AutoVE Tuning
Tutorial for LS1 Controllers

Andy Reyna (TAQuickness) & David Christie (Tre-Cool)

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First published
16 Aug 2004

Revised
11 November 2016

Disclaimer:

Before you begin, understand that I am in no way responsible for what you do with this information. This write up has been written for informational purposes only. In other words, use at your own risk.

Credits:

It is not my intent to take credit for work that is not mine. The content of this write up is largely derived from the Internet and my own personal experience. If it looks like you originally wrote any part of this, you probably did, and I thank you for sharing that information on the Internet.

Special thanks to Black02SS, EFILive, RedHardSupra, and all persons providing feedback.

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Introduction

**Please read the entire contents of this tutorial
before performing any of the steps.**

Before you begin:

1. The contents of this tutorial are specific to Gen III LSx PCM's. While the concepts of this tutorial are applicable to a wide variety of GM PCM's, the calibration references to non-Gen III PCM platforms may not be accurate.

2. The fuelling sections of this tutorial will provide reference to AFR, EQ Ratio & Lambda; however its recommended users learn to move away from AFR or in the very least know not to modify wide band stoich values when dealing with ethanol blended fuels.

3. Upgrading to the latest release of the EFILive software will ensure all features are available and appear as documented.

   Upgrades may be downloaded, free of charge here:
   http://www.EFILive.com/latest/cat/download-EFILive

4. Ensure you have access to a wide band O2 sensor compatible with EFILive/FlashScan. This sensor must be installed, calibrated, and in proper working order.

5. If you are running fuel injectors with flow ratings other than stock, the {B4001} "Injector Flow Rate" table needs to be calibrated to match your injectors.

6. If you are running a 1999 or 2000 operating system, you should consider upgrading to a 2001 or later operating system. The 2001 and later operating systems simplify the tuning process and provide an opportunity to upgrade to one of EFILive's custom operating systems.

   > 1997 and 1998 PCM's currently do not have the option to upgrade to a custom operating system.
   >
   > 2001 PCM's have custom operating systems available, however, the 2002 based operating system offers a wider variety of custom operating system upgrade paths.

Oxygen Sensors – Wide band vs Narrow band

A wide band is a high precision oxygen sensor, with there being 3 common Wide band Sensors on the market. They are the Bosch 4.2, 4.9 LSU and NTK/Uego sensors. Most wide band kits utilize Bosch sensors due to costs, the 4.9 is a much faster reacting sensor and thus with the right controller can provide more samples per second. Being of a newer design the 4.9 is also less prone to contamination of the "clean air" sample like in the 4.2 and heat resistant.

Both sensors recommend to be "free air calibrated" often depending on use. If you think your sensor data is bad always check against another for peace of mind. It doesn't hurt to check.

NTK/Uego sensors are even older than the Bosch 4.2 sensors and thus are not as accurate/quick in sampling the air stream.

There are a few other older "wide band" sensors on the market but I would not recommend using these for any critical engine tuning.

Most GM ECU systems utilise narrow band sensors to provide minor corrections to fuelling, this is because as there name suggests they have a NARROW margin in which they can sense either a rich or lean mixture & this is only around stoich. It's not recommended to tune off these alone, but it can be done, just not to any great precision.

Sensor Location

Most wide band controllers will mention a minimum distance from a collector merge or distance from a turbocharger. This is mostly due to the sensors safe operating zone, too close to the engine and exhaust pulses and heat will affect the sensors life span. Angle of the sensors is mainly to prevent fuel/water vapour from building up around the sensor tip.

Analog Vs Digital

Most good wide bands on the market now offer serial (rs232) or CAN based output along with an analog 0-5v signal.

When tuning it is preferred to utilize the digital form of data from the wide band into your tuning software so that the data the wide band is transmitting is exactly what you see in the logger.

With analog signals you can get ground offsets affecting the transmitted voltage based on where your powering your wide band from, even noise from the wide bands own electronics when producing the 0-5v output signal can cause an adjusted voltage other things such alternator load, car stereo systems can affect the readings you get from the wide band.

Nothing is more frustrating than watching a gauge and seeing perfect fuelling and then finding your logger has recorded something completely different.

Analog Wide bands:

To be compatible with EFILive, the wide band O2 sensor's controller must output a 0 to 5 Volt analog voltage proportional to the measured AFR/Lambda Signal.

EFILive V7.5 & V8 has built in support for the following wide band controllers in AFR:

- ➢ Autronic
- ➢ Innovate LC-1, LM1, MTX-L
- ➢ PLX
- ➢ Tech Edge
- ➢ Wide Band Commander

Other compatible wide band controllers, not listed above, can be added via a custom pid configured in the *My Documents\EFILive\V7\calc_PIDs.txt* file. See the creating custom PIDs section for examples.

It is however **recommended** to use a wide band with serial data output due to the previous issues mentioned.

Digital (Serial output) Wide bands:

EFILive V7.5 & V8 has built in support for the following wide band controller serial protocols:

- ➢ ALM Ecotrons
- ➢ Innovate LC-1, LM1,LM2, MTX-L
- ➢ PLX
- ➢ Tech Edge 1.5 & 2.0
- ➢ AEM
- ➢ FJO Gen1-3
- ➢ J.A.W
- ➢ ECM

Generally what you see on your gauge display screen will be identical to what you will see logged via the External W02-Serial PIDs. Any difference between the two will be purely a millisecond response rate/delay.

Not all wide bands are created equal & data speeds do vary between controllers.

FlashScan V2 needs to be configured to understand the relevant data protocol from your wide band. Configuration can be managed by;

V8 Scan and Tune: With FlashScan V2 connected to your PC, open V8 Scan and Tune. Navigate to [F6: Devices] -> [F8: Serial I/O] and select wide band options. Use the **Program** button to update the configuration on your FlashScan V2 device.

FlashScan V2: On the FlashScan V2 device, navigate to [F4 Options] -> [F1 Setup] -> [F1: Edit Settings]. Using the arrow keys navigate to:

Option	Description
WO2 Type	Select the type of Wide Band device connected to serial port*.
WO2 Fmt	Set the Wide Band controller configuration. Bank 1, Bank 2, Both.
WO2 Data	Set the Wide Band data display format.
WO2-1 ID	Configure the ID's for multiple ECM AFR wide band controllers.
WO2-2 ID	Configure the ID's for multiple ECM AFR wide band controllers.

Lambda vs AFR – What does it all mean?

Since pump gas is the most common fuel available, most wide band meters are calibrated for the stoichiometric ratio of (14.7:1). The important part to understand is that the wide band meter doesn't know (or care) what fuel it is reading. All it is looking at is the oxygen content in the exhaust. The wide band meter basically works natively in lambda and in order to display AFR, it must be told what air fuel ratio equates to lambda 1.00 so it can display the right number.

So let's assume that the wide band meter is set for a stoichiometric AFR of 14.7:1. This means when it is reading lambda 1.00 (regardless of fuel), it will display 14.7:1. Run it at lambda 1.00 on VP 109 and it will read 14.7:1. Run it at lambda 1.00 on E85 and it will read 14.7:1. Run it at lambda 1.00 on methanol and it will read…. Drum roll please… 14.7:1.

Now assume we want to run at 0.85 lambda somewhere in the map. Our wide band is still configured with a stoichiometric AFR of 14.7:1. 0.85 x 14.7 is 12.495:1. This means that regardless of the fuel type, the wide band will read 12.495 if we are running 0.85 lambda.

If however we adjust the stoichiometric setting in the wide band for the fuel we are running, everything changes. Let's say we change to E85 and we set the wide band to a stoich ratio of 9.85:1. Now when the lambda is 1.00, the wide band will read 9.8:1. If we specify 0.85 lambda in the tune for 100kpa @ 3000rpm, we would hope to see the wide band read 0.85 x 9.8 = 8.33:1.

In Short, As long as your wide band is setup for petrol/gas @ 14.7 then setup the car's ecu stoich ratio to match the same figure or vice versa otherwise you could end up with a very large inconsistency with your BEN. Explained further below.

This is why it's recommended to tune & log in Lambda/EQ values because if your wide band controller has a modified AFR stoich ratio you could be adjusting your tune from incorrect data.

A perfect example of getting it wrong

This would be a LS1 controller set to a stoich ratio of 14.67:1 and a wide band set to E85 stoich of 9.8:1, say the tune is perfectly fine and is dead on accurate for the entire map, but you're seeing an idle AFR of 9.8:1 so you think it's running rich & decide to pull out fuel to get it back to a 14.67 afr figure, but as you pull more and more fuel out the engine is finding it harder & harder to run until it simply won't start.

The reason it won't run is because you have pulled out nearly 40% of the fuel, now imagine if you have a forced induction car where you need to run richer mixtures in the low 12 to mid 11's & your seeing those AFR's but your wide band is setup for a custom stoich ratio of 10.5:1… Best case scenario you notice the lack of power, worst case…Your picking up bits of your motor off the highway as you've just ran the motor at a real gas AFR of 16.25:1. That's why by tuning with lambda values it doesn't matter.

Lambda 1.00 is stoichiometric, regardless which fuel you use. 14.7:1 for pump gas, 13.4:1 for VP 109, 9.8:1 for E85.

Some GM ecu's will work in either AFR/Lambda or EQ, EQ moves in the opposite direction to that of Lambda, but a number of 1 is ALWAYS Stoich.

EQ	Gas Stoich	GAS AFR	Stoich	E10 AFR	E85 Stoich	E85 AFR	LAMBDA
0.95	14.63	15.4	14.12	14.86316	9.78	10.29474	1.052632
0.96	14.63	15.23958	14.12	14.70833	9.78	10.1875	1.041667
0.97	14.63	15.08247	14.12	14.5567	9.78	10.08247	1.030928
0.98	14.63	14.92857	14.12	14.40816	9.78	9.979592	1.020408
0.99	14.63	14.77778	14.12	14.26263	9.78	9.878788	1.010101
1	14.63	14.63	14.12	14.12	9.78	9.78	1
1.01	14.63	14.48515	14.12	13.9802	9.78	9.683168	0.990099
1.02	14.63	14.34314	14.12	13.84314	9.78	9.588235	0.980392
1.03	14.63	14.20388	14.12	13.70874	9.78	9.495146	0.970874
1.04	14.63	14.06731	14.12	13.57692	9.78	9.403846	0.961538
1.05	14.63	13.93333	14.12	13.44762	9.78	9.314286	0.952381

Some GM ecu's will work in either AFR/Lambda or EQ, EQ moves in the opposite direction to that of Lambda, but a number of 1 is ALWAYS Stoich.

EFILive Scan Setup

Select PIDs for AutoVE in AFR

1. Start the EFILive Scan Tool Software.

2. Press F8 or click the [PIDs (F8)] tab page.

3. Clear the PID selection by clicking on the "Clear existing PID selection" button

4. Select the following PIDs for SD (Speed Density) tuning:
   To help locate the PIDs more easily, select the *system* from the drop down list, and then select the PID.

System	Parameter	Name
Air	SAE.MAP	Intake Manifold Absolute Pressure
Conditions	SAE.RPM	Engine RPM
	SAE.VSS	Vehicle Speed Sensor
External	EXT.AD*n*	External Analog Voltage *n*
Fuel	GM.AFR	Commanded Air Fuel Ratio
Spark	GM.KR	Retard Due to Knock
	SAE.SPARKADV	Ignition Timing Advance for #1 Cylinder
Temperature	SAE.ECT	Engine Coolant Temperature
	SAE.IAT	Intake Air Temperature
Tune	DYNCYLAIR_DMA	Air Flow Grams/Cyl – Speed Density
Throttle	SAE.TP	Absolute Throttle Position
WO2-Analog	CALC.AFR_*XXXn*	Wide Band AFR *n* - *XXX*
	CALC.BEN_*XXXn*	Base Efficiency Numerator *n* - *XXX*

   n is either 1 or 2 depending on which FlashScan analog input the wide band O2 sensor is connected.
   XXX is chosen so that it matches your wide band O2 controller.

5. Save the PID file as ***My Documents\EFILive\V7.5\AutoVE-afr.pid*** by clicking on the "Save PID selection file with a new name" button.

   The final PID selection should look like this:
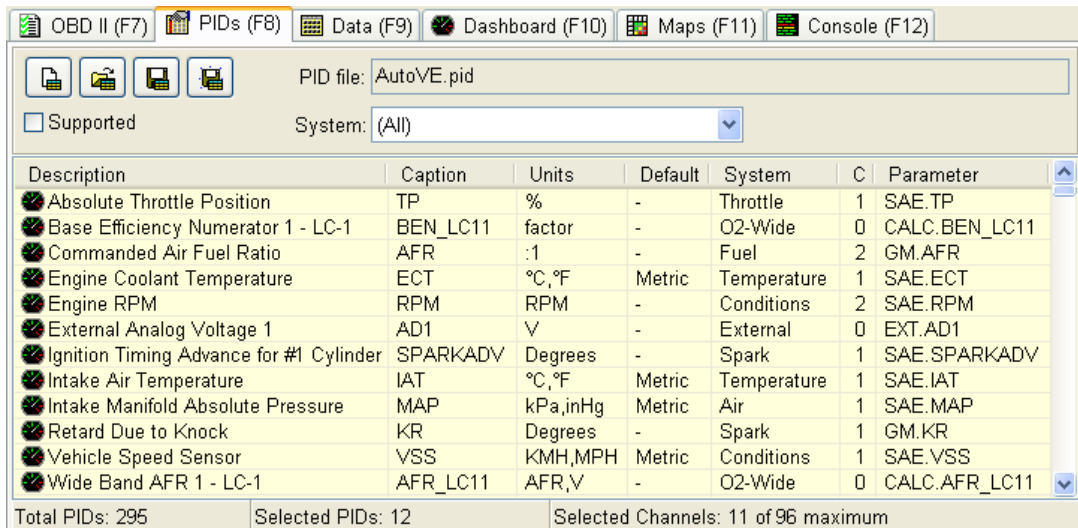
The above PIDs are the *minimum* for SD tuning. You may add additional PIDs if required. Do not exceed 24 selected channels.

Select PIDs for AutoVE in EQ/Lambda

As we want to deal with EQ & Lambda values, you will be required to create some custom PIDs before the following steps. Skip to Creating Custom PIDs if you have not done so already.

1. Start the EFILive Scan Tool Software.

2. Press F8 or click the [PIDs (F8)] tab page.

3. Clear the PID selection by clicking on the "Clear existing PID selection" button

4. Select the following PIDs for SD (Speed Density) tuning:
   To help locate the PIDs more easily, select the *system* from the drop down list, and then select the PID.

System	Parameter	Name
Air	SAE.MAP	Intake Manifold Absolute Pressure
Conditions	SAE.RPM	Engine RPM
	SAE.VSS	Vehicle Speed Sensor
External	EXT.AD*n*	External Analog Voltage *n*
Fuel	EQIVRATIO	Equivalence Ratio (Instead of GM.AFR)
Spark	GM.KR	Retard Due to Knock
	SAE.SPARKADV	Ignition Timing Advance for #1 Cylinder
Temperature	SAE.ECT	Engine Coolant Temperature
	SAE.IAT	Intake Air Temperature
Throttle	SAE.TP	Absolute Throttle Position
Tune	DYNCYLAIR_DMA	Air Flow Grams/Cyl – Speed Density
O2-Analog	CALC.AFR_XXX*n*	Wide Band AFR *n* – *XXX*
W02-Ben	CALC.LAMBDA_XXX*n*	Wide Band Lambda from *n* - *XXX*
W02-Ben	CALC.LAMBDA-W02BENA	BEN from Analog Lambda
W02-Ben	CALC.LAMBDA	Wide Band Lambda from Analog AFR

n is either 1 or 2 depending on which FlashScan analog input the wide band O2 sensor is connected.
XXX is chosen so that it matches your wide band O2 controller.

Select PIDs for AutoVE via Serial

1. Start the EFILive Scan Tool Software.

2. Press F8 or click the [PIDs (F8)] tab page.

3. Clear the PID selection by clicking on the "Clear existing PID selection" button

4. Select the following PIDs for SD (Speed Density) tuning:
   To help locate the PIDs more easily, select the *system* from the drop down list, and then select the PID.

System	Parameter	Name
Air	SAE.MAP	Intake Manifold Absolute Pressure
Conditions	SAE.RPM	Engine RPM
	SAE.VSS	Vehicle Speed Sensor
Fuel	EQIVRATIO	Equivalence Ratio (Instead of GM.AFR)
Spark	GM.KR	Retard Due to Knock
	SAE.SPARKADV	Ignition Timing Advance for #1 Cylinder
Temperature	SAE.ECT	Engine Coolant Temperature
	SAE.IAT	Intake Air Temperature
Throttle	SAE.TP	Absolute Throttle Position
Tune	DYNCYLAIR_DMA	Air Flow Grams/Cyl – Speed Density
W02-Serial	CALC.EQBEN_LS1	Base Efficiency Numerator – External W02LAM1 LS1
	W02LAM	External Wide band Lambda

Save the PID file as ***My Documents\EFILive\V7.5\PIDs\AutoVE-serial.pid*** by clicking on the "Save PID selection file with a new name" button.

The final PID selection should look like this:

| Description	Caption	Units	Default	System	Channels	Parameter
Absolute Throttle Position	TP	%	-	Throttle	1	SAE.TP
Air Flow Grams/Cyl - Speed Density	DYNCYLAIR_DMA	Grams/cyl	-	Tune	2	GM.DYNCYLAIR_DMA
Base Efficiency Numerator - External W02LAM1_LS1	EQBEN_LS1	factor	-	W02-Ben	0	CALC.EQBEN_LS1
Engine Coolant Temperature	ECT	°C,°F	Metric	Temperature	1	SAE.ECT
Engine RPM	RPM	RPM	-	Conditions	2	SAE.RPM
Equivalence Ratio	EQIVRATIO	:1	-	Fuel	2	GM.EQIVRATIO
External Wide Band Lambda	W02LAM1	Lambda	-	W02-Serial	0	EXT.W02LAM1
Ignition Timing Advance for #1 Cylinder	SPARKADV	Degrees	-	Spark	1	SAE.SPARKADV
Intake Air Temperature	IAT	°C,°F	Metric	Temperature	1	SAE.IAT
Intake Manifold Absolute Pressure	MAP	kPa,PSI	Metric	Air	1	SAE.MAP
Retard Due to Knock	KR	Degrees	-	Spark	1	GM.KR
Vehicle Speed Sensor	VSS	KMH,MPH	Metric	Conditions	1	SAE.VSS

Supported   System: [(All)]

Create AutoVE MAP

For all operating systems

EFILIVE have included preconfigured maps for many years to do auto-ve but the following instructions are included so that you can always create your own.

(See next page for additional steps for 1997 - 2000 operating systems)

1. Start the EFILive Scan Tool Software (if it is not already started).

2. Press F11 or click the [MAPs (F11)] tab page.

3. Select MAP [A] or the first available MAP (from A to J).

4. Press Ctrl+Enter to open the MAP property editor window.

5. Select the [Data] tab page and check the selected check box.

6. Select "Base Efficiency Numerator *n* - *XXX*" from the Parameter drop down list box, where *n* is the analog connection (1 or 2) and *XXX* is the wide band controller.

7. Select the [Column] tab page and check the selected check box.

8. Select "Intake Manifold Absolute Pressure (kPa)" from the Parameter drop down list box.

9. Start the EFILive Tuning Tool Software (If it is not already started)

10. Open calibration {B0101} "Main VE Table".

    Select all cells by clicking in the extreme top-left, grey cell.
    Right click on any cell and select ***Copy with labels (Shift+Ctrl+C)***

11. Return to the EFILive Scan Tool and press the ***"Paste Labels"*** button. The following labels should appear in the Col labels text field:
    `,15,20,25,30,35,40,45,50,55,60,65,70,75,80,85,90,95,100,105`
    Note the leading comma – it must be included.

12. Select the [Row] tab page and check the selected check box.

13. Select "Engine RPM (RPM)" from the Parameter drop down list box.

14. Press the ***"Paste Labels"*** button. The following labels should appear in the Row labels text field:
    `,400,800,1200,1600,2000,2400,2800,3200,3600,4000,4400,4800,5200,5600,60`
    `00,6400,6800,7200,7600,8000`
    Note the leading comma – it must be included.

15. Click the Save as button and save the map as:
   ***My Documents\EFILive\V7\Maps\AutoVEPrimary.map***
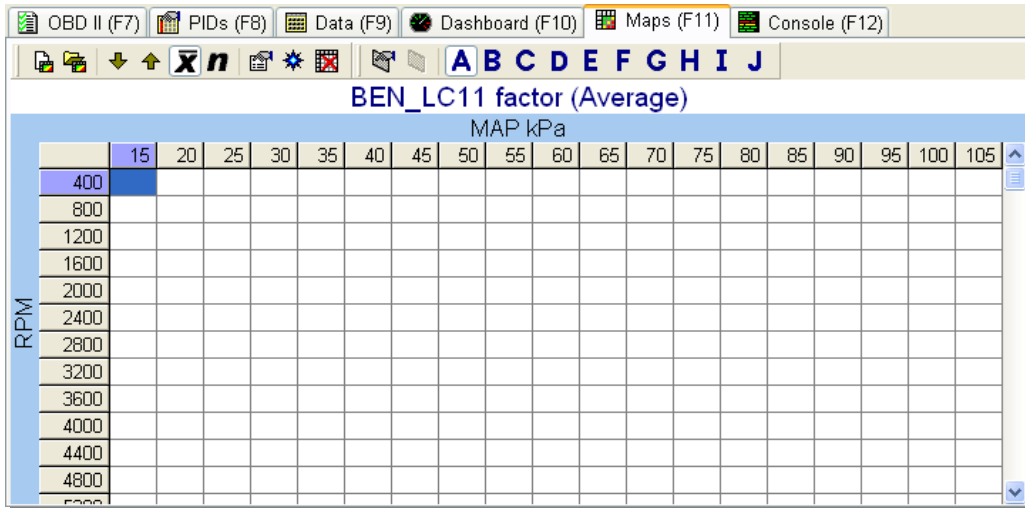
Sample BEN AutoVEPrimary MAP using an LC-1 wide band.

For 1997 - 2000 operating systems

(See previous page for 2001 and later operating systems)

Repeat Steps 1 to 13 from the previous section, with the following changes:

1. In step 3, select Map [B] instead of Map [A].

2. In step 10, use calibration {B0103} "Backup VE Table":

3. In step 15, use the following filename:
   My Documents\EFILive\V7\Maps\AutoVEBackup.map
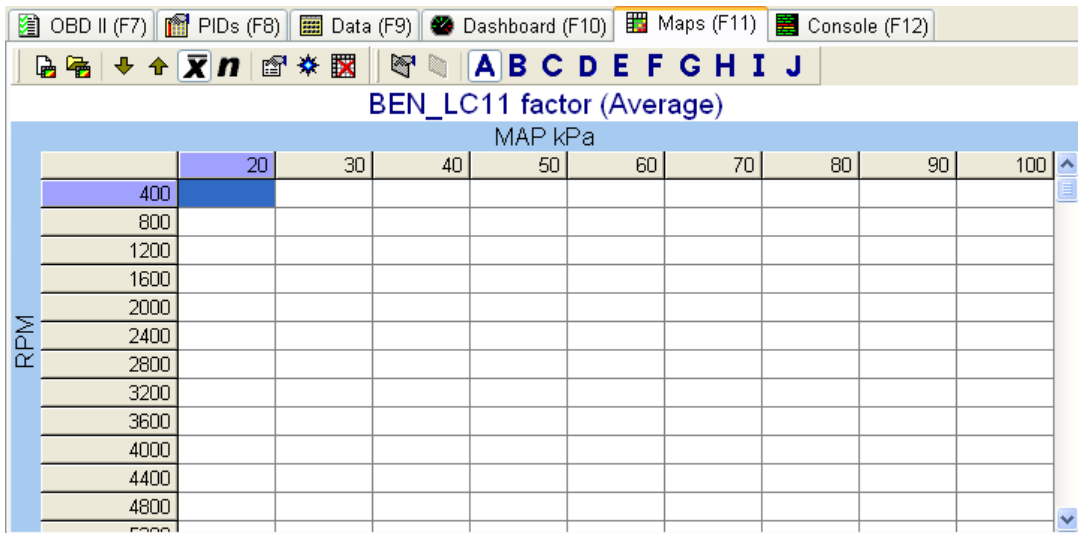
Sample BEN AutoVEBackup MAP using an LC-1 wide band.

Set up Open Loop, Speed Density

1. Upload the current calibration from your PCM.

   Save 3 copies of your tune:

   > *i. Original Tune.tun*
   > *ii. SDAutoVE.tun*
   > *iii. OrgBackUp.tun*

2. Open the **SDAutoVE.tun**

> (i) Hint, to quickly find and display any calibration, enter the calibration ID including the curly braces (i.e. {B0101}) into the Navigator and click the [Search] button.

3. Open calibration {B0101} "Main VE Table".
    Select all cells by clicking in the extreme top-left, grey cell.
    Enter 15 into the Adjust text box and click the [%] button.
    This will increase all cells' values by 15%.

> ⚠ Note: The increase of 15% is a precautionary measure to prevent extremely lean conditions that may damage your engine.

4. If you are tuning a 1997 - 2000 operating system, repeat step 3 for the {B0103} "Backup VE Table".

5. Open calibration {B3313} "DFCO Temp Enable"
   Set it to 122 °C (252° F)

6. Open calibration {B3618} "PE Modifier Based on RPM"
    Configure this table with the requested AFR/EQ or Lambda values you want to run when Power Enrichment kicks in. As an example here is a Naturally Aspirated target in Lambda, AFR & EQ.

	Value		Value		Value
0	0.96	0	14.04	0	1.04
400	0.96	400	14.04	400	1.04
800	0.96	800	14.04	800	1.04
1200	0.96	1200	14.04	1200	1.04
1600	0.96	1600	14.04	1600	1.04
2000	0.96	2000	13.99	2000	1.05
2400	0.94	2400	13.76	2400	1.06
2800	0.92	2800	13.46	2800	1.09
3200	0.88	3200	12.87	3200	1.14
3600	0.87	3600	12.73	3600	1.15
4000	0.87	4000	12.73	4000	1.15
4400	0.87	4400	12.73	4400	1.15
4800	0.87	4800	12.73	4800	1.15
5200	0.87	5200	12.73	5200	1.15
5600	0.87	5600	12.73	5600	1.15
6000	0.87	6000	12.73	6000	1.15
6400	0.87	6400	12.73	6400	1.15
6800	0.87	6800	12.73	6800	1.15
7200	0.87	7200	12.73	7200	1.15

7. It's extremely important you know what your commanded fuel value maps are displayed in especially if you are dealing with EQ vs Lambda. **If you get this wrong bad things will happen!**

8. You configure this by going to Edit → Properties and choosing from the drop down list.

> Commanded fuel values:
>
> Display in: AFR
>
> Stoich: 14.63
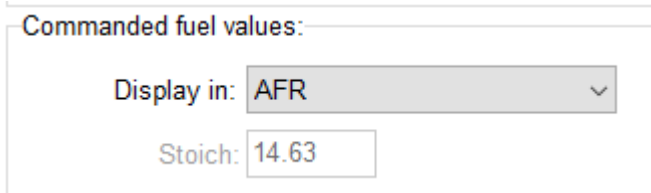
9. Now if you have configured your enrichment to happen via PE Mode, then you will need to set the following step tables to Either 1 for Lambda & EQ or 14.63/7 if you're working in AFR. Alternatively you can set the PE enrichment table to all 1's for all rpm's or 14.63/7 AFR etc. But you WILL need to do it 1 way or the other, the choice is yours. Bear in mind that the ECU will use whatever is the richer of the 2.

10. If you are going to enrichen via PE, take note of the following:
{B3613} PE MAP Threshold – This is the MAP pressure that must be met before enrichment can happen
{B3618} Minimum Throttle Position for enrichment to begin vs RPM
{B3619} Engine Coolant Temp - Additional
If you don't want to use PE to dial in your Fuel map then you must configure the following tables depending on your OS.

11. If your tune contains {B3605}, open calibration {B3605} "Commanded Fuel When in Open Loop"

	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
-40	1.67	1.62	1.62	1.62	1.65	1.67	1.67	1.67	1.69	1.69	1.72	1.72	1.75	1.75	1.75	1.75	1.75
-30	1.48	1.48	1.50	1.52	1.54	1.56	1.56	1.58	1.58	1.60	1.62	1.62	1.62	1.62	1.62	1.62	1.62
-20	1.33	1.33	1.33	1.34	1.35	1.37	1.39	1.41	1.42	1.44	1.46	1.46	1.47	1.47	1.47	1.47	1.47
-10	1.27	1.27	1.27	1.27	1.28	1.29	1.32	1.33	1.34	1.35	1.38	1.38	1.40	1.40	1.40	1.40	1.40
0	1.21	1.21	1.21	1.21	1.22	1.23	1.26	1.27	1.28	1.29	1.32	1.33	1.34	1.34	1.34	1.34	1.34
10	1.14	1.14	1.14	1.15	1.16	1.17	1.20	1.21	1.24	1.25	1.28	1.30	1.30	1.30	1.30	1.30	1.30
20	1.06	1.07	1.07	1.08	1.10	1.15	1.17	1.19	1.21	1.23	1.25	1.28	1.28	1.28	1.28	1.28	1.28
30	1.04	1.05	1.05	1.07	1.09	1.12	1.15	1.16	1.18	1.20	1.23	1.25	1.26	1.26	1.26	1.26	1.26
40	1.08	1.08	1.13	1.14	1.14	1.14	1.14	1.14	1.14	1.15	1.18	1.18	1.18	1.18	1.18	1.18	1.18
50	1.07	1.07	1.11	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14
60	1.05	1.06	1.07	1.07	1.08	1.08	1.08	1.08	1.08	1.09	1.11	1.12	1.13	1.13	1.13	1.13	1.13
70	1.03	1.04	1.05	1.05	1.06	1.06	1.06	1.06	1.08	1.09	1.11	1.12	1.13	1.13	1.13	1.13	1.13
80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.04	1.08	1.12	1.13	1.13	1.13	1.13	1.13
90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.04	1.08	1.12	1.13	1.13	1.13	1.13	1.13
100	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.04	1.08	1.12	1.13	1.13	1.13	1.13	1.13
110	1.00	1.01	1.02	1.02	1.03	1.04	1.06	1.06	1.08	1.09	1.11	1.12	1.13	1.13	1.13	1.13	1.13
120	1.00	1.01	1.02	1.02	1.03	1.04	1.06	1.06	1.08	1.09	1.11	1.12	1.13	1.13	1.13	1.13	1.13
130	1.00	1.01	1.02	1.02	1.03	1.04	1.06	1.06	1.08	1.09	1.11	1.12	1.13	1.13	1.13	1.13	1.13
140	1.00	1.01	1.02	1.02	1.03	1.04	1.06	1.06	1.08	1.09	1.11	1.12	1.13	1.13	1.13	1.13	1.13

MAP kPa {link: SAE.MAP} — ECT °C {link: SAE.ECT}

If the calibration is displayed as EQ Ratio then set the values as per the red rectangle in this table

MAP kPa {link: SAE.MAP}																	
	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
-40	8.76	9.01	9.01	9.01	8.88	8.76	8.76	8.76	8.63	8.63	8.51	8.51	8.38	8.38	8.38	8.38	8.38
-30	9.86	9.86	9.76	9.65	9.52	9.39	9.39	9.29	9.26	9.16	9.03	9.03	9.01	9.01	9.01	9.01	9.01
-20	11.01	11.01	10.97	10.93	10.80	10.67	10.50	10.37	10.28	10.16	10.03	10.03	9.95	9.95	9.95	9.95	9.95
-10	11.52	11.52	11.52	11.52	11.46	11.34	11.10	10.98	10.93	10.81	10.63	10.57	10.45	10.45	10.45	10.45	10.45
0	12.05	12.05	12.05	12.05	12.01	11.90	11.62	11.51	11.43	11.31	11.08	10.97	10.89	10.89	10.89	10.89	10.89
10	12.86	12.78	12.78	12.76	12.64	12.50	12.17	12.05	11.81	11.68	11.44	11.29	11.23	11.23	11.23	11.23	11.23
20	13.81	13.73	13.63	13.59	13.30	12.76	12.45	12.34	12.12	11.92	11.66	11.47	11.42	11.42	11.42	11.42	11.42
30	14.03	13.99	13.88	13.68	13.42	13.03	12.74	12.64	12.44	12.16	11.87	11.66	11.60	11.60	11.60	11.60	11.60
40	13.54	13.54	13.00	12.84	12.84	12.84	12.84	12.84	12.84	12.72	12.44	12.42	12.41	12.41	12.41	12.41	12.41
50	13.67	13.67	13.17	12.85	12.85	12.85	12.85	12.85	12.85	12.85	12.85	12.85	12.85	12.85	12.85	12.85	12.85
60	13.93	13.81	13.67	13.67	13.54	13.54	13.54	13.54	13.54	13.45	13.14	13.05	12.95	12.95	12.95	12.95	12.95
70	14.20	14.07	13.93	13.93	13.81	13.81	13.81	13.74	13.54	13.45	13.14	13.05	12.95	12.95	12.95	12.95	12.95
80	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.07	13.53	13.05	12.95	12.95	12.95	12.95	12.95
90	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.07	13.53	13.05	12.95	12.95	12.95	12.95	12.95
100	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.07	13.53	13.05	12.95	12.95	12.95	12.95	12.95
110	14.63	14.45	14.35	14.35	14.24	14.05	13.84	13.74	13.54	13.45	13.14	13.05	12.95	12.95	12.95	12.95	12.95
120	14.63	14.45	14.35	14.35	14.24	14.05	13.84	13.74	13.54	13.45	13.14	13.05	12.95	12.95	12.95	12.95	12.95
130	14.63	14.45	14.35	14.35	14.24	14.05	13.84	13.74	13.54	13.45	13.14	13.05	12.95	12.95	12.95	12.95	12.95
140	14.63	14.45	14.35	14.35	14.24	14.05	13.84	13.74	13.54	13.45	13.14	13.05	12.95	12.95	12.95	12.95	12.95

(ECT °C {link: SAE.ECT})

If the calibration is displayed as AFR then set the values as per the green rectangle in this table

12. If your tune contains {B3647} (custom OS V3 and later), open calibration {B3647} "Commanded Fuel vs RPM"

kPa {link: SAE.MAP}																	
	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.05	1.05	1.05	1.05	1.05
400	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.01	1.02	1.06	1.06	1.06	1.06	1.06
800	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.01	1.02	1.03	1.07	1.07	1.07	1.07	1.07
1200	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.02	1.03	1.05	1.08	1.08	1.08	1.08	1.09
1600	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.02	1.05	1.07	1.09	1.10	1.10	1.10	1.10
2000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.03	1.06	1.09	1.11	1.11	1.11	1.11	1.11
2400	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.03	1.07	1.10	1.12	1.12	1.12	1.12	1.12
2800	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.04	1.08	1.12	1.13	1.13	1.13	1.13	1.13
3200	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.04	1.08	1.12	1.13	1.13	1.13	1.13	1.13
3600	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.04	1.08	1.12	1.13	1.13	1.13	1.13	1.13
4000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.04	1.08	1.12	1.13	1.13	1.13	1.13	1.13
4400	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.04	1.08	1.12	1.13	1.13	1.13	1.13	1.13
4800	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.04	1.08	1.12	1.13	1.13	1.13	1.13	1.13
5200	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.04	1.08	1.12	1.13	1.13	1.13	1.13	1.13
5600	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.04	1.08	1.12	1.13	1.13	1.13	1.13	1.13
6000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.04	1.08	1.12	1.13	1.13	1.13	1.13	1.13
6400	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.04	1.08	1.12	1.13	1.13	1.13	1.13	1.13
6800	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.04	1.08	1.12	1.13	1.13	1.13	1.13	1.13
7200	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.04	1.08	1.12	1.13	1.13	1.13	1.13	1.13

(RPM {link: SAE.RPM})

If the calibration is displayed as EQ Ratio then set the values as per the this table

kPa {link: SAE.MAP}																
	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
0	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	13.97	13.93	13.92	13.92	13.91
400	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.54	14.46	14.38	13.82	13.78	13.77	13.77	13.77
800	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.46	14.29	14.15	13.67	13.64	13.63	13.63	13.62
1200	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.38	14.13	13.91	13.52	13.50	13.48	13.48	13.48
1600	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.31	13.99	13.68	13.36	13.35	13.35	13.35	13.34
2000	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.23	13.83	13.46	13.22	13.21	13.21	13.21	13.21
2400	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.15	13.68	13.26	13.08	13.08	13.08	13.08	13.07
2800	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.07	13.53	13.05	12.95	12.95	12.95	12.95	12.95
3200	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.07	13.53	13.05	12.95	12.95	12.95	12.95	12.95
3600	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.07	13.53	13.05	12.95	12.95	12.95	12.95	12.95
4000	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.07	13.53	13.05	12.95	12.95	12.95	12.95	12.95
4400	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.07	13.53	13.05	12.95	12.95	12.95	12.95	12.95
4800	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.07	13.53	13.05	12.95	12.95	12.95	12.95	12.95
5200	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.07	13.53	13.05	12.95	12.95	12.95	12.95	12.95
5600	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.07	13.53	13.05	12.95	12.95	12.95	12.95	12.95
6000	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.07	13.53	13.05	12.95	12.95	12.95	12.95	12.95
6400	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.07	13.53	13.05	12.95	12.95	12.95	12.95	12.95
6800	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.07	13.53	13.05	12.95	12.95	12.95	12.95	12.95
7200	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.63	14.07	13.53	13.05	12.95	12.95	12.95	12.95	12.95

(Left axis label: RPM {link: SAE.RPM})

If the calibration is displayed as AFR then set the values as per this table

13. **For Custom OS V3 and later**, open calibration {A0008} "Open Loop ECT Commanded Fuel Multiplier" and set the following values:

Open Loop ECT Commanded Fuel Multiplier (Factor)	
	Value
-40	1.670
-30	1.575
-20	1.411
-10	1.332
0	1.271
10	1.214
20	1.186
30	1.157
40	1.140
50	1.139
60	1.080
70	1.064
80	1.000
90	1.000
100	1.000
110	1.064
120	1.064
130	1.064
140	1.064

(Left axis label: ECT °C {link: SAE.ECT})

ⓘ These settings are required for additional enrichment during engine warm up. This calibration may require additional user adjustments for desired drivability.

14. Open calibration {B3801} "Long Term Fuel Trim Correction"
    Set it to **Disable** calibration {B4205}

15. Open calibration {B4205} "Closed Loop Temp Enable"
    Select all cells by clicking in the extreme top-left, grey cell.
    Enter 122 °C (252° F) into the Adjust text box and click the [#] button.
    That will set all cells' values to 122 °C (252° F)

16. Open calibration {B0701} "Catalytic Converter Protection Enable"
    Set it to **Disable**.

    ⚠️ If you have catalytic converters, and get crazy on your drive, you may overheat and damage the catalytic converters.

17. Open calibration {B5913} "Spark High-Octane Table"
    Select all cells by clicking in the extreme top-left, grey cell.
    Right click on any cell and select **Copy (Ctrl+C)**
    Open calibration {B5914} "Spark Low-Octane Table"
    Right click in the top left cell and select **Paste->Paste (Ctrl+V)**

    ℹ️ If you upgrade your PCM to EFILive's Speed Density custom operating system, step 13 is not required. EFILive's Speed Density operating system restored dual spark map and full adaptive spark control when running MAF-less.

18. Open calibration {C6002} "Engine DTC MIL Enablers"
    Set P0101, P0102, and P0103 to **No MIL**.

19. Open calibration {C2901} "MAF High Frequency Fail 1"
    Set it to 1 Hz.

20. Open calibration {C2902} "MAF High Frequency Fail 2"
    Set it to 1 Hz.
    If calibration {C2902} is not available in the operating system that you are using, then ignore this step.

21. Open calibration {C2903} "MAF High Frequency Fail Limit"
    Set it to 1.

22. Pop the hood and unplug the MAF sensor (see note)

    ⚠️ Note: If your MAF has a 5-pin plug, your IAT sensor is built into the MAF. You will need to make provisions to get the IAT signal into the PCM. Various write-up's on this can be found at:
    www.EFILive.com and www.ls1tech.com.

    Vehicles equipped with automatic transmissions should go to table {E0104} "Transmission DTC Fault Pressure Modifiers" and set P0101, P0102, and P0103 to NO to prevent the PCM from increasing shift pressures.

23. For vehicles equipped with electronic throttle control, "ETC", open calibration {C6101}, enter 40 into the Adjust text box and click the [%] button.
    This will increase all cells' values by 40%.

⚠️ Note: The increase of 40% is a precautionary measure to prevent the PCM from setting DTC P1514. Depending on engine modifications, users may need to further adjust this calibration to prevent DTC P1514.

24. Save this tune and perform a calibration only reflash of this file into your PCM.

Data Logging

1. Start the engine and let it come up to full operating temperature.

2. While the engine is warming up, start the EFILive Scan Tool software, connect to the vehicle and start monitoring your data (do not log at this time).

   ℹ️ To start monitoring data, click the yellow button.
   To start logging data, click the red button.
   Once logging or monitoring has started, you can toggle between logging and monitoring by pressing Ctrl+space bar.

3. While waiting for the car to warm up it's prudent to reset the learned LTFT's, to do this simple press the F12 key or go to the DVT tab & select the LS1 controller from the drop down list.

4. Click on Activate, then click on the learning tab & then hit the Fuel Reset button, you can hit it a few times for good measure but once is generally enough.

5. Once the engine has reached normal operating temperature, usually 68° C (180° F) or higher, start your drive and start data logging.

6. It helps to have a passenger viewing the BEN factor map while it is displaying the cell count. You want to hit as many cells as you can, as many times as you can. Try to get a cell count of 50+ per cell.

7. After you have finished logging data, save the log file as
   My Documents\EFILive\V7\Logged data\AutoVE.efi

Update Calibrations

1. Start the EFILive Tuning Tool software and open the SDAutoVE.tun file.

2. Start the EFILive Scan Tool software and open the AutoVE.efi file.

3. Press F11 to display the [Maps (F11)] tab page.

4. Press A to display the primary VE BEN factor map.

5. Click the Average button to display the cell's average logged values.

6. Build and apply the following filter which excludes unwanted frames from the data log:
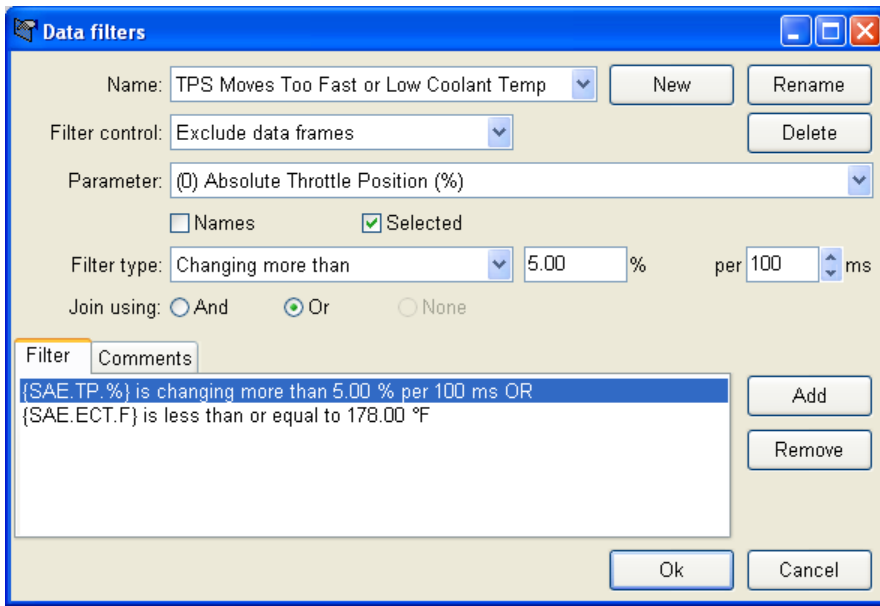
Filter configuration using °F
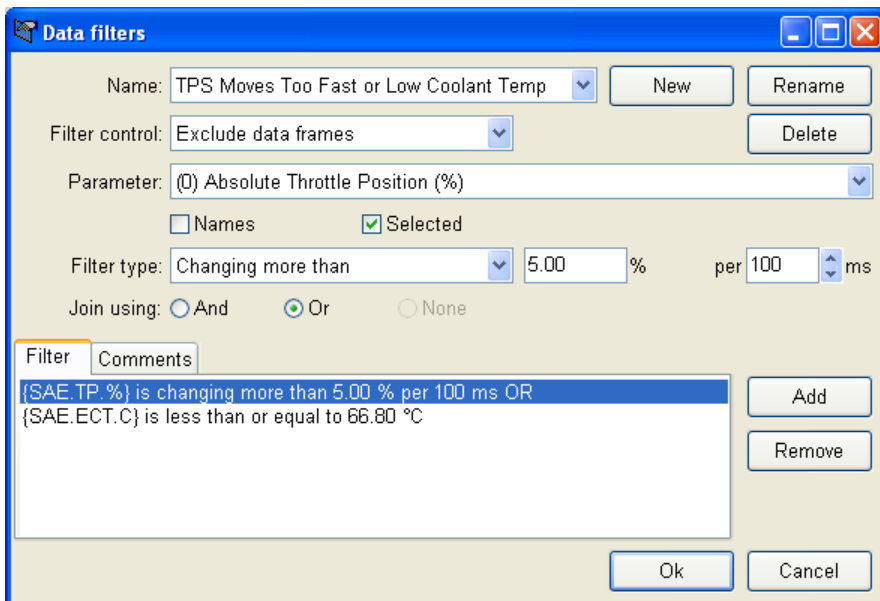
Filter configuration using °C

7. Hide all cells with a value of less than 50.

8. Select all cells in the table by clicking in the extreme top-left grey cell, then right click and select *Copy with labels (Shift+Ctrl+C)*.

9. Switch back to the EFILive Tuning Tool.

10. Open calibration {B0101} "Main VE Table".

11. Right click on any cell and select *Paste->Paste and multiply with labels*.

12. If you are tuning a 1997 - 2000 operating system then repeat steps 3 to 11 to copy/paste the VE data from map [B] to the {B0103} "Backup VE Table".

13. Save your tune as:
    My Documents\EFILive\V7\Bins\SDAutoVE_0000.tun

14. Perform a calibration only reflash of *SDAutoTune_0000.tun* into the PCM.

15. If necessary repeat the steps in the previous section, Data logging, and this section until the average cell values in your BEN map(s) are close to 1.00 (aim for +/- .01).

Return the PCM to Closed Loop, Speed Density

⚠️ Do not perform this section if you are using an EFILive custom operating
system, V3 (i.e. 2/3 bar support) or later.

Information Warning:

Before switching back to closed loop you must remember that once you complete the
following steps the ECU will not exit / switch into Power Enrichment until it meets the
relevant requirements. Make yourself familiar with them! Refer to **Step 10** in Set up
Open Loop.

1. Start the EFILive Tuning Tool software and open the ***Original Tune.tun*** file.

2. Open calibration {C2901} "MAF High Frequency Fail 1"
   Set it to 1 Hz.

3. Open calibration {C2902} "MAF High Frequency Fail 2"
   Set it to 1 Hz.
   If calibration {C2902} is not available in the operating system that you are using,
   then ignore this step.

4. Open calibration {C2903} "MAF High Frequency Fail Limit"
   Set it to 1.

5. Open calibration {C6002} " Engine DTC MIL Enablers"
   Set P0101, P0102, and P0103 to ***No MIL***.

6. Select menu option ***File->Load alternate calibration for comparison*** and
   select ***SDAutoVE_0000.tun***.

7. Select menu option ***File->Display calibration difference summary*** and locate
   the {B0101} "Main VE table" calibration in the list. Click the link to highlight
   calibration {B0101}. Then, click the Update button at the bottom right of the
   screen to copy the data from the alternate calibration to the primary calibration.

   ℹ️ If the {B0101} calibration is not displayed in the calibration difference
   summary window, then there is no difference between the primary and
   alternate {B0101} data. That can mean either your VE table was
   extremely accurate to begin with, or the AutoVE tuning process has not
   been competed correctly.

8. If you are tuning a 1997 - 2000 operating system, repeat step 5 for the {B0103}
   "Backup VE Table".

9. Open calibration {B5913} "Spark High-Octane Table"
   Select all cells by clicking in the extreme top-left, grey cell.
   Right click on any cell and select ***Copy (Ctrl+C)***
   Open calibration {B5914} "Spark Low-Octane Table"
   Right click in the top left cell and select ***Paste->Paste (Ctrl+V)***

   ℹ️ If you upgrade your PCM to EFILive's Speed Density custom operating
   system, step 9 is not required. EFILive's Speed Density operating
   system restored dual spark map and full adaptive spark control when
   running MAF-less.

10. Save your tune as
    My Documents\EFILive\V7\Bins\Original Tune_0000.tun

11. Perform a calibration only reflash of ***Original Tune_0000.Tun*** into your PCM.

Verification

1. Start the EFILive Scan Tool software and add the following PIDs to the
   AutoVE.pid selection file:

System	Parameter	Name
Fuel	SAE.LONGTFT1	Long Term Fuel Trim – Bank 1
	SAE.LONGTFT2	Long Term Fuel Trim – Bank 2

2. Start your engine and the Scan Tool and go for a drive.

3. Monitor Commanded AFR/EQ and WBO2 AFR/Lambda or your BEN PID/MAP,
   they should be extremely close.

4. Long-term fuel trims should eventually settle in the range –4 to 0.

5. Repeat any of the above sections as necessary to achieve the desired LTFT's.

Creating Custom Analog PIDs:

1) Do yourself a favour and download a good text editor like Notepad ++ or equivalent.

2) Browse to and open the following file: ***My Documents\EFILive\V7.5\user configuration\calc_PIDs.txt***

3) For every custom pid you want to show up in the scanner you must define a "slot definition" & the "parameter reference number" information. Think of the slot definition as the input information you want to take in and put limits or configuration about for the scanner window, like max/min values. FMT is format or how many values past the decimal you want to show. Each SLOT must have a unique name before you declare the configuration. In our case the EFILIVE documentation states that it must start with CLC-00- & then an unused number.

For example an analog wide band will generally always output a 0-5v signal based on how much air it's reading, but not all manufacturers will have a range between 10-20 afr. One might be 10-30 afr, so even though the voltages are in the same range, the actual air to fuel ratio is very different. To work that out there must be some math applied to the expression. Expressions will always reference either an external input (AD1-4) or internal supported pid. In this case we are dealing with the analog voltage signal.

```
34  #Units              Low           High         Fmt  Expression
35  #------------------- ------------- ------------ ---- ----------------------
36  *CLC-00-001
37  V                    0.0           5.0          .1   "{EXT.AD1}"
38  AFR                 10.0          20.0          .2   "{EXT.AD1}*2+10"
39  lambda               0.5           1.5          .4   "{EXT.AD1}*2+10/14.7"
```

What we can see is happening here is that to work out the AFR we must multiply the voltage by 2 & and then add 10. So let's say the wide band is outputting 2.5v, multiply it by 2 = 5 +10 = 15.0afr

2.8v * 2 +10 = 15.6afr, now to work out the Lambda value we could either use another math expression or simply use the afr equation and then divide it by stoich of 14.7 & using the 2 previous voltages we get:

- 2.5 * 2 + 10 = 15.0/14.7 = 1.02 Lambda

- 2.8 * 2 + 10 = 15.6/14.7 = 1.06 Lambda

4) The Parameter Reference Number is description information that will show up in the scanner that links to the slot definition. In this case the following:

Code	PRN	SLOT	Units	System	Description
CALC.AFR_WB1	F001	CLC-00-001	"AFR,lambda,V"	WO2-Analog	"Wide Band AFR AD1"

Description	Caption	Units	Default	System	Channels	Parameter
Wide Band AFR 1 - AFR	AFR_AFR1	AFR,V	-	WO2-Analog	0	CALC.AFR_AFR1
Wide Band AFR 1 - AUT	AFR_AUT1	AFR,V	-	WO2-Analog	0	CALC.AFR_AUT1
Wide Band AFR 1 - DJ	AFR_DJ1	AFR,V	-	WO2-Analog	0	CALC.AFR_DJ1
Wide Band AFR 1 - FJO	AFR_FJO1	AFR,V	-	WO2-Analog	0	CALC.AFR_FJO1
Wide Band AFR 1 - LC1	AFR_LC11	AFR,V	-	WO2-Analog	0	CALC.AFR_LC11
Wide Band AFR 1 - LM1	AFR_LM11	AFR,V	-	WO2-Analog	0	CALC.AFR_LM11
Wide Band AFR 1 - LM2	AFR_LM21	AFR,V	-	WO2-Analog	0	CALC.AFR_LM21
Wide Band AFR 1 - NGK	AFR_NGK1	AFR,V	-	WO2-Analog	0	CALC.AFR_NGK1
Wide Band AFR 1 - PLX	AFR_PLX1	AFR,V	-	WO2-Analog	0	CALC.AFR_PLX1
Wide Band AFR 1 - TE	AFR_TE1	AFR,V	-	WO2-Analog	0	CALC.AFR_TE1
Wide Band AFR 1 - WBC	AFR_WBC1	AFR,V	-	WO2-Analog	0	CALC.AFR_WBC1
Wide Band AFR AD1	AFR_WB1	AFR,Lambda,V	-	WO2-Analog	0	CALC.AFR_WB1

Build an Analog Ben PID

Since we have now built ourselves a pid to work out the incoming AFR/LAMBDA we want to create another pid that tells us how close we are to the requested/commanded fuelling.

To do this, we need to again create a slot definition:

```
144   *CLC-00-133
145   factor            0.5            1.5          .3   "{GM.EQIVRATIO}*{CALC.LAMBDA_FTPS}
146
147   *CLC-00-134
148   factor            0.5            1.5          .3   "{GM.EQIVRATIO}*{CALC.AFR AEM EGR.lambda}
```

The example in the above picture includes 2 different slot definitions that reference 2 different calculated PIDs. The first one gives a BEN based on the data from another calculated pid I setup to work out the lambda value from the onboard Fuel Temp Pressure Sensor voltage which is pid "GM.FTPS".

The factory ecu often has unused 0-5v signal ports so they can be used for all sorts of devices, generally however most people will feed the signal wire into one of the AD ports on the V1/V2 units.

The 2nd calculated slot again references another custom pid that works out the AFR & Lambda data from the onboard egrs sensor. So you have a clear understanding and follow on, here is a picture of the slot definition of that pid.

```
90    *CLC-00-013
91    V                 0.0            5.0          .1   "{GM.EGRS}"
92    AFR               10.0           20.0         .2   "2.3750*{GM.EGRS}+7.3125"
93    lambda            0              2            .4   "0.1621*{GM.EGRS}+0.4990"
```

Now that we have the Slot Definitions established, Let's move onto the PRN side.

```
#Code                    PRN   SLOT          Units             System            Description
#----------------------- ----  ------------  ----------------  ----------------  ----------------------------------------
CALC.Lambda-WO2BEN.FTPS  F110  CLC-00-133    factor            "WO2-Ben"         "Lambda BEN LS1 FTPS"
CALC.BEN.EXTA            F110  CLC-00-134    factor            "WO2-Ben"         "Base Efficiency Numerator from Lambda"
```

As you can see from the above picture there are 6 fields that are required.

1. Code is simply a name we are giving the PID

2. PRN can always be F110

3. Slot field must match the slot your providing information for

4. Units will always be a factor for a BEN

5. System is simply the name of the drop down list you want the pid to show up in. you can use an existing field name or create your own. Just as I have here.

6. Description is self explanatory

Description	Caption	Units	Default	System	Channels	Parameter
🔋 Base Efficiency Numerator from Lambda	BEN	factor	-	W02-Ben	0	CALC.BEN.EXTA
🔋 Calculated AFR from External	AFR-EXT	AFR	-	W02-Ben	0	CALC.AFR-EXT
🔋 LS1 EQ BEN from External Lambda	EQBEN_LS1	factor	-	W02-Ben	0	CALC.EQBEN_LS1

When configured correctly you should end up with something like the above

Creating Custom Serial PIDs

Just like the above examples it's pretty easy to create PIDs to deal with data coming from a serial connected wide band. If anything it's actually easier as we do not need to know about voltages or math expressions etc. We are simply working with pre-defined PIDs.

Those PIDs are: EXT.W02LAM01, EXT.W02AFR01 & EXT.W02EQR1 generally if a wide band transmits a serial data connection it will be transmitting lambda data. So to show that in the scanner we simply need to add one of the mentioned PIDs.

Build a Serial BEN PID

Now to build a BEN around that data we simply create a new Slot with the following data:

Units	Low	High	Fmt	Expression
*CLC-00-002				
factor	0.5	1.5	.3	"{GM.EQIVRATIO}*{EXT.WO2LAM1}"

Then a new PRN with the following:

Code	PRN	SLOT	Units	System	Description
CALC.EQBEN_LS1	F110	CLC-00-002	factor	"W02-Ben"	"Base Efficiency Numerator - External W02LAM1_LS1"

You then end up with:

Description	Caption	Units	Default	System	Channels	Parameter
🔋 Base Efficiency Numerator - External W02LAM1_LS1	EQBEN_LS1	factor	-	W02-Ben	0	CALC.EQBEN_LS1
⚪ Calculated AFR from External	AFR-EXT	AFR	-	W02-Ben	0	CALC.AFR-EXT
✖ AFR BEN AD1	AFR-WO2BEN	factor	-	W02-Ben	0	CALC.AFR-WO2BEN....
✖ AFR BEN AD2	AFR-WO2BEN	factor	-	W02-Ben	0	CALC.AFR-WO2BEN....
✖ AFR BEN AD3	AFR-WO2BEN	factor	-	W02-Ben	0	CALC.AFR-WO2BEN....
✖ AFR BEN AD4	AFR-WO2BEN	factor	-	W02-Ben	0	CALC.AFR-WO2BEN....
✖ AFR BEN LS1 ACP	Lambda-WO2BEN	factor	-	W02-Ben	0	CALC.Lambda-WO2B....

Revision History:

Oct 02, 2004:

    Corrected typo's

Dec 28, 2006:

By: Andy Reyna (TAQuickness)

    Revised credits

    Revised introduction

    Added verbiage for '97+ PCM's

    Added conversions for Metric and Imperial units

    Revised Open Loop commanded fuelling

    Added verbiage for custom operating systems

    Added notes to disabling MAF

Mar 10, 2007:

By: Andy Reyna (TAQuickness)

    Added verbiage for ETC

October 5 2016:

By: David Christie (Tre-Cool)

Added reference to AFR & adding in EQ & Lambda

Added in serial wide band support information

Added in custom calc pid information

Added TOC

Formatting changes