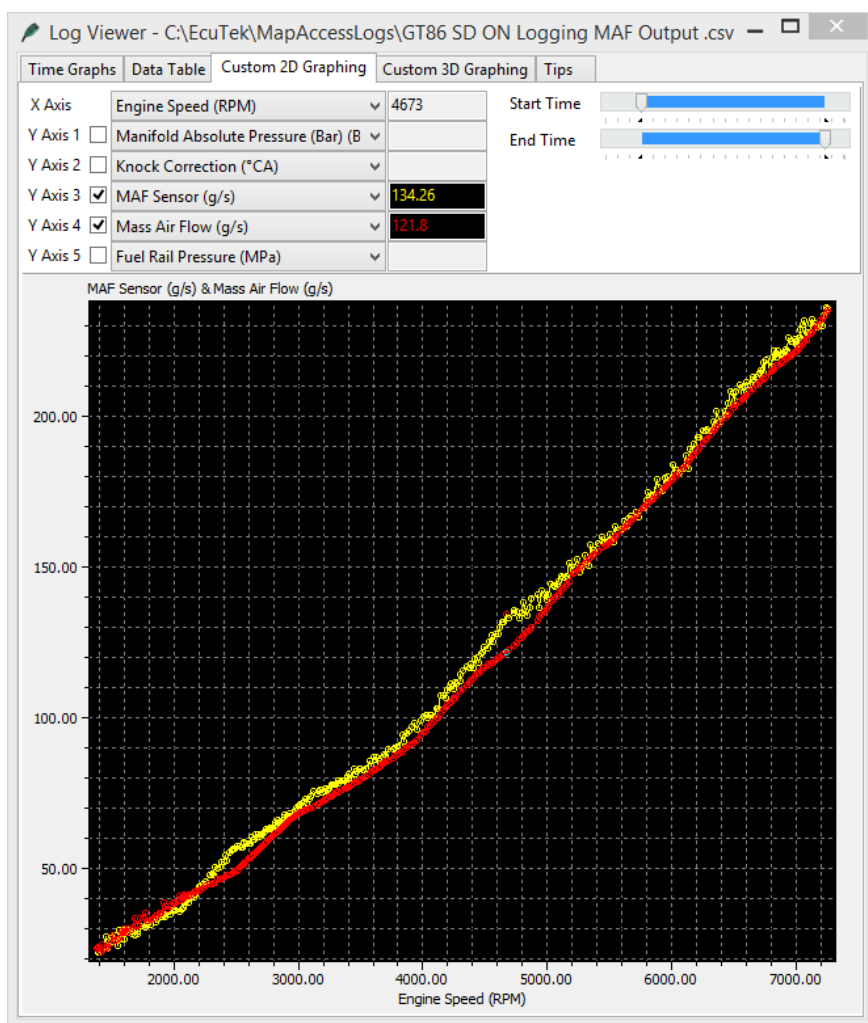
As previously stated the FTST are transposed into FTLT, these FTLT (and AF Learn values) can take weeks to learn and take effect.

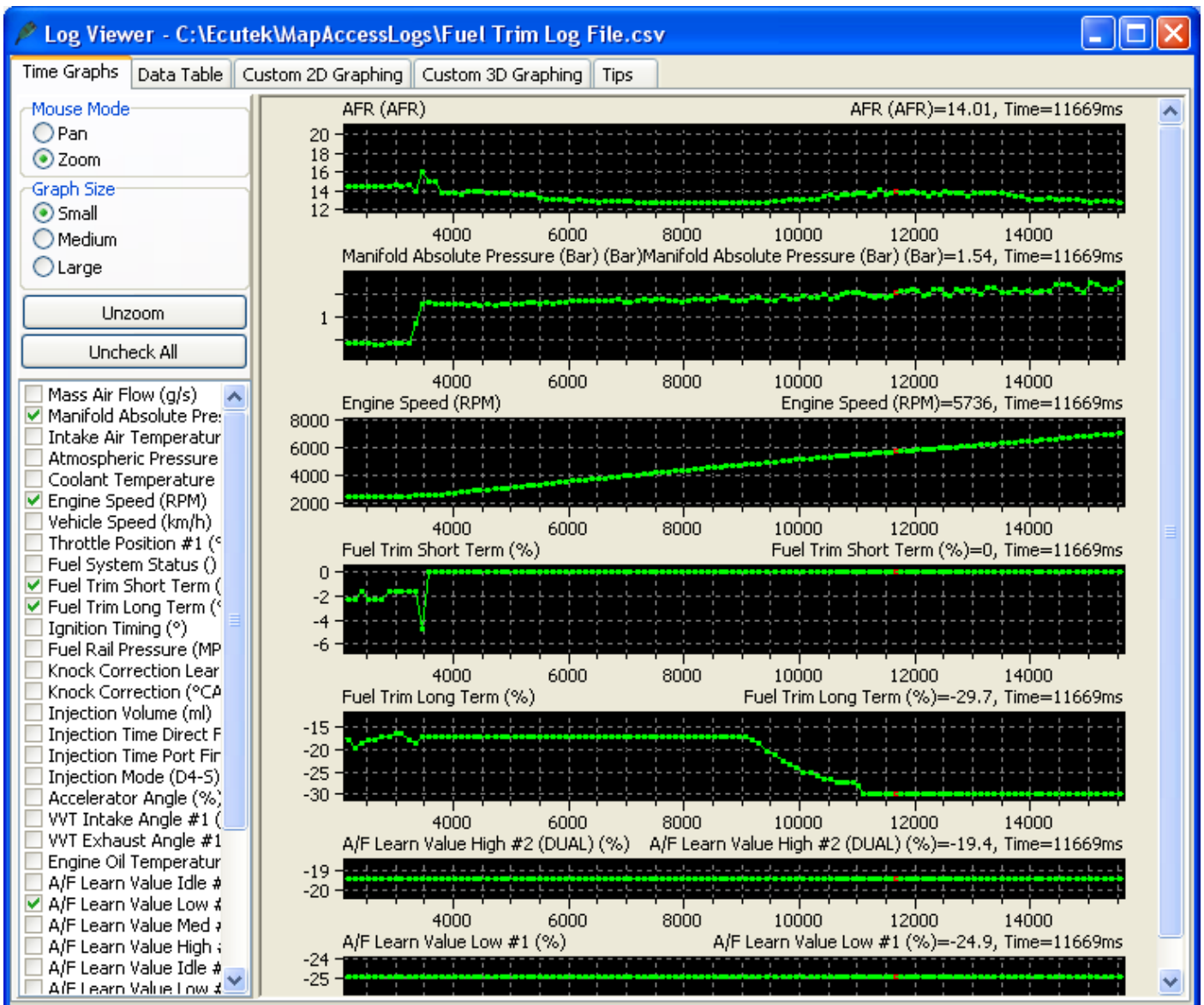
As these are applied in Open Loop and this can drastically change your wide open throttle AFRs making the car run very rich or very lean over a long term period.

See the Hybrid SD section later in the manual for additional

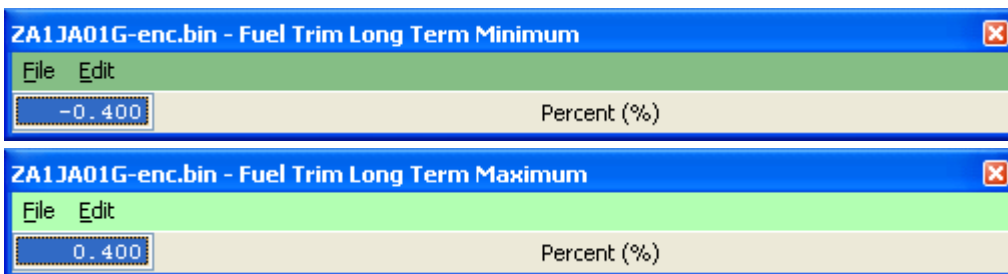
information and how the SD-VE logging parameter can show if SD is enabled or not (using a calculated SD value when running MAF).

See the next screen shot on a FI engine running 1.54bar absolute and 14.0AFR because the FTLT have removed -29% of the fuel volume, for this reasons it's important that your closed loop FTs are within 5-10% when in steady state.





The two maps shown below FTLT Min and Max values should be set to zero to help prevent the FT from altering the Injection volume in Open Loop. Though the Fuel Learning is not fully understood these maps are critical to the open loop FT factors though we advise you check very carefully where ever possible that open loop FTs are not applied in other modes or conditions.



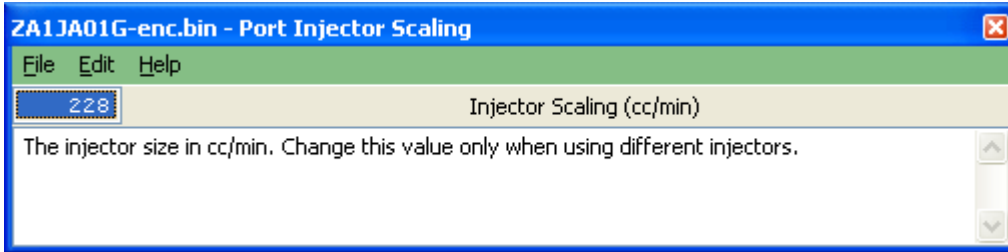
4.2.2. How to calibrate Larger Injectors

It's very important that the ECU knows the true size of the Port Injectors that are fitted so it can accurately calculate the correct time period to open the injector to deliver a required volume of fuel.

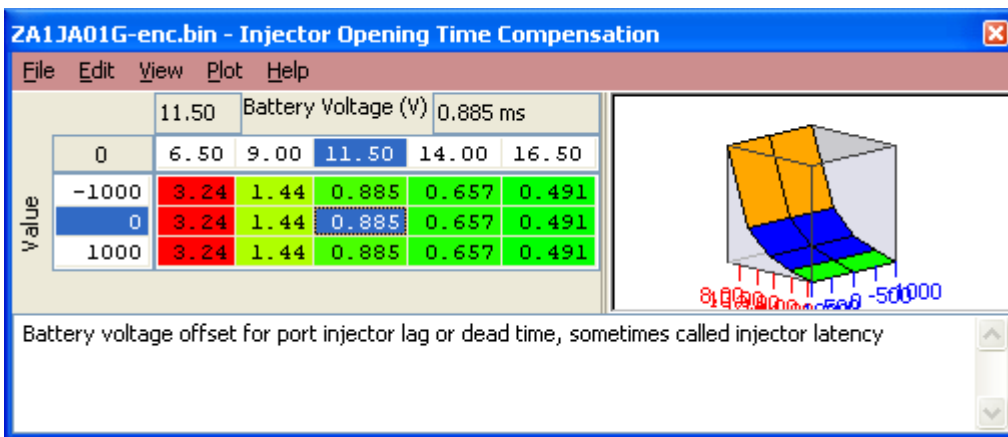
After fitting larger port injectors the following maps will need rescaling.

- Port Injector Scaling
- Injector Opening Time Compensation
- Injector Minimum Open Time

Generally the replacement larger Port Injectors will be supplied with an Injector calibration size and that should be entered here.



The different Injectors will have different characteristics to the stock injectors and will normally take longer to open. This time period is referred to as 'dead time, lag time or latency' and this time period is affected by the current battery voltage. Using the manufacturers technical data, enter the correct lag times for a given voltage in the maps called '**Injector Opening Time Compensation**'.



If this data is not available then we suggest you just change the Injector size then leave the battery voltage comp map until you see how the engine is currently running.

You should now follow the sequence '**How to setup an Intake or Induction Kit**' section and pay attention to the fuel trims in closed loop and watch the wideband AFR sensor in Open loop to see how far out the AFR is compared to the fuel map targets.

As per the previous section the fuel map should be filled with a fixed value (like 12:1 AFR) for simplicity of adjusting the calibration and cross referencing with the wideband.

Note: the Injector Opening Time Compensation values will have much **more** of an effect at Idle and light load when the Injector open times are much smaller (2-5ms at Idle and light load VS 10-18ms for full load).

In addition, where larger Port Injectors are fitted it may be advantageous to fine tune the DI/PI ratio to ensure that the DI Injectors are delivering enough fuel volume and that the bigger PI injectors do not simply deliver all the fuel. They should supplement the DI and not replace it.

Remember that the Port Injectors can open up to 18ms at 6000rpm whereas the DI can only inject for less than half of that (due to Spark BTDC and valve overlap), so around 5ms MAX is recommended for DI.

Changes should also be made to the PI/DI ratio map along with the Min and Max allowed ratios for larger injectors, see the Forced Induction Tuning section for further info.

4.2.3. How to rescale the MAP sensor

The factory MAP sensor can read to around 1.37bar absolute, we recommend that the MAP sensor is replaced on all Forced Induction models. The popular plug and play replacement items are OMNI 3 and 4 bar sensors.

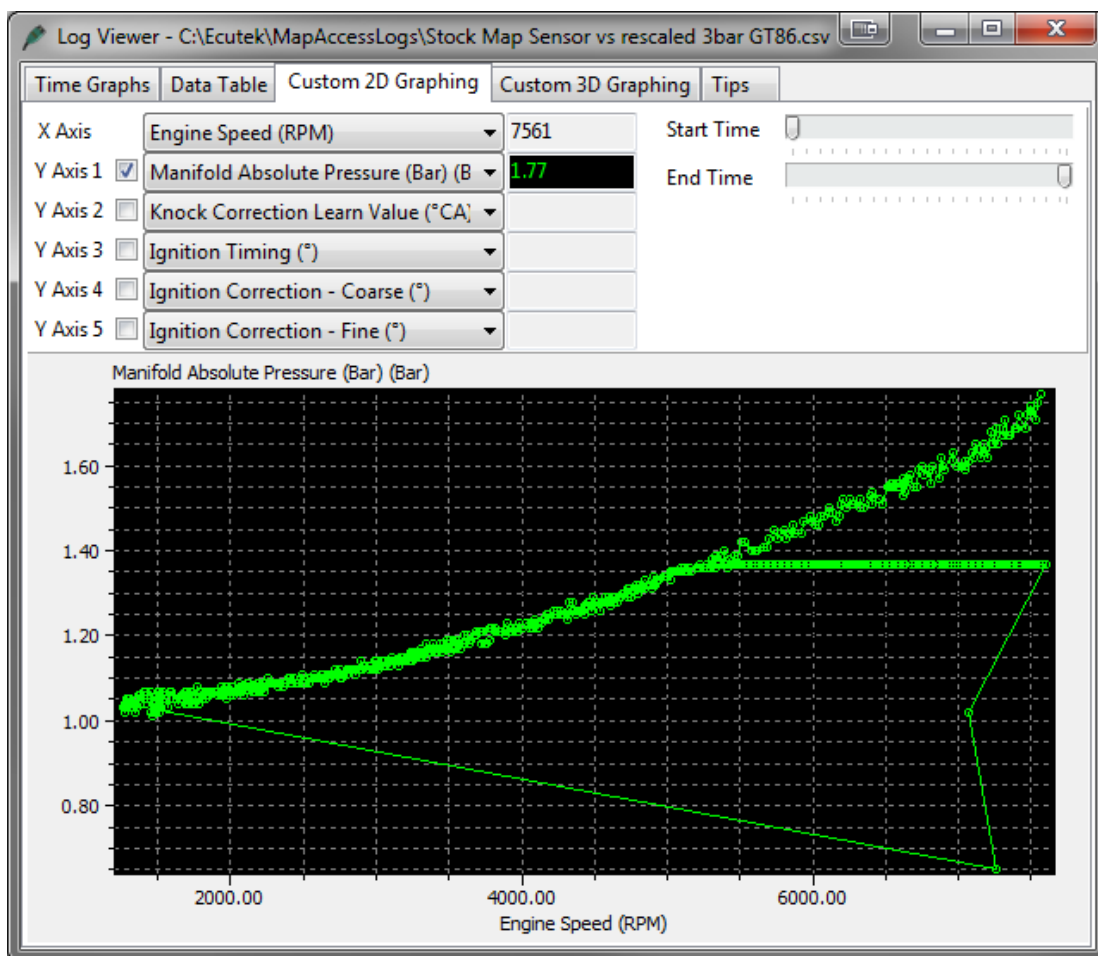
NOTE: It's very important that the MAP sensor scaling is accurate when using Speed Density.

Sensor scaling	Multiplier	Offset
1.37 Bar Factory MAP sensor	0.333	-0.2
3 Bar MAP sensor	0.617	0.03
4 Bar MAP sensor	0.825	0.031

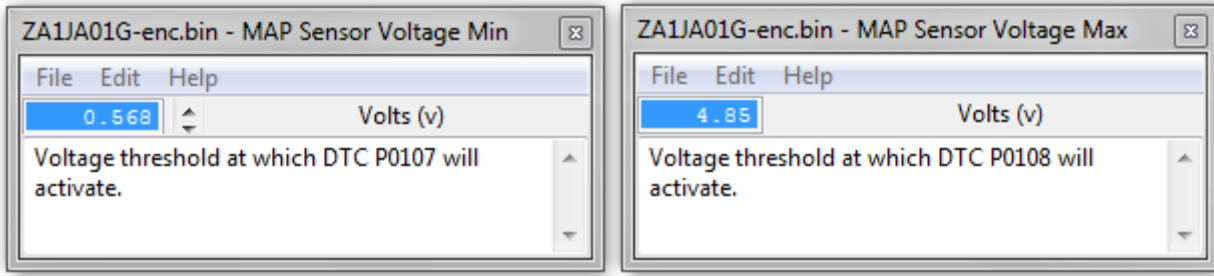
With the stock MAP sensor in LIVE DATA check the Manifold Absolute Pressure with Ignition ON (engine not running) and at stable Idle, make a quick log file.

Then fit new 3 or 4bar MAP sensor and enter new scaling as above and repeat the test to ensure it's the same manifold pressure with the Ignition ON (engine not running) and at Idle.

The log file below shows two log files that have been added together in excel. The first log is with standard MAP sensor that flat lines at 1.37bar. The second log is a 3bar sensor that has been correctly rescaled. The two lines are identical till 5400rpm where the stock sensor flat lines and but the 3bar continues to read the true manifold pressure until 7600rpm.



You may need to raise and lower the MAP sensor Voltage Min and Max to avoid the P0107 and P0108 on model fitted with a 2 bar or 3 bar sensor (as the voltage generated at Idle will be considerably lower).



NOTE: If a 3 or 4 bar MAP sensor is fitted and the sensor scaling is NOT rescaled, then the engine will NOT start. The cranking fuel is based on MAP and if the MAP sensor scaling is not correctly then the engine will struggle to start or will not start at all, quite a few tuners have been caught out by this so try to remember this!

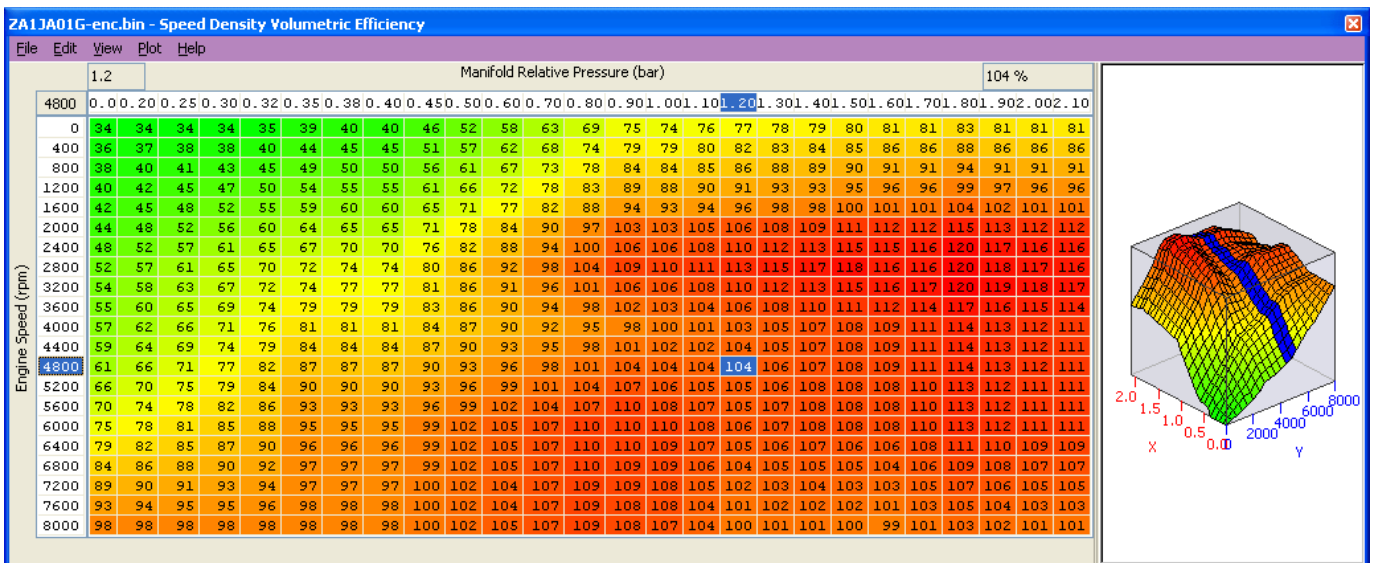
4.2.4. How to setup Speed Density (SD) **

EcuTek RaceROM Feature Files (RRFF) offer a Speed Density tuning option for trade customers, or Retail customers that have purchased the optional RaceROM BRZ upgrade package. This is a MAP sensor based load input into the ECU (compared to the more forgiving factory MAF sensor based load input).

In certain situations Speed Density is more suitable over a MAF based input, these are usually:

- The air speed through Large MAF tubes is too slow to accurately measure for a stable Idle
- Turbo compressor wheel cause reverberations up the intake pipe and upset the MAF sensor reading
- Turbo installs use Vent To Atmospheric Blow Off Valves (BOV's) instead of preferred recirc designs
- Supercharger recirc valves cause reverberations up the intake pipe and upset the MAF sensor reading
- The stock MAF is flat lined at 5volts and cannot read any higher than the 5v limit (where ideally a slightly larger MAF tube should be fitted like 69 to 76mm)

In these situations the Speed Density or Hybrid Speed Density can be used.



The SD VE map is against Engine Speed (RPM) and Manifold Pressure (Bar). The values in the map are volumetric efficiency (VE) %.

The older RRFF SD Map had Mass Airflow values in the SD map, but the latest RRFF now uses a superior VE based SD calculation which we will cover here.

When the SD map is active, it simply replaces the current Mass Airflow (g/sec) reading that would normally come from the MAF sensor, therefore ALL load calculations are not affected by the MAF sensor at all.

When the SD map is correctly calibrated, there is little difference from running on MAF and the SD VE map works like this:

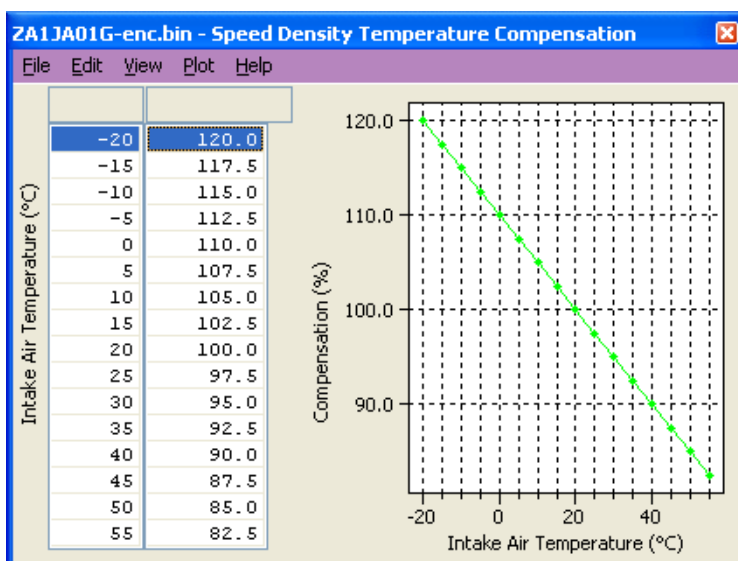
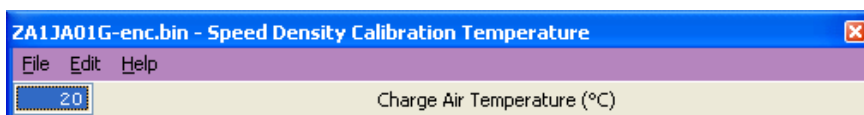
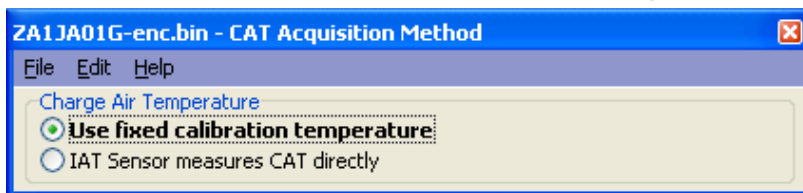
- INCREASING the SD values will make Engine Load higher, therefore retarding the Ignition and increasing the Injection volume amount will make the AFR richer
- REDUCING the SD values will make Engine Load lower, therefore advancing the Ignition and reducing the Injection volume amount will make the AFR leaner

If SD is used, ensure that the MAP sensor can read to the pressure you are running!! (Any pressure over 1.37bar absolute will need a 3bar MAP sensor fitting etc)

As a VE based calculation it is seriously affected by any fundamental change in VE like fitting a Supercharger, Turbocharger, changes in the VVT angles or the VVT not actually working.

Charge Air Temp (CAT) also plays a critical part in the VE calculation. As a Charge Air Temp sensor is NOT fitted by the factory, we have to assume a fixed temperature and then make a calibrated compensation based against Intake Air Temp.

No air temp sensor fitted in the charge pipe

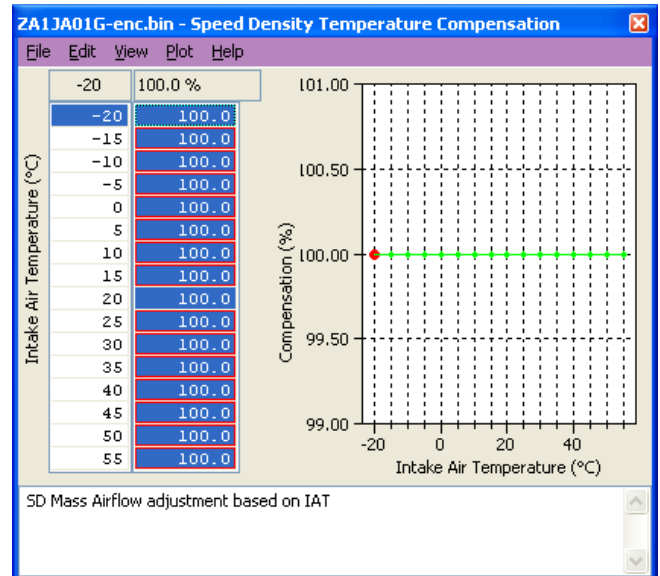
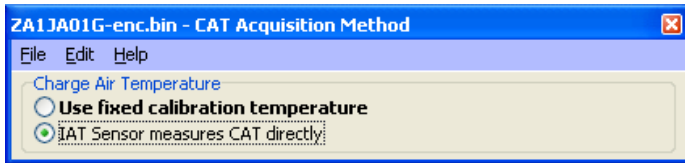


The Speed Density Temp Compensation map will adjust the SD VE calculation based on the current IAT, therefore attempting to calculate the true air density by calibration.

Intake Air temp sensor fitted in the charge pipe

If the Air Intake Temp sensor (AIT) has been placed in the charge pipe and the IAT is measuring true CAT (after the turbo/supercharger and intercooler) then we do NOT need to use the 'Speed Density Temp Compensation' map (as VE calculation is including true CAT). In this situation, we need to select the CAT Acquisition Method of 'IAT sensor measures the CAT directly' option.

We also need to set the values in the 'Speed Density Temp Compensation' to 100 as we are not 'guessing' the CAT anymore.

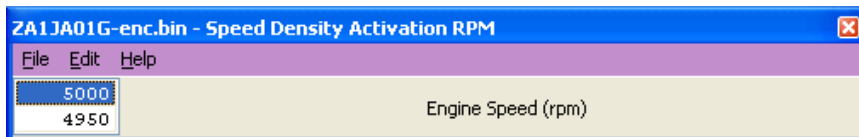


Hybrid SD mode options

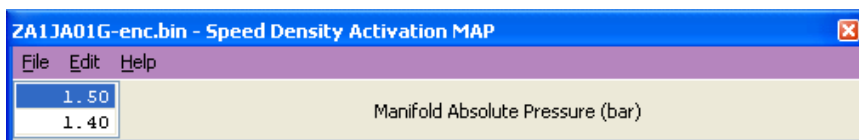
RaceROM's powerful Hybrid Speed Density allows the Load Input to be switched between MAF and SD as required. This could be 'MAF then SD' or 'SD then MAF'. The condition to switch between the two inputs can be one or several of the following:

- Engine Speed (RPM)
- MAP (Bar)
- Mass Airflow (g/sec)

If you wish to have the engine running on MAF at Idle and low load and then continue on MAF until 5000rpm then switch to SD past 5000rpm, set the RPM threshold like this.



In addition you can specify that the boost pressure has to be over a certain pressure before the switch to SD as well (like over 5000rpm **and** over 1.5bar boost absolute or 7.5psi boost if you prefer), this is the Hybrid mode.



The base SD VE calibration has been made against a stock naturally aspirated engine (NA) with stock cam timing. We have also developed a SD VE map to suit the Vortech Supercharger setup.

NOTE : If running full time SD or Hybrid SD we recommend the P0103 DTC is disabled, this 5 volt MAF protection DTC will force the ECU to use the 1d value called 'MAF Failsafe Load Calculation Multiplier' which will change the Engine Load (even if full time SD).

** If using Hybrid SD then ensure you use RFF version 8 or newer, older versions can cause a hesitation when switching from MAF to SD.

The next section shows a Hybrid SD transition log file and includes the SD Volumetric Efficiency (%) in the log file. SD VE can still be 'calculated' even if the ECU is currently running on MAF.

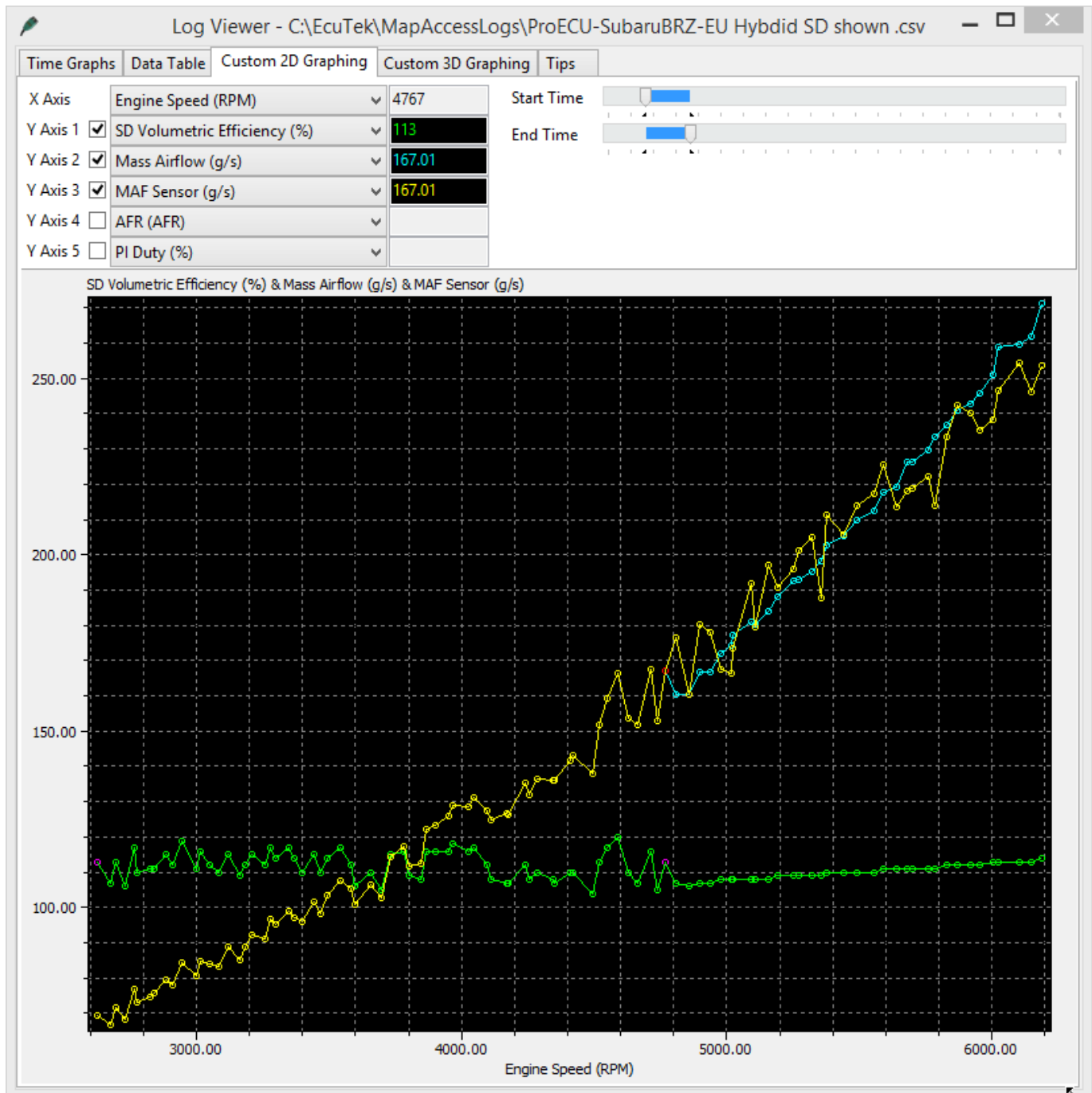
See the log file below that shows the transition from MAF to Speed Density at 4750 RPM.

So below 4750rpm the ECU is running MAF.

Over 4750rpm the ECU is running SD, but the MAF reading can still be logged even though the ECU is not using the MAF reading – Yellow Line.

See the Mass Airflow (Blue Line) and MAF Sensor reading (Yellow Line) are the same below 4750rpm.

Over 4750rpm the Blue and Yellow line separate as the Mass Airflow is calculated from the SD map and not the MAF sensor reading.



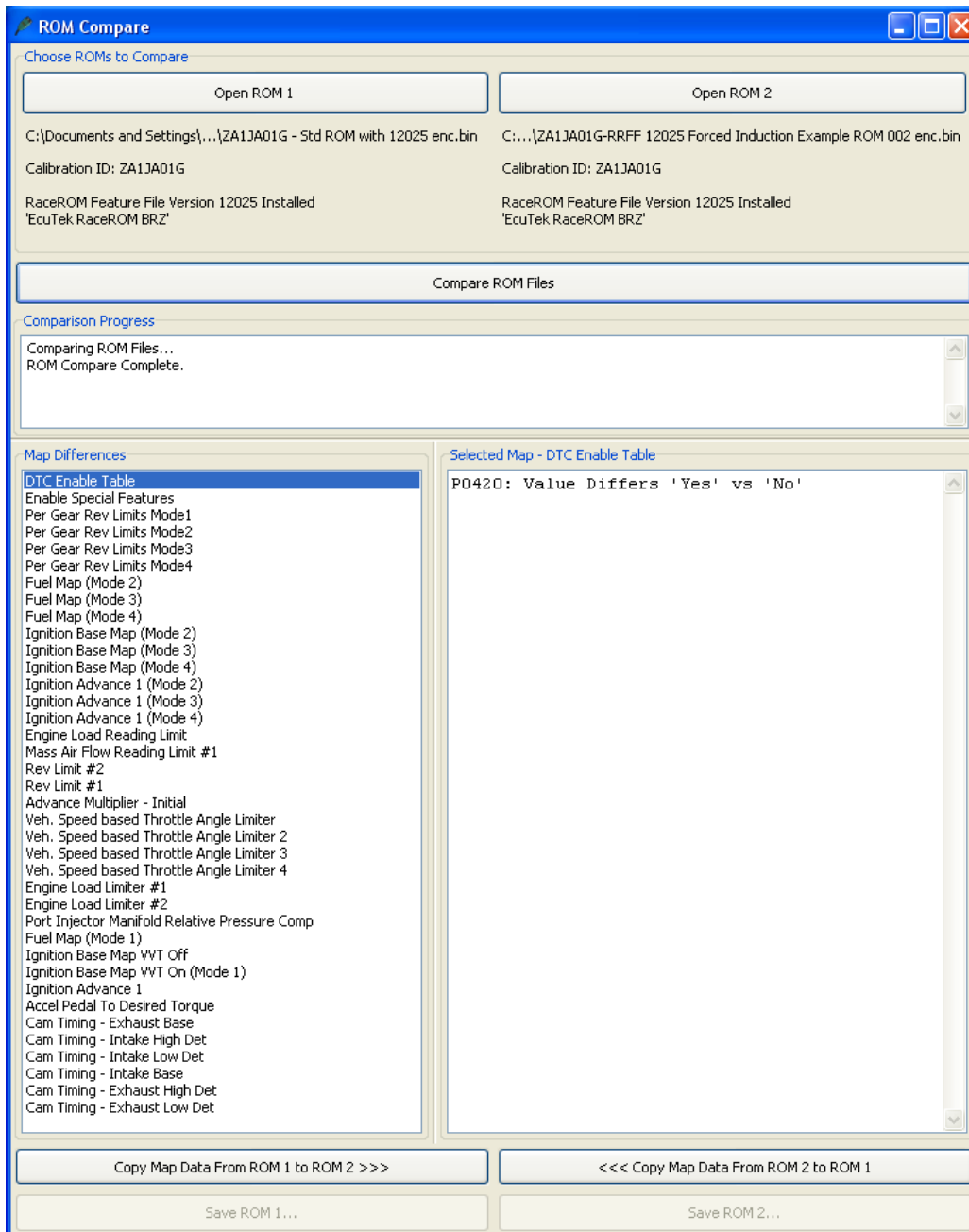
See how much smoother the Mass Airflow and Speed Density parameters are when they come from the RaceROM Speed Density map!

4.2.5. How to tune a Forced Induction setup

The factory ECU has not been calibrated for Forced Induction (FI) installations, so after fitting either a Turbocharger (TC) or Supercharger (SC), the key maps will need adjusting. With more airflow and higher engine load, the Ignition and fuel map load axis will need rescaling to provide the resolution required for safe calibration. The Injection maps will also need adjusting.

It is suggested that any FI tune should start with our base FI Example ROM file, these are available for the following region ROMs: USA, Euro or JDM region. These ROMs have the key maps modified to start your calibration with. If your ROM is for another region, use ROM COMPARE*** to see the maps that have been altered and the typical settings used.

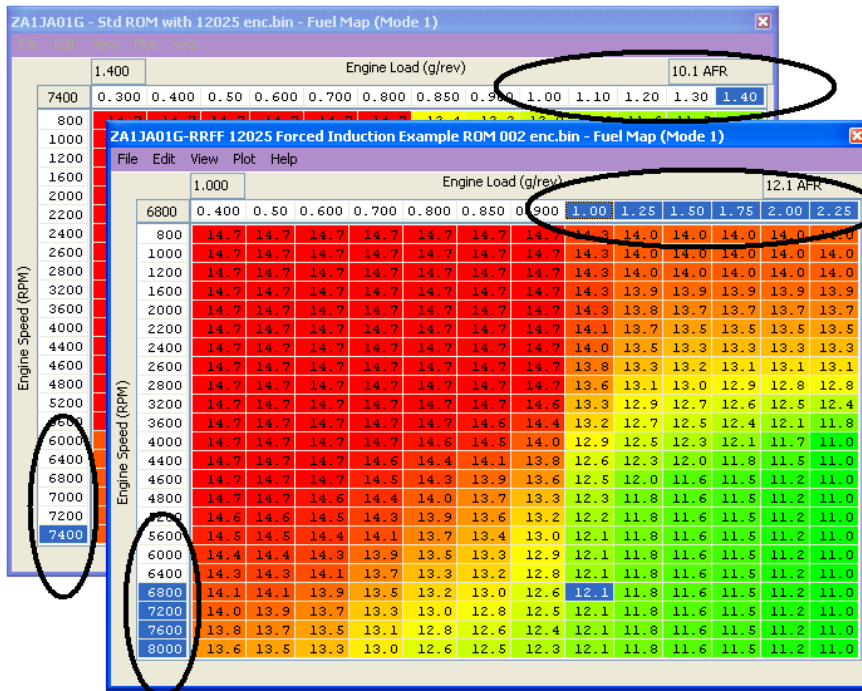
*** Example ROMs and ROM Compare are only available for Trade customers



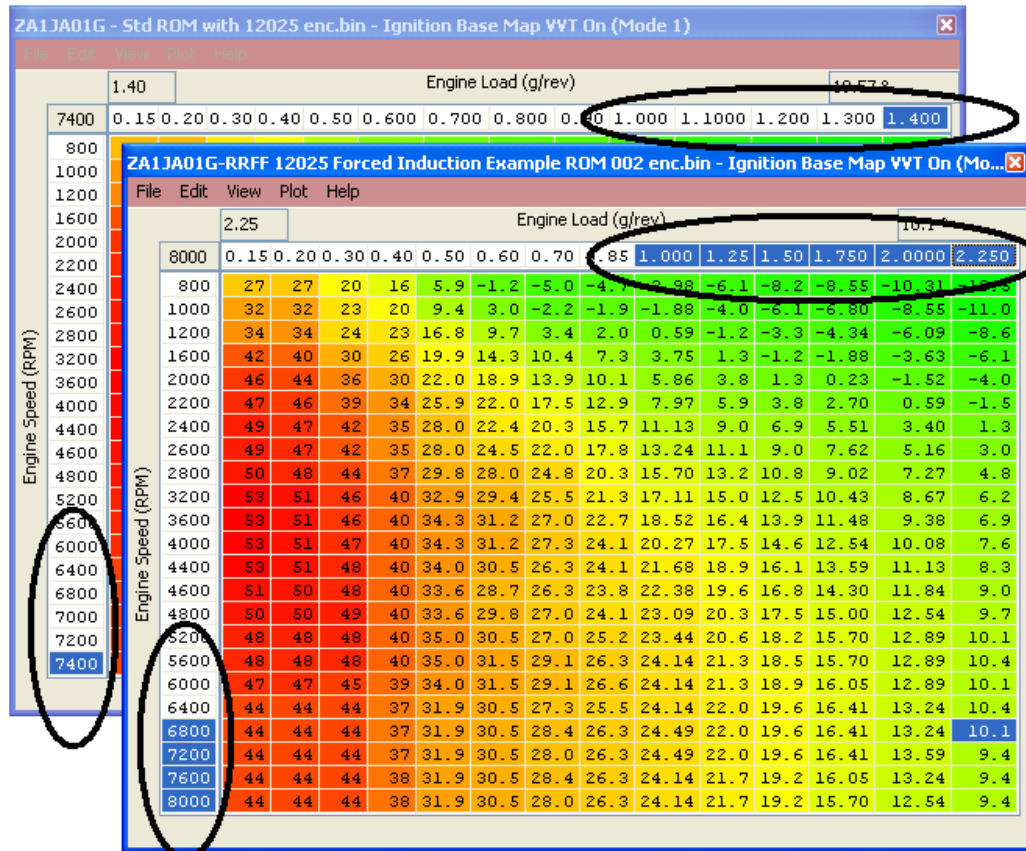
Here are the changes we have made and the reasons why we made these changes:

Engine Load Map Rescaling

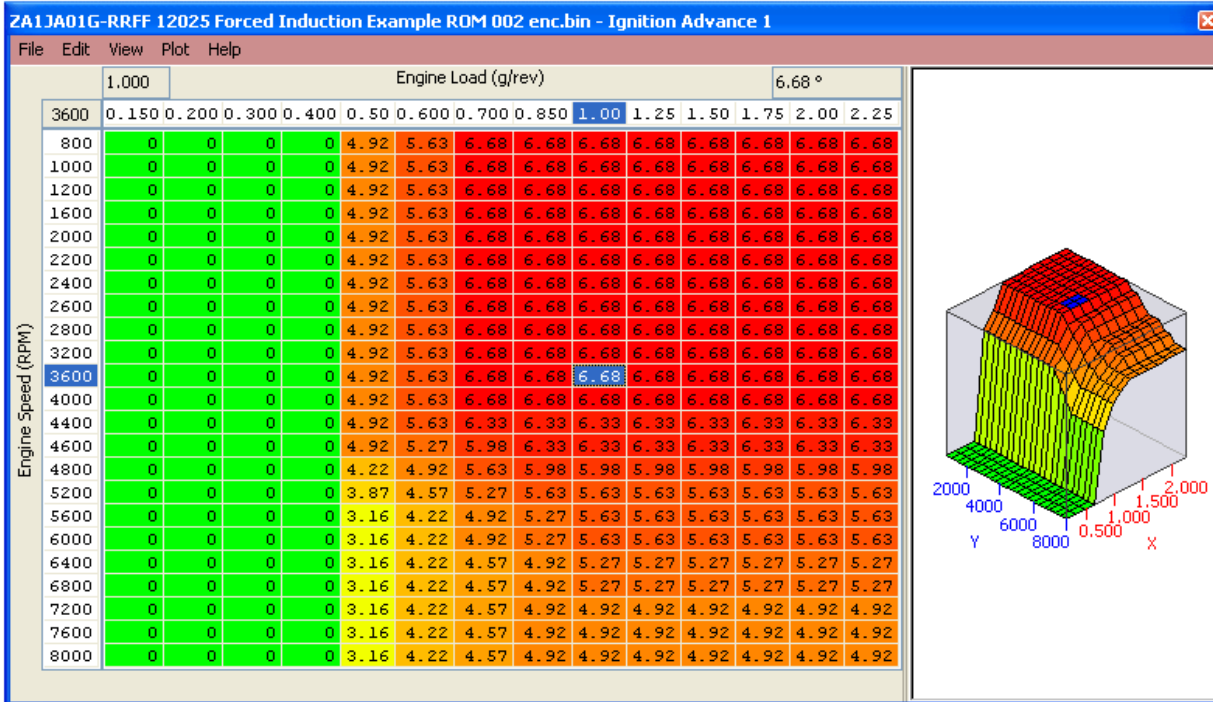
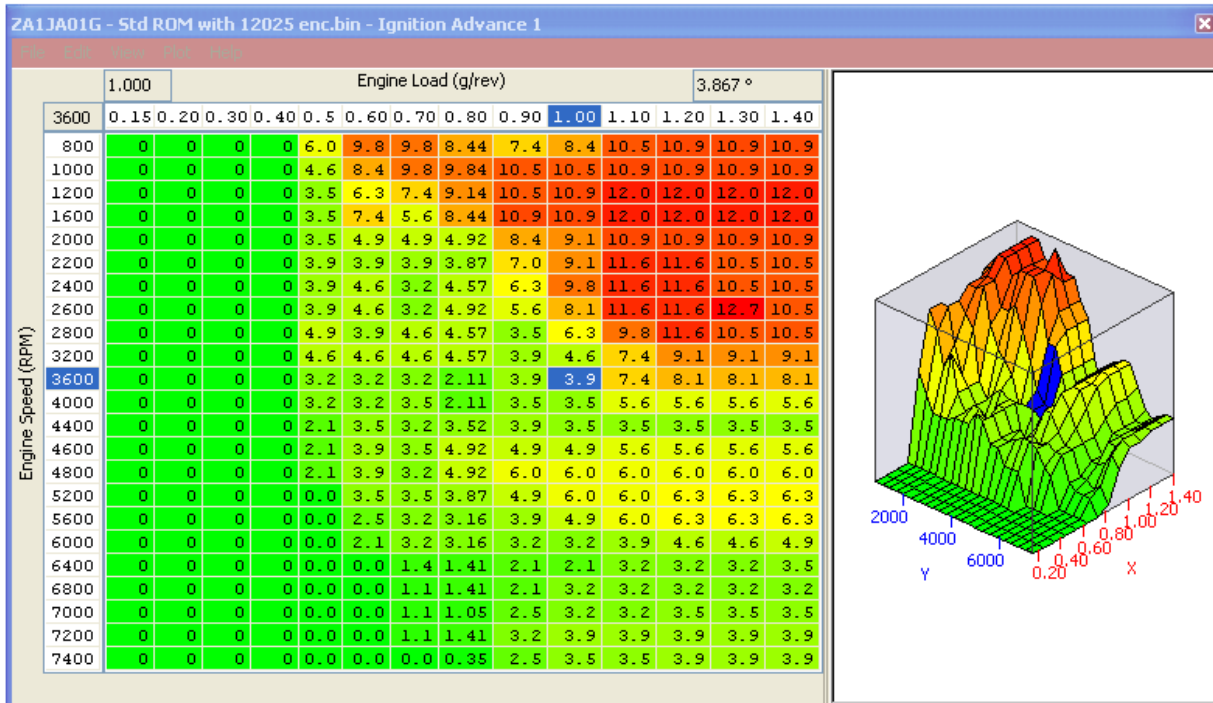
- Fuel Maps – we rescaled the X axis from 1.4 to 2.25 Engine Load as shown below, you can also see the optimised AFR values compared with a stock fuel map.



- Ignition Base Maps – we rescaled the X axis from 1.4 to 2.25 Engine Load as shown below, we also advanced the Ignition timing slightly over stock settings.



- Ignition Advance maps - we rescaled the X axis from 1.4 to 2.25 Engine Load, and have also smoothed the advance map values for easier calculations of Ignition timing when added to the Ignition Base map. This smoothing method also helps to visualise fine learning knock retard by looking at 'knock control learned value' in LIVE DATA. With 6 degrees in the advance map, the 'knock control learned value' should show a consistent 5 or 6 degrees during logging (assuming there is no learned knock retard in memory for fine learning and also assuming the Advance Multiplier is 1).

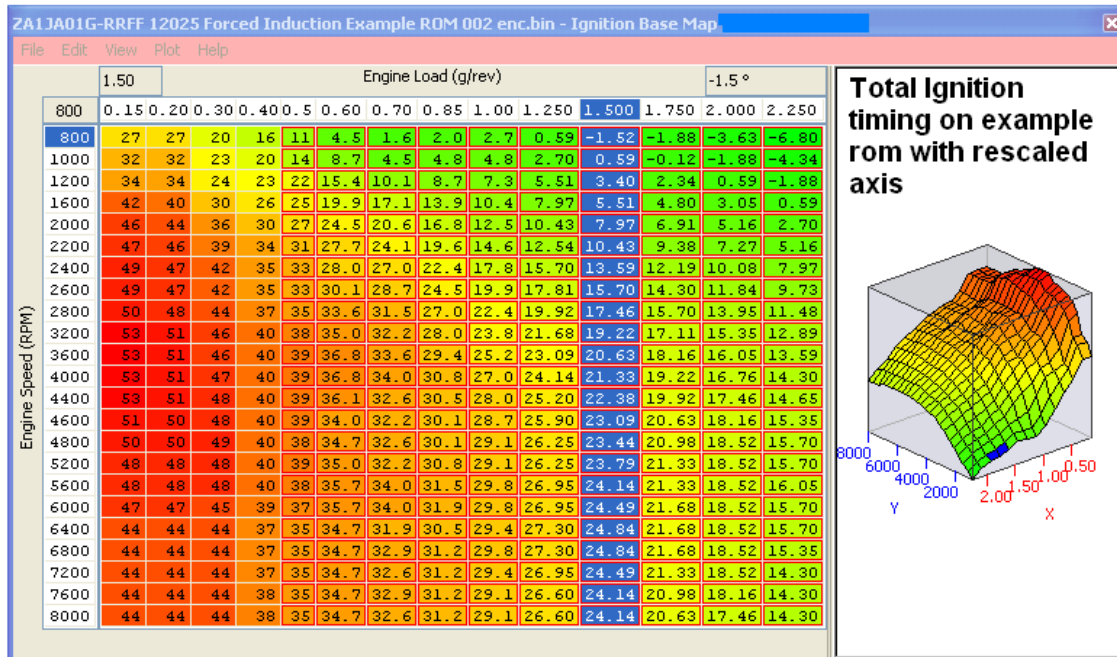
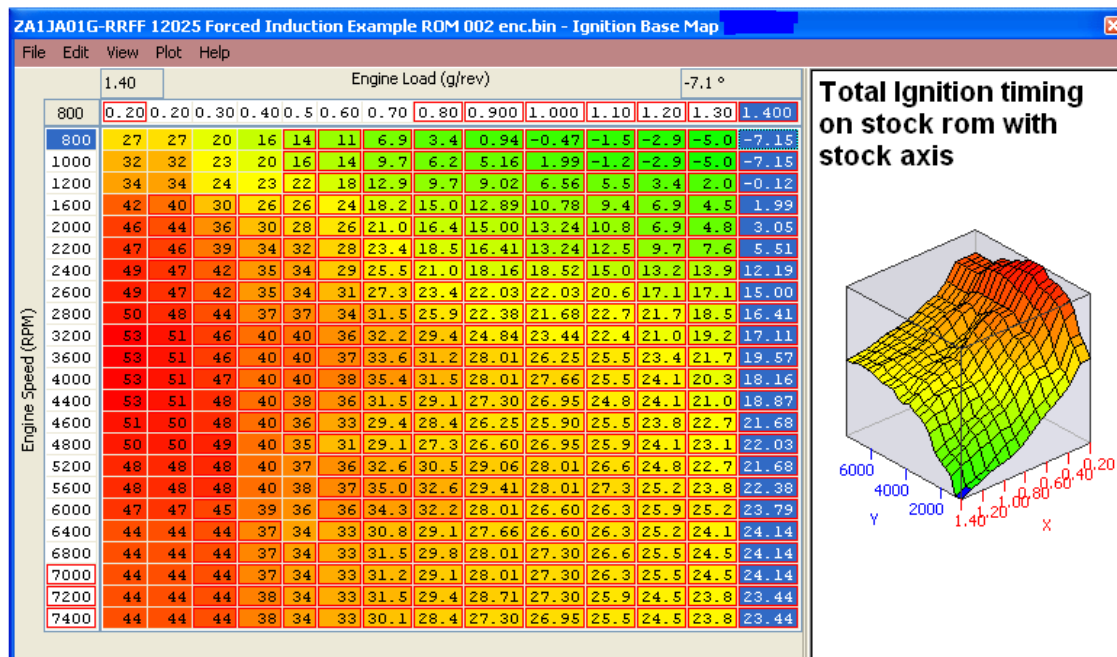


It is possible to calculate the complete Ignition timing by adding the Ignition Base map to the Ignition Advance map, this can be done in Excel but ensure that your X and Y axis line up when you add the values together.

We have added the stock Ignition Base map to the stock Ignition Advance map to see the total Ignition timing for a stock car.

We have also done the same for the example ROM and the differences can be seen below, note the stock total ignition timing screen shot is only scaled to 1.4 Engine Load compared to the example ROM that's scaled to 2.25 Engine Load.

You can see the example ROM has a smoother profile vs the stock map.

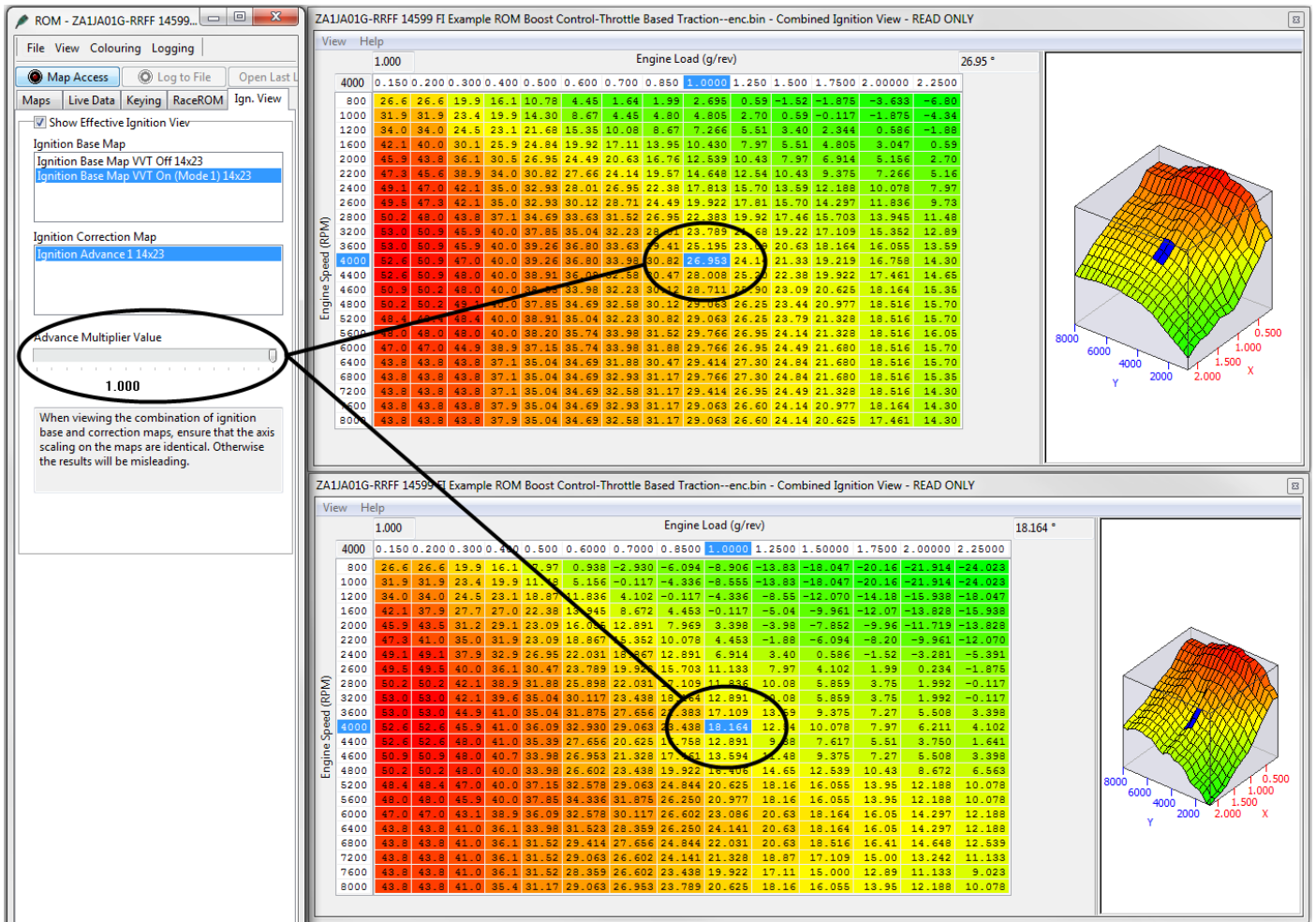


Using the combined Ignition view makes it much easier to see the total Ignition timing.

By simply moving the slider from left to right we can see the effect the Advance Multiplier has on the total Ignition Timing.

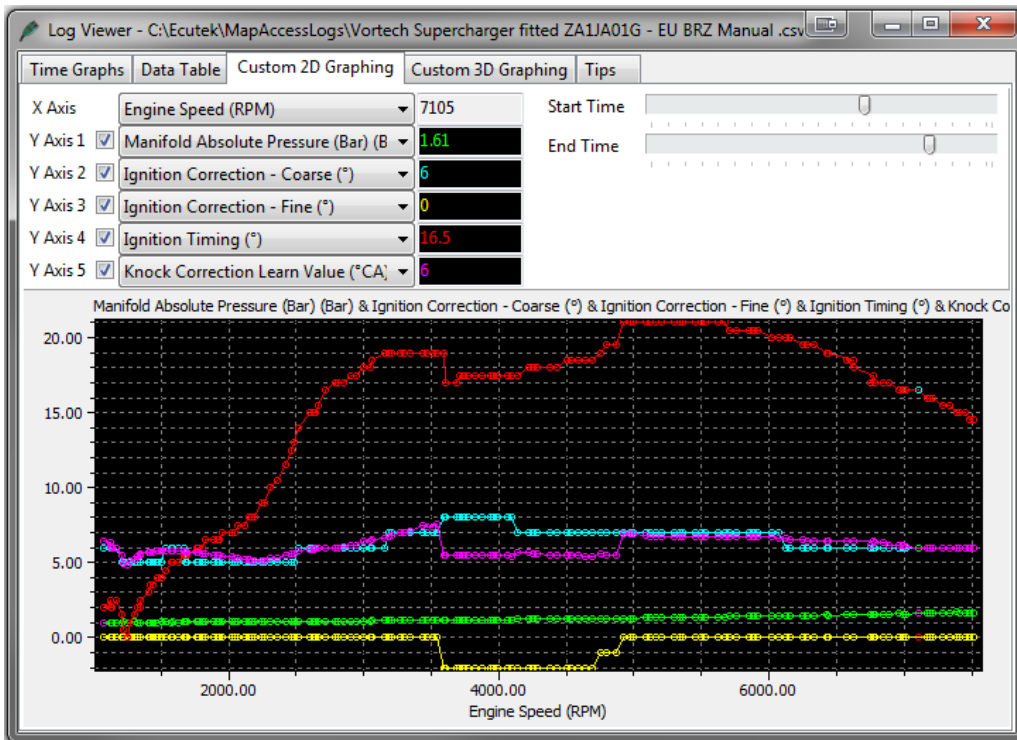
If the AM is 0 then NONE of the **Ignition Advance map** will be added to the **Ignition Base map**.
 If the AM is 1 then ALL of the **Ignition Advance map** will be added to the **Ignition Base map**.
 If the AM is 0.73 then 73% of the current **Ignition Advance map** value will be added to the **Ignition Base map**.

See the "Advance Multiplier - Coarse Correction" section in the Ignition Timing section for more information.



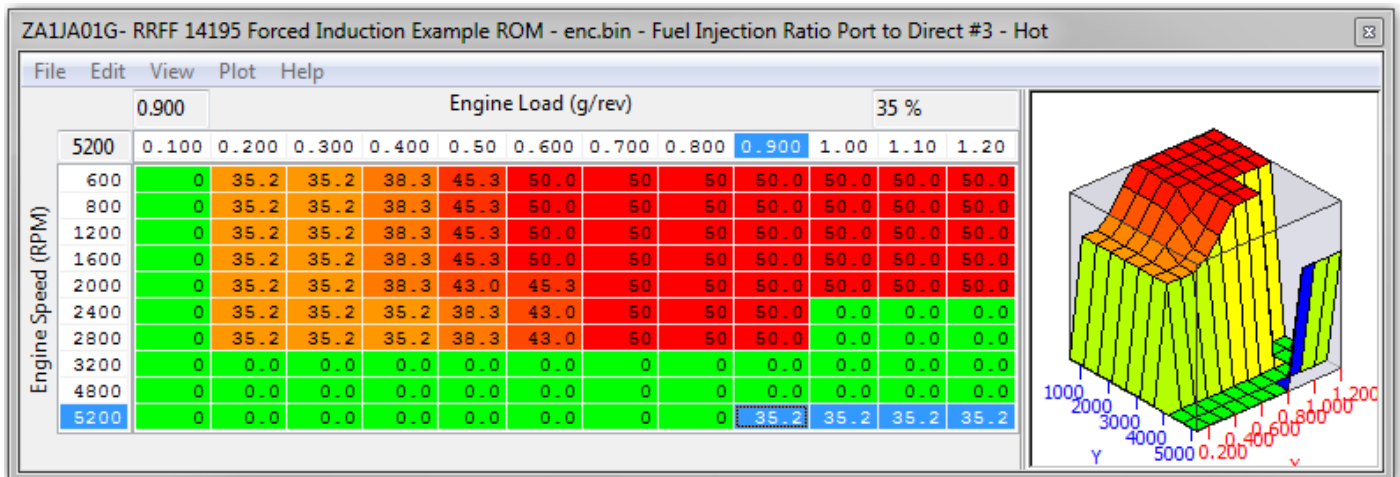
Forced Induction Ignition

Tuners will note that Ignition timing will normally climb (advance) on a NA car at higher RPM. But with a Vortech supercharger installed the Ignition timing is retarding at higher RPM (past 5500rpm), this is due to the characteristic of the centrifugal supercharger which creates more boost the faster you spin it. See the RED line decreasing as the boost increases and increases.

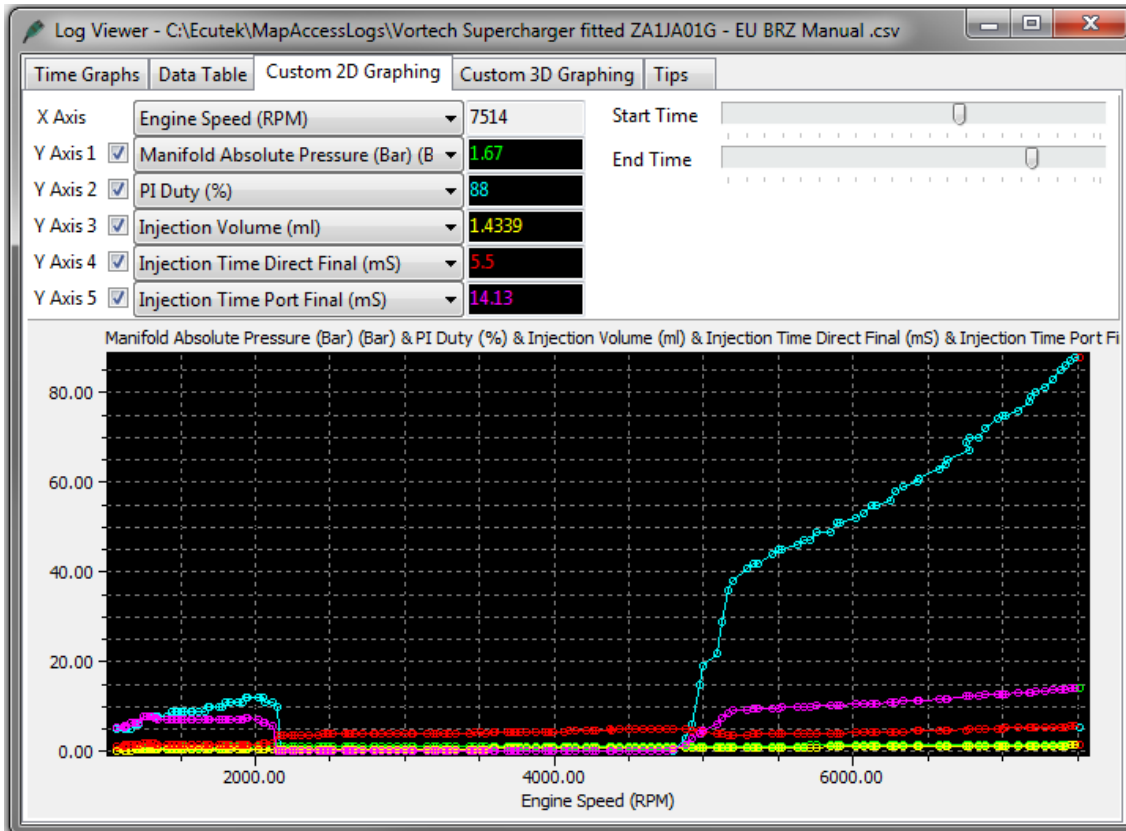


Forced Induction Fueling

The stock fuel system can deliver around 300bhp on stock Port and Direct Injection injectors. To achieve the full fuel delivery required for 300bhp on stock injection you need to ensure that the Port Injectors (PI) are running at 80-90% at 7000rpm on. This PI/DI ratio is controlled by the 3d maps called 'Fuel Injection Ratio Port to Direct #1 - #3'. The factory map is configured so the PI will deliver 20% of the required fuel volume amount past 5200rpm. We need to increase this PI ratio to around 35% so the PI Duty is over 80% like shown below.



With PI delivering 35% of the fuel volume the PI Duty is now running at 88% as seen below, this reduces the DI open time period giving more potential DI open time if we need it. In the log file below showing our (Vortech Supercharger GT86) you can see the DI is only open for 5.5ms and a total fuel volume of 1.43ml. This is getting near the limit of the stock fueling and the maximum open time for the DI injectors.

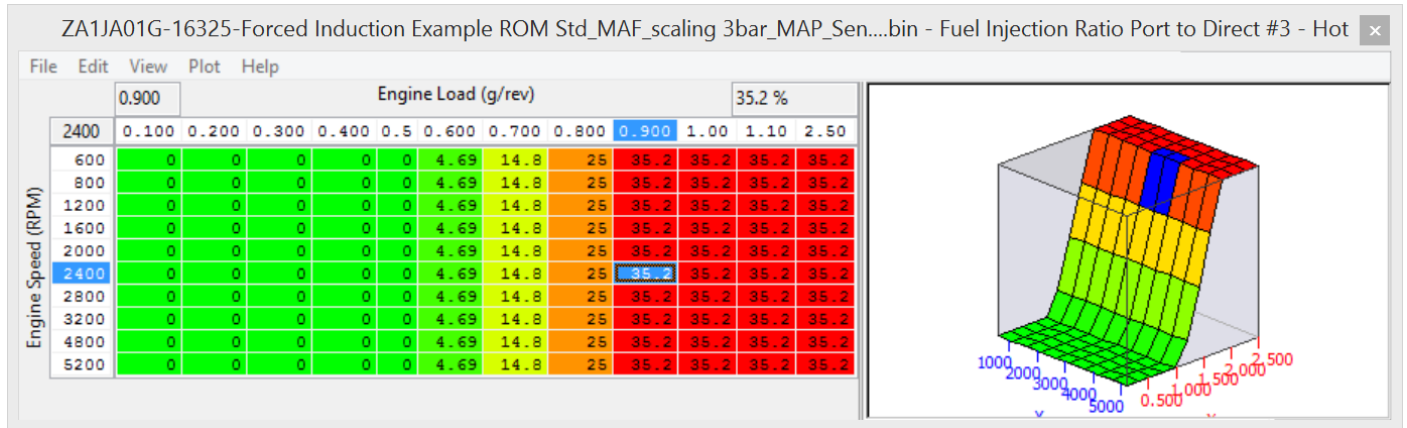


This also applies when larger PI have been fitted but we make a further change as well.

Larger Port Injector Tuning

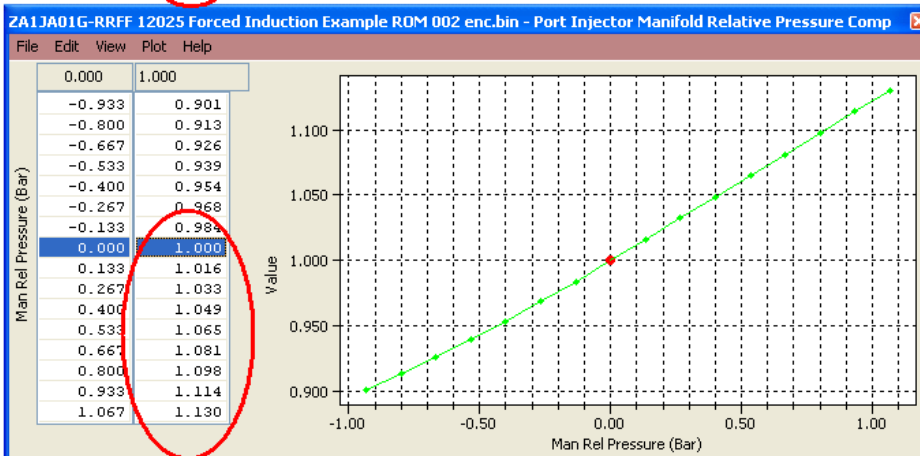
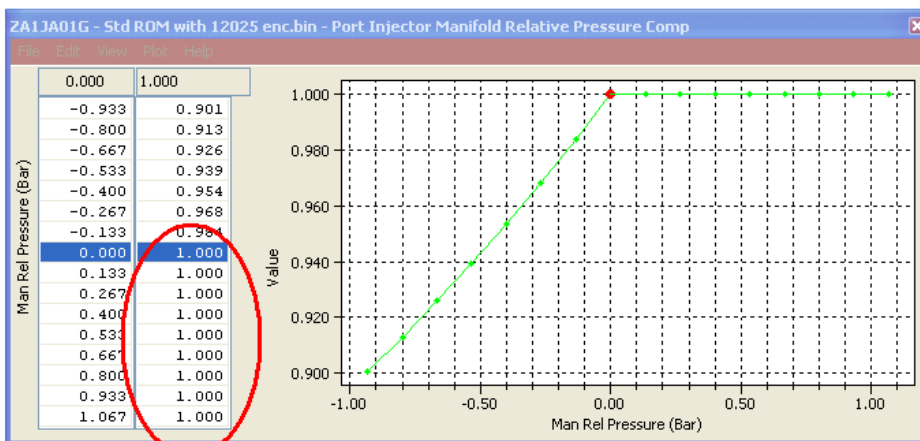
When larger PI injectors have been fitted (450cc, 750cc or 1000cc) it can cause a slight hesitation at low RPM and light load, this can happen as the Port Injectors switch from off to the factory calibration ratio of 35% fuel volume delivery. This can be changed using the PI ratio Threshold – Lower limit but the best solution is to prevent the PI from working at low RPM and light load.

See the following screenshot example of how to configure all 3 of the ‘Port to Direct Injection Ratio’ maps. The PI will not work until there is a reasonable load and airflow and this will eliminate any transition drivability issues.

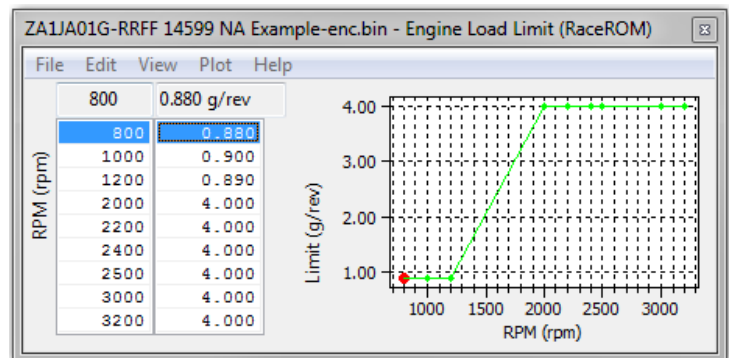


If you wish the PI to deliver less than 35% of the total fuel volume amount then reduce the 1d map called ‘PI Ratio Threshold – Lower Limit’ down from 35% for this to be possible.

- Port Injector Manifold Relative Pressure Compensation – rescaled for positive pressure compensation so that the correct volume of Port Injector fuel will be delivered relative to forced induction manifold pressure.



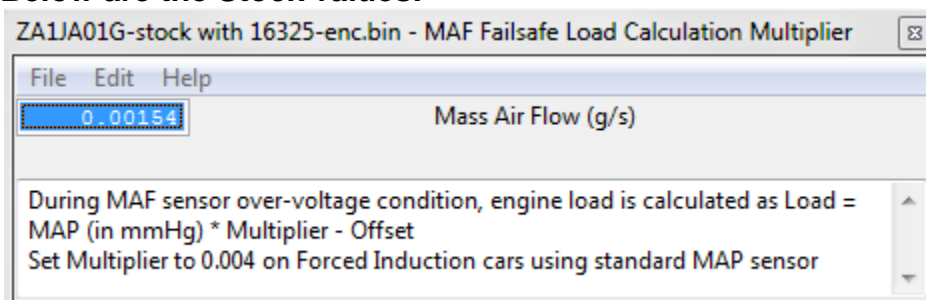
- DI Quantity Maximum Allowed – !!! Very Important to raise this map !!! These DI Limiter values should be increased to 1.1 to 1.3 ml otherwise the DI will not be allowed to inject the fuel volume that is required. Try to you keep your DI open time below 5.5ms past 5000rpm to avoid the DI Injecting when the spark plug is fired. Make sure you check the logging parameter called 'Fuel Injection End DI to Spark (ms) which shows the time period left between the direct injector closing and the spark plug firing, critical to maximize the DI Open Time.
- Fuel Injection Ratio Port to Direct #1- #3 – These maps define the distribution ratio between PI and DI for a given volume of fuel. This can be altered to allow PI to be used full time (**not** recommended as the DI needs fuel flowing through the injector to stay cool) or at a given percentage, if a larger injector is required to supply between 0 to 35% or from 75% to 100% of the total fuel quantity adjust the PI ratio thresholds to suit your requirements. If you wish the PI ratio to always follow the Fuel injection ratio Port to Direct maps set the load or RPM threshold to a low value.
- Engine Load Limit (RaceROM) – This map **MUST** be increased or the AFR will be lean on full load, the stock load limit values are retained at lower RPM to prevent a unnaturally high Engine Load being achieved which causes poor running on full load and full throttle. Keep the values low below 1600rpm to avoid an unrealistic engine load reading at low rpm which will cause a rich AFR and retarded ignition due to valve overlap, see below.
- Engine Load Reading Limit – Increased to avoid the engine load being capped and making the fuel mixture too lean.
- Engine Load Limiters #1 #2 – These are replaced by the Engine Load Limit (RaceROM) map.
- Mass Air Flow reading Limit – Increased to avoid the engine load being capped and making the fuel mixture too lean.
- MAF Sensor Voltage Failsafe – When the MAF sensor Voltage output reach its maximum threshold the ECU will then use the Manifold Absolute Pressure (MAP) Sensor for its Engine Load calculation, you will also get a P0103 DTC.

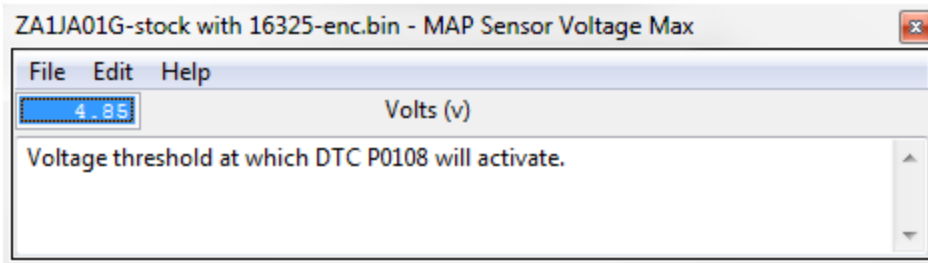


If using the “stock” MAP sensor these values will be unsuitable for forced induction vehicles as the ignition timing will be too far advanced and the fuelling too lean, this is due to the stock MAP sensor being unable to accurately measure positive manifold pressure conditions, potentially this could cause engine damage.

To avoid this condition we must change the MAF Failsafe Load Calculation Multiplier and the MAP Sensor Voltage Max value.

Below are the Stock values:





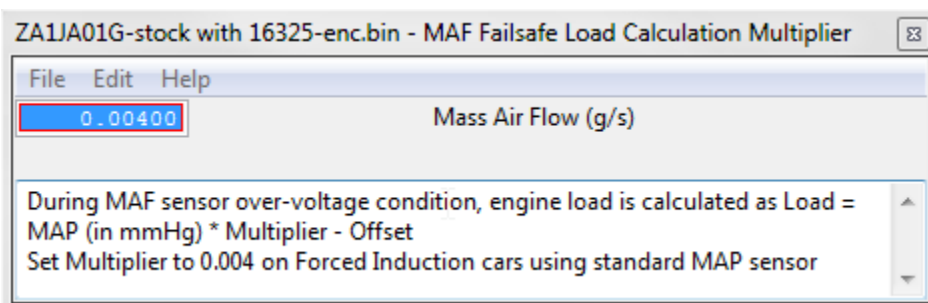
So Load = $0.00154 * \text{MAP (in mmHg)} - 0.16$, now 1.0Bar is equivalent to 760 mmHg.
 So assuming a standard MAP Sensor is fitted and vehicle is making 1 bar boost at 7000rpm (2bar Absolute) then you hit 5volts on the MAF and ECU goes fail safe and uses the MAP sensor reading for its load calculation. This is the calculation that will happen.

$1.37 * 760 = 988$, now $988 * 0.00154 = 1.52$ Engine Load
 Next SUBTRACT the Offset value of 0.16 = 1.36 Engine Load

So the new Engine Load is 1.36 when the MAF hits 5 volts with STD MAP sensor. Now the true engine load should be 2.5+ so this means over advanced Ignition timing and lean fueling so this is why this map is important on FI cars running stock map sensor.

Suggested values:

So when running a stock MAP sensor on a FI vehicle we suggest to change the Multiplier to 0.004 as shown below:



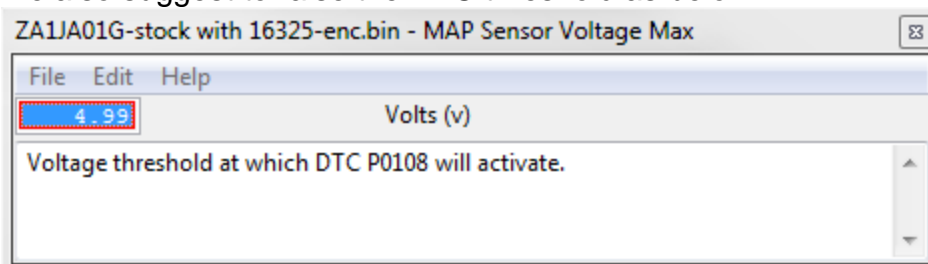
So $1.37 * 760$ (Bar into mmHg) = 988, now $988 * 0.004 = 3.952$, next SUBTRACT the Offset value of 0.16 = 3.79 Engine Load which is over rich and retarded should you hit 5v MAF output! Now with a 3 bar MAP sensor you should still change the value as shown below.

Assuming you are making 2bar absolute when you hit 5 volts MAF

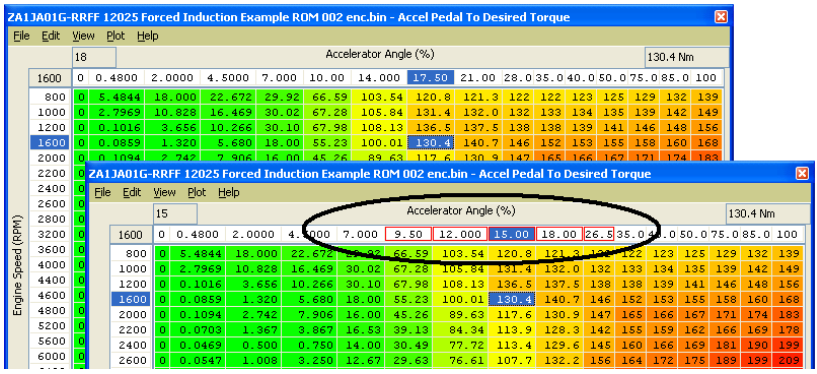
So $2 * 760$ (Bar into mmHg) = 1520, now $1520 * 0.00154 = 2.3408$, next SUBTRACT the Offset value of 0.16 = Engine Load 2.18 for a 3bar MAP sensor running 2bar boost when they hit 5volts MAF.

If you change the MAF Failsafe Load Calculation Multiplier to 0.002 then if you hit 5 volts MAF at 2 bar absolute boost then the Engine Load will be 2.88.

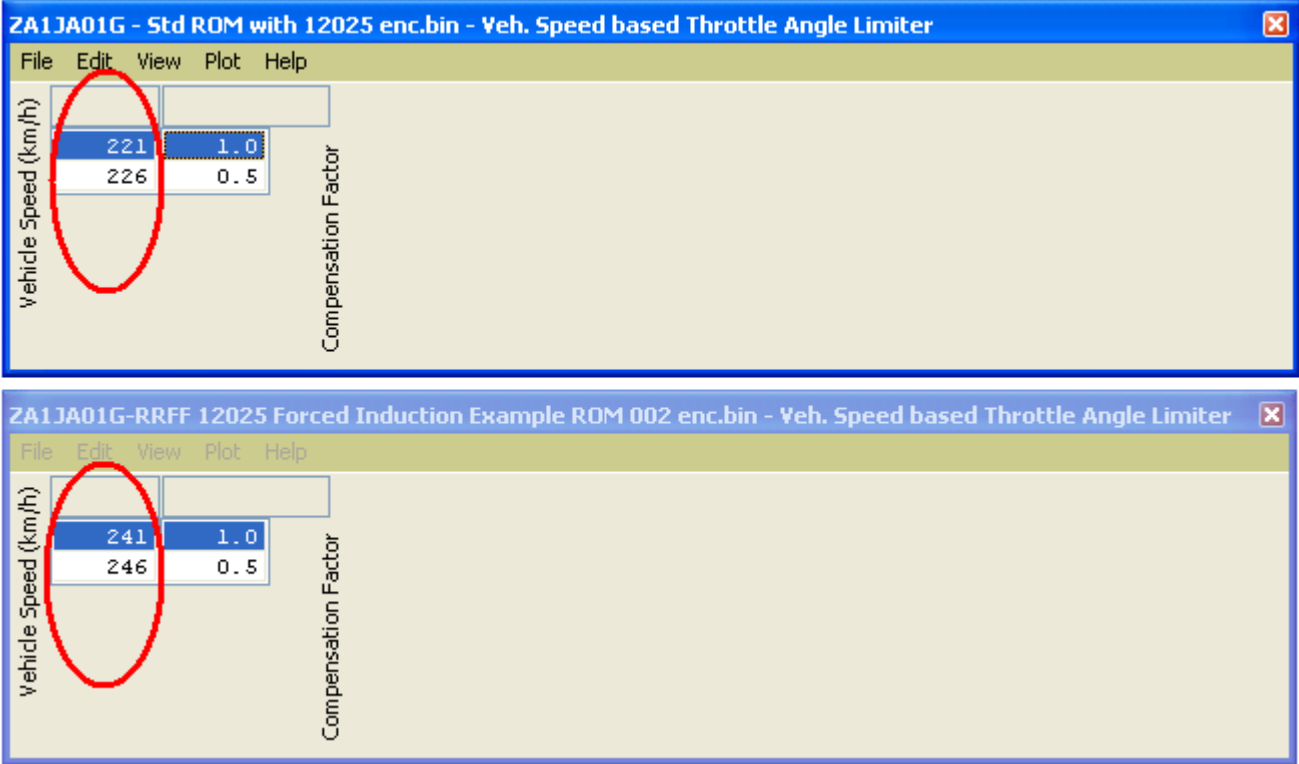
We also suggest to raise the DTC threshold as below.



- Cam Timing – Intake and Exhaust - have been optimised to provide a greater torque output and a more consistent AFR reading across the midrange, the low rpm, low load region has also been reduced therefore reducing internal EGR affect used for emission control. The X axis has been rescaled for a higher engine load.
- Accel Pedal to Desired Torque – The X axis values have been slightly reduced which elegantly provides a greater torque output for a lesser accel pedal amount.



- Advance Multiplier Initial – we increased the value to 1 so that 100% of the Ignition Advance is added to the Ignition Base map immediately after programming the ECU so there is waiting for the AM to increase from 0.7 to 1 each time, saving valuable time!
- Vehicle Speed Based Throttle Limiter – The vehicle speed has been increased by in the left hand column, do not adjust the right hand column values as this can cause trustful throttle CEL conditions.

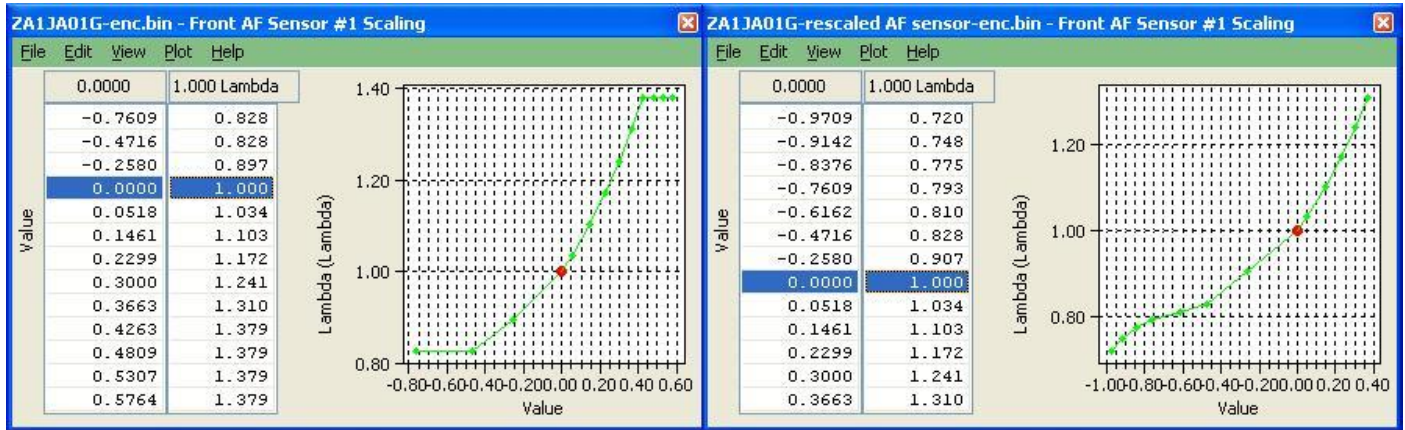


- DTC Enable – we turned off the P0420 CAT EFFICIENCY code as most FI cars have the cats removed.
- Enable Special Features – we turned on Launch Control, Flat Foot Shift and Auto Blip for fun.
- Rev Limits – we raised the rev limits by 200rpm to 7600rpm.
- Ensure you are using the latest RRFF version 20479 or newer which has improved fueling calculations to prevent lean running at high RPM.

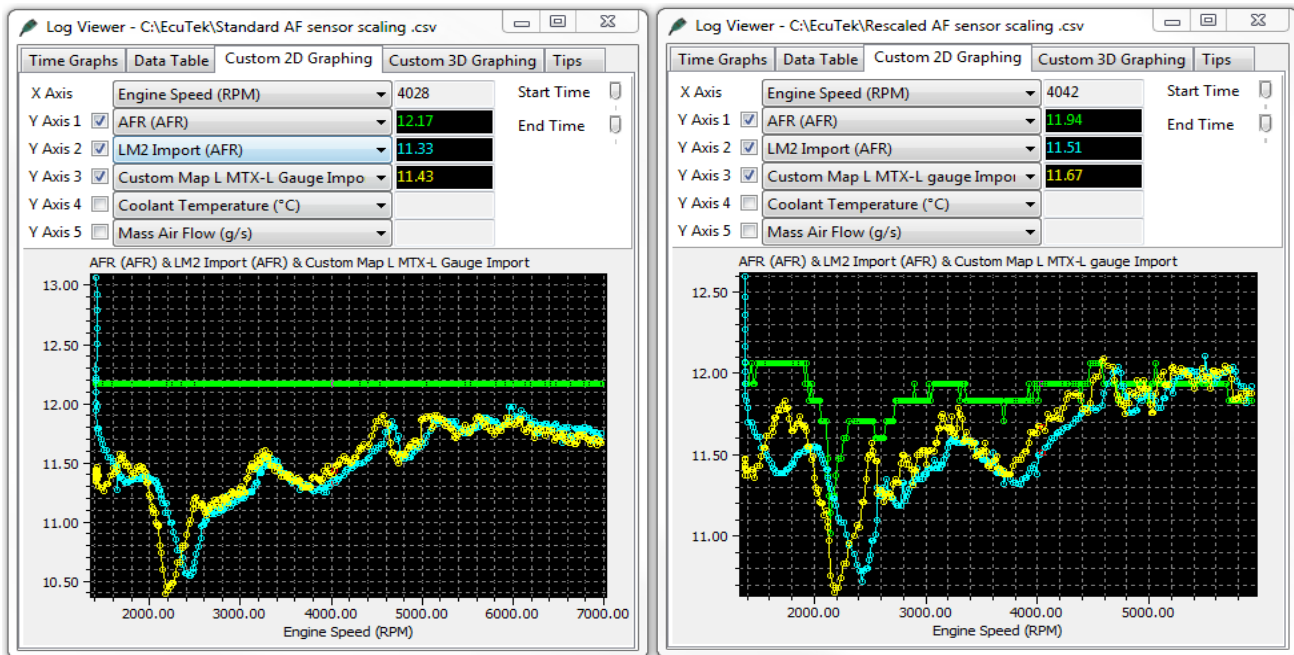
4.2.6. How to rescale the factory AF Sensor

The factory “wide range” AF sensor cannot display AFR richer than 12.2:1 AFR or 0.82 Lambda. By rescaling the factory AF sensor scaling its possible to show AirFuel Ratios below 12.2:1 but not with great accuracy.

Stock factory AF Sensor scaling is shown below, the Stock AF Sensor Scaling is only scaled to 0.82 Lambda (12.2:1 AFR). To allow the factory AFR sensor to read below 0.82 Lambda we need to rescale the Front AF Sensor #1 Scaling as shown below.



You can see we have rescaled the Input axis and the output of the map for the Front AF Sensor #1 scaling. Its now rescaled down to 0.72 Lambda though the factory sensor cannot be relied upon below 0.9 Lambda, rescaling the AF sensor should only be done as reference only , an external “Wide Band” O2 sensor should always be used for tuning especially when tuning forced induction vehicles.



On the previous page the left hand log file below shows the factory AF sensor reading has flat lined at 12.17:1 AFR (Green log file line) but the right hand Air side log file shows the sensor rescaled and the AFR reading more accurately at 11.94:1.

The factory widerange sensor has even shown AFR as low as 11:1 AFR / 0.75 Lambda which is the current richest AFR reading it can show.

We have also imported our chassis dyno's Innovate LM2 sensor reading into ProECU, this is a plug and play feature of ProECU and you simply get the LM2 working in Innovate Logworks software then close logworks and open ProECU, open your ROM and the LM2 logging will be shown in the live data capture window.

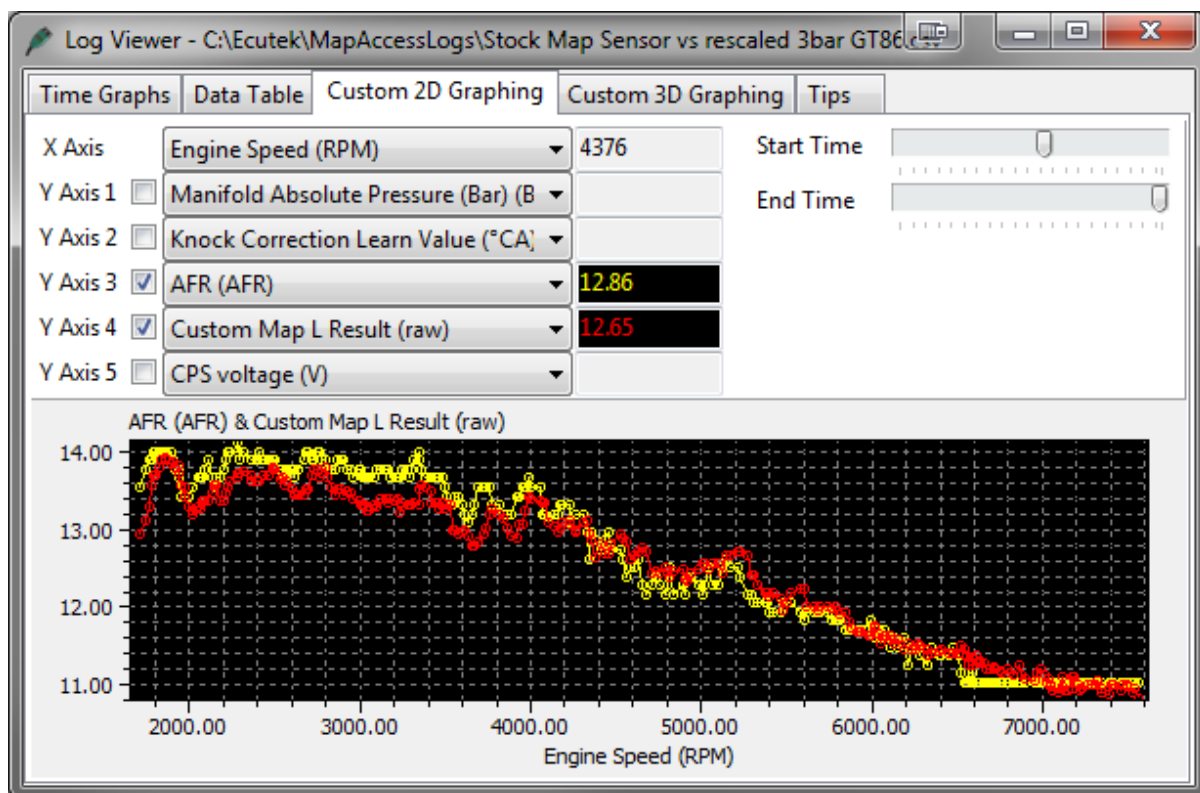


On our own EcuTek development vehicle we have fitted an Innovate MTX-L wideband AFR gauge into the dashboard air duct, we have welded an extra lambda sensor fitting into our exhaust manifold/header to accept the additional MTX wideband sensor. The Innovate MTX-L gauge has an analogue 0-5 v output and we have imported this into the factory ECU via one of the Custom Maps Auxiliary ECU Input pins (see the Custom Map manual for wiring information).

Other products such as the Innovate LC1 and AEM AFR gauges also have a 0-5v output, these could also be used.

In our log file screen shot shown on the previous page we have 2 different wideband sensors imported into ProECU, the Innovate LM2 and the Innovate MTX-L Gauge as well as the rescaled factory AF sensor.

Below you can see the Red Custom Map L Result line showing the MTX-L gauge output that's been imported into the ECU and also the Yellow line which is the rescaled factory AF sensor, they are quite close but the factory sensor should not be relied upon for accuracy.



It is possible to set up a custom map to protect the engine for an excessively rich or lean condition, this could prove useful on a forced induction vehicle.

You could create a Custom map that would put on a CEL or close the throttle should the wideband AFR reading go leaner than 13.5:1 AFR or richer than 10:1 AFR when you are on full load with the map only active over a certain engine load (full power).

You would calibrate your fueling as normal and once the AFR is profiled (Target AFR as such) then add these AFR readings into a Custom Map against RPM and Load (a copy of your fuel map as such if you're your MAF scaling is correct and your Fuel Map actually matches your true AFR). Then use the output of this Custom Map as the Input to another Custom Map.

Then having the True Wideband Custom Map input vs the Target AFR Input you can make your decision what to do. This safety feature might just save an engine one day.

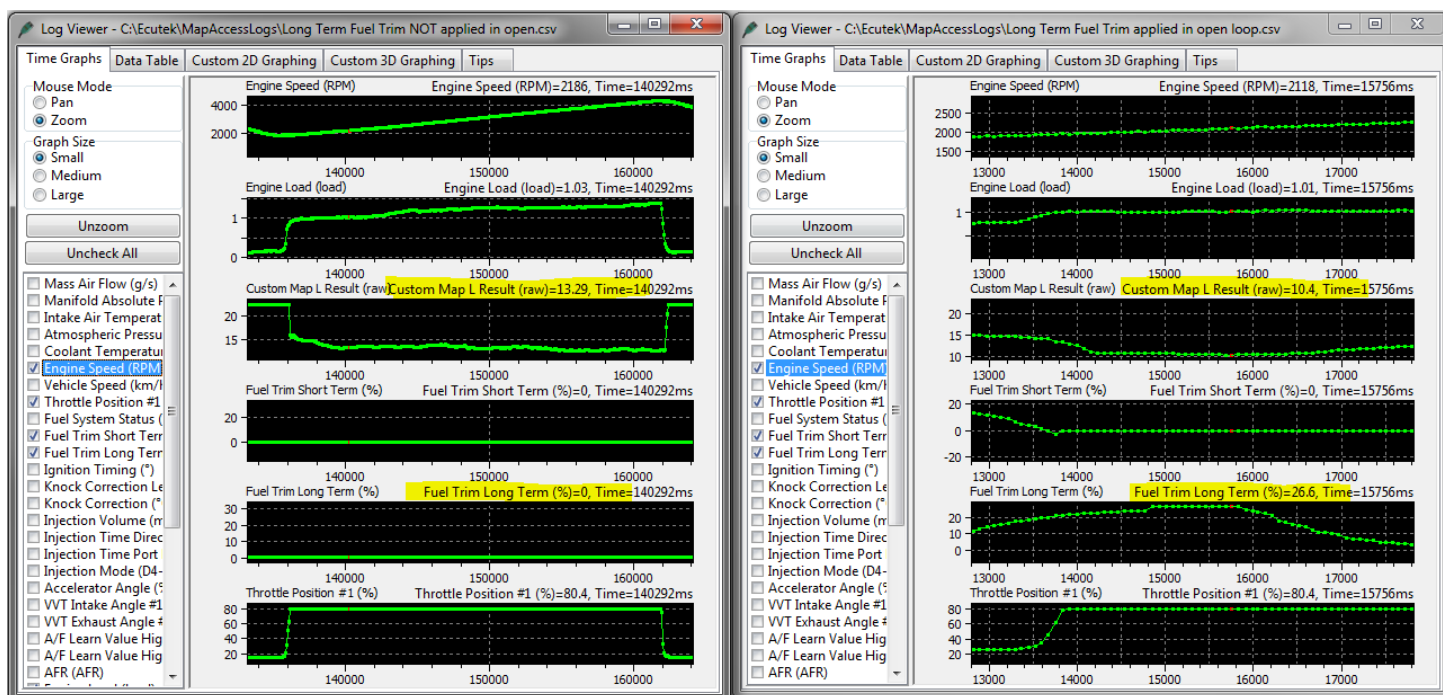
Examples might be

- Increase the Injection Volume for a Lean AFR
- Put the CEL on for a Lean or Rich condition
- Retard the Timing aggressively to reduce power
- Reduce the desired Torque to close the throttle
- Dramatically reduce wastegate duty for turbocharged vehicles.

4.2.7. How to turn off Long Term Fuel Trims

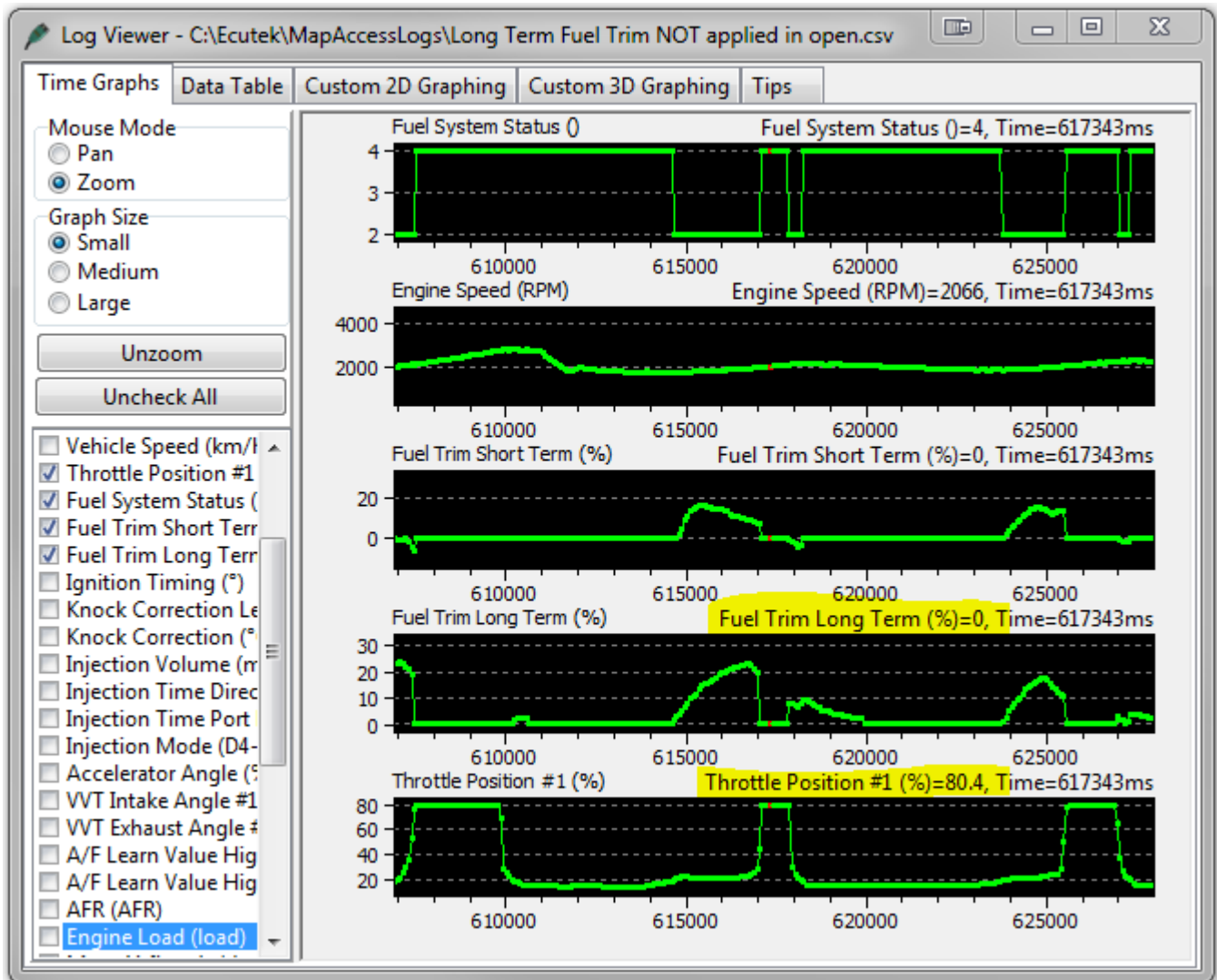
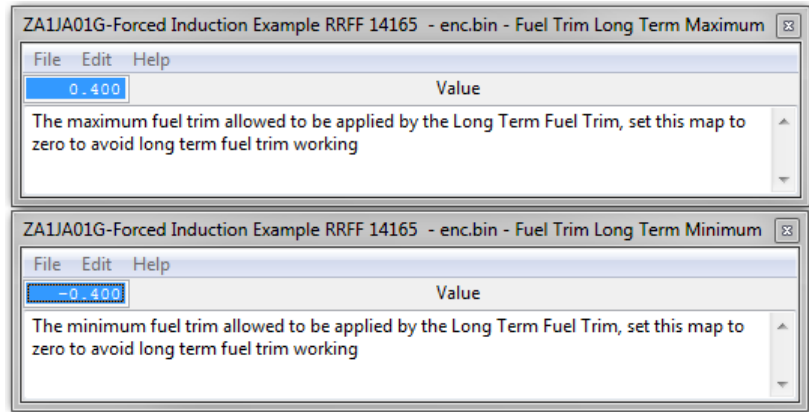
As part of the closed loop fuelling control, the Long Term Fuel trim can be applied in open loop. This can cause the AFR to change significantly. See the log file below on the left hand side where on full load the LTFT were zero and the AFR is 13.29 (Custom Map L Result is the Innovate Wideband import).

On the right hand log you can see the LTFT is +26% and the AFR is now 10.4AFR! If the LTFT was -26% this would make the AFR very lean and on a forced induction vehicle this could cause engine damage so we need to limit the LTFT from working.



These are the minimum and maximum allowed fuel trims applied in open loop.

Set these values to zero to prevent the closed loop fuel trims from working and being applied in open loop, you can see below that each time STFT stops working and the ECU is in Open Loop (Fuel System Status 4) then the LTFT are set at 0.



4.2.8. How to disable Rear O2 AF Correction #3

When removing or repurposing the Rear O2 sensor the AF Correction #3 can become active and will change the Target AFR during closed loop, the logging parameter called Equivalence Ratio Commanded shows this particularly well.

To avoid AF Correction #3 altering the cruise closed loop Target AFR you need to set the values in the following two maps to zero:

- AF Correction #3 Limit – Rear O2
- AF Correction #3 CL Target Compensation Limits

4.2.9. How to maximise your PI and DI fueling

The PI can inject for a full two revolutions, Induction, Compression, Power and Exhaust, this is 720 degs and the logging parameter called PI Duty will show this as 0 – 100% so you can see when you have maxed out your Port Injectors.

With DI its slightly more difficult as we can only inject during Induction and Compression but there are other factors that limit the maximum possible open time period, these are valve overlap and spark advance.

We have added certain maps to allow you to maximise the total fuel quantity that can be delivered from your PI and DI setup and the split ratio that can be achieved. We have DI firing angle maps and these can be used to maximise the fuel delivery from the DI system.

Watching the fuel volume delivery parameters and the Fuel Injection End DI to Spark (ms) time you can fine tune the injection control.

Fuel Quantity DI - the total fuel volume delivered by the Direct Injectors

Fuel Quantity PI - the total fuel volume delivered by the Port Injectors

Fuel Quantity Total - the total fuel volume delivered in micro litres

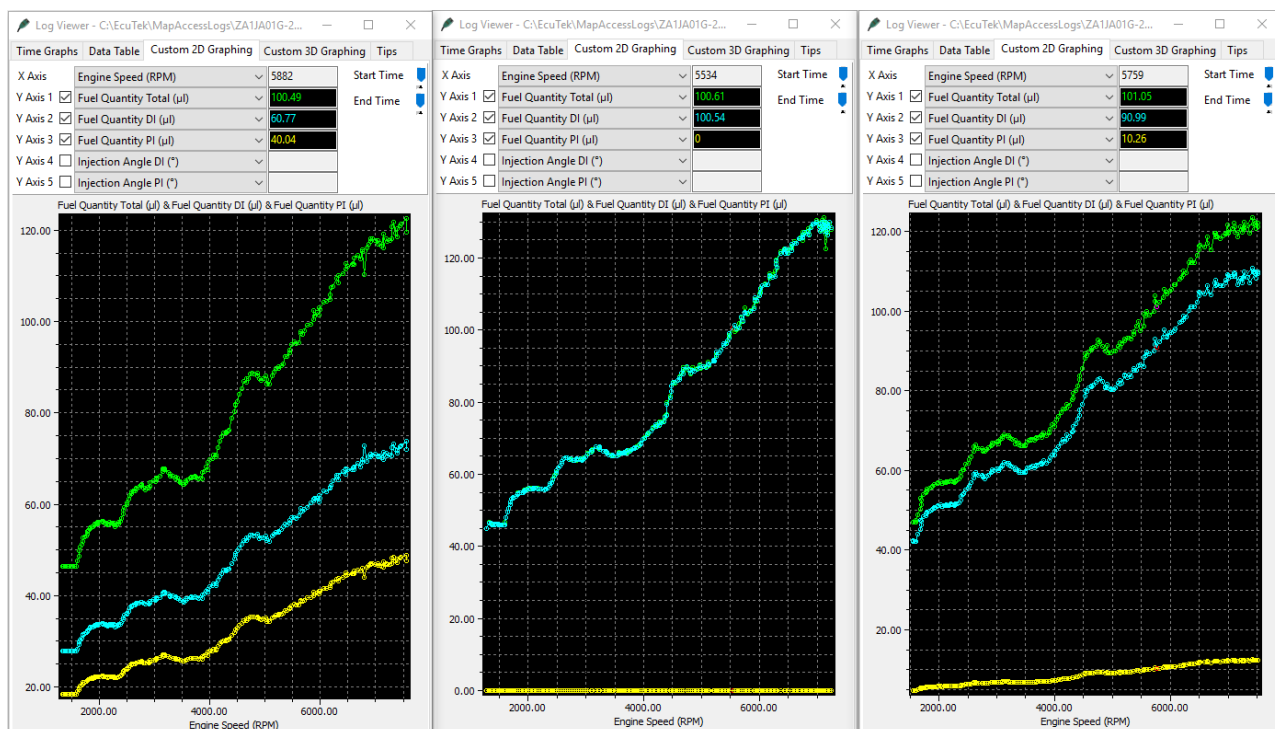
The Fuel Quantity Total will verify the PI and DI fueling calculation is correct and accurate.

Here you can see the PI and DI split ratio is clearly shown in each example.

40% PI Ratio

0% PI Ratio

10% PI Ratio



Other important logging parameters are as follows:

Fuel Injection End to PI Spark (ms)

This is the time period left between the port injector closing and the spark plug firing, not so important so the port injector can fire through a full 720 deg

Fuel Injection End DI to Spark (ms)

This is the time period left between the direct injector closing and the spark plug firing, critical to maximize the DI Open Time

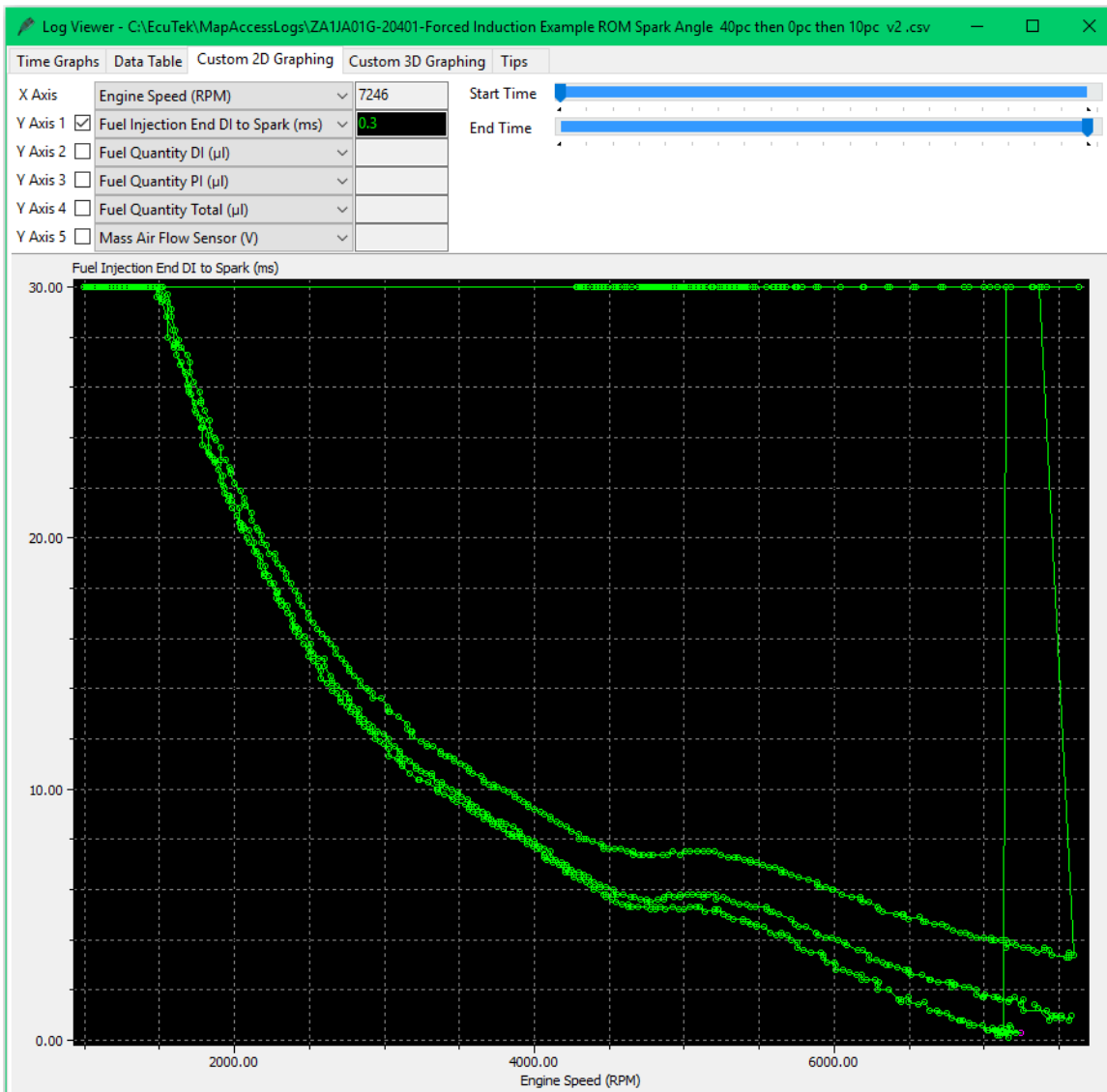
This new DI to Spark logging parameter is important to maximise your PI and DI fuel delivery, see below where 3 power runs shown on the previous page were made with different PI/DI split ratios.

40% PI Ratio left 4ms between End of DI Injection and the Spark Plug firing

10% PI Ratio left less than 1ms between End of DI Injection and the Spark Plug firing

0% PI Ratio left less than 0.3ms between End of DI Injection and the Spark Plug firing and the engine was misfiring and was unable to finish the power run.

We would advise you do not you run below 1.0ms to allow a reasonable time for the fuel to mix before the spark plug fires.



4.2.10. How to set up a Boost Limit (fuel cut) **

It's possible to use Custom Maps to set us a Fuel Cut for an over boost condition. It's also possible to add a time delay before the fuel cut is triggered (allowing for slight momentary over boost spikes).

You can see in the example below that Custom Map M has been added as a fuel volume multiplier that will multiply the fuel volume by zero over 1.80 bar boost absolute (resulting in a fuel cut). In addition, the Activation Definition has been configured so the map can only work over 1.80 bar and then the 1 second timer delay must expire before the Fuel Volume is multiplied by zero.

The screenshot displays the configuration of Custom Map M for a boost limit. The main window shows the 'Custom Map M' configuration, which includes a 3D plot and a data table. The data table shows the output of the map for various engine speeds and manifold pressures.

Y channel (raw)	0	0.200	0.400	0.600	0.800	1	1.20	1.40	1.60	1.80	2
4800	1	1	1	1	1	1	1	1	1	1	1
800	1	1	1	1	1	1	1	1	1	1	1
1600	1	1	1	1	1	1	1	1	1	1	1
2400	1	1	1	1	1	1	1	1	1	1	1
3200	1	1	1	1	1	1	1	1	1	1	1
4000	1	1	1	1	1	1	1	1	1	1	1
4800	1	1	1	1	1	1	1	1	1	1	0
5600	1	1	1	1	1	1	1	1	1	1	0
6400	1	1	1	1	1	1	1	1	1	1	0
7200	1	1	1	1	1	1	1	1	1	1	0
8000	1	1	1	1	1	1	1	1	1	1	0
8800	1	1	1	1	1	1	1	1	1	1	0

4.2.11. How to set up an Engine Load limit

Using Engine Load we can configure a load based fuel cut that considers atmospheric pressure. As Engine Load will change with altitude we can alter the Engine Load where fuel cut will occur. The following two custom maps show how a load based fuel cut can be calibrated to consider atmospheric pressure. This ROM can be found in your BRZ ROMs directory and also includes FlexFuel settings.

Custom Map H:

X axis is Engine Load

Y axis is Atmo pressure

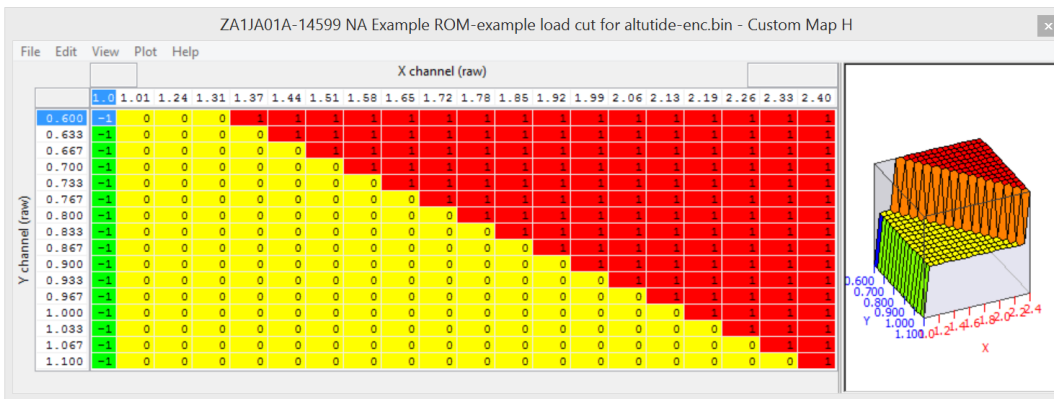
Output will be -1, 0 or 1 depending on X and Y axis values

Custom Map I:

X axis is Engine Load

Y axis is Atmo pressure

Output will multiply the Total Fuel Quantity by zero depending on the output of Map H.



ZA1JA01A-14599 NA Example ROM-example load cut for altitude-enc.bin - Custom Map H Output Definition

File Edit Help

Output channel

- Unused
- Calculation Only
 - Ignition Base Timing (*)
 - CPC Duty (%)
 - Cam Angle Inlet(*)
 - Cam Angle Exhaust (*)
 - Target AFR (n:1)
 - Mass Airflow (g/s)
 - Total Fuel Quantity
 - Fuel Injection Ratio
 - PI Fuel Quantity
 - DI Fuel Quantity
 - Accelerator Pedal (%)
 - Cranking PI Pulsewidth(ms)
 - Charge Air Temp for SD (°C)
 - Injection Angle DI (°)
 - Injection Angle PI (°)

Output function

- Replace channel value with map output
- Add map output to channel value

ZA1JA01A-14599 NA Example ROM-example load cut for altitude-enc.bin - Custom Map H X Input Definition

File Edit Help

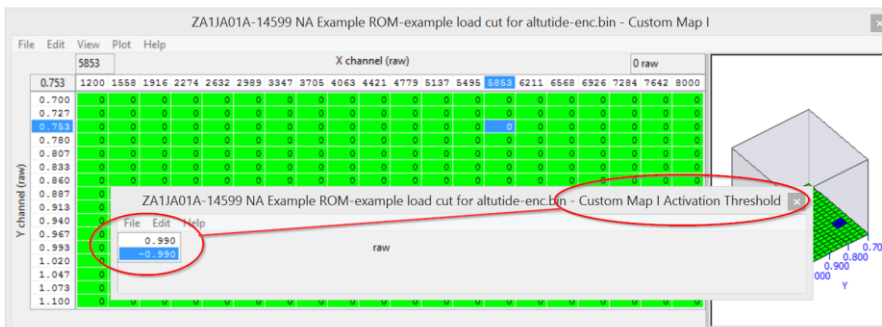
- CPC Pressure Sensor (V)
- Engine Load (g/rev)
- Engine Speed (RPM)
- Gear

ZA1JA01A-14599 NA Example ROM-example load cut for altitude-enc.bin - Custom Map H Y Input Definition

File Edit Help

- Ambient Temp (°C)
- Atmospheric Pressure (KPA)
- Battery Voltage
- Boost Pressure (bar)
- Coolant Temp (°C)

The output will be dependent on Engine Load and Atmospheric Pressure, when the engine load is low the output is always -1, this will prevent Map I from doing anything. Map I will not actually activate until Map H output is 1.



ZA1JA01A-14599 NA Example ROM-example load cut for altitude-enc.bin - Custom Map I Output Definition

File Edit Help

Output channel

- Unused
- Calculation Only
- Ignition Base Timing
- CPC Duty (%)
- Cam Angle Inlet
- Cam Angle Exhaust
- Target AFR (n:1)
- Mass Airflow (g/s)
- Total Fuel Quantity
- Fuel Injection Ratio
- PI Fuel Quantity
- DI Fuel Quantity
- Accelerator Pedal (%)
- Cranking PI Pulsewidth(ms)
- Charge Air Temp for SD (°C)
- Injection Angle DI (°)
- Injection Angle PI (°)

Output function

- Replace channel value with map output
- Add map output to channel value
- Multiply channel value by map output
- Use map output as a maximum for channel
- Add map output to integral. Add integral
- Add map output to integral. Multiply channel

ZA1JA01A-14599 NA Example ROM-example load cut for altitude-enc.bin - Custom Map I X Input Definition

File Edit Help

- Engine Load (g/rev)
- Engine Speed (RPM)

ZA1JA01A-14599 NA Example ROM-example load cut for altitude-enc.bin - Custom Map I Y Input Definition

File Edit Help

- Ambient Temp (°C)
- Atmospheric Pressure (KPA)
- Battery Voltage
- Boost Pressure

ZA1JA01A-14599 NA Example ROM-example load cut for altitude-enc.bin - Custom Map I Activation Definition

File Edit Help

- Custom Map H result
- Custom Map I result
- Custom Map J result
- Custom Map K result
- Custom Map L result
- Custom Map M result
- Custom Map N result
- Custom Map O result
- Custom Map P result

Activation mode

- Map is always active
- Map is only active when channel value is above threshold (with hysteresis)
- Map is only active when channel value is below threshold (with hysteresis)
- Map is only active when channel value is between the threshold values

Activation options

- Map activates and deactivates as normal
- Map is initially inactive. Once activated, remains active until key off
- Map is initially active. Once deactivated, remains inactive until key off

Custom Map I can only work when the Output of Map H is over 0.99 and when this happens Map I will cut the fuel injectors suddenly. Custom Map I will stop working when Custom Map H output is below -0.99 and the Injectors will be restored, so engine load will have to drop significantly before the injectors are restored.

4.2.12. How to set up Boost Control **

Using RaceROM Custom Maps, we can set up closed loop boost control on turbocharger installations. Some tuners have also used Custom Maps to control the recirc valves on Supercharger installs at part throttle as well.

The factory BRZ/GT86 ECU does not have the ability to control a wastegate solenoid valve, but as a solution, we can replace the Carbon Purge Canister (CPC) valve with a wastegate solenoid valve and use the frequency controlled CPC output to control the turbo boost.

We can use the boost control in two ways:

- Open Loop – where a fixed wastegate duty is applied for a given RPM against any other input (like Accel pedal, Gear, Vehicle Speed, Temperature etc)
- Closed Loop – the same as Open Loop but a proportional and integral compensation are applied for a given boost error using RaceROM Custom Maps Boost Control (example shown below) **

NOTE: If you wish to use the boost control in open loop then simply do not enable the proportional or integral maps.

Custom Map I - Target Boost Pressure

- X axis is Accel Pedal position (%)
- Y axis is Engine Speed (rpm)
- Map values are Boost Pressure Absolute (bar)

The map output is the target Boost Pressure and the value is stored as a Calculation Only.

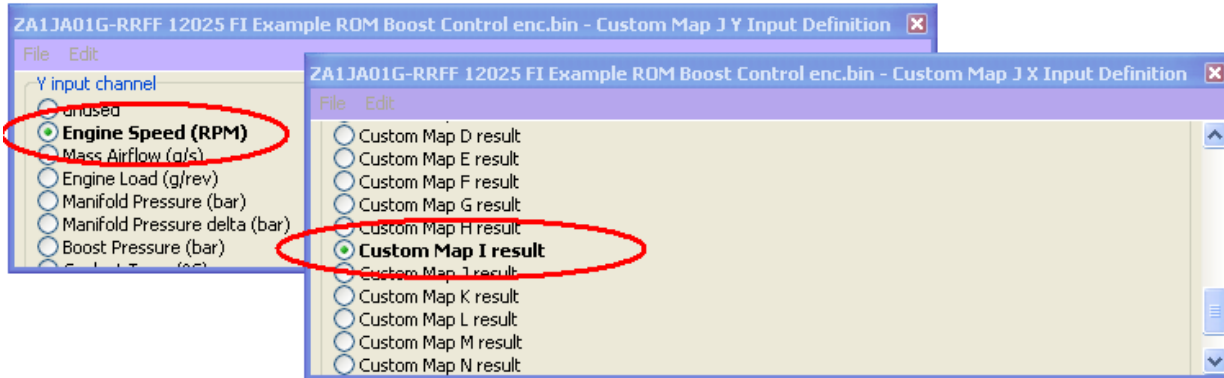
The screenshot displays the RaceROM Custom Map I configuration and output. The top window shows the 'Y input channel' configuration with 'Engine Speed (RPM)' selected. The middle window shows the 'X input channel' configuration with 'Accelerator Pedal (%)' selected. The bottom window shows the 'Output channel' configuration with 'Calculation Only' selected. The central window displays a 2D map grid for engine speed (4800-9000 RPM) vs accelerator pedal (0-100%).

Y channel (rpm)	0.00	5.26	10.5	15.8	21.1	26.3	31.6	36.8	42.1	47.4	52.6	57.9	63.2	68.4	73.7	78.9	84.2	89.5	94.7	100
4800	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
600	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
1200	0.70	0.74	0.79	0.83	0.87	0.91	0.96	1.00	1.07	1.13	1.20	1.27	1.33	1.40	1.47	1.53	1.60	1.67	1.73	1.80
1800	0.70	0.74	0.79	0.83	0.87	0.91	0.96	1.00	1.07	1.14	1.21	1.28	1.35	1.42	1.50	1.57	1.64	1.71	1.78	1.85
2400	0.70	0.74	0.79	0.83	0.87	0.91	0.96	1.00	1.08	1.15	1.23	1.30	1.38	1.45	1.52	1.60	1.67	1.75	1.83	1.90
3000	0.70	0.74	0.79	0.83	0.87	0.91	0.96	1.00	1.08	1.17	1.25	1.33	1.42	1.50	1.58	1.67	1.75	1.83	1.92	2.00
3600	0.70	0.74	0.79	0.83	0.87	0.91	0.96	1.00	1.09	1.18	1.27	1.37	1.46	1.55	1.64	1.73	1.82	1.92	2.01	2.10
4200	0.70	0.74	0.79	0.83	0.87	0.91	0.96	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.10	2.20
4800	0.70	0.74	0.79	0.83	0.87	0.91	0.96	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.10	2.20
5400	0.70	0.74	0.79	0.83	0.87	0.91	0.96	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.10	2.20
6000	0.70	0.74	0.79	0.83	0.87	0.91	0.96	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.10	2.20
6600	0.70	0.74	0.79	0.83	0.87	0.91	0.96	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.10	2.20
7200	0.70	0.74	0.79	0.83	0.87	0.91	0.96	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.10	2.20
7800	0.70	0.74	0.79	0.83	0.87	0.91	0.96	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.10	2.20
8400	0.70	0.74	0.79	0.83	0.87	0.91	0.96	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.10	2.20
9000	0.70	0.74	0.79	0.83	0.87	0.91	0.96	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.10	2.20

Custom Map J - Wastegate Duty Map

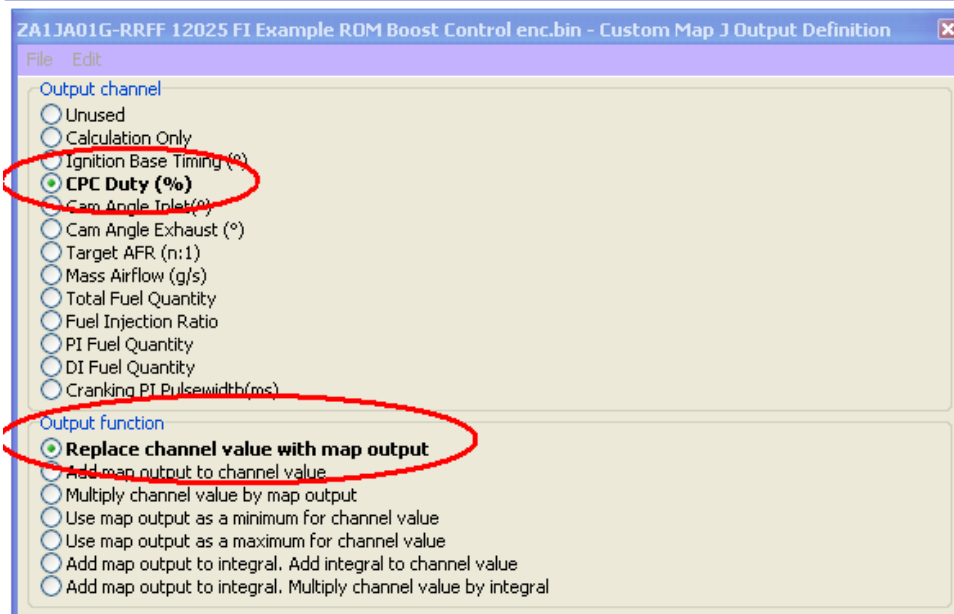
- X axis is Target Boost Pressure
- Y axis is RPM
- Map values are Wastegate Duty for the CPC Valve.

Custom Map J has been configured as the base wastegate duty for a given RPM (Y axis) and Target Boost Pressure (output of Map I), the values in the map are WG Duty (CPC Valve Duty).



The screenshot shows a data table for Custom Map J. The Y-axis represents RPM (3000 to 9000) and the X-axis represents Target Boost Pressure (2 to 2.30). The table contains numerical values for Wastegate Duty, with colors ranging from green (low duty) to red (high duty).

Y channel (raw)	2	0.167	0.333	0.5	0.667	0.833	1	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.10	2.20	2.30	
3000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2250	0	0	0	0	0	0	0	0	5	10	15	20	22.8	25.6	28.3	31.1	33.9	36.7	39.4	42.2	45
2500	0	0	0	0	0	0	0	5	10	15	20	23.3	26.7	30.0	33.3	36.7	40.0	43.3	46.7	50	
3000	0	0	0	0	0	0	0	5	10	15	20	24.4	28.9	33.3	37.8	42.2	46.7	51.1	55.6	60	
3600	0	0	0	0	0	0	0	5	10	15	20	24.9	29.8	34.7	39.6	44.4	49.3	54.2	59.1	64	
4200	0	0	0	0	0	0	0	5	10	15	20	25.3	30.7	36.0	41.3	46.7	52.0	57.3	62.7	68	
4800	0	0	0	0	0	0	0	5	10	15	20	25.8	31.6	37.3	43.1	48.9	54.7	60.4	66.2	72	
5400	0	0	0	0	0	0	0	5	10	15	20	26.2	32.4	38.7	44.9	51.1	57.3	63.6	69.8	76	
6000	0	0	0	0	0	0	0	5	10	15	20	26.7	33.3	40.0	46.7	53.3	60.0	66.7	73.3	80	
7000	0	0	0	0	0	0	0	5	10	15	20	27.8	35.6	41.7	48.9	56.1	63.3	70.6	77.8	85	
8000	0	0	0	0	0	0	0	5	10	15	20	27.8	35.6	43.3	51.1	58.9	66.7	74.4	82.2	90	
9000	0	0	0	0	0	0	0	5	10	15	20	27.8	35.6	43.3	51.1	58.9	66.7	74.4	82.2	90	



Custom Map K - Wastegate Duty Proportional Control

- X axis is current Manifold Pressure
- Y axis is Boost Target
- Map values are Wastegate Duty proportional compensation factor.

Custom Map K will add the map output value to the current WG Duty (CPC Duty). In the example shown above the Y axis Target Boost Pressure (output of Map I) is 1.8bar but the X axis current manifold pressure is 2.1bar, so -9% WG Duty would be added to the current WG Duty output of Map J (therefore reducing the WG Duty).

ZA1JA01G-RRFF 12025 FI Example ROM Boost Control enc.bin - Custom Map K Y Input Definition

File Edit

- Wheel Speed RR (km/h)
- Steering Angle (°)
- Custom Map A result
- Custom Map B result
- Custom Map C result
- Custom Map D result
- Custom Map E result
- Custom Map F result
- Custom Map G result
- Custom Map H result
- Custom Map I result**
- Custom Map J result
- Custom Map K result

ZA1JA01G-RRFF 12025 FI Example ROM Boost Control enc.bin - Custom Map K X Input Definition

File Edit

X input channel

- unused
- Engine Speed (RPM)
- Mass Airflow (g/s)
- Engine Load (g/rev)
- Manifold Pressure (bar)**
- Manifold Pressure delta (bar)
- Boost Pressure (bar)
- Coolant Temp (°C)
- Intake Air Temp (°C)

ZA1JA01G-RRFF 12025 FI Example ROM Boost Control enc.bin - Custom Map K

File Edit View Plot

		X channel (raw)																		-9.0 raw	
		2.1																			
		0.0	0.15	0.30	0.450	0.600	0.7500	0.9000	1.0500	1.200	1.350	1.500	1.650	1.800	1.9500	2.1000	2.250	2.402	552	702	85
1.8	0.0	0	-4.5	-9.0	-13.5	-18.0	-22.50	-27.00	-31.50	-36.0	-40.5	-45.0	-49.5	-54.0	-58.50	-63.00	-67.5	-72	-77	-81	-86
0.2	0.0	5	0.0	-4.5	-9.0	-13.5	-18.00	-22.50	-27.00	-31.5	-36.0	-40.5	-45.0	-49.5	-54.00	-58.50	-63.0	-68	-72	-77	-81
0.3	0.0	9	4.5	0.0	-4.5	-9.0	-13.50	-18.00	-22.50	-27.0	-31.5	-36.0	-40.5	-45.0	-49.50	-54.00	-58.5	-63	-68	-72	-77
0.5	0.0	14	9.0	4.5	0.0	-4.5	-9.00	-13.50	-18.00	-22.5	-27.0	-31.5	-36.0	-40.5	-45.00	-49.50	-54.0	-59	-63	-68	-72
0.6	0.0	18	13.5	9.0	4.5	0.0	-4.50	-9.00	-13.50	-18.0	-22.5	-27.0	-31.5	-36.0	-40.50	-45.00	-49.5	-54	-59	-63	-68
0.8	0.0	23	18.0	13.5	9.0	4.5	0.00	-4.50	-9.00	-13.5	-18.0	-22.5	-27.0	-31.5	-36.00	-40.50	-45.0	-50	-54	-59	-63
0.9	0.0	27	22.5	18.0	13.5	9.0	4.50	0.00	-4.50	-9.0	-13.5	-18.0	-22.5	-27.0	-31.50	-36.00	-40.5	-45	-50	-54	-59
1.0	0.0	32	27.0	22.5	18.0	13.5	9.00	4.50	0.00	-4.5	-9.0	-13.5	-18.0	-22.5	-27.00	-31.50	-36.0	-41	-45	-50	-54
1.2	0.0	36	31.5	27.0	22.5	18.0	13.50	9.00	4.50	0.0	-4.5	-9.0	-13.5	-18.0	-22.50	-27.00	-31.5	-36	-41	-45	-50
1.4	0.0	41	36.0	31.5	27.0	22.5	18.00	13.50	9.00	4.5	0.0	-4.5	-9.0	-13.5	-18.00	-22.50	-27.0	-32	-36	-41	-45
1.5	0.0	45	40.5	36.0	31.5	27.0	22.50	18.00	13.50	9.0	4.5	0.0	-4.5	-9.0	-13.50	-18.00	-22.5	-27	-32	-36	-41
1.7	0.0	50	45.0	40.5	36.0	31.5	27.00	22.50	18.00	13.5	9.0	4.5	0.0	-4.5	-9.00	-13.50	-18.0	-23	-27	-32	-36
1.8	0.0	54	49.5	45.0	40.5	36.0	31.50	27.00	22.50	18.0	13.5	9.0	4.5	0.0	-4.50	-9.00	-13.5	-18	-22	-27	-32
1.9	0.0	59	54.0	49.5	45.0	40.5	36.00	31.50	27.00	22.5	18.0	13.5	9.0	4.5	0.00	-4.50	-9.0	-14	-18	-23	-27
2.1	0.0	63	58.5	54.0	49.5	45.0	40.50	36.00	31.50	27.0	22.5	18.0	13.5	9.0	4.50	0.00	-4.5	-9	-13	-18	-23
2.3	0.0	68	63.0	58.5	54.0	49.5	45.00	40.50	36.00	31.5	27.0	22.5	18.0	13.5	9.00	4.50	0.0	-5	-9	-14	-18

ZA1JA01G-RRFF 12025 FI Example ROM Boost Control enc.bin - Custom Map K Output Definition

File Edit

Output channel

- Unused
- Calculation Only
- Ignition Base Timing (°)
- CPC Duty (%)**
- Cam Angle Inlet(°)
- Cam Angle Exhaust (°)
- Target AFR (n:1)
- Mass Airflow (g/s)
- Total Fuel Quantity
- Fuel Injection Ratio
- PI Fuel Quantity
- DI Fuel Quantity
- Cranking PI Pulsewidth(ms)

Output function

- Replace channel value with map output
- Add map output to channel value**
- Multiply channel value by map output
- Use map output as a minimum for channel value
- Use map output as a maximum for channel value
- Add map output to integral. Add integral to channel value
- Add map output to integral. Multiply channel value by integral

Custom Map L - Wastegate Duty Integral Control

- X axis is current Manifold Pressure
- Y axis is Boost Target
- Map values Wastegate Duty integral compensation factor.

Custom Map L will add the map output value to the current WG Duty (CPC Duty) but as an integral, so the value will keep increasing over a period of time.

In the example shown above the Y axis Target Boost Pressure (output of Map I) is 1.8bar but the X axis current boost pressure is 2.1bar so -9% WG Duty would be removed to reduce the WG Duty and reduce the boost pressure.

Custom Map L X Input Definition

- unused
- Engine Speed (RPM)
- Mass Airflow (g/s)
- Engine Load (g/rev)
- Manifold Pressure (bar)**
- Manifold Pressure delta (bar)
- Boost Pressure (bar)
- Coolant Temp (°C)
- Intake Air Temp (°C)
- Oil Temp (°C)

Custom Map L Y Input Definition

- Custom Map E result
- Custom Map F result
- Custom Map G result
- Custom Map H result
- Custom Map I result**
- Custom Map J result
- Custom Map K result
- Custom Map L result

Custom Map L

		X channel (raw)																-0.112 raw				
		2.100																				
Y channel (raw)		1.80	0.000	0.150	0.300	0.450	0.600	0.7500	0.900	1.050	1.200	1.350	1.500	1.650	1.800	1.950	2.1000	2.250	2.400	2.55	2.700	2.850
0.00		0.000	-0.056	-0.112	-0.169	-0.225	-0.2813	-0.338	-0.394	-0.450	-0.506	-0.563	-0.619	-0.675	-0.731	-0.7875	-0.844	-0.900	-0.96	-1.01	-1.07	
0.15		0.056	0.000	-0.056	-0.112	-0.169	-0.2250	-0.281	-0.338	-0.394	-0.450	-0.506	-0.563	-0.619	-0.675	-0.7312	-0.788	-0.844	-0.90	-0.96	-1.01	
0.30		0.112	0.056	0.000	-0.056	-0.112	-0.1688	-0.225	-0.281	-0.338	-0.394	-0.450	-0.506	-0.562	-0.619	-0.6750	-0.731	-0.788	-0.84	-0.90	-0.96	
0.45		0.169	0.112	0.056	0.000	-0.056	-0.1125	-0.169	-0.225	-0.281	-0.338	-0.394	-0.450	-0.506	-0.563	-0.6187	-0.675	-0.731	-0.79	-0.84	-0.90	
0.60		0.225	0.169	0.112	0.056	0.000	-0.0563	-0.112	-0.169	-0.225	-0.281	-0.338	-0.394	-0.450	-0.506	-0.5625	-0.619	-0.675	-0.73	-0.79	-0.84	
0.75		0.281	0.225	0.169	0.113	0.056	0.0000	-0.056	-0.112	-0.169	-0.225	-0.281	-0.338	-0.394	-0.450	-0.5063	-0.563	-0.619	-0.68	-0.73	-0.79	
0.90		0.338	0.281	0.225	0.169	0.112	0.0562	0.000	-0.056	-0.112	-0.169	-0.225	-0.281	-0.337	-0.394	-0.4500	-0.506	-0.563	-0.62	-0.68	-0.73	
1.05		0.394	0.338	0.281	0.225	0.169	0.1125	0.056	0.000	-0.056	-0.113	-0.169	-0.225	-0.281	-0.338	-0.3938	-0.450	-0.506	-0.56	-0.62	-0.68	
1.20		0.450	0.394	0.338	0.281	0.225	0.1687	0.113	0.056	0.000	-0.056	-0.113	-0.169	-0.225	-0.281	-0.3375	-0.394	-0.450	-0.51	-0.56	-0.62	
1.35		0.506	0.450	0.394	0.338	0.281	0.2250	0.169	0.113	0.056	0.000	-0.056	-0.112	-0.169	-0.225	-0.2812	-0.338	-0.394	-0.45	-0.51	-0.56	
1.50		0.563	0.506	0.450	0.394	0.338	0.2812	0.225	0.169	0.112	0.056	0.000	-0.056	-0.112	-0.169	-0.2250	-0.281	-0.338	-0.39	-0.45	-0.51	
1.65		0.619	0.563	0.506	0.450	0.394	0.3375	0.281	0.225	0.169	0.112	0.056	0.000	-0.056	-0.113	-0.1687	-0.225	-0.281	-0.34	-0.39	-0.45	
1.80		0.675	0.619	0.563	0.506	0.450	0.3938	0.338	0.281	0.225	0.169	0.112	0.056	0.000	-0.056	-0.1125	-0.169	-0.225	-0.28	-0.34	-0.39	
1.95		0.731	0.675	0.619	0.563	0.506	0.4500	0.394	0.338	0.281	0.225	0.169	0.112	0.056	0.000	-0.0562	-0.113	-0.169	-0.22	-0.28	-0.34	
2.10		0.788	0.731	0.675	0.619	0.563	0.5063	0.450	0.394	0.338	0.281	0.225	0.169	0.113	0.056	0.0000	-0.056	-0.113	-0.17	-0.23	-0.28	
2.25		0.844	0.788	0.731	0.675	0.619	0.5625	0.506	0.450	0.394	0.338	0.281	0.225	0.169	0.112	0.0563	0.000	-0.056	-0.11	-0.17	-0.22	

Custom Map L Output Definition

Output channel

- Unused
- Calculation Only
- Ignition Base Timing (°)
- CPC Duty (%)**
- Cam Angle Inlet(°)
- Cam Angle Exhaust(°)
- Target AFR (n:1)
- Mass Airflow (g/s)
- Total Fuel Quantity
- Fuel Injection Ratio
- PI Fuel Quantity
- DI Fuel Quantity
- Cranking PI Pulsewidth(ms)

Output function

- Replace channel value with map output
- Add map output to channel value
- Multiply channel value by map output
- Use map output as a minimum for channel value
- Use map output as a maximum for channel value
- Add map output to integral. Add integral to channel value.**
- Add map output to integral. Multiply channel value by integral

The Integral Min/Initial/Max has been set so it can only add or subtract a value of 10, this prevents the Integral from drastically changing the WG duty during spool and part throttle conditions.

ZA1JA01G - FI Example ROM Boost Control enc.bin - Custom Map L Integral Min/Initial/Max

File Edit Help

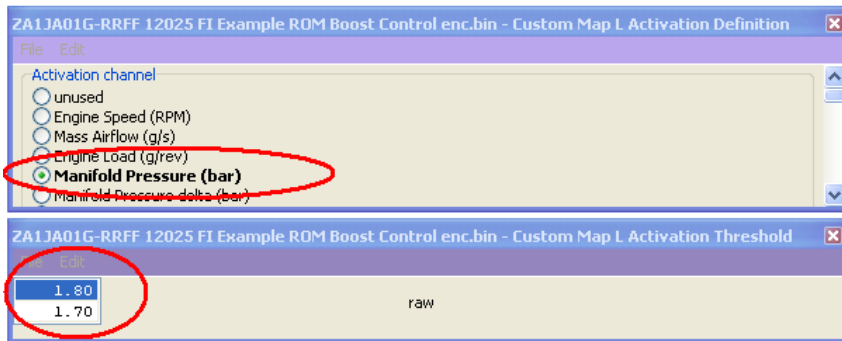
-10

0

10

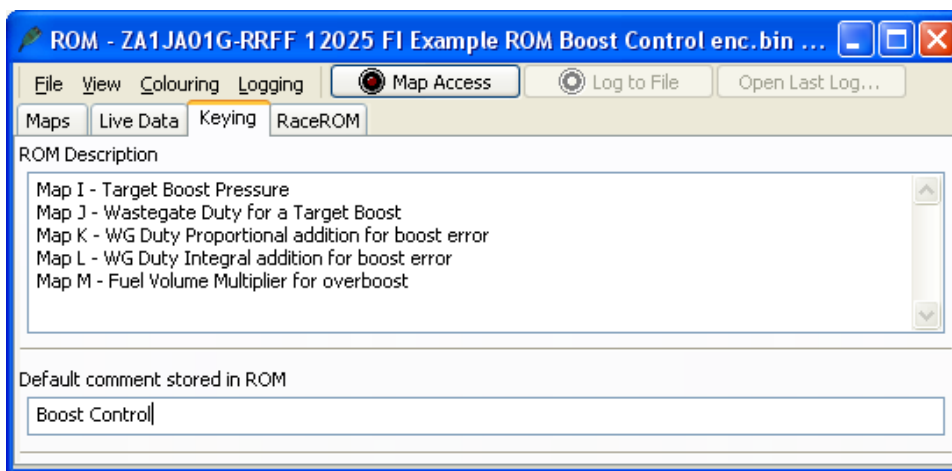
raw

To further improve the boost control logic the Map L activation has been set at 1.8bar so the Integral factor will ONLY be applied over 1.8bar and stop working below 1.7bar. But the Integral will always start from 0 when the map becomes active as the Integral Initial value has been set to zero as shown on the previous screenshot.



So as a summary the four custom maps used for boost control are shown below.

In addition, custom map M is used as a boost limit.



We suggest that the proportional and integral maps are not enabled until the base WG Duty map J has been profiled and is fairly close for tight boost control.

We then suggest you enable the proportional map and check for boost stability, its good practice to entice an overboost to check the control of the proportional map, the following sequence is great for producing an accurate proportional or integral map.

Example: If you are running 2bar boost absolute at 60% WG Duty then set your target boost to 1.7bar absolute with 60% WG Duty, you will then overshoot to 2bar and the Proportional will attempt to reduce the boost to 1.7 bar. See how the proportional control deals with the overshoot, log the INTERIM and RESULT of Custom Map K which shows the proportional component working.

If the boost only reduces from 2.0bar to 1.85bar then you have the perfect proportional values for a 0.15bar boost error, this method can soon populate an accurate proportional map suitable for the size of your turbocharger.

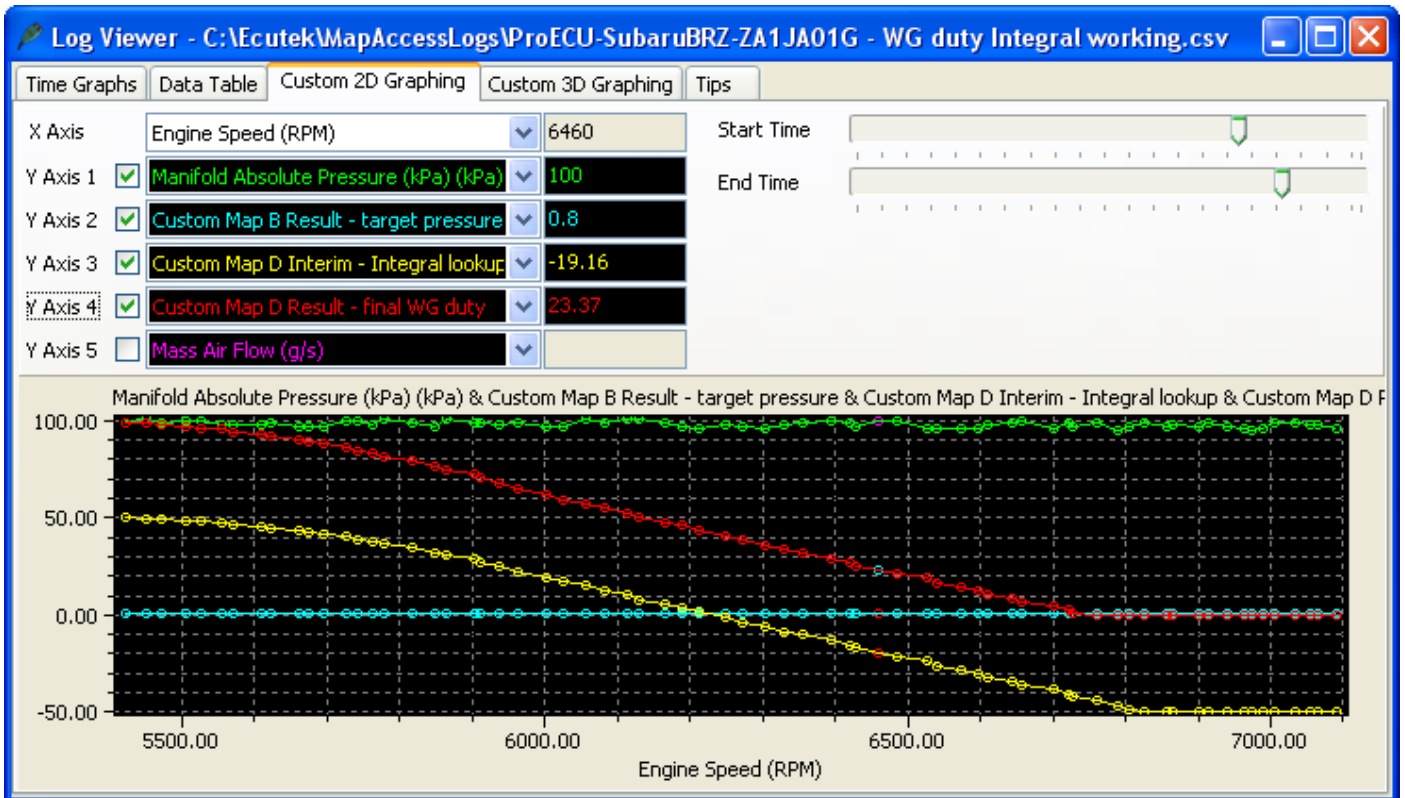
If the proportional is simply too aggressive then halve all the values in Map K, if it takes too long to double the values in map K.

Once your proportional map is calibrated then turn off Map K (prop) and enable Map L (integral).

See how the integral control deals with the overshoot and if it is too aggressive then halve all the values in map L, if it takes too long to double the values in map L, the integral values have to be much smaller than the proportional values. We cannot adjust the frequency of the integral addition but doubling or halving the values will have the same affect.

Below you can see an integral addition in action, in this fictitious situation where the target pressure is 0.8bar absolute but the manifold pressure is held at 1bar absolute for purpose of example. We also labelled the log file custom map names for ease of explanation.

You can see the yellow integral value (Map D interim) constantly decreasing and the red final WG Duty (Map D Result) reducing until eventually the WG Duty is zero and the integral is sat at -50%.

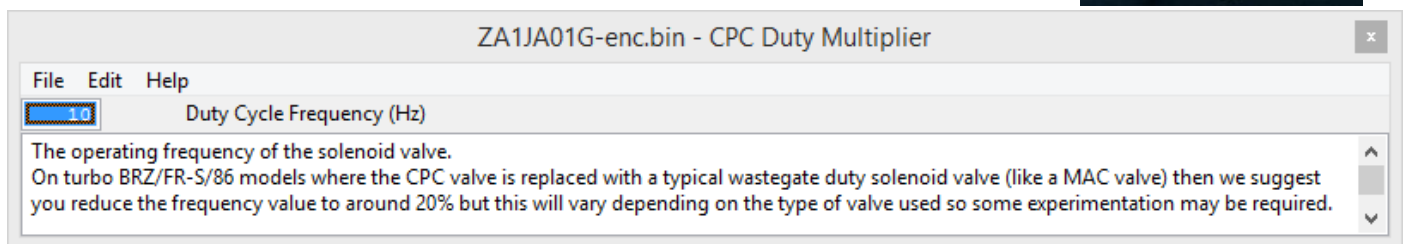


Other compensation factors can also be created, some examples below.

- Target boost pressure compensation for coolant temp
- Per Gear Boost compensation
- Per Gear WG Duty compensation
- Air Temp WG Duty compensation
- Atmospheric pressure Boost and WG Duty compensation

The CPC Valve cannot be used to control boost pressure, it's simply not a suitable valve design.

We replaced the CPC valve with a very common Subaru WRX WG Duty valve (part no.16102AA360), it's direct plug and play and the valve frequency should be reduced to 20 to 30% for the best results.

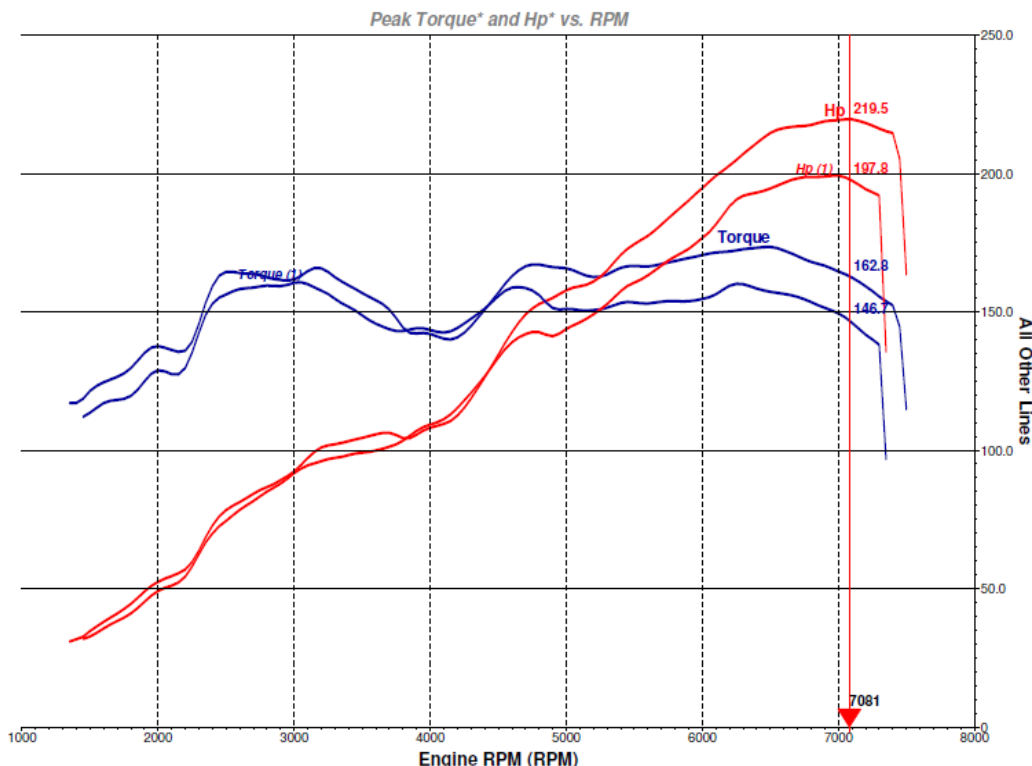


So you can see the closed loop boost control is very powerful and offers the tuner complete calibration control. There is no real limitation of what Custom Maps can do!

4.2.13. How to set up for Ethanol and import Flex Fuel sensor **

Using Custom Maps, it is possible to tune the BRZ/GT86/FR-S for Ethanol based fuels (E85 etc). When running E85, we are able extract more energy from the fuel and this leads to more power.

DYNOMite test "E85 Tuning" by EcuTeK



On our stock GT86 we were able to gain plus 22bhp from simply tuning for E85.

Fuel Volume

When running on E85 we need to increase the amount of fuel volume that is added per cylinder fill, the extra fuel volume amount is typically between 25% and 35% more depending on the method used to increase the volume.

Ignition Timing

Along with extra fuel volume we also need to advance the Ignition timing as Ethanol takes longer to burn and longer to release all its energy, for this reason we needed to advance the timing on full load.

Cranking Fuel

In addition, cranking fuel is normally a fixed injection volume amount and needs increasing independently of the main fuel volume calculations.

Using Custom Maps it possible to adjust the Ignition and Fuel for the current true Ethanol Content Ratio, this eliminates the risk of engine damage and also avoids having to run an empty tank before refuelling with Ethanol.

In addition the tuning will always be correct for whatever the current Ethanol Ratio is.

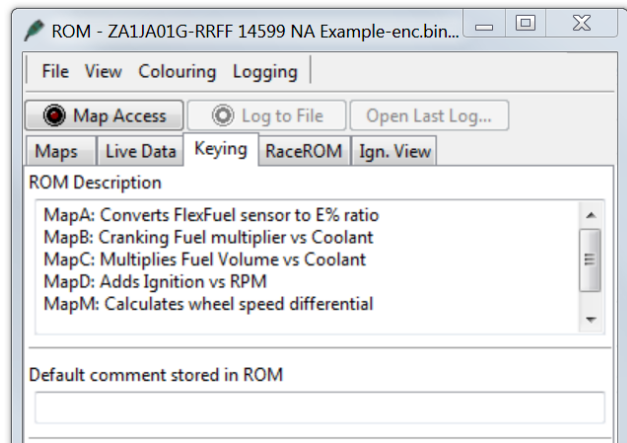
The current Ethanol Ratio can also be displayed on the Digital Coolant Temp Gauge during Mapswitch mode in any of the 4 modes if required.

Another point worth mentioning is the fact that you are injecting 30% more fuel that the stock injection system will be at 100% by 230-240bhp instead of 280-300bhp for regular gas (petrol). Watch closely the logging parameter called 'Fuel Injection End DI to Spark (ms)' which is the time period left between the direct injector closing and the spark plug firing, critical to maximize the DI Open Time.

NOTE: On Forced Induction models with higher cylinder pressure the same amount of Ignition Advance should not be used, take care as E85 doesn't knock very easily. So to run on E85 we have to make the following calibration changes using Custom Maps.

- Increase Ignition Timing by up to 10 degrees on full load (depending on your region and modifications)
- Increase Injection Volume Amount by around +30% everywhere
- Increase Port Injector Open Time during Cranking by 30 to 50% depending on Coolant Temp

Using an example ROM these are the 4 custom maps that we changed:



- Map A - Converts the Flex-Fuel sensor voltage into Ethanol ratio %
- Map B - Cranking Fuel multiplier adds extra fuel volume during cranking for a given coolant
- Map C - Multiplies the Fuel Volume amount (ml) for a given coolant temp
- Map D - Adds Ignition Timing for a given Ethanol amount against RPM



Using an aftermarket Flex-Fuel sensor fitted on the lower pressure fuel rail return pipe, and installing a Zeitronic Ethanol Content display, we were able to measure the true Ethanol content of the fuel.

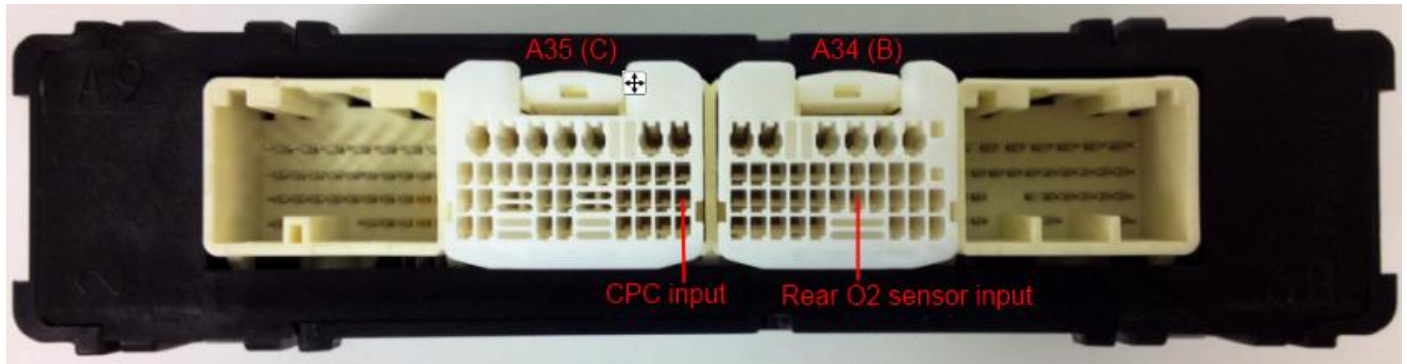
The Zeitronic Ethanol sensor has a 0-5v analogue output signal depending on the Ethanol content of the fuel, this can be imported into the factory Engine ECU through either the 'CPC Pressure Sensor Voltage' ECU pin or the Rear O2 Sensor Input pin (if the Rear O2 sensor is no longer required.)

The factory ECU inputs for "CPC Pressure Sensor voltage" or "Rear O2 sensor voltage" can be used as 0-5v analogue inputs enabling us to set up custom maps to control a variety of different functions, just remember to set the AF Correction #3 maps to zero.

The CPC Pressure Sensor signal normally comes from the carbon canister pump module, which is non-essential and only fitted in some markets (USA region for example), the vehicles rear O2 sensor checks for the correct functioning of the catalytic converter and also provides the ECU with fuel trim information, if the fuel trims are turned off the input can then be used for any 0-5v analogue signal to control a custom map.

You can choose to delete the carbon canister module (if fitted) or the rear O2 sensor and utilise these inputs to import analogue outputs from an aftermarket wide band air/fuel ratio gauge or a fuel ethanol content analyser.

Use caution when connecting the auxilliary inputs to ensure that the correct ECU pins are used.

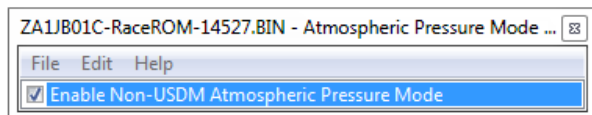


Using the Rear O2 Sensor input

If you are using the Rear O2 sensor input pin it is essential to turn off the ECU Long Term Fuel Trims and AF Correction #3 as well.

See the “How to turn off Long Term Fuel Trims” and “How to disable Rear O2 AF Correction #3” headings for more information on how to do this.

Using the CPC Pressure sensor input



If you repurpose the CPC Pressure Sensor input on a USDM vehicle then the Atmospheric Pressure calculation will be incorrect.

We have added a checkbox on affected vehicles to force the ECU to use the MAP sensor for the Atmospheric Pressure Calculation instead.

Please enable this feature when repurposing the CPC Pressure Sensor on a USDM vehicle so the atmospheric pressure reading is correct and shown correctly in Live Data.

See the Example ROMs like “**ZA1JA01G-RRFF 14599 NA Example-enc.bin**” for an example to start your tuning.

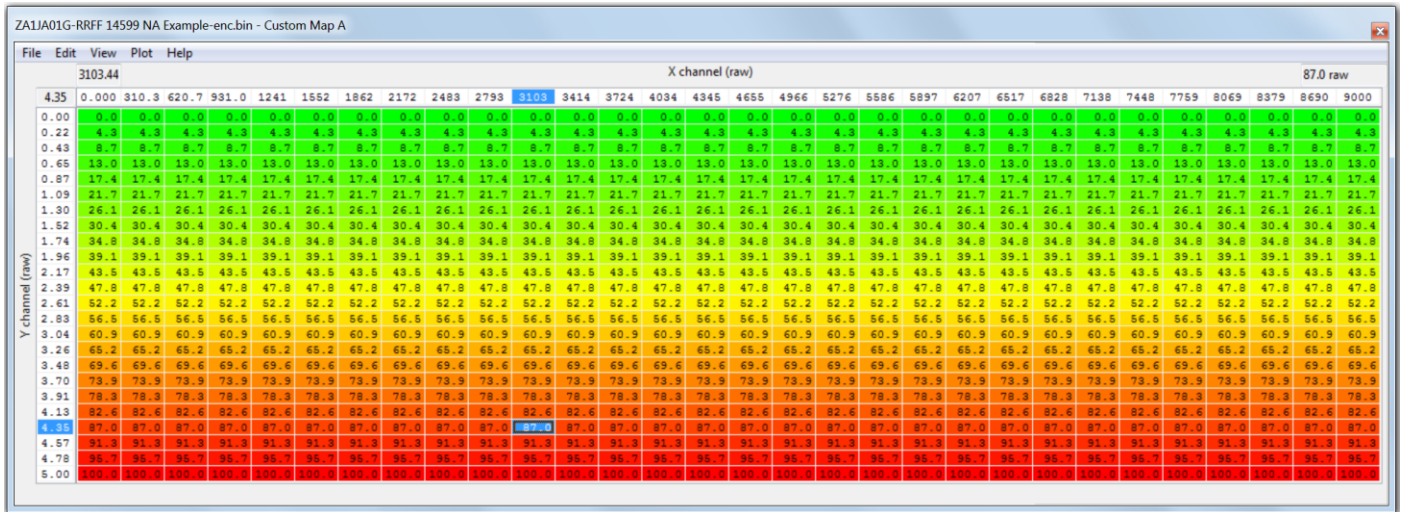
These are the maps that have been changed on the following few pages:

Map A – Ethanol Sensor Scaling for Flex Fuel Sensor Import

Custom Map A : Will import and convert the signal from the Flex-Fuel Ethanol sensor from Voltage to an Ethanol % ratio. It acts as a 2d map and RPM was added but does nothing.

Custom Map A : X Axis Input Definition is Engine Speed

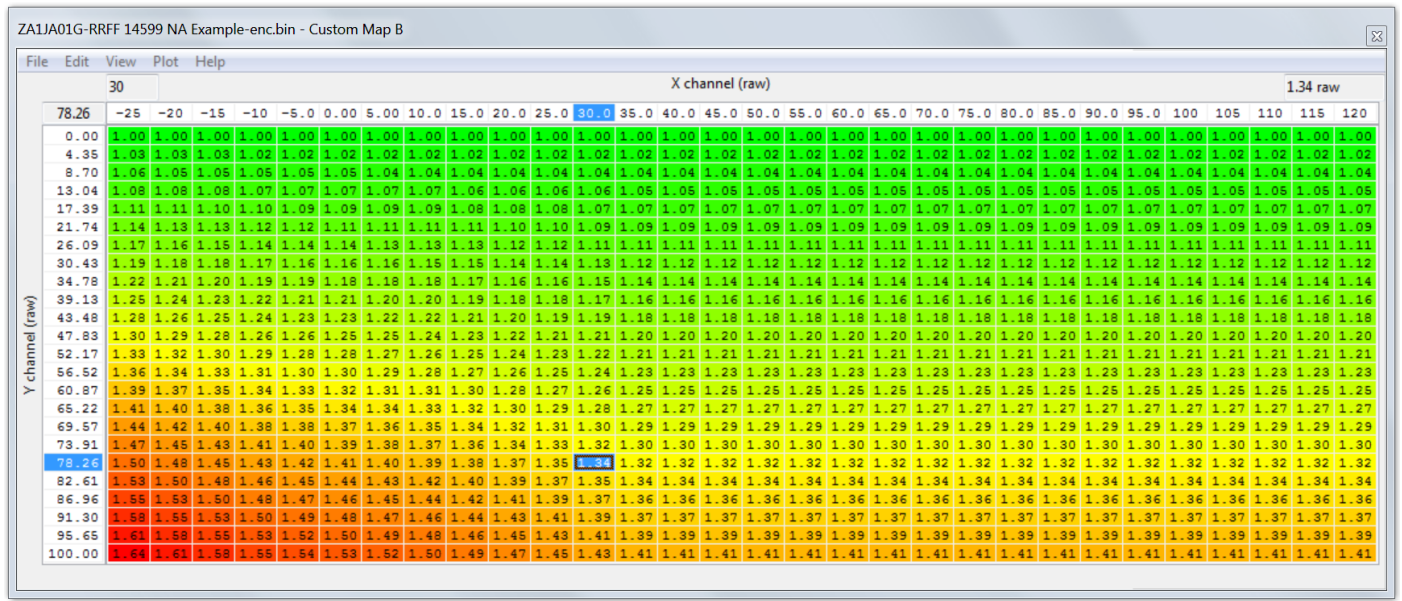
Custom Map A : Y Axis Input Definition is the CPC Pressure sensor voltage (which now has the Ethanol Content Ratio Sensor connected)



Custom Map A Output Definition : Is configured as a 'CALCULATION ONLY' and will REPLACE CHANNEL VALUE so this output can be used by other Custom Map actions

Custom Map A Enabled : Map A must be ENABLED and turn off Debug for it to work in all 4 Map Switch modes.

Map B – Cranking Fuel Multiplier for Ethanol Content



Custom Map B : This map will multiply the Cranking Fuel Volume amount by the current Ethanol Content ratio of the result of Map A

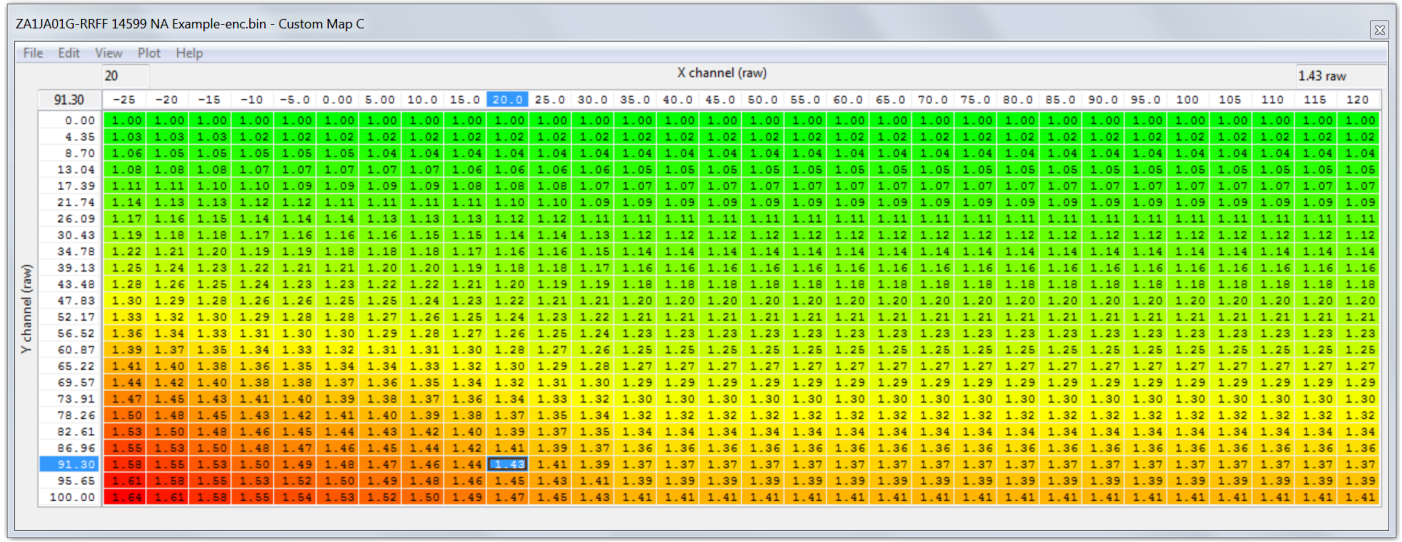
Custom Map B : X Axis Input Definition is Coolant temp (Deg C)

Custom Map B : Y Axis Input Definition is the output of Map A

Custom Map B Output Definition : The output will be multiplied by the current cranking fuel volume for a given coolant temp.

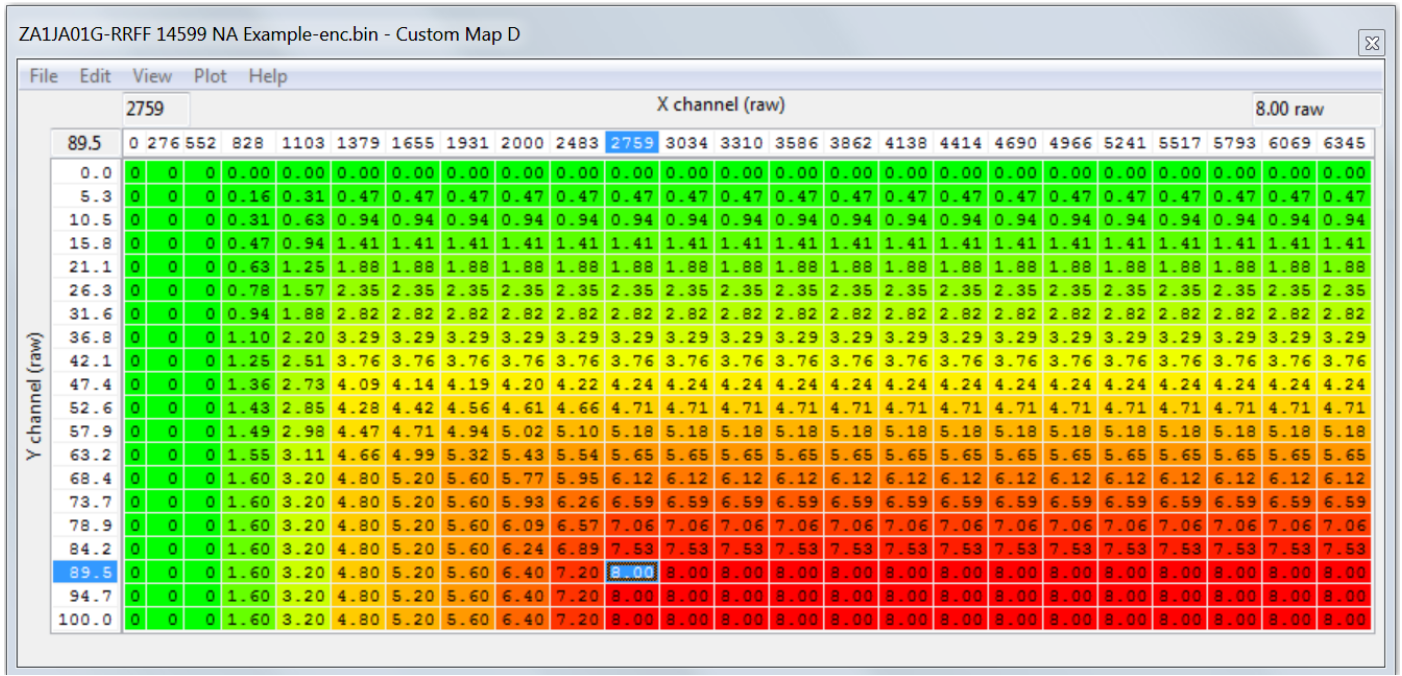
Custom Map B Enabled : Map B must be ENABLED and turn off Debug for it to work in all 4 Map Switch modes.

Map C – Fuel Volume multiplier for Ethanol Content

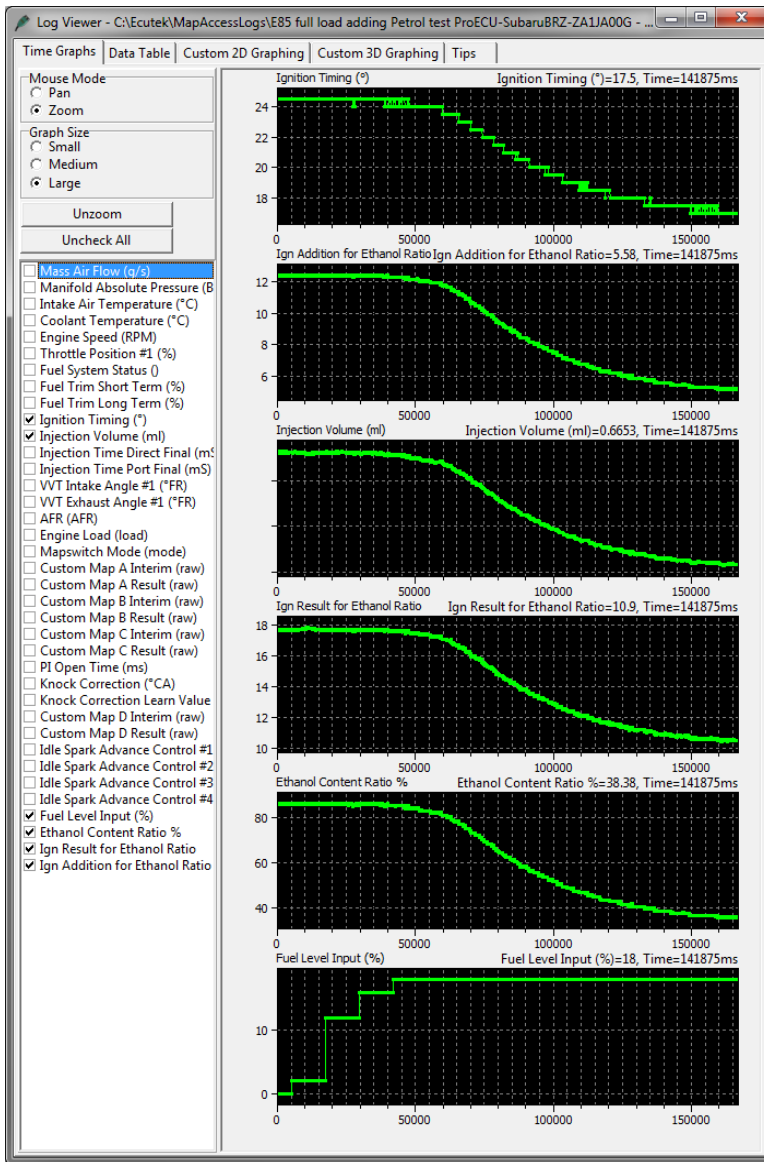


- Custom Map C :** This map is the fuel volume multiplier,
- Custom Map C :** X Axis Input Definition is Coolant Temp (deg C)
- Custom Map C :** Y Axis Input Definition is the output of Map A
- Custom Map C Output Definition :** The output will multiply the current fuel volume amount depending on Coolant temp.
- Custom Map C Enabled :** Map C must be ENABLED and turn off Debug for it to work in all 4 Map Switch modes.

Map D – Ignition Addition for Ethanol Content



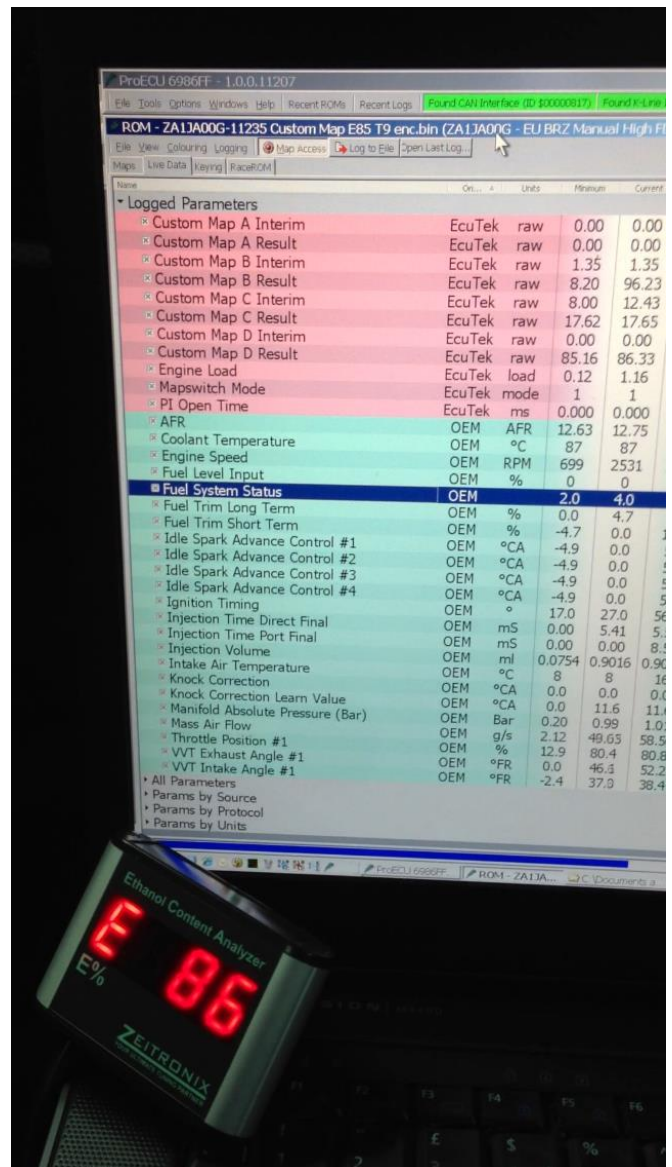
- Custom Map D :** This map is Ignition Timing in Degrees, it is filled with 0deg to 8Deg
- Custom Map D :** X Axis Input Definition is Engine Speed (RPM)
- Custom Map D :** Y Axis Input Definition is the output of Map A
- Custom Map D Output Definition :** The output will be between 0 and 8 degrees, this will be ADDED to the current Ignition timing.
- Custom Map D Enabled :** Map D must be ENABLED and turn off Debug for it to work in all 4 Map Switch modes.



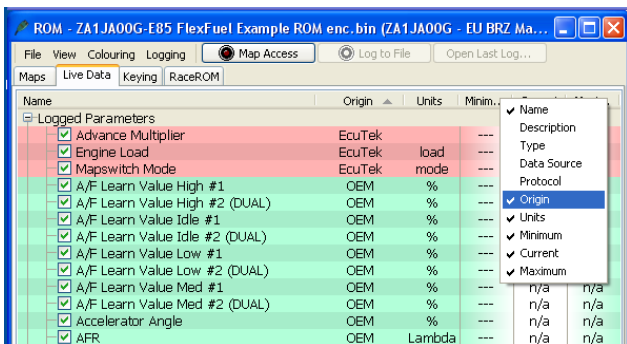
To prove the real Flex-Fuel ability we held the car on full power at 2000rpm with pure E85 in the fuel tank, we then added regular 98 Octane Petrol into the fuel tank. The results were logged with ProECU.

The Ethanol content ratio reduced from 85% (E85) down to 30% (E30)

The log file clearly shows whilst adding the Petrol to the E85 how the Injection Volume was reduced and the Ignition Timing was retarded as the Ethanol content of the fuel was reduced.



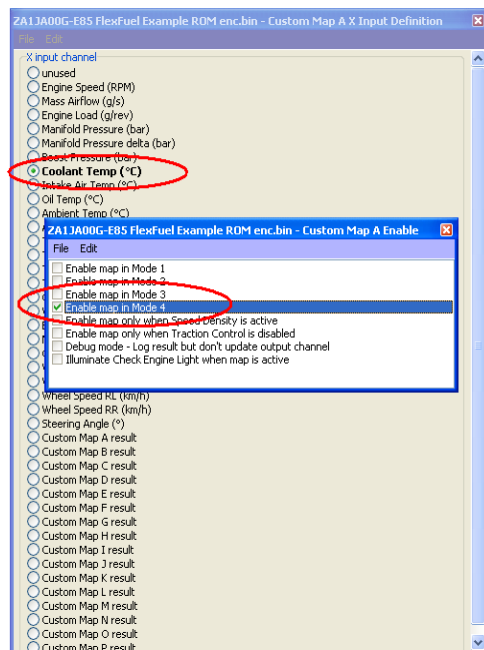
You see the importance of logging the Custom Map logging parameters as shown in the screen shot on the right, the parameters have been ordered by ORIGIN which shows all the custom EcuTek parameters in RED and all the OEM parameters in GREEN.



Logging the custom parameters is very important to understand how your Custom Maps are working.

If you do not want to use a Flex-Fuel sensor and you want to run a dedicated E85 map, simply fill Map A with 85, then regardless of the CPC pressure valve input voltage, the output will always be 85% Ethanol.

Y channel (raw)	0.0	0.2	0.4	0.7	0.9	1.1	1.3	1.5	1.7	2.0	2.2	2.4	2.6	2.8	3.0	3.3	3.5	3.7	3.9	4.1	4.3	4.6	4.8	5.0
0.0	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
0.2	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
0.4	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
0.7	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
0.9	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
1.1	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
1.3	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
1.5	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
1.7	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
2.0	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
2.2	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
2.4	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
2.6	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
2.8	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
3.0	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
3.3	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
3.5	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
3.7	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
3.9	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
4.1	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
4.3	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
4.6	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
4.8	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
5.0	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85

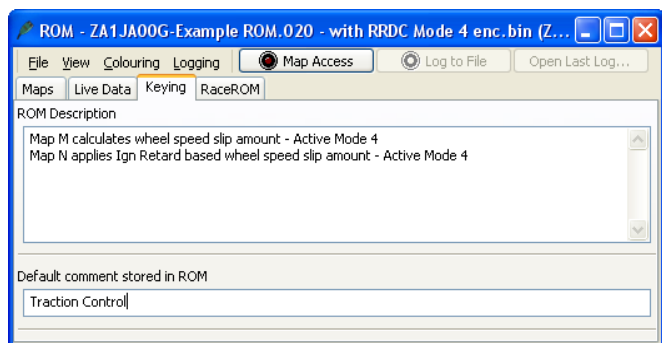


In addition, you could change Y axis to Coolant temp and then have a Coolant temp influence on the Injection Volume amount for lower coolant temps.

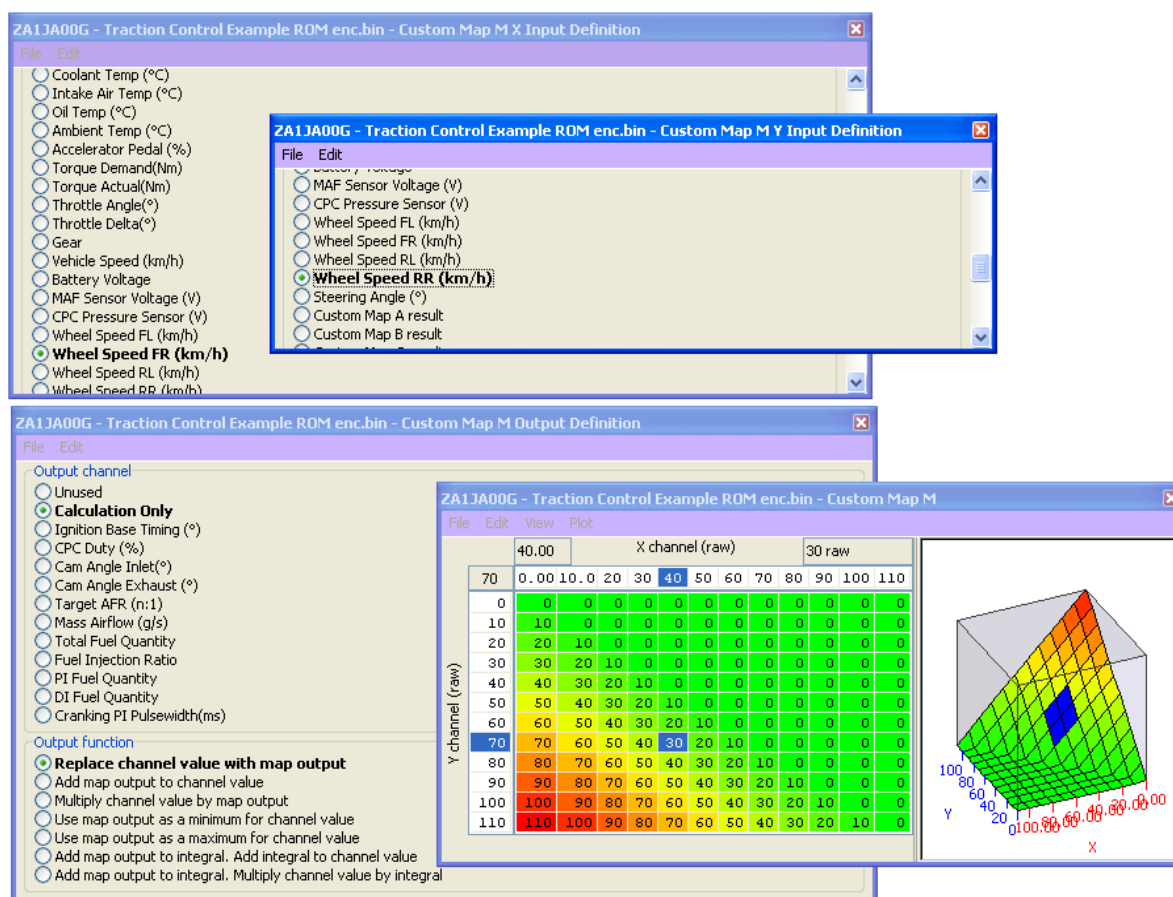
You will also need to ensure that the Ethanol based maps are only enabled in a certain mode, in this example Map A is enabled in Mode 4.

4.2.14. How to set up Traction Control **

By using Custom Maps and our powerful 4 channel wheel speed logging, it's possible to create a torque reduction map for wheel speed differential.



Custom Map M calculates the amount of wheel slip by comparing the front wheel and rear wheel speeds.



The map will only output a value if the rear wheel speed is greater than the front wheel speed, as the vehicle is rear wheel drive this should always be the case.

If the front wheels are doing 40kph and the rear wheels are 70kph then the wheel speed differential is 30kph, this value is then stored as the Custom Map M Result.

Custom Map N applies an amount of Ignition retard based on the wheel speed differential. By using the Custom Map M Result we can apply an Ignition Retard amount for a given wheel slip amount.

This map is progressive and allows a small amount of slip before it really starts to retard the ignition timing (reducing engine torque) , it also reduces the torque output by a greater amount at higher RPM.

ZA1JA00G - Traction Control Example ROM enc.bin - Custom Map N X Input Definition

- Unused
- Engine Speed (RPM)**
- Mass Airflow (g/s)
- Engine Load (g/rev)
- Manifold Pressure (bar)
- Manifold Pressure delta (bar)
- Boost Pressure (bar)
- Coolant Temp (°C)
- Intake Air Temp (°C)
- Oil Temp (°C)
- Ambient Temp (°C)
- Accelerator Pedal (%)
- Torque Demand(Nm)
- Torque Actual(Nm)

ZA1JA00G - Traction Control Example ROM enc.bin - Custom Map N Y Input Definition

- Custom Map F result
- Custom Map G result
- Custom Map H result
- Custom Map I result
- Custom Map J result
- Custom Map K result
- Custom Map L result
- Custom Map M result**
- Custom Map N result
- Custom Map O result
- Custom Map P result

ZA1JA00G - Traction Control Example ROM enc.bin - Custom Map N Output Definition

- Unused
- Calculation Only
- Ignition Base Timing (°)**
- CPC Duty (%)
- Cam Angle Inlet(°)
- Cam Angle Exhaust (°)
- Target AFR (n:1)
- Mass Airflow (g/s)
- Total Fuel Quantity
- Fuel Injection Ratio
- PI Fuel Quantity
- DI Fuel Quantity
- Cranking PI Pulsewidth(ms)

ZA1JA00G - Traction Control Example ROM enc.bin - Custom Map N

		X channel (raw)										-35 raw		
		4500	1000	2000	2500	3000	3500	4000	4500	5000	6000	7000	8000	
Y channel (raw)	20	0	0	0	0	0	0	0	0	0	0	0	0	
	5	0	0	-5	-5	-5	-5	-5	-8.8	-13	-16	-20	-50	
	10	0	0	-10	-10	-10	-10	-10	-13.8	-18	-21	-25	-50	
	15	0	0	-15	-15	-15	-15	-15	-18.8	-23	-26	-30	-50	
	20	0	0	-30	-30	-30	-30	-30	-35.0	-40	-45	-50	-50	
	25	0	0	-35	-35	-35	-35	-35	-38.8	-43	-46	-50	-50	
	30	0	0	-40	-40	-40	-40	-40	-42.5	-45	-48	-50	-50	
	40	0	0	-50	-50	-50	-50	-50	-50.0	-50	-50	-50	-50	-50
	50	0	0	-50	-50	-50	-50	-50	-50.0	-50	-50	-50	-50	-50
	50	0	0	-50	-50	-50	-50	-50	-50.0	-50	-50	-50	-50	-50
	75	0	0	-50	-50	-50	-50	-50	-50.0	-50	-50	-50	-50	-50
100	0	0	-50	-50	-50	-50	-50	-50.0	-50	-50	-50	-50	-50	

ZA1JA00G - Traction Control Example ROM enc.bin - Custom Map N Output Function

- Replace channel value with map output
- Add map output to channel value**
- Multiply channel value by map output
- Use map output as a minimum for channel value
- Use map output as a maximum for channel value
- Add map output to integral. Add integral to channel value
- Add map output to integral. Multiply channel value by integral

further maps can be added for vehicle speed where multipliers could be used to differentiate between a low speed acceleration wheel slip (1st or 2nd gear) vs a fast corner 'high speed' drift situation where you may want to dampen the torque rather than completely kill the torque.

Accelerator pedal output can also be intercepted to create a throttle based traction control strategy with the addition of ignition retard and steering angle inputs for further wheel slip control.

ZA1JA01G- RaceROM Traction Control throttle reduction for wheel slip amount .bin - Custom Map M X Input Definition

- Coolant Temp (°C)
- CPC Pressure Sensor (V)
- Engine Load (g/rev)
- Engine Speed (RPM)**
- Gear
- Intake Air Temp (°C)
- MAF Sensor Voltage (V)
- Manifold Pressure (bar)
- Manifold Pressure delta (bar)

ZA1JA01G- RaceROM Traction Control throttle reduction for wheel slip amount .bin - Custom Map M Y Input Definition

- Custom Map B result
- Custom Map C result
- Custom Map D result**
- Custom Map E result
- Custom Map F result

ZA1JA01G- RaceROM Traction Control throttle reduction for wheel slip amount .bin - Custom Map M Output Definition

- Unused
- Calculation Only
- Ignition Base Timing (°)**
- CPC Duty (%)
- Cam Angle Inlet(°)
- Cam Angle Exhaust (°)
- Target AFR (n:1)
- Mass Airflow (g/s)
- Total Fuel Quantity
- Fuel Injection Ratio
- PI Fuel Quantity
- DI Fuel Quantity
- Accelerator Pedal (%)**
- Cranking PI Pulsewidth(ms)
- Charge Air Temp for SD (°C)

ZA1JA01G- RaceROM Traction Control throttle reduction for wheel slip amount .bin - Custom Map M

		X channel (raw)										0.477 raw	
		4500	1000	1700	2400	3100	3800	4500	5200	5900	6600	7300	8000
Y channel (raw)	20	1	1	1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	0	1	1	1	0.739	0.716	0.693	0.670	0.647	0.624	0.601	0.577	0.554
	15	1	1	1	0.580	0.563	0.545	0.527	0.510	0.492	0.475	0.457	0.440
	20	1	1	1	0.542	0.521	0.499	0.477	0.455	0.433	0.411	0.389	0.368
	25	1	1	1	0.525	0.499	0.472	0.446	0.420	0.394	0.368	0.341	0.315
	30	1	1	1	0.507	0.477	0.446	0.416	0.385	0.354	0.324	0.293	0.262
	35	1	1	1	0.490	0.455	0.420	0.385	0.350	0.315	0.280	0.245	0.210
	40	1	1	1	0.465	0.432	0.399	0.366	0.332	0.299	0.266	0.233	0.200
	40	1	1	1	0.465	0.432	0.399	0.366	0.332	0.299	0.266	0.233	0.200

ZA1JA01G- RaceROM Traction Control throttle reduction for wheel slip amount .bin - Custom Map M Output Function

- Replace channel value with map output
- Add map output to channel value
- Multiply channel value by map output**
- Use map output as a minimum for channel value
- Use map output as a maximum for channel value
- Add map output to integral. Add integral to channel value
- Add map output to integral. Multiply channel value by integral

5. Technical Service Bulletins (TSB)

There are various known cam control issues with the FA20 engine, these have resulted in various recalls and TSB's in an attempt to fix and solve these issues. Here are two TSB's that are related to VVT control.

TSB Number 1

- 1) TSB 02-132-12, you can search this online to download the full PDF document that includes the full test process.

SERVICE BULLETIN			
APPLICABILITY:	2012MY Impreza with FB Engine 2013MY BRZ	NUMBER:	02-132-12
SUBJECT:	DTCs Relating to the AVCS (Active Valve Control System) P000A, P000B, P000C, P000D, P0011, P0014, P0018, P0017, P0019, P0021 & P0024	DATE:	08/21/12

INTRODUCTION

The purpose of this Service Bulletin is to provide diagnostic information regarding "AVCS Slow Response" DTCs P000A, P000B, P000C and P000D along with "AVCS System Failure" DTCs P0011, P0014, P0017, P0018, P0019, P0021 and P0024.

IMPORTANT:

- Read through the diagnostic flow chart and test mode graphs thoroughly then follow the procedures step-by-step **BEFORE** ordering parts or making any repairs.
- It is important to remind customers who perform their own maintenance or have it done elsewhere the importance of following the Owner's Manual recommendation for proper oil viscosity, API specification and service intervals.

PART INFORMATION

Applicable Parts, Sprocket Assembly - Camshaft

13320AA020, 13320AA030, 13321AA010, 13322AA030, 13322AA040, 13323AA010

Test Modes

PART		ABNORMALITY OF CRANK AND CAM TIMING		SLOW RESPONSE		TARGET ERROR	
Intake VVT	RH	P0016	Mode B	P000A	Mode B	P0011	Mode B
	LH	P0018		P000C		P0021	
Exhaust VVT	RH	P0017	Mode A	P000B	Mode B	P0014	Mode B
	LH	P0019		P000D		P0024	

Test Modes for AVCS DTCs

TEST MODES

Test Mode A

1. Bring the engine up to operating temperature then shut it off.
2. Restart the engine and maintain the engine speed around 2800 rpm for 10 seconds by applying the accelerator pedal with the shifter in Park position.
3. Leave the vehicle idle for 15 seconds or more.
4. Raise the engine speed to around 2800 rpm for 10 seconds again by applying the accelerator pedal with the shifter in Park position.
5. Leave the vehicle idle for 15 seconds or more then shut off the engine.
6. Perform the above procedure from steps #2 to #5 again.
7. Restart the engine and let the vehicle idle for 3 minutes or more when completed.
8. Confirm if any DTCs or temporary codes are reset in ECM memory.

Test Mode B

1. Start the engine and let it idle for 1 minute or more.
2. Drive the vehicle and accelerate it with 50 % accelerator pedal opening angle "D" range (A/T models) for 10 seconds as steadily as you can.
3. Coast the vehicle without applying the accelerator pedal for 10 seconds.
4. Perform steps #2 and #3 again.
5. Stop the vehicle and shut off the engine.
6. Restart the engine and perform steps #2 and #3 again.
7. Stop the vehicle and confirm if any DTCs or temporary codes are reset in the ECM memory.

TSB Number 2

- 2) Scion S-SB-0033-13, this issue is related to a camshaft position sensor clearance issue.

Some 2013 model year FR-S vehicles may exhibit intake and/or exhaust camshaft position sensor related and/or engine misfire DTCs (P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0301, P0302, P0303, and P0304) due to the camshaft position sensor clearance being out of specification. In addition, some vehicles may also experience rough idle or extended cranking. This bulletin provides inspection and repair procedures to address this condition.

Production Change Information

This bulletin applies to vehicles produced **BEFORE** the Production Change Effective VIN shown below.

MODEL	PRODUCTION CHANGE EFFECTIVE VIN
FR-S	JF1ZNAA1#D#008792

Warranty Information

OP CODE	DESCRIPTION	TIME	OFF	T1	T2
EG1311	R & R Shim Camshaft Sensor	0.6	SU003-00186	07	44

Hard Start, Rough Idle, Camshaft Sensor or Misfire DTCs

Parts Information

PART NUMBER	PART NAME	QTY
SU003-00184	O-Ring Camshaft (Bank 1 Exhaust)	As needed
SU003-00185	O-Ring Camshaft (All Others)	As needed
SU003-04600	Repair Part Set*	1

* Refer to the table below to see the list of the included parts in the Repair Part Set.

PART NUMBER RH (B1) EXHAUST ONLY	PART NUMBER INTAKE AND LH (B2) EXHAUST ONLY	CAM SENSOR MEASURED CLEARANCE (MM)	SHIM THICKNESS (MM)	TARGET GAP (MM)
10130-AA170	10130-AA070	0.45 – 0.55	0.8	1.25 – 1.35
10130-AA180	10130-AA080	0.56 – 0.65	0.7	1.26 – 1.35
10130-AA190	10130-AA090	0.66 – 0.75	0.6	1.26 – 1.35
10130-AA200	10130-AA100	0.76 – 0.85	0.5	1.26 – 1.35
10130-AA210	10130-AA110	0.86 – 0.95	0.4	1.26 – 1.35
10130-AA220	10130-AA120	0.96 – 1.05	0.3	1.26 – 1.35
10130-AA230	10130-AA130	1.06 – 1.15	0.2	1.26 – 1.35
10130-AA240	10130-AA140	1.16 – 1.25	0.1	1.26 – 1.35



S-SB-0033-13

August 30, 2013

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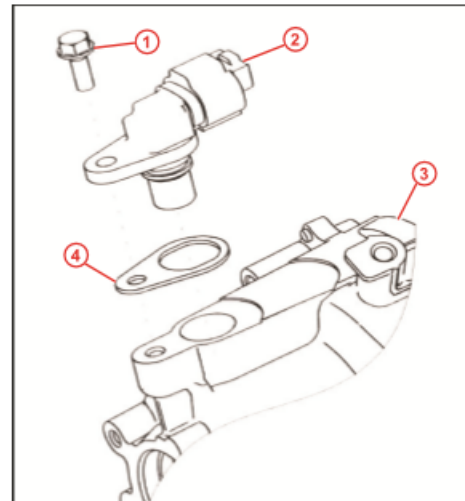
Hard Start, Rough Idle, Camshaft Sensor or Misfire DTCs

Inspection Procedure

1. Confirm MIL "ON" with Camshaft Sensor DTC as described in the Introduction.
2. Disconnect the negative (-) battery cable.
3. Proceed to the applicable repair procedure based on the DTC listed in the table below.

DTC	BANK	CONDITION	REPAIR PROCEDURE
P0340	B1 Intake	Circuit	Intake Camshaft Position Sensor
P0341		Circuit/Performance	
P0345	B2 Intake	Circuit	Intake Camshaft Position Sensor
P0346		Circuit/Performance	
P0365	B1 Exhaust	Circuit	Exhaust Camshaft Position Sensor
P0366		Circuit/Performance	
P0390	B2 Exhaust	Circuit	Exhaust Camshaft Position Sensor
P0391		Circuit/Performance	

Figure 1.



1	Torque = 6.4 N*m (0.7 Kg*f*m, 4.7 ft*lb*f)
2	Camshaft Sensor
3	Timing Chain Cover
4	Shim (to Be Added)

Repair Procedure: Intake Camshaft Position Sensor

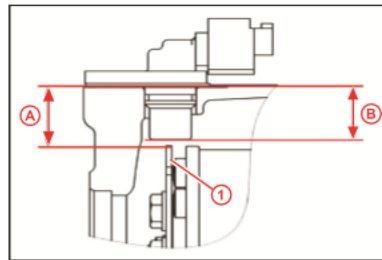
1. Remove applicable camshaft sensor.

Refer to the Technical Information System (TIS), applicable model and model year Repair Manual:

- 2013 FR-S:
Engine/Hybrid System – Engine Control – “FA20 Engine Control: Camshaft Position Sensor: [Removal](#)”

2. Take measurement “A” (top of timing chain cover to camshaft position sensor plate) on the 3 sections of the sensor plate (at approximately 70° apart) and record the readings.

Figure 2.

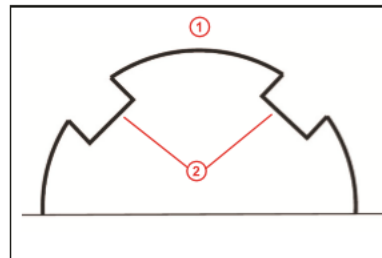


A	Top of Timing Chain Cover to Camshaft Position Sensor Plate
B	Camshaft Position Sensor Mating Surface to the Bottom of the Sensor
1	Camshaft Position Sensor Plate

- A. Take measurement “A” and record the reading.

NOTE
 When measuring “A”, make sure you are measuring the outside diameter or “top” of the sensor plate, and NOT in the notch as shown in Figure 3. Be sure to record all measurements.

Figure 3.



1	Top of the Sensor Plate (Measure at this Point)
2	Notch (Do NOT Measure at this Point)

Repair Procedure: Intake Camshaft Position Sensor (Continued)

Figure 4.



- B. Using a breaker bar and 22 mm socket, place the socket on the crankshaft pulley bolt and rotate the engine clockwise approximately 70°. Keep in mind NOT to measure the notches as described in Figure 3.

NOTICE
 Do NOT rotate the engine counterclockwise, doing so will loosen the crankshaft pulley bolt. If the engine is accidentally turned counterclockwise, make sure the bolt is re-torqued following the proper procedure in the applicable Repair Manual.

- C. Use the smallest of the 3 measurements and record the result.

Repair Procedure: Intake Camshaft Position Sensor (Continued)

3. Take measurement B (camshaft position sensor mating surface to the bottom of the sensor) and record the readings.

NOTE

When taking measurement "B", use a flat steel ruler or equivalent along with the Digital Caliper.

- A. Measure the distance between the camshaft position sensor mounting surface and the bottom of the sensor as shown.

NOTE

The specified clearance is 1.3 +/- 0.05 mm (1.25 to 1.35 mm or 0.049 to 0.053 in.).

Example calculation:

- A = Top of timing chain cover to camshaft position sensor plate
- B = Camshaft position sensor mating surface to the bottom of the sensor
- A = 23.70 mm
- B = 22.58 mm
- A - B = 1.12 mm (clearance)

In this example a 0.2 mm shim is required.

- B. Select appropriate shim and go to step 4.

NOTE

Select ONLY 1 shim. Do NOT stack shims.

4. Install the NEW O-Ring Camshaft (one time use item).

Refer to TIS, applicable model and model year Repair Manual:

- 2013 FR-S:
Engine/Hybrid System – Engine Control – "FA20 Engine Control: Camshaft Position Sensor: Installation"

5. Reinstall the camshaft position sensor and shim.

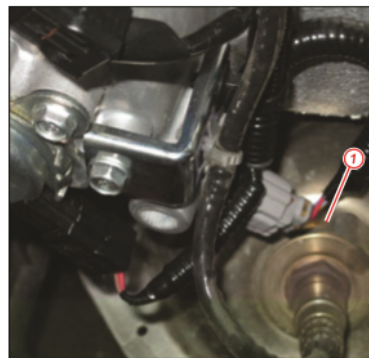
Repair Procedure: Intake Camshaft Position Sensor (Continued)

6. Tighten the sensor retaining bolt.
Torque: 6.4 N*m (0.7 kgf*cm, 4.7 ft*lbf)
7. Reconnect the sensor engine wiring harness connector.
8. Reconnect the negative (-) battery cable to complete the repair.
9. Clear the ECM memory before returning the vehicle to the customer.
10. Confirm repair by test driving the vehicle and confirm that the DTC do not reset.

Repair Procedure: Exhaust Camshaft Position Sensor

Use the following procedure if your DTC pertains to the exhaust side sensor.

Figure 6.



1 Camshaft Position Sensor Harness Connector

1. Confirm DTC pertains to the exhaust side camshaft sensor (see DTC Chart).
2. Remove the applicable sensor from the timing cover and install 0.2 mm thick shim from the applicable kit.

NOTE

Select ONLY 1 shim. Do NOT stack shims.

Repair Procedure: Exhaust Camshaft Position Sensor (Continued)

3. Install the NEW O-Ring Camshaft (one time use item).

Refer to TIS, applicable model and model year Repair Manual:

- 2013 FR-S:
Engine/Hybrid System – Engine Control – “FA20 Engine Control: Camshaft Position Sensor: [Installation](#)”

4. Reinstall the camshaft position sensor and shim.
5. Tighten the sensor retaining bolt.
Torque: 6.4 N*m (0.7 kgf*cm, 4.7 ft*lbf)
6. Reconnect the sensor engine wiring harness connector.
7. Reconnect the negative (-) battery cable to complete the repair.
8. Clear the ECM memory before returning the vehicle to the customer.
9. Confirm repair by test driving the vehicle and confirm that the DTCs do not reset.

Following the two different TSB will help you solve any cam control issues you may have but remember that after starting the engine the Exhaust cam takes some time to become active, up to 30 seconds. If a power test is made whilst the Exhaust VVT is not active then a significant amount of power and torque will be lost.

6. Glossary

AFM

Air Flow Meter

AFR

Air Fuel Ratio

AIT

Air Intake Temperature

Calculated Air Flow

The air flow sensor voltage is not linearly related to the amount of air flow. The ECU uses a scaling map to translate the air flow sensor voltage into an air flow rate value i.e. calculated air flow.

CAT

Charge Air Temp

DI

Direct Injection or Direct Injector

ECT

Engine Coolant Temperature

Engine Load

The ECU calculates engine load based on calculated air flow divided by engine RPM. It is effectively how much air enters the engine on each revolution.

FMIC

Front Mounted Intercooler

FTST

Fuel Trim Short Term

FTLT

Fuel Trim Long Term

AIT

Intake Air Temp

MAF

Mass Air Flow (sensor)

MAP

Manifold Absolute Pressure (sensor)

MRP

Manifold Relative Pressure or boost pressure

O2 Sensor

Lambda Sensor (oxygen sensor)

PI

Port Injection or Port Injector

SC

Supercharger or Supercharging

SD – Speed Density

The Mass Air Flow in grams is calculated from MAP sensor not MAF sensors

TC

Turbocharger or Turbocharging

VE

Volumetric Efficiency

VVT

Variable Valve Timing