

034 EFI

TUNING MANUAL

Introduction

The 034EFI Stage II “ Electronic Control Unit “ is a highly advanced DSP (Digital Signal Processor) based engine management system. When tuned and implemented properly, this system will provide highly refined and advanced fuel and ignition control over a wide variety of engine configurations. Though its electronic control is highly advanced, tuning the Stage II systems can be relatively simple to configure and tune for intended results, and quickly. There is certain methodology and considerations that should be used when tuning a fuel and ignition management system. *This document has been created not as a step-by-step tuning manual, but to address some frequently asked questions about tuning as well as giving an overall theory or understanding as to how tuning the ECU should be approached.*

****Stage IIa users should ignore sections describing idle control and ignition control****

*****Important - this tuning manual should be used in conjunction with the 034EFI ECU manual and other “Support Documents” provided. These documents address different aspects of the product and thus should be used in conjunction.***

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Installation Considerations

Sensor Requirements

The 034 Stage II ECU requires certain and specific inputs in order to measure, manage and output to different engine functions - including fuel injection, ignition timing, auxiliary and idle control. If the sensors used do not have the same calibration as the ECU, then the measurement will be incorrect. Below is a list of inputs and their requirements:

Water Temperature

The water temp sensor should be a GM specification or what your dealer provides. Resistance should be 2700ohm @ 25° C or room temperature. The sensor should be installed in the cylinder head water jacket return “ to the cooling system” area as an accurate gauge of engine temperature.

Air Temperature

The air temp sensor should be a GM specification or what your dealer provides. Resistance should be 2700ohm @ 25° C or room temperature. The sensor should be installed after the intercooler in turbo charged application or after the air filter in the intake system in normally aspirated applications.

Throttle Position

Any standard 3-wire TPS will work with the system and should be wired as according to the connector wiring pin-out chart. The two outside pins will determine if the TPS reads from closed to open, or from open to closed. The sensor should be wired to reflect a closed position at idle and an open position at WOT (wide-open throttle). Not all sensors will register across the full range of the TPS matrix, this is normal, and the ECU can compensate for this. TPS Blend is intended for idle and part throttle fuel mapping only, especially in applications with abnormally low vacuum (more than 80kpa at idle for example). Also, if the polarity of the TPS is reversed, this can be “flipped” in the configuration screen for Engine Setup so no rewiring is necessary.

Oxygen Sensor

Narrowband

Standard narrow-band or wide-band (0-1v) sensors should be used with the system. Though a 1-wire or 3-wire sensor can technically be used, it is highly recommended that a 4-wire sensor be used for the highest accuracy and most reliable signal. The narrow band O2 sensor voltage curve has been developed for a specific NTK-style sensor available through www.034efi.com, for the more accurate closed loop programming, this sensor should be used. Universal Bosch style sensors work well also. Though the narrow band sensors can be considered more inaccurate when compared to the wide-band (0-5v) sensor, it will provide a very good feedback loop for tuning and closed loop operation (too rich, too lean, or stoich). The sensor should be placed relatively close to the exhaust source, typically after the exhaust manifold and turbo (if used). If a location further down

the exhaust is required, the use of a heated 4-wire sensor will ensure that the sensor is properly heated for an accurate signal.

Wideband

With the advent of affordable Wide Band O2 kits, Wide Band accuracy can now be implemented with any of the systems.

If the kit you have provides a “translated 0-1v output” such as those provided by www.innovativemotorsports.com, this can be fed directly into the ECU to replace the narrowband 0-1v input. Note that the 0-1v output may need to be calibrated to ensure the EGO values of the controller and 034efi ECU are the same (the shape of the voltage curve). Follow the wide-band manufacturers instructions for calibration. Also consider the Innovate Motorsports LC1 which allows wide band accuracy for 034EFI standalone systems, for under \$200.

By far the best and most accurate closed loop EGO options is to run the standard 0-1v linear EGO curve out of the Innovate directly into the 034EFI EGO circuit. Voltage relative to Lambda ($\text{Lambda} = \text{a/f ratio} \div 14.7$) can be fine tuned under the Configuration>Closed Loop Setup>EGO Type field of the tuning software. For example, Innovate systems default a 10:1 a/f at 0v, and 18:1 at 1v, thus Lambda values of 1.224 (18@14.7) at 0v and .680 (10@14.7) at 1v would be a good starting point.

Timing Phase Angle Reference (TRGIDX)

The Stage II systems can use one TDC timing reference for camshaft position. Though this signal is not required for simple sequential function, for true valve-timed sequential function this timing reference should be used, even for waste spark applications. Coil on plug systems must determine the correct phase (intake or exhaust stroke) when the engine starts, and unless each coil is fired on both phases, a TDC trigger is required. Thus the user can calculate individual fuel injector activation based on a camshaft trigger reference. Any proper hall-sender will trigger off a steel pin mounted in the cam gear pulley or even off of a camshaft lobe for example. This is a 5v output.

The Stage IIc system is degree based, thus injector firing can be determined in degrees from TDC. Thus, the only need for the timing reference is for starting, the TRGIDX lets the ECU know which TDC cycle is the compression stroke, not exhaust. This input can be deleted, however, as the ECU has a 50% chance of determining this on its own. A backfire could result in the occasion that it does not find the correct cycle, the ECU should simply be powered down and back up and another attempt will likely result in a start. Once the ECU determines the proper cycle, this input is no longer used until the next starting. If a suitable TrigIDX cannot be supplied, then coils should be fired on both intake and exhaust upstrokes of the engine in “wasted spark”.

RPM Reference (VRA/TRA)

The Stage Ia/b and IIa/b ECU's will trigger off most factory-type, distributor hall senders with 1-trigger event per cylinder. Proper function will depend on the correct number of trigger-windows (one for each cylinder typically) and the proper rotor phase angle in relation to hall sender. In order to determine this, the hall sender should be lined up with the leading edge of the trigger window (as it transitions from steel to air) as the rotor is lined up with the contact trigger in the distributor cap. Typically this can be adjusted by moving the rotor in relation to the hall sender in most applications. This may require re-keying the distributor rotor onto the shaft of the distributor, or re-bonding the rotor onto the shaft in the correct position.

The unit can also be triggered off of pins on a camshaft reference wheel. Pins (one for each cylinder typically) can be mounted in the cam-gear, for example, as in the timing reference signal. Unless a proper RPM signal can be established, the ECU will not inject the correct amount of fuel or activate the fuel pump trigger, etc. A distributor with vacuum and mechanical advance can be used when the hall sensor inside is calibrated (as per above), and the jumpers set inside the ECU # J-4 & J-3 to H (hall sensor) or V (VR or Variable Reluctance), depending on the sensor inside the distributor.

The Stage IIc ECU requires a crankshaft mounted toothed wheel to trigger RPM. Due to newer factory (Audi, BMW, Porsche, etc) and Bosch applications running a 60-tooth wheel, the current ECU is compatible with a 60 minus-two tooth wheel, actually 58 teeth - more applications will be developed in the future (Also supported 60-1, 36-2, 36-1, 24-1, 12-1). Missing teeth tell the ECU that TDC is coming, the # of teeth between TDC and the missing teeth is configurable inside the ECU under Configuration>Engine Setup. The "C" ECU will run either a Hall sender or VR sender, to determine which sensor should be used, contact the dealer or specify at the time of order. If you have any doubt that you have the right ECU, jumpers on the ECU circuit board can be moved to correct "VR" or "HS" positions (see below). Mounting of either sensor is critical, and should meet the following criterion:

- The mounting bracket must be VERY rigid, if it is moveable by force of the hand, then the bracket should be strengthened.
- The air gap target range for hall senders should be in .02 to .04", for VR senders should be approximately .05". When using a VR sensor, if a miss or backfire is detected, the airgap may be too small, or the missing teeth may not be low enough, contact your dealer for technical advice (see below)
- Runout for the toothed wheel should be less than .003", excessive runout will cause the ECU to lose its reference and may result in a backfire miss or complete loss of spark.
- Wheel material should be magnetic steel and very rigidly mounted.
- Hall or VR sensor wiring must be shielded and routed away from any injector, coil, or alternator wiring, never loop or coil wire as this creates electro-magnetic waves that cause electrical interference.
- Internal jumpers MUST BE CORRECT (J-3 & J-4) when using a VR sensor as opposed to Hall Sensor, ensure that both jumpers are changed, and that

any board protective coating is removed from the board pins with a solvent on a rag. The ECU cover must first be removed (using 1/6" allen) to access the jumpers.

- Reference synch can be verified in the "Monitor" screen of the 882C software. "#Trigs" is the actual teeth being counted by the ECU, "#Cam" is the number of cam TDC references being counted, "Wdbg" is the calculated # of teeth the ECU reads per revolution, thus, if a 60 minus-two wheel is being used, the ECU will count 58 teeth and the 2 missing teeth as one tooth, thus a "59" should be observed. If this value varies AT ALL, EVEN THE SLIGHTEST, then there is a synch error, and the VR sensor and air-gap and wiring should be verified. "Cdbg" is the ECU's calculated cam triggers; this value should be steady as well, never changing.

Output Component Requirements

The ECU creates electronic output signals to several components. To ensure proper operation, these components should be of the proper specification:

Electronic Injectors

For proper operation all Electronic "solenoid style" injectors can be used. These should measure approximately from 2-14 ohms. Sizing should be determined by the user or with the assistance of your dealer. 034EFI uses the most powerful 8 Amp injector drivers on the market, current draw per injector can be calculated using the formula:

Amperage = Voltage ÷ Resistance

-Thus, a 4 ohm injector will draw 3.5 Amps at 14 Volts, well within the capabilities of the 034EFI Injector driver current.

Idle Air Control Motor

For proper operation the user should source the dealer specified IAC. Though this IAC appears to be standard "GM", there are many different units with different pin-outs. To avoid confusion and mis-operation the proper unit should be sourced from your 034EFI dealer. Also, some 2-wire PWM idle motors can also be used driven off one of the GPO's.

Fuel Pump Relay Trigger

The unit will trigger ground to any standard 12v relay via one of the GPO's. The fuel pump should always be triggered via a relay, as the output has not been designed to support the amperage required by a high output fuel pump, and battery voltage and current will allow the pump to work at maximum and consistent flow. Using a Bosch relay, pin 86 will be supplied switched 12v+, Pin 85 will be the GPO Ground trigger, pin 87 will supply ground to the fuel pump, pin 30 will go to chassis ground. The fuel pump will be supplied with constant ignition switched 12v, and will run when the relay closes to provide chassis ground to the pump.

Other Component Installation Considerations

Fuel Pressure Regulator

Any manifold referenced fuel pressure regulator can be used to regulate pressure to a minimum of 3 Bar or 40-45psi (typically the lowest operating pressure for EFI recommended). An adjustable regulator is recommended, though not required, for an added level of tune-ability. DO NOT use a rising rate regulator as they are unnecessary and will render many of the delicate volumetric efficiency algorithms useless.

Fuel Pump

There are many considerations for the system fuel pump. Typically a fuel pump provided originally on any EFI equipped or Bosch CIS (Continuous Injection System) will provide good flow at the lower EFI pressures. Carburetor pumps are NOT suitable for the 3-7BAR pressures required by EFI. If an upgraded pump is needed, CIS pumps came OEM on many VW, Audi and other European cars and provide excellent flow for up to 500HP. To determine proper fuel pump capacity fuel pressure should be monitored under max output. There are also many aftermarket options as well. Also, be hesitant to crank fuel pressure to remedy injectors that are too small, fuel pump flow drops proportionately as pressure rises, keep pressure as low as possible while maximizing fuel injector size.

Boost Control

Boost can be controlled by manually manipulating the pressure signal to the wastegate or by using an outside electronic boost controller. Currently the ECU will control boost pressure to a wastegate via one of the GPO channels (General Purpose Output). Many different strategies can be applied, but most will involve pulsing a frequency valve to bleed or modify the wastegate pressure signal. This can be mapped via a GPO using various parameters. NOTE: If the range of the frequency valve is very limited using the GPO output (ie: only works between 60 to 70%), insert a 50-100V, 3-5 amp Diode across the solenoid terminals to increase its effective range. The Cathode should go to the Power side, the Anode going to the groundside (ECU output)

Tachometer

A standard tachometer output, high side (12v plus), is provided in the ECU that can be connected to the factory or aftermarket tachometer input. Note that the tachometer will operate independently from the "tach full scale" setting in the ECU software. Also, older tachs originally triggered off the coil negative side may not function properly as they run off high voltage spikes and high current. Contact your dealer for more information.

Ignition Coil

Most factory type and aftermarket ignition coils can be used with the ECU since the ignition output is configurable. If there is any concern with coil compatibility, any of the standard MSD coils will work well such as the MSD-8203, 034Motorsport also stocks a full line of custom, high performance coils for virtually

any application. Very high boosted applications will require the highest quality coil available; experimenting with some different models will prove the best results.

For the “ C “ system, most factory type coils can be used, all 2-wire coils are compatible, most 3-wire will be that have a ground. Most 4-wire coils that contain an integral driver can also be supported by 034EFI ECU's, contact your dealer or 034EFI for more information. The 034EFI can supply the proper ECU with drivers (different hardware) that can fire newer coils - email contact@034motorsport.com for more information.

Ignition Components

Standard factory type or aftermarket replacement parts will work well in distributor and spark components (such as Ignition wires, plugs, etc)

OEM idle motors

Standard factory type idle motors will work driven by the GPO, especially in the 3-D mapping portion of the Stage Ic and Ilc ECUs. 2-wire motors are only compatible, and can be pulsed with a PWM signal from the GPO. Typically, warm idle should be set with the throttle stop, then cold start idle rpm can be added mapped CLT x RPM to add rpm when the motor is cold.

Tuning Functions

Please familiarize yourself with the various tuning functions contained within the 034EFI "882" ECU tuning software. Each area of input gives the tuner valuable control over tuning parameters and ultimately engine control. Measurement of the engine system, careful identification of tuning deficiencies (ie: lean, overly advanced, missing, bogging, rough running, etc) and the addressing of these problem areas using the proper tuning function will make engine tuning effective, simple and rewarding.

NOTE - There are several types of input fields used in the ECU interface software to setup your maps/configuration. These can either be:

1 - Direct input field, what you enter is what you get. For instance in the Phase Configuration screen there are boxes to enter the degree of crank revolution where you want an event to occur. This field has no other modifications done to it, what you enter in here is the exact value you're working with.

2 - Multiplier fields, these fields are a value that multiplies another value by a set amount. For instance, if you enter 1.5 in a coolant enrichment multiplier field, this will multiply the current injection pulse width by 1.5. These numbers generally can range from 0 to 2.0, unless otherwise noted.

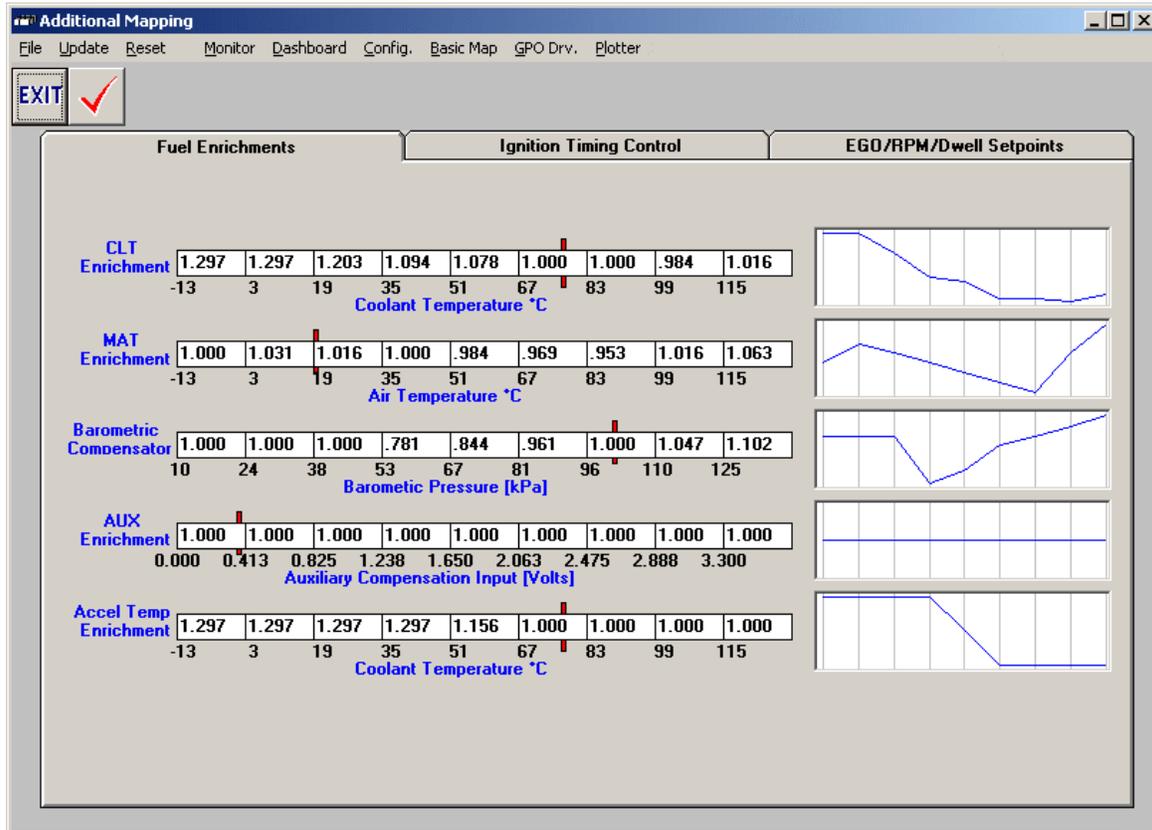
3 - Offset fields, these are used to add or subtract an amount to a variable. Commonly used in the timing maps where you want to subtract or add timing based on map pressure.

NOTE - 034EFI is not responsible for damage of person or property as the result of tuning any of its Engine Management Systems. Users tuning the system accept full responsibility of the result of tuning and running the system.

Additional Map Tuning

Additional Map tuning are supplementary tuning functions to the Basic Mapping screen. Compensation for EGO (Exhaust Gas Oxygen), air and water temp, and all ignition maps are programmed here. The Additional Mapping Screen contains 3 tabs with different tuning emphasis, described below:

Additional Fuel Enrichments



Though the base fuel map is set in Basic Mapping, certain conditions require the “base fuel map” to be augmented with Additional Fuel Mapping.

CLT Enrichment

This map allows a fuel multiplier to be applied to the base fuel calculation based on coolant temperature, this is mostly useful for tuning the fuel curve on initial start up to overcome fuel condensation in the ports due to cold temperatures below running temp. This field does NOT tune “Cold Start” per se, that is the function of the Configuration>Powerup/Options>Cold Priming values. CLT Enrichments modify base fueling, depending on coolant temperature.

MAT Enrichment

This map allows a fuel multiplier based on air temperature, mainly to compensate for the increase in the density of air at lower temperatures, and visaversa. If the

engine us running on a “good tune” and air temperature fluctuates dramatically, use this field to compensate for any fuel curve changes.

Barometric Compensator

This field allows a fuel multiplier based on barometric pressure as a result of elevation change. Typically, add more fuel as elevation decreases, take away as elevation increases.

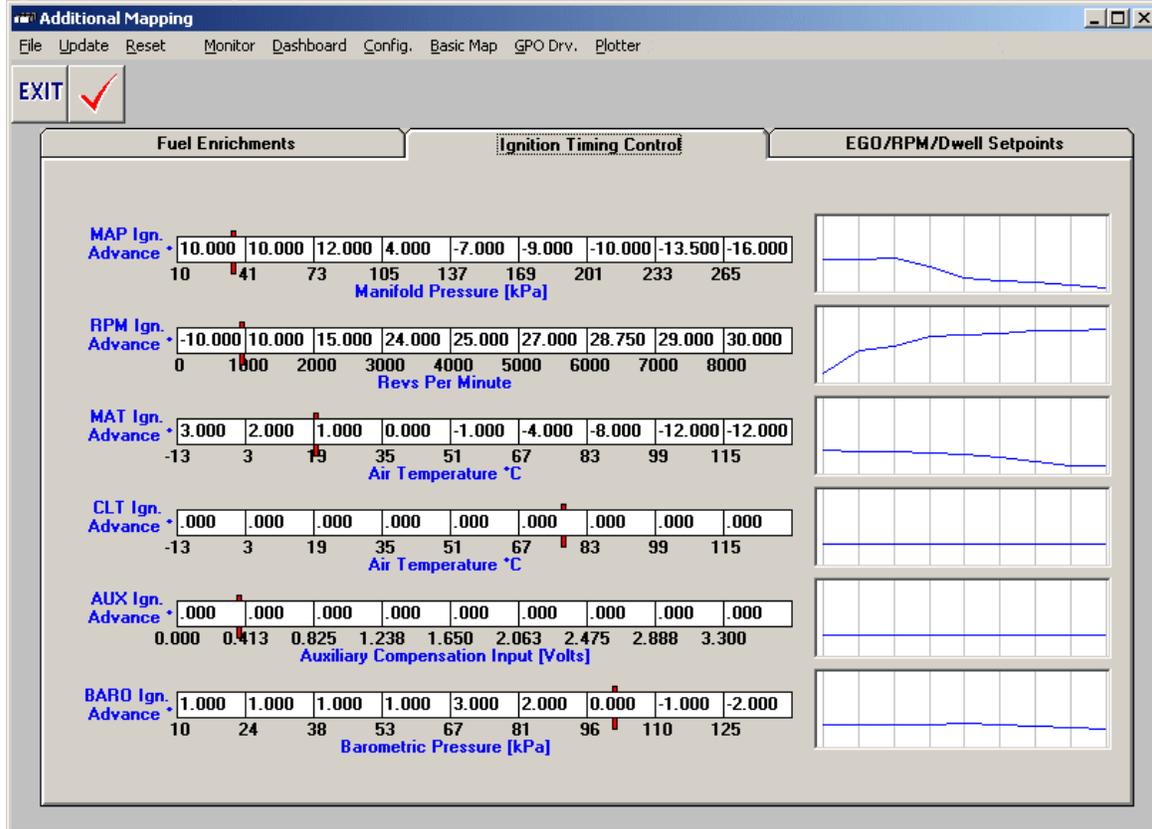
AUX Enrichment

This field allows a fuel multiplier based on the auxiliary 0-5v input, or is used by the launch control/anti-lag system for triggering when aux input voltage rises or drops below 1.67 volts.

Accel Temp Enrichment

This field gives multipliers that modify the Accel Max PW value under the Configuration>Acceleration Enrichments field. Cold engines require more acceleration enrichment, thus adjustments can be made based on coolant temperature.

Ignition Timing Control



This tab allows most “mass” changes to ignition timing and the definition of the base ignition timing curve/s. Use the below maps to create conditional timing curves.

MAP Ign. Advance

This map sets an ignition curve based on manifold pressure or engine load; this is especially useful for forced induction applications where timing retard needs to be added under specific boost pressures. This map is not as useful for NA applications where the base timing curve should be augmented mostly with RPM, not Manifold pressure, however, it is useful for small timing changes based on load of the motor. Always set the base timing curve using RPM, only using MAP to augment the curve as influenced by load.

Note the graphical representation of each map series, this, again, can be used to verify any problems in mapping, for example if accidentally 8 degrees of advance are entered under full boost instead of 8 degrees of retard! Always visually verify tuning changes before implementing them to the actual running engine.

RPM Ign. Advance

This map will allow the base timing curve to be set across RPM to allow the engine to accelerate, most motors require a “curve” across rpm, where timing at idle is lower, advanced at part throttle, pre-torque-peak, retarded across the torque-peak, then advanced again to redline after the torque-peak. Don't forget

that the field value applies to the left hand side of the cell, thus a 20d retard in the 0-1000 field would result in -20 at 0 RPM, and interpolated across that field to 1000 RPM with the value in the cell to the right. This allows very fine-tuning of the curve and the use of different strategies.

MAT Ign. Advance

This field allows ignition timing advance or retard due to varying air temperatures of the induction system. Typically, lower than normal temps will allow some advance, and retard as temps increase. (Note: "B" ECU's can only retard timing from some set mechanical advance).

CLT Ign. Advance

This field allows timing changes based on coolant or engine temperature, this is especially helpful by allowing some timing advance when the engine is cold to raise idle speed, or to retard timing to allow the engine to warm up faster. It can also be used as a safety device on engine over or under heating.

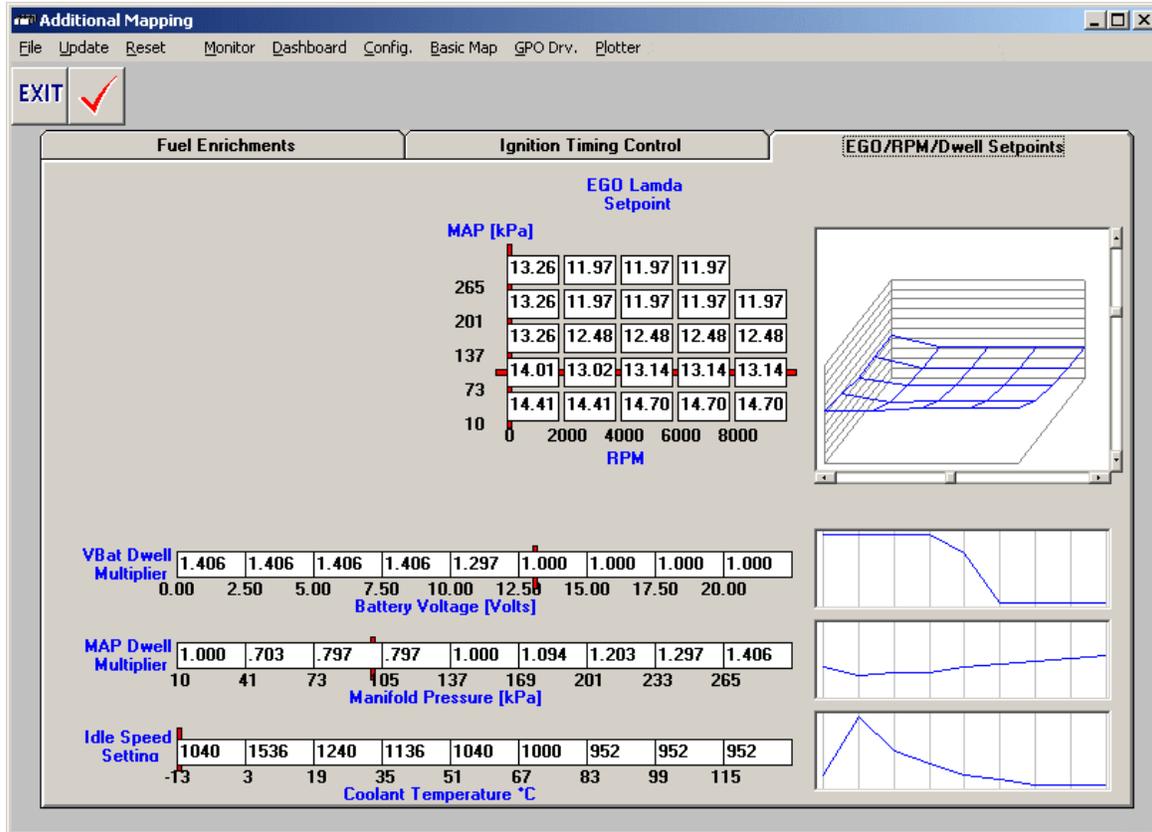
AUX Ign. Advance

This field allows timing changes based on Aux input voltage, it is especially useful for timing augmentation when used with turbo anti-lag strategies or even use with Nitrous.

BARO Ign. Advance

This field allows ignition timing advance or retard due to varying barometric pressures, due to mass elevation changes.

EGO/RPM Setpoints



EGO Lambda Setpoint Table:

This 3-D map allows the preferred EGO value to be entered into a matrix of RPM and Pressure. The closed loop fuel control system will use this map in the fuel feedback it provides.

Vbat Dwell Multiplier

This feature provides a multiplier map for the base coil dwell setting based on input voltage, typically, as voltage drops, dwell can be increase to compensate for lost spark energy due to lower coil input voltage.

MAP Dwell Multiplier

This is an extremely valuable feature for heavily turbocharged engines that can develop an ignition miss under very high combustion pressures. The value in the cell multiplies the base Dwell setting (under Configuration Ignition Parameters) to change with varying MAP values. Thus, at idle and part throttle conditions, a minimal, suitable amount of dwell can be used, since that's all that is required. However, under heavy boost, coil dwell can be multiplied for longer and longer periods to keep spark firing under the high combustion pressures. This also helps protect the coils from saturating or burning out, preventing the maximum coil dwell setting under all conditions.

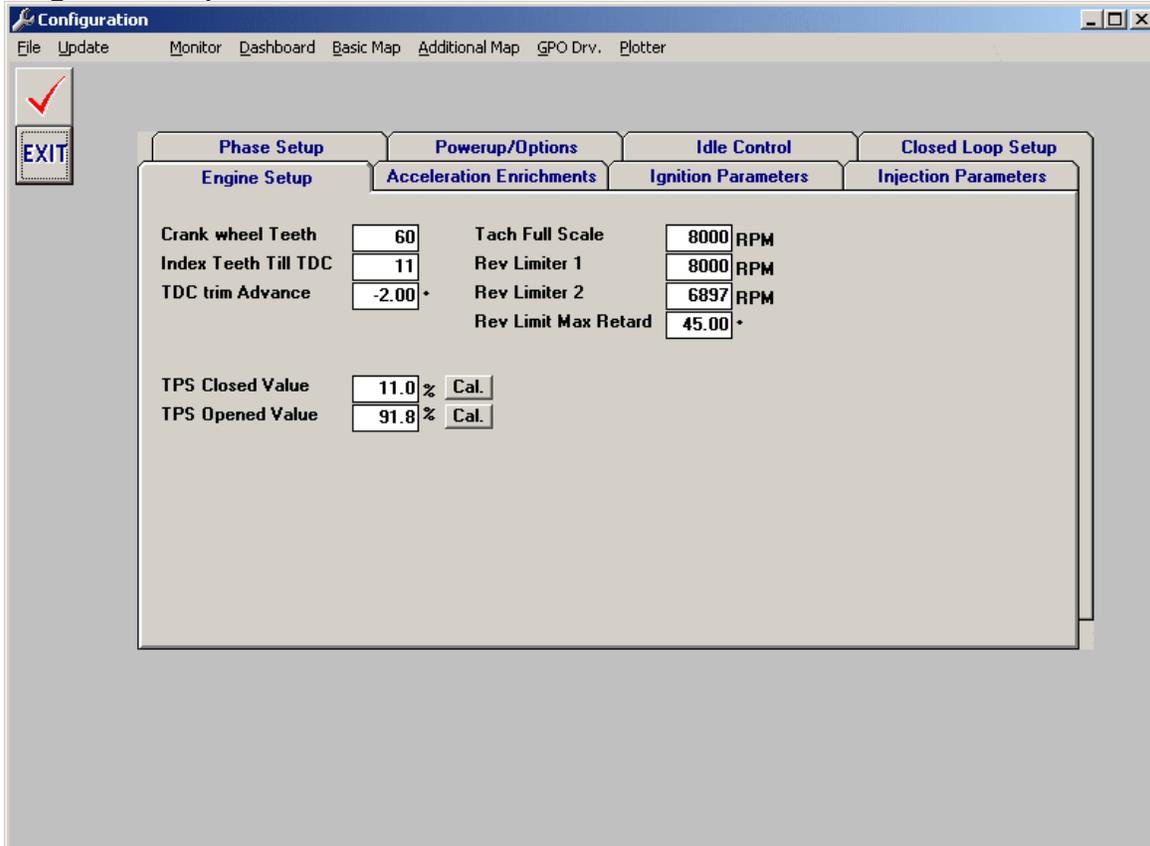
Idle Speed Setting

This is set in the 2-D map screen under “Idle Speed Setting”. It is quite straightforward, idle speed is set according to water temperature. Colder temperatures may require a higher idle speed and can be entered here. NOTE: This feature only modifies the control parameters of Configuration>Idle Control, unless the closed loop idle circuit is being used, changes to this field will not change idle speed.

Configuration Screen Tuning

The Configuration Screen features 8 separate tabs for tuning basic settings of the ECU

Engine Setup



Crank Wheel Teeth

The number of crank wheel teeth is entered here for the VRA input crank tooth profile. Currently supported tooth profiles are: 60-1, 30-2, 30-1, 24-1, 12-1 and LS1. For custom applications, please contact 034EFI to discuss.

Index Teeth Till TDC

The # of teeth between the missing teeth and actual engine TDC position are entered here.

TDC Trim Advance

Running the "C" system will also require trimming off any ignition error in the "TDC trim Advance" field. By clicking the "Set timing to 0" field in the Dashboard, a timing light can be used to determine the actual timing error between what the ECU is calculating and what the motor is actually getting. This can effectively be reduced to 1/4 degree or less.

TPS Closed and Opened Values

These fields allow the tuner to set 0% and 100% throttle position, simply position the throttle at either the Open or Closed value and click "Cal." For the appropriate field. If TPS reads backwards, it can easily be flipped by entering opposite values.

Rev-Limiter settings: "C" ECU's include a highly advanced rev-limiting circuit to ensure safe, precise limiting of RPM. The Rev-Limiter is a "dual stage" configuration, first pulling out a pre-programmed amount of timing, then shutting off fuel and spark once timing retard has been realized. Though there are 2 Rev-Limiters included in the Configuration screen, Rev-Limiter 2 should be used to limit maximum engine RPM (fuel cut) due to the electronic design of the circuit. The first stage is timing retard only, typically all that is needed to suppress the torque output of most motors is bringing timing back to before 0 degrees. Thus, if 20d of advance exist at full load and RPM, then -50 degrees for the Rev-Limiter will be enough to slow the motor down before the second stage fuel cut of the Rev-Limiter is realized. The second stage of the Limiter is a fuel and ignition cut, which shuts off power to the injectors and coils - which prevents any fuel/spark from taking place.

The rpm window in which first the timing retard is applied, then the fuel cut, is determined by the formula below, and is dependent on the full scale tach being used:

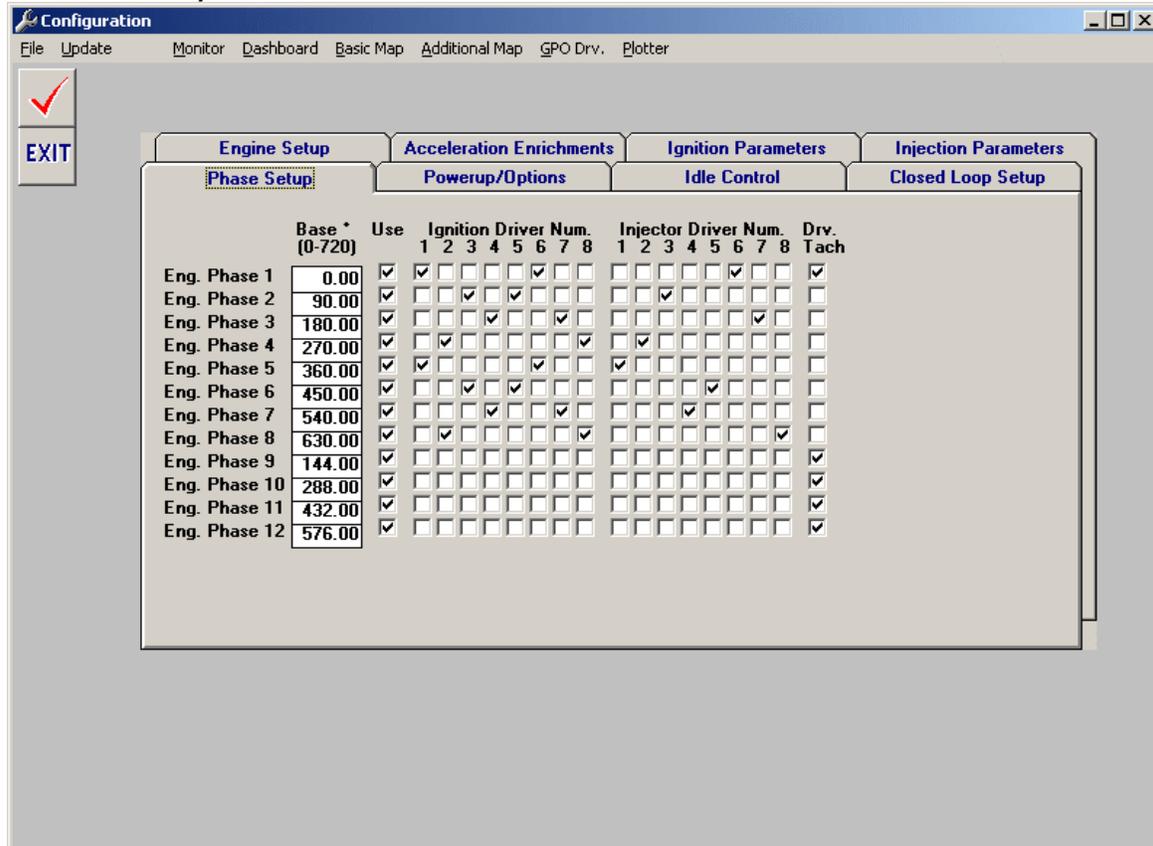
```
soft_rev_rpm_start = rev_limit value entered
RPM_FS=Full Scale Tach RPM
soft_rev_rpm_end = "rev_limit 1" + (.032 * RPM_FS)
hard_rev_rpm = "rev_limit 2" + (.04 * RPM_FS)
```

Thus, the timing retard will be manifest over a range of rpm up until the fuel/coil cut. For example, using round numbers, if a tach full-scale of 10000 and a rev limit of 8000 are entered, the soft rev limit begins from 8000 rpm to 8320, with the hard cut at 8400 (as dictated by the formula above).

Also, it is important to note that for proper max RPM rev-limit function, both Rev Limiter 1 and 2 should be entered as the same value, unless Anti-Lag/Launch Control is being used (described below under the "Additional Tuning Considerations" section).

NOTE - TACH FULL SCALE MUST ALWAYS BE LARGER THAN THE REV LIMITER VALUE, OTHERWISE THE ECU WILL NOT CALCULATE ANY REVLIMITER.

Phase Setup



The configuration of the ignition and fuel drivers must be set up to ensure the right coil and injector fires on the right cylinder at the right time - this feature is what separates 034efi systems from much of the other product offerings on the market, which don't allow any flexibility in this area of tuning. For example, many systems are setup with "hard programmed" firing orders and cylinder #'s, meaning only a 4-cyl ECU can be used on a 4-cyl and cannot be configured differently. This is done by determining engine phase degree timing and correlating this to the proper driver.

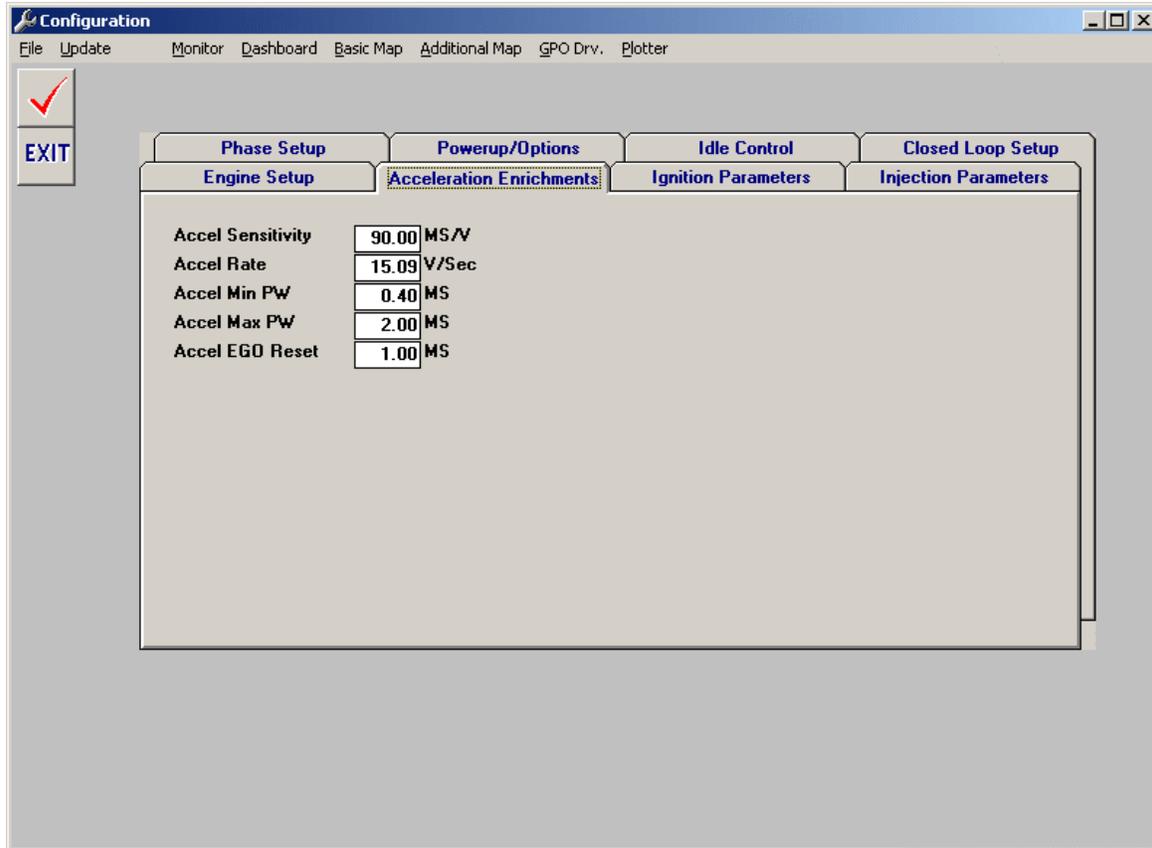
Drivers must be setup for 720 degrees of crank rotation, usually degree separations are calculated by dividing 720 by the # of cylinders. To calculate the degree breaks for each phase of a sequentially fired engine, divide 720 degrees by the number of cylinders.

The example below shows a typical 8 cylinder (with a firing order of 1, 2, 3, 4, 5, 6, 7, 8), with injection firing 360 deg off from ignition. Using the Base degree individual cylinder timing trim can easily be accomplished as well by adding or taking away degree timing from each phase. Because the ECU can be set up with "virtual phases", and the ECU determines RPM by the # of active phases, driver tach check marks are provided to ensure accurate RPM readings.

Drv. Tach

is used to include a given phase in the tachometer calculation, thus even a 4 cyl. Tach can be run off a setting for a V8 motor.

Acceleration Enrichments



When the throttle is quickly engaged the motor is challenged to accelerate as a large amount of air enters the intake manifold. Thus, a corresponding amount of fuel must be injected to feed this demand. Acceleration enrichment is tuned in the Configuration window. The 5 fields determine the acceleration fuel PW, and are described in the ECU Manual. Careful tuning of these parameters will ensure fast engine response to acceleration conditions and smooth drivability. Use the settings described below:

Accel Sensitivity

Sets the amount of throttle opening enrichment. Higher numbers gives more fuel when the throttle is opened rapidly. Use values of 10.0 or greater

Accel Rate

Sets the length of time that the acceleration enrichment will operate. Lower numbers will give longer enrichment times. Use values of 5.0 or greater.

Accel Min PW

Sets the minimum calculated acceleration pulse width that will be used. This prevents small throttle changes from causing unwanted enrichments. Larger numbers will give lower emissions, but poorer response.

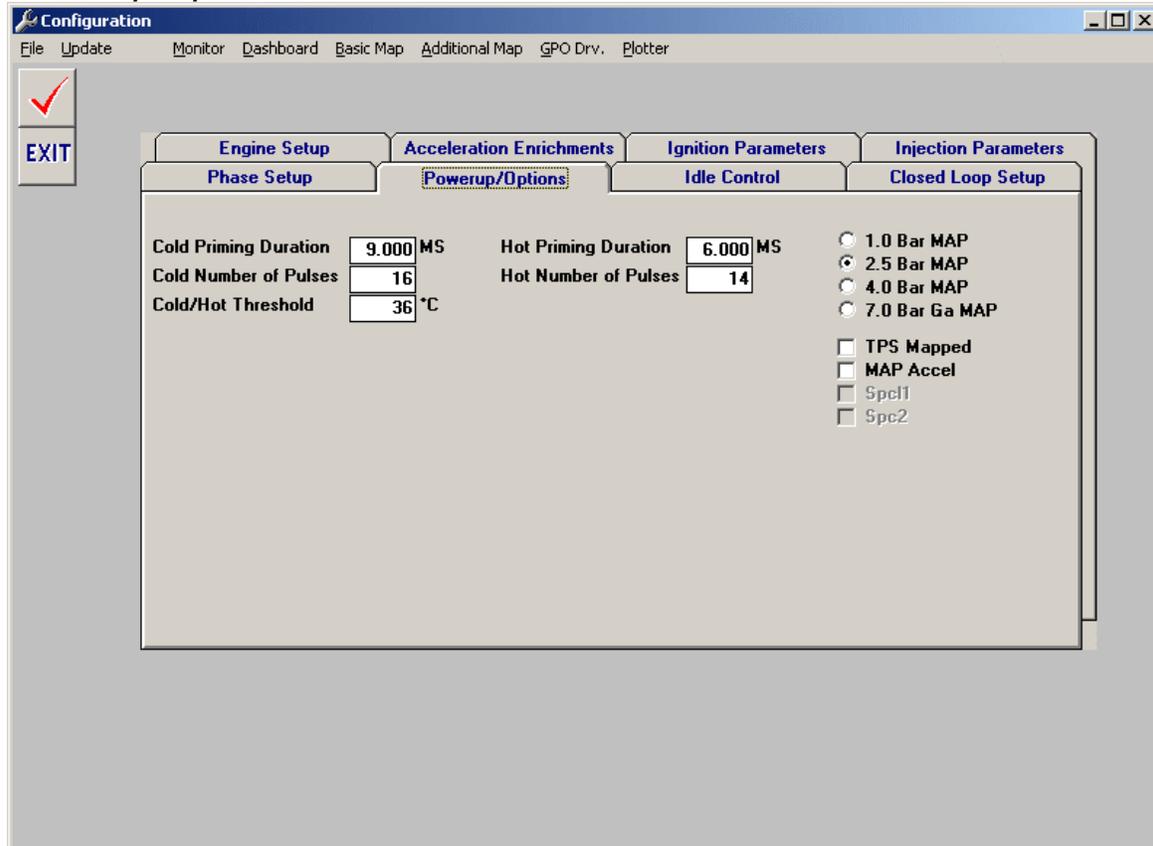
Accel Max PW

Sets a limit on the amount of acceleration enrichment that can be used. Larger numbers will allow higher enrichments.

Accel EGO Reset

Sets the amount of enrichment that will disable then reset the closed loop (EGO operation). Lower numbers will reset the EGO algorithm and prevent closed loop operation during transients. Setting this value too low can cause problems with normal or static closed loop operation.

Powerup/Options



Cold/Hot Priming Duration

The length or pulsewidth in milli-seconds of fuel to be injected for priming.

Cold/Hot Number of Pulses

Number of a set injections can be programmed to fire as the ignition is turned on for priming the engine with fuel for startup. These parameters should only be tuned when cold or hot starting. Typically it takes quite a bit of fuel to get a motor started, don't be afraid to use a lot of fuel here if necessary (5 pulsed of 9.0 for example).

1.0, 2.5, 4.0 or 7.0 BAR MAP

These values calibrate the ECU to the proper MAP sensor that is being used, this should be pre-set from the factory, if any changes to the MAP sensor are made, they can be adjusted here.

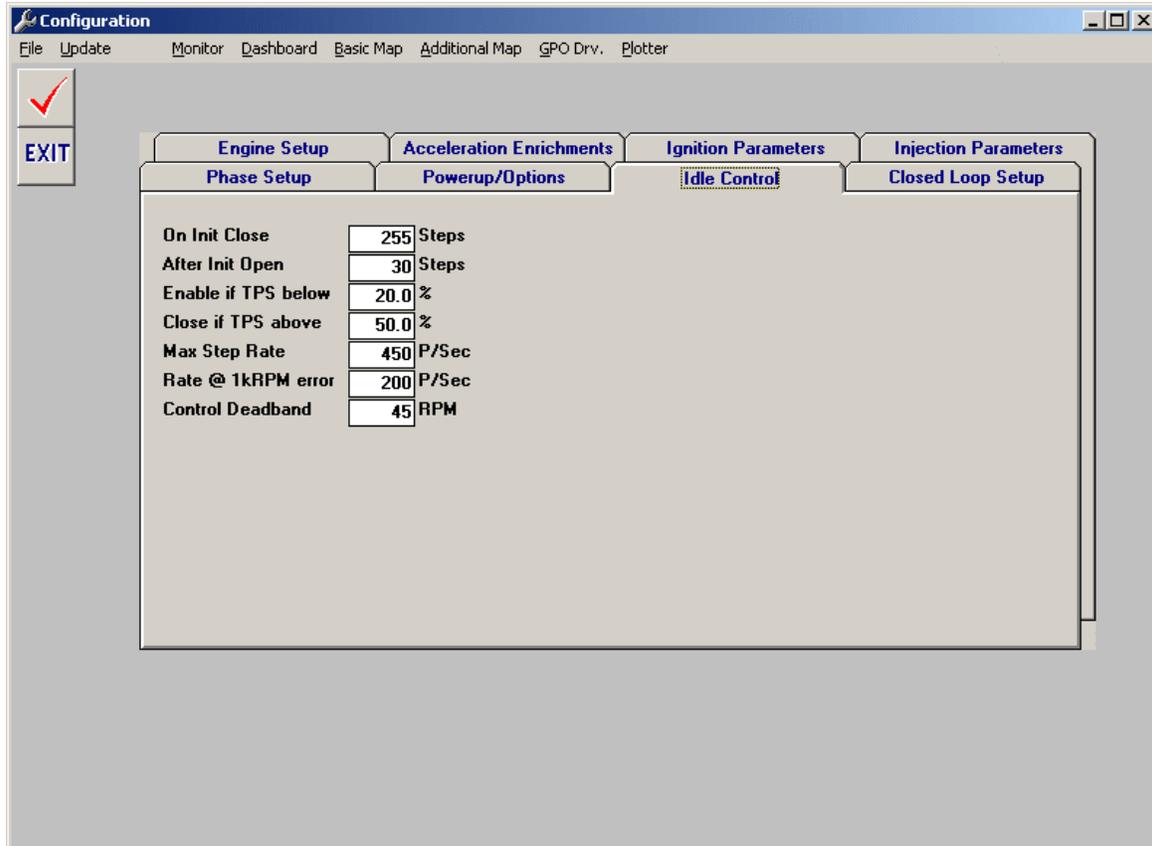
TPS Mapped

The basic mapping screen, by default, is set up with MAP on the Y-axis, this can be changed to TPS or Throttle position in the event where intake manifold vacuum is so low that its not useful. As long as the motor makes less than 75kPa at idle, leave the default setting.

Map Accel

In the event that a TPS Sensor is not available, acceleration enrichments can be set up using the MAP Sensor output.

Idle Control



The ECU uses a “GM Style” idle air motor. This is a stepper motor and controls the throttle-body-bypass of air by stepping a plunger in small increments, thus giving it great accuracy and control. If tuned properly the ECU will control this motor as accurately as any factory type system. IAC Parameter explanations below.

Note: a standard Bosch 2-wire idle motor can also be used in conjunction with one of the GPO drivers as well to accomplish “cold idle air” function, set up on a base map of CLT and RPM. Once the motor is warm, the warm idle can be set with the static opening of the throttle body.

On Init Close

The IAC will close this many steps on startup. This value should be more than the After Init Open parameter. Should also be less than 250 because the IAC stepper only seems to have 200 to 300 total steps from closed to open. This parameter ensures the IAC is fully closed upon startup and gives a repeatable reference point for the IAC to work off of.

After Init Open

This is the target IAC position to start the car. The IAC will open this many steps. This will depend on your throttle stop setting, the lower the throttle-stop-idle setting you have the more steps will need to be opened to enable the proper idle

speed. It is generally recommended that the throttle stop be set to give good idle speed with an After Init Open value of about 100.

Enable if TPS Below

The IAC is only adjusted when the throttle is closed. It detects that the throttle is closed when the TPS value is less than this parameter. If the closed throttle reading “on the monitor” says 15%, set the Enable if TPS Below to 17% or so. Do not make this value too close to the TPS closed point or temperature or small mechanical changes will haunt idle performance. Set to 0% if it’s desired to disable the IAC adjustment.

Close if TPS is Above

The IAC will quickly and automatically close if the TPS goes above this value. This will keep ensure from loosing boost out of the IAC. When the TPS drops below the “Enable if TPS Below” value, the IAC will reopen to the “After Init Open” position, and idle will resume. Set to 101% to disable IAC closure, like if there are problems with stalling on throttle closure. Generally on boosted motors this value should be set close to 40% or the throttle point where real boost begins to build.

Max Step Rate

This sets the speed at which the IAC is stepped when during Init, and sets the max rate that it will ever be allowed to step. Generally most IACs won’t move properly for values above 500 “Hz”, so be careful. This value shouldn’t be set too close to the IACs capabilities because it may not work at higher temperatures or under some boost conditions when the IAC is loaded more.

Rate at 1K error

This sets the speed that the stepper will move as a function of the error between the actual engine speed, and the speed set point table in Additional Mapping. Any value in here is generally fine since the ECU will never try to move the IAC faster than the Max Step Rate value. This parameter controls how the idle stability versus correction speed compromise is made. If the value is too high, the idle will oscillate or bounce, too low and the engine speed adjustments may be sluggish or stall the engine before the adjustments can be carried out. Start with small numbers 20 or so, then move up to higher values until there are stability problems, then divide the number by 2.

Control Deadband

This sets the minimum error in RPM that must exist in order for adjustment to be performed. Setting it to 50 with a RPM set point of 1000 would disable IAC corrections from 950 to 1050 RPM. If this value is set too low, the idle might oscillate - also the IAC may overheat if it is continuously adjusted when with only trivial errors in idle speed.

Injection Parameters

Parameter	Value	Unit
Battery Offset Time	60.8	µsec/V
Engine Decel	18.0	kPa
Max TPS for Decel	1.2	%
Max/Cut Pressure	245.1	kPa

Injector Channel	Main Gain	Idle Trim	P.W. Clamp
Injector Channel 1	1.000	0.000	MS
Injector Channel 2	1.000	0.000	MS
Injector Channel 3	1.000	0.000	MS
Injector Channel 4	1.000	0.000	MS
Injector Channel 5	1.000	0.000	MS
Injector Channel 6	1.000	0.000	MS
Injector Channel 7	1.000	0.000	MS
Injector Channel 8	1.000	0.000	MS

This screen is used to modify injection settings. The base fuel parameter is the Injector Main value in the basic mapping; however, this value can be offset cylinder-by-cylinder using the Main Gain and Idle Trim values to compensate for different cylinder combustion conditions. Certain channels can also be setup to be “staged” so that two sets of injectors can be used, one set for idle and low power conditions, and another set “staged” to turn on under boost, nitrous or a heavy cam, for example.

Battery Offset Time

This will offset the injection time based on battery voltage to compensate for fuel injector response time.

Engine Decel

is a setting for fuel deceleration shut off, under high vacuum, coasting conditions; fuel will be turned off for drivability, emissions and economy reasons. Ensure it is not set too high as to cut fuel during normal driving or idle.

Max TPS for Decel

Is used to fine tune the fuel cutoff on deceleration. The fuel will not be cut based on **Engine Decel** unless the TPS signal is below this value. Some engines can draw a large amount of vacuum under light load, this can cause a higher than desired setting for the fuel cutoff on deceleration. Using this value you can raise

the decel kPa for quicker RPM drops, and less popping/wasted fuel on true deceleration, and maintain high-vacuum drivability.

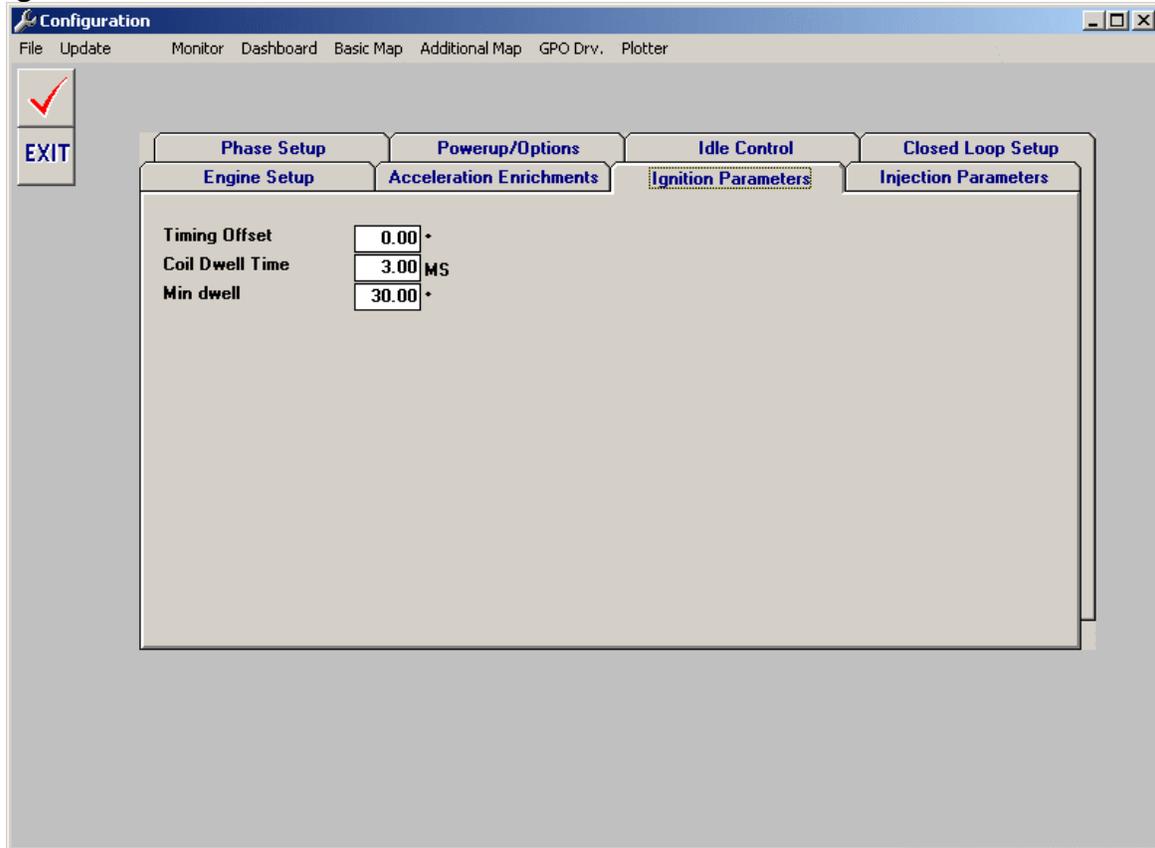
Max/Cut Pressure

This value is an 'overboost' safety measure. Any time the MAP value is above this limit the fuel will be cut to avoid engine or turbo damage.

Pulsewidth clamp

can be placed on certain channels to keep them from turning on below a given PW value. Remember, more than 1 high or low impedance injector can be run off per channel, thus in a 5 cyl application, 5 channels can be used for the main injectors sequentially, and 5 more injectors can be run staged in a batch fire mode from the remaining channels. Thus, the primary injectors can be "clamped off" at a certain PW and allow the larger set of injectors to blend it transitioning over under boost and higher power conditions. Especially useful for heavily turbocharged applications where a smooth, stock like idle is desired.

Ignition Parameters



Timing Offset

This value will globally add/subtract timing. Can be used for quick adjustments to the entire timing curve for testing or troubleshooting.

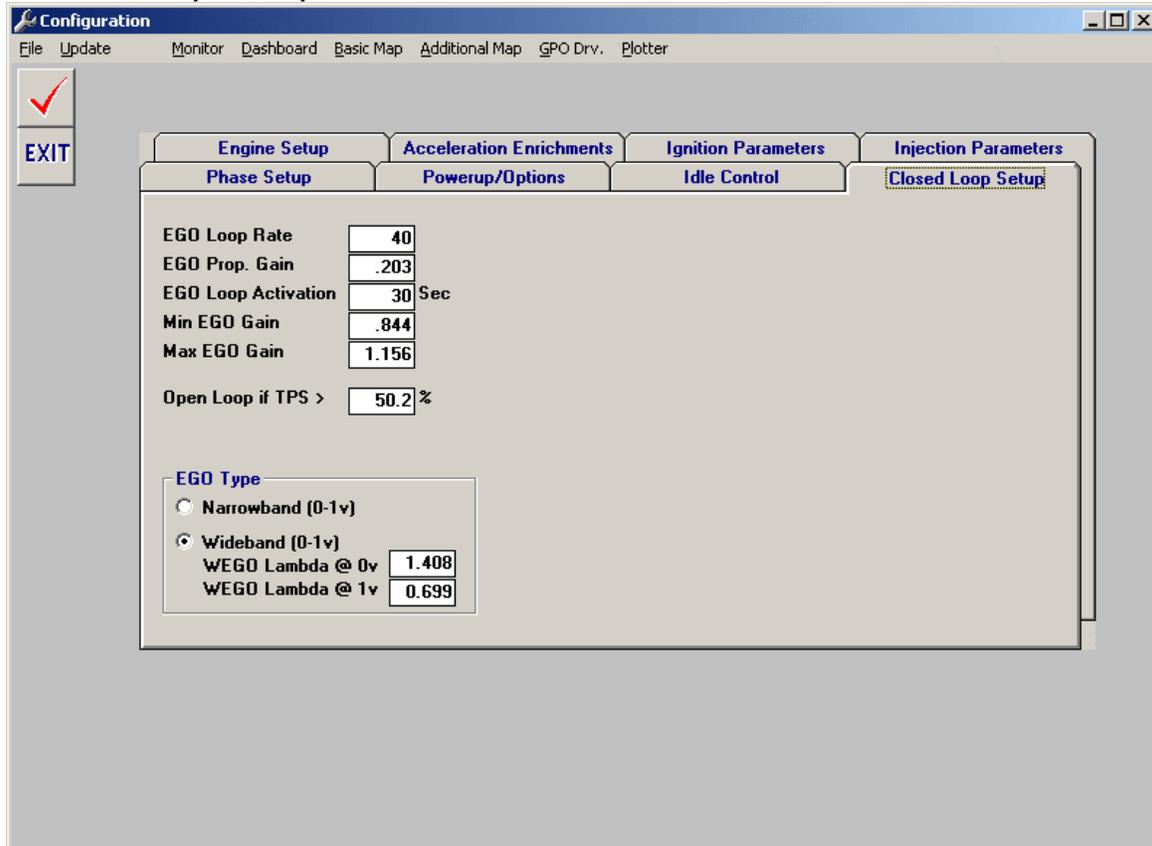
Coil dwell

This is the amount of time the coil is charged before a spark event. Typically, a coil dwell time of 3MS is safe and useable for most applications, in heavily turbocharged or ultra-high specific output motors (above 150hp/l), increases in coil dwell time may be needed.

Min Dwell

A Min dwell setting of 10-25 degrees is almost always acceptable, higher values lower the minimum dwell calculated and will ensure more spark at starting and low RPM conditions.

Closed Loop Setup



EGO Loop Rate

This field determines the speed at which the EGO loop is calculated, higher the number means the less often its calculated. The default loop rate setting is 200 times per second, the EGO Loop Rate Value divides the default setting for the calculated loop rate. For example, to set the loop rate at 10 times per second, a value of 20 would calculate $200 \div 20 = 10$ loops per second.. Generally values between 5 and 15 will give the best results.

EGO Prop. Gain

This field is the instantaneous calculated value that will be applied to the fuel parameter based upon the difference between the EGO output and the EGO set point target. This value is a percentage, for example, a value of .5 represents 50%, thus 50% of the difference between the actual EGO and the target field will be multiplied against the base fuel calculation. Thus, smaller values or "percentages" will cause a smaller change as a function of closed loop.

For example, if actual lambda is .9, and the EGO target setpoint value is 1.0, a value of .5 will multiply the difference of Lambda .1 by 50% for a value of .05. Thus, a multiplier of .95 (or a 5% decrease) will be applied to the base fuel parameter to lean it out and bring it closer to the target value of 1.0. Generally values of .25 to .75 work well, choose a value that causes gradual yet effective cycling of actual EGO around the targeted setpoint value.

EGO Loop Activation

This value determines how long it takes for closed loop function to begin once the engine is started. A value of 0 turns off closed loop completely.

Min/Max EGO Gain

These values limits the minimum/maximum EGO gain that the ECU will use, generally, if EGO gain values are too large, its indicative of a base map that is not tuned enough. Typically target EGO gain values of .9 to 1.1, of more than this is needed, chances are more base tuning is required.

Open Loop if TPS>

TPS values above the entered value will disable closed loop operation; this is useful for only using closed loop at idle and lower load conditions, and turning it off under full load where the base fuel map is well tuned.

EGO Type

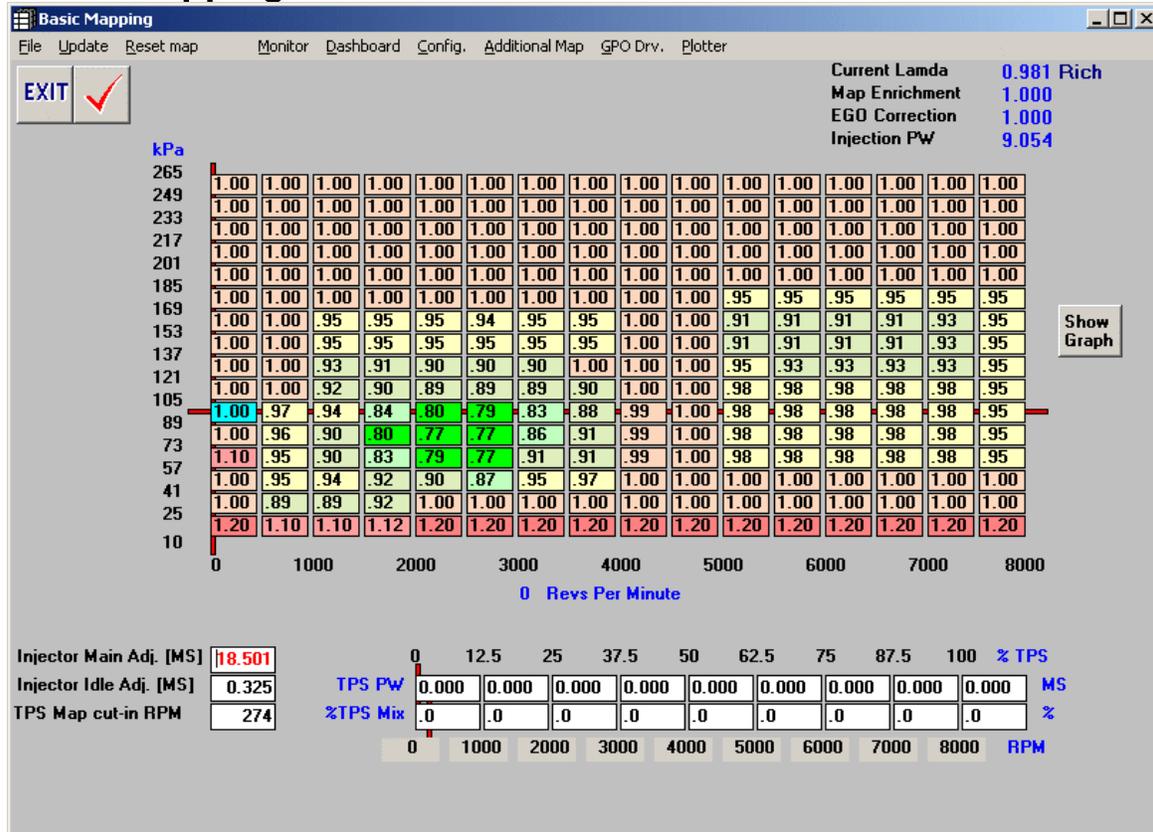
Narrowband:

When using a standard Bosch/NTK narrow band oxygen sensor, choose this option for normal closed loop operation.

Wideband (0-1v)

When using the 0-1v analog output of a Wide Band controller such as those offered by Innovate Motorsports, use this function. By far the best and most accurate closed loop EGO options is to run the standard 0-1v linear EGO curve out of the Innovate directly into the 034EFI EGO circuit. Voltage relative to Lambda ($\text{Lambda} = a/f \text{ ratio} \div 14.7$) can be fine tuned under the Configuration>Closed Loop Setup>EGO Type field of the tuning software. For example, Innovate systems default a 10:1 a/f at 0v, and 18:1 at 1v, thus Lambda values of 1.224 ($18 \div 14.7$) at 0v and .680 ($10 \div 14.7$) at 1v would be a good starting point.

Basic Mapping



Injector Main Adj. Value

This is the main fuel parameter, similar to the function of main jets on a carbureted engine. This number equates to the basic “unmapped” pulse width that the controller would calculate at the maximum manifold pressure. Increasing this number will generally give more fuel at a give pressure/engine load. Be careful to correctly select your fuel injector rates, as if the injection pulse width gets too long, the injectors can be opened for 100% of their duty, at which point the engine will lean out, and likely become damaged. For more information of injector selection, please call or email technical support.

Injector Idle Adj. Value

This parameter is usually considered a trim adjustment, similar to the idle and progression circuit in a carbureted engine. This parameter is typically near zero, or even slightly negative in many medium performance applications. In higher performance applications, where the idle manifold vacuum is low, this parameter can be somewhat more negative, where the calculated pulse width at idle is too high due to higher manifold pressure (poor vacuum). The negative Injector Offset parameter subtracts “if negative” from the basic pulse width so that the resultant pulse width is what is needed to control the engine.

MAP x RPM Matrix

The MAP x RPM matrix is the second most important tuning parameter after the Injector Main and Idle settings. This matrix allows fine-tuning of the fuel curve

based on precise and narrow pressure and engine speed points. Values across the matrix are interpolated between cells (not stair-stepped as it appears) and have a percentage influence over the final PW calculation. Thus if a .95 is entered into a particular cell, as the engine speed and manifold pressure reference lines intersect in that cell the .95 value will be interpolated (as a percentage calculation) with the values of the cells adjacent to it to effect a leaner PW calculation. Conversely, if a 1.05 were entered it would interpolate into a richer calculation. Thus, if specific tuning points are either lean or rich after the best Scaler and offset inputs, this matrix can be used to address those narrow ranges of fueling. All initial scaler and offset tuning should be done with the matrix values at 1.0. A good tuning benchmark should be to keep values in these cells between .8 and 1.2, and 1.0 at WOT, full power.

TPS PW

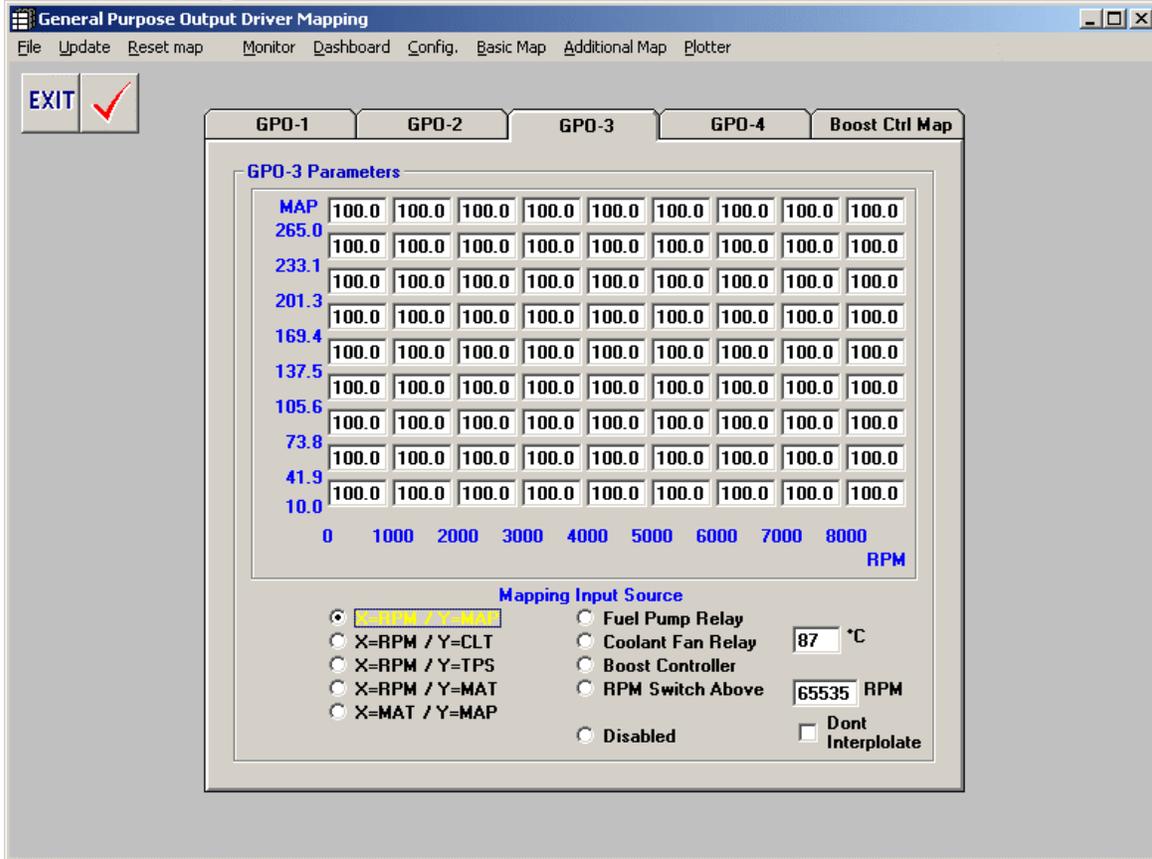
These parameters set the desired pulse width from this cell TPS position to the next cell TPS position. This acts as the TPS independent contribution to the pulse width calculation. The TPS PW series of cells forms a 2 dimensional pulse width curve that can be mixed into the normal pulse width calculations. These parameters along with the %TPS MIX parameters can assist in stabilizing the idle and light load pulse widths in heavily cam'd or with very low volume induction systems. Reducing the parameters in these fields will reduce the TPS based contribution to the pulse width when the %TPS MIX values are not zero. PW values should rise from small (below 1) to no more than 5 or 6 (typically). Values bigger than this will cause excessive enrichment in low-rpm, large throttle opening conditions.

%TPS Mix

These parameters set the amount of mixture between the normal mapping based pulse width, and the TPS based contribution. The %TPS Mix parameters allows a tapered mix function based upon engine RPM, where the engine can transition from a higher TPS based mixture at low RPMs to a lower or even zero TPS based mixture at higher RPMs.

This feature allows a controlled transfer from a primarily throttle based idle, to a pressure based control at higher RPMs, where perhaps the volumetric efficiency is better, or manifold pressure stabilizes. Setting these parameters to zero will fully disable (default) the TPS based mixture, and numbers up to 100% will run primarily off of the throttle position sensor. Values should taper to close to zero at large throttle openings.

GPO Tuning



All Stage IIc ECU's come with 4-GPO drivers. A GPO is a pulsewidth modulated output operating at 38Hz. The Stage "C" ECU's allow full 3-D mapping (where applicable) of different parameters in conjunction with each other. Fields can be setup with varying pulsewidth percentage values to drive supplementary functions such as Vtec, fuel pump, water injection, nitrous, boost control, cooling fans, etc, etc.

Fuel Pump Relay

By selecting this checkmark, the GPO will prime the fuel pump for up to 8 seconds on initial powerup, run the fuel pump when RPM is detected, and shut off the fuel pump when RPM stops for safety in the case of an accident or engine shutoff.

Coolant Fan Relay

By selecting this checkmark, the GPO will activate when the target temperature value is reached.

Boost Controllers

Selecting this will activate the current GPO output for controlling a solenoid valve to manipulate pressure to the wastegate. Details on the boost controll functions can be found later in this article.

RPM Switch Above

By selecting this checkmark, the GPO will activate above the targeted RPM value entered, there is a 250 RPM window before the GPO will deactivate to prevent hysteresis.

Disabled

Choose this field when the GPO is not being used.

Don't Interpolate

The ECU algorithms automatically blend or interpolate between cells, choose this field when this is not desired, as in when a "hard" turn on/off is desired, not a "blended" function.

Boost Control

The screenshot shows the 'General Purpose Output Driver Mapping' software window. It features a menu bar with 'File', 'Update', 'Reset map', 'Monitor', 'Dashboard', 'Config.', 'Basic Map', 'Additional Map', and 'Plotter'. Below the menu is an 'EXIT' button with a checkmark icon. The main area is divided into tabs for 'GPO-1', 'GPO-2', 'GPO-3', 'GPO-4', and 'Boost Ctrl Map'. The 'Boost Ctrl Map' tab is active, displaying a 9x9 matrix of boost pressure targets. The vertical axis is labeled 'MAT' with values 115, 99, 83, 67, 51, 35, 19, 3, and -13. The horizontal axis is labeled 'RPM' with values 0, 1000, 2000, 3000, 4000, 5000, 6000, 7000, and 8000. The matrix contains numerical values representing boost pressure in kPa. Below the matrix are input fields for PID parameters: 'Enable if MAP above' (110.0 kPa), 'Integrator Preset' (80 %), 'Proportional Gain' (1.300), 'Loop Rate' (30), 'Integral Gain' (0.050), 'Derivative Gain' (0.000), and an 'Invert Control Loop' checkbox.

MAT \ RPM	0	1000	2000	3000	4000	5000	6000	7000	8000
115	174.0	174.0	174.0	174.0	174.0	174.0	174.0	174.0	174.0
99	174.0	174.0	174.0	174.0	174.0	174.0	174.0	174.0	174.0
83	174.0	174.0	174.0	174.0	174.0	174.0	174.0	174.0	174.0
67	174.0	174.0	174.0	174.0	174.0	174.0	174.0	174.0	174.0
51	201.0	201.0	201.0	201.0	201.0	201.0	201.0	201.0	201.0
35	201.0	201.0	218.0	218.0	218.0	218.0	218.0	218.0	218.0
19	201.0	201.0	218.0	218.0	218.0	218.0	218.0	218.0	218.0
3	201.0	201.0	218.0	218.0	218.0	218.0	218.0	218.0	218.0
-13	201.0	201.0	218.0	218.0	218.0	218.0	218.0	218.0	218.0

Enable if MAP above: kPa Integrator Preset: %
 Proportional Gain: Loop Rate:
 Integral Gain:
 Derivative Gain: Invert Control Loop

034EFI systems now feature a closed loop PID (Proportional Integral Derivative) boost control algorithm. This is a complex mathematical control strategy that allows one GPO driver to target a programmable boost target. What this means to the tuner is that boost can be controlled to a precise pressure target regardless of engine load, flow, air temperature, outside air pressure or your significant other's hormonal swings. There are few boost controllers on the market that allow closed loop control, this control system allows the tuner to implement one of the most accurate and advanced boost control systems available anywhere.

9x9 Boost Target Matrix

This 81 cell matrix allows boost pressure targets, in kPa, to be entered based upon RPM and MAT (Manifold Air Temp). Boost curve strategies can be implemented here as well, for example an overboost or underboost at 4000 RPM to maximize turbo performance or traction issues. Fields interpolate with each other to ensure a smooth transition to different values.

Enable If Above

Set this value typically above 100kPa but below the targeted boost value. This prevents the valve from cycling needlessly below boost and also arms the valve with sufficient time to anticipate the boost control PWM loop. Since the control loop will go to 100% until the target pressure is reached (to prevent wastegate creep), there is no need to try to implement this value too late as doing so will actually slow down boost response.

Proportional Gain

This value sets the PWM to go up or down in proportion to the error, if the value is too large, then the PWM change will overcompensate for the amount of error present, causing the PWM to go too far in either direction to regulate the targeted boost pressure. Typically start with a value between 1 and 4, this value will need to be lowered if large oscillations or cycles in boost pressure are observed.

Integral Gain

This value moves the PWM up or down in proportion to the rate of change of the error, and thus controls the rate of change of the control loop, or how fast the control loop will enable changes to PWM when zoning in on the target boost pressure. Typically start with a value between .001 and .1, large over or under-shoots of boost pressure will be observed if this value is not optimal.

Derivative Gain

This value moves the PWM up or down in proportion to the rate of change of the error, it acts as a dampener or “shock” the control loop, the higher this value, the slower PWM changes will happen. Typically start with a value of 0, try small values and move up from there. If large overshoots are observed, this value may not be needed and can be left at 0.

Integrator Preset

This value sets the integrator, which is the controller’s “memory” for where the PWM sits when boost is controlled. This value is a percentage, and can be set above or below the actual control percentage duty-cycle to influence the control loop. Typically set to 50%, however if the entered value is larger than the actual control percentage, then an overshoot can be implemented. Play with different values until you are happy with the under or overshoot of the control loop.

Loop Rate

This value determines how many times per second the control loop will be analyzed and implemented. This field is a divisor of the default value is 200, thus a value of 1 would allow 200 times per second, a value of 10 would equal 20 times per second, etc. Too many or too few times per second will result in an unstable boost control, typical values are between 10 and 40.

Invert Control Loop

This value should only be checked when 100% duty cycle equals the minimum boost level and not the maximum. If 0% is the peak level of boost, then check this field.

Basic Mapping and GPO Key Strokes

Several keystroke options are available in the Basic Map.

Per cell Keystroke changes

Click on any cell, hold down shift and Up Arrow or Down Arrow, the cell value will change in .01 increments.

Mass Cell-Block Changes

Click on any cell, hold down control, keep holding it down, then using the arrow keys choose the diagonal opposite of the first cell to create a range of cells.

Release the control key and a text box will appear giving options to multiply, divide, add or enter cell values to quickly change a range or “cellblock” of cells easily and quickly.

Using the Monitor

The screenshot shows the 'Real Time Monitor' window with a menu bar (File, Dashboard, Config., Basic Map, Additional Map, GPO Drv., Plotter) and an 'EXIT' button. The main display area is divided into several sections:

- Comm Group Delay:** 23.7 MS (with a green status indicator)
- Map#:** 0
- #Trigs:** 23018
- #Cam:** 0
- WDbg:** 59
- CDbg:** 0

The left side of the monitor displays a list of engine parameters with their current values and units:

- Engine Speed: 962 RPM
- A/F Ratio: 14.28 AFR
- Coolant Temp.: 86 °C
- AirTemp.: 29 °C
- Throttle Position: 0 %
- Manifold Pressure: 34.4 kPa
- Barometric Pressure: 101.7 kPa
- Base Injection PW: 1.842 ms
- Accel Enrichment: .000 ms
- EGO Correction: 0.906 Gamma
- MAP Enrichment: 0.938 Gamma
- CLT Enrichment: 0.984 Gamma
- Battery Voltage: 12.39 Volts DC
- AUX Input: 0.358 Volts DC
- IAC State: CLOSING
- IAC Error: OK
- IAC Position: 0
- IAC RPM Setpoint: 848 RPM
- Timing: 18.75B

On the right side, there is a table showing injection and ignition data for 8 channels:

	Injection		Ignition	
	Inj ms	Duty%	Dwell	Duty%
Chan1	1.845	1	2.290	4
Chan2	1.845	1	2.290	4
Chan3	1.845	1	2.290	4
Chan4	1.845	1	2.290	4
Chan5	1.845	1	2.290	4
Chan6	1.845	1	2.290	4
Chan7	1.845	1	2.290	4
Chan8	1.845	1	2.290	4

The monitor, shown below, is simply a screen that can be used to monitor many of the ECU's inputs and outputs. Use this screen when something appears to be wrong (to quickly troubleshoot a bad sensor, etc), to monitor RPM synch with the trigger wheel and the sensor, quickly see changing ignition timing, etc, etc. No inputs or parameters can be configured here.

Some Fields Identified:

- Map# - This shows the status of the map select input, either map #1 or #2. To change maps, ground the appropriate ECU pinout (see the wiring diagram provided).
- #Trigs - the actual teeth as the ECU counts them (Stage C only)
- #Cam - The actual cam TDC pulses as they happen. (Stage C only)
- Wdbg - The calculated number of teeth on the reference wheel. Missing teeth are counted as one tooth, thus a 60-2 wheel will register 59 teeth. ANY fluctuation of this # means there are synch errors.
- Cdbg - The calculated position of the cam trigger reference, this # should remain stable.

- Timing - the actual ignition timing that the ECU is calculating.

Using the Plotter



The Plotter is a useful datalogging feature of the 034EFI “C” ECU’s, it allows ECU data to be recorded and saved to the laptop hard drive for future analysis. This is especially useful as there is typically a large amount of hard-drive space available for extended, almost unlimited amounts of datalogging time.

To start the Plotter, click the large “Start” button, this will create and record a .csv file to the hard drive of the laptop with the name entered in the plotter screen. Up to 12 different ECU input/output streams can be selected. Choose the logging interval, for values like MAP, RPM and other quickly changing values, 100MS or “As Fast as the Comm Will Allow” are recommended for the best resolution.

To access this .csv file, go to the installation directory of ECU882C in the Program Files folder. .csv files can be opened and manipulated in Excel and other programs.

Tuning Philosophy

Every ECU is provided with a sample map (with firing order configured) that should get the motor fired on more or less the first try (assuming all inputs and outputs are installed correctly). If all inputs are provided properly getting a motor to fire should be quite simple. Every motor and application is different, however, and requires specific and precise tuning. This section will attempt to outline the basic steps and methodology behind tuning the ECU. It needs to be emphasized, however, that each user needs to interact with the software, over time, to gain a more intimate understanding of the effect of different inputs the many tuning fields that the "882" software interface provides. Tuning an engine is much like playing a musical instrument, no written document can give simple steps that guarantee ability - only practice will make perfect! Consider this experience an investment in gaining a valuable skill that few have, which will allow you to develop engine systems to any desired output.

Initial Adjustments

Before any tuning is attempted, closed loop programming should be disabled, this can be done in the Dashboard window or by entering a 0 for EGO loop activation in the Configuration window. In order to estimate current air/fuel ratio the "Cur Lamda" value in either the Dashboard or Basic Map should be referenced. Generally, values of .85 are very rich and values of 1.0 or higher are very lean WHEN USING A NARROW BAND SENSOR. Generally, using a narrow band O2 sensor, values in the .9-.95 will be best for idle and part throttle, and .84-.9 for WOT.

Running the linear 0-1v EGO input from a Wideband controller will result in extremely accurate a/f inputs, typically Lambda of .8-.83 are safe for WOT, and Lambda of 1.0 are Stoich.

Before attempting to start the car, ensure your computer is communicating with the ECU. Though each ECU comes with a sample map, certain fields may need to be modified according to the installation. One of the primary adjustments may relate to ignition timing. Preferably set the ignition distributor to TDC or 0 degrees of advance. Stock settings can be used as well, but in the case the distributor does not use any mechanical advance or retard, 0 degrees will be best until the motor can be started and timing set dynamically with the motor running

If running a "C" system with distributorless ignition, review the timing curve in the ECU, ensure that nothing is overly advanced or retarded, most any motor will run with a safe 10-15d of constant advance, remember, error on the side of conservative when tuning ignition, tuning to the "ragged edge" brings minimal gains for the massive safety risk it poses to damaging your motor.

Ignition Timing Control:

During this time its important to consider ignition timing as well. Generally ignition timing can be advanced at idle and light load conditions, and retarded at higher

RPM and full load conditions. Up to 30-40d of advance under light load conditions will give excellent fuel mileage and smooth running. The best emissions will be created with minimal advance, use about 5 degrees of advance at idle for good emissions. Notice that up to -20 degrees of initial retard can be entered in the RPM Ign Retard 0-1000 field to enable smooth starting. This is interpolated across the fields however, so that at an idle of about 900 RPM, the amount of retard is much less than 20 degrees, in actuality its calculated to only 2 or 3 degrees. This is because the 20 degrees of retard is applied at only 0 RPM and interpolated to the value in the field above it (1000-2000) which is 0. This strategy can be used in all the ignition-timing fields to produce a smooth timing curve that can anticipate full load conditions while providing excellent response, smoothness and efficiency at low load conditions. For example at 2000 RPM with a light load 40 kPa the full 35 degrees of advance is applied, but under full load higher RPM conditions a full 15 degrees of retard is applied. Generally high output turbocharged engines will run well on low octane fuel with somewhere under 15-20 degrees of advance.

Getting the motor started:

This is the first tuning step. A fully charged battery is important and proper wiring and installation of the unit is implied. Also ensure that the cooling system is functioning and that the engine installation is complete. If the motor cranks but will not start, it likely needs more fuel. The two main fueling parameters for the ECU are the Injector Main and Idle Adj, seen in the page view below:

NOTE: BEFORE ANY OTHER FIELDS ARE CHANGED, USE THE INJECTOR MAIN AND IDLE VALUES TO GET THE MOTOR RUNNING AND UNDER LOAD, ONLY THEN SHOULD OTHER ACCEL, BASIC MAP AND ADDITIONAL MAPPING FUNCTIONS BE USED

The injector scaler or “The Injector Main Adjustment” is the primary fueling parameter for the ECU, and determines the base maximum pulsewidth (PW) at the maximum MAP pressure, and across the pressure range.. Thus, if 10.2 is entered as the main value, the base MAP based PW will be 10.2 at 255 kPa (for the 2.5BAR ECU). If more fuel is needed to start the car, slowly increase the main value until the motor starts to catch and starts. Once the motor is running, the idle value can be manipulated to create a more stable idle for the time being.

The Idle Adj. value is usually considered a trim adjustment, similar to the idle and progression circuit in a carbureted engine. This parameter is typically near zero, or even slightly negative in many medium performance applications. In a typical intake manifold application with throttle body and a mild cam, tune this value between 0 and .5. In higher performance applications, where the idle manifold vacuum is low (not below 90 kPa), this parameter can be somewhat more negative, where the calculated pulse width [at idle] is too high due to higher manifold pressure (poor vacuum). The negative Injector Idle parameter subtracts “if negative” from the basic pulse width so that the resultant pulse width is what is needed to control the engine. Usually a value greater than .5 in the offset field (in a 1 or 2.5BAR ECU, 5BAR ECU’s may require much higher idle values) indicates that the overall Injector Main # is off (too low) and should be increased to deliver

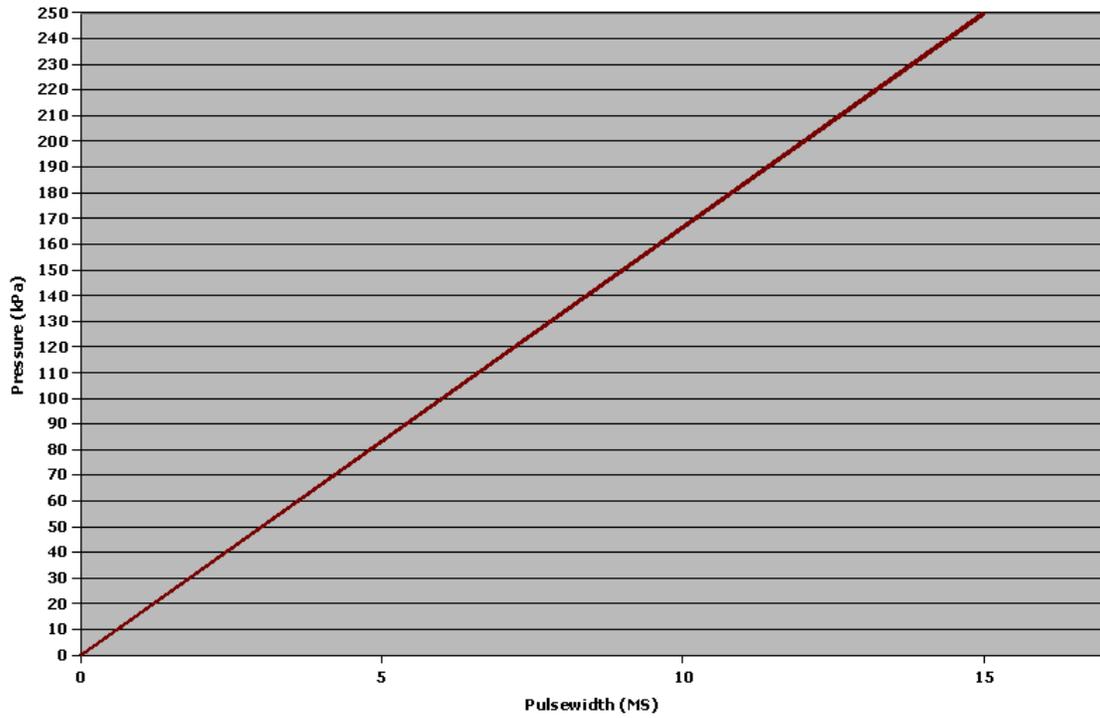
more fuel at all rpm and MAP levels. Generally a Lambda of .9-.95 is required to achieve a good idle.

Note that the Idle Adj value adds this value to the calculated PW at all times, across all pressure ranges - thus a .5 will add .5MS of fuel at all times. The purpose of this value is that at low PW values, such as idle, it will be a much larger percentage of the PW than at high pressure levels, where proportionately it will be almost insignificant. For example, .5 at 1MS is a much larger increase than .5 at 20MS.

Below are graphical examples of the Injector Main and Injector Idle values manifest in a 2.5BAR application:



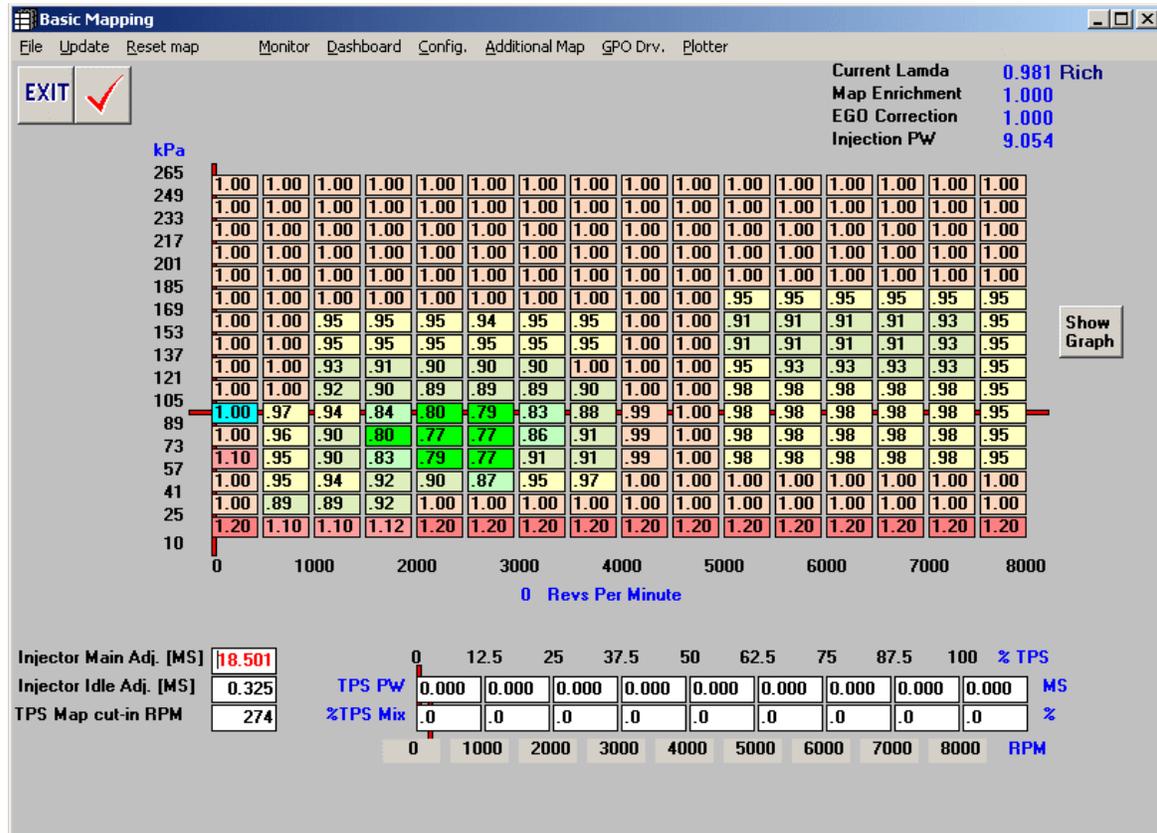
Injector Main Adjustment 15, Idle 0.0



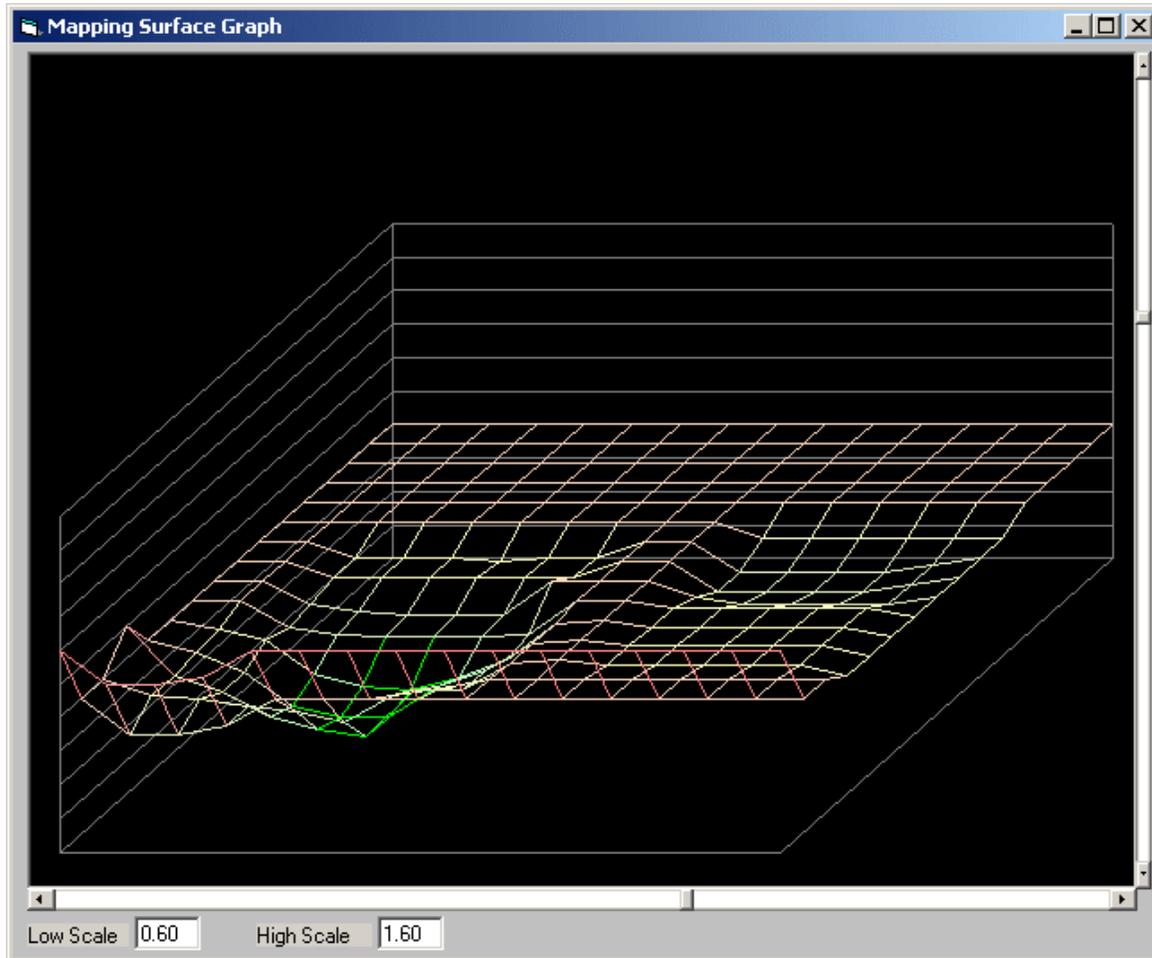
Note how the two settings manifest across the pressure range, this is the speed density method of fuel calculation. The Idle Adjustment simply adds the programmed value across all pressure ranges, in this case, 2 MS.

Getting the motor running through the RPM range

Once the motor is at normal running temps, and a stable idle has been achieved, attempt to run the motor in gear, additional adjustments to the Main Injector value can be made to get good fueling throughout the RPM range. Keep all the values in the large kPa x RPM field 1.0 for now, as they should only be used for fine-tuning in the later stages. Once the motor runs acceptably through the lower RPM range at lighter loads, slowly the scalar can be continually adjusted for higher RPM and full load conditions.



Also, note that matrix values can be graphically verified - below is the graph manifest of Screen Shot B, above. Note that this is NOT a representation of actual 3D Pulsewidth values, but of the matrix modifier values in the basic mapping. Use this to verify any keystroke errors, for example, a .10 under the WOT portion of the mapping could cause horrible engine damage; a quick graphical verification would help prevent this. Also use this to view the volumetric efficiency "map" of the engine system, certain RPM ranges benefit from resonance tuning and thus draw much greater amounts (as much as 200% more) as other areas in the power-band.



Tuning for WOT and full load

At this point, it's wise to find a long stretch of road or a rolling road dyno for these stages of tuning. If on the road, often a long, uphill stretch of road can help in loading up the motor while keeping speeds down. Again, carefully throttle into WOT and build up load and power to the peak. Carefully observe the EGO, most turbocharged applications should tune for an EGO of .88 to .90, this correlates to approximately a 12:1 air fuel ratio. The main fueling parameter for WOT max power should be the Injector Main value. Once full power fueling is set, then part

throttle, light load and idle mixtures can continue to be fine-tuned and modified from the WOT/Max Power settings.

Other Tuning Considerations

Keystroke Shortcut

When modifying the Basic Mapping matrix, by clicking on a specific field and holding down the shift key, the up or down arrow will increase or decrease the field value by increments of .01. This feature also works in other, but not all fields, elsewhere in the software interface.

Tuning with Closed Loop [EGO] Parameters:

Closed loop parameters are set in the Configuration Window as seen below is Screen Shot F. Tuning for the closed loop programming is done in the Additional Map window. The desired EGO value is entered into the matrix based on MAP and RPM. The closed loop tuning parameters should be integrated once a good base-tuning map has been created, or in other words, the best possible parameters for engine running, excluding the involvement of the Closed Loop programming. In the ideal tuning situation, the ECU would function without the assistance of the closed loop programming. In order to program a good performing motor in as many varied conditions as possible, the base tuning maps must be complete and compensate as well as possible without the involvement of closed loop. Once this kind of map has been created, then and only then should the Closed Loop Parameters be integrated to compensate for the conditions that were not addressable with the base maps. All initial tuning should be done with a 0 in the EGO Loop Activation field to disable EGO correction. Once EGO correction is activated, the Min and Max EGO Gain measurements should be help to a range of 10% on either side. In other words, the Min EGO gain should be held to .9 and Max to 1.1. If the EGO correction does not perform well with these parameters, then the base tuning maps likely need further adjustment. This is a good tuning benchmark to maintain.

Launch Control and Anti-Lag

“C” ECU’s also provide the option of a second rev-Limiter, (Limiter 1) which, when used in conjunction to the Aux. Input, can limit engine timing and rpm to serve the purpose of Launch Control and Turbo Anti-Lag strategies.

To properly activate Rev Limiter 1 for the function of Launch Control/Anti-Lag, the full voltage of 3.3/5v (depending on the ECU manufacturing date) should be fed to the Aux. Input, activating Rev Limiter 2 as the main engine speed limiter. Thus, Rev-Limiter 1 will be activated when voltage is cut (using a switch to break the circuit) below 1.67v, allowing Rev-Limiter 1 to be programmed with a lower RPM setting for the use of the above function.

Whenever ignition timing is retarded past a certain point, the engine will no longer have the ability to accelerate; this serves the purpose of holding engine rpm and load well.

Launch Control can be used for the purpose of holding engine rpm at a set rpm point - drag racing, for example, where a set rpm launch point is helpful. The Aux. Input can be brought to below 1.67v by using a grounded switch when fed by ECU

sensor (CLT, TPS, etc) 3.3v output into the Aux. circuit. Remember that the fuel mixture may also be changed in accordance with the value placed in the appropriate cell. This switch can be placed on a steering wheel button, the clutch pedal, 1st-gear shift position, etc. NOTE - a 10k resistor should be used inline from the voltage source to the Aux. Input if it is taken to ground to reduce voltage, ensure this is wired properly to prevent damage to the ECU. Anti-Lag can be facilitated in a similar means to launch control, in fact it can be the same exact setting, the idea is to pull timing back under WOT so that max. fuel and air can be pumped through the motor while reducing torque to much lower levels. For example when entering a turn, typically in a turbo car the driver would lift off the throttle until the apex of the turn is reached, at which point WOT would be applied, the turbo would spool, and the engine would accelerate out of the turn. Using Anti-lag, instead of lifting when entering the turn, the 1st Rev-Limiter can be applied via push button on the steering wheel so that the turbo never spools down. WOT is held until the apex, at which point the 1st Rev-Limiter is de-activated, ignition timing is restored, and thus engine power. The turbo never stops spooling and turbo lag problems are eliminated. This is essentially an electronic way to left foot brake to keep the turbo spooled.

Cold Running Tuning

The main parameters for adjustment for cold start tuning are the CLT Enrichment in the Additional Mapping field. A cold motor needs more fuel to overcome fuel condensation on cold metal surfaces and cold, high viscosity oil. These parameters should be tuned during the relevant temperature range. MAT (Manifold Air Temp) calculations should be made for ambient running conditions (increased air density) but not so much for "cold starting" fueling.

Tuning with Throttle Position

(Note: In applications with high intake manifold vacuum, running either a 1 or 2.5BAR MAP Sensor, TPS tuning is not recommended or practically useful. All part throttle fuel programming can easily be done in the basic map matrix. TPS table values should be set to 0.00. Applications running individual throttle bodies with low intake vacuum, or running the 5 BAR MAP will benefit from TPS tuning). The "882" software allows tuning for throttle position as part of the "PW mix". Tuning using throttle position is accomplished through the TPS matrix at the bottom of the Basic Map Window. This matrix allows a calculated PW value to "offset" the main PW calculated value. Two parameters interact to create this calculation, the TPS PW and the % TPS Mix.

Thus, the 1.0 in the 0-1000 RPM range will offset the calculated 1.6 by mixing in 1.0 MS with 1.6 at a mix of 30%. The resulting pulsewidth will end up approximately a 1.55, which may be just the right amount of fuel for the idle condition being tuned for.

Generally the TPS matrix should only be tuned to address part throttle and lighter load conditions. Notice in the above matrix how the percent and PW values taper off into the higher RPM to the effect of 3% at 5-6000 RPM and 0% thereafter. Again, WOT tuning should be accomplished solely with the Injector Main field. One thing to be careful of, if the motor RPM are at 1500 per se, but WOT is

engaged; the TPS PW will calculate a higher value in the 75-87.5% range. If a large PW value of say 9.0 was in that field as opposed to the 3.0, the 9.0 would be mixed at a % of 35, which would flood the motor with too much fuel and cause a bog. Thus, the strategy should show a taper off into higher RPM and load conditions to prevent drivability problems as described. Initial tuning should be done with all zeros in the TPS matrix, and once base tuning is accomplished slowly integrated to fine tune idle and part throttle fueling conditions. The TPS blend table may not be used in motors with strong vacuum at idle and part throttle conditions, which respond very well to MAP Matrix tuning only.

Using EGT's (Exhaust Gas Temperatures)

Though 034efi ECU's do not have a dedicated EGT input, this is a valuable operating parameter to observe during the tuning process, especially for the use of ignition timing calculations under power or WOT. Typically, overly retarded (from the ideal) ignition will cause high EGT's due to the delaying of combustion relative to the exhaust valve opening. By starting with conservative, retarded timing and moving towards advance, EGT temps should be observed as lowering with each degree or two of advance. At a certain point of advance, EGT's will stabilize, then begin to grow again, at this point, ideal, safe ignition advance should be realized. This also assumes acceptable, safe Air/Fuel Ratios of about 12.5:1 consistently through testing.

Conclusion

This concludes the 034EFI ECU tuning manual. You should have received an indepthidea how to approach the overall tuning effort required to create a smooth running, powerful and responsive motor. No manual can replace cause and effect tuning experience, so don't be afraid to try different tuning values and strategies. By keeping many different maps saved this can be done easily and safely.

It is important to remember that no factory system will give the flexibility of tuning like the 034EFI ECU will, and excellent results will await the patient and perceptive tuner. This ECU can fuel and time any engine up past 20k rpm, it is immensely capable, as you will be with some experience and increased knowledge. The important thing to remember is that all tuning experiences, good and bad, will add to your knowledge and experience base - use this to improve your tuning aptitude, and enjoy the learning process!