



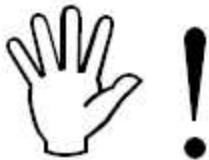
**PERFORMANCE ELECTRONICS**

# Infinity User Manual

**THIS PRODUCT IS LEGAL IN CALIFORNIA FOR RACING VEHICLES ONLY  
AND SHOULD NEVER BE USED ON PUBLIC HIGHWAYS.**

**WARNING:**

This installation is not for the tuning novice! Use this system with EXTREME caution! The AEM EMS System allows for total flexibility in engine tuning. Misuse or improper tuning of this product can destroy your engine! If you are not well versed in engine dynamics and the tuning of engine management systems DO NOT attempt the installation. Refer the installation to a AEM trained tuning shop or call 800-423-0046 for technical assistance. You must also visit the AEM Tech Forum at <http://forum.aempower.com/forum> to ensure that you are using the most current information and software.



**NOTE:** All supplied AEM calibrations, Wizards and other tuning information are offered as potential starting points only. IT IS THE RESPONSIBILITY OF THE ENGINE TUNER TO ULTIMATELY CONFIRM THE CALIBRATION IS SAFE FOR ITS INTENDED USE. AEM holds no responsibility for any engine damage that results from the misuse or mistuning of this product!

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## Introduction

### 1.1 12 Month Limited Warranty

Advanced Engine Management Inc. warrants to the consumer that all AEM High Performance products will be free from defects in material and workmanship for a period of twelve (12) months from date of the original purchase. Products that fail within this 12-month warranty period will be repaired or replaced at AEM's option, when determined by AEM that the product failed due to defects in material or workmanship. This warranty is limited to the repair or replacement of the AEM part. In no event shall this warranty exceed the original purchase price of the AEM part nor shall AEM be responsible for special, incidental or consequential damages or cost incurred due to the failure of this product. Warranty claims to AEM must be transportation prepaid and accompanied with dated proof of purchase. This warranty applies only to the original purchaser of product and is non-transferable. All implied warranties shall be limited in duration to the said 12-month warranty period. Improper use or installation, accident, abuse, unauthorized repairs or alterations voids this warranty. AEM disclaims any liability for consequential damages due to breach of any written or implied warranty on all products manufactured by AEM. Warranty returns will only be accepted by AEM when accompanied by a valid Return Merchandise Authorization (RMA) number. Product must be received by AEM within 30 days of the date the RMA is issued.

Please note that before AEM can issue an RMA for any electronic product, it is first necessary for the installer or end user to contact the EMS tech line at 1-800-423-0046 to discuss the problem. Most issues can be resolved over the phone. Under no circumstances should a system be returned or a RMA requested before the above process transpires.

AEM will not be responsible for electronic products that are installed incorrectly, installed in a non-approved application, misused, or tampered with.

Any AEM electronics product can be returned for repair if it is out of the warranty period. There is a minimum charge of \$50.00 for inspection and diagnosis of AEM electronic parts. Parts used in the repair of AEM electronic components will be extra. AEM will provide an estimate of repairs and receive written or electronic authorization before repairs are made to the product.

### 1.2 AEM Infinity

The AEM Infinity is a user-programmable Electronic Control Unit (ECU) that uses a powerful twin-CPU design. The unit features a 200Mhz 32-bit processor and a 20Mhz 16-bit aux processor with 4GB flash drive standard, expandable up to 64GB (flash drive) memory. The Infinity includes a configurable internal data logger capable of recording

100 channels at up to 1kHz of information. Every Infinity system comes with all functions installed and activated and there are no expensive options or upgrades to be performed.

The Infinity is a tool that allows the user to custom tune an engine by specific requirements. This is extremely useful and usually necessary when upgrading the engine for maximum performance, especially if installing a turbocharger, supercharger or building up a normally aspirated engine. The Infinity completely replaces the factory ECU and features unique plug and play technology, which means that each system is configured especially for the make and model of car. There is no need to modify the factory wiring harness and in most cases the vehicle may be returned to stock in a matter of minutes. The Infinity Tuner software is configured to work with the factory sensors and equipment, so that there is no need for expensive or hard to find sensors making replacement and repairs as simple as with an unmodified car.

## 1.3 Background

The Infinity platform is very different from previous generation AEM EMS products. The hardware (circuit board assembly) is designed around a very advanced automotive grade microcontroller (processor or “chip”). Several layers of software reside on this chip that allow for real time firmware programming without the need to write computer code. This technology has allowed AEM to develop advanced control models never before used on other AEM EMS products. We’ve listened to our customers over the years and have attempted to simplify the tuning process by employing an airflow based fuel control model eliminating many of the lookup and trim tables from previous generation ECUs. The look and feel is very different and it may take some time to adjust to the new tuning environment.

Our new tuning tool, Infinity Tuner is also a brand new product built from the ground up to interface with the new hardware. It features a modular design that allows users and developers to build completely customized templates and even design “plug in” applications that can automate many tuning tasks. Unlike previous AEM Setup Wizards in older products like AEM Pro and AEM Tuner, the Infinity Tuner Setup Wizard “plug in” is a completely stand-alone application that will evolve with Infinity Tuner. It is much more integrated with the ECU hardware and performs complex validation checks for all requested changes.

Among other things, Infinity Tuner is a powerful math processor. Special features allow users to create completely custom conversion channels for table data. Virtually any function can be employed to display data in different formats or units. Math functions are also used for table edits. ANY MATH function can be used not just a list of pre-defined selections. Advanced users will really enjoy the flexibility this feature adds.

A built-in logging playback/controls synchronization feature allows tuners to view live plot data and make changes to their calibration values on the fly, knowing exactly where the ECU was accessing table data. For more detailed post processing of data, AEM offers its new analysis package, AEMdata.

## 1.4 Revision History Log

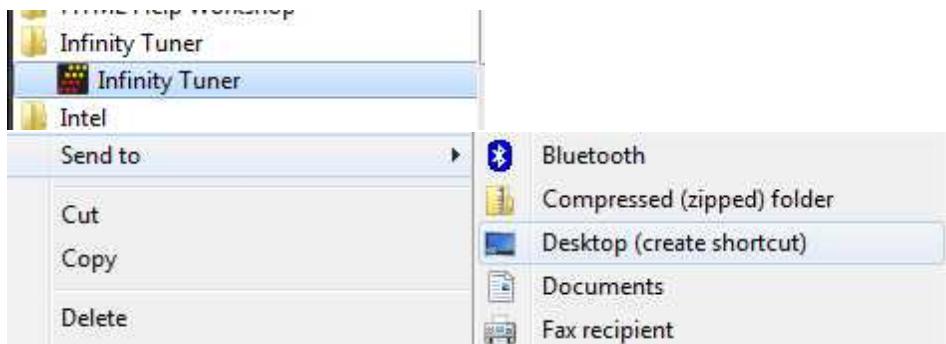
Version	Date	Modified Sections	Descriptions
B	4/23/13	Miscellaneous updates	
C	7/1/13	Wiring	Removed Supra Specific Content
D	9/30/13	Wiring	Power Distribution Schematic and Pinout updated
E	2/5/14	Many	Updated to reflect v95 revisions
F	8/25/14	Many	Updated to reflect v95 revisions

## Software

### 2.1 Software Installation

All current Infinity Tuner software installations and drivers are available for download from AEM at <http://www.aemelectronics.com/products/support>

1. Run the setup.exe. Hit Next> and follow the instructions on each page.
2. Read and accept the terms of agreement and pick your desired location for Infinity Tuner to be installed. Hit Next> and allow the software to complete installation.
3. You may now exit the Infinity Tuner installer. You can now run Infinity Tuner. To use Infinity Tuner with an ECU connected first you will need to install the necessary drivers.
4. If desired, add a desktop link for InfinityTuner. Click the Windows Start button and navigate to All Programs\InfinityTuner. Right click on the InfinityTuner link and select Send to>Desktop (create shortcut).



## 2.2 Device Driver Installation

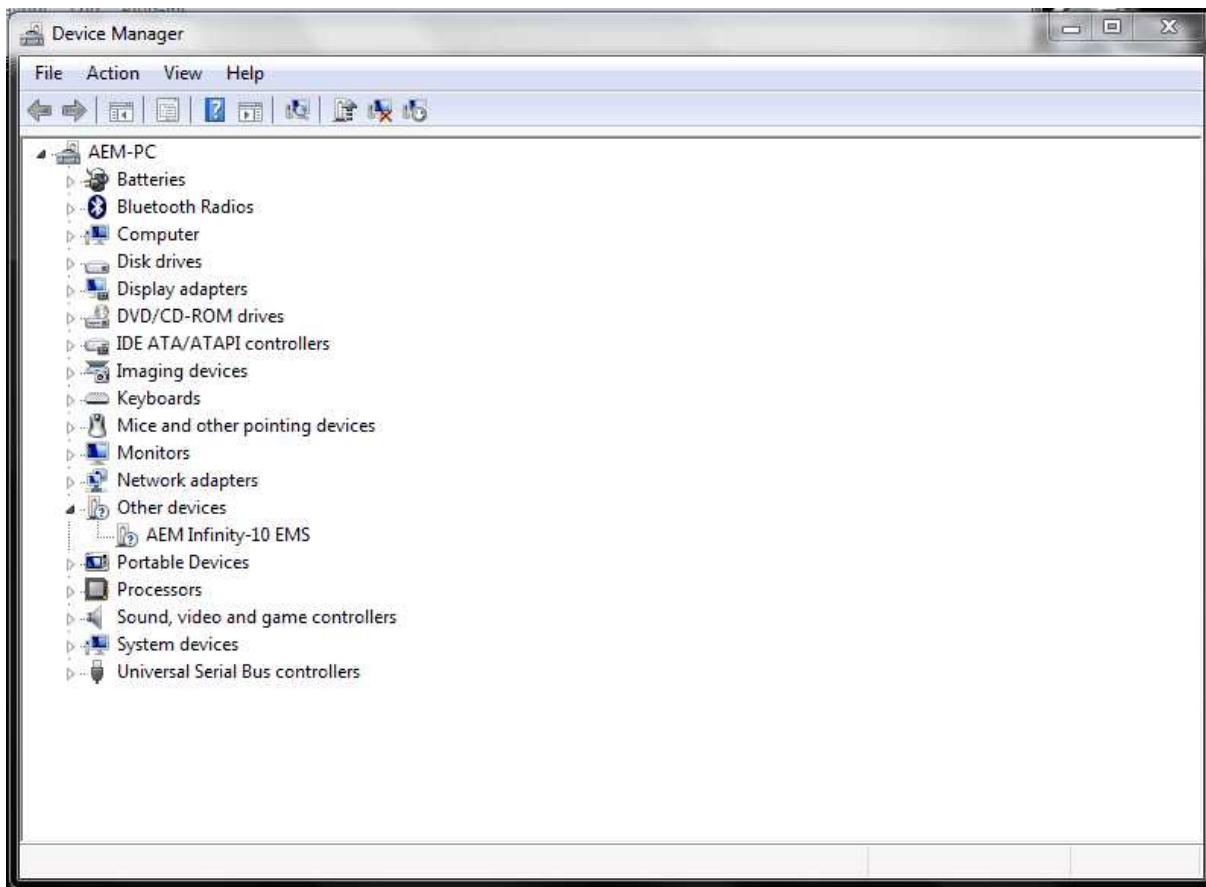
USB drivers are installed automatically as of Infinity Tuner version 2.95.7043. If installation problems occur, follow the procedure below to manually install the drivers.

USB drivers are available for download from <http://www.aemelectronics.com/products/support>

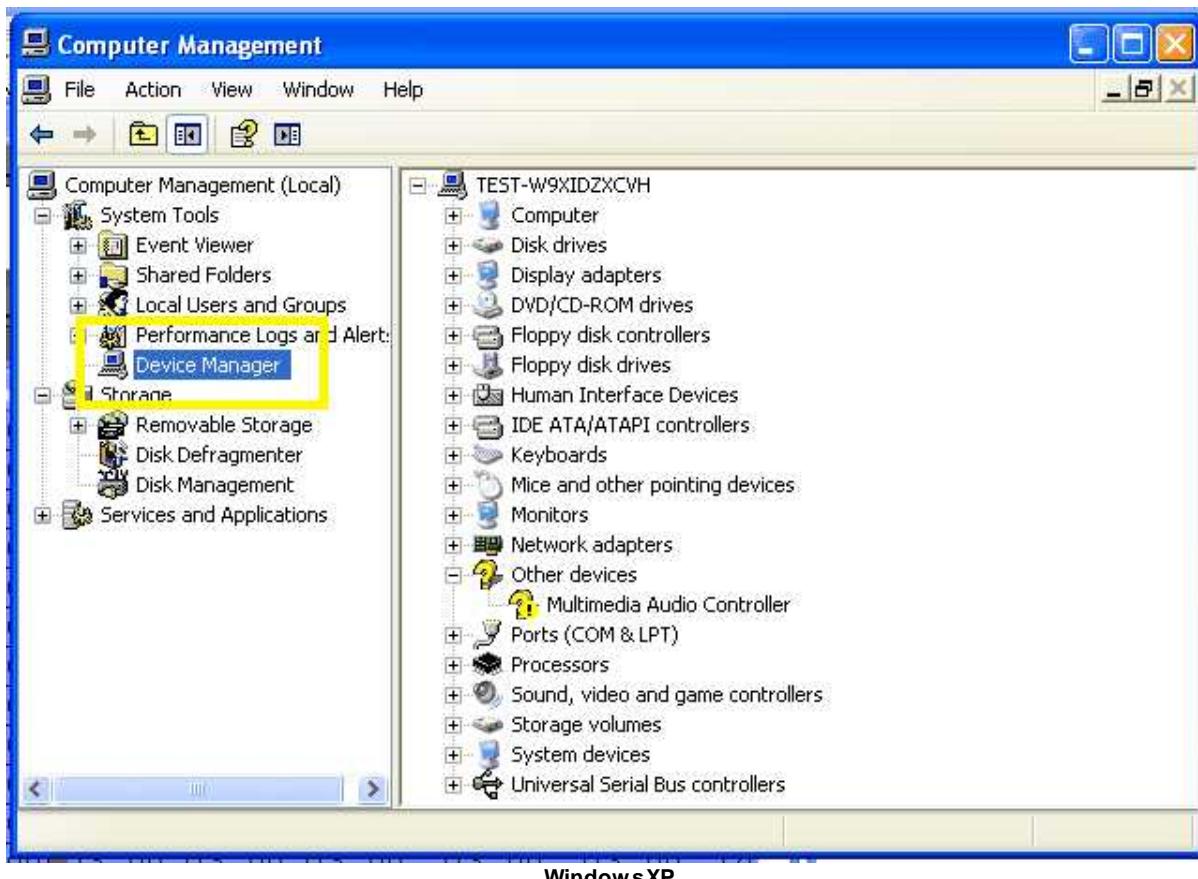
A step by step guide for driver installation is documented in the following [video](#)...or copy and paste the following link into a web browser:

<http://www.youtube.com/watch?v=i5AY2MFmnzI>

1. For these next steps the Infinity ECU will need to be installed and powered up. Refer to your harness instructions details. You will need the ignition key in the on position. Connect your computer to the ECU via the USB cable.
2. Open the device manager. How to find your device manager is described below.

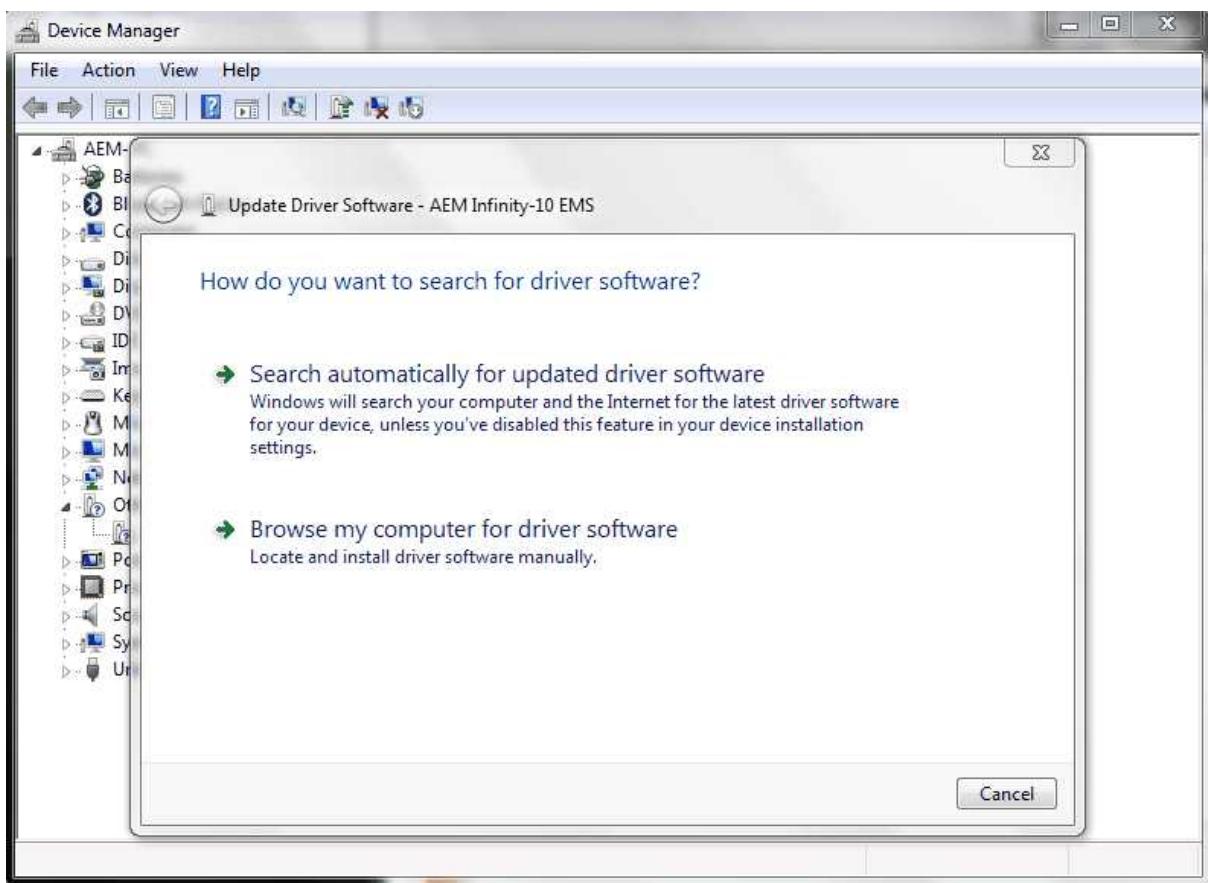


Windows 7



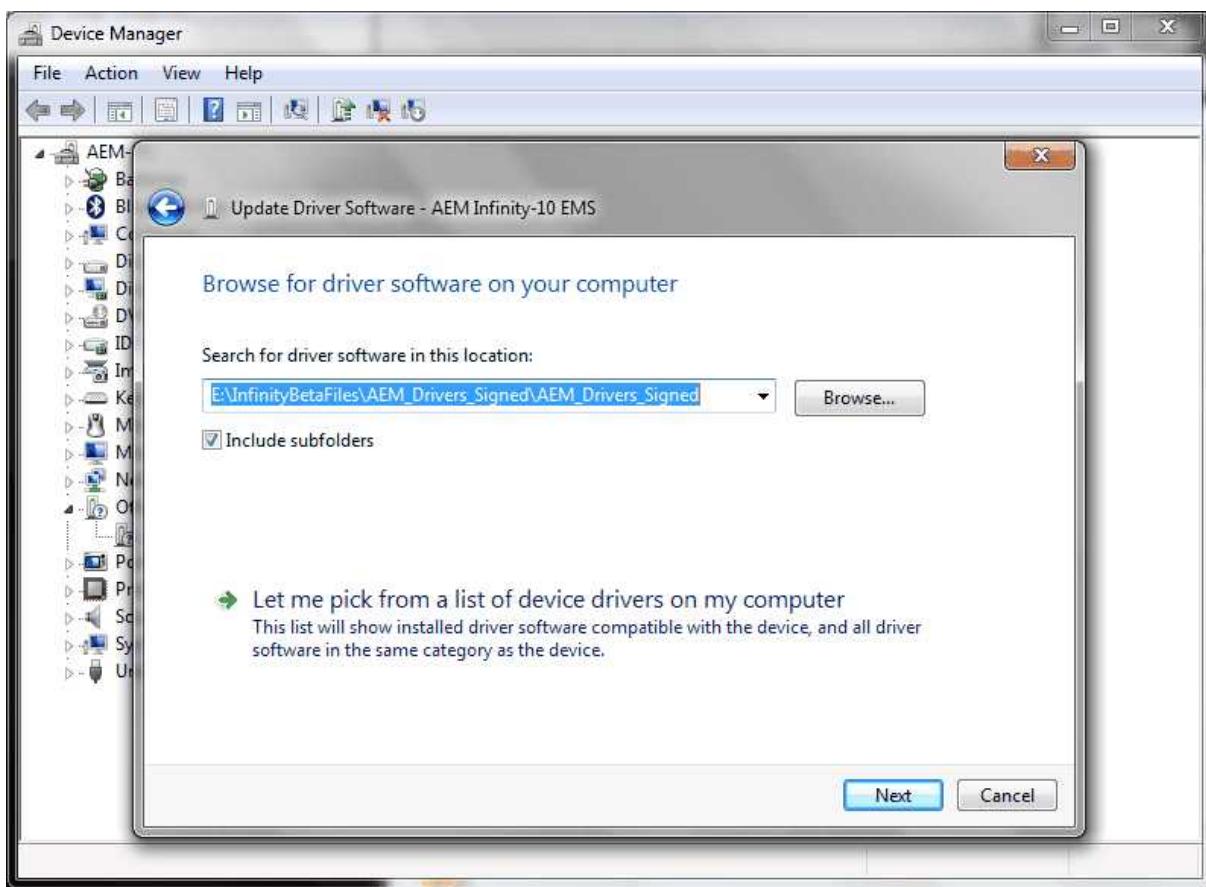
Windows XP

- For Windows 7 users you may simply search for and open the “Device manager” using the search bar under the start tab. You should see a window that looks similar to the Device manager shown above on the left hand side.
- For Window XP users right click on “My Computer” under the start tab. Click on “Manage”. Select “Device Manager”. You should see a window that looks similar to the Device manager shown above on the right hand side.



3. Next look for a device labeled something close to "AEM Infinity-10 EMS". It may be listed under "Other devices". Right click "AEM Infinity-10 EMS" and select Update Driver Software. When prompted with "How do you want to search for driver software?" select the second option, "Browse my computer for driver software Locate and install driver software manually". USB driver files can be downloaded from <http://www.aemelectronics.com/catalog-software-downloads-72/>

Save this file in an easy to find location like the Windows Desktop. You will need this link below.



**\*\*If AEM Infinity-10 EMS does not appear** on the list please verify that the USB plug is securely plugged into your computer and the ECU. Also make sure that the ECU is in fact powered up and connected correctly. If problem persists, try turning the key off and then back to the on position or try a different USB port on the PC.

4. Hit Browse and select the "AEM\_Drivers\_Signed" folder. Make sure to have the "Include subfolders" box checked. Hit next. This will install the driver software onto your computer. You will now be able to use the "Connect to USB" option in InfinityTuner.

**AEM recommends restarting your PC after making changes to your device driver installation.**

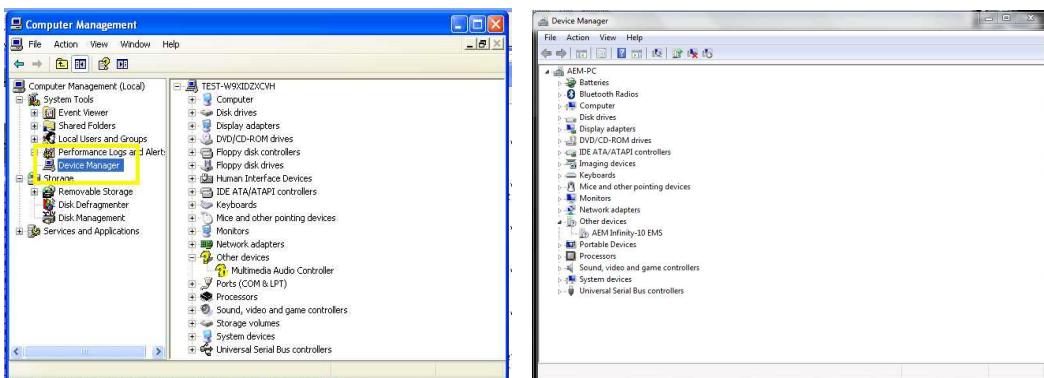
Note: To confirm the driver installed properly you can return to your device manager window. The "AEM Infinity-10 EMS" device will now be recognized and fall under the tab "AEM EMS Controllers".

## 2.3 FAQ

**In Infinity Tuner when I try to connect to my ECU using “Connection>> Connect to USB” I am experiencing an error that reads “Could not connect: The specified interface is not connected Retry?” My ECU is on and connected. What should I do?**

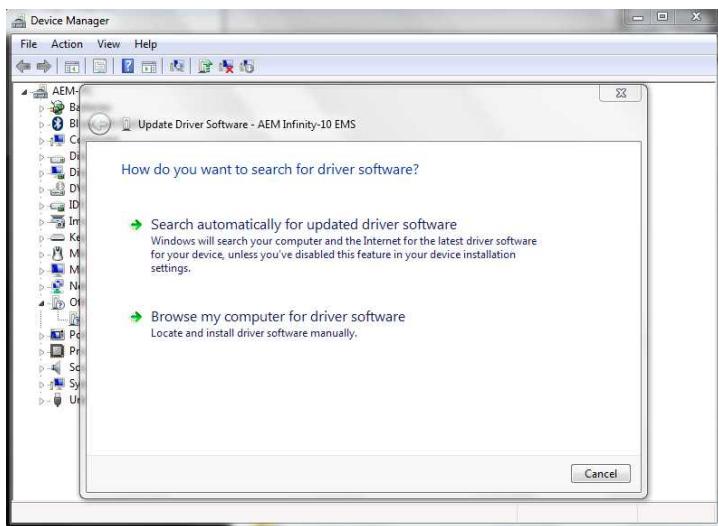


1. This problem may be occurring because the device driver needs to be installed or is not being recognized correctly. **\*Before moving forward** please verify that the USB plug is securely plugged into your computer and the ECU. Also make sure that the ECU is in fact on and connected correctly. Once verifying everything is connected properly you will need to obtain the driver files. Download the driver from <http://www.aemelectronics.com/catalog-software-downloads-72/>. Extract the AEM\_Drivers\_Signed folder into a location of your choosing.
2. Next you will need to open the device manager. How to find your device manager is described below.

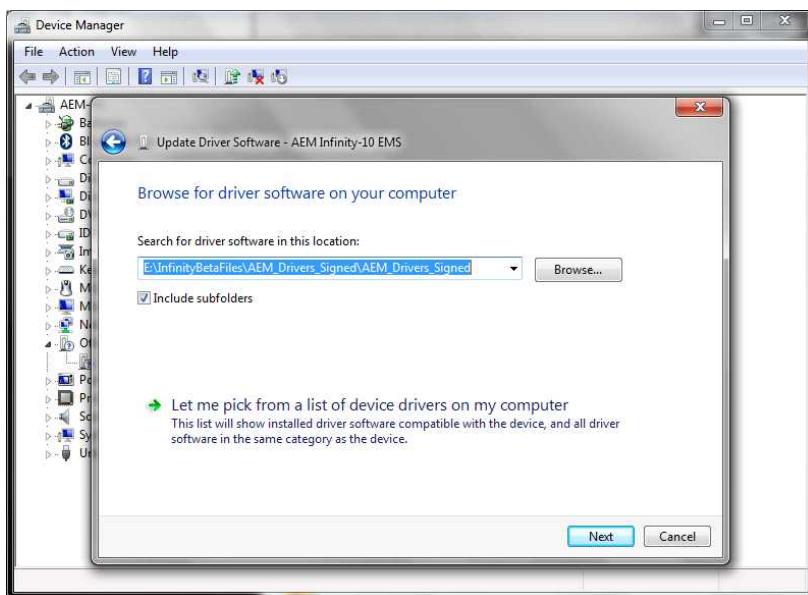


- For Windows 7 users you may simply search for and open the “Device manager” using the search bar under the start tab. You should see a window that looks similar to the Device manager shown above on the left hand side.
- For Window XP users right click on “My Computer” under the start tab. Click on “Manage”. Select “Device Manager”. You should see a window that looks similar to the Device manager shown above on the right hand side.

3. Next look for a device labeled something close to “AEM Infinity-10 EMS”. It may be listed under “Other devices”. Right click “AEM Infinity-10 EMS” and select Update Driver Software. When prompted with “How do you want to search for driver software?” select the second option, “Browse my computer for driver software Locate and install driver software manually”.



4. Hit Browse and select the “AEM\_Drivers\_Signed” folder from step 2. Make sure to have the “Include subfolders” box checked. Hit next.



This should begin to install the driver software onto your computer. Please allow it a moment to finish installing the driver. Once installation is complete you may close that window. You will now successfully be able to use the “Connect to USB” option in Infinity Tuner. To confirm the driver installed properly you can return to your device

manager window. The “AEM Infinity-10 EMS” device will now be recognized and fall under the tab “AEM EMS Controllers”.

**While running the Infinity Tuner Wizard Installer it is unable to successfully finish. A message that reads “Setup Infinity Tuner Wizard needs the Microsoft .NET 4.0 Full Framework to be installed. Press OK and Install that first.” What should I do?**

1. You need to install Microsoft .NET Framework 4. These files can be found at:

<http://www.microsoft.com/download/en/details.aspx?displaylang=en&id=17851>

The installer “**dotNetFx40\_Full\_setup.exe**” is available for download on this site. Once you have installed Microsoft .NET Framework 4 you may continue using Infinity Tuner or installing the Infinity Tuner Wizard.

**When I first start Infinity Tuner I am experiencing the following error message: “The wizard plug in has encountered an unknown problem(UI thread). Please try again.” What should I do?**

1. You need to install Microsoft .NET Framework 4. These files can be found at:

<http://www.microsoft.com/download/en/details.aspx?displaylang=en&id=17851>

The installer “**dotNetFx40\_Full\_setup.exe**” is available for download on this site. Once you have installed Microsoft .NET Framework 4 you may continue using Infinity Tuner or installing the Infinity Tuner Wizard.

## 2.4 Flash Memory Functions

Changes made to calibration tables are stored on the ECU in a temporary memory location and applied immediately. In other words, while tuning live, all changes take effect immediately. They are not however immediately saved to ECUs flash memory. The menu function *Target – Commit modifications* (Hot Key – “CTRL + SHIFT + C) is used to save all current changes to the flash. This feature allows the user to choose what changes to save to the ECU during a tuning session. *Target – Revert modifications* (Hot Key – “CTRL + SHIFT + R) removes any changes not previously saved. At key off, the system will automatically commit all unsaved changes if the Key Off Commit option is checked in the Tuning Preferences Setup Wizard page.

## 2.5 Getting Started

### File Extensions

The Infinity EMS software uses several different file naming conventions.

#### **.ITSSN**

This file represents a Session (or Calibration). AEM provided base sessions are installed to the following location.

\Documents\AEM\Infinity Tuner\Sessions\Base Sessions

#### **.ITLOG**

This file is created when saving a Log.

#### **.ITLYT**

This file is created when making a Layout. Layouts allow the user to customize the way information and data is presented on the screen. AEM provided sample layouts are installed to the following location.

\Documents\AEM\Infinity Tuner\Layouts

#### **.PDF**

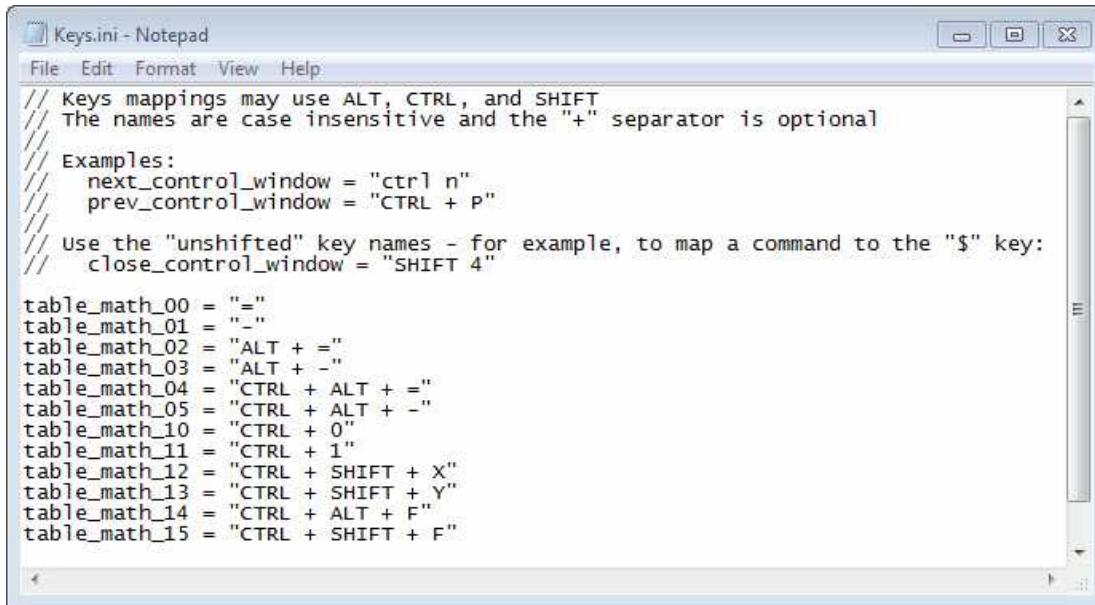
These are Adobe Reader files. All documentation is in this format. AEM provide instructions are installed to the following location.

\Documents\AEM\Infinity Tuner\Instructions

## Keyboard Shortcuts

Custom keyboard shortcuts can be created easily by navigating to the following folder location:

### My Documents / AEM / Infinity Tuner / Keys.ini



```
Keys.ini - Notepad
File Edit Format View Help

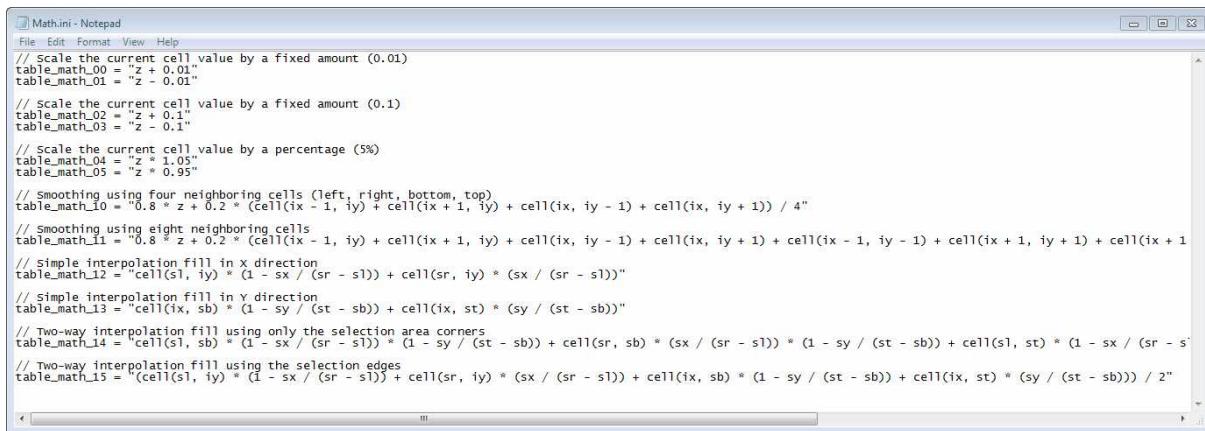
// Keys mappings may use ALT, CTRL, and SHIFT
// The names are case insensitive and the "+" separator is optional
//
// Examples:
//   next_control_window = "ctrl n"
//   prev_control_window = "CTRL + P"
//
// use the "unshifted" key names - for example, to map a command to the "$" key:
//   close_control_window = "SHIFT 4"

table_math_00 = "="
table_math_01 = "_"
table_math_02 = "ALT + ="
table_math_03 = "ALT + -"
table_math_04 = "CTRL + ALT + ="
table_math_05 = "CTRL + ALT + -"
table_math_10 = "CTRL + 0"
table_math_11 = "CTRL + 1"
table_math_12 = "CTRL + SHIFT + X"
table_math_13 = "CTRL + SHIFT + Y"
table_math_14 = "CTRL + ALT + F"
table_math_15 = "CTRL + SHIFT + F"
```

## Math Functions

Custom math functions can be created easily by navigating to the following folder location:

### My Documents / AEM / Infinity Tuner / Math.ini



```
Math.ini - Notepad
File Edit Format View Help

// Scale the current cell value by a fixed amount (0.01)
table_math_00 = "z + 0.01"
table_math_01 = "z - 0.02"

// scale the current cell value by a fixed amount (0.1)
table_math_02 = "z + 0.1"
table_math_03 = "z - 0.1"

// scale the current cell value by a percentage (5%)
table_math_04 = "z * 1.05"
table_math_05 = "z * 0.95"

// Smoothing using four neighboring cells (left, right, bottom, top)
table_math_10 = "0.8 * z + 0.2 * (cell(ix - 1, iy) + cell(ix + 1, iy) + cell(ix, iy - 1) + cell(ix, iy + 1)) / 4"

// Smoothing using eight neighboring cells
table_math_11 = "0.8 * z + 0.2 * (cell(ix - 1, iy) + cell(ix + 1, iy) + cell(ix, iy - 1) + cell(ix, iy + 1) + cell(ix - 1, iy - 1) + cell(ix + 1, iy - 1) + cell(ix - 1, iy + 1) + cell(ix + 1, iy + 1)) / 8"

// Simple interpolation fill in x direction
table_math_12 = "cell(s1, iy) * (1 - sx / (sr - s1)) + cell(sr, iy) * (sx / (sr - s1))"

// Simple interpolation fill in y direction
table_math_13 = "cell(ix, sb) * (1 - sy / (st - sb)) + cell(ix, st) * (sy / (st - sb))"

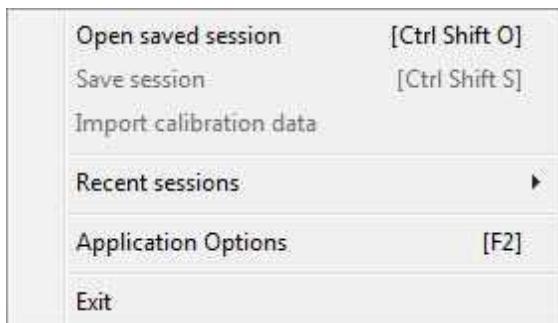
// Two-way interpolation fill using only the selection area corners
table_math_14 = "cell(s1, sb) * (1 - sx / (sr - s1)) * (1 - sy / (st - sb)) + cell(sr, sb) * (sx / (sr - s1)) * (1 - sy / (st - sb)) + cell(s1, st) * (1 - sx / (sr - s1)) * (1 - sy / (st - sb))"

// Two-way interpolation fill using the selection edges
table_math_15 = "(cell(s1, iy) * (1 - sx / (sr - s1)) + cell(sr, iy) * (sx / (sr - s1)) + cell(ix, sb) * (1 - sy / (st - sb)) + cell(ix, st) * (sy / (st - sb))) / 2"
```

For more information, go to [Hot Keys](#) 

## 2.6 File Menu

In the Infinity Tuner software, select the **File** drop down menu.



### **Open saved session:**

Opens the background models from a previously saved session. Opening a session implies connecting to the offline Infinity simulator.

### **Save Session:**

Saves the current session. If logged data is included in the session, two files will be saved with this command:

.itssn - the configuration and calibration data

.itlog - the logged data file

### **Import calibration data:**

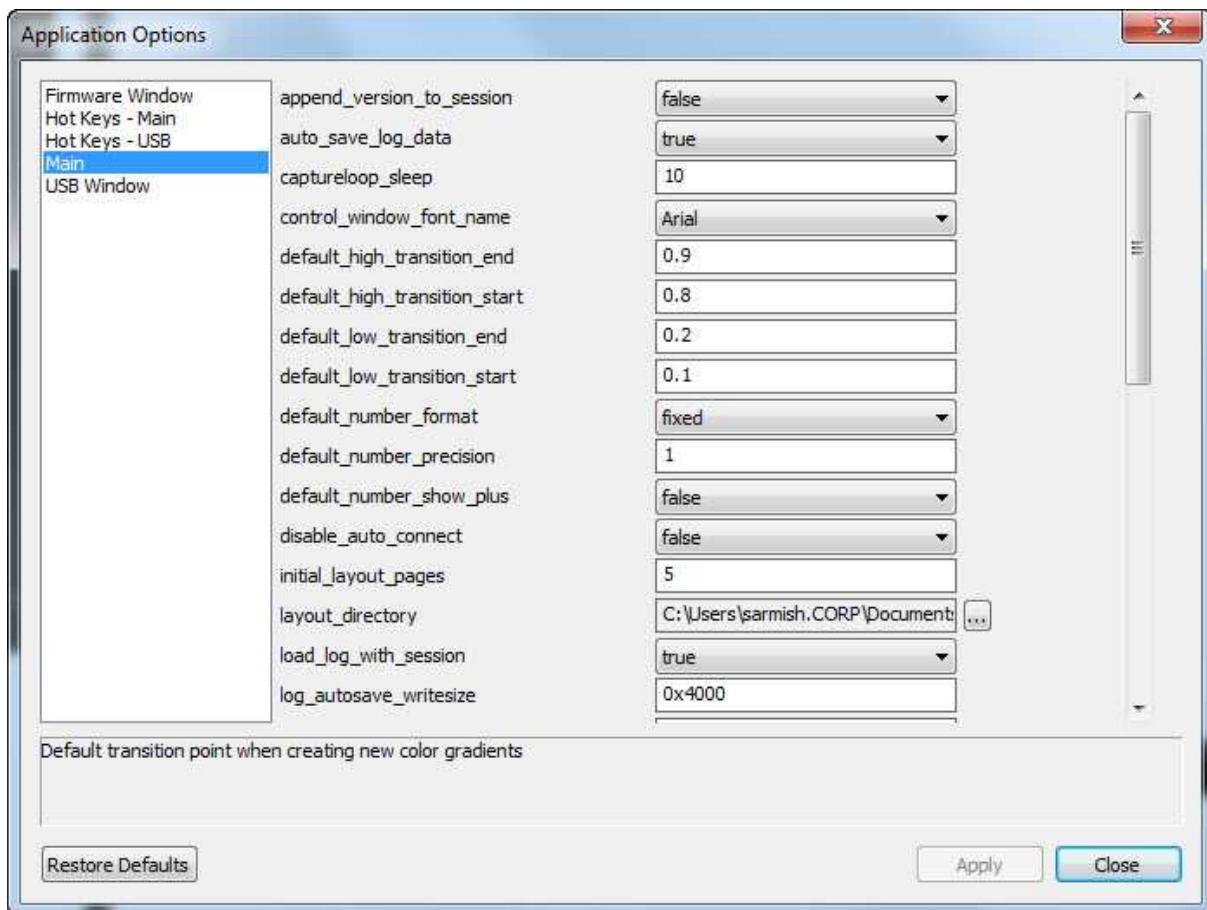
Imports modifiable data such as calibration changes to tables, etc. This command allows the download of a saved calibration to the controller. The saved calibration consists created items, system Predefined items, and Unresolved External Names. The existing system calibration will be cleared before the calibration is downloaded.

### **Recent sessions:**

Displays a listing of most recently opened session files for quick reference.

### **Application Options:**

Allows fine tuning of many application preferences. Clicking on...or hovering the mouse over each setting will display a corresponding description in the lower part of the window.

**Exit:**

Closes the Infinity Tuner

## 2.7 Connection Menu

In the Infinity Tuner software, select the **Connection** drop down menu.

### Connect to USB:

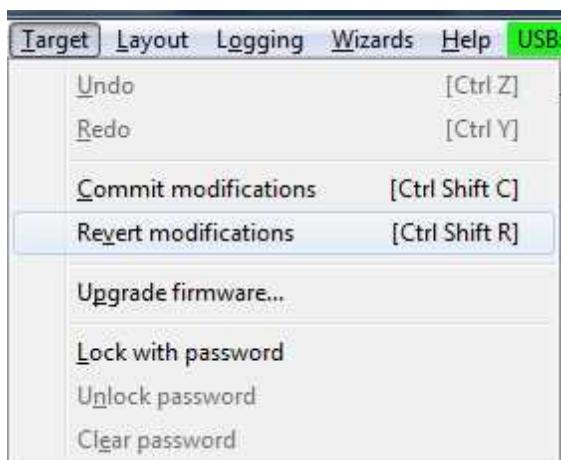
Connects to the ECU using the USB port. The ECU must be powered properly.

### Disconnect:

This option will terminate the ECU USB connection.

## 2.8 Target Menu

In the Infinity Tuner software, select the **Target** drop down menu.



### Undo:

Undo last commanded edit. Hotkey = Ctrl Z

### Redo:

Redo last commanded edit. Hotkey = Ctrl Y

### Commit modifications:

This action will update the non-volatile storage of the ECU with the users changes. The data that would be saved on the ECU includes the following:

- Table data changes.
- Initial value changes.
- "Predefined item" changes especially "Static" types.

### Revert modifications:

Resets all data changed since the last time the calibration was "Committed". Once the "Commit" is performed, the changes cannot be "Reverted". The user can make changes to the table data while tuning and "Revert" the changes before "Committing". The user

can always save the calibration to a file as well.

#### **Upgrade firmware....:**

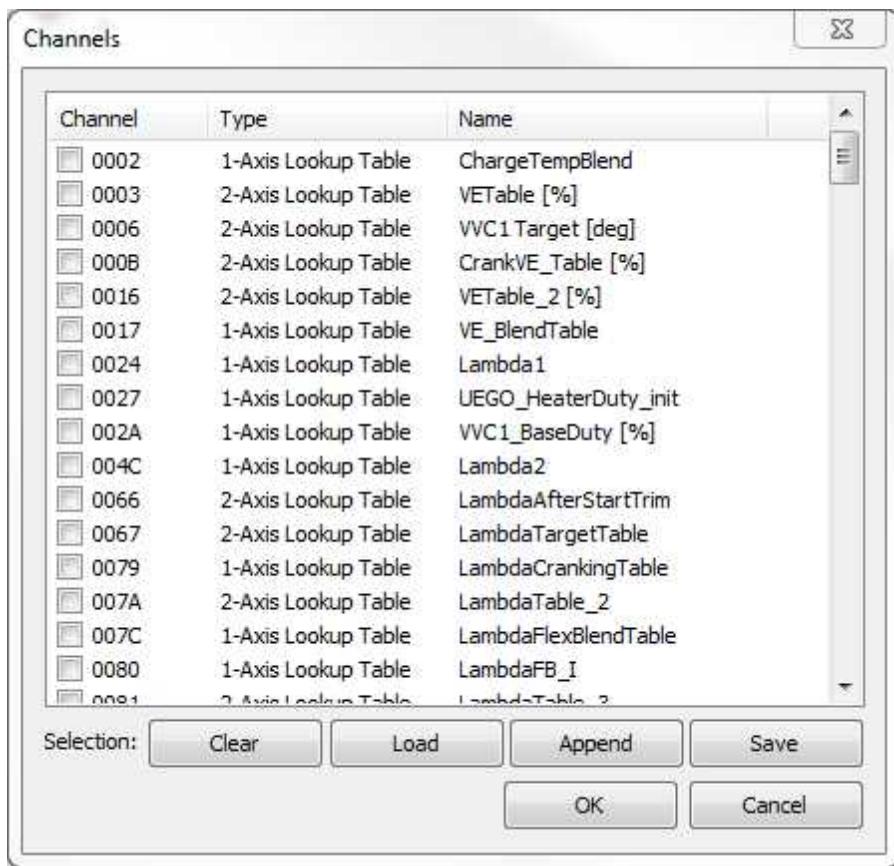
The firmware update process is described in [Firmware Update](#)<sup>66</sup> under the Infinity ECU Hardware section.

#### **Lock with password:**

Table data can be locked with a password on an individual channel basis.



Click the Set button to select channels.



This dialog allows the user to select channels for password protection. Manually select channels by left clicking on the check box or alternately by using the arrow keys to scroll through the list and the space bar key to select. Lists can be saved for later use by using the Save button. The Load button will load previously saved lists of channels. The Append button will append a different list of channels onto the existing list of selected channels. Enter and confirm the password to set.

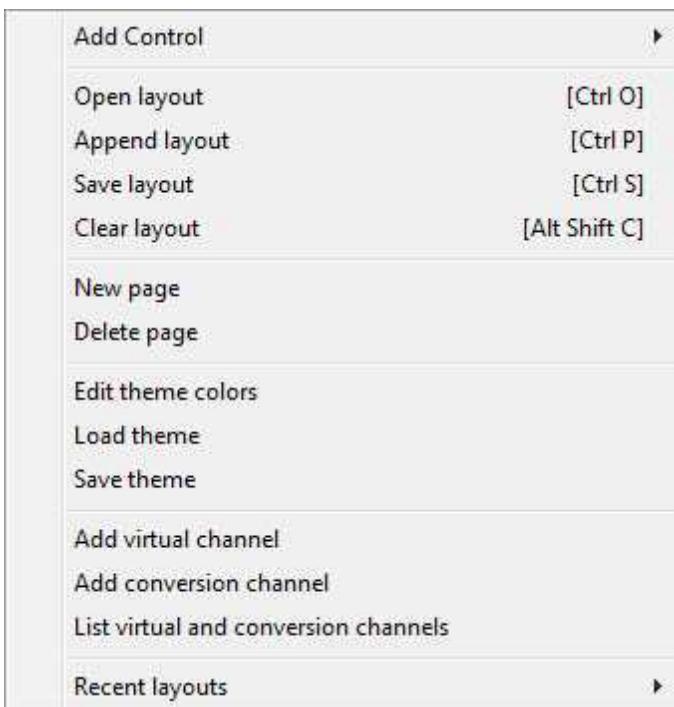
#### **Clear password:**

An existing password can be cleared but all data in the protected channels will be cleared as well and usually set to all zeros.



## 2.9 Layout Menu

The Layout feature controls how the channels within Infinity Tuner are used and viewed. In the Infinity Tuner software, select the **Layout** drop down menu.



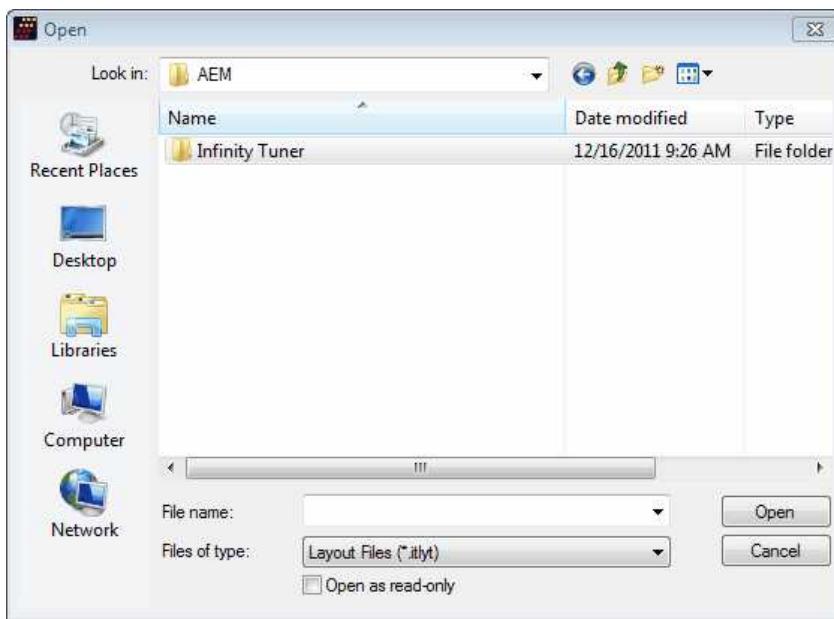
### **Add Control:**

Adds a new control window to the existing layout. See [Software>Control Windows](#) [32] for more detail.

### **Open layout:**

Opens a new layout file.

Note that layout files can be saved as shortcuts. Clicking the shortcut will launch Infinity Tuner and load the layout file.

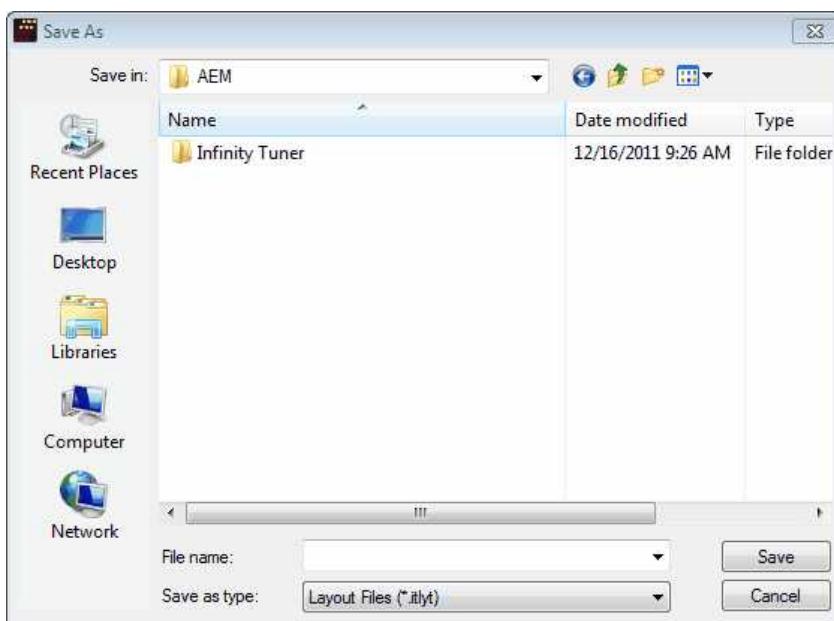


### Append layout:

This function can be used to append layout controls from another file onto the current one.

### Save layout:

This function saves a new layout.



### Clear layout:

This feature clears all controls from the current layout.

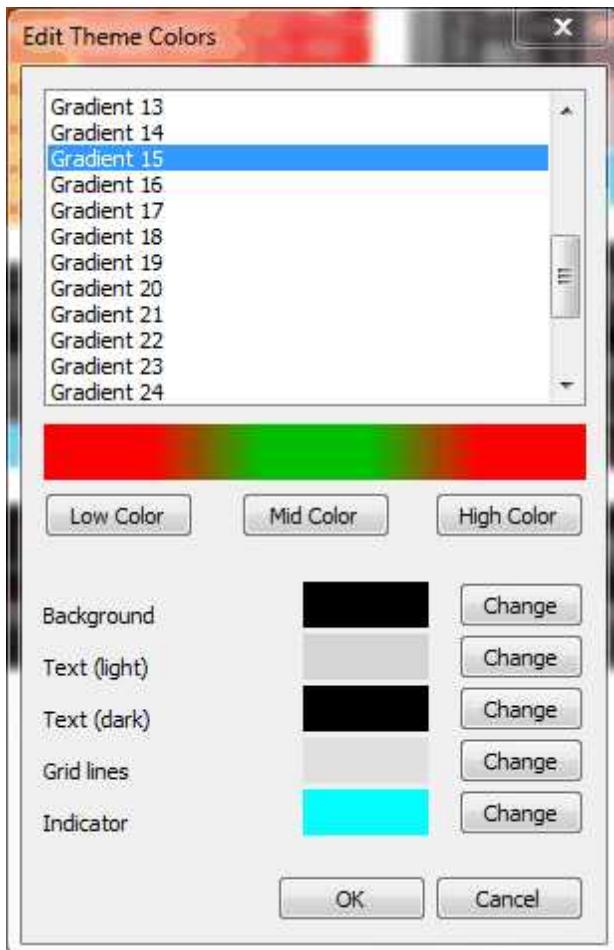
**New Page:**

This function adds a new page to the layout. Note the "Page 19" tab shown below.

**Delete Page:**

This function deletes the current page selected.

- Simply select the tab that you wish to remove from the layout
- Navigate to Layout | Delete Page
- Make sure to save the layout if you would like to keep these changes

**Edit theme colors:**

The complete look of Infinity Tuner can be customized from within this dialog. Up to 30 individually customizable gradients can be used to configure colors to user preferences. Background colors, text colors grid lines and indicator colors can all be customized.

**Load theme:**

This feature loads a previously saved theme.

**Save theme:**

Use to save a new theme file.

**Add virtual channel:**

This function allows the user to add a virtual channel. See [Software>Virtual and Conversion Channels](#)<sup>[49]</sup> for more detail.

**Add conversion channel:**

This function allows the user to add a conversion channel. See [Software>Virtual and Conversion Channels](#)<sup>[49]</sup> for more detail.

**List virtual and conversion channels:**

This function lists all available virtual and conversion channels and allows editing. See [Software>Virtual and Conversion Channels](#)<sup>[49]</sup> for more detail.

**Recent layouts:**

Displays a list of recently used layout files for quick reference.

## 2.10 Default Layouts

AEM includes a selection of version specific layouts with each software installation. Default layouts are saved to your \Documents\AEM\Infinity Tuner\Layouts\v95 folder where "v95" reflect the most recent firmware revision.

Documents library			
v95			
Name	Date modified	Type	Size
Infinity-6	3/20/2014 2:18 PM	File folder	
Infinity-8_10_12	3/20/2014 2:18 PM	File folder	
Infinity-8h	3/20/2014 2:18 PM	File folder	

Layouts are further separated by hardware platform, Infinity-6, Infinity-10, etc.

Name	Date modified	Type	Size
Adv_Tuning_MultiMap	3/20/2014 1:45 PM	Infinity Tuner Lay...	46 KB
AllTabs	3/20/2014 5:52 PM	Infinity Tuner Lay...	186 KB
Basic_Tuning	3/20/2014 1:19 PM	Infinity Tuner Lay...	27 KB
BoostControl	3/20/2014 1:53 PM	Infinity Tuner Lay...	20 KB
Dash	3/20/2014 12:20 PM	Infinity Tuner Lay...	13 KB
DBW	3/20/2014 2:07 PM	Infinity Tuner Lay...	15 KB
Knock	3/20/2014 1:52 PM	Infinity Tuner Lay...	23 KB
Launch_ShiftCut	3/20/2014 1:57 PM	Infinity Tuner Lay...	21 KB
Nitrous	3/20/2014 2:00 PM	Infinity Tuner Lay...	15 KB
Setup_Protect_Diag	3/20/2014 12:25 PM	Infinity Tuner Lay...	41 KB
Start_Idle	3/20/2014 1:48 PM	Infinity Tuner Lay...	22 KB
TC_Gear	3/20/2014 1:50 PM	Infinity Tuner Lay...	26 KB
VVC	3/20/2014 2:02 PM	Infinity Tuner Lay...	19 KB

Within each folder is a listing of function specific layouts. Depending on the situation, different layouts may work better and of course, they can be further customized as needed. Two of the included layouts might be most useful for new installations.

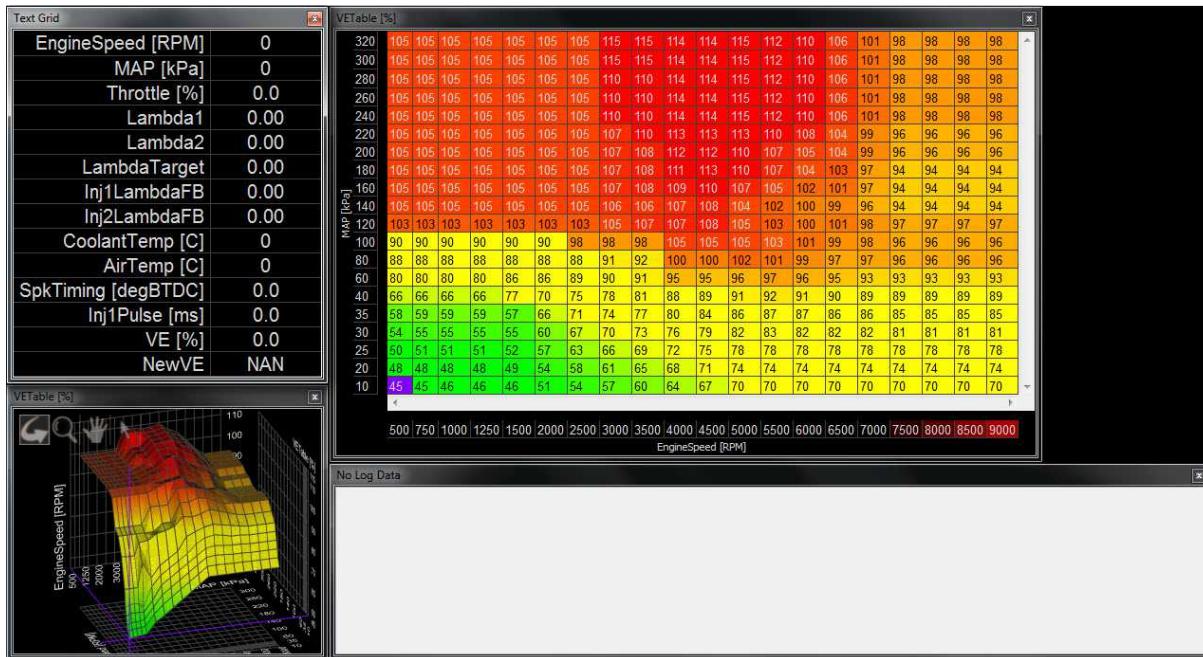
## Setup\_Protect\_Diag

This layout contains useful data for new installations where setup and troubleshooting are of interest. An example image is shown below for the *Inputs* page of the Setup\_Protect\_Diag layout. The Inputs page includes useful information for setting up hardware input channels.



## Basic\_Tuning

This layout file includes useful channels setups for basic tuning. The *VE* tab is setup for quick tuning of the VE table and related data. The *Tuning* tab is available for quick setup of a PC logging template for dyno pulls or other vehicle/engine testing.

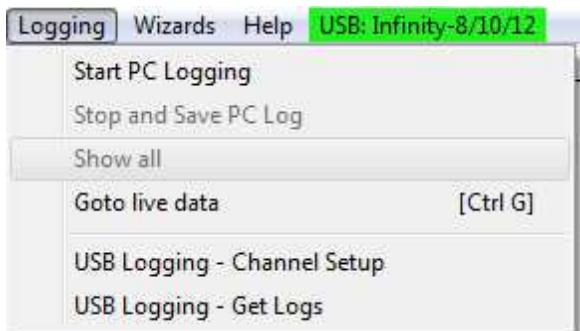


AEM recommends using the Layout - Append layout function to build customized user

layouts. Start with either the *Basic\_Tuning*, *Setup\_Protect\_Diag* or both and append other function specific tabs as needed depending on the type of testing. Note that the Infinity system logs PC data very fast, up to 500 Hz in some cases. A very large layout will result in very large PC log files and (depending on the PC) may take a long time to save and load. It is best to always use the layout best suited for a particular testing need.

## 2.11 Log Menu

By clicking the **Logging** drop down menu, the following options are available:



**Start PC Logging:** When selected from the navigation bar, this data logs all channels.

**Stop and Save PC Log:** Selecting this option while recording will turn OFF the log. A current log will be lost once a new log starts. To save a log, be sure to do a Save Session from the File Menu

**Show all:** Selecting this option will show all logs

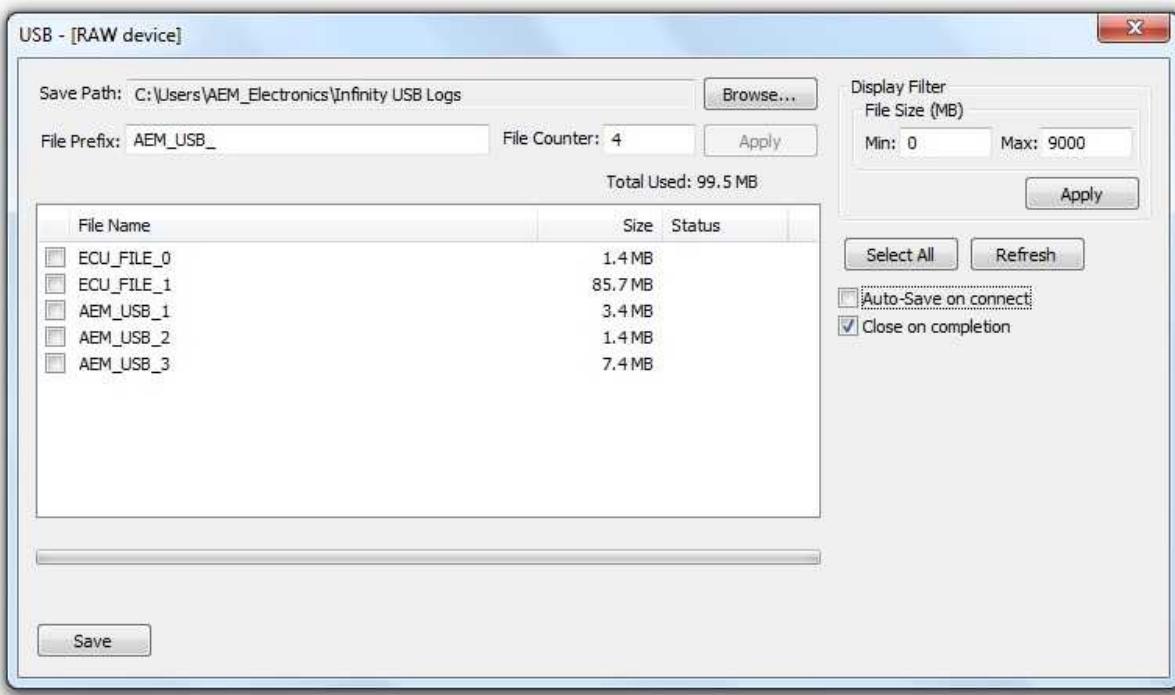
**Goto live data:** Quick function that allows transition from log viewing to live data

**USB Logging - Channel Setup:** This dialog allows the user to select channels for USB logging. Manually select channels by left clicking on the check box or alternately by using the arrow keys to scroll through the list and the space bar key to select. Logging lists can be saved for later use by using the Save button. The Load button will load previously saved lists of channels. The Append button will append a different list of channels onto the existing list of selected channels. Note that the list of channels for logging is saved in ECU memory. Channels can't be selected offline. They can only be selected when connected to an ECU.

Channel	Type	Name
0000	Model identifier	Model_ID
0002	No Operation	CAN_FRWS [MPH]
0003	No Operation	CAN_FLWS [MPH]
0004	No Operation	CAN_RRWS [MPH]
0005	No Operation	CAN_RLWS [MPH]
0006	No Operation	CC_Enable
0007	No Operation	CC_Set
0008	No Operation	CC_Cancel
0009	No Operation	CC_Up
000A	No Operation	CC_Down
000B	No Operation	CC_ModeSwitch
000C	Engine Description	Engine Description
000E	If-Else Condition	EngineProtectOut
000F	If-Else Condition	MILOutput
0010	1-Axis Lookup Table	MIL_Manual_Trigger
0011	No Operation	DBW1_UserEnable
0012	No Operation	DBW1_Traction_Clamp_H

**USB Logging - Get Logs:** This menu allows the user to configure the file transfer features for USB logging.

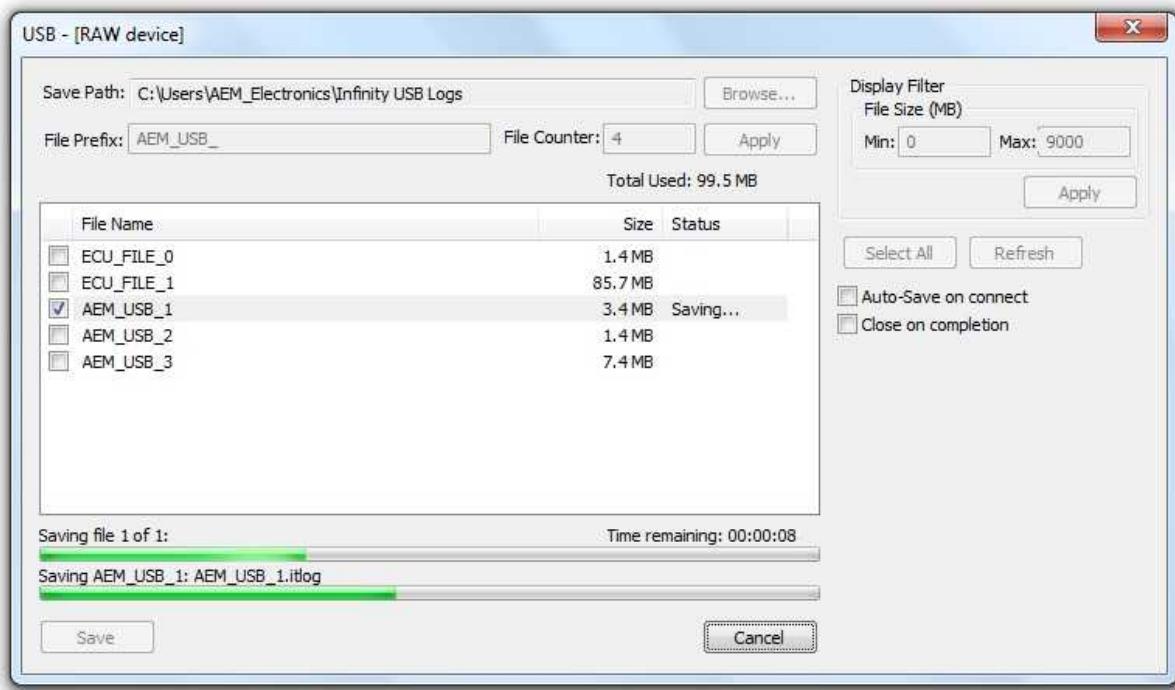
If Auto-Save On Connect is selected below, the system will automatically transfer file from the USB storage device to the PC when connected according to the settings in the Upload Files... dialog shown below.



Define the save path by clicking the Browse... button and choosing a save folder location. A user File Prefix and File Counter can be chosen as shown in the example above. There is a display filter that allows the user to filter the file list for files above a certain size. All USB log files are saved individually. Every time the logging conditions are met, a file is opened. When the logging conditions are no longer met, the file is closed and saved. The Display Filter can filter out small files that may result from quick logging start/stop conditions.

To choose a list of individual files to save, select them from the list by left clicking the check box. Alternately, they can be selected by using the arrow keys and space bar to select. Under the Save category, choose to save either Selected files or All files. The Close on completion option will automatically close the dialog when the save task is complete.

The dialog will display the current status of the file transfer(s) as shown below.



## 2.12 Wizards Menu

The wizards menu allows the user to select from several smart tools to aid in setup and tuning. See the [Wizard Setup](#) section for more information.

## 2.13 Help Menu

Information on the Infinity Tuner build can be found here.

## 2.14 Connection Status

Various connection statuses are displayed to indicate current ECU mode from connected, simulation, or not connected.

**USB: Infinity-8/10/12**

Example showing USB connection  
to Infinity ECU

**Saved session: 2014\_02\_27\_15\_34\_54\_0.itssn**

Example showing session file opened offline

**Not connected**

Not connected to ECU. No  
session file currently opened.

**USB: Unknown Board**

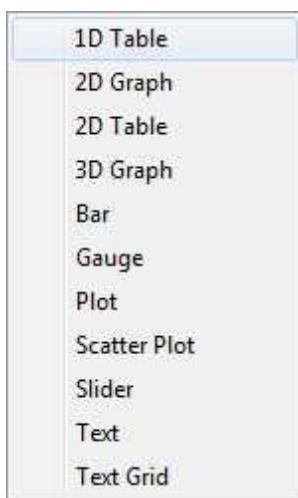
Possible problem with board, try  
turning ignition off and on and ensure  
ping C1-9 Flash Enable is not  
connected to 12v

## 2.15 Control Windows

There are many different types of controls including: 1D Table, 2D Graph, 2D Table, 3D Graph, Bar, Gauge, Plot, Scatter Plot, Slider, Text, and Text Grid.

To create a control

1. Select *Layout > Add Control*.
2. Select the desired control from the Add Control menu.



3. Select the desired channel(s) from the Channel List dialog box.
4. Click OK to access the Control Properties dialog box.
5. Adjust control property settings, if applicable.
6. Click OK to create the control and display it in the layout.

### 1D Table

A 1D Table represents a one-dimensional translation (one input channel). It is essentially a math calculation that maps one value to another based on a look-up table, instead of a math expression.

To add a 1D Table

1. Select *Layout > Add Control > 1D Table*.
2. Right Click on the window and select *Set Channel*.

Channel	Type	Name
0000	Engine Description	1GDSM
0001	1-Axis Lookup Table	Coil1TrimTable [deg]
0002	1-Axis Lookup Table	Coil2TrimTable [deg]
0003	1-Axis Lookup Table	Coil3TrimTable [deg]
0004	1-Axis Lookup Table	Coil4TrimTable [deg]
0005	1-Axis Lookup Table	Coil5TrimTable [deg]
0006	1-Axis Lookup Table	Coil6TrimTable [deg]
0007	Math Calculation	SpkTiming1 [degBTDC]
0008	Math Calculation	SpkTiming2 [degBTDC]
0009	Math Calculation	SpkTiming3 [degBTDC]
000A	Math Calculation	SpkTiming4 [degBTDC]
000B	Math Calculation	SpkTiming5 [degBTDC]
000C	Math Calculation	SpkTiming6 [degBTDC]
000D	Speed Density	MAF_SD [gms/s]
000E	1-Axis Lookup Table	ChargeTempBlend
000F	2-Axis Lookup Table	VETable [%]
0010	If-Else Condition	VEswitch
0011	Multiplexor	VE [%]

OK Cancel

3. Select the desired 1-Axis Lookup Table from the Channel List dialog box.
4. Click OK.

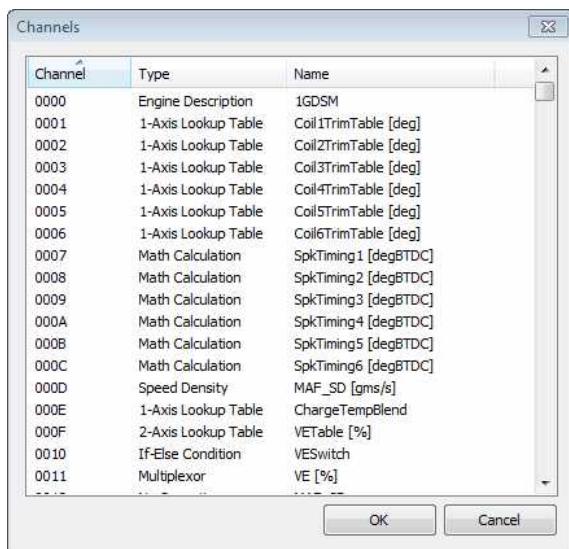
AirTempCal [C]																	
127	108	82	67	58	51	45	39	33	25	18	12	6.001	0	-8	-23	-50	
0.1	147	314	508	733	1000	1320	1711	2200	2829	3667	4840	6600	9533	15400	33000	1.0978e+06	
AirTempResistance [ohms]																	

## 2D Graph

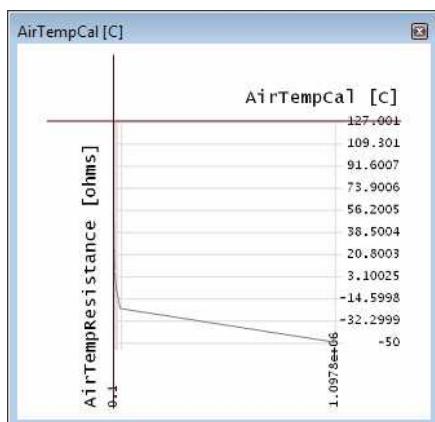
A 2D Graph represents a one-dimensional translation (one input channel). It is essentially a math calculation that maps one value to another based on a look-up table, instead of a math expression.

To add a 2D Graph

1. Select *Layout > Add Control > 2D Graph*.
2. Right Click on the window and select *Set Channel*.



3. Select the desired 1-Axis Lookup Table from the Channel List dialog box.
4. Click OK.

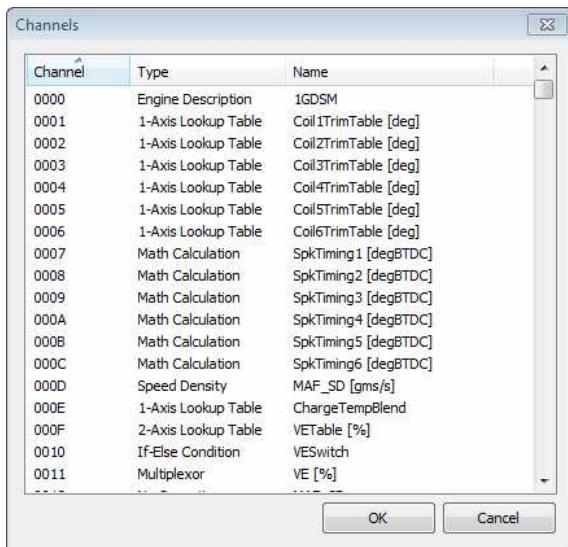


## 2D Table

A 2D Table represents a two-dimensional matrix (two input channels). The two inputs index into a lookup table for the output.

To add a 2D Table

1. Select *Layout > Add Control > 2D Table*.
2. Right Click on the window and select *Set Channel*.



3. Select the desired 2-Axis Lookup Table from the Channel List dialog box.
4. Click OK

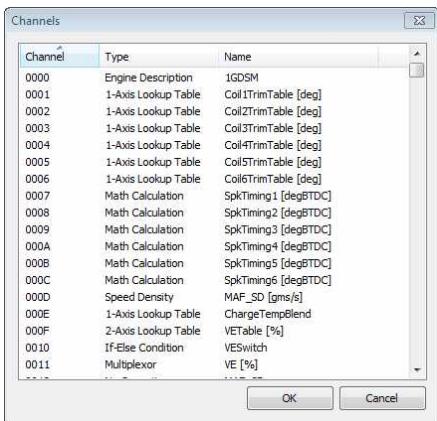


## 3D Graph

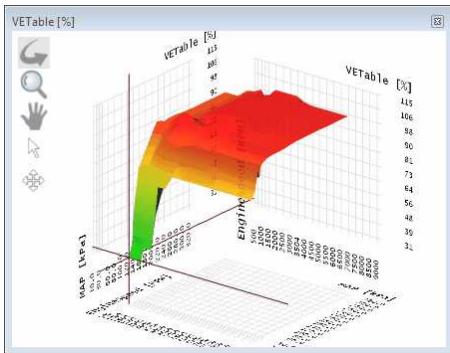
A 3D Graph represents a two-dimensional matrix (two input channels). The two inputs index into a lookup table for the output.

To add a 3D Graph

1. Select *Layout > Add Control > 3D Graph*.
2. Right Click on the window and select *Set Channel*.



3. Select the desired 2-Axis Lookup Table from the Channel List dialog box.
4. Click OK. A 3D Graph provides a visual representation of one channel input relative to another channel input.



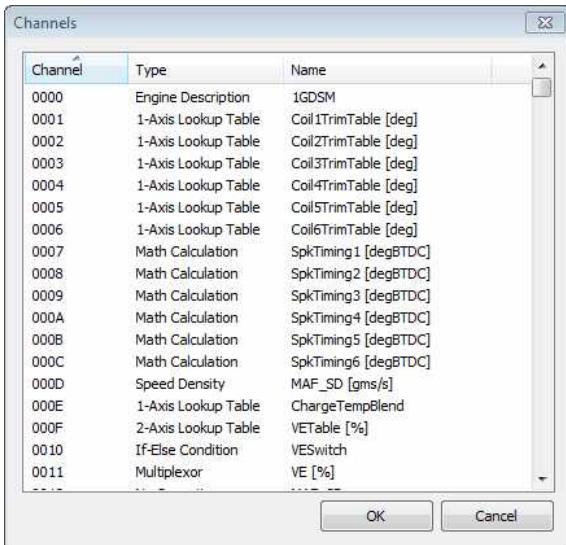
- Rotate: Rotates the 3D graph. Left-click, hold, and move the cursor to the right, left, up or down to rotate the graph right, left, up or down.
- Zoom: Zooms in and out. Left-click, hold, and move the cursor to enlarge or reduce the graph size.
- Pan: Moves the 3D graph left, right, up, or down.

## Bar

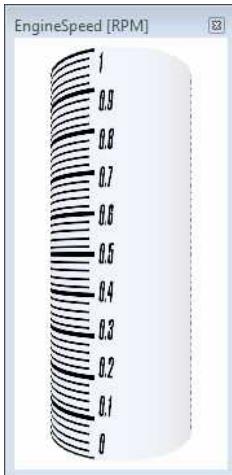
A Bar is a measuring instrument that requires one input channel.

To add a Bar

1. Select Layout > Add Control > Bar
2. Right Click on the window and select *Set Channel*.



3. Select the desired Channel from the dialog box.
4. Click OK.

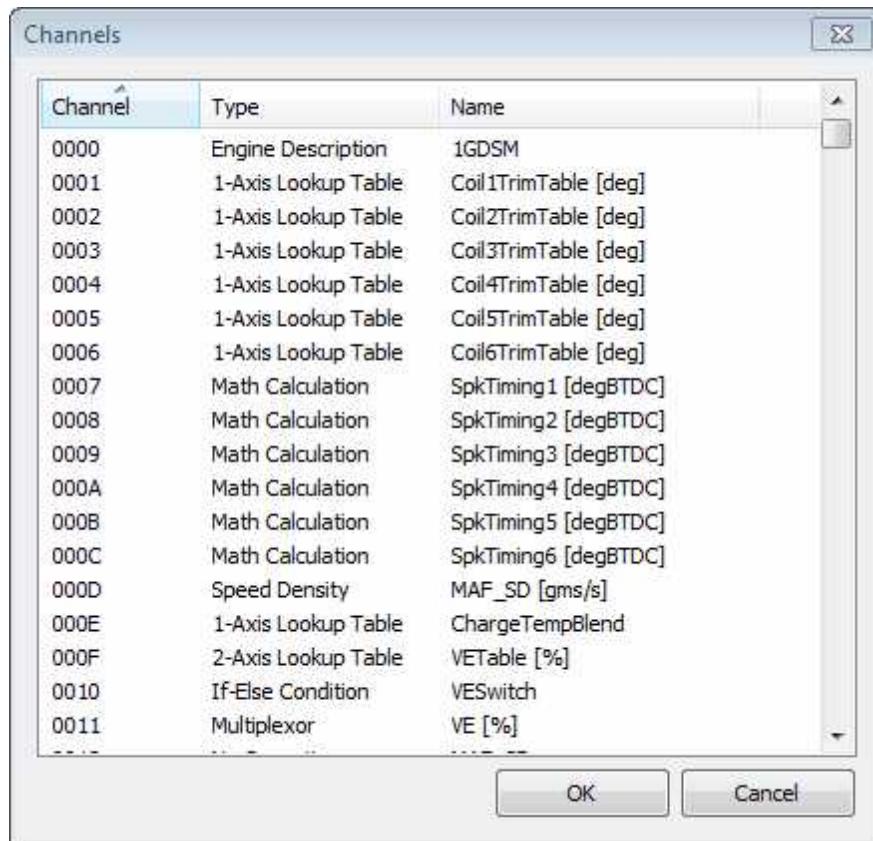


## Gauge

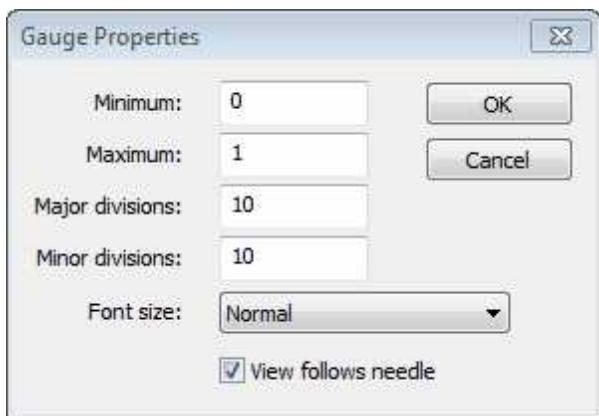
A Gauge is a measuring instrument that requires one input channel. It is displayed as a simulated analog-style 3D model.

To add a Gauge

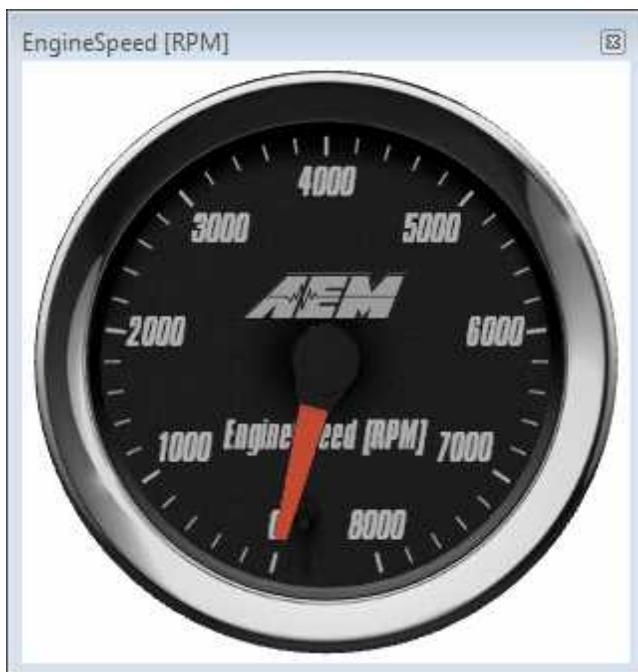
1. Select *Layout > Add Control > Gauge*.
2. Right Click on the window and select *Set Channel*



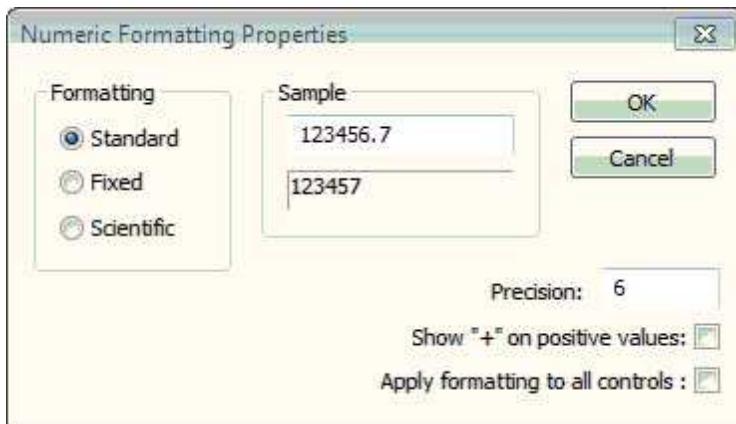
3. Select the desired Channel from the dialog box and Click OK.
4. When right clicking and selecting *Properties*, the following dialog box appears.



- Minimum: Minimum value for the gauge (should be greater than, or equal to, the minimum value of the selected channel).
- Maximum: Maximum value for the gauge (should be less than, or equal to, the maximum value of the selected channel).
- Major divisions: Number of major divisions in the gauge.
- Minor divisions: Number of minor divisions in the gauge.
- Font Size: Allows multiple sizes to be selected.
- OK: Creates the gauge in the layout.



5. When right clicking and selecting *Number Format Options*, the following dialog box appears:



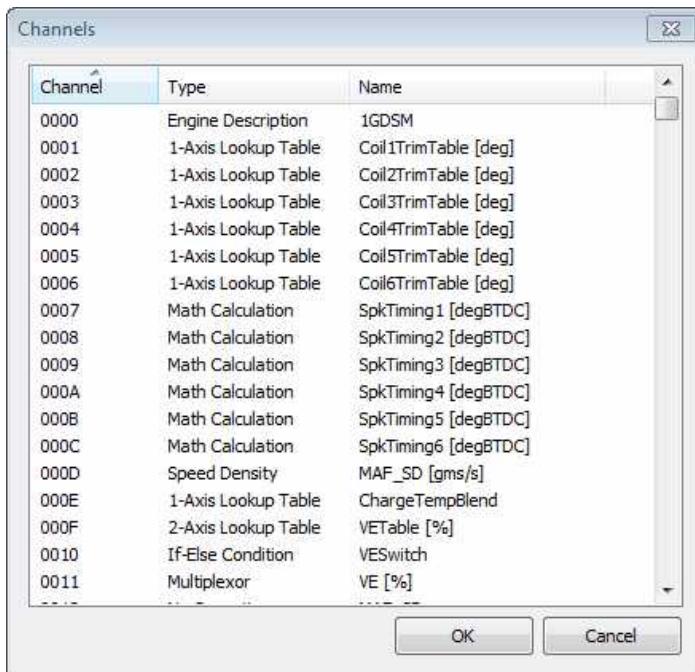
- This dialog box allows custom formats to be used such as Standard, Fixed, and Scientific numerals.
- The precision can be changed which allows for extra decimals on the values.
- Values can be represented with a "+" if there are positive.
- The custom formatting specified in this dialog box can be applied to all control using this channel.

## Plot

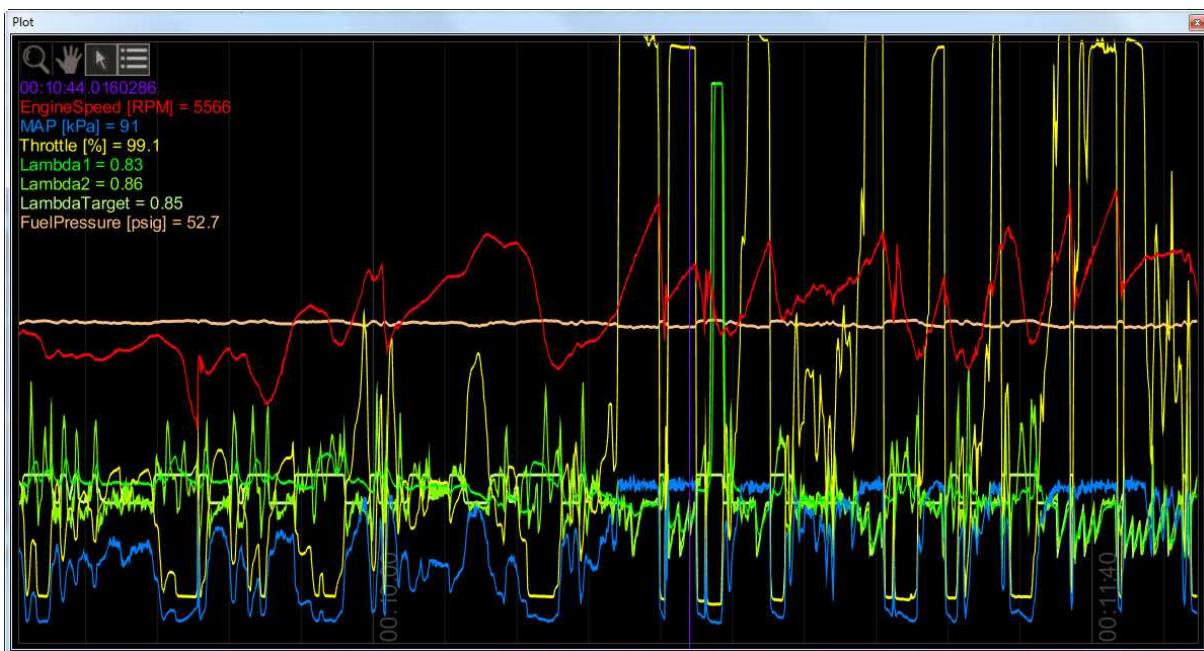
A Plot data logs the output value of one or more channels over time. This channel requires the log to be enabled. Log | Start Recording

To add a Plot

1. Select *Layout > Add Control > Plot.*
2. Right Click on the window and select *Add Channel.*

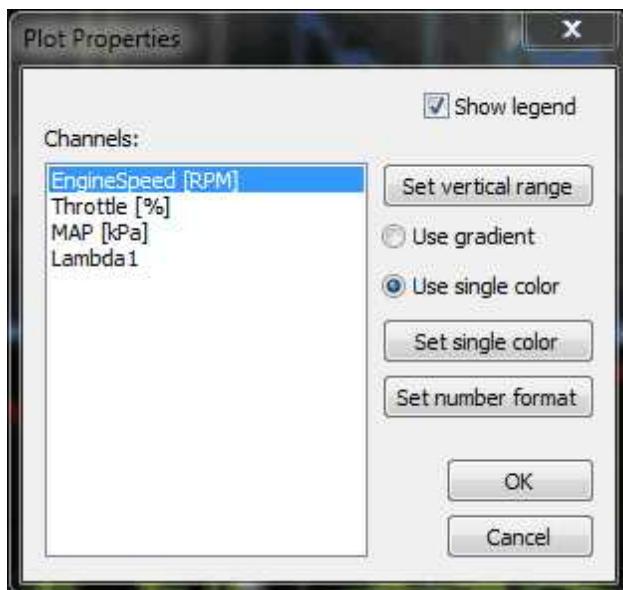


3. Select the desired Channel from the dialog box and click OK.
4. The Y-axis represents the output value, and the X-axis represents time.



Things to do with a plot control:

- Zoom: Zooms in and out. Click, hold, and move the cursor to enlarge or reduce the graph size.
- Pan: Move the log data forward or backward in time while staying at the current zoom level.
- Auto Zoom: Will force the entire log to be displayed on each sample.
- Auto Pan: Will follow the data, displaying the same length of time for each sample



Plot Properties

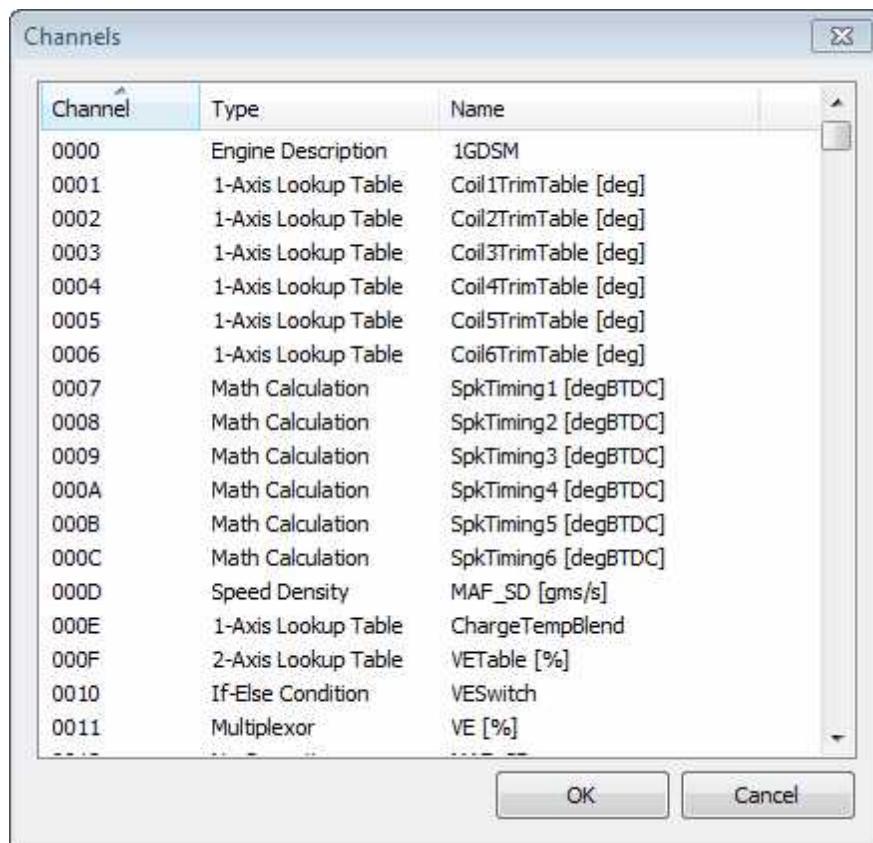
- Show Legend - toggles the legend feature in the upper right hand corner of the plot window
- Set vertical range - sets vertical range for each channel
- Use gradient - sets color preferences according to pre-configured gradients
- Set single color - allows selection of a single fixed color instead of a gradient
- Set number format - sets number format preferences for each channel

## Scatter Plot

A Scatter Plot requires 2 input channels. Once the logger has been enabled (Log | Start Recording) a recorded trace of where the two channels have been operating will be viewable.

To add a Scatter Plot

1. Select *Layout > Add Control > Scatter Plot*.
2. Right click and select the two desired x and y-axis channels from the Channel List dialog box.

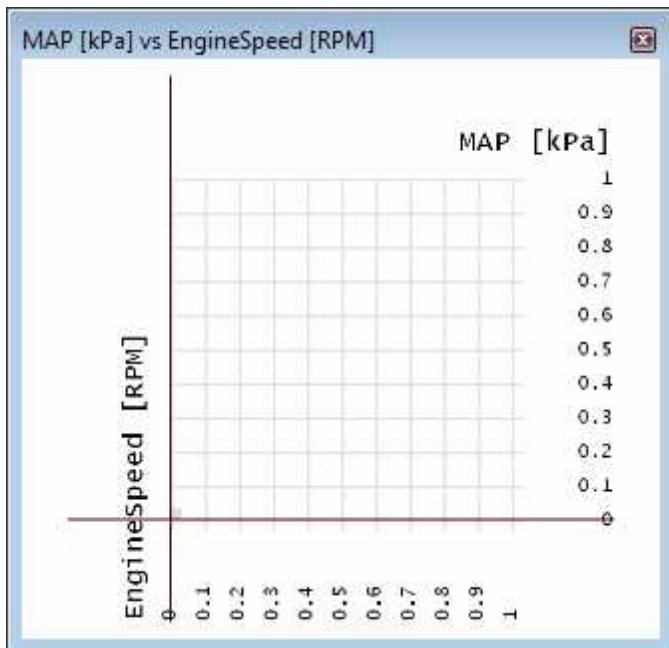


3. By right clicking and selecting Properties, the following dialog box opens



- Min Value: Minimum value for the associated X, or Y-axis.
- Max Value: Maximum value for the associated X, or Y-axis.
- OK: Creates the scatter plot in the layout.

4. The order of the channels can be changed by using the *Swap Axis*.  
5. Click OK

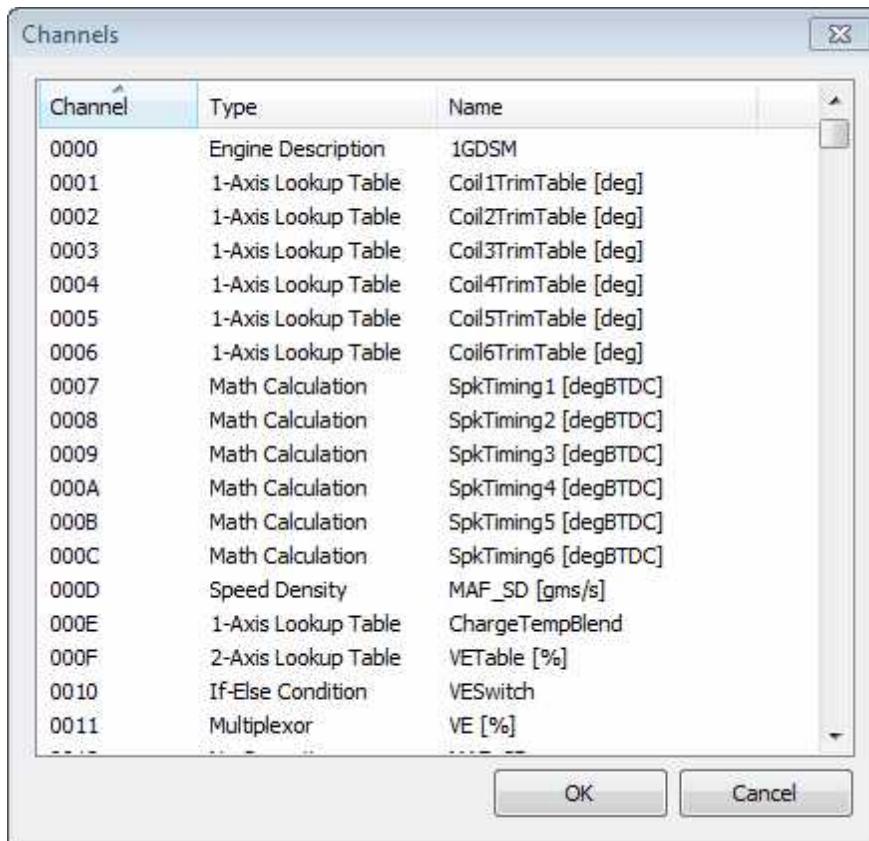


## Text

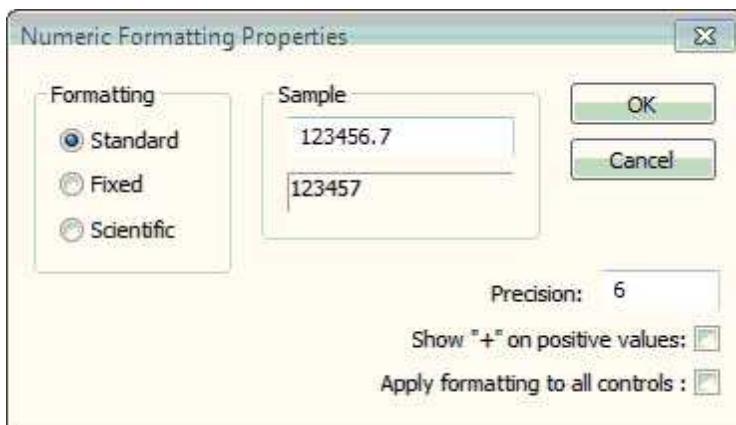
Text is used to view a specific channel's current state or condition.

To add Text

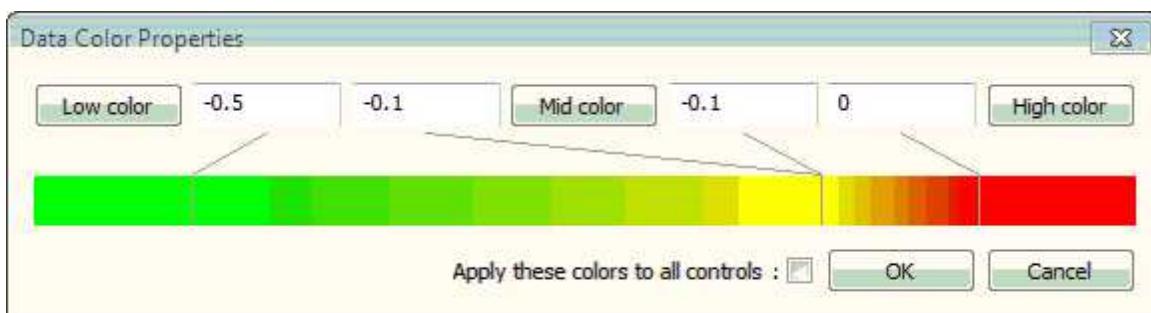
1. Select Layout > Add Control > Text
2. Right click and select Set Channel



3. Select the desired channel from the Channel List dialog box.
4. Clicking **OK** creates the text control in the layout.
5. Display Options: When right clicking, the following options change how the control will display in the layout.
  - Initial Value: When selecting, the initial value will be displayed. This is the value saved to flash memory when changes are committed. Edit this value and commit changes if you want the change to be maintained after a power cycle.
  - Number Format Options: This dialog box allows custom formats to be used such as Standard, Fixed, and Scientific numerals.



- The precision can be changed which allows for extra decimals on the values.
- Values can be represented with a "+" if there are positive.
- The custom formatting specified in this dialog box can be applied to all control using this channel.
- Color Options:



- A custom spectrum of colors can be constructed depending on the Low Color, Mid Color, and High Color specified.
- This color array can be applied to all controls using this channel.
- Move: When selected, this allows the window to be moved freely.
- Size: When selected, this allows the window to be sized appropriately.

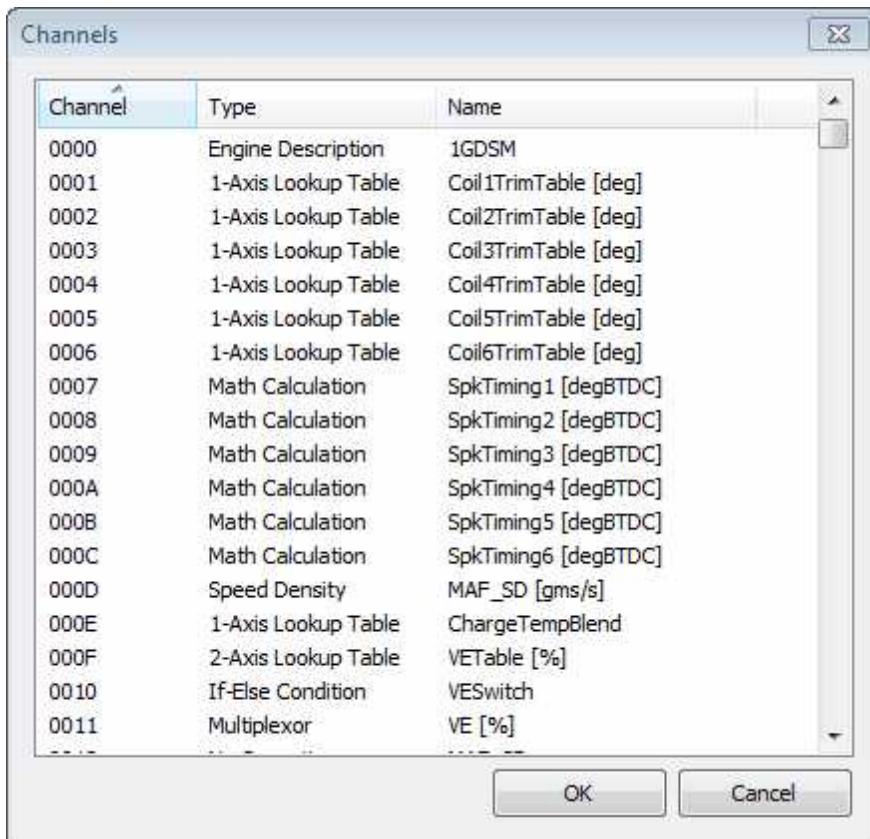


## Text Grid

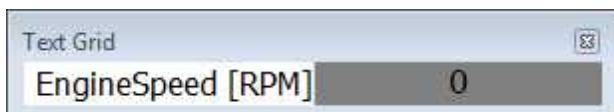
Text Grid is used to view the current state or condition of multiple channels.

To add Text Grid

1. Select Layout > Add Control > Text Grid
2. Right click and select Set Channel



3. Select the desired channel from the Channel List dialog box.
4. Clicking *OK* creates the text control in the layout.



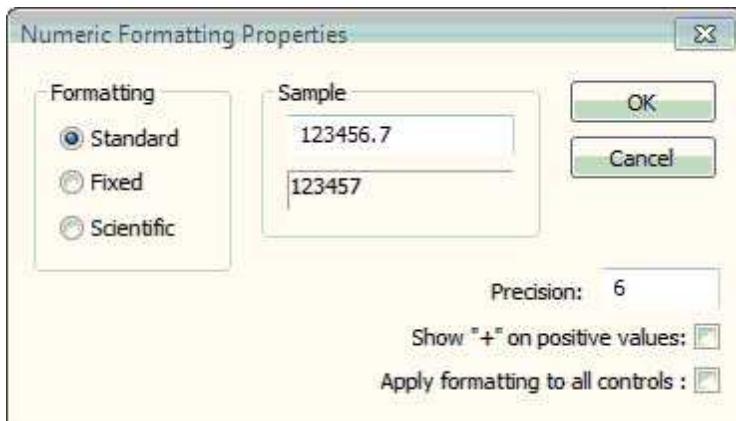
Display Options: When right clicking, the following options change how the control will display in the layout.

- Add Channel: This allows multiple to be added in rows.
- Move: When selected, this allows the window to be moved freely.
- Size: When selected, this allows the window to be sized appropriately.

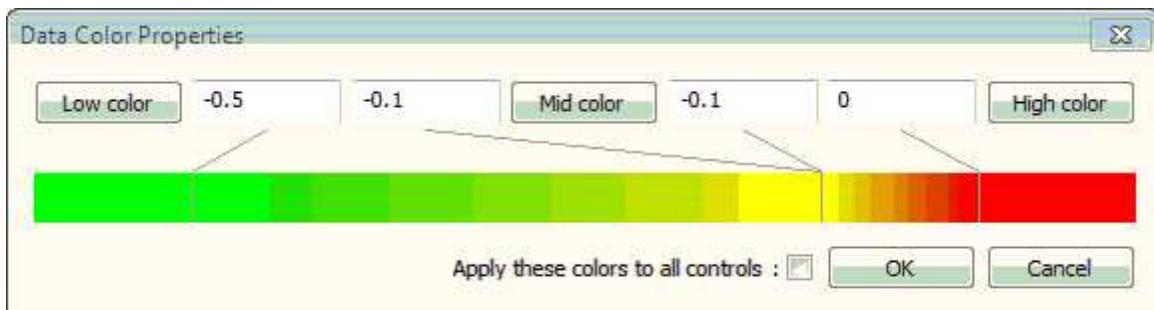
When right clicking the channel, the following display options appear.

- Remove: This will remove the selected channel

- Move Up: This will move the selected channel up one row at a time
- Move Down: This will move the selected channel down one row at a time.
- Number Format Options: This dialog box allows custom formats to be used such as Standard, Fixed, and Scientific numerals.



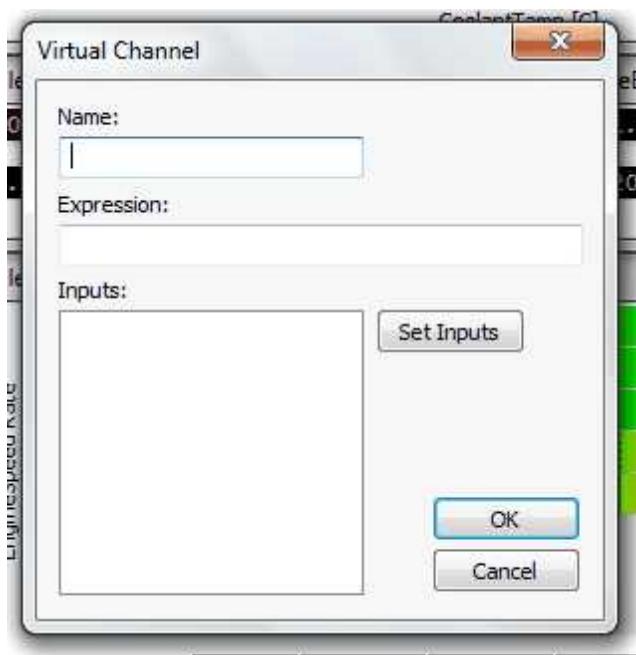
- The precision can be changed which allows for extra decimals on the values.
- Values can be represented with a "+" if there are positive.
- The custom formatting specified in this dialog box can be applied to all control using this channel.
- Color Options:



- A custom spectrum of colors can be constructed depending on the Low Color, Mid Color, and High Color specified.
- This color array can be applied to all controls using this channel.

## 2.16 Virtual and Conversion Channels

Virtual Channels provide you with a flexible means of defining and manipulating the raw data you are viewing in Infinity Tuner. Virtual Channels allow you to select any of the available channels present in your session and include them in custom math expressions defined by you.



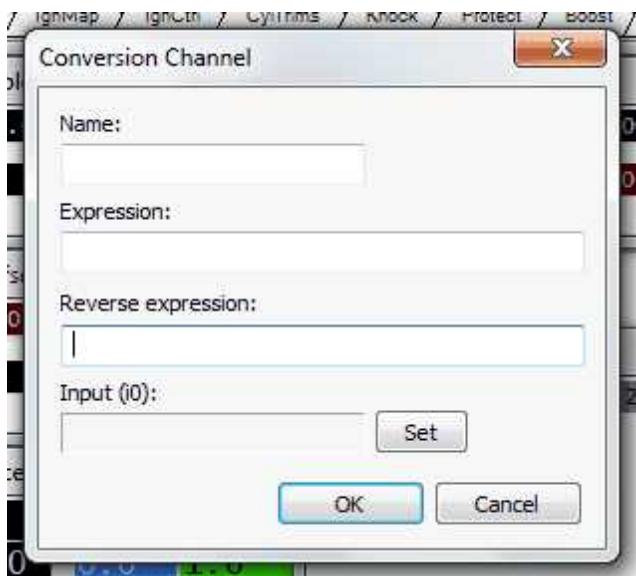
**Name:** Enter desired name of the virtual channel being defined.

**Expression:** Enter desired expression. Inputs in expressions are listed as i0, i1, i2 and so on. For details and examples of the syntax see below.

**Inputs:** A list of the current channels that can be used in this virtual channel.

**Set Inputs:** Can add/remove the channels that can be used with this virtual channel.

Conversion channels provide you with a quick means of converting the values of an entire table or graph. Once created simply right click on the table or graph and select the desired conversion channel from "Table conversion."



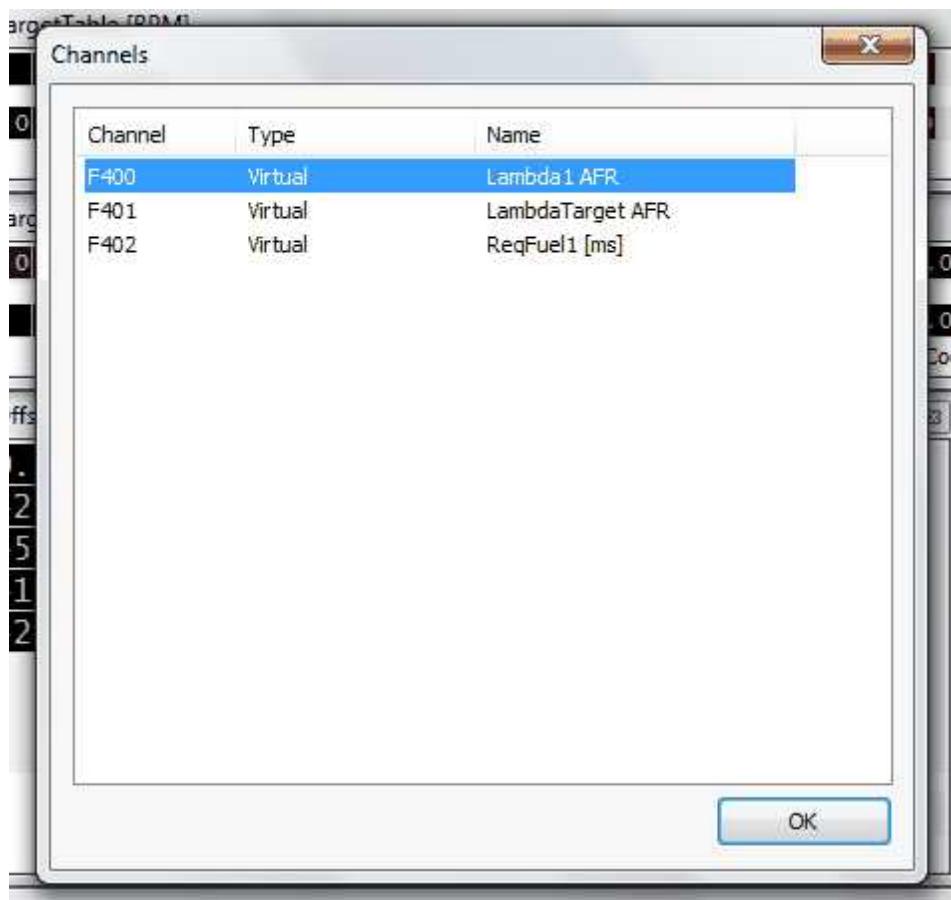
**Name:** Enter desired name of virtual channel being defined.

**Expression:** Enter desired expression. For details and examples of the syntax see below

**Reverse expression:** Enter expression to convert channel back to its original value.

**Set:** Select the channel you wish to create a conversion.

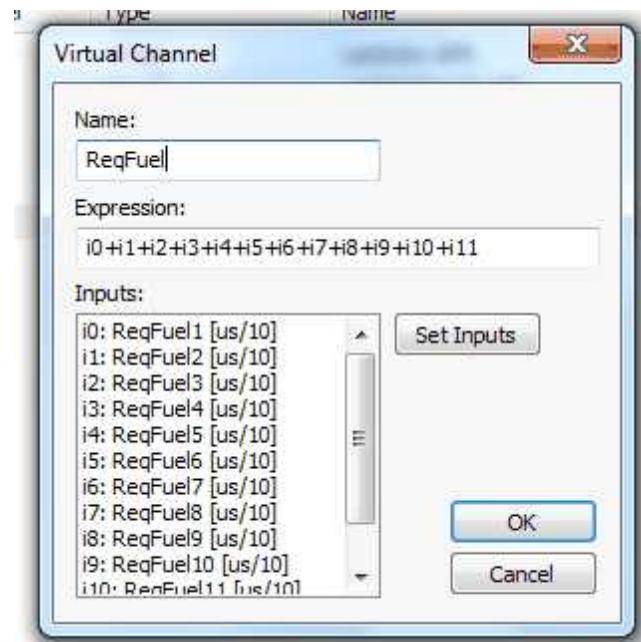
Here you may review all of the virtual and conversion channels you have defined in the current session you have running. The Channel number, Type, and Name are listed in the three columns. Right clicking on any of the channels listed provides you with the option of removing the channel or editing the channel. By selecting edit, you can redefine anything about the given channel. If you made a mistake or something changes you can easily go back and make your desired changes.



The syntax for the math expressions you can define in Infinity Tuner is fairly straightforward. The slight detail that may seem strange at first is listing the selected inputs in the expression as i0, i1, i2, and so on according to the order they appear on the list of Inputs.



This detail may seem strange at first but is very convenient in the long run. "(i0\* 14.64)" for the above expression for example would have had to of been typed as "(LambdaTarget \* 14.64)" otherwise.



The "ReqFuel" virtual channel illustrates the benefit of this well. You can now enter "i0+i1+i2 +i3+i4+i5+i6+i7+ i8+i9+i10+i11" to add the required fuel for all of the fuel injectors. Without this syntax the expression would get overwhelmingly large fast..."(ReqFuel1 [us/10] + ReqFuel2 [us/10] + ReqFuel3 [us/10] + ReqFuel4 [us/10] + ReqFuel5 [us/10] + ReqFuel6 [us/10] + ReqFuel7 [us/10] + ReqFuel8 [us/10] + ReqFuel9 [us/10] + ReqFuel10 [us/10] +

ReqFuel11 [us/10] + ReqFuel12 [us/10]"

## Hardware

### 3.1 Serial Number



All Infinity ECUs are serialized. Be sure this identification tag stays intact. Write the number down to be safe. Infinity ECU's are programmed with cryptographically secure firmware files and each ECU has a unique file set. The serial number is used to identify the correct files for your ECU.

## 3.2 Account Registration

### Account Registration

Note: Hardware part numbers shown in the screen shots below are examples only. Refer to your individual ECU part number and serial number when filling out registration information.

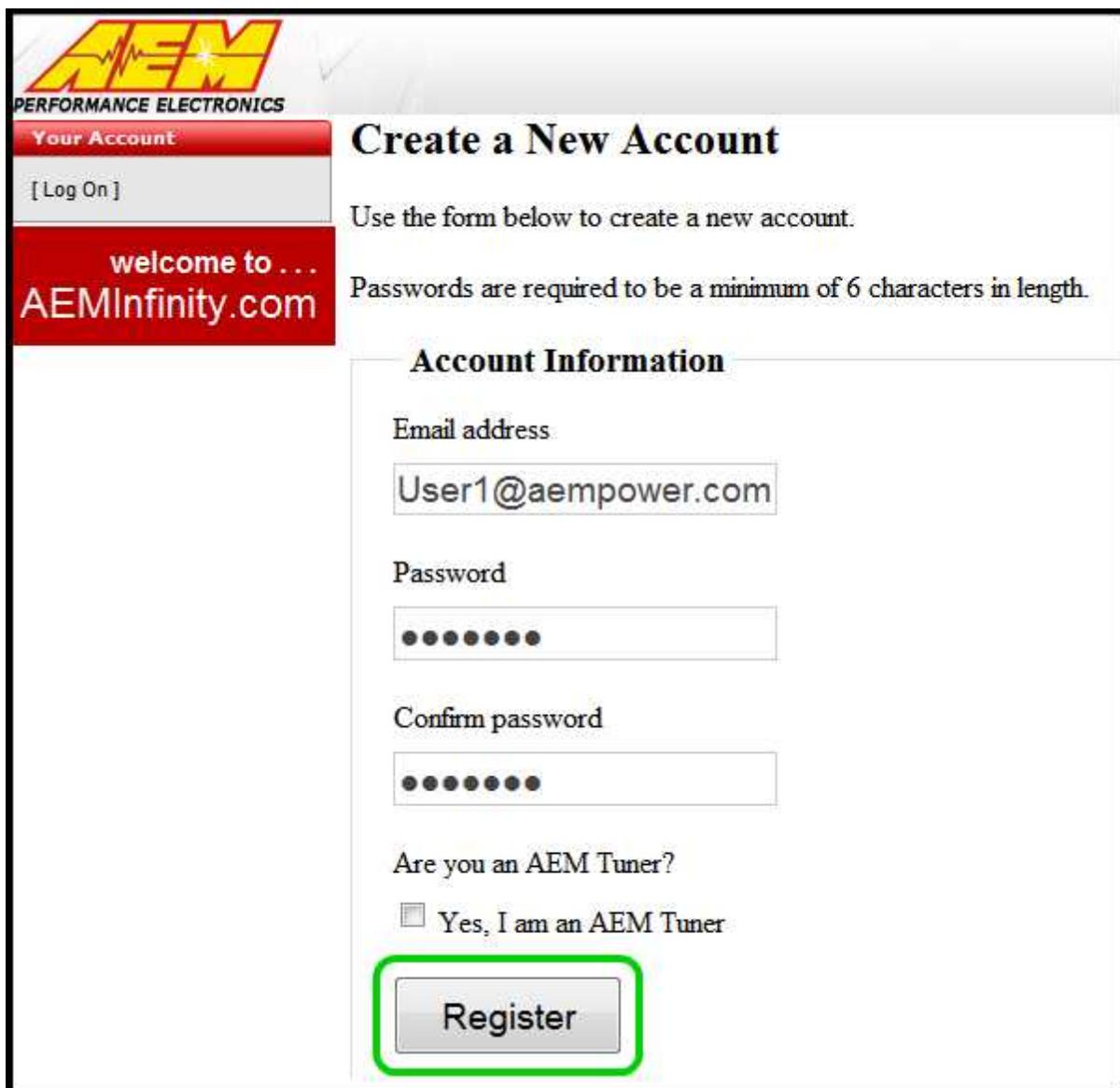
- 1) Go to <http://www.aeminfinity.com>

- a. Click on “Register Here” button



- 2) Enter required information

- a. Click the “Register” button



The screenshot shows the 'Create a New Account' page from the AEM Infinity website. At the top left is the AEM logo and 'PERFORMANCE ELECTRONICS'. A red sidebar on the left says 'Your Account' and '[ Log On ]'. The main area has a red banner with 'welcome to ... AEMInfinity.com'. The title 'Create a New Account' is at the top right. Below it is a note: 'Use the form below to create a new account. Passwords are required to be a minimum of 6 characters in length.' The form is titled 'Account Information'. It includes fields for 'Email address' (containing 'User1@aempower.com'), 'Password' (containing six dots), 'Confirm password' (containing six dots), and a question 'Are you an AEM Tuner?' followed by a checkbox 'Yes, I am an AEM Tuner'. A large green rectangular box surrounds the 'Register' button at the bottom.

Create a New Account

Use the form below to create a new account.  
Passwords are required to be a minimum of 6 characters in length.

**Account Information**

Email address

User1@aempower.com

Password

••••••

Confirm password

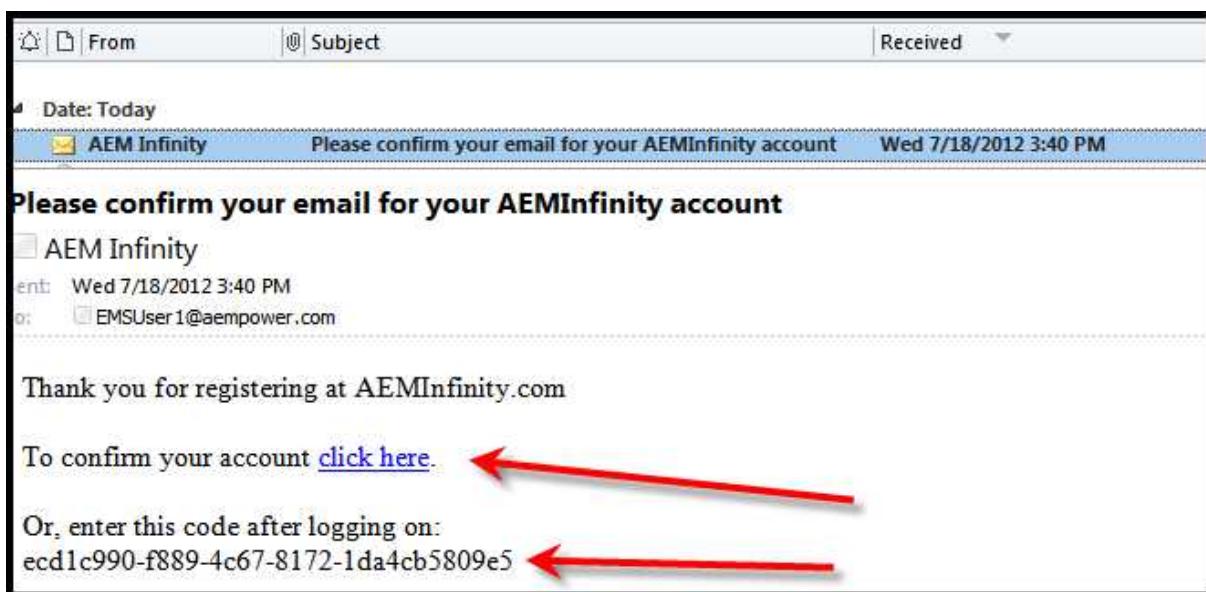
••••••

Are you an AEM Tuner?

Yes, I am an AEM Tuner

Register

- 3) A confirmation email will be sent to the supplied email address. Choose one of the following options:
  - a. Click on the "click here" link
  - b. Or, copy the code and enter it into the Confirmation Code Box.



4) After entering the code, click on the “Confirm” button



5) Click on the “your account page” to continue with ECU registration, otherwise click the “Log Off” button.

AEM Infinity ECU Registration

1) Go to <http://www.aeminfinity.com>

a. Log in to your account



2) Click on the “Register New Product” button

The screenshot shows the AEM Infinity Home page. On the left, there's a sidebar with a red header "Your Account" containing links: Welcome, EMSUser1@aempower.com!, Member Home, Tuner Membership, Change Password, Contact AEM, and Log Off. Below this is a red banner with the text "Welcome to... AEMInfinity.com". The main content area has a grey header "Home". In the top right corner, there's an "INFINITY" logo with a stylized gear icon. To the right of the logo is a black image of an ECU (Engine Control Unit). Below the header, there's a red button with the text "Register New Product" which is circled in green. Underneath this button, the text "Your Products:" is followed by a table header for "Infinity Engine Management System" with columns: Serial Number, Used For, Activated, and More Info. The table body below it says "No Products Registered". At the bottom of the main content area, there's another table header for "Firmware That Has Been Updated Since You Downloaded It" with columns: Serial Number, Firmware, Download Date, Dowloaded Firmware Date, and Current Firmware Date. The table body below it says "No Firmware Updates".

### 3) Enter the Serial Number and Security Code

- Serial Number found on sticker on ECU case
- Security Code included in ECU packaging

The screenshot shows the "Product Registration" page. The left sidebar is identical to the one in the previous screenshot. The main content area has a grey header "Product Registration". Below the header is a form titled "Register". The first field is "Serial Number:" with a help icon (blue question mark) and a red input box containing the value "7100-9991", which is circled in green. Below this is an "Example: XXXX-XXXX" placeholder. The second field is "Security Code:" with a help icon and a red input box containing the value "01000013", which is also circled in green. Below this is an "Example: XXXXXXXX" placeholder. At the bottom of the form is a red "Register" button.

### 4) Enter Product Registration Information

- You must first read and accept the Agreement

The screenshot shows the 'Add Product' page of the AEM Infinity website. At the top left is the AEM logo and 'PERFORMANCE ELECTRONICS'. At the top right is the 'INFINITY' logo. On the left, a sidebar titled 'Your Account' lists 'Welcome', 'EMSUser1@aempower.com!', 'Member Home', 'Tuner Membership', 'Change Password', 'Contact AEM', and 'Log Off'. Below this is a red banner with the text 'Welcome to... AEMinfinity.com'. The main form has a header 'Add Product'. It includes fields for 'Serial Number' (7100-9991) and 'Status' (Ready To Register). The 'Your Information' section contains fields for address, city, state, country, zip code, and phone number. The 'Product Usage' section contains fields for vehicle make (Honda), model (Civic), and year (1998). The 'Register' section includes a 'Usage Agreement' checkbox labeled 'Click Here to View Agreement' (which is highlighted with a green rectangle), and a 'Complete Registration' button. A note at the bottom indicates that the 'Address' field is required.

Serial Number	7100-9991
Status:	Ready To Register

Your Information

\* Address:  
123 Fake Street

Address (Line 2):  
[empty]

\* Zip Code:  
92656

\* City:  
Aliso Viejo

\* State:  
California

\* Country:  
United States

\* Phone Number:  
(555) 867-5309

Product Usage

Vehicle Information:

\* Make: Honda

\* Model: Civic

\* Year: 1998

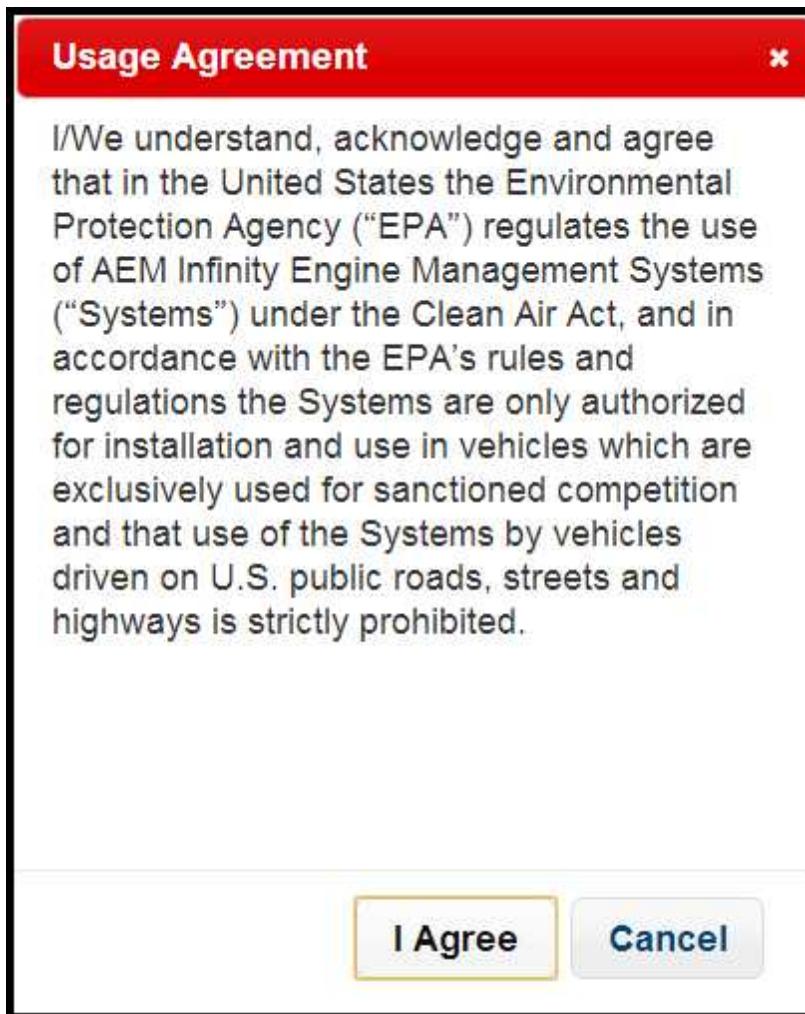
Register

\* Usage Agreement:  
 Click Here to View Agreement

Complete Registration

\* Required Fields

5) Read and then accept Usage Agreement by selecting the "I Agree" button.



- 6) Click the "Complete Registration" button once the Usage Agreement has been accepted.

The screenshot shows the AEM Infinity website's account management interface. On the left, a sidebar titled 'Your Account' lists options like 'Welcome', 'EMSUser1@aempower.com!', 'Member Home', 'Tuner Membership', 'Change Password', 'Contact AEM', and 'Log Off'. A red banner at the bottom of the sidebar reads 'Welcome to AEMinfinity.com'. The main content area has a header 'Add Product'. It includes sections for 'Your Information' (Address, Zip Code, City, State, Country, Phone Number) and 'Product Usage' (Vehicle Information: Make, Model, Year). A 'Register' section contains an 'Usage Agreement' checkbox (unchecked) and a 'Complete Registration' button, which is highlighted with a green border. A note at the bottom indicates '\* Required Fields'.

Serial Number	7100-9991
Status:	Ready To Register

**Your Information**

\* Address:  
123 Fake Street

Address (Line 2):  
[empty]

\* Zip Code:  
92656

\* City:  
Aliso Viejo

\* State:  
California

\* Country:  
United States

\* Phone Number:  
(555) 867-5309

**Product Usage**

Vehicle Information:

\* Make: Honda

\* Model: Civic

\* Year: 1998

**Register**

\*Usage Agreement:  
Agreed 10/02/2012

**Complete Registration**

\* Required Fields

## Firmware and Configuration Updates

1) Go to <http://www.aeminfinity.com>

a. Log in to your account



- 2) Locate Firmware and Configuration updates
  - a. Check for Firmware Updates since last downloaded
  - b. Click the "INFO" button to locate Firmware and Configuration files.

The screenshot shows the AEM Infinity website homepage. On the left, there's a sidebar with a red header "Your Account" containing links for Welcome, Member Home, Tuner Membership, Change Password, Contact AEM, and Log Off. Below this is a red banner with the text "Welcome to... AEMInfinity.com". The main content area has a large "Home" heading. At the top right is a logo for "INFINITY" with "AEM" below it. In the center, there's a "Register New Product" button. To the right is an image of an AEM Infinity Engine Management System unit. Below these are sections for "Your Products:" and "Firmware That Has Been Updated Since You Downloaded It". The "Your Products:" section shows a table with one row:

Serial Number	Used For	Activated	More Info
7100-9991	1998 Honda Civic	10/2/2012 3:27:32 PM	b. <a href="#">INFO &gt;</a>

The "Firmware That Has Been Updated Since You Downloaded It" section shows a table with one row:

Serial Number	Firmware	Download Date	Downloaded Firmware Date	Current Firmware Date
			a. <a href="#">No Firmware Updates</a>	

3) Locate the desired Configuration file and click the “Download” button.

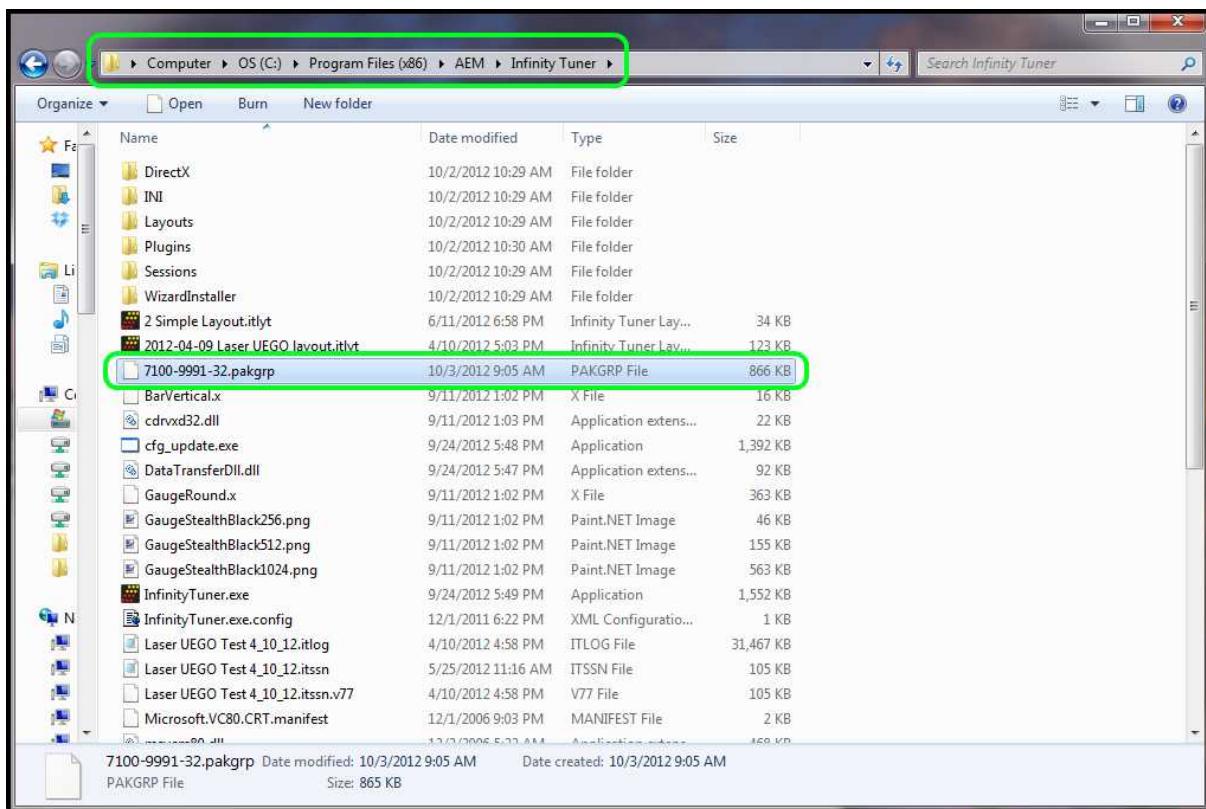
- The Configuration file includes the Firmware and the Configuration files as a .pakgrp file

The screenshot shows the AEM Infinity Tuner software interface. On the left, there's a sidebar with links like 'Your Account', 'Welcome', 'EMSUser1@aempower.com!', 'Member Home', 'Tuner Membership', 'Change Password', 'Contact AEM', and 'Log Off'. Below that is a red banner with the text 'Welcome to... AEMinfinity.com'. The main area has a header 'Product Details' with a table containing product information. A note at the bottom says 'NOTE: Infinity Tuner software must be installed before product software can be used!' followed by a link 'Click Here to Download the latest Infinity Tuner.' Below this is another section titled 'Available Software:' with a table.

File	Configuration	Created
<b>Download</b>	00.0000.00.0.0.00.0	10/2/2012 3:20:30 PM

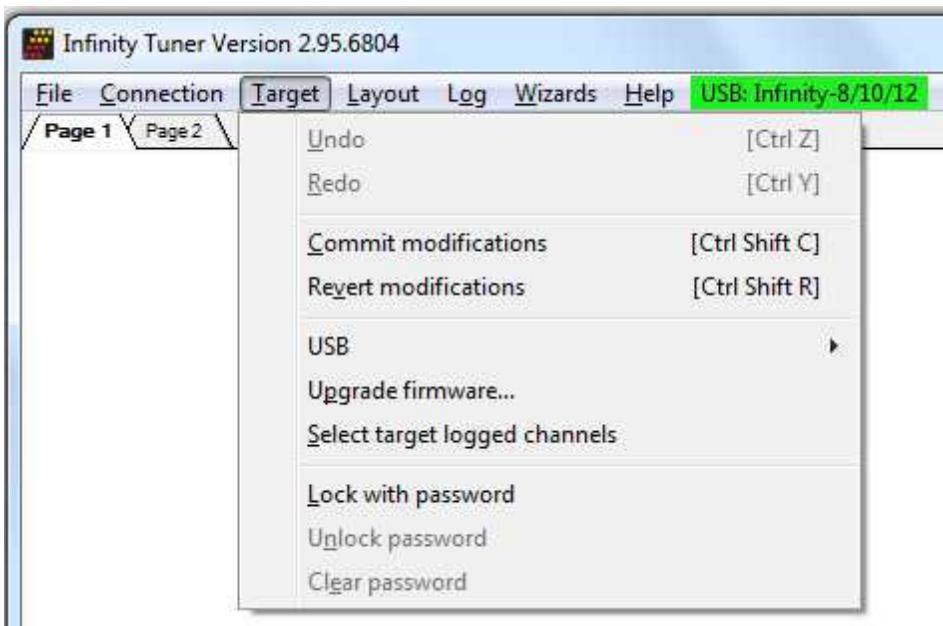
4) Save the .pakgrp file in the AEM Infinity Tuner directory

a. C:/Program Files (x86)/AEM/Infinity Tuner

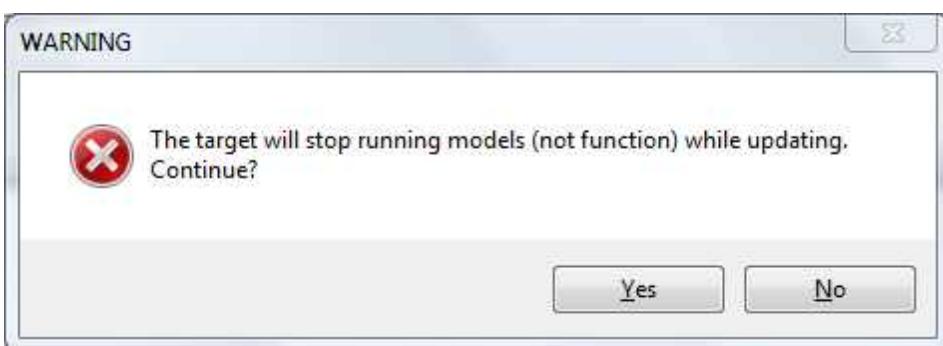


### 3.3 Firmware Update

- 1) Connect to Infinity Tuner
  - a. Plug the USB cable from the ECU into your computer USB port and key ignition ON
  - b. Open Infinity Tuner
- 2) Click the Target drop-down list and select “Upgrade firmware...”



- 3) The ECU should not be running an engine at this time. Select “Yes” when the warning message appears.

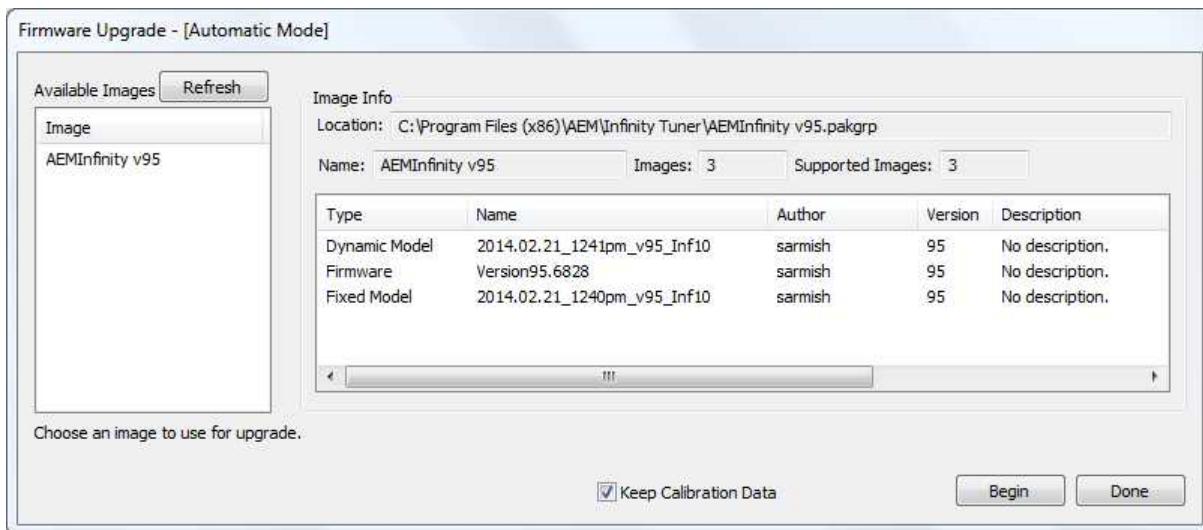


Note: The firmware update utility is periodically updated and may not match the descriptions below. In the event of a conflict, please follow the instructions provided in the dialog windows themselves or supplemental instructions provided by AEM.

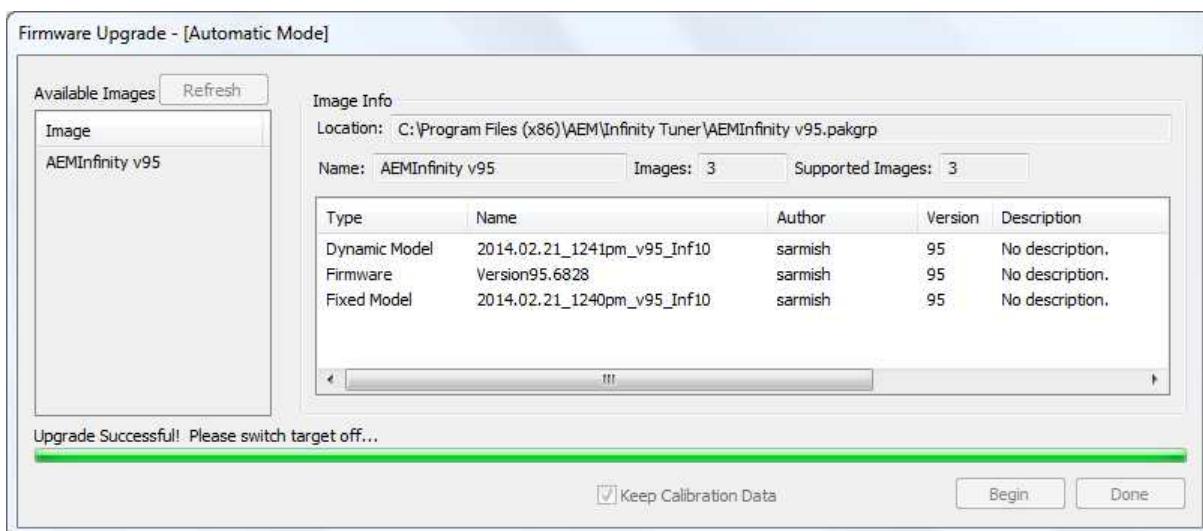
**Important Note: BEFORE beginning the update process, be sure to have a saved copy of your tuned session file. If a power failure**

**occurs during the update process, this is the only way to ensure that the calibration data is not lost.**

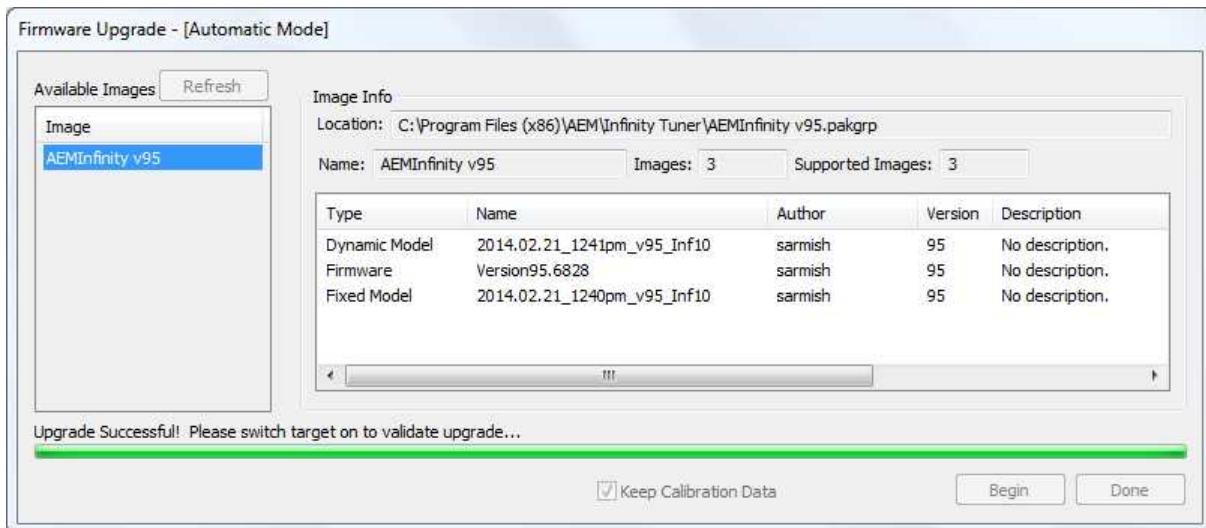
- 4) Begin the Firmware Upgrade process
  - a. Select the desired Configuration "Image" on the left
    - i. If no images are present check "C:\Program Files (x86)\AEM\Infinity Tuner\" and verify .pakgrp file is there. If not, visit Infinity website, log in, and download appropriate file.
  - b. **Ensure "Keep Calibration Data" check-box is marked to save current calibration**
  - c. Click the "Begin" button to start the upgrade process



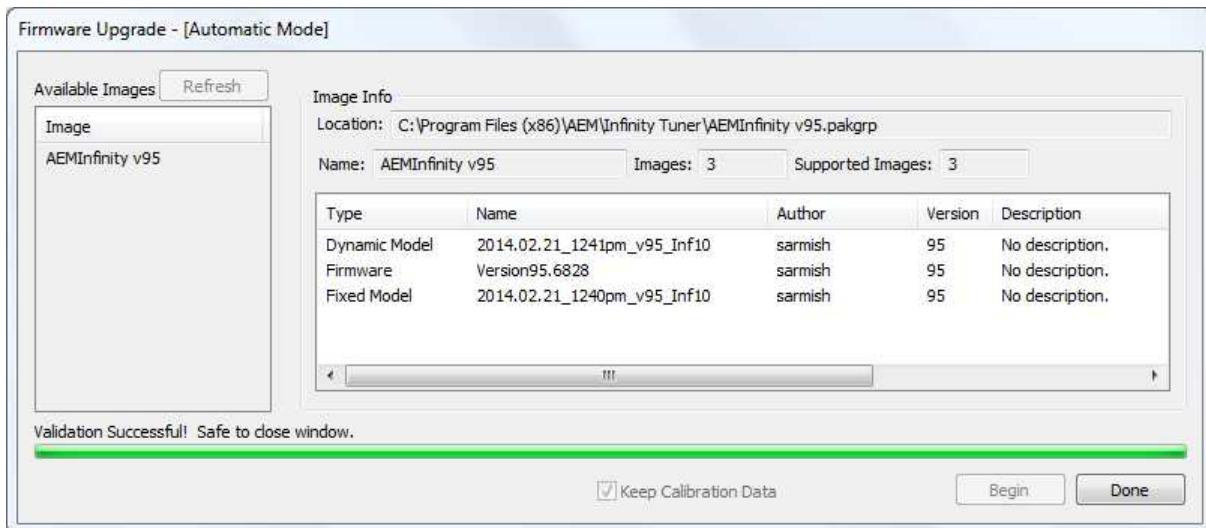
- 5) Follow the message at the bottom, and turn the ignition switch OFF when instructed to do so.



- 6) Follow the message at the bottom, and turn the ignition switch back ON when instructed to do so.



- 7) When the message at the bottom indicates that it's safe to close the window, click the "Done" button.



**For applications that use a stepper motor idle valve, it's important that a full power reset be done prior to starting the engine. Turn the key off and wait at least 20 seconds before starting. This will allow the stepper valve to park and reset.**

**A firmware update will erase the USB log channel list stored in the ECU memory. This channel list will need to be reset before USB logging will function correctly. See [Log Menu](#) 27 for more info.**

**Troubleshooting:**

If the process hangs at any point, wait at least one minute for it to continue. Some PCs take longer to reconnect to the ECU during this process. Some PCs may have other processes running that affect the response time of the USB ports. If the process has not continued as described above after one minute, do not cycle key power. Instead, remove the USB cable from the PC, wait a few seconds then plug it back in. Often this will force the OS to reset the port allowing the process to continue.

### 3.4 Infinity Hardware Specifications

Specifications	Infinity-6	Infinity-8h	Infinity-8	Infinity-10	Infinity-12
Cylinders	Up to 6	Up to 8	Up to 8	Up to 10	Up to 12
Injectors, Low Impedance (Sequential)	6	N/A	8	10	12
Injectors High Impedance (Sequential)	Up to 6	Up to 8	8	10	12
Coils-0-5V Falling Edge	6	8	8	10	12
Connector Pins	80	80	129	129	129
Drive-by-Wire	Single	Single	Dual	Dual	Dual
H-Bridge Channels	1	1	2	2	2
RS232 Channels*	1	1	1	1	1
CAN Channels	2	2	2	2	2
2-Stroke Engines	Yes	Yes	Yes	Yes	Yes
4-Stroke Engines	Yes	Yes	Yes	Yes	Yes
Knock Control	2-Channel	2-Channel	2-Channel	2-Channel	2-Channel
Analog Voltage Inputs	Up to 9	Up to 9	Up to 17	Up to 17	Up to 17
Analog Temp Inputs	Up to 3	Up to 3	Up to 6	Up to 6	Up to 6
VR/Mag Inputs	Up to 4	Up to 4	Up to 6	Up to 6	Up to 6
Digital Inputs	Up to 8	Up to 6	Up to 8	Up to 8	Up to 8
Internal Wideband UEGO Controller	1	1	2	2	2
High Side Outputs	1	1	Up to 2	Up to 2	Up to 2
Low Side Outputs	8	6	10	10	10

4-Wire Stepper Motor Control	Yes	Yes	Yes	Yes	Yes
Boost Control (RPM, Time, Gear, VSS, Switch Input, Flex Fuel Content)	Yes	Yes	Yes	Yes	Yes
Engine Protection	Yes	Yes	Yes	Yes	Yes
Variable Cam Control	Up to 2	Up to 2	Up to 4	Up to 4	Up to 4
Launch Control	Yes	Yes	Yes	Yes	Yes
Nitrous Control	Single Stage				
Data Logging	Up to 64 GB				
Traction Control	Up to 2-Wheel Speed	Up to 2-Wheel Speed	Up to 4-Wheel Speed	Up to 4-Wheel Speed	Up to 4-Wheel Speed
Weather Resistance	Yes, Sealed Enclosure with IP67 Connectors				
Enclosure Dims	5.855"x5.55"x1 .8"	5.855"x5.55"x1 .8"	6.75"x6.00"x1. 8"	6.75"x6.00"x1. 8"	6.75"x6.00"x1. 8"
Weight	18.8 oz/476.27g	18.8 oz/476.27g	24oz/680g	24oz/680g	24oz/680g

\*\*Dual use pins. Tx and Rx shared with 2 digital inputs.

### 3.5 ECU Installation

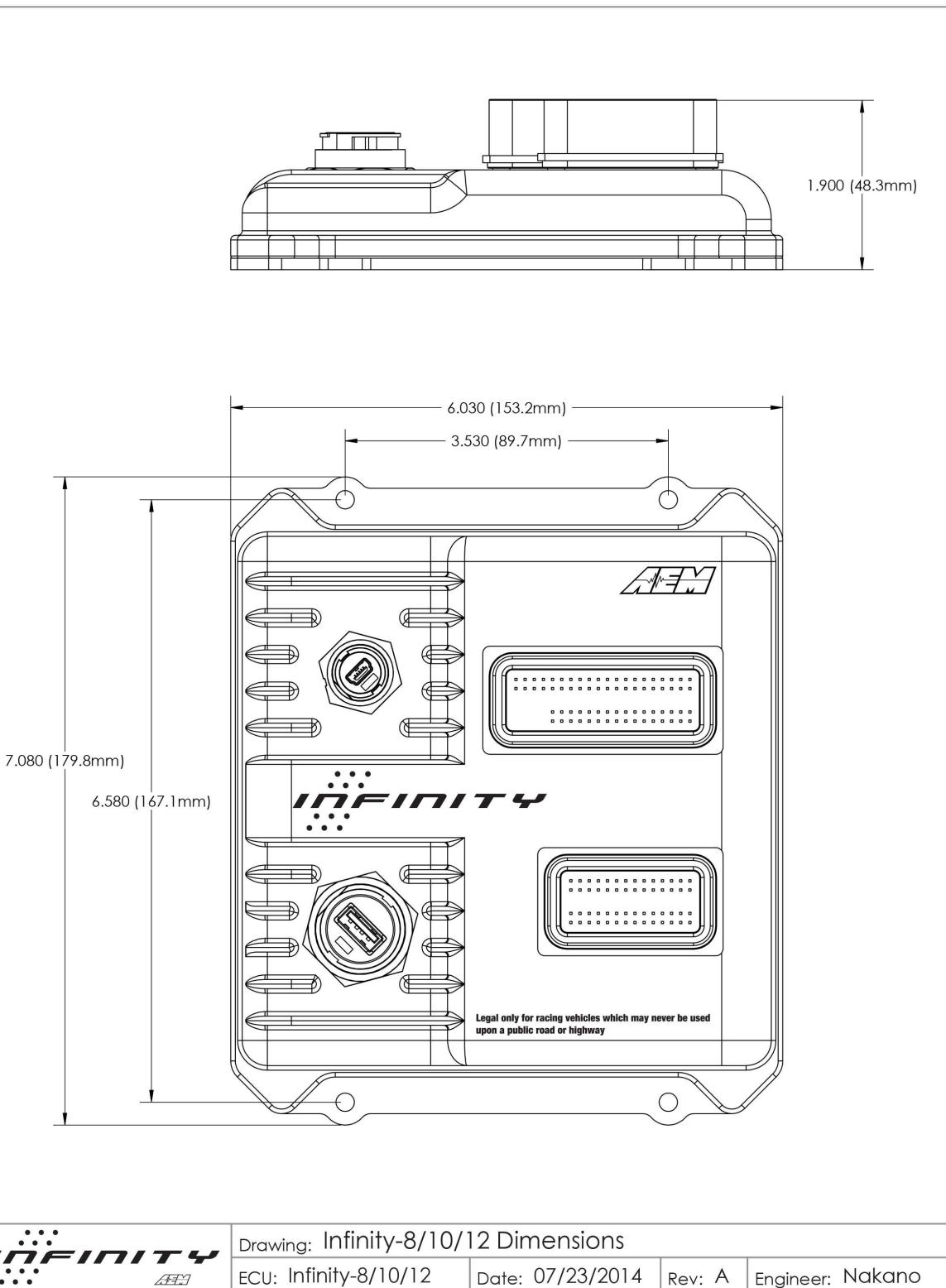
**Note: Before installing this system, the vehicle must be in proper working condition. Check the following before installation:**

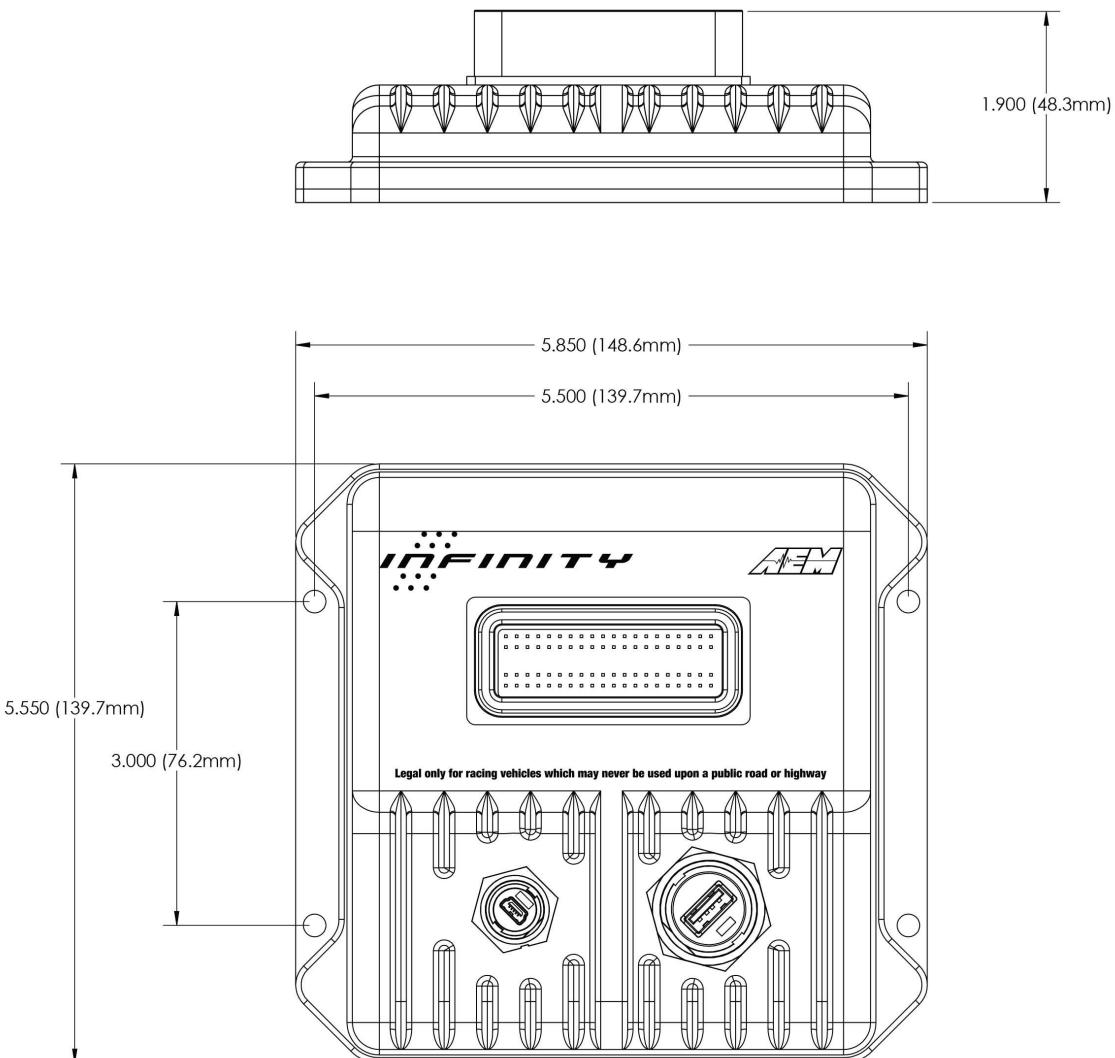
- Fuel pressure (must be set to factory specs)
- Spark plugs (recommend starting with new plugs)
- Ignition timing (must be set to factory specs)
- Fuel filter (recommend starting with new filter)
- Fuel injectors (must be in known good working condition)
- Spark plug wires
- Distributor cap and rotor (if applicable)
- See included fuel system recommendations before starting

This system will not fix any mechanical issues that are causing running problems. Fix any pre-existing problems before installation.

1. Disconnect battery negative cable
2. Locate factory Engine Control Unit (ECU)
  - a. Most ECU's are located in the passenger kick panel, or passenger floor
  - b. Others are located behind the center console
  - c. Newer vehicles typically mount them in the engine bay
3. Unplug factory wiring harness plugs at ECU and unscrew fasteners holding ECU in place to remove ECU.
5. Plug factory harness plugs into AEM Infinity Adapter Harness
  - a. Note: these will only plug in one way
6. Mounting the AEM Infinity
  - a. It is recommended that the ECU be placed in an environment that does not expose it to temperatures above 85° Celsius (185F).
  - b. In cases where the Infinity is to be used in place of the stock ECU, the location that the stock ECU occupied is best.
  - c. On applications where the ECU is to be located in a different position than stock, the interior of the vehicle is best.
  - d. The Infinity should be located in a place that allows the shortest length of wire to be used while maintaining an environmentally sound location.
  - e. If this is plug-n-play, reference the Application Notes for the proper location.
7. Once the Infinity is mounted, run the USB cable to an easily accessible location away from moisture and any sharp metal corners. Metal stamping can cut through wires very easily. **Note: the glove box is an excellent choice for the COM cable location, as it will be used frequently.**
8. Re-connect battery cable.

### 3.6 ECU Installation Dimensions





Drawing: Infinity-6/8h Dimensions

ECU: Infinity-6/8h

Date: 07/23/2014

Rev: A

Engineer: Nakano

## Tuning Guide

### 4.1 Background

What is “Tuning”? Tuning can mean anything from adjusting the idle mixture screw on a carburetor to experimenting with custom length headers on an engine to setting up the flow ratio between primary and secondary injectors in an EFI calibration. Tuning covers a wide range of topics and not all are related to fuel injection. In its most basic form, EFI tuning involves optimizing the fuel flow and spark advance variables to maximize performance and economy. For the purpose of this manual, tuning refers to the act of making changes to a calibration file for a programmable AEM Infinity ECU to optimize the performance of an engine.

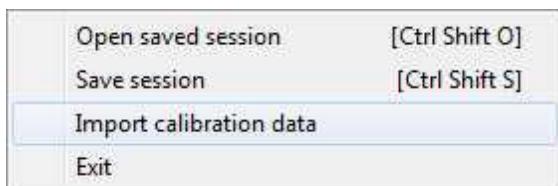
## 4.2 Basic Tuning

### 4.2.1 Calibration Data

#### Connecting, Saving and importing session data

- 1) With the Ignition in the ON position and InfinityTuner Running, click on the *Connection* menu item and select *Connect to USB* from the dropdown list. A progress bar will be displayed as the laptop gets the calibration info from the ECU.
- 2) Open a layout file by clicking on the *Layout* menu item and select *Open*. Layout files have a .itlyt extension and should be saved in the My Documents\InfinityTuner\Layouts folder.
- 3) Save the session file by selecting *File – Save session*. Session files have a .itssn extension and should be saved in the My Documents\InfinityTuner folder.

The default calibration data provided by AEM should be sufficient to start an engine with similar displacement, sensor setup, and injectors. Every vehicle must be tuned before use. AEM provided base calibration data is installed to the My Documents\AEM\Infinity Tuner\Sessions folder. To import calibration data from a saved session file, go to File > Import calibration data.



Wait a few seconds for the operation to complete. If the import function is done while connected to an ECU, after the import is complete:

- 1) Turn the key off and wait for the main relay to power down completely. This usually takes about 10 seconds but depends on the model.
- 2) Turn the key back on

Please be aware of cross-platform differences that may require additional attention after importing calibration data. For instance, the Digital7 pin is available on the Infinity-6 ECU but not available on the Infinity-8H ECU. After importing Infinity-6 session data to an Infinity-8, any input that was assigned to use Digital7 will be displayed as 'invalid' in the wizard and need to be reassigned to work properly.

## 4.2.2 Wizard Setup

### 4.2.2.1 Wizard Design

The ECU setup wizard is designed to simplify the initial configuration of the Infinity ECU. **AEM recommends using the wizard only when connected to the ECU via USB with the power on.** Most of the setup wizards require the engine to NOT be running. Exceptions will be clearly stated in the function descriptions.

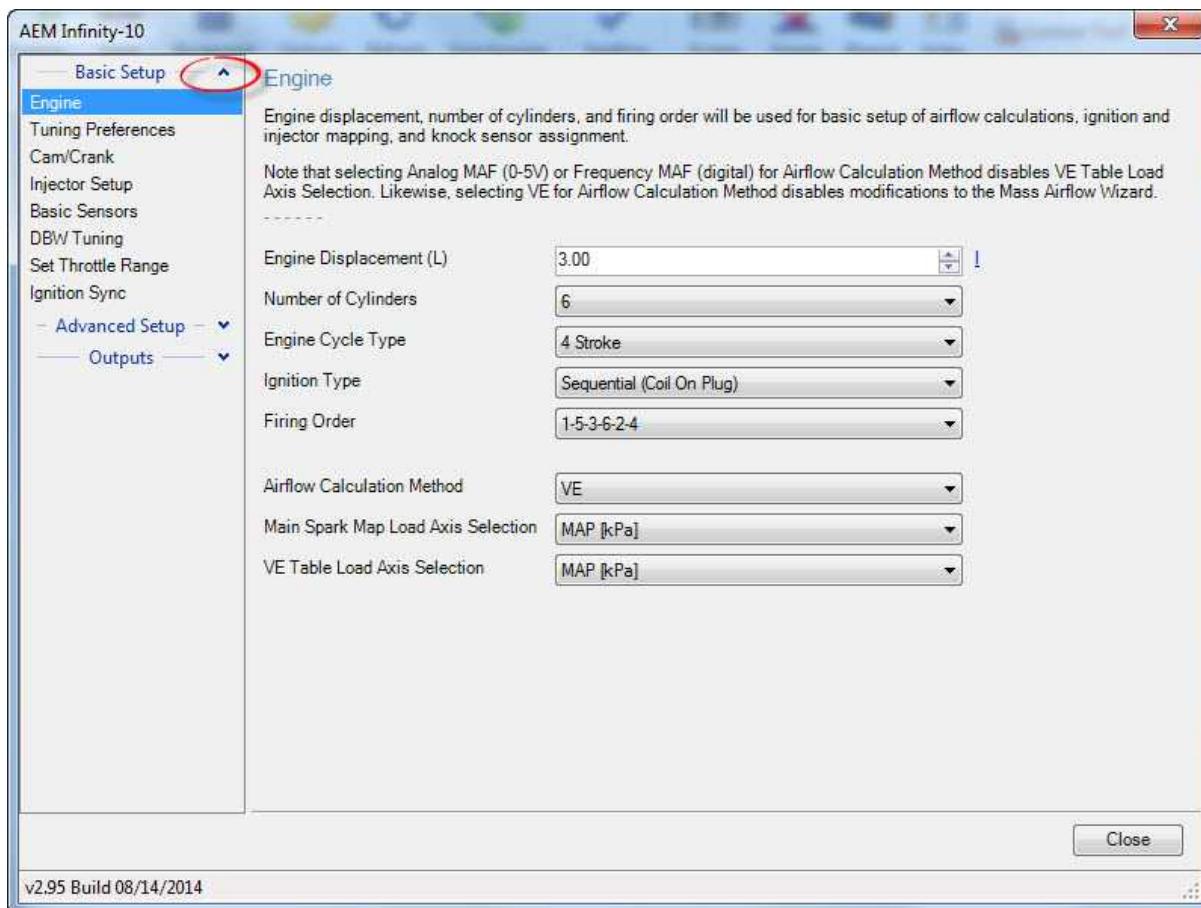
The setup wizard contains general and detailed descriptions with each major function. The most imperative functions are discussed below. Use the descriptions in the wizard to assist in the completion of all other setup features. New setup wizard features are being added constantly. Please follow the written descriptions on each wizard page as this document may not accurately represent the features included in the most recent versions.

The Setup Wizard is a stand alone application that runs in conjunction with Infinity Tuner. This software is updated periodically and its appearance and features may not completely match the descriptions below. In the event of a conflict, refer to the descriptions and instructions on the Setup Wizard pages themselves.

With the laptop connected to the Infinity ECU via USB and InfinityTuner connected, Go to the Wizard menu at the top of the InfinityTuner layout and select Setup Wizard.

### 4.2.2.2 Wizard Organization

The wizard is organized into different sections with expandable menu items on the left hand pane. Use the highlighted arrow below in each section to expand the available sections.



#### 4.2.2.3 Basic

**Basic**

Engine displacement, number of cylinders, and firing order will be used for basic setup of airflow calculations, ignition and injector mapping, and knock sensor assignment.

Note that selecting Analog MAF (0-5V) or Frequency MAF (digital) for Airflow Calculation Method disables VE Table Load Axis Selection. Likewise, selecting VE for Airflow Calculation Method disables modifications to the Mass Airflow Wizard.

-----

Engine Displacement (L)	3.00
Number of Cylinders	6
Engine Cycle Type	4 Stroke
Ignition Type	Sequential (Coil On Plug)
Firing Order:	1-5-3-6-2-4
Airflow Calculation Method	VE
Main Spark Map Load Axis Selection	MAP [kPa]
VE Table Load Axis Selection	MAP [kPa]

**Note: This wizard can not be used when the engine is running.**

**Engine Displacement (L)**

Enter the engine displacement in liters.

Min value = 0.250, Max value = 10.0

**Number of Cylinders:**

Enter the number of cylinders within the engine.

Min value = 1, Max value = 10

Possible values: 1,2,3,4,5,6,8,10

**Engine Cycle Type:**

Enter the engine type: 2 Stroke or 4 Stroke.

**Firing Order:**

Select the firing order of the engine.

**Airflow Calculation Method:**

Select how the airflow calculation is processed. There are 3 options:

**VE:** This is the default configuration. Airflow is calculated using the speed density algorithm.

**0-5V MAF:** Airflow is calculated using a 1-axis lookup table that has an analog (0-

5V) input from a typical OEM MAF sensor.

**Frequency MAF:** Airflow calculated using a 1-axis lookup table that has a digital input from a typical OEM MAF sensor

**Main Spark Map Load Axis Selection:**

This selection will set the load (y-axis) of the ignition maps. Note: The BaselnMap and FlexlgnMap must have the same load channel.

Load Axis Channels

- MAP [kPa]
- Throttle [%]
- MassAirflow [gms/s]
- MassAirflow [gms/rev]
- MAP/EBP
- MAP/Baro

**VE Table Load Axis Selection:**

This is only available if the Airflow Calculation Method is selected. It will set the load (y-axis) of the VE Table.

Load Axis Channels

- MAP [kPa]
- Throttle [%]
- MassAirflow [gms/s]
- MassAirflow [gms/rev]
- MAP/EBP
- MAP/Baro

#### 4.2.2.4 Tuning Preferences

Calibration data is automatically saved to ECU flash memory at key off if the "Key Off Commit" function is selected in the Tuning preferences wizard page. Proper power sequencing is critical in order to avoid problems. If power is removed from both pins C1-10 and C2-50 (Infinity 8/10/12 hardware) before this action is completed, the ECU may become inoperable and require reprogramming at AEM.

##### Tuning Preferences

###### Key Off Commit:

If Key Off Commit is selected, the ECU will automatically save any unsaved changes when the ignition power input, Pin C1-65 is turned off.

This function could take several seconds to complete.

If power is removed from both pins C1-10 and C2-50 before this action has completed, the ECU may become inoperable and require reprogramming at AEM.

Key Off Commit

#### 4.2.2.5 Cam/Crank

Choose the Cam/Crank timing type that will be used. The description field notes important information about edge selections and wiring requirements.

##### Cam/Crank

Use the Cam/Crank wizard to select the sensor type, trigger pattern, and noise filter settings for the Cam and Crankshaft sensor inputs.

\*The Cam/Crank wizard will also set the CamSyncAdjust, TriggerOffset, and VR PWM table specific to your engine type.

###### WARNING:

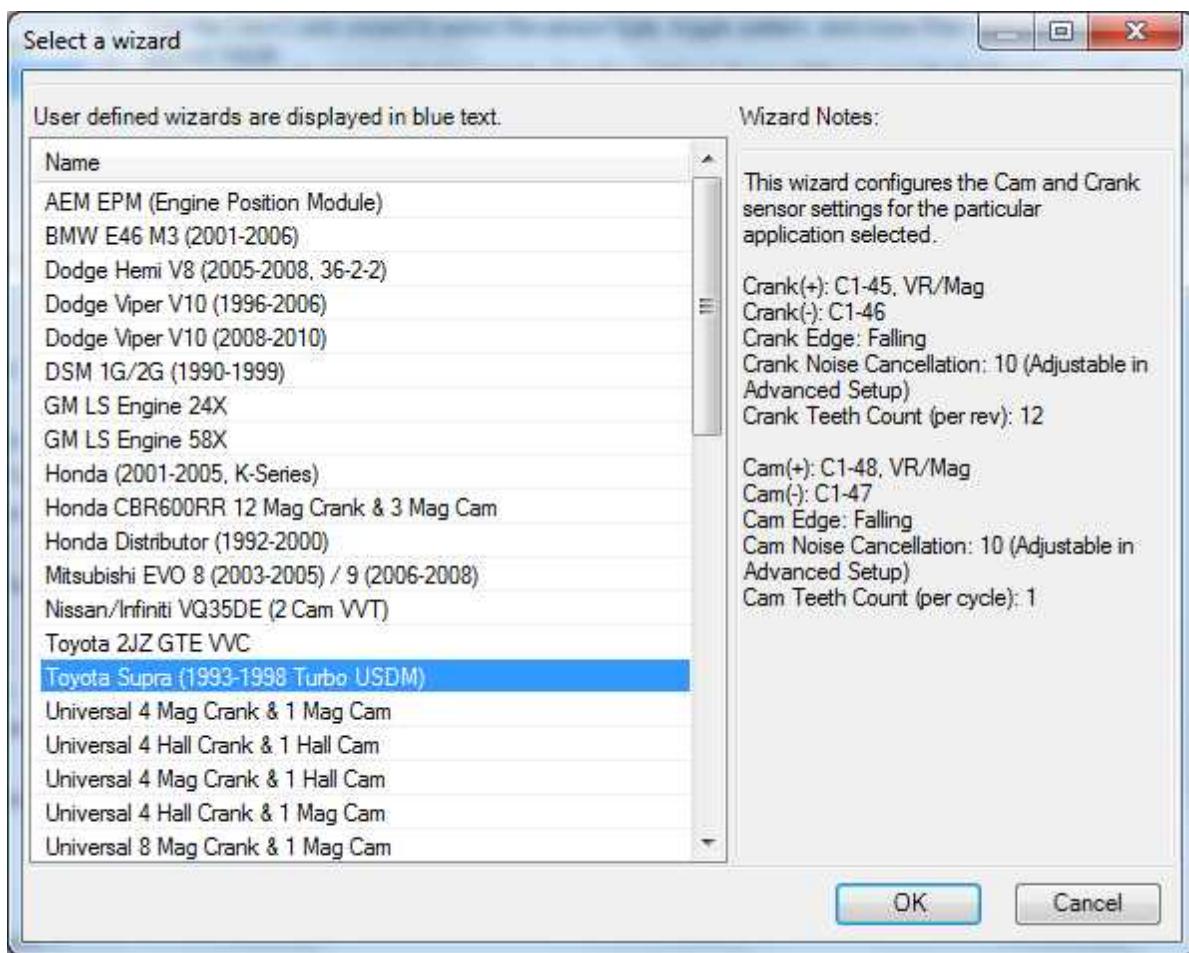
After making changes to Cam/Crank input settings, the Ignition Timing Sync Wizard MUST be used to verify the ignition timing displayed by the ECU matches the ignition timing measured at the crankshaft with a timing light. Failure to do so may result in engine damage!

Sensor Selection:

Toyota Supra (1993-1998 Turbo USDM)



\* deviates from the selection default values



Additional settings exist to adjust noise cancellation.

#### 4.2.2.6 Ignition Sync

**Ignition Sync**

The purpose of the Ignition Timing Sync Wizard is to ensure that the ignition timing measured at the crankshaft matches the SpkTiming [DegBTDC] channel displayed by Infinity Tuner. Lock the ignition timing at the chosen setpoint and compare with the timing mark on the vehicle's crankshaft pulley using a timing light. Use the Large (5 degree increments) and the Small (0.5 degree increments) Sync Adjustments to match the target and actual ignition timing.

**Ignition Timing**

Lock ignition timing at  degrees BTDC.

**Sync Adjustment**

**Advance Timing**      **Retard Timing**

**Large** **Small** **Small** **Large**

**▼ Hide Advanced Setup**

Trigger Offset:  degrees BTDC

The Pickup Sensor Delay is used to compensate for very small delays inherent in the vehicle's timing inputs and ignition outputs. If the timing at the crankshaft is accurate at low RPM but slightly retarded at high RPM, increase the Pickup Sensor Delay value.

Pickup Sensor Delay: Less - + More  us

The engine's ignition timing must be synchronized with the Infinity Tuner's ignition timing display. This is crucial with older vehicles that have adjustable distributors, adjustable cam angle sensors, etc. Most modern engines do not utilize a manual adjustment for ignition timing. However, this wizard should always be used for verification as sensors can be frequently installed backwards or upside down. This can catch a problem before damage occurs.

**Note: This wizard can only be used when the engine speed is greater than 50 RPM.**

#### Ignition Timing

For synchronizing, the ignition timing can be locked by checking the box.  
Allowable values: Min value = 0, Max value = 45

#### Sync Adjustment

The window includes 4 buttons. Two buttons are used to Advance Timing and TWO

buttons are used to Retard Timing.

The button labeled Large edits the CamSyncAdjustment TrigOffset [degBTDC] channel in 1.0 deg steps. The range is 0 to 719 degrees. The button labeled Small edits the TrigOffset [degBTDC] channel in 0.1 deg steps.

The TrigOffset [degBTDC] is adjustable by Resolution. The Resolution setting has a range of 0.25 deg to 2.0 degrees in 0.25 degree increments. This “stepping” function allows the user to make TrigOffset [degBTDC] adjustments with the Small button up to the range limit.

## Advanced Setup

### Pickup sensor delay

The More and Less buttons increase/decrease the SpkDelayComp [us] value in increments/decrements of 5.

Min value = 0, Max value = 500

Two separate procedures are required depending on the Infinity application: Plug and Play, or Universal Application.

### Plug and Play

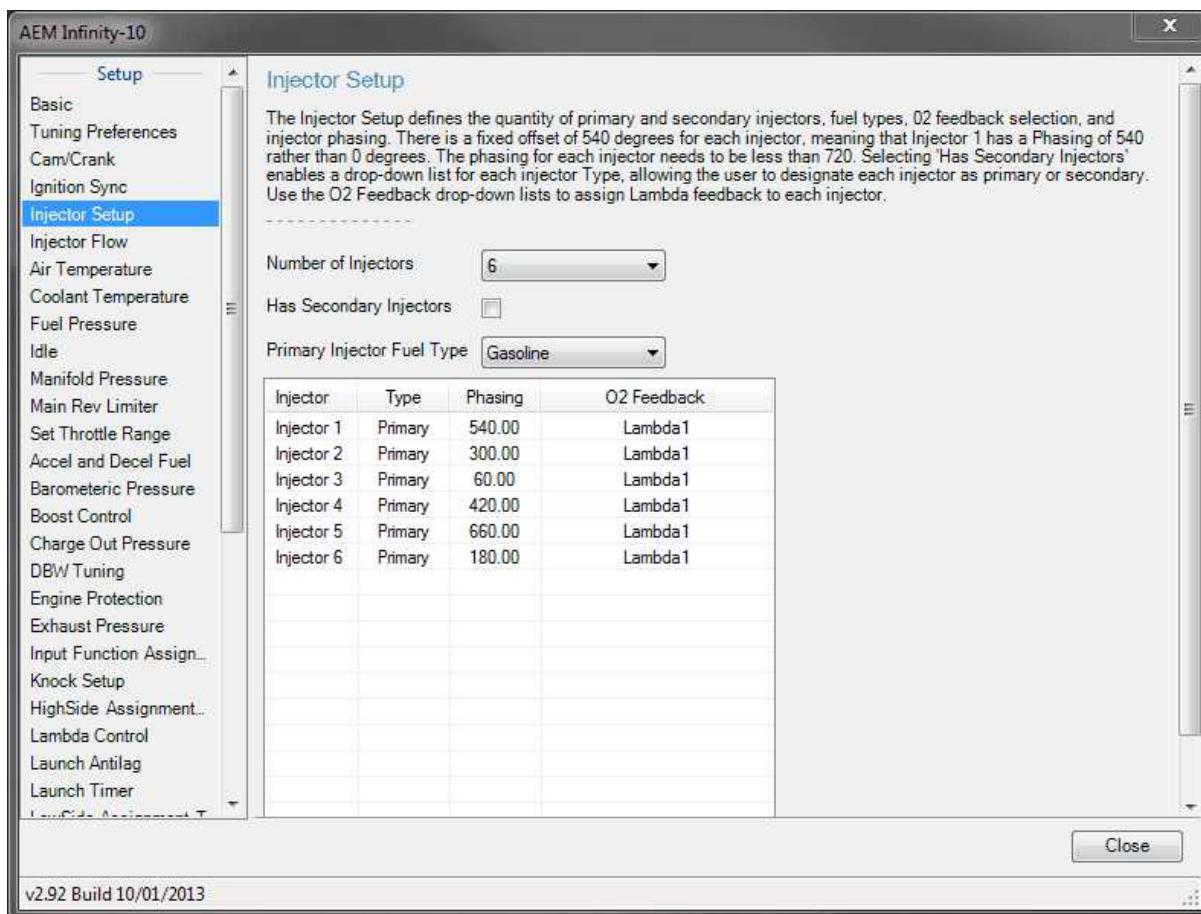
- a. In the Ignition Sync wizard, select the checkbox “Lock ignition timing at” and set the “degrees BTDC” (10.0 deg BTDC is the default).
- b. Start the engine and use a timing light to verify that the crankshaft timing matches the locked ignition timing set point (10.0 deg BTDC if using the default setting).
- c. If there is a deviation between the locked set point and the actual timing observed with the timing light, use the Sync Adjustment arrows to match the wizard-displayed value with the actual value. As the Sync Adjustment arrows are advanced or retarded, the timing observed on the crankshaft will change, while the “Lock ignition timing at 10.0 degrees BTDC” will remain constant.

### Universal Application

- a. In the Ignition Sync wizard, select the checkbox “Lock ignition timing at” and set the “degrees BTDC” (10.0 deg BTDC is the default).
- b. **Do NOT attempt to start the engine.** Disable (unplug) the fuel injectors and/or fuel pump.
- c. While cranking the engine, use a timing light to verify that the crankshaft timing matches the locked ignition timing set point (10.0 deg BTDC if using the default setting).
- d. If there is a deviation between the locked set point and the actual timing observed with the timing light, use the Sync Adjustment arrows to match the wizard-displayed value with the actual value. As the Sync Adjustment arrows are advanced or retarded, the timing observed on the crankshaft will change, while the “Lock ignition

- timing at 10.0 degrees BTDC" will remain constant.
- e. Reconnect the fuel injectors and fuel pump.
  - f. Once the remaining Setup Wizards have been configured, repeat the Ignition Sync process with the engine running to ensure that the crankshaft timing matches the locked ignition timing set point.

#### 4.2.2.7 Injector Setup



#### Number of Injectors

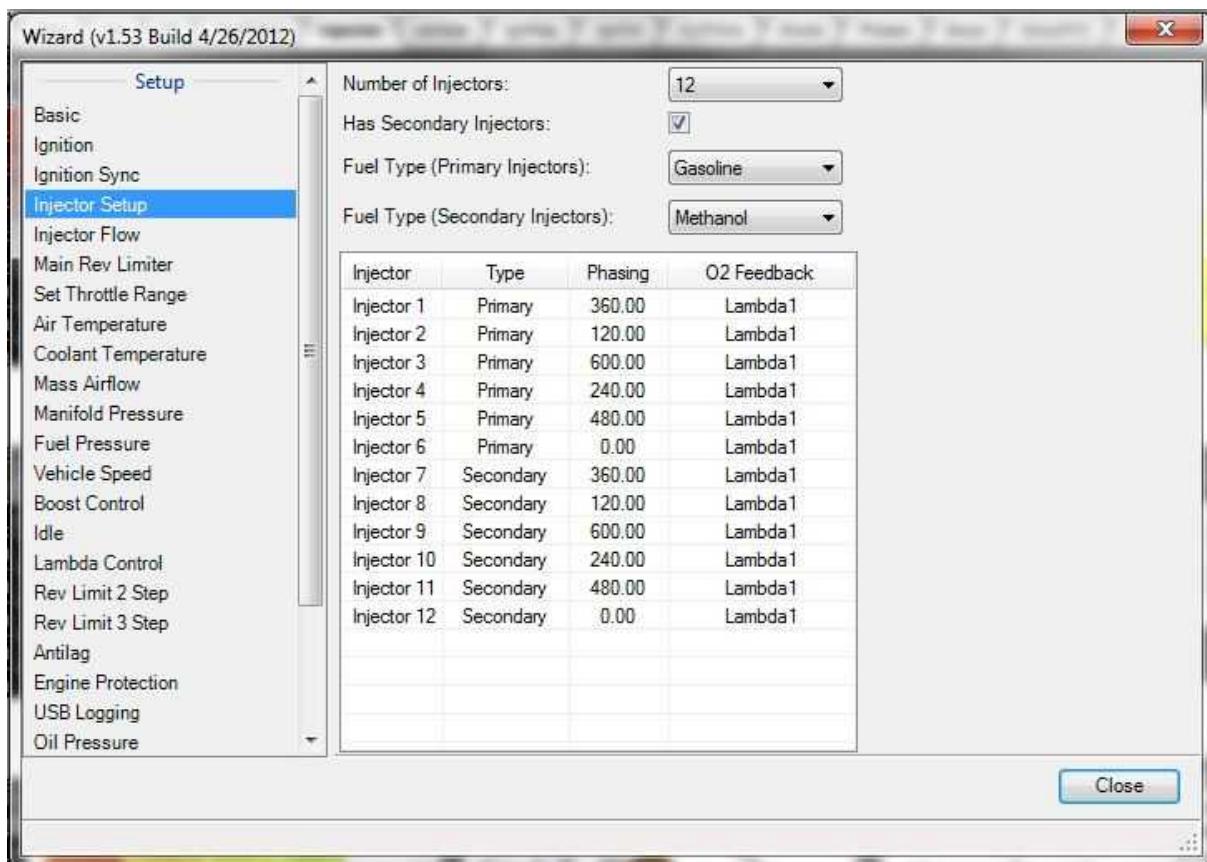
The drop down box allows the user to select the desired Number of Injectors. Min value = 4, Max value = 12.

#### Has Secondary Injectors

If secondary injectors will be used, select this check box. A new fuel type menu is now visible labeled Fuel Type (Secondary Injectors)

See [Staged Injection](#) for additional tuning information.

**Note:** If secondary injectors are being used the option *Has Secondary Injectors* must be selected and the table must be filled out indicating any injector number greater than the number of engine cylinders as secondary. These selections must be made before restarting the ECU and closing the form otherwise an error will occur. See image below for a typical 6 cylinder engine setup with 6 additional injectors classified as secondary. Note also the option to select a different fuel type for primary and secondary.



## Fuel Type

This drop down menu contains the following setup information for primary (and secondary fuel types, if selected).

- Gasoline
- Ethanol
- Methanol
- E85
- Flex Fuel

## Phasing

The default injector phasing for the primary injectors is determined from the Firing Order information from the Ignition Wizard. There is a fixed offset of 540 for injectors. After this offset is added, the system checks to see if the result is less than 720. If the result of the calculation is greater than or equal to 720, it is subtracted by 720 from that result.

Example:

4 cylinder 1-3-4-2 firing order:

Injector 1 phasing =  $0 + 540$  (offset) = 540

Injector 3 phasing =  $180 + 540$  (offset) = 0

Injector 4 phasing =  $360 + 540$  (offset) = 180

Injector 2 phasing =  $540 + 540$  (offset) = 360

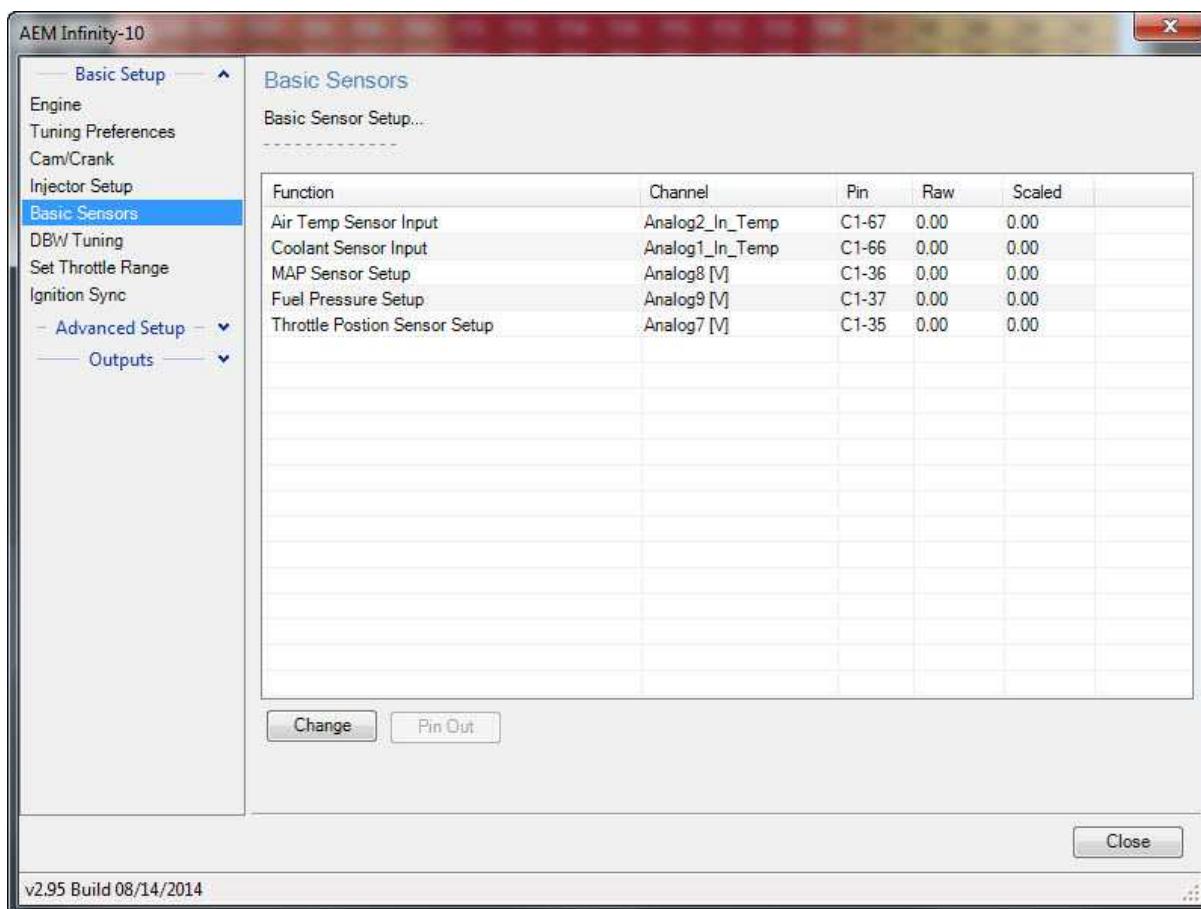
## O2 Feedback

Lambda sensor assignment is determined by assigning a value of 1 or 2 to the InjXLambdaFB channels. A value of 1 will assign the Lambda 1 sensor and a value of 2 will assign the Lambda 2 sensor.

Min value = 1, Max value = 2.

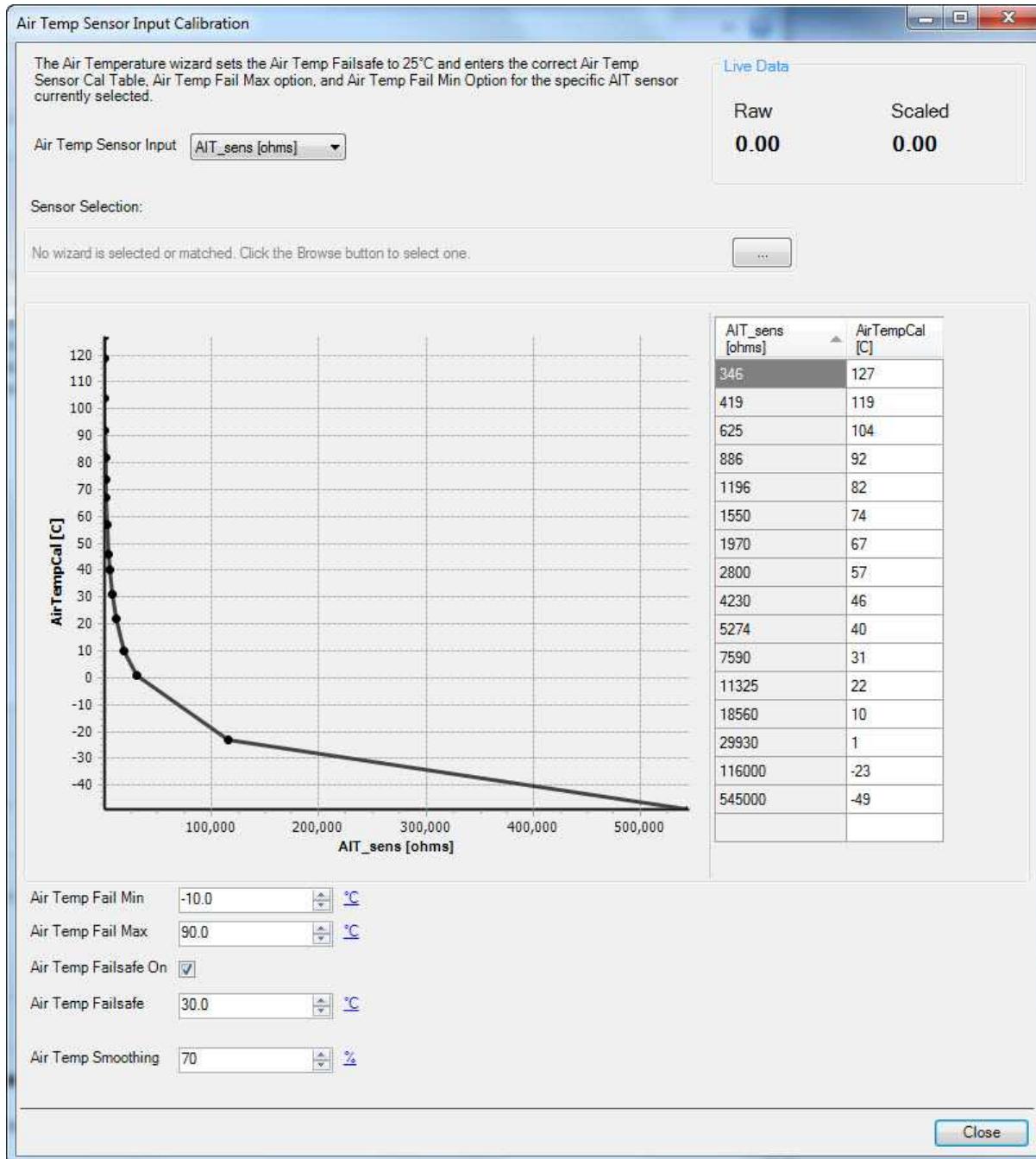
#### 4.2.2.8 Basic Sensor Setup

Most basic sensors can be configured using this wizard setup window. A summary of the setup data is included in the table shown below. Double clicking on a selection will open a more detailed interface where calibration data can be edited.

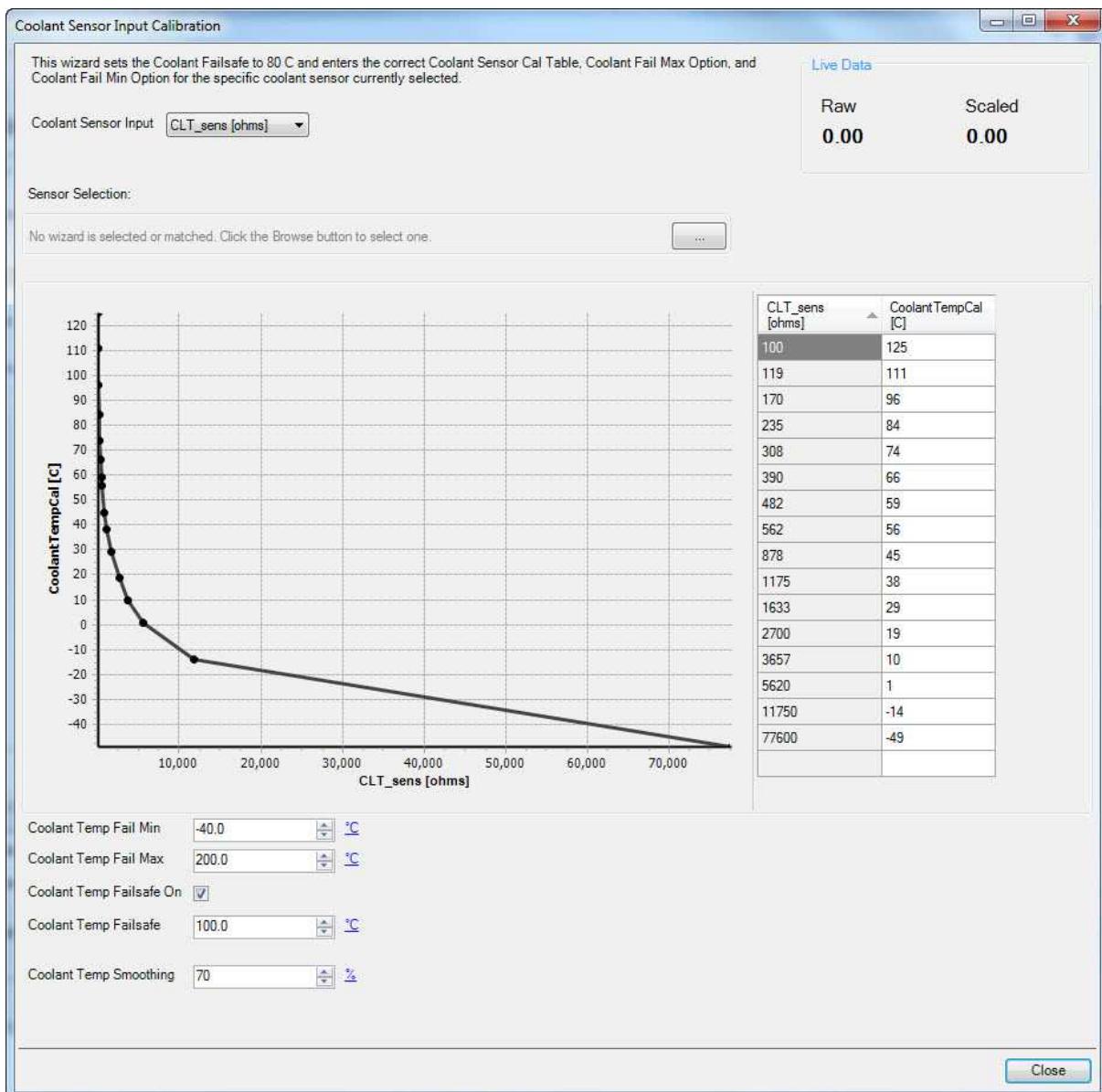


Several examples are shown below. The selections available in base session data may vary by application.

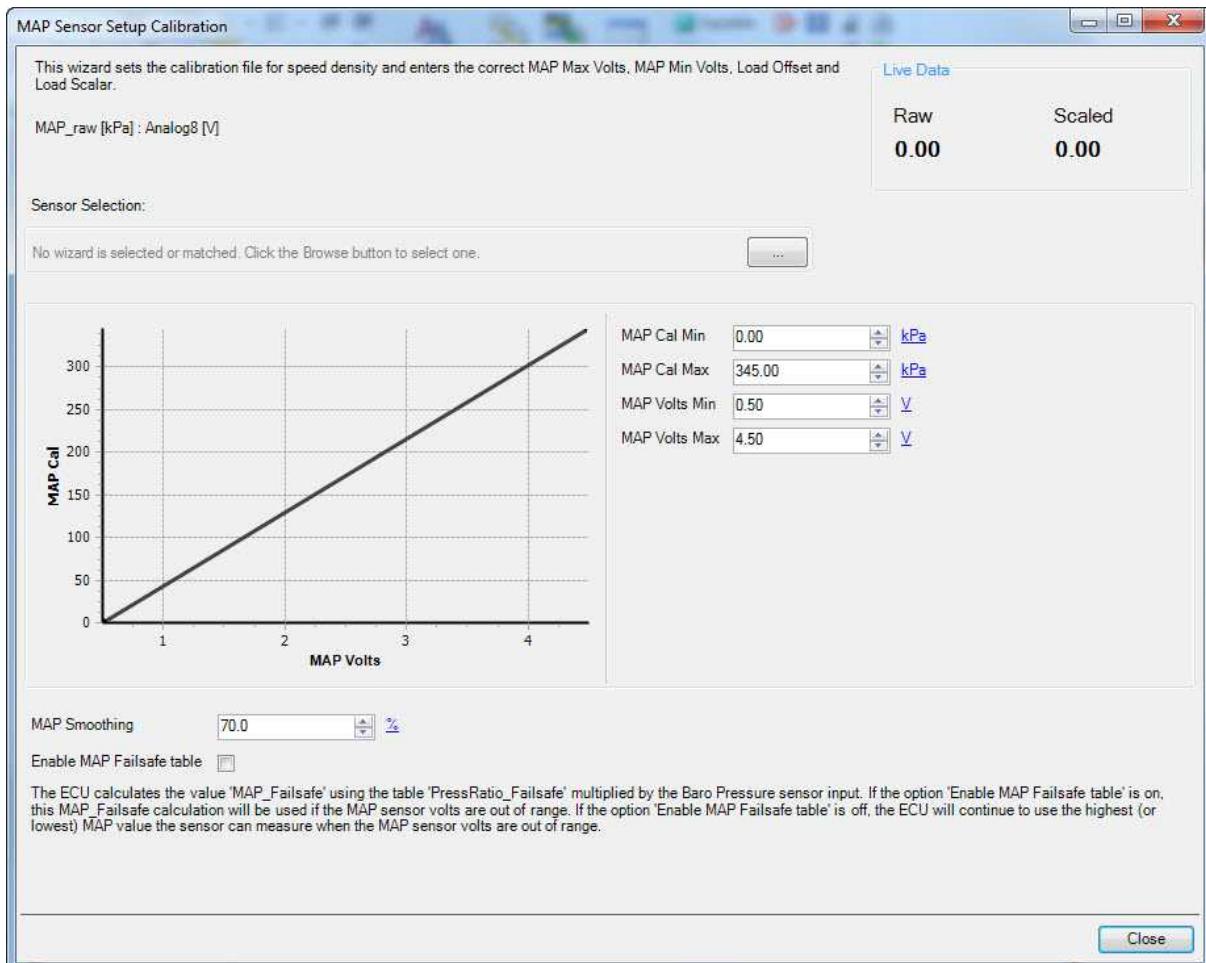
## Air Temperature



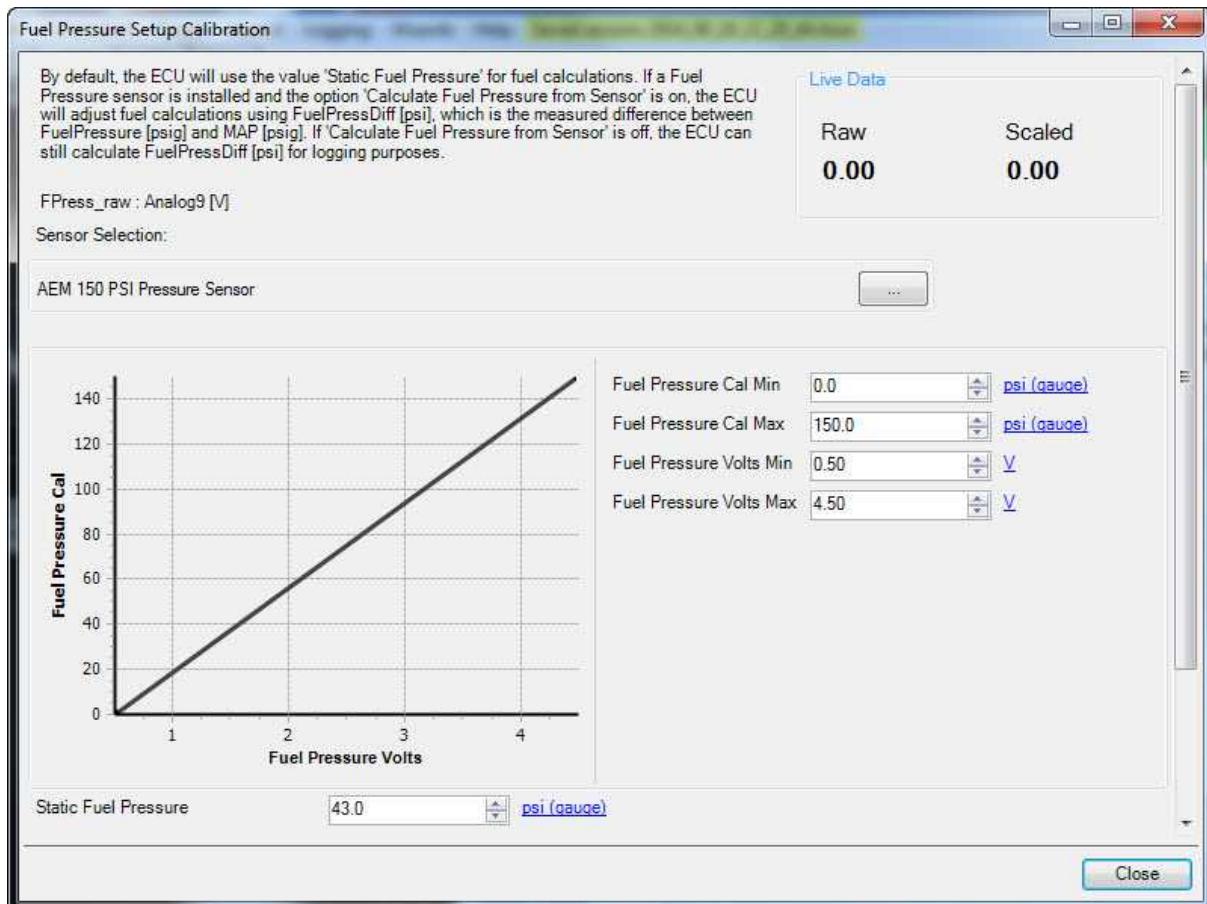
## Coolant Temperature



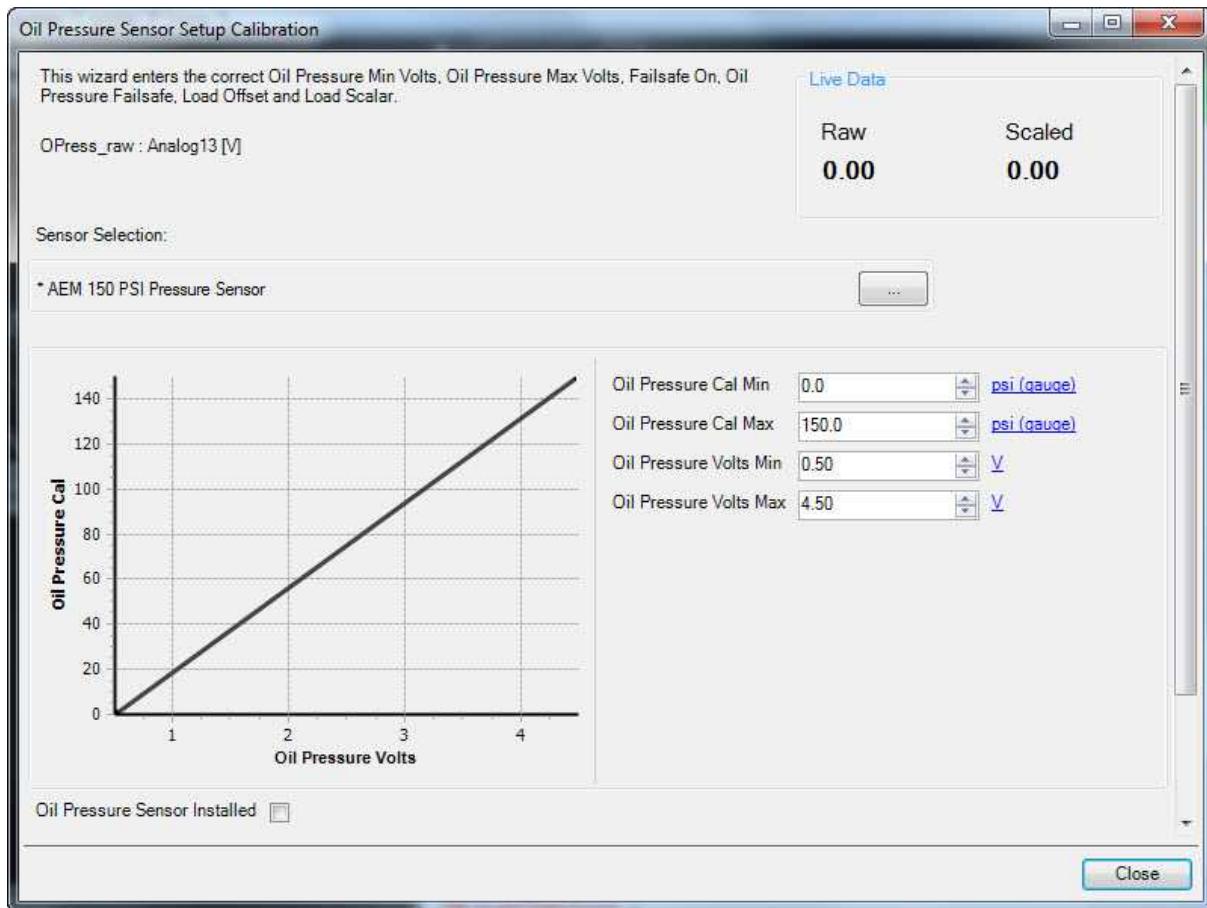
## MAP Sensor



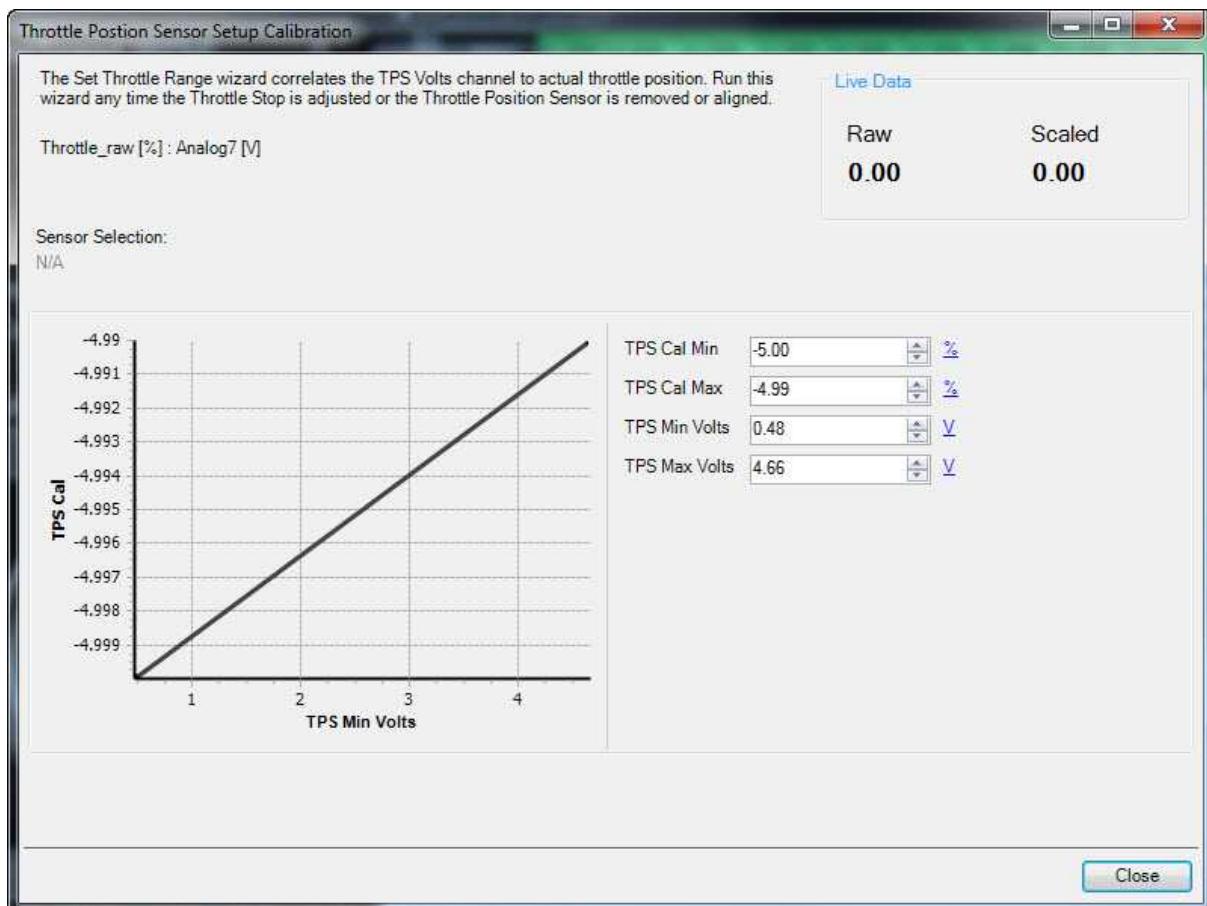
## Fuel Pressure



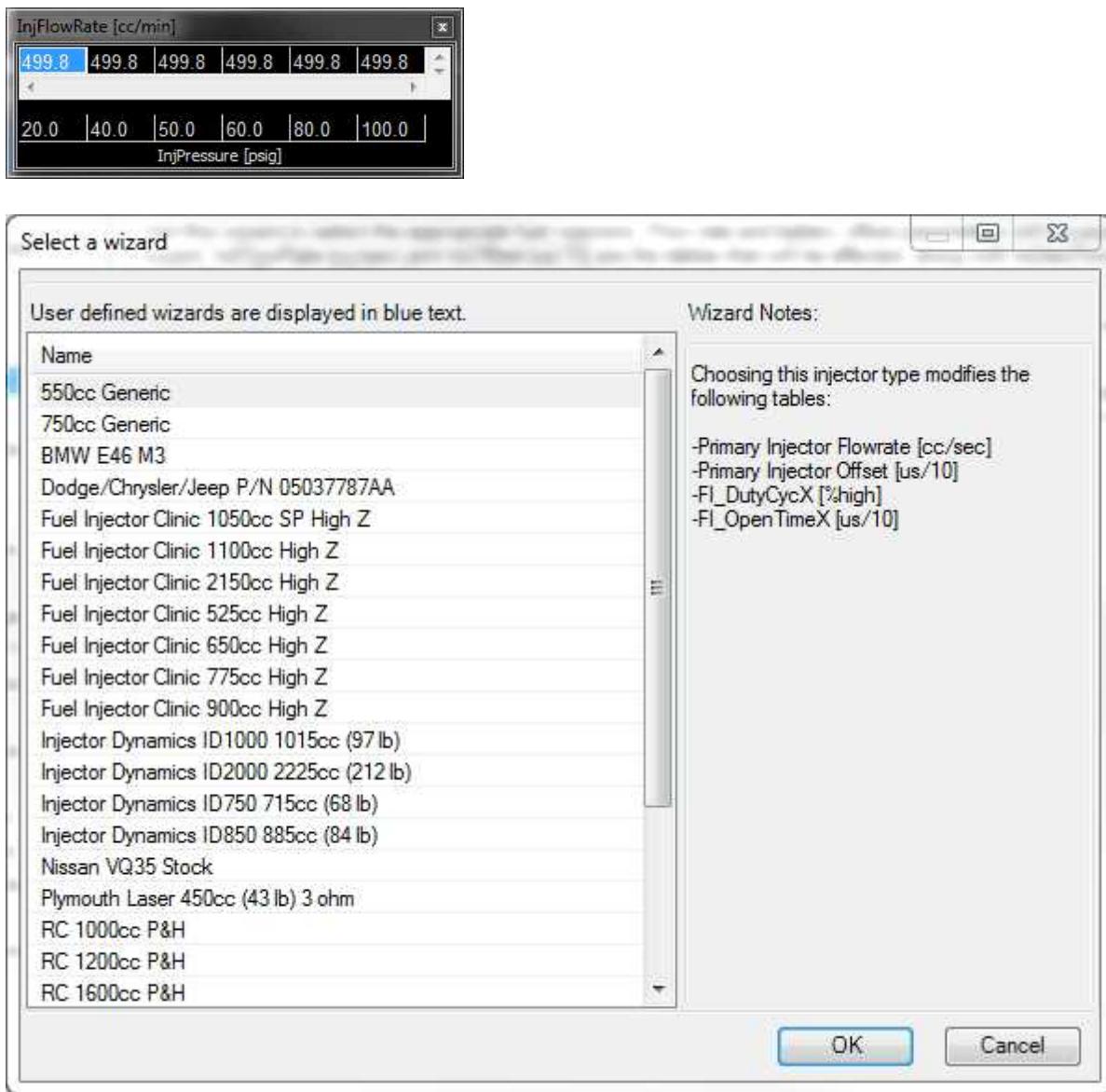
## Oil Pressure



## Throttle Position



#### 4.2.2.9 Injector Flow



#### Fuel Pressure Regulator Reference

Allows the user to choose the proper reference pressure for the fuel pressure regulator. The drop down has the following options:

**Manifold Vacuum Reference:** This should be selected if the fuel pressure regulator's port is connected to a vacuum or vacuum/boost source.

**Atmospheric Reference:** This should be selected if the fuel pressure regulator's port is open to atmosphere or if a dead end fuel system is used where fuel pressure is constant.

## Primary Injector Flow Selection

This database allows the user to select proper primary injector flow data.

InjFlowRate [cc/sec], 1-Axis lookup table of flow vs injector pressure.

Width (in cells): 6

Min cell value: 1

Max cell value: 85

Cell precision: 16-bit fixed precision

InjOffset [us/10], 2-Axis lookup table of PW offset vs battery voltage and injector pressure

Width (in cells): 4

Height (in cells): 6

Min cell value: 0

Max cell value: 65535

Cell precision: 16-bit fixed precision

## Secondary Injector Flow Selection

If Secondary Injectors were selected in the Injector Setup Wizard, this Secondary Injector Flow Selection database will be enabled. This allows the user to select proper secondary injector flow data.

InjSecFlowRate [cc/sec], 1-Axis lookup table of flow vs injector pressure.

Width (in cells): 6

Min cell value: 1

Max cell value: 85

Cell precision: 16-bit fixed precision

InjSecOffset [us/10], 2-Axis lookup table of PW offset vs battery voltage and injector pressure

Width (in cells): 4

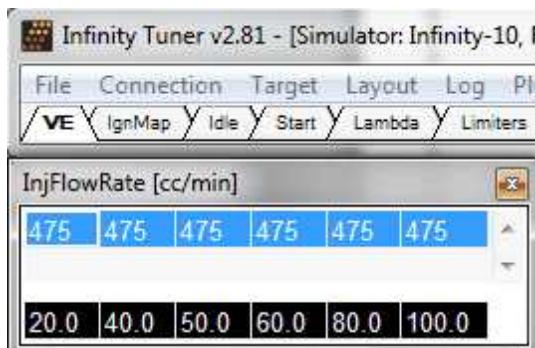
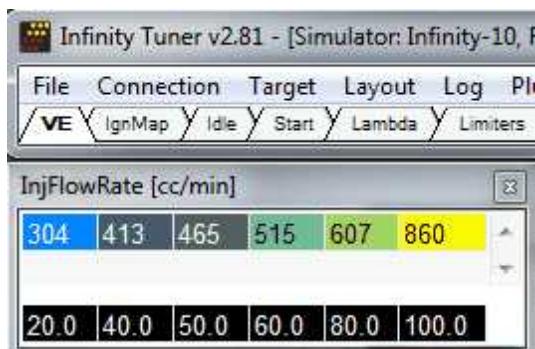
Height (in cells): 6

Min cell value: 0

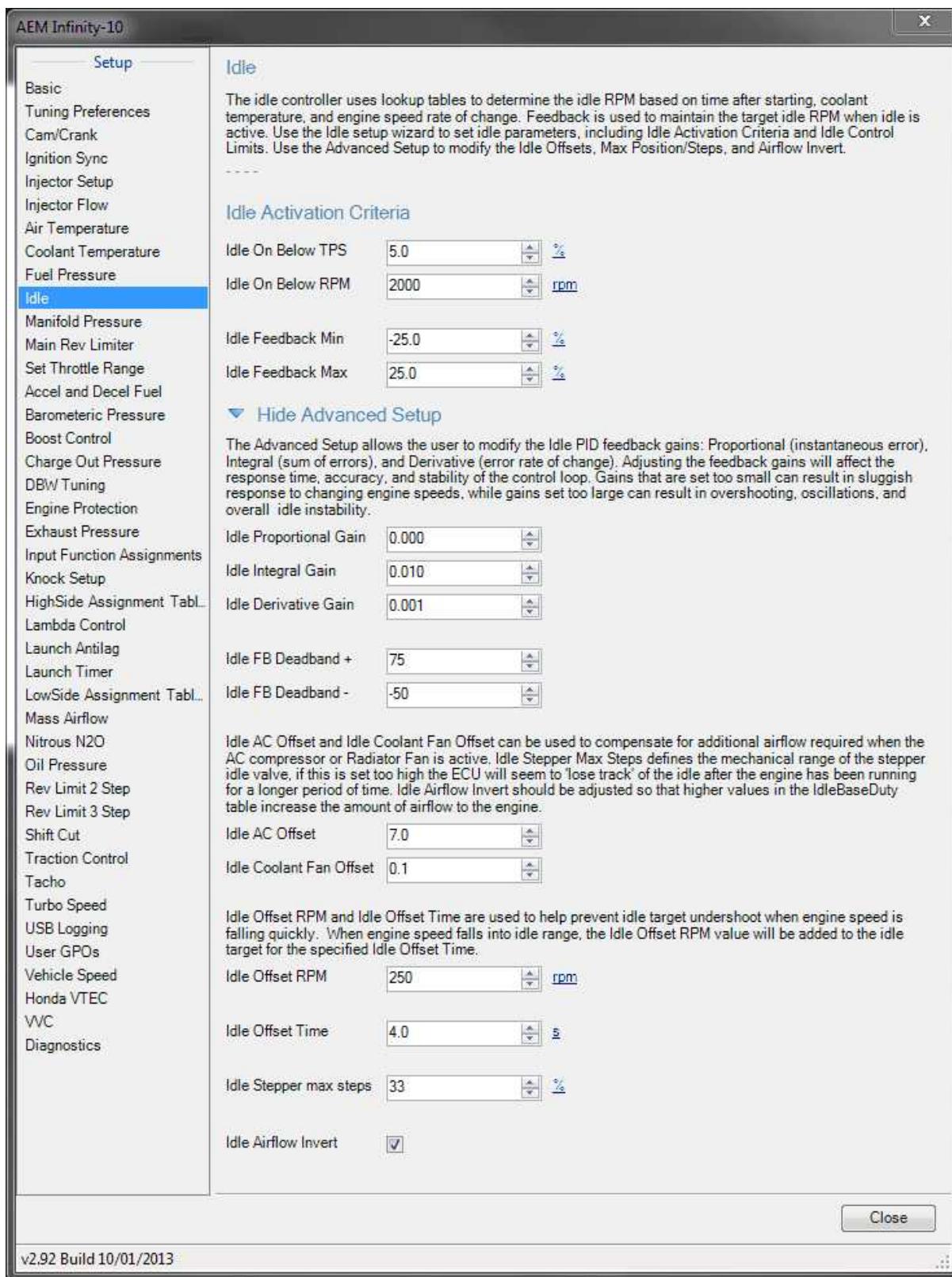
Max cell value: 65535

Cell precision: 16-bit fixed precision

**NOTE:** If the Setup Wizard does not contain your specific fuel injector type, you can modify the InjFlowRate table manually. If you do not know the different flow rates at different fuel pressures, choose a flow rate (based on Manufacturers specs) at a known pressure and populate the entire row with that value. For example, you have a fuel injector that is not listed in the Wizard Selection. You know that it flows 475 cc/min at 45 psi. Select the cells in the upper row of the InjFlowRate [cc/min] table and manually input 475. This will suffice to get the car up and running, though proper flow data is ideal.



### 4.2.2.10 Idle



**Idle Activation Criteria:****Idle On Below TPS [%]:**

Closed-loop idle feedback will be active when the throttle position is below this value, and the 'Idle On Below RPM' condition is also met.

Min value = 0, Max value = 10

**Idle On Below RPM [RPM]:**

Closed-loop idle feedback will be active when the EngineSpeed is below this value, and the 'Idle On Below TPS' condition is also met.

Min value = 500, Max value = 3000

**Idle Feedback Min [%]:**

Minimum amount of correction allowed.

Min value = -50, Max value = 0

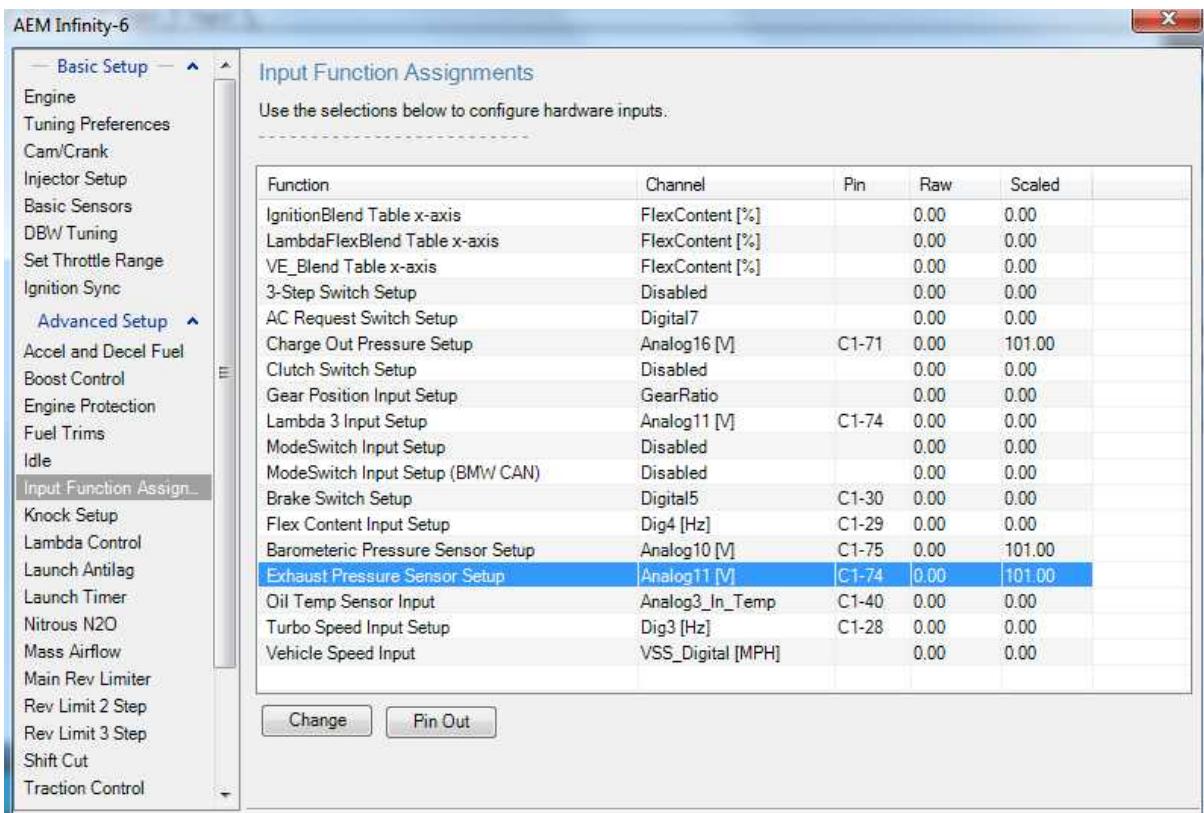
**Idle Feedback Max [%]:**

Maximum amount of correction allowed.

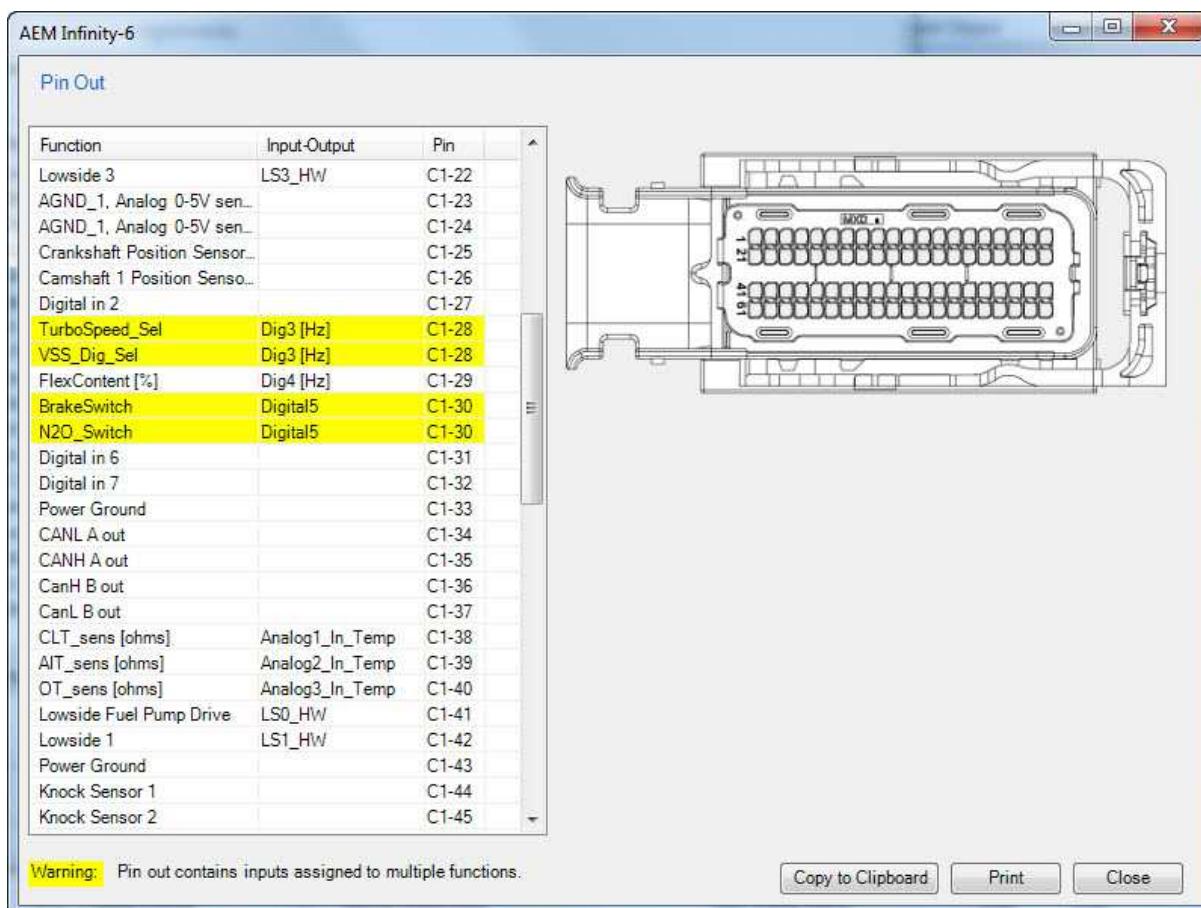
Min value = 0, Max value = 50

#### 4.2.2.11 Input Function Assignments

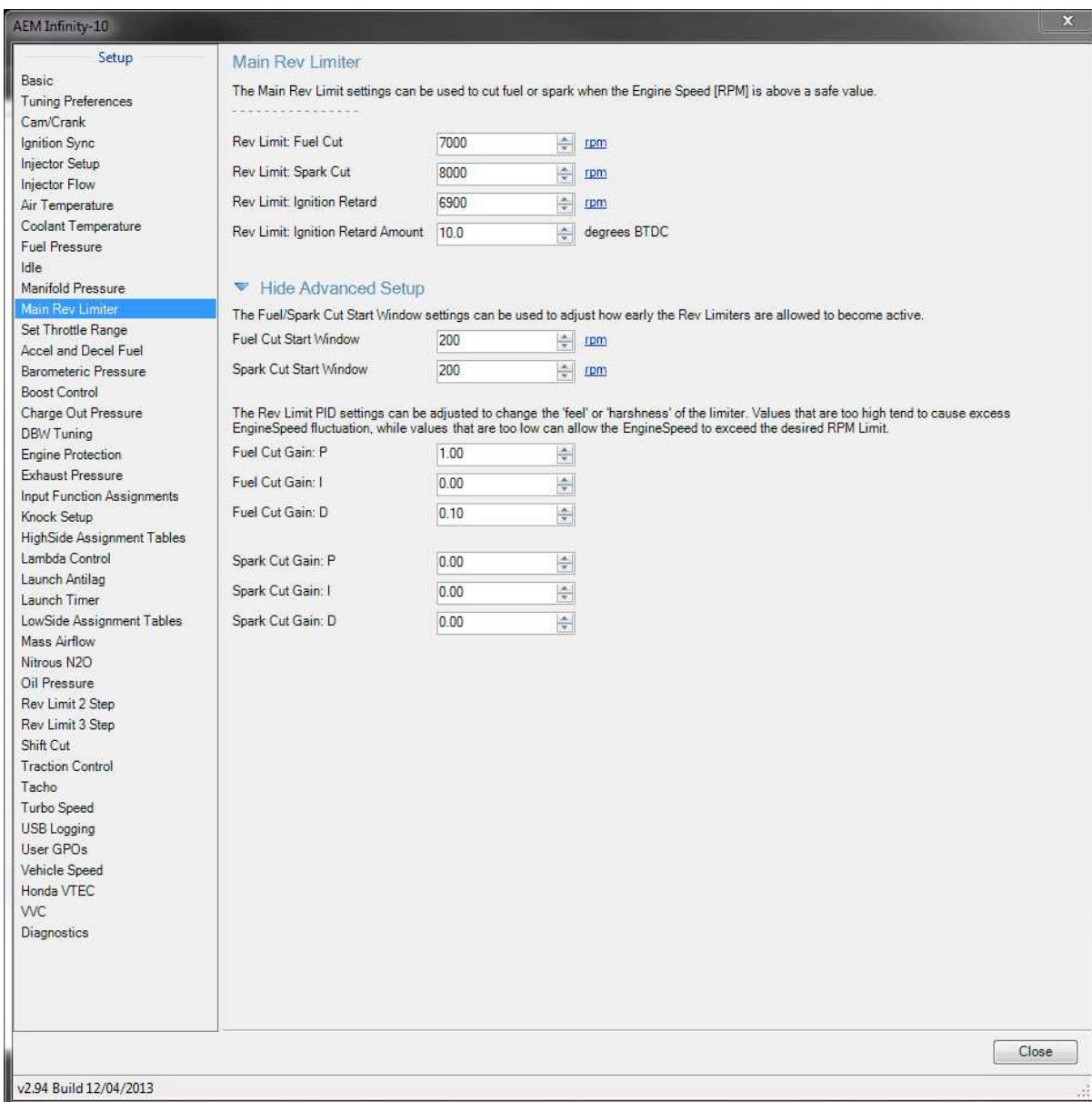
Programmable inputs can be configured in the following window. Double click the item or left click and select the *Change* button.



Clicking the *Pin Out* button will display a pinout diagram showing the current configuration of the system. Inputs that are assigned to multiple functions will be highlighted for user reference. The user can optionally copy this information to the clipboard or even print it.



#### 4.2.2.12 Main Rev Limiter



##### Rev Limit Fuel Cut:

Desired RPM for the main limiter fuel cut. Set to an unattainable RPM value to disable.  
Min value = 2000 RPM, Max Value = 20,000 RPM

##### Rev Limit Spark Cut:

Desired RPM for the main limiter spark cut. Set to an unattainable RPM value to disable.

Min value = 2000 RPM, Max Value = 20,000 RPM

##### Rev Limit Ignition Retard:

Option to retard ignition timing during main limiter operation. Sometimes desirable on N/A applications to smooth the feel of the limiter. Set to an unattainable RPM value to disable. **Note: Using ignition retard while on the main limiter is not recommended for turbocharged applications.**

Min value = 2000 RPM, Max Value = 20,000 RPM

#### **Ignition Retard Amount:**

Desired ignition retard while on main limiter and ignition retard active.

Min value = 0 deg, Max Value = 30

#### **Fuel Cut Start Window:**

Adjusts how early the fuel rev limiter is allowed to become active. This is an amount BELOW your target cut RPM.

Min value = 0 deg, Max Value = 300

#### **Spark Cut Start Window:**

Adjusts how early the spark rev limiter is allowed to become active. This is an amount BELOW your target cut RPM.

Min value = 0 deg, Max Value = 300

#### 4.2.2.13 Set Throttle Range



**The wizard displays a warning message to the user if the software is not connected to a hardware target.**

#### Live TPS Volts

Text and graphical representation of the raw analog voltage is shown.

#### Steps

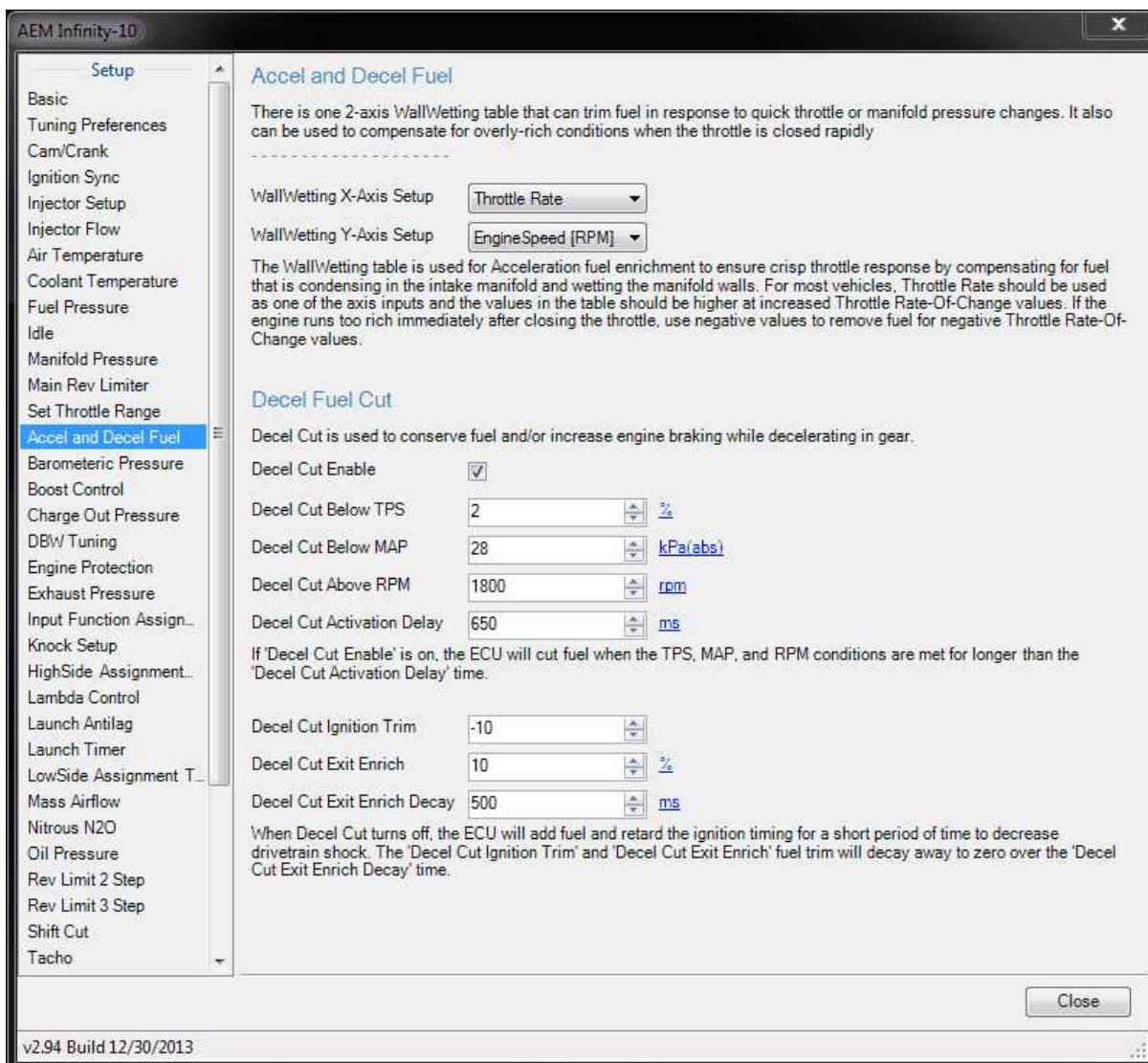
##### **Set TPS Volts Min**

Press this button when the throttle pedal is fully released. This will write the current value of Analog7 [V] to the Throttle\_raw [%] Analog In conditioner and display the resultant value on the TPS Min Volts: X.XX display.

##### **Set TPS Volts Max**

Press this button after the throttle pedal is fully depresses. This will write the current value of Analog7 [V] to the Throttle\_raw [%] Analog In conditioner and display the resultant value on the TPS Max Volts: X.XX display.

#### 4.2.2.14 Accel and Decel Fuel



##### WallWetting X-Axis Setup:

This allows the x-axis of the WallWetting table to be reassigned from the default setting of Throttle Rate to other inputs such as MAP, MAP Rate, Coolant Temp, or Engine Speed.

##### WallWetting Y-Axis Setup:

This allows the y-axis of the WallWetting table to be reassigned from the default setting of Engine Speed to other inputs such as MAP, MAP Rate, Coolant Temp, or Throttle Rate.

**Decel Cut Enable:**

Enable/disables the deceleration fuel cut feature.

**Decel Cut Below TPS:**

Fuel will be cut if the throttle is below this value, and all other conditions or met. Set this as low as possible, if this value is too high the engine will 'hesitate' due to Decel cut remaining active when the driver wants to accelerate.

Min value = 0%, Max value = 100%

**Decel Cut Below MAP:**

Fuel will be cut if the MAP signal is below this value, and all other conditions or met. This should be set to at least 2-3 kPa lower than the MAP value at idle .

Min value = 0 kPa, Max value = 110 kPa

**Decel Cut Above RPM:**

Fuel will be cut if the Engine Speed is above this value, and all other conditions or met. This should be set to at least 100-200 RPM higher the target idle RPM. Min value = 1000 RPM, Max value = 15000 RPM

**Decel Cut Activation Delay:**

Fuel will be cut if all the conditions above are met for this amount of time. This should be set high enough to avoid triggering decel fuel cut when shifting gears quickly.

Min value = 0 ms, Max value = 2000 ms

**Decel Cut Ignition Trim:**

After decel cut turns off, the ECU will retard ignition timing by this amount to decrease drivetrain shock.

Min value = 0 ms, Max value = 2000 ms

**Decel Cut Exit Enrich:**

After decel cut turns off, the ECU will increase fuel by this amount to avoid hesitation by replacing the fuel that was removed from intake runner surfaces while the fuel cut was active.

Min value = 0%, Max value = 40%

**Decel Cut Exit Enrich Delay:**

After decel cut turns off, the 'Decel Cut Ignition Trim' and 'Decel Cut Exit Enrich' trims will decay away over this amount of time.

Min value = 0 ms, Max value = 2000 ms

#### 4.2.2.15 Barometric Pressure

Baro Pressure Sensor Installed:	<input checked="" type="checkbox"/>
Baro Pressure Wizard Selection:	
<input type="button" value="..."/>	
<b>▼ Hide Details</b>	
Baro Pressure Min Volts:	0.50
Baro Pressure Max Volts:	4.50
Baro Pressure Cal Min [psig]:	50.00
Baro Pressure Cal Max [psig]:	120.00
Baro Pressure Failsafe On:	<input checked="" type="checkbox"/>
Baro Pressure Failsafe:	101.00

##### Baro Pressure Sensor Installed

If a barometric pressure sensor is installed, check this box

##### Baro Pressure Wizard Selection

Selecting this box will present a menu with multiple pre configured barometric pressure sensors to choose from.

##### Show Details

When selecting, the following options will be displayed.

##### Baro Pressure Min Volts:

This sets the minimum voltage capable from a properly working sensor. Check the manufacturer specifications for more information. Min value = 0, Max value = 5. Baro Pressure Max Volts must be > Baro Pressure Min Volts. User entries that do not meet this criteria are not allowed.

##### Baro Pressure Max Volts:

This sets the maximum voltage capable from a properly working sensor. Check the manufacturer specifications for more information. Min value = 0, Max value = 5. Baro Pressure Max Volts must be > Baro Pressure Min Volts. User entries that do not meet this criteria are not allowed.

##### Baro Pressure Cal Min [psig]:

This sets the minimum pressure capable, in psig, from a properly working sensor. Check the manufacturer specifications for more information. Min value = 0, Max value = 125. Baro Pressure Cal Max must be > Baro Pressure Cal Min. User entries

that do not meet this criteria are not allowed.

**Baro Pressure Cal Max [psig]:**

This sets the maximum pressure capable, in psig, from a properly working sensor. Check the manufacturer specifications for more information. Min value = 0, Max value = 125. Baro Pressure Cal Max must be > Baro Pressure Cal Min. User entries that do not meet this criteria are not allowed

**Baro Pressure Failsafe On:**

When clicking, the failsafe feature is enabled. This is typically used when the sensor is mistakenly unplugged or has failed.

**Baro Pressure Failsafe:**

The value entered here will be displayed and used for the barometric pressure corrections when the sensor has failed or is simply unplugged. Min value = 0, Max value = 125

#### 4.2.2.16 Boost Control

Boost controls setup wizard details can be found [here](#) .

#### 4.2.2.17 Lambda Control

**Lambda Control**

Use the Lambda Control wizard to set the Lambda Activation Criteria using min/max engine speed as well as min/max engine load (MAP kPa).

The Advanced Setup allows the user to modify the Lambda PID feedback gains; Proportional (instantaneous error), Integral (sum of errors), and Derivative (error rate of change). Adjusting the feedback gains will affect the response time, accuracy, and stability of the control loop. Gains that are set too small can result in sluggish response to changing AFRs, while gains set too large can result in overshooting, oscillations, and overall system instability.

UEGO 1 Sensor Installed

UEGO 2 Sensor Installed

**Lambda Enable:**

Lambda Feedback Enable

Lambda Feedback Rich Limit 20.0 %

Lambda Feedback Lean Limit -20.0 %

**Lambda Activation Criteria:**

Lambda Feedback Min Speed 800 rpm

Lambda Feedback Max Speed 10000 rpm

Lambda Feedback Min Load 5 kPa

Lambda Feedback Max Load 700 kPa

**▼ Hide Advanced Setup**

Lambda Feedback Proportional Gain 0.100

Lambda Feedback Integral Gain must be adjusted using the 1D table 'LambdaFB\_I'. The gain can be adjusted per RPM

Lambda Feedback Derivative Gain 0.005

Lambda Feedback After-Start Delay 15 s

Lambda Feedback Max WallWetting 10

LambdaTarget Table Y-Axis MAP [kPa]

#### UEGO Sensors Installed

Infinity 8 and Infinity 10 ECUs can have up to 2 UEGO sensors installed. Infinity 6 and Infinity 8H can have up to 1 UEGO sensor installed. Check the "UEGO Sensor Installed" boxes for each sensor that is connected to the ECU. Selecting

UEGO Sensor Installed effects the following:

Malfunction Indicator Lamp (MIL)

Uncheck the "UEGO Sensor Installed" box if a sensor is not installed to prevent the MIL Output from activating.

UEGO heater circuit

The UEGO heater circuit requires accurate status of which UEGO sensors are installed for proper functionality.

**Lambda Feedback Enable:**

Enable/disables the lambda feedback feature.

**Lambda Feedback Rich Limit:**

Maximum allowable feedback value when adding fuel to enrich the fuel mixture. Lambda feedback will be clamped to this maximum value, even if the measured air/fuel ratio is leaner than the target.

Min value = 0%, Max value = 50%

**Lambda Feedback Lean Limit:**

Maximum allowable feedback value when removing fuel to lean the fuel mixture. Lambda feedback will be clamped to this maximum value, even if the measured air/fuel ratio is richer than the target.

Min value = -50%, Max value = 0%

**Lambda Activation Criteria:**

**Lambda Feedback Min Speed [RPM]:**

Lambda feedback is disabled below this RPM. This value should be increased for setups with aggressive camshafts or very short exhaust piping after the sensor, which can result in 'false lean' measurements when the O2 sensor measures outside air in addition to exhaust gas at low engine speeds.

Min value = 0, Max value = 20,000

**Lambda Feedback Max Speed [RPM]:**

Lambda feedback is disabled above this RPM. Used to force open loop operation above a certain engine speed.

Min value = 0, Max value = 20,000

**Lambda Feedback Min Load [kPa]:**

Lambda feedback is disabled below this manifold pressure. Sometimes useful for setups with aggressive camshaft or very short exhaust piping where exhaust reversion can cause 'false lean' measurements when cruising at very low manifold pressures. If using decel fuel cut, it may be useful to set this value to the same value as the **Decel Cut Below MAP** value.

Min value = 0, Max value = 700

**Lambda Feedback Max Load [kPa]:**

Lambda feedback is disabled above this manifold pressure. Some tuners prefer to run open loop without lambda feedback above a certain MAP pressure.

Min value = 0, Max value = 700

**Advanced Setup:****Lambda Control Proportional Gain:**

Proportional control is a pure gain adjustment acting on the magnitude of the target error to provide the system response. The advantage of a proportional-only control is it can respond quickly to large errors; when the error is large the proportional response will be large. The disadvantage of proportional gain for idle control is the proportional response will decrease to zero as the measured Lambda value gets closer to the target lambda, and excessive Proportional gain can sometimes result in 'hunting' lambda values near the target. Since most tuners want to hit their lambda target and stay there, it is recommended to rely more heavily on the Integral feedback gain and leave Proportional gain at lower values. If the system responds too slowly to quick disturbances or large errors, increase this value slightly.

Min value = 0.000, Max value = 0.500

**Lambda Control Integral Gain:**

Note that the integral gain is adjusted in the table LambdaFB\_I, which adjusts the integral gain based on Engine Speed. It is recommended to adjust the LambdaFB\_I table before adjusting the Proportional or Derivative values. More details in the [Lambda Control](#)<sup>[213]</sup> section.

**Lambda Control Derivative Gain:**

The derivative term adjusts the feedback based on how quickly the target error changes. Derivative control is used to reduce the amount of overshoot that may occur due to the Proportional gain's response to large errors. For instance, if the Lambda1 value is below the target but increasing toward the target quickly, the Derivative term will decrease feedback to avoid a possible overshoot. In this example, larger derivative gains would result in larger negative feedback. When the lambda value increases more slowly, the Derivative contribution will decrease. Note: for most setups, it is recommended to leave the Derivative gain

set to zero.

Min value = 0.000, Max value = 0.100

#### **Lambda Feedback After-Start Delay:**

Lambda feedback will be disabled for this many seconds after the engine is started. Adjust this value to avoid performing feedback while the exhaust sensor may still contain fresh air. If the engine begins running poorly when feedback turns on, try increasing this value.

Min value = 0 seconds, Max value = 25 seconds

#### **Lambda Feedback Max WallWetting:**

Lambda feedback can be disabled for 750ms after a significant amount of WallWetting has been added for acceleration fuel enrichment. Adjust this value to set the maximum amount of WallWetting that should be allowed without disabling Lambda Feedback

Min value = 2, Max value = 30

#### **LambdaTarget Table Y-Axis:**

The y-axis of the LambdaTarget table can be reassigned from the default setting of MAP to use Throttle. This may be useful for naturally aspirated engines with very aggressive camshafts, or other setups that do not pull a significant amount of vacuum when the throttle is closed.

### **4.2.2.18 Tacho**

#### Tacho

This wizard sets the LS9\_Freq [Hz] table and LS9\_Duty [%] table based on your engine configuration/tacho type.

Tacho Selection.

Tacho 2 Pulses/Rev



#### **Tacho Wizard Selection**

Selecting this box will present a menu with multiple pre configured tacho types to choose from and properly configures LowSide 9 output.

Note: It is possible to reconfigure associated 1D and 2D tables to a different LowSide output or make modifications to the tables if your Tacho setup is not an available selection.

#### 4.2.2.19 USB Logging

##### USB Logging

Use the USB Logging wizard to set the start and stop criteria for the USB logging.

---

USB Logger Use Log Switch Input

USB Logger On Above RPM  rpm

USB Logging Speed  Hz (Samples per Second, each channel)

**Use Log Switch Input:**

Analog input on pin 35 of the 56 pin blue header. Analog voltage must be below 2.5 volts for this input to activate.

**USB Logger On Above RPM:**

Engine Speed must be above this value for logger to start logging.

**USB Logging Speed:**

Sample rate for channels selected.

**Note: All of the above conditions must be true for the logger to start unless *Use Log Switch Input* is not checked. In this case, the analog input is ignored but all other conditions must still be true.**

#### 4.2.2.20 Vehicle Speed

Vehicle Speed Calibration:	1.00	<input type="button" value="▼"/>
----------------------------	------	----------------------------------

**Vehicle Speed Calibration:**

This is a multiplier which is used to synchronize the actual speed of the vehicle to the Infinity Tuner's Vehicle Speed

Min value = 0, Max value = 10

#### 4.2.2.21 Honda VTEC

**Honda VTEC**

Use the following settings to configure VTEC.

---

VTEC Off Below RPM	4500	<input type="button" value="▼"/>	<a href="#">rpm</a>
VTEC On Above RPM	5000	<input type="button" value="▼"/>	<a href="#">rpm</a>
VTEC Off Below Throttle	45	<input type="button" value="▼"/>	<a href="#">%</a>
VTEC On Above Throttle	50	<input type="button" value="▼"/>	<a href="#">%</a>

**VTEC Off Below RPM:**

VTEC deactivates if below this RPM

**VTEC On Above RPM:**

VTEC enables once this RPM is reached

**VTEC Off Below Throttle:**

VTEC deactivates if below this Throttle.

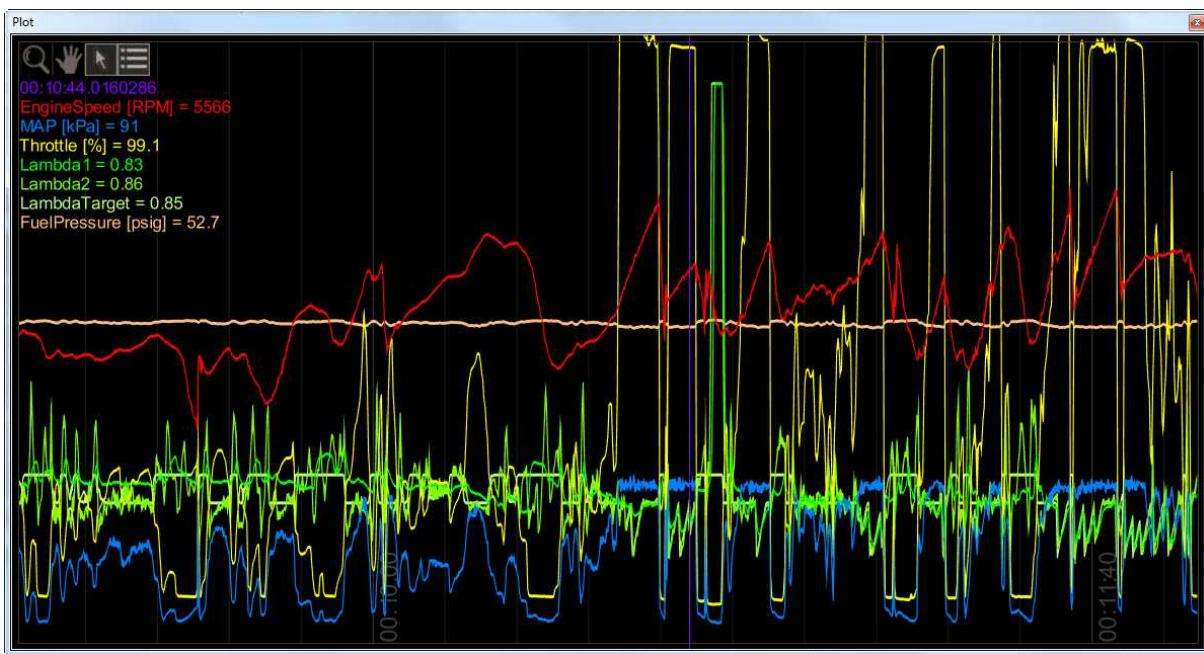
**VTEC On Above Throttle:**

VTEC enables once this Throttle is reached

**Note: All the above conditions must be met to enable VTEC and only one to deactivate VTEC.**

#### 4.2.3 Plot Data and Control

AEM supplied layout files will come pre-loaded with several “Plot Control” windows (users can always add, delete or edit them as desired). These are special controls that allow real time data logging and playback. To begin a PC log, go to the *Log* menu and select *Start recording* or hit the “CTRL + L” hot key. Select *Stop recording* or hit the “CTRL + L” hot key again to stop logging. A dialog will ask if you want to save the data or not. If you select “Yes”, you will be prompted to save the current session file. A session file contains all the current configuration and calibration data along with a log file. If you open that session file again, the file will be loaded and all plot controls will be populated with the recorded data.



#### Plot Window Tools



Selection tool. Choose this icon by clicking on it then left click and drag through the plot window to view current data values.



Pan tool. Choose this icon by clicking on it then left click and drag through the plot window to pan the data left or right. Hot key - Left/Right arrow



Zoom tool. Choose this icon by clicking on it then left click and drag up and down to zoom in and out. Alternatively, a mouse scroll wheel can be used after selecting the zoom tool. Hot key - Up arrow/Page up, Down arrow/Page down



Show legend. Displays or hides the data legend.

Additional hot keys available in plot control window:

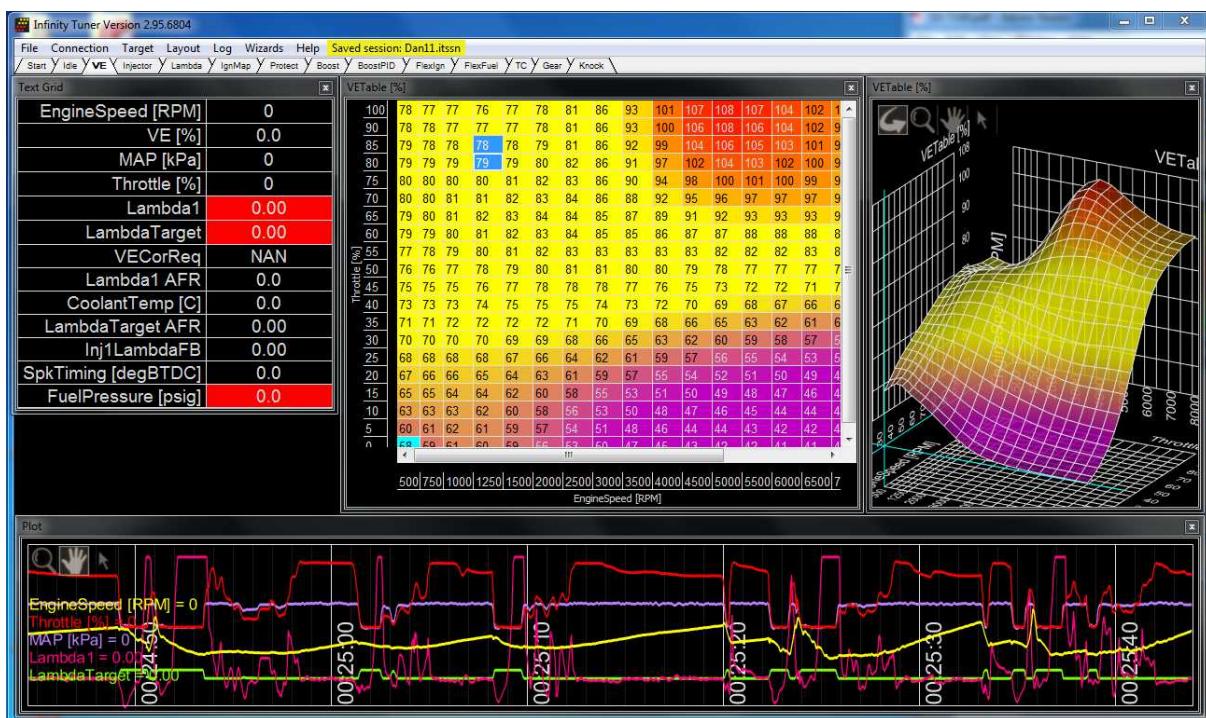
Home - Bring you to the start of the log.

End - Brings you to the end of the log.

For Home and End, the current display range is kept. So if viewing 10 seconds worth of data, Home will display the first 10 seconds while end will display the last 10 seconds.

## Controls Synchronization

When the plot control is populated with data, using the selection tool and dragging through the plot will cause Infinity Tuner to synchronize all control windows to the plot data. This happens when connected to the simulator offline or when connected to the ECU via USB. To go back to viewing “live” data, go to the *Log* menu and select *Goto live data*.



The image above shows plot data sync'd to control windows. All table cursors update with their position relative to the logged data in the plot control. Note that in this mode, table edits are still possible.

#### 4.2.4 Windows Hot Keys

First, it is important to know that PCs have their own preset mapping.

Ctrl + Alt + F3 = Enable Build-in Display  
Ctrl + Alt +F11 = Enable/Disable Panel Fitting  
Ctrl + Alt +F12 = Open Graphics and Media Control Panel  
Ctrl + Alt +UP = Rotate screen to Normal  
Ctrl + Alt +LEFT = Rotate screen 90 degrees  
Ctrl + Alt +DOWN = Rotate screen 180 degrees  
Ctrl + Alt +RIGHT = Rotate screen 270 degrees

Use the shortcut 'Ctrl + Alt + F12' to open the 'Graphics and Media Control Panel', select: Options > Hot Key Manager



If Infinity Tuner is installed and running on a freshly installed version of windows, the Hot Key Functionality is likely enabled. If one of these preset hot keys will be programmed into Infinity Tuner, this will cause an interference.

#### 4.2.5 Infinity Hot Keys

Hot keys can be edited through the Applications Options window. See [Software>Application Options](#) [155] for more detail.

Below are some preset Hot Keys for Infinity Tuner.

Action	Default Key
open_layout	CTRL + O
save_layout	CTRL + S
append_layout	CTRL + P
goto_main_window	ESC
next_control_window	TAB
prev_control_window	SHIFT + TAB
close_control_window	CTRL + F4
next_layout_page	CTRL + TAB
prev_layout_page	CTRL + SHIFT + TAB
toggle_logging	CTRL + L
connect_usb	CTRL + SHIFT + U
disconnect	CTRL + SHIFT + D
commit_modifications	CTRL + SHIFT + C
revert_modifications	CTRL + SHIFT + R
select_all	CTRL + A

Keys mappings may use ALT, CTRL, and SHIFT

The names are case insensitive and the "+" separator is optional

Examples:

```
next_control_window = "ctrl n"
prev_control_window = "CTRL + P"
```

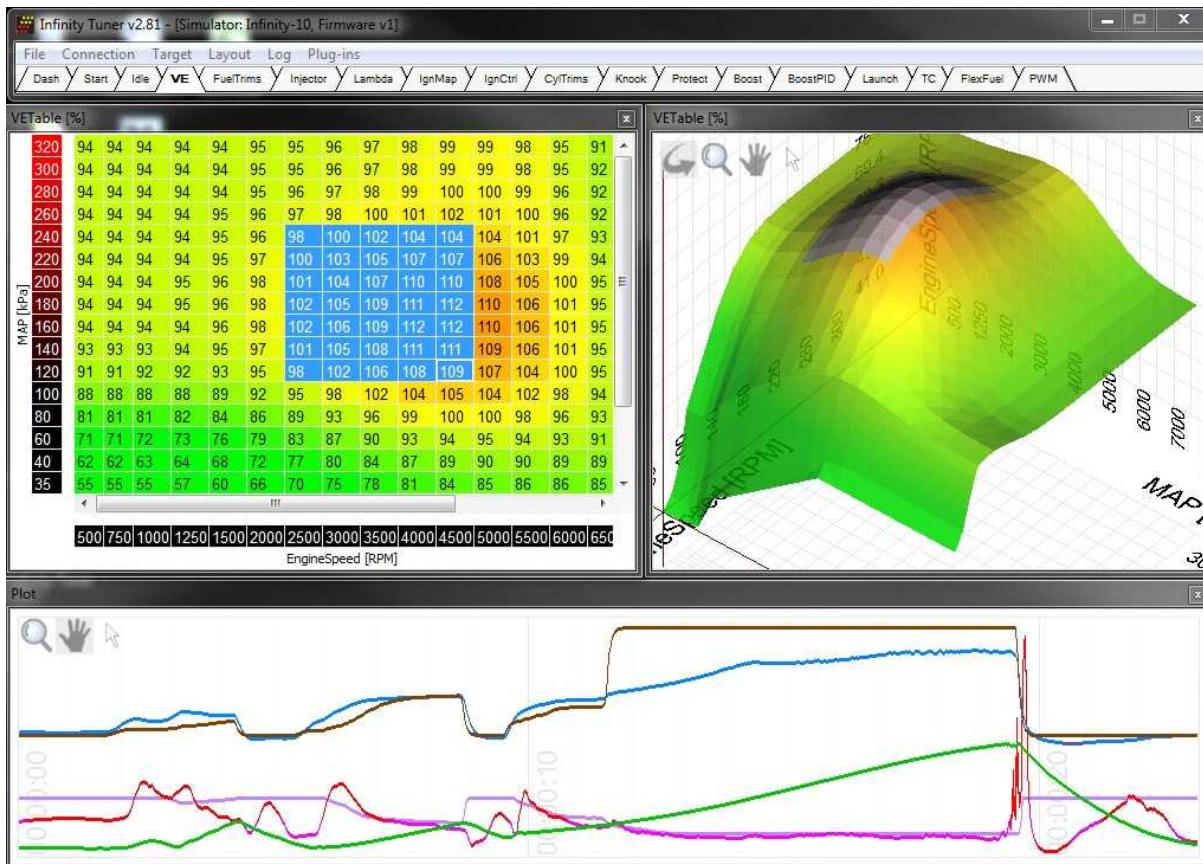
Use the "unshifted" key names - for example, to map a command to the "\$" key:

```
close_control_window = "SHIFT 4"
```

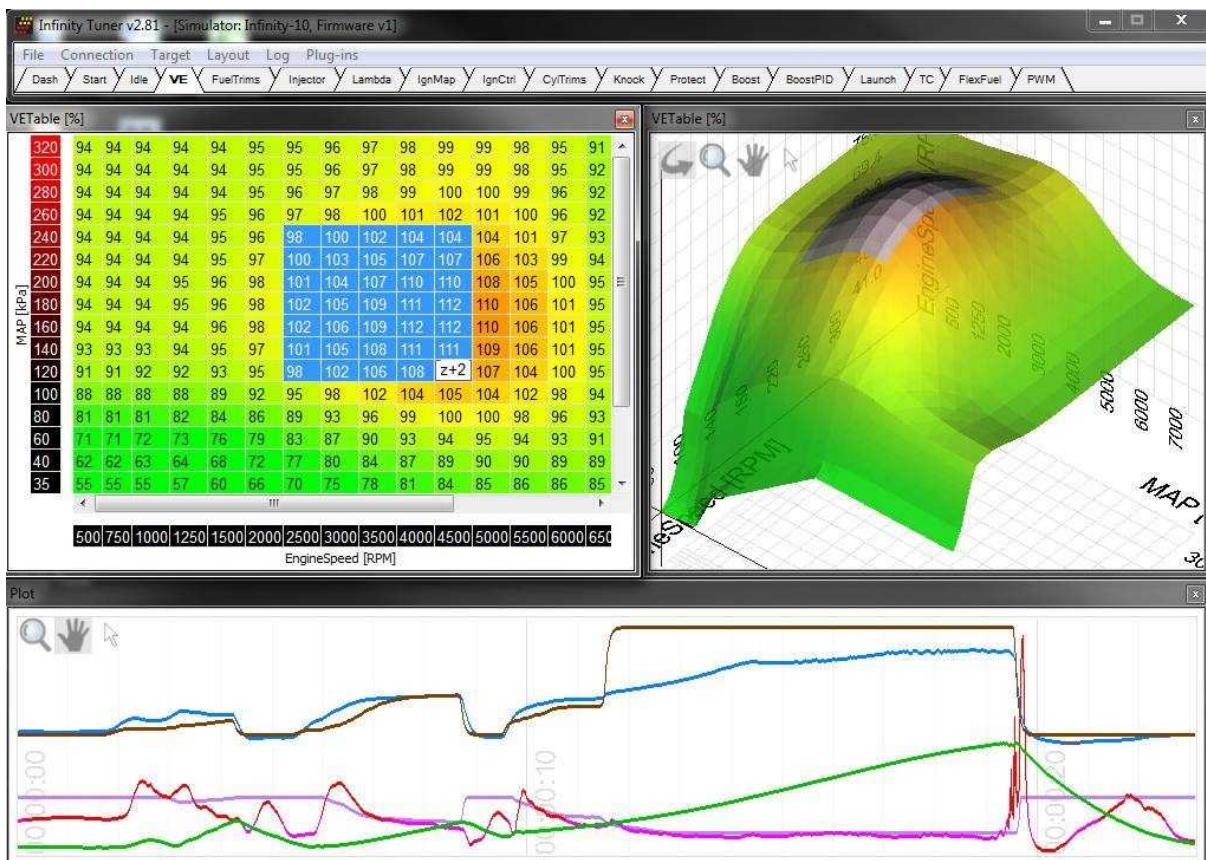
#### Table selection and direct math function edits

Any math function can be directly applied to cell selections. In the first image below, a

small section of the VE Table is selected using mouse left click and drag or shift + arrow selection.



The next image shows a direct math function application typed into the table. This function will be applied to all selected cells. “z” is the current value of the cell “+2” is the applied math function. In this case the result will be adding “2” to the current value of each cell. Any valid math operation can be applied using this method.



In the Infinity Tuner folder, open the “Keys.ini” in a text editor like notepad. Here you can define shortcut keys used in Infinity Tuner. Simply enter into the text editor.

Action	Default Key
table_math_00	=
table_math_01	-
table_math_02	CTRL + =
table_math_03	CTRL + -
table_math_04	SHIFT + =
table_math_05	SHIFT + -
table_math_06	CTRL + 6
table_math_07	CTRL + 7
table_math_08	CTRL + 8
table_math_09	CTRL + 9
table_math_10	CTRL + 0

table_math_11	CTRL + 1
table_math_12	H
table_math_13	V
table_math_14	C
table_math_15	E
table_math_16	X
table_math_17	CTRL + SHIFT + 7
table_math_18	CTRL + SHIFT + 8
table_math_19	CTRL + SHIFT + 9

\*Be sure to save when making changes to the Keys.ini settings. These changes will not take affect until Infinity Tuner is reopened.

When highlighting cells in tables, the user is able to manipulate the data and enter an expression to modify the cells. In the Infinity Tuner folder, open the “Math.ini” in a text editor like notepad. Here you can define various math functions to be used in Infinity Tuner. Simply enter into the text editor

**table\_math\_xx = desired math expression,**  
*where xx is an integer ranging between 00 to 19*

While using Infinity Tuner, these math functions may be used by using the shortcut key you defined for that table\_math\_xx. The format should be as follows:

**// Modify the current cell value(s) by 1%**

```
table_math_00 = "z * 1.01"
table_math_01 = "z * 0.99"
```

**// Modify the current cell value(s) by 10%**

```
table_math_02 = "z * 1.1"
table_math_03 = "z * 0.9"
```

**// Modify the current cell value(s) by 5%**

```
table_math_04 = "z * 1.05"
table_math_05 = "z * 0.95"
```

**// Modify the current cell value(s) by 1**

```
table_math_06 = "z + 1"
table_math_07 = "z - 1"
```

```

// Modify the current cell value(s) by 10
table_math_08 = "z + 10"
table_math_09 = "z - 10"

// Smoothing using four neighboring cells (left, right, bottom, top)
table_math_10 = "0.8 * z + 0.2 * (cell(ix - 1, iy) + cell(ix + 1, iy) + cell(ix, iy - 1) +
cell(ix, iy + 1)) / 4"

// Smoothing using eight neighboring cells
table_math_11 = "0.8 * z + 0.2 * (cell(ix - 1, iy) + cell(ix + 1, iy) + cell(ix, iy - 1) +
cell(ix, iy + 1) + cell(ix - 1, iy - 1) + cell(ix + 1, iy + 1) + cell(ix + 1, iy - 1) + cell(ix - 1, iy + 1)) / 8"

// Simple interpolation fill in X direction for 2D Tables
table_math_12 = "cell(sl, iy) * (1 - sx / (sr - sl)) + cell(sr, iy) * (sx / (sr - sl))"

// Simple interpolation fill in Y direction for 2D Tables
table_math_13 = "cell(ix, sb) * (1 - sy / (st - sb)) + cell(ix, st) * (sy / (st - sb))"

// Two-way interpolation fill using only the selection area corners
table_math_14 = "cell(sl, sb) * (1 - sx / (sr - sl)) * (1 - sy / (st - sb)) + cell(sr, sb) * (sx /
(sr - sl)) * (1 - sy / (st - sb)) + cell(sl, st) * (1 - sx / (sr - sl)) * (sy / (st - sb)) + cell(sr,
st) * (sx / (sr - sl)) * (sy / (st - sb))"

// Two-way interpolation fill using the selection edges
table_math_15 = "(cell(sl, iy) * (1 - sx / (sr - sl)) + cell(sr, iy) * (sx / (sr - sl)) + cell(ix,
sb) * (1 - sy / (st - sb)) + cell(ix, st) * (sy / (st - sb))) / 2"

// Simple interpolation fill in X direction for 1D Tables
table_math_16 = "cell(sl, 0) * (1 - sx / (sr - sl)) + cell(sr, 0) * (sx / (sr - sl))"

```

Valid math operators and keywords include the following:

Syntax	Description
pi	3.14159...
e	2.71828...
+	Addition
-	Subtraction
*	Multiplication
/	Division

$\wedge$	Exponent
$\%$	Modulus
$\text{sqrt}(a)$	Square root
$\text{abs}(a)$	Absolute value
$\text{log}(a)$	Natural log
$\text{log10}(a)$	Log base 10
$\text{sin}(a)$	Sine (a in radians)
$\text{cos}(a)$	Cosine (a in radians)
$\text{tan}(a)$	Tangent (a in radians)
$\text{asin}(a)$	Arc-sine (result in radians)
$\text{acos}(a)$	Arc-cosine (result in radians)
$\text{atan}(a)$	Arc-tangent (result in radians)
$\text{floor}(a)$	Round a down to the nearest integer
$\text{ceil}(a)$	Round a up to the nearest integer
$\text{min}(a,b)$	Smaller of a and b
$\text{max}(a,b)$	Larger or a and b
$\text{clamp}(a,b,c)$	Value of a, clamped between b and c, where $b < c$

**For manipulating tables...**

$\text{cell}(a,b)$	The value of the cell at position(a,b)
$x$	The value on the x-axis at the current position
$y$	The value on the y-axis at the current position
$z$	The value of the current cell; same as $\text{cell}(ix,iy)$
$i$	The index of the current cell in a 1D table or on an axis.
$ix$	The x-index of the current cell (zero is the left-most column.)
$iy$	The y-index of the current cell (zero is the bottommost row.)
$w$	The width of the current table
$h$	The height of the current table
$sx$	The x-index of the current cell relative to the current selection
$sy$	The y-index of the current cell relative to the current selection
$sl$	The left-most column that is selected
$sr$	The right-most column that is selected
$st$	The top-most row that is selected

sb	The bottom-most row that is selected
----	--------------------------------------

Below is an example of how table\_math\_13 is solved.

### // Simple interpolation fill in Y direction

```
table_math_13 = "cell(ix, sb) * (1 - sy / (st - sb)) + cell(ix, st) * (sy / (st - sb))"
```

(st - sb) is the number of selected cells minus one. This is just "selection\_top minus selection\_bottom."

And "sy" will go from zero to that number.

So, (sy / (st - sb)) will be a value that goes from zero to one. It will be zero at the bottom of the selection and one at the top, and some fraction in the middle.

Let's call that value "delta." Now we can rewrite the whole thing as:

```
(cell(ix, sb) * (1 - delta)) + (cell(ix, st) * delta)
```

Those "cell" calls would just give you the cell at the bottom of the selection and the cell at the top of the selection, so it's basically:

```
bottom * (1 - delta) + top * delta
```

The "1 - delta" part will just be the opposite of delta. As delta goes from zero to one, "1 - delta" will go from one to zero.

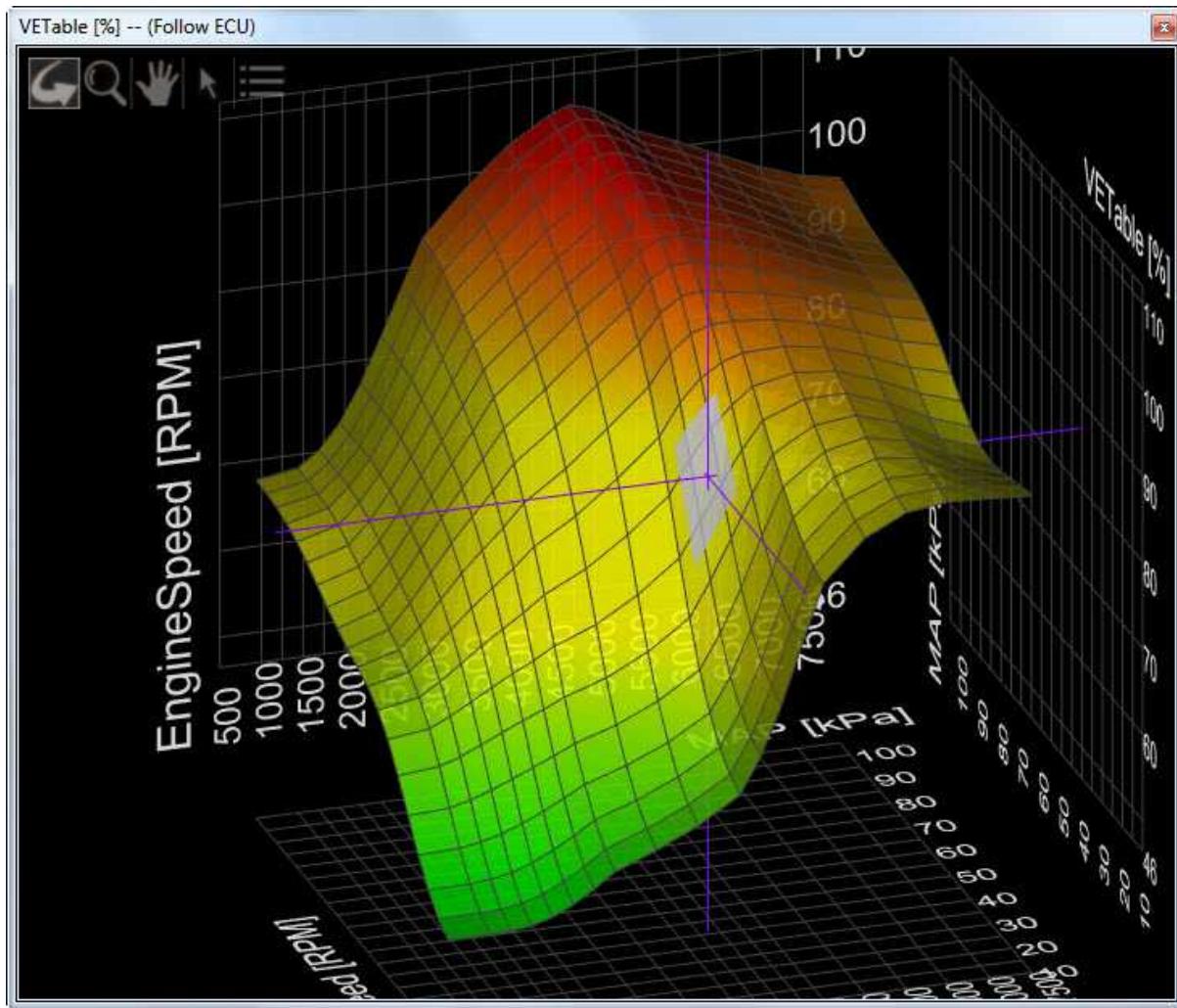
The end result is all the cells between top and bottom will be some combination of top and bottom, based on that "delta" value. This is a pretty standard way to do what is called "linear interpolation."

The "table\_math\_14" expression is a 2D version of the same thing. It has a "delta" in the X direction and another "delta" in the Y direction. Every cell inside the selection would be some combination of the four corners weighted by those two deltas.

#### 4.2.6 Follow ECU

The follow ECU feature forces a small cell selection to "follow" the ECU as the table input data changes. Using this feature combined with the hot key data manipulation options, allows the tuner to quickly edit table data on the fly. The feature is available when connected to an ECU via USB or when playing back logged data.

To turn on, with either a 1D/2DTable or 2D/3DGraph as the active control hit CTRL + F. When activated, the follow will be set to all table type controls for the given item, and those controls will have a "-- (Follow ECU)" in their title bar.



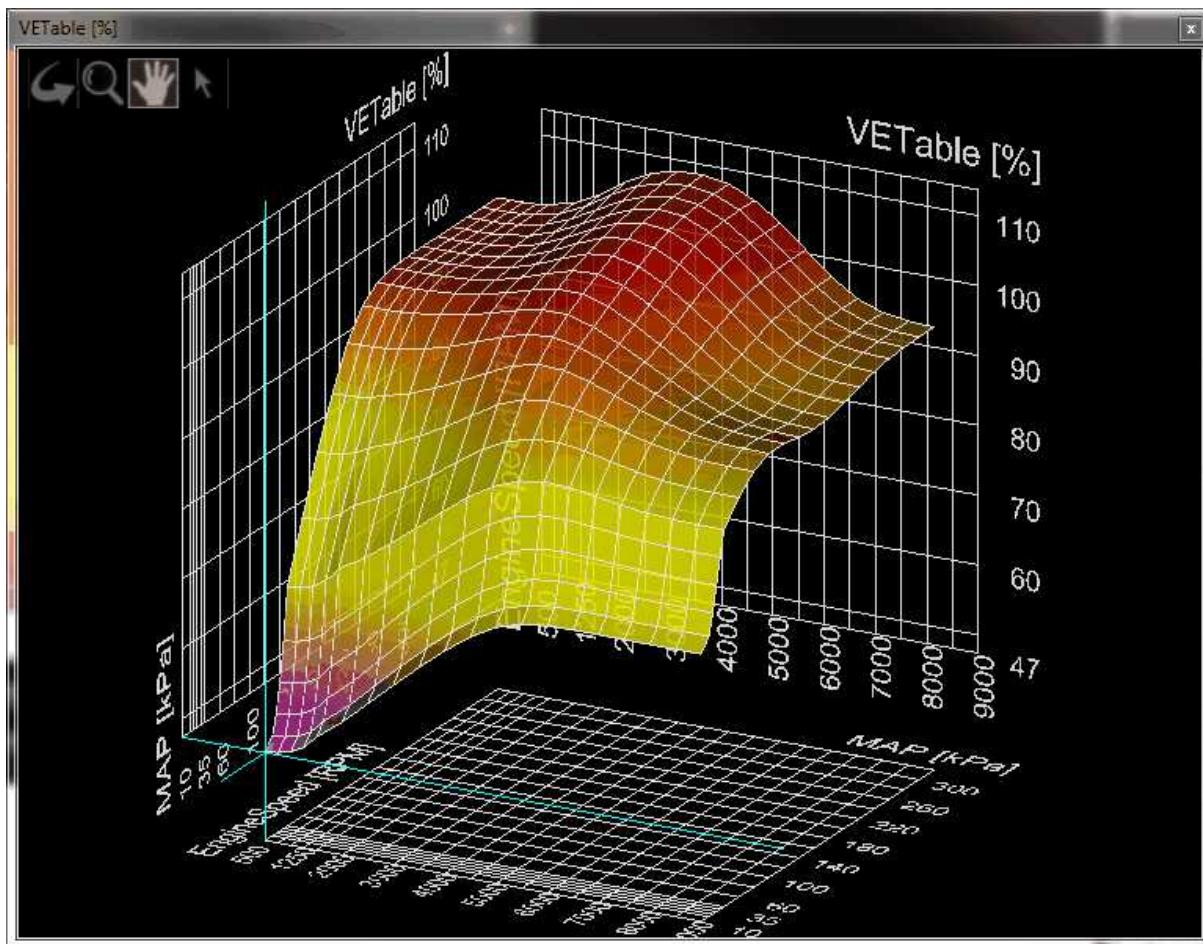
#### 4.2.7 VE & Airflow Based Tuning

The Infinity ECU uses significantly different methods of calculating the fuel delivery requirements and outputs than previous AEM products.

Measured data from sensors, i.e. Manifold Absolute Pressure (MAP [kPa]), Air Temperature, Coolant Temperature, and Engine RPM are acquired. The ECU uses this

sensor data in combination with Volumetric Efficiency (VE%) to estimate airflow.

The Volumetric Efficiency is a percentage of air and fuel that actually enters the cylinder during induction relative to the volumetric capacity (rated displacement) of the cylinder under static conditions. The VE lookup table is a 2-axis lookup table, with load values (typically MAP [kPa]) versus Engine RPM. In each table cell, the Engine RPM corresponds with a specific MAP [kPa], and a Volumetric Efficiency is defined for that cell.



The Volumetric Efficiency is combined with temperature sensor data to estimate a compensated Mass Airflow. The ChargeTempBlend table dictates what ratio of air temperature to coolant temperature is used at specific Engine RPM to adjust the density of the inducted air. A higher number gives priority to Coolant Temperature, and is seen at lower Engine RPM.



Once Mass Airflow has been calculated using the tables above, the Infinity ECU will look up the Target Lambda (AFR) and then calculate the fuel requirements. Target AFR will be used as a main parameter in determining fuel injector flow rate. The LambdaTargetTable (below Left) and AFR Target Table conversion table (below Right) will have default values. Based on the calculated Mass Airflow, the Infinity ECU will attempt to add enough fuel to hit the target AFR.

**Note: The calculated LambdaTarget influences the fuel delivered to the engine at all times, even when closed-loop O2 feedback is disabled.**

LambdaTargetTable										
MAP [kPa]	220	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
100	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750	0.750
80	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850
60	0.920	0.920	0.940	0.990	0.990	0.990	0.920	0.920	0.920	0.920
40	0.950	0.950	0.980	0.990	0.990	0.990	0.920	0.920	0.920	0.920
30	0.980	0.980	0.980	0.990	0.990	0.990	0.920	0.920	0.920	0.920
	500	1000	1500	2000	2500	3000	3500	4000	6000	8000
	EngineSpeed [RPM]									

AFRTargetTable Gasoline										
MAP [PSIG]	17	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95
14	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95
11	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95
7	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95
3	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95
-0	12.41	12.41	12.41	12.41	12.41	12.41	12.41	12.41	12.41	12.41
-3	13.43	13.43	13.72	14.45	14.45	14.45	13.43	13.43	13.43	13.43
-6	13.87	13.87	14.31	14.45	14.45	14.45	13.43	13.43	13.43	13.43
-9	14.31	14.31	14.31	14.45	14.45	14.45	13.43	13.43	13.43	13.43
-10	14.31	14.31	14.31	14.45	14.45	14.45	13.43	13.43	13.43	13.43
	500	1000	1500	2000	2500	3000	3500	4000	6000	8000
	EngineSpeed [RPM]									

The suggested tuning method is to set the AFR using the LambdaTargetTable or AFR Target Table to a value safe and suitable for the engine. For normally aspirated engines

a value of 13.0:1 or 0.887 lambda is usually sufficient at all operating conditions. For boosted applications, the operating conditions dictate a safe AFR. Please consult a tuner knowledgeable in your engine's requirements for help. Once the target lambda (AFR) values are chosen, run the engine at as many operating conditions as possible and adjust the VE Table to reach the AFR Target Table values. Once the VE Table has been tuned to accurately reach the AFR Target Table values at all operating ranges, then you can change the AFR Target Table to use different AFR settings later. Never adjust VETable to run a different AFR, only to achieve the LambdaTarget value.

The Injector Flowrate is very important in determining the fuel requirements. The Infinity ECU uses actual Injector Flowrate [cc/min] to determine the proper injector pulse width. The InjFlowRate [cc/min] table is calibrated from the Setup Wizard: Injector Flow, however the table can be modified manually for unlisted injectors.

InjFlowRate [cc/min]					
499.8	499.8	499.8	499.8	499.8	499.8
20.0	40.0	50.0	60.0	80.0	100.0
InjPressure [psig]					

Now that the base injector flow rate has been determined, the Infinity ECU applies a few more compensating factors. Wall Wetting is a function of fuel condensing in the intake manifold at the injection point. At different rates of change in the MAP [kPa] values, and at different Coolant Temperatures, fuel enrichment compensations are used to prevent lean and rich conditions during rapid manifold pressure changes. Note that this table has several different functions. It can be used for dynamic transients by nature of its "MAP Rate" x-axis. It can also be used for more steady state compensations by adjusting the values in the "middle band" of the table where MAP rate changes are very small. Positive numbers in this table will effectively add fuel to enrichen the mixture. Negative numbers have the opposite effect.

WallWetting										
CoolantTemp [C]	-500.0	-200.0	-100.0	0.0	25.0	50.0	100.0	200.0	300.0	500.0
100.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	10.0	15.5	15.5
80.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	10.0	15.5	15.5
60.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	10.0	15.5	15.5
40.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	15.0	23.5	23.5
20.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	20.0	31.0	31.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	20.0	31.0	31.0
-20.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	20.0	31.0	31.0
Throttle Rate										

The X and Y axis inputs of the WallWetting table can be set to several different variables. These settings are found in the Setup Wizard page for Accel and Decel Fuel.

Axis selections include:

Map Rate  
Throttle Rate  
Coolant Temp  
MAP [kPa]  
EngineSpeed [RPM]

**Accel and Decel Fuel**

There is one 2-axis WallWetting table that can trim fuel in response to quick throttle or manifold pressure changes. It also can be used to compensate for overly-rich conditions when the throttle is closed rapidly

---

WallWetting X-Axis Setup   

WallWetting Y-Axis Setup   

The WallWetting table is used for Acceleration fuel enrichment to ensure crisp throttle response by compensating for fuel that is condensing in the intake manifold and wetting the manifold walls. For most vehicles, Throttle Rate should be used as one of the axis inputs and the values in the table should be higher at increased Throttle Rate-Of-Change values. If the engine runs too rich immediately after closing the throttle, use negative values to remove fuel for negative Throttle Rate-Of-Change values.

A second WallWetting table is also available for even more transient fuel compensation functionality. See the WallWetting2 Table topic for more information.

LambdaAfterStartTrim is a 2-axis table that is used to modify the Lambda (AFR) for specified time after starting the engine. This table adds a lambda offset for a small period of time after the engine is started. By allowing a slightly richer mixture target, it will keep the engine from stalling or running rough immediately after starting and the lambda correction to a minimum. The last column should be populated with "0" trim at operating temperatures to prevent a continuous lambda offset.

		LambdaAfterStartTrim				
		1.0	5.0	10.0	15.0	20.0
		AfterStartTime [s]				
CoolantTemp [C]	120.0	-0.075	-0.050	-0.025	-0.025	0.000
	100.0	-0.075	-0.050	-0.025	-0.025	0.000
	80.0	-0.075	-0.050	-0.025	-0.025	0.000
	60.0	-0.075	-0.050	-0.025	-0.025	0.000
	40.0	-0.075	-0.075	-0.050	-0.025	-0.025
	20.0	-0.075	-0.075	-0.075	-0.050	-0.050
	0.0	-0.075	-0.075	-0.075	-0.050	-0.050
	-20.0	-0.075	-0.075	-0.075	-0.050	-0.050

#### 4.2.8 Target Lambda

To control the engine's fuel delivery system, the Infinity can be programmed to run open loop and/or closed loop O2 feedback. Closed loop uses feedback from the oxygen sensor to make temporary, but immediate, corrections to the injection to maintain a target air fuel ratio (AFR) or lambda. The type of the O2 sensor will determine how lambda target can be controlled. Due to the nature of standard narrow band O2 sensors, the only accurate measurement that can be maintained in closed loop is Lambda 1.0. However, wideband O2 sensors can be used in almost every feedback condition.

Note that 14.64:1 is called the stoichiometric AFR for gasoline. It is the ratio where all available fuel is burned completely. For most performance applications, it is not the ideal AFR to operate the engine at all the time nor is it the AFR that creates the most power or even economy under all conditions.

When the fuel system is open loop, the O2 sensor is ignored and the injector pulse width relies on the VE Table and fuel compensators to adjust injection duration. Open loop is necessary during engine starts, when the O2 sensor has cooled below its operating temperature. It may also be necessary when coolant temperatures are low. In this state, the fuel vaporization is poor and the engine will require a richer mixture to properly operate. When under heavy load, the engine typically requires an air fuel ratio that is out of a narrow band oxygen sensor's standard range and open loop will be necessary. When the accelairflow function is triggered during hard accelerations, open loop may be necessary to help stabilize the Target Lambda. Also, when the deceleration function cuts fuel completely, target lambda will not be necessary.

### LambdaTargetTable

**Units:** Engine Load vs Engine Speed vs Lambda

**Description:** This table sets the target lambda for various engine conditions.

LambdaTargetTable											
[Pa]	220.0	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	
	200.0	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	
	175.0	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	
	150.0	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	
	125.0	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	0.710	
	100.0	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	0.820	
	80.0	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	0.990	
	60.0	0.940	0.940	0.940	0.980	0.950	0.940	0.940	0.940	0.940	
	40.0	0.940	0.940	0.940	0.980	0.950	0.940	0.940	0.940	0.940	
	30.0	0.940	0.940	0.940	0.980	0.950	0.940	0.940	0.940	0.940	
		500	1000	2000	3000	4000	5000	6000	7000	8000	
		EngineSpeed [RPM]									

## Tuning Target Lambda

The first step before tuning the

1. Open **Infinity Tuner** and connect to the ECU.
2. Open the **Lambda Tab** and confirm the **Lambda1Cal Table** is setup for the oxygen sensor used.
3. Open the **Lambda Control Wizard** and check the **Lambda 1 Feedback Enable** and/or **Lambda Feedback Enable** boxes.
4. Set the **Lambda Feedback Max Speed**. Wideband O2 sensors are accurate in most situations so this can be activated all the time, if need be.
5. Set the **Lambda Feedback After Start Delay**. Typical-10 seconds.

The Infinity Tuner functions are located in the **TargetLambda** tab.

1. Use the **Lambda Control Proportional Gain** by itself and set the **Lambda Control Integral Gain** and **Lambda Control Derivative Gain** to zero.
2. Log the channels **Lambda1** (or 2) and **ErrorLambda1** (or 2).
3. Increase the **Lambda Control Proportional Gain** until the point of instability

- or a sustained oscillation is reached.
4. From here, the ultimate proportional ( $K_u$ ) is found.
  5. From the log, measure the period of oscillation from peak to peak, in seconds, to obtain the critical time constant or ultimate period ( $P_u$ ).
  6. Once the values for  $K_u$  and  $P_u$  are obtained, the PID parameters can be calculated from the following equations.

Proportional, Integral, and Derivative feedback

**Lambda Control Proportional Gain = 0.60 ( $K_u$ )**

**Lambda Control Integral Gain = 2 ( $K_p$ ) /  $P_u$**

**Lambda Control Derivative Gain = ( $K_p$ )( $P_u$ ) / 8**

Note that these values are not optimal values and additional fine tuning may be required to obtain the best target lambda performance.

For more information, go to [Lambda Control](#) 

#### 4.2.9 Fuel Trims

##### WallWetting

**Units:** Throttle Rate vs EngineSpeed vs MassAirflow Adder

**Description:** This table adds additional fuel enrichment for acceleration conditions. This is mostly used to help the engine accelerate well and avoid a lean condition that can occur when the throttle is opened quickly at low RPM.

		WallWetting											
		7000	6000	5000	4000	3000	2000	1000	0.0	5.0	10.0	15.5	15.5
EngineSpeed [RPM]	7000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	10.0	15.5	15.5	15.5
	6000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	10.0	15.5	15.5	15.5
	5000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	10.0	15.5	15.5	15.5
	4000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	15.0	23.5	23.5	23.5
	3000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	20.0	31.0	31.0	31.0
	2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	20.0	31.0	31.0	31.0
	1000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	20.0	31.0	31.0	31.0
		-500	-200	-100	0	25	50	100	200	300	500		
Throttle Rate													

##### WallWetting2

**Units:** Throttle Rate vs CoolantTemp vs MassAirflow Adder

**Description:** This table adds additional fuel enrichment for acceleration conditions when the engine is cold. Both tables (WallWetting and WallWetting2) are added together.

		WallWetting2											
		120	100	80	60	40	20	0	0.0	5.0	10.0	15.5	15.5
CoolantTemp [C]	120	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	7.0	9.0	9.0	9.0
	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	7.0	9.0	9.0	9.0
	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	7.0	9.0	9.0	9.0
		-500	-200	-100	0	25	50	100	200	300	500		
Throttle Rate													

**FuelTrim\_1 [%]**

**Units:** EngineSpeed vs MAP vs Fuel Trim

**Description:** This table is a generic 2-axis fuel trim. Most common usage is to add fuel or remove fuel when Manifold Pressure is high, especially if using Throttle for the VETable Load Axis selection.

FuelTrim_1 [%]																			
MAP [kPa]	0	0	0	2	3	5	5	5	8	8	8	6	4	2	0	-2	-2	-5	-5
320	0	0	0	2	3	5	5	5	8	8	8	6	4	2	0	-2	-2	-5	-5
300	0	0	0	2	3	5	5	5	8	8	8	6	4	2	0	-2	-2	-5	-5
280	0	0	0	2	3	5	5	5	8	8	8	6	4	2	0	-2	-2	-5	-5
260	0	0	0	2	3	5	5	5	8	8	8	6	4	2	0	-2	-2	-4	-4
240	0	0	0	2	3	5	5	5	8	8	8	6	4	2	0	0	0	-2	-2
220	0	0	0	1	2	3	3	3	4	4	4	3	2	1	0	0	0	0	0
200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

500 750 1000 1250 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 6500 7000 7500 8000 8500 9000  
EngineSpeed [RPM]

Aside from these main fuel trims, there are a few other functions that can add fuel trims:

**FuelTrim\_N2O:**

FuelTrim\_N2O is the amount of fuel added when the nitrous function is enabled. See the Nitrous section for more details.

**FuelTrim\_Decel:**

FuelTrim\_Decel is the amount of fuel added after the decel cut has turned off, to prevent the engine from running lean when the fuel turns back on. See the [Accel and Decel Fuel](#)<sup>106</sup> section of the wizard for more details.

### ChargeTempBlend

**Units:** Charge Temp Blend Multiplier vs RPM

**Description:** The table tells the Speed Density submodel whether to use Air Temp or Coolant Temp (or a blend of both) when calculating the density of the air entering the engine.

If set to a low number (0) the Air Temperature will be used when calculating the air density.

If set to a high number (1) the Coolant Temperature will be used when calculating the air density.

Typically, the table will have higher numbers at low RPM (assuming Coolant Temp has a greater influence on air density when velocity is low) and lower numbers at high RPM (assuming Air Temp has a greater influence on air density when velocity is high).

ChargeTempBlend																
0.8	0.8	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
500.0	1000.0	1500.0	2000.0	2500.0	3000.0	3500.0	4000.0	4500.0	5000.0	5500.0	6000.0	6500.0	7000.0	7500.0	8000.0	

### Inj1FuelTrimTable

**Units:** Injector1 Fuel % vs RPM

**Description:** This table allows for a cylinder trim of fuel injector 1. This can be used if there is a known flow discrepancy with an intake manifold runner or a mismatched fuel injector for instance.

Inj1FuelTrimTable [%]										
0	0	0	0	0	0	0	0	0	0	0
1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	
EngineSpeed [RPM]										

### Inj2FuelTrimTable

**Units:** Injector2 Fuel % vs RPM

**Description:** This table allows for a cylinder trim of fuel injector 2. This can be used if there is a known flow discrepancy with an intake manifold runner or a mismatched fuel injector for instance.

Inj2FuelTrimTable [%]										
0	0	0	0	0	0	0	0	0	0	0
1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	
EngineSpeed [RPM]										

### Inj3FuelTrimTable

**Units:** Injector3 Fuel % vs RPM

**Description:** This table allows for a cylinder trim of fuel injector 3. This can be used if there is a known flow discrepancy with an intake manifold runner or a mismatched fuel injector for instance.

Inj3FuelTrimTable [%]										
0	0	0	0	0	0	0	0	0	0	0
1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	
EngineSpeed [RPM]										

**Inj4FuelTrimTable**

**Units:** Injector4 Fuel % vs RPM

**Description:** This table allows for a cylinder trim of fuel injector 4. This can be used if there is a known flow discrepancy with an intake manifold runner or a mismatched fuel injector for instance.

**Inj5FuelTrimTable**

**Units:** Injector5 Fuel % vs RPM

**Description:** This table allows for a cylinder trim of fuel injector 5. This can be used if there is a known flow discrepancy with an intake manifold runner or a mismatched fuel injector for instance.

**Inj6FuelTrimTable**

**Units:** Injector6 Fuel % vs RPM

**Description:** This table allows for a cylinder trim of fuel injector 6. This can be used if there is a known flow discrepancy with an intake manifold runner or a mismatched fuel injector for instance.

**4.2.10 Ignition Tuning**

The ignition timing or spark timing value refers to the distance in crank degrees between the spark plug firing event (initiating combustion) and the uppermost point of the pistons stroke (top center TC, top dead center TDC, etc.)

If the start of the combustion process is progressively advanced before TDC, the compression stroke work transfer (which is from the piston to the cylinder gases) increases. If the end of the combustion process is progressively delayed by retarding the spark timing, the peak cylinder pressure occurs later in the expansion stroke and is reduced in magnitude. These changes reduce the expansion stroke work transfer from the cylinder gases to the piston. The optimum timing which gives the maximum brake torque called maximum brake torque (or MBT timing) occurs when the magnitudes of these two opposing trends just offset each other. Timing which is advanced or retarded from this optimum gives lower torque. MBT timing defines the optimum point (maximum brake torque) for peak cylinder pressure relative to crank angle.

Certain operating conditions, combustion chamber designs, fuel types, etc. will prohibit an engine from reaching MBT timing before detonation occurs. Detonation, or spark knock, is caused by the gases spontaneously combusting at the outer edges of the piston before the normal combustion flame front reaches those areas. This causes pressure spikes that can damage the engine over time.

Every engine will have different spark timing requirements. Unlike fuel tuning where you can take advantage of inexpensive, commonly available wideband oxygen sensor kits, spark tuning requires expensive laboratory equipment for complete optimization. Spark tuning is best accomplished on an engine dyno. If that is not practical, a chassis dyno is the next best thing. But even with the use of a dyno, spark tuning requires experience to know where to start and what kind of changes to make. Ignition timing values can range from 50+ degrees BTDC to 15+ degrees after top dead center for certain extreme conditions on race vehicles.

### **Ignition Synchronization**

The ignition timing measured with a timing light must be synchronized with the displayed value in Infinity Tuner. This is one of the most important steps in the setup process. Without it, the commanded ignition timing may not be accurate.

It's a good idea to disable the fuel injectors and/or fuel pump during this step as well. Until the timing is sync'd, it doesn't make any sense to inject fuel just to fire it at the wrong time. The ignition coil(s) must be connected and in working order.

See [Ignition Sync](#)<sup>83</sup> for more detail.

## BaselnMap

**Units:** MAP vs RPM vs Ignition Timing BTDC

**Description:** This is the core ignition map that all trims are based from. The higher the value, the more advanced the timing will be. The lower the value, the more retarded the timing is. Negative values are further retarding the ignition timing, but is actually firing the spark plugs after top dead center (ATDC).

BaselnMap [degBTDC]																				
MAP [kPa]	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
	320.0	300.0	280.0	260.0	240.0	220.0	200.0	180.0	160.0	140.0	120.0	100.0	80.0	60.0	40.0	35.0	30.0	25.0	20.0	
320.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
300.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
280.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
260.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
240.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
220.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
200.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
180.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
160.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
140.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
120.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
100.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
80.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
60.0	16.8	16.8	16.9	17.6	21.4	26.6	31.6	34.0	35.2	35.9	35.3	35.6	36.1	36.7	37.2	37.8	38.2	38.3	38.3	
40.0	17.0	17.0	17.1	18.3	23.0	28.6	33.5	35.6	36.7	37.2	36.4	36.6	37.2	37.9	38.5	39.1	39.7	39.8	39.8	
35.0	17.0	17.0	17.2	18.4	23.1	28.9	33.8	35.8	36.9	37.3	36.6	36.7	37.3	38.0	38.7	39.3	39.8	40.0	40.0	
30.0	17.0	17.0	17.2	18.5	23.2	28.9	33.8	35.9	36.9	37.3	36.6	36.7	37.3	38.0	38.7	39.3	39.8	40.0	40.0	
25.0	17.0	17.0	17.2	18.5	23.2	28.9	33.8	35.9	36.9	37.3	36.6	36.7	37.3	38.0	38.7	39.3	39.8	40.0	40.0	
20.0	17.0	17.0	17.2	18.5	23.2	28.9	33.8	35.9	36.9	37.3	36.6	36.7	37.3	38.0	38.7	39.3	39.8	40.0	40.0	
10.0	17.0	17.0	17.2	18.5	23.2	28.9	33.8	35.9	36.9	37.3	36.6	36.7	37.3	38.0	38.7	39.3	39.8	40.0	40.0	
	500	750	1000	1250	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000	7500	8000	8500	9000
	EngineSpeed [RPM]																			

#### 4.2.11 Ignition Trims

##### IgnTrimAirTempMap

**Units:** MAP vs AirTemp vs Ignition Timing

**Description:** This table allows for an ignition timing compensation based on engine load and intake air temperature.

IgnTrimAirTempMap [degBTDC]											
MAP [kPa]	300.0	0.0	0.0	0.0	0.0	0.0	0.0	-2.0	-2.0	-2.0	-2.0
	200.0	0.0	0.0	0.0	0.0	0.0	0.0	-2.0	-2.0	-2.0	-2.0
	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	100.0
AirTemp [C]											

##### IgnTrimCoolantTempMap

**Units:** MAP vs CoolantTemp vs Ignition Timing

**Description:** This table allows for an ignition timing compensation based on engine load and coolant temperature. On a catalyst vehicle, retarding the ignition timing can be used to light a cool catalytic converter off sooner for improved emissions.

IgnTrimCoolantTempMap [degBTDC]											
MAP [kPa]	300.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2.0	-2.0
	200.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-2.0	-2.0
	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		-20.0	0.0	20.0	40.0	60.0	80.0	90.0	100.0	110.0	120.0
CoolantTemp [C]											

### IgnTrimAfterStart

**Units:** Ignition Timing vs After Start Time

**Description:** This table allows for an ignition timing trim based on the after start condition. On a catalyst vehicle, retarding the ignition timing can be used to light a cool catalytic converter off sooner for improved emissions.

IgnTrimAfterStart [degBTDC]											
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0	2	4	6	8	10	12	14	16	18	20	
AfterStartTime [s]											

### Coil1TrimTable

**Units:** Coil 1 Ignition Timing vs RPM

**Description:** This table allows for a cylinder ignition trim of coil 1. This can be used if there is a known exhaust gas temperature discrepancy with a runner for instance.

Coil1TrimTable [deg]											
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0	0	0	0	0	1	1	1	1	1	1	
EngineSpeed [RPM]											

### Coil2TrimTable

**Units:** Coil 2 Ignition Timing vs RPM

**Description:** This table allows for a cylinder ignition trim of coil 2. This can be used if there is a known exhaust gas temperature discrepancy with a runner for instance.

Coil2TrimTable [deg]											
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0	0	0	0	0	1	1	1	1	1	1	
EngineSpeed [RPM]											

### Coil3TrimTable

**Units:** Coil 3 Ignition Timing vs RPM

**Description:** This table allows for a cylinder ignition trim of coil 3. This can be used if there is a known exhaust gas temperature discrepancy with a runner for instance.

Coil3TrimTable [deg]										
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0	0	0	0	0	1	1	1	1	1	1

### Coil4TrimTable

**Units:** Coil 4 Ignition Timing vs RPM

**Description:** This table allows for a cylinder ignition trim of coil 4. This can be used if there is a known exhaust gas temperature discrepancy with a runner for instance.

Coil4TrimTable [deg]										
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0	0	0	0	0	1	1	1	1	1	1

### Coil5TrimTable

**Units:** Coil 5 Ignition Timing vs RPM

**Description:** This table allows for a cylinder ignition trim of coil 5. This can be used if there is a known exhaust gas temperature discrepancy with a runner for instance.

Coil5TrimTable [deg]										
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0	0	0	0	0	1	1	1	1	1	1

### Coil6TrimTable

**Units:** Coil 6 Ignition Timing vs RPM

**Description:** This table allows for a cylinder ignition trim of coil 6. This can be used if there is a known exhaust gas temperature discrepancy with a runner for instance.

Coil6TrimTable [deg]										
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0	0	0	0	0	1	1	1	1	1	1
EngineSpeed [RPM]										

#### 4.2.12 Engine Start

There are several tables and options that affect starting the engine.

##### CrankVE\_Table

**Units:** kPa vs RPM vs VE%

**Description:** This table sets the percentage of volumetric efficiency to be supplied to the engine at various loads and engine speeds. This applies only while cranking the engine and does not apply after the engine has reached idle speeds.

CrankVE_Table [%]					
MAP [kPa]	70.0	70.0	70.0	70.0	70.0
100	70.0	70.0	70.0	70.0	70.0
90	70.0	70.0	70.0	70.0	70.0
80	70.0	70.0	70.0	70.0	70.0
70	70.0	70.0	70.0	70.0	70.0
60	70.0	70.0	70.0	70.0	70.0

EngineSpeed [RPM]

##### LambdaAfterStartTrim

**Units:** Coolant Temp vs After Start Time vs Lambda Offset

**Description:** This table adds an lambda offset from the LambdaTargetTable as soon as the engine is started. By allowing a slightly richer mixture target, it will keep the engine sound and the lambda correction to a minimum. The AfterStartTime (X-Axis) breakpoints can be adjusted for a specific timeframe. Note: It is not a good idea to have anything but a 0 in the last X-axis cell where the engine is fully warmed up and above. This would add a lambda target offset all the time.

LambdaAfterStartTrim						
	1.0	5.0	10.0	15.0	20.0	
CoolantTemp [C]	120.0	-0.075	-0.050	-0.025	-0.025	0.000
100.0	-0.075	-0.050	-0.025	-0.025	0.000	
80.0	-0.075	-0.050	-0.025	-0.025	0.000	
60.0	-0.075	-0.050	-0.025	-0.025	0.000	
40.0	-0.075	-0.075	-0.050	-0.025	-0.025	
20.0	-0.075	-0.075	-0.075	-0.050	-0.050	
0.0	-0.075	-0.075	-0.075	-0.050	-0.050	
-20.0	-0.075	-0.075	-0.075	-0.050	-0.050	

### FuelTrim\_Coolant

**Units:** Coolant Temp vs After Start Time vs Fuel Trim

**Description:** As opposed to the LambdaAfterStartTrim that trims the target lambda, this table applies a fuel trim as a percentage multiplier where a value of 5.0 would add 5 % to the fuel pulse calculation.

FuelTrimCoolant [%]					
	1.000	5.000	10.000	15.000	20.000
CoolantTemp [C]	120.0	2.0	0.0	0.0	0.0
100.0	2.0	2.0	0.0	0.0	0.0
80.0	3.0	2.0	1.0	0.0	0.0
60.0	4.0	4.0	3.0	3.0	0.0
40.0	4.0	4.0	3.0	3.0	0.0
20.0	5.0	4.0	3.0	3.0	0.0
0.0	5.0	4.0	3.0	3.0	0.0
-20.0	5.0	4.0	3.0	3.0	0.0

### LambdaCrankingTable

**Units:** Lambda Offset vs Coolant Temp

**Description:** This table allows for the Lambda to be offset when cranking the engine. By allowing a slightly richer mixture this will keep the engine and the lambda correction sound.

Lambda Cranking Table														
0.20	0.20	0.20	0.20	0.20	0.26	0.33	0.49	0.63	0.70	0.70	0.70	0.70	0.70	0.70
-20.0	-10.0	0.0	10.0	20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0

#### 4.2.13 Idle Air Control

The following tables and options affect the basic functions of the idle air control strategy. Please see the [Idle - Advanced](#) section for more details.

##### IdleTargetTable

**Units:** Coolant Temp vs Idle Target [RPM]

**Description:** This is first step in the idle calculation. This table sets the desired Engine Speed for idling, depending on coolant temperature. For most vehicles, the desired idle target will be increased when coolant temperature is low.

IdleTargetTable [RPM]											
1400	1400	1400	1400	1100	1000	1000	1000	1000	1000	0	
-20.0	0.0	20.0	40.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0	
CoolantTemp [C]											

##### IdleBasePosition

**Units:** Coolant Temp vs Idle Position %

**Description:** This is the second\* step in the idle calculation. Depending on the desired Idle Target RPM, this table sets the initial open loop idle position that will be used to reach the desired idle RPM. This happens before any closed-loop idle feedback.

IdleBasePosition											
7	13	21	30	37	45	51	54	56	56	56	
800	900	1000	1100	1200	1300	1400	1500	1600	1800	2000	
IdleTarget [RPM]											

(\* In addition to the IdleTargetTable, there are actually a few other factors that help determine IdleTarget [RPM]. Please see the [Idle - Advanced](#) section for more details.)

##### IdleFB\_Active

This is the third step in the idle calculation. If the engine speed and throttle position meet certain conditions, this channel will turn on and the ECU will use closed-loop idle feedback to try and get the engine speed closer to the idle target RPM.

##### IdleFB

**Units:** Idle Position %

This is the fourth step in the idle calculation. When IdleFB\_Active is on, the ECU will check the difference between the desired **IdleTarget [RPM]** and the measured

**EngineSpeed [RPM].** If the measured engine speed is not close enough to the desired idle RPM, the ECU will try to adjust the amount of idle airflow to adjust EngineSpeed. The amount of closed-loop feedback that is currently being used to adjust airflow gets calculated by the ECU and is displayed as this value, **IdleFB**.

### **Idle Setup: stepper idle valves**

(For 2-wire PWM idle valves, or drive-by-wire vehicles, please skip ahead to the Idle Basic Setup section).

When working with a 4-wire or 6-wire stepper idle valve, it is necessary for the ECU to know the correct value for **Idle Stepper max steps** before adjusting any other idle settings. The ECU can never measure a stepper valve's actual position, it can only command that the valve take steps up or steps down and remember how many steps have been commanded. To operate a stepper valve correctly, the ECU must know the maximum number of steps that can be commanded before hitting the mechanical stop. Please follow the instructions below to determine the correct value for **Idle Stepper max steps** on an unknown idle stepper motor.

1. With the engine off, remove accessory components as needed so the stepper valve's plunger is visible and it is possible to hear the sound of the stepper valve hitting its mechanical stop. Note that some setups use the engine's intake manifold or throttle body for the mechanical stop; when working with these setups, the stepper valve must remain connected to the mechanical stop.
2. Without changing the **Idle Max Position**, disable feedback by setting the **Idle Feedback Min** and **Idle Feedback Max** to 0%.
3. Set the **IdleBasePosition** to zero.
4. Press [CTRL+U] to increase the **IdleBasePosition** value one percent at a time, from 0 to 100. If you hear the idle valve hit the mechanical stop before the table value is 100 , your **Idle Max Position** is too high. If you do not hear the idle valve hit the mechanical stop, the **Idle Max Position** may be too low.
5. Increase the **Idle Max Position** value by one.
6. Reset the ECU (so it will park the idle valve)
7. Repeat the test again. The goal is to use most of the stepper's possible range without letting the valve hit the stop.

### **Idle Basic Setup:**

The next step before tuning the idle system is to determine the direction of the motor. The ECU displays the channel **Idle Position**, which is 0-100 percent. For some vehicles, increasing the **Idle Position** will decrease the airflow to the engine, and it's important for the ECU to be aware if this is the case. It is very easy to determine which way your specific idle valve works.

1. Open **Infinity Tuner** and connect to the ECU.
2. Confirm the **Throttle** is set properly and the ECU's Throttle channel increases from 0% as soon as the throttle is pressed without any 'dead spots'.

3. Open the **Idle Wizard** and set **Idle On Below TPS** to 10%.
4. Initially set the **Idle On Below RPM** to 3000RPM.
5. Set the option **Idle Feedback Min** to -50%, and **Idle Feedback Max** to 50%.
6. Open the **Idle Tab** and set the entire **IdleTargetTable** to 2000 RPM.
7. Temporarily set the entire **IdleBasePosition** table to 50.

These settings will allow idle feedback whenever the engine RPM is below 3000RPM and the throttle is below 10%. These settings are not intended to be used after the setup process is completed, but they should allow the feedback to help the vehicle stay running without holding the throttle so you can begin tuning the idle base tables.

8. Start the engine and get it to idle. This may require creative throttle movements to stabilize the idle until it catches itself.
9. Confirm **Lambda** is measuring safe values, so the vehicle has sufficient fuel to idle without stalling but is not running so rich it will foul spark plugs.
10. Make sure that **Engine Speed** is less than 3000RPM. If not, there may be a vacuum leak.
11. Be sure the throttle pedal is at rest and confirm the ECU's measured **Throttle** value displays less than **10%**.
12. Confirm that an increase in the **IdleBasePosition** values will increase engine speed.
13. If RPM decreases when **IdleBasePosition** increases, change the **Idle Airflow Invert** option in the **Idle Wizard**.

### **Idle Basic Tuning:**

1. After the engine gets up to operating temperature, confirm that the **IdleTarget** displays 2000RPM.
2. Add or subtract idle values from the **IdleBasePosition** table until the **IdleFB** channel displays between -3% and -8%. Note: if the idle motor does not allow enough airflow to reach 2000 RPM, try some lower target RPM that can be achieved.
3. Change the **IdleTargetTable** to 1800RPM.
4. Add or subtract idle percent for the 1800 RPM cell in the **IdleBasePosition** table until the **IdleFB** channel parameter is between -3% and -8%.
5. Change the target value in the **IdleTargetTable** to 1600RPM.
6. Repeat steps 4-5, adjusting the values in the **IdleBasePosition** table until the lowest desired idle RPM.

Now the **IdleTargetTable** can be set to your desired values for normal operation. Many tuners increase the idle target by 200-400 RPM when the engine is cold for increased idle stability and to help the engine warm up more quickly.

It is recommended to set the **Idle On Below TPS** option to 2-3% higher than the ECU's measured **Throttle** position when the engine is running and the throttle is at rest. This will allow for minor fluctuations in the throttle signal without disabling idle feedback.

Typical values for **Idle On Below RPM** are 1500-2000 RPM, so the feedback will be active at high idle target RPM when coolant temperatures are low, but idle feedback is not active when the engine is in gear and decelerating.

Some tuners prefer to set the **Idle Feedback Min** to a smaller value than the **Idle Feedback Max** to limit the amount of negative feedback that can be accumulated in situations where idle feedback is active but some external factor is limiting the engine's response to idle feedback. An example is when the vehicle is decelerating in gear with the clutch engaged, the vehicle's drivetrain may prevent the engine from reaching the idle target RPM and idle feedback will continue to accumulate. When the clutch becomes disengaged the drivetrain gets removed from the equation, and the engine speed will fall quickly if a lot of negative feedback has been accumulated. Another way to alleviate this would be to decrease the value for **Idle On Below RPM**. See the [Idle](#) section of the wizard for more info.

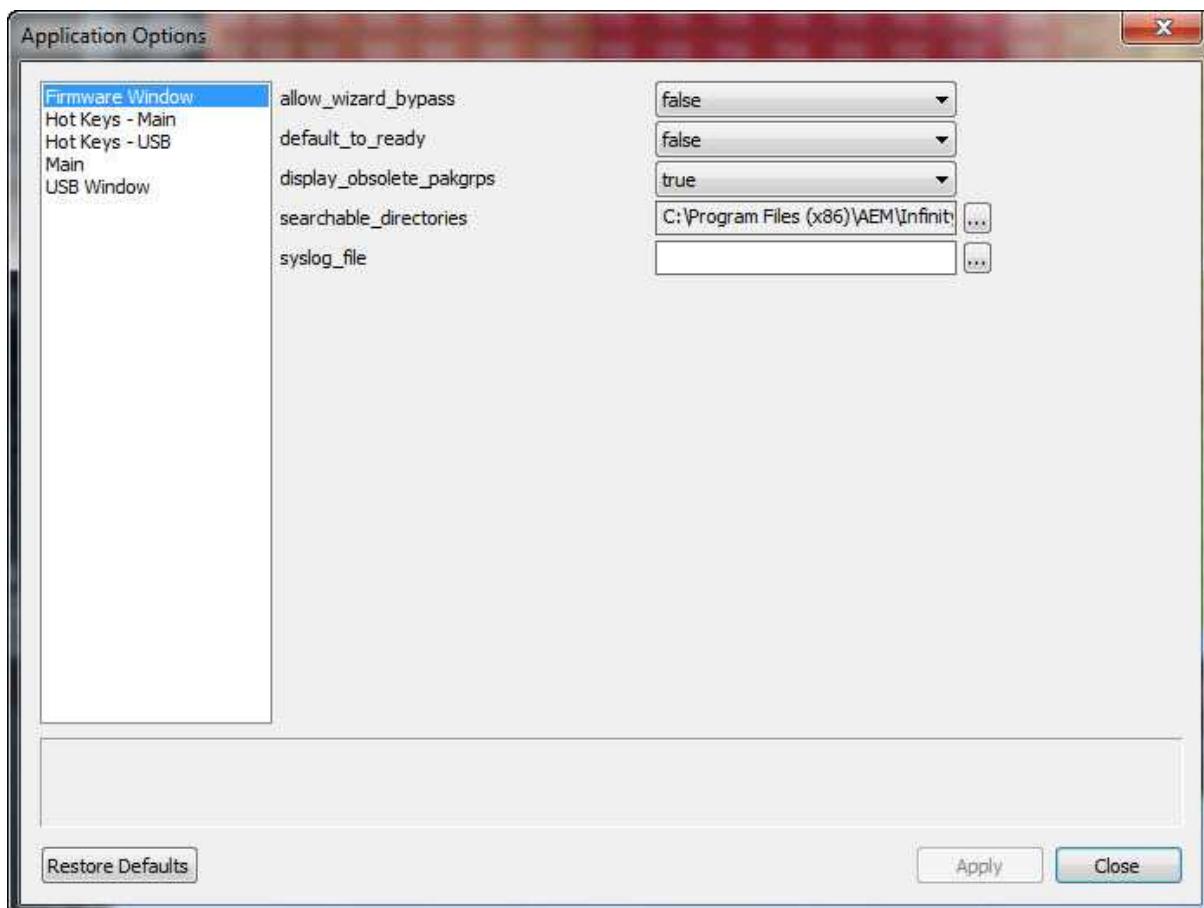
## 4.3 Advanced Tuning

### 4.3.1 Application Options

The following windows will allow users to customize the Infinity Tuner application for their preferences. Adjusting these settings is optional and in most if not all cases, they will be set properly by default.

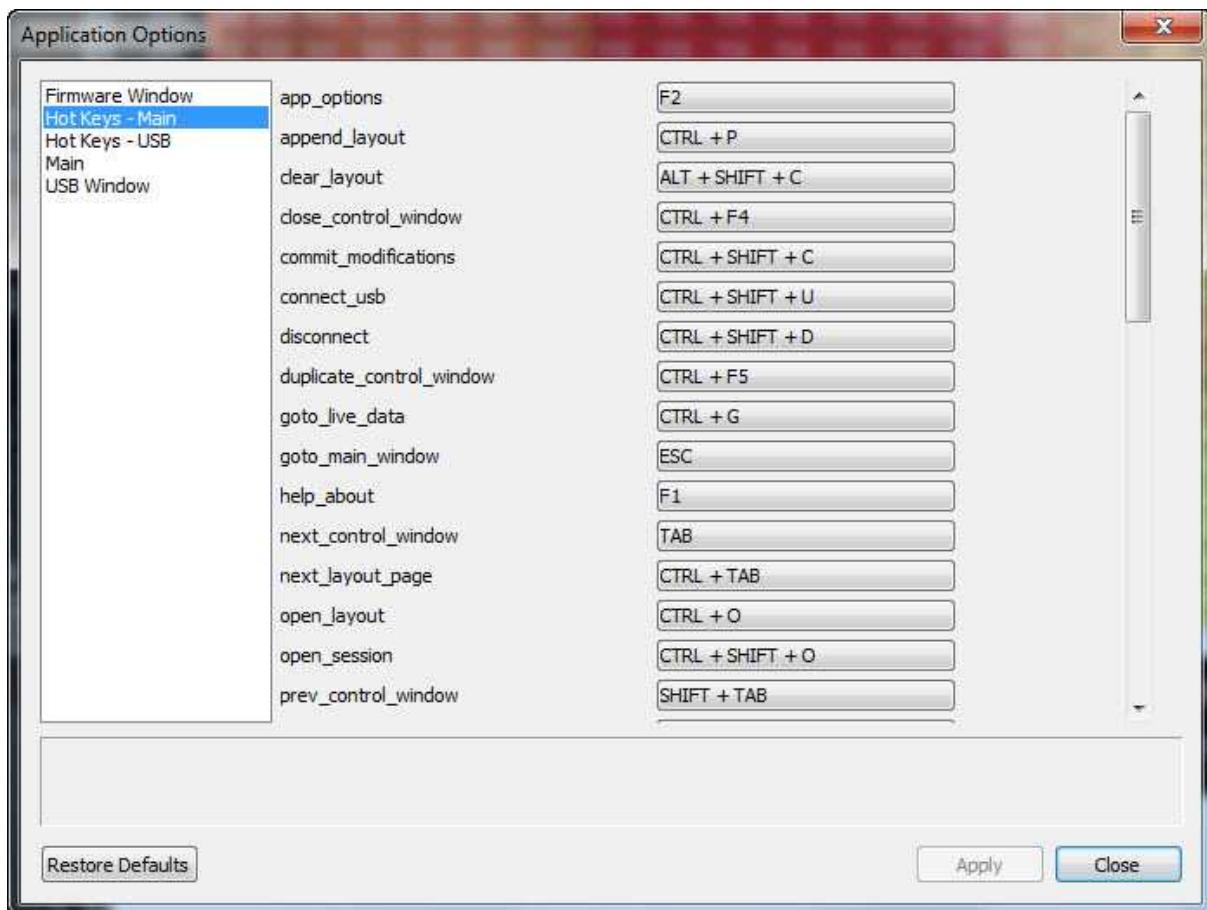
#### Firmware Window

These application preferences are used by the firmware upgrade window. They should be set correctly by default and should not need adjustment. They can be used in some cases for troubleshooting certain file management issues during the firmware upgrade process.



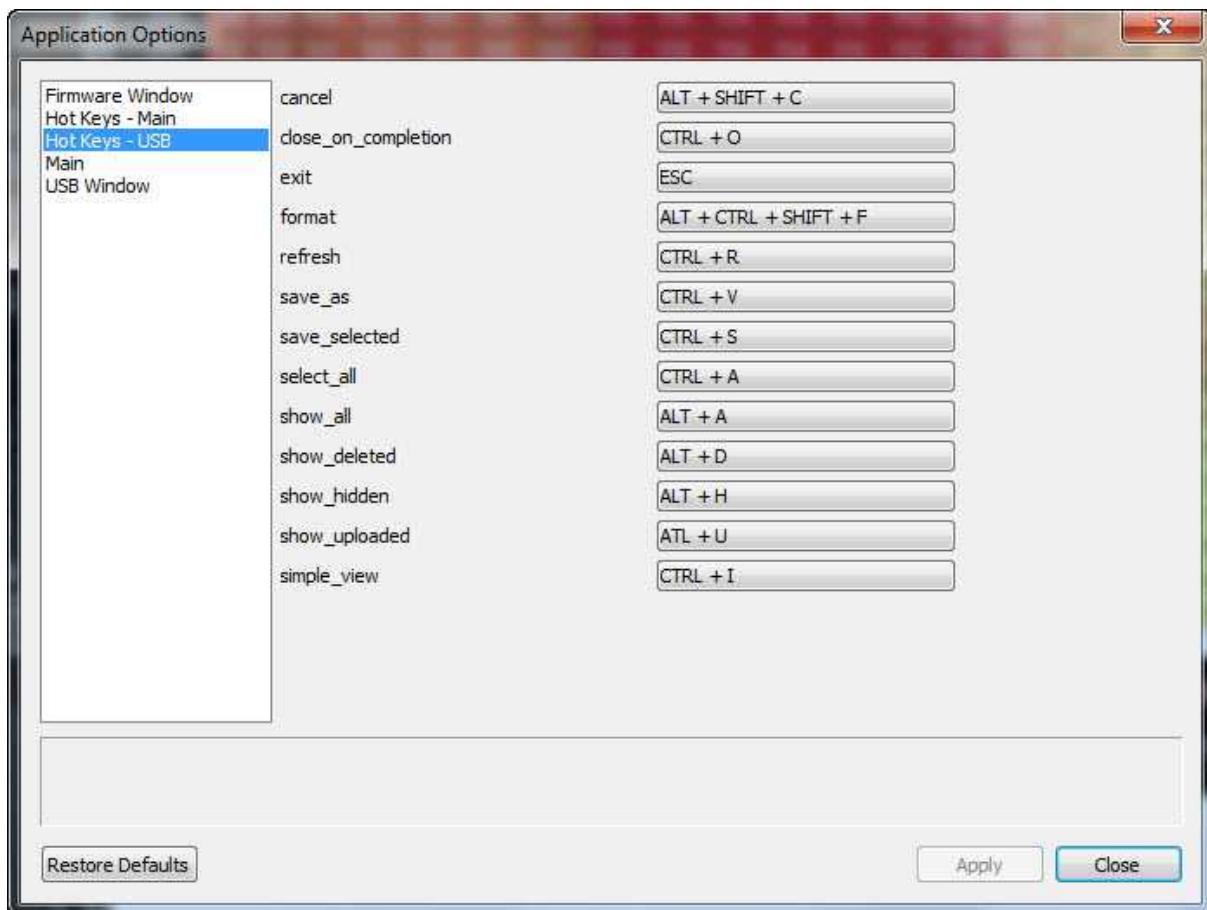
## Hot Keys - Main

These application preferences are used to set up hot keys for most general application tasks. To change a hot key assignment, select the hot key assignment by left clicking on the button. Hit the enter key to begin recording the new assignment.



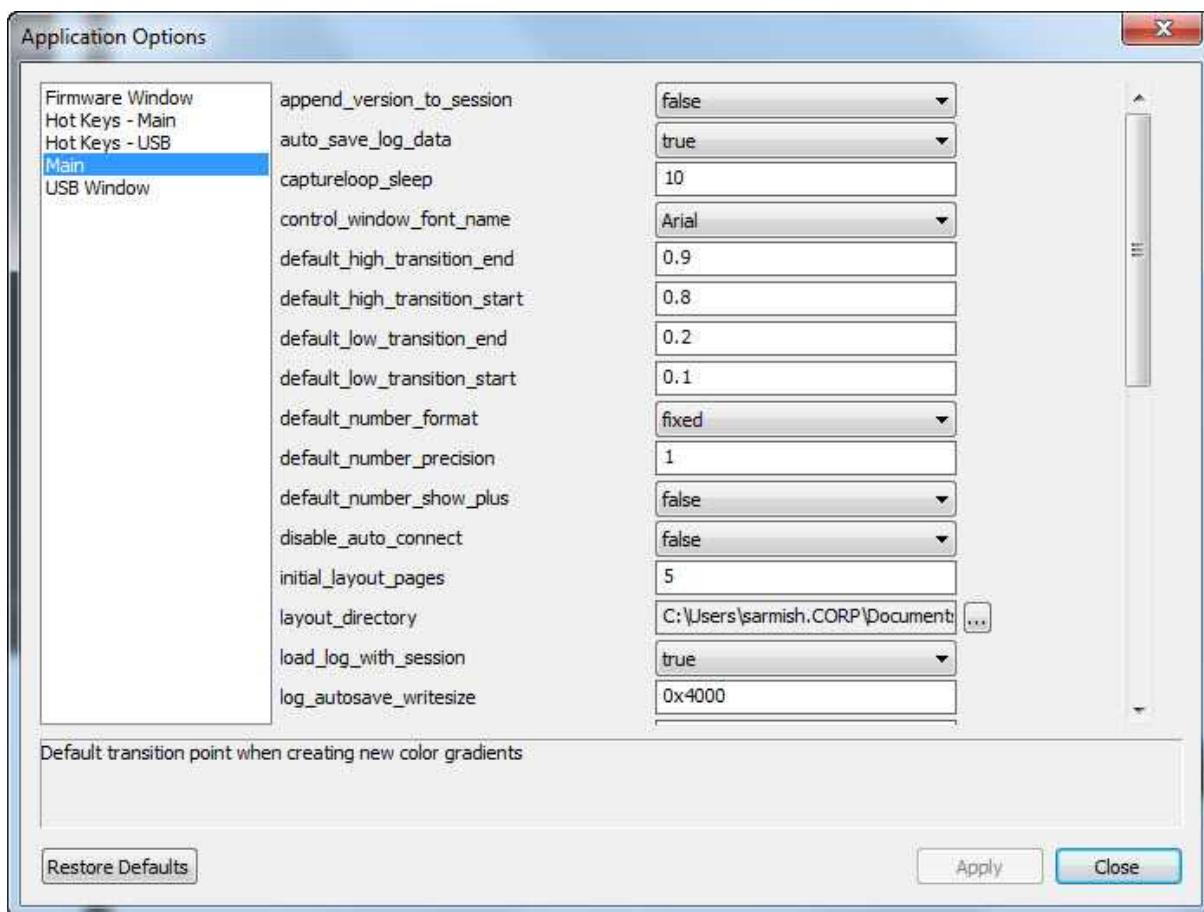
## Hot Keys - USB

These application preferences are used by the *USB logging - get logs* window. They can be used in some cases for troubleshooting certain file management issues during the USB log file save process.



## Main

These application preferences are used to set generic application preferences.



Most of these settings will be configured properly by default. The following list might be used more often by users to customize the application for their preferences:

*auto\_save\_log\_data* - Periodically save PC log data to disk while logging. Takes effect when logging starts/restarts.

*captureloop\_sleep* - This sets the PC logging frequency. The number of milliseconds between data captures from the ECU. A value larger than 1000 (1 second) will be ignored. Lower performance PCs may benefit from a value greater than 50 here. Depending on the size of the layout, values less than 20 may result in very large PC log files that take a long time to open and/or save.

*layout\_directory* - The current directory for layouts.

*load\_log\_with\_session* - Determines if .itlog files are loaded with a .itssn file is opened.

*session\_directory* - The current directory for session files.

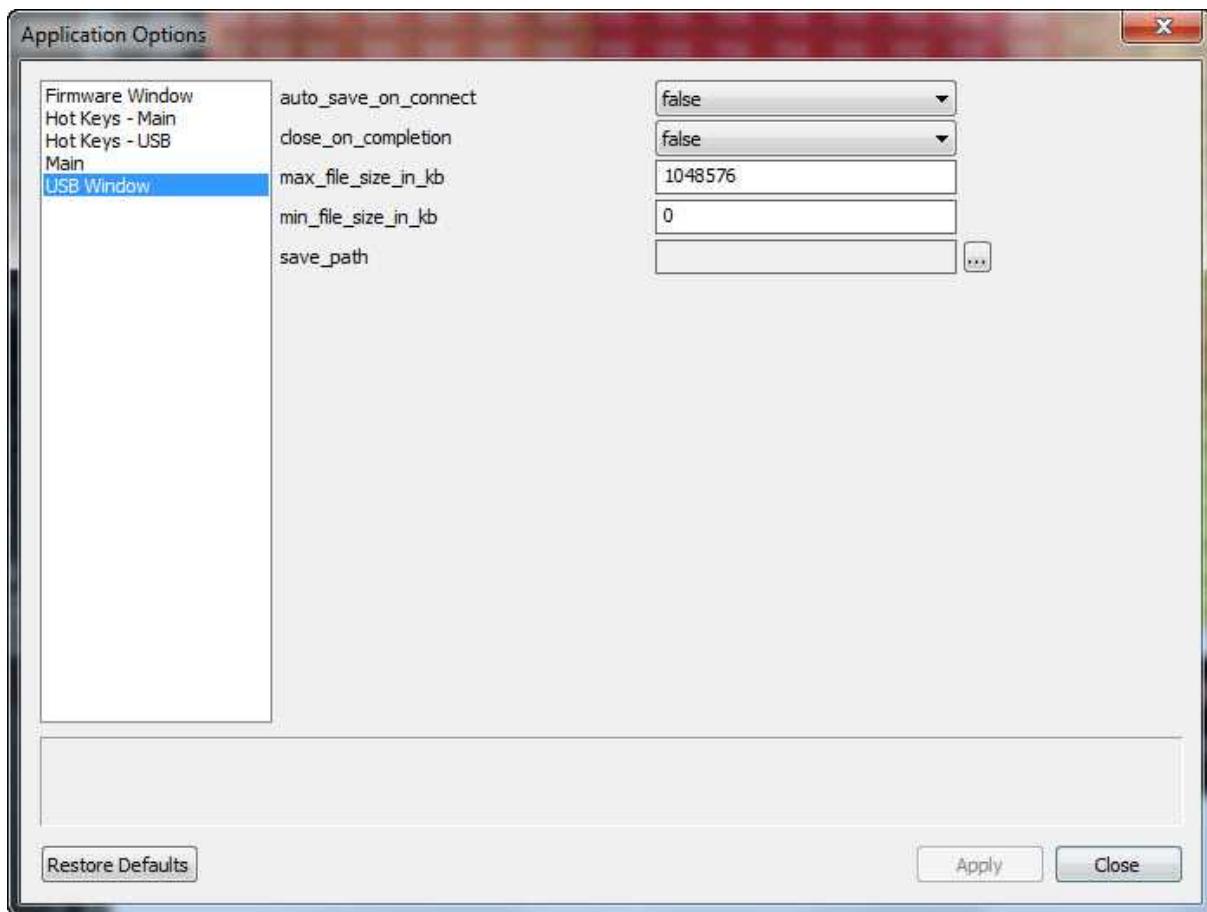
*startup\_layout* - Specifies how to perform the loading of a startup layout. Will only take effect on the next launch of Infinity Tuner. Options are:

load\_last  
load\_specific  
none  
prompt user

If *load\_specific* is chosen, a file must be set in the *startup\_layout\_file* setting.

## USB Window

These application preferences are used by the *USB logging - get logs* window. They can be used in some cases for troubleshooting certain file management issues during the USB log file save process.



### 4.3.2 Idle - Advanced

#### ▼ Hide Advanced Setup

The Advanced Setup allows the user to modify the Idle PID feedback gains: Proportional (instantaneous error), Integral (sum of errors), and Derivative (error rate of change). Adjusting the feedback gains will affect the response time, accuracy, and stability of the control loop. Gains that are set too small can result in sluggish response to changing engine speeds, while gains set too large can result in overshooting, oscillations, and overall idle instability.

Idle Proportional Gain

Idle Integral Gain

Idle Derivative Gain

Idle FB Deadband +

Idle FB Deadband -

Idle AC Offset and Idle Coolant Fan Offset can be used to compensate for additional airflow required when the AC compressor or Radiator Fan is active. Idle Stepper Max Steps defines the mechanical range of the stepper idle valve, if this is set too high the ECU will seem to 'lose track' of the idle after the engine has been running for a longer period of time. Idle Airflow Invert should be adjusted so that higher values in the IdleBaseDuty table increase the amount of airflow to the engine.

Idle AC Offset

Idle Coolant Fan Offset

Idle Offset RPM and Idle Offset Time are used to help prevent idle target undershoot when engine speed is falling quickly. When engine speed falls into idle range, the Idle Offset RPM value will be added to the idle target for the specified Idle Offset Time.

Idle Offset RPM  rpm

Idle Offset Time  s

Idle Stepper max steps  %

Idle Airflow Invert

#### Advanced Setup:

##### Idle Proportional Gain:

Proportional control is a pure gain adjustment acting on the magnitude of the target error to provide the system response. The advantage of a proportional-only control is it can respond quickly to large errors; when the error is large the proportional response will be large. The disadvantage of proportional gain for idle control is the proportional response will decrease to zero as the engine speed gets closer to the idle target RPM, and this tends to result in 'hunting' or fluctuations in engine speed. It is recommended to begin tuning idle feedback with this value set to zero or very low values. If the system responds

too slowly to quick disturbances, increase this value slightly.  
Min value = 0.000, Max value = 1.000

**Idle Integral Gain:**

Integral control uses an integrator or 'accumulator' method, essentially checking if the target error is positive or negative and then taking one step up or one step down every 400ms to reduce the target error. The advantage of integral response for idle control is the idle airflow will be slowly and smoothly adjusted until the engine speed reaches the target, and then remain at whatever feedback value reached the target. Note: although Integral gain is less likely to cause hunting or fluctuations than Proportional or Derivative gains, excessively high Integral values will take steps that are too large which can result in instability.

Min value = 0.000, Max value = 1.000

**Idle Derivative Gain:**

The derivative term adjusts the feedback based on the rate of change of the target error. Derivative control is used to reduce the magnitude of the overshoot produced by the Proportional component and improve the combined controller-process stability. Note: for most setups, it is recommended to leave the Derivative gain set to zero. For tuners who are very familiar with PID feedback and are observing a situation that could be alleviated by adjusting Derivative gain, it is recommended to use the Idle\_Decel table rather than the Derivative gain.

Min value = 0.000, Max value = 1.000

**Idle FB Deadband:**

The idle airflow valve is not the only factor that can influence engine speed and idle stability. In some cases, changing idle airflow in response to the engine's natural instability will cause the engine to fluctuate even more than if the idle valve were locked at a constant position. The Idle feedback deadband range defines an operating window where the engine speed is considered to be 'close enough' to the idle target and the IdleFB value should be paused. This deadband range should be larger for engines that do not idle smoothly, such as setups including aggressive camshafts, lightweight flywheels, or fuel injectors that flow inconsistently when operated at small pulsed widths.

**Idle FB Deadband +**

Within this range above the target idle RPM, idle feedback is paused and additional feedback will not be calculated.

Min value = 0 RPM, Max value = 300 RPM

**Idle FB Deadband -**

Within this range below the target idle RPM, idle feedback is paused and additional feedback will not be calculated.

Min value = -300 RPM, Max value = 0 RPM

**Idle Offsets:**

**Idle AC Offset:**

When the Air Conditioning system is activated, the compressor and/or fan will put an additional load on the engine. Idle AC Offset increases the open-loop idle air control valve position when the air conditioning clutch is active. When this value is adjusted properly, the engine speed should not decrease significantly when the compressor cycles ON, and should not flare high when the compressor turns OFF. When this value is not set correctly, the IdleFB value may fluctuate significantly when the AC compressor turns on or off.

Min value = 0, Max value = 50

**Idle AC Target Offset:**

For low-powered engines, it can be helpful to increase the target idle RPM to prevent stalling while the AC is enabled.

Min value = 0 RPM, Max value = 1000 RPM

**Idle Coolant Fan Offset:**

When the coolant fan is activated, the alternator will put an additional load on the engine. Idle AC Offset increases the open-loop idle air control valve position when the coolant fan function is active. When this value is adjusted properly, the engine speed should not decrease significantly when the compressor cycles ON, and should not flare high when the compressor turns OFF.

Min value = 0, Max value = 50

When idle feedback turns on, there is a good chance the engine is decelerating down into the idle conditions. To allow the engine to settle down to idle gracefully, the idle target RPM will be temporarily increased by the 'Idle Offset RPM' value, then decay down to the normal idle target after a short period of time.

**Idle Offset RPM:**

When idle feedback turns on, the idle target will increase by this amount.

Min value = 0 RPM, Max value = 1500 RPM

**Idle Offset Time:**

After idle feedback turns on, the Idle Offset RPM will slowly decay down to zero after this amount of time.

Min value = 0 seconds, Max value = 10 seconds

**Idle Stepper max steps:**

The number of physical steps the stepper idle valve is capable of moving without hitting its mechanical stop. See the Idle Setup: stepper idle valves' section of [Idle Air Control](#)<sup>151</sup>.

Min value = 0, Max value = 300

**Idle Airflow Invert:**

Some idle air control motors have an inverse relationship between position and airflow. In other words, 0% position results in maximum airflow and 100% position results in minimum airflow. If working with this type of air control valve, turning on 'Idle Airflow Invert' will invert the final step in the ECU's Idle calculations, 'Idle Position', so that vehicle's idle valve can work properly without requiring changes to the vehicle's wiring harness.

**Idle Decel**

**Units:** Engine Speed Rate vs RPM vs Idle%

**Description:** This table allows an extra idle airflow offset to prevent the engine from stalling when decelerating down to idle. When the engine is decelerating quickly, the lower-right cells in this table will be used. These cells can be set to add airflow in order to slow the engine's deceleration 'on the way down' which makes the engine less likely to stall. This is especially helpful for vehicles with lightweight flywheels. Table values 300-800RPM above the target idle speed are the most important ones to adjust; increasing idle position when the engine reaches or drops below the target idle speed is generally too late.

Idle_Decel						
EngineRate	0	0.0	0.0	0.0	0.0	0.0
	-500	0.0	0.0	0.0	0.0	0.0
	-1000	0.0	0.0	0.0	4.0	4.0
	-1500	0.0	0.0	2.0	5.0	5.0
		750	1000	1100	1500	2000
EngineSpeed [RPM]						

**IgnTrimIdle**

**Units:** Ignition timing trim vs Idle RPM error

**Description:** This table applies an ignition trim as a function of idle RPM error.

Negative values retard ignition timing from the value in the main ignition map, which tends to decrease engine speed slightly. Positive values advance timing, which tends to increase engine speed slightly.

IgnTrimIdle											
5.0	5.0	5.0	2.5	0.0	-2.5	-5.0	-5.0	-5.0	-5.0	-5.0	-5.0
-200	-150	-100	-50	0	50	100	150	200	250		
IdleRPM_error											

### **IdleTargetOffset**

**Units:** Idle Target Offset RPM vs After Start Time

**Description:** This table can be used to increase the target idle RPM for a few seconds after starting the engine. This will allow the catalytic converter to light off earlier for improved emissions and will also fight a lean mixture from excessive wall wetting from poor fuel injector atomization.

IdleTargetOffset [RPM]					
0	0	0	0	0	0
0.000	2.000	4.000	6.000	8.000	10.000
AfterStartTime [s]					

### **IdleTPSOffset**

**Units:** Idle RPM Offset vs TPS

**Description:** This table offsets the idle target RPM at low throttle angles, to increase the desired idle speed when idle feedback may still be active. The values are offset from the **IdleTargetTable**.

IdleTPSOffset [RPM]					
0	0	25	50	200	500
0	1	1	2	3	5
Throttle [%]					

### **Idle Advanced Tuning:**

If there are problems with **IdleFB** oscillations or response time, the feedback PID settings may need to be adjusted. Please understand that the original PID settings provided by AEM should be a good starting point for most vehicles, and adjusting the PID values by small amounts can create severe problems. It is recommended to first look into other potential problems if the engine does not idle smoothly, such as the VE table values, ignition timing, etc.

1. Set **Idle Proportional Gain**, **Idle Derivative Gain**, **Idle Integral Gain** values to zero. Also set the table values for **Idle\_Decel** and **IgnTrimIdle** to zero. This will disable all idle feedback for airflow and ignition timing, which should result in a stable idle RPM assuming the mechanical load on the engine is not fluctuating due to the radiator fan, AC clutch, or vacuum leaks. Ensure that the fuel and ignition maps have been configured in a way that does not cause the

engine to fluctuate or hunt. If idle feedback is disabled but the engine hunts and the measured Lambda values fluctuate, it's recommended to adjust the VETable values until measured Lambda is more smooth.

2. Log the channels **Engine Speed**, **IdleFB**, **IdlePosition**, and **IdleTarget**. Observe the amount of natural fluctuation without any idle feedback. It may be possible to reduce fluctuation by adjusting the values in the **IgnTrimIdle** table. Based on your logs, you can set reasonable values for the **IdleFB\_Deadband+** and **IdleFB\_Deadband-** limits.
3. Increase the **Idle Integral Gain** slowly, observing the effects on the IdleFB value calculated. Once the engine reaches the idle target RPM, put the transmission in gear and slowly begin release the clutch as if driving through the pits slowly. Watch that the idle feedback responds quickly enough to prevent the engine from stalling. If the O2 sensor reads lean when releasing the clutch, try increasing the **VETable** values for the cells that are reached when the engine load increases. Repeat as necessary, adjusting Idle Integral Gain and possibly Idle Proportional Gain until you are satisfied with the idle feedback response to changes in engine load.
4. Press the throttle and hold at least 2500RPM for 1-2 seconds, then release the throttle so the engine decelerates down to idle. If the engine falls below the idle target RPM, first ensure that the **VETable** is adjusted such that the O2 sensor does not read lean when decelerating the last 500-1000 RPM down to idle. After the VETable has been confirmed OK, adjust the values in the **Idle\_Decel** table so the engine decelerates gradually near the idle target without overshooting or stalling. For some vehicles, values as large as 15 or 20 may be helpful in the **Idle\_Decel** table. Repeat as necessary.
5. Press the throttle very gently so the position is 1-2-3-4% throttle. Watch idle feedback; if the feedback appears to be 'fighting' the throttle and trying to prevent the engine from accelerating when you press the throttle gently, you can decrease the **'Idle On Below TPS'** value so feedback is disabled sooner, or you can increase the values in the **IdleTPSOffset** table so the ECU's idle feedback does not 'fight' the throttle at very low angles.

### Ignition Trim IDLE PID Feature:

Although not generally needed, a closed loop ignition trim for idle is now available. The following setup wizard settings are used to enable the feature.

Idle Ignition Proportional Gain	0.000	<input type="button" value="▲"/>	<input type="button" value="▼"/>
Idle Ignition Integral Gain	0.00	<input type="button" value="▲"/>	<input type="button" value="▼"/>
Idle Ignition Derivative Gain	0.000	<input type="button" value="▲"/>	<input type="button" value="▼"/>
Idle Ignition Min	-10.0	<input type="button" value="▲"/>	<input type="button" value="▼"/>
Idle Ignition Max	10.0	<input type="button" value="▲"/>	<input type="button" value="▼"/>

When enabled, this feedback control system will use closed loop ignition timing changes

to help maintain a target idle.

### **Idle Feedback Disable Window Feature:**

Idle Feedback Disable Window:   rpm

Rather than using the 'Idle On Below RPM' option above, Idle feedback can be disabled when EngineSpeed is greater than the IdleBaseTarget by this much. Setting this value low can prevent idle feedback from calculating negative values while decelerating in gear.

Can be used in place of the Idle On Below RPM option. This is a more adaptive way of managing the idle target while decelerating in gear. It can prevent integral wind up and potential stalling problems when the clutch pedal is pushed in while coasting to a stop.

#### **4.3.3 Shift Cut**

The ECU can decrease engine power for quick and consistent gear shift events while the driver holds full throttle. Power reduction can be achieved by a combination of ignition retard, fuel cut, and spark cut in response to a clutch switch, a clutch pressure sensor, or a switch or strain gauge mounted to the shift lever. Shift cut time can be adjusted for each gear using the "ShiftCutTime" table. After the cut time has been completed, ignition timing retard can be "ramped-out" over a certain amount of time to decrease drive-train shock when power is reapplied.

### **Shift Cut Activation**

#### **Shift Cut Minimum RPM:**

Shift Cut will be disabled below this RPM. Set this value high enough to prevent shift cut from triggering when shifting into gear from idle.

Min value = 1500 RPM, Max value = 20000 RPM

#### **Shift Cut Minimum Throttle:**

Shift cut will be disabled below this throttle position. Set this value high enough to prevent shift cut from triggering when cruising at low throttle positions.

Min value = 5%, Max value = 100%

#### **Shift Cut Re-Arm Delay Time:**

Shift cut should be disabled for a short time after each cut event, to prevent double-triggering if the switch or sensor 'bounces' and sends an additional shift signal.

Min value = 600 ms, Max value = 2000 ms

#### **Shift Cut Method:**

Use this list to select the method of reducing engine power during the shift cut. Possible methods are:

- Ignition Retard only
- Ignition Retard + Fuel Cut
- Ignition Retard + Spark Cut
- Ignition Retard + Fuel and Spark Cut

**Ign Retard Amount:**

This is the total amount of ignition retard to allow while the shift cut is active, and the starting point for ignition retard ramp-out after the cut turns off. Set this to zero if you do not wish to retard timing after the shift cut..

Min value =0 degrees, Max value = 30 degrees

**Ign Retard Ramp-Out Time:**

This is the amount of time it takes for the ignition retard to be ramped out to zero after the shift cut turns off.

Min value =10 ms, Max value = 500 ms

#### 4.3.4 Rev Limit 2Step

##### Rev Limit 2 Step

The 2-Step limiter holds the Engine Speed at a certain RPM to allow consistent launches at the starting line.

2 Step Fuel Cut Enable

2 Step Spark Cut Enable

##### 2 Step Activation Criteria

2 Step Maximum Vehicle Speed   mph

The 2-Step limiter will be active when the 'ClutchSwitch' signal is on and Vehicle Speed is below the '2 Step Maximum Vehicle Speed' limit.

Ignore Clutch Switch

If 'Ignore Clutch Switch' is selected, the 2 Step limiter will be activated by Vehicle Speed only.

2-Step Target RPM can be configured in the 2StepTargetFuel [RPM] and 2StepTargetSpark [RPM] tables.

##### ▼ Hide Advanced Setup

An external 12 position switch allows the user to adjust the target 2-Step launch RPM at the starting line. After selecting which input pin to use, adjust the values in the 2StepTargetFuel [RPM] and 2StepTargetSpark [RPM] tables to set the desired launch RPM depending on input pin voltage.

2 StepTarget table inputs

It is not recommended to use the 'Clutch Switch invert' option, it is scheduled to be removed from future firmware versions. Please set 'Clutch Switch Invert' to off and adjust the values in the 1D table 'ClutchSwitch' so the table output is 1 when the clutch is pressed.

Clutch Switch Invert

Main rev limiters are found at the end of the engine's power band. Secondary rev limiters (2 step) are most commonly used in drag racing for consistent vehicle launches. However, secondary rev limiters can also be used for full throttle shifting, anti-lag, valet parking, etc.

##### **2 Step Fuel Cut Enable:**

Use a fuel cut for the launch limiter. This can be used along or combined with spark cut.

##### **2 Step Spark Cut Enable:**

Use a spark cut for the launch limiter. This can be used alone or combined with fuel cut.

**2 Step Maximum Vehicle Speed:**

Allows the user to disable the 2 step limiter when the vehicle begins moving. This is the only option that will disable the 2Step when a clutch switch is not installed on the vehicle. This requires a properly functioning and calibrated vehicle speed sensor.

**Ignore Clutch Switch:**

If this option is active, the ECU ignores the ClutchSwitch input and allows the user to enable the 2 Step function using vehicle speed only. This can be useful if a clutch switch is not installed on the vehicle.

**2 Step Target table inputs**

Allows the user to reassign the input voltage for the 2StepTargetFuel and 2StepTargetSpark tables. Wiring a 12-position switch can allow the driver to quickly adjust the desired launch RPM without connecting a laptop to the ECU.

#### 4.3.5 Rev Limit 3Step

##### Rev Limit 3 Step

The 3-Step function can be used to limit wheel-slip. The wheels used to calculate Vehicle Speed must not be slipping, this can be configured in the Vehicle Speed setup.

3 Step Fuel Cut Enable

3 Step Spark Cut Enable

Using the 1D tables '3StepTargetFuel [RPM]' and '3StepTargetSpark [RPM]', a maximum desired Engine Speed can be configured depending on Vehicle Speed. If 3-Step is enabled and the Engine Speed increases above the 3-Step limit, it can be assumed there is excessive slip and the ECU will cut fuel or spark to prevent 'blowing away the tires'.

##### ▼ Hide Advanced Setup

For very powerful vehicles that spin the rear tires and lift the front tires, the VehicleSpeed calculation may not be accurate enough for 3 Step use. It may be preferable to use the LaunchRampTime[ms] as the input for the 3 Step tables. See the wizard page 'Launch Timer' for more details.

3 StepTargetFuel table input

3 StepTargetSpark table input

The 3Step Rev Limiter is a simplistic traction control system that is commonly used in race series that do not permit wheel speed sensors. Instead this system uses the transmission's vehicle speed sensor along with the crank sensor(engine speed) to limit the amount of tire slip. There are two tables (3StepFuelCut and 3StepSparkCut) that are

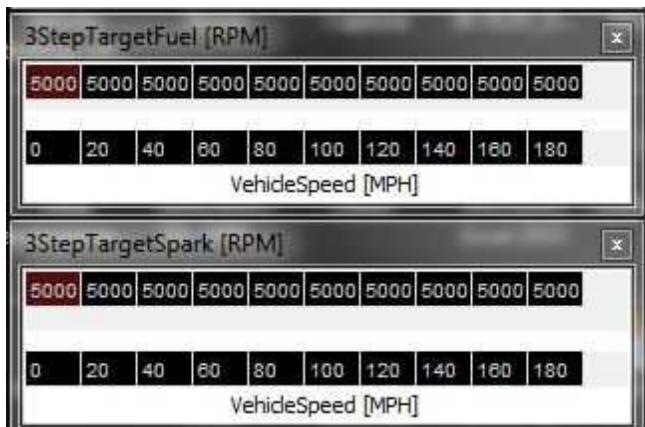
associated with the following channels.

**3 Step Fuel Cut Enable:**

Enable or disables the fuel cut 3 step feature.

**3 Step Spark Cut Enable:**

Enable or disables the spark cut 3 step feature.

**3StepTarget tables (not shown in wizard):**

The 3Step Target tables shown above are used in conjunction with the setup wizard options.

**4.3.6 Launch Antilag**

Turbo lag is defined as the time delay before the turbocharger has produced boost pressure. Anti-lag is when a turbocharger is subjected to a very late burn causing the exhaust to expand in the turbine housing. This energy is concentrated at the turbocharger causing a very quick turbo spool up. Since turbochargers are designed and sized to operate at specific rpm ranges and air flow conditions, some turbo lag is inherent in the system. To fully understand turbo lag, you must first understand the operation principles behind what causes a turbo to make boost.

Boost is not made by RPM alone. There is a big difference in the airflow through an engine at 6,000 rpm in neutral, 6,000 rpm in first gear at part throttle, and 6,000 rpm in high gear at full throttle. Turbochargers are even more effected by these airflow differences and especially load differences than most other devices. This is why you may be able to see a small amount of boost with a positive displacement supercharger at WOT in neutral, but you may not see any boost at WOT in neutral with a turbocharger.

A given turbocharged vehicle may produce full boost in first gear by 3,500 rpm. This same vehicle may produce full boost in 4th gear by 2,300 rpm. When pulling a heavy trailer, it may produce full boost by 1,800 rpm even in 1st gear. These conditions are more specific to manual transmission vehicles as the boost has to build in each gear after the throttle is closed during the shift. Automatic transmission vehicles operate

differently as they can be "loaded" by stalling up the converter and placing enough load to build boost before the vehicle even moves. Also, with an automatic transmission, the throttle is not shut during shifts which causes the boost to "pop up" because the turbo is supplying enough air flow to feed the boosted engine at high rpms and suddenly the rpms are drastically cut down by the shift as well as increased load has been placed on the system at the same time. This can cause an engine that is accelerating in 1st gear with low boost to instantly go to full boost upon shifting into 2nd gear.

### Tuning Anti-Lag

The basic idea is to fire the ignition after TDC to cause afterburn in the exhaust to spool the turbocharger to a desired boost level for launching the vehicle. There are a couple of things to consider to obtain the desired results.

- Engine Speed: The amount of engine speed is directly related to how much boost can be made under anti-lag conditions. A higher engine speed will equate to a higher boost level as well as a faster boost response. If you are unable to make the desired boost pressure for launching, no matter how much ignition retard is used, then more than likely you need to increase the engine speed limiter.
- Ignition Retard: The more the ignition is retarded, the more afterburn and heat will be put into the exhaust. Start at a conservative 5 degrees ATDC, and add more ignition retard until the desired time and boost is reached. Typical numbers are 15-20 degrees ATDC of ignition retard.
- Engine Load: If the boost control is set at "x" pressure, then no more "x" pressure can be obtained when launching. The Infinity Tuner can allow a lower or higher launch boost than the operating boost setting.
- Additional Fuel: Added fuel will also aid in the anti-lag process by insuring the fuel mixture will be there throughout the engine cycle. A typical increase is 5-10%.

#### Launch Antilag

For turbocharged vehicles, it is possible to retard ignition timing in order to increase boost at the starting line. There is a 2-axis table `IgnTrimLaunchMap [degBTDC]` that can be used to trim ignition timing when the Launch Retard activation conditions are met. The ignition trim value from this table is combined with all other ignition trims. **WARNING:** Antilag will increase wear on the engine and turbocharger, and should only be used for brief periods of time. It should be possible to stage the car with less throttle input, and use full throttle only as long as necessary to reach the required boost level before launching.

Launch Retard Enable	<input type="checkbox"/>	
Launch Retard Active Above Throttle	85.0	%
Launch Retard Active Above RPM	4000	rpm

An external 12 position switch allows the user to select a target launch boost. The system compares this value to the current manifold pressure and calculates a launch boost error. The launch boost error is an input to the `IgnTrimLaunchTable`.

**Launch Retard Enable:**

Enable or disables the launch retard feature

**Launch Retard Active Above Throttle:**

Throttle [%] must be above this value for the Anti Lag function to enable.

**Launch Retard Active Above RPM:**

EngineSpeed [RPM] must be above this value for the Anti Lag function to enable.

#### 4.3.7 Launch Timer

**Launch Timer**

The Launch Timer can be activated by holding and then releasing the 'ClutchSwitch' input. If a clutch switch is not used, this can be connected to the vehicle's line lock switch or trans brake switch. The timer becomes armed when the switch is held for longer than the 'Launch Timer Arm Time', then begins counting when the switch is released.

Launch Timer Enable

Launch Min Throttle 75 %

Launch Timer Arm Time 500 ms

'LaunchRampTime [ms]' is the output of the Launch Timer. It can be selected as an input to the 3-Step Limiter and BoostControl functions.

Launch Pedal Window 1000 ms

If the driver releases the throttle while the timer is counting, the Launch Timer will pause. If the throttle reaches Launch Min Throttle again before the 'Launch Pedal Window' time has expired, the timer will continue from the previous value from before it was paused.

Launch Timer Time Out 180000 ms

'If the Launch Timer counts above the Launch Timer Time Out' value, it will be reset to zero.

**Launch Timer Enable:**

Check box to enable or disable Launch Timer controls.

**Launch Min Throttle:**

Minimum Throttle [%] before launch timer can be activated.

**Launch Timer Arm Time:**

Time to hold trigger before launch timer is activated

**Launch Pedal Window:**

Amount of time allowed between conditions to use Launch Timer

**Launch Timer Time Out:**

Time before launch timer pedal window resets to 0.

#### 4.3.8 Boost Control

The Infinity has a very comprehensive and flexible boost control strategy. Using a pulse width modulated (PWM) solenoid, boost can be controlled by vehicle speed, throttle position, rpm, switch input, etc. AEM recommends using the AEM Boost Solenoid Kit (AEM P/N: 30-2400) for boost control which is good for 120psi. Another solenoid that is commonly used is the GM PWM Boost Solenoid (GM P/N: 1997152).

The AEM and GM solenoids, listed above, are both 3-way valves which can be either normally closed (N.C.) or normally open (N.O.) valves depending on which port the filter (muffler) is attached. 2-way boost solenoids are also found in factory turbocharged vehicles. Depending on the manufacturer, these can be normally closed (N.C.) or normally open (N.O.) valves. In other words, if they were unplugged, the some would block flow and some would allow flow to pass through as if it were not installed. On the other hand, if a constant 12V and ground were applied to solenoid, the exact opposite would happen. If an unknown solenoid is being used, this can be easily tested by blowing through the solenoid while disconnected.

Because of the discrepancies between solenoids and wastegate types, there should be some thought put into plumbing and how the Infinity Tuner software will control them. Below are a few different examples, however, there are many other wastegate styles and turbocharger setups that are not listed.

When using the AEM 30-2400 with an internal wastegate, AEM recommends plumbing the vacuum (boost) lines like the following:



When using the AEM 30-2400 solenoid with an external wastegate, AEM recommends plumbing the vacuum (boost) lines like the following:



When using the GM 1997152 solenoid with an internal wastegate, AEM recommends plumbing the vacuum (boost) lines like the following:



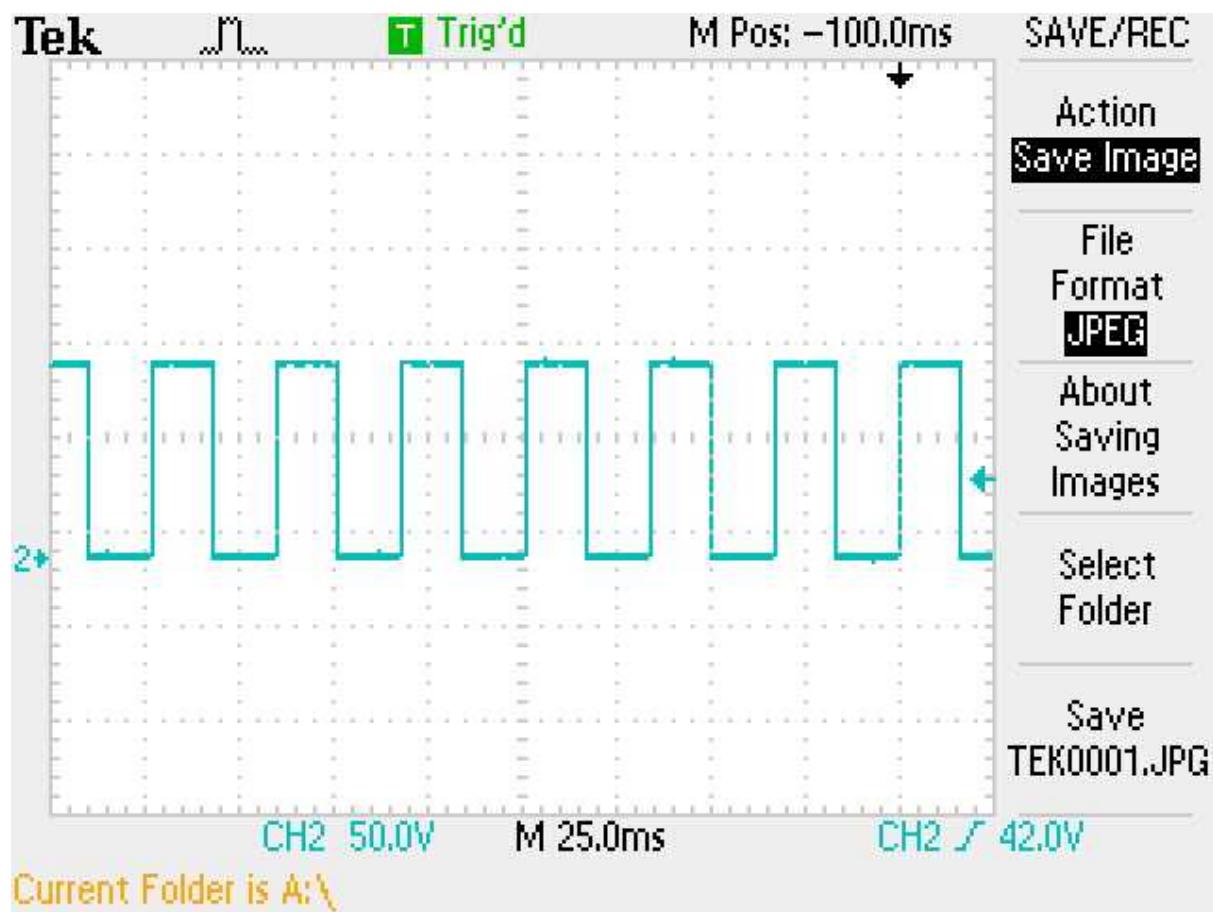
When using the GM 1997152 solenoid with an external wastegate, AEM recommends plumbing the vacuum (boost) lines like the following:



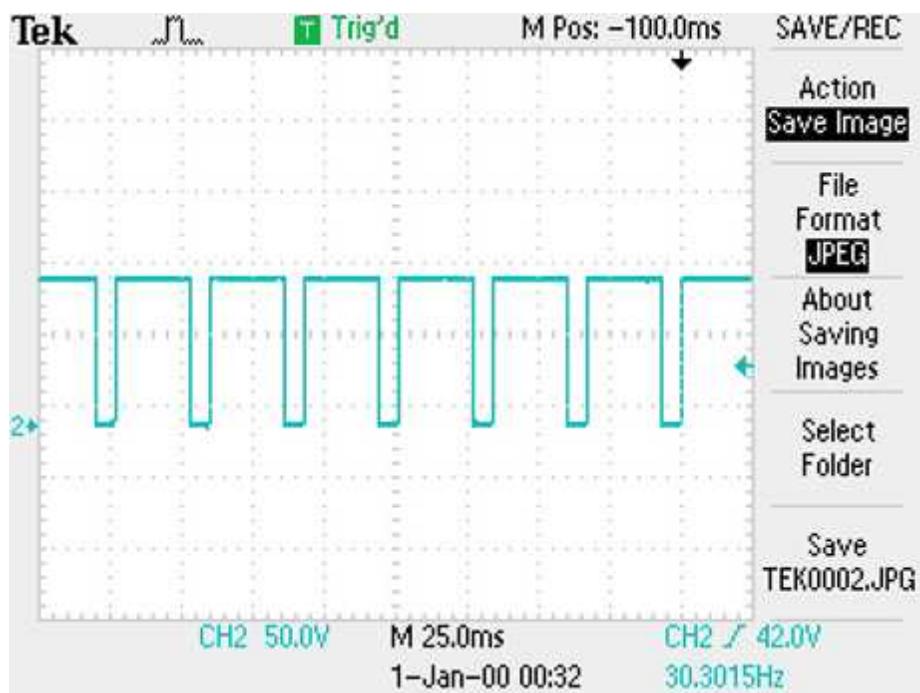
The next step in creating a new setup is determining what frequency the solenoid needs to be operated. This information is typically provided by the manufacturer of the part. Both AEM and GM solenoids are optimal at 31Hz. If using a plug n' play Infinity ECU with a factory boost control solenoid, this comes pre configured by AEM.

The default Infinity PWM output for boost control is LowsideSwitch\_2 (Pin C1-17). There are two wire connections for a boost solenoid and there is no polarity. One wire connects to 12 volt switched power and the other will connect to Infinity Pin C1-17.

To understand how the solenoid becomes a variable air flow restricting valve to meet a specific wastegate position, note the following duty cycle signal examples. The oscilloscope trace below shows a 30Hz, 50% duty cycle signal coming from the Infinity ECU. The solenoid will be ON when the signal is low and OFF when the signal is high.



The oscilloscope trace below shows a 30Hz, 20% duty cycle signal. The solenoid will be ON when the signal is low (20% of the time) and OFF when the signal is high (80% of the time).



## Boost Control Related Functions

The following settings are available in the Boost Control Setup Wizard page.

### Boost Output Enable

**Units:** On/Off

**Description:** This enables the boost control feature.

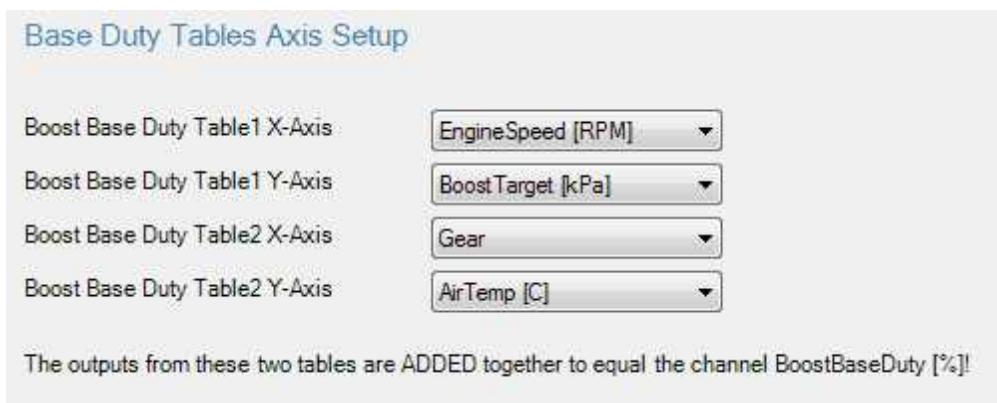


### **Boost Feedback Enable**

**Units:** On/Off

**Description:** This enables the closed loop boost control feedback PID strategy. When performing the preliminary boost tuning, it is advisable to turn this OFF. Once the open loop duty cycle output from the various lookup tables is complete and the boost pressure is close to the desired target, this can be activated. PID (proportional, integral, derivative) control will always work better when it does not need to make large corrections.

### **Base Duty Tables Axis Setup**



There are two 2D base duty tables in the calibration. They are named:

- BoostBaseDuty1 [%]
- BoostBaseDuty2 [%]

These two tables add together so the user can use one table as primary and the second as a trim if desired. Both axis inputs are selectable from the drop down lists shown above.

### **Boost Target Tables Axis Setup**



There are two 2D boost target tables in the calibration. They are named:

- BoostTargetTable1 [kPa]
- BoostTargetTable2 [kPa]

These two tables add together so the user can use one table as a primary and the second as a trim if desired. Both axis inputs are selectable from the drop down lists shown above.

### **Boost Solenoid Control Frequency [Hz]**

**Units:** Hz

**Description:** This should be set to the manufacturer specifications. This sets the frequency to operate the pulse width modulated boost solenoid. If the boost solenoid is excessively noisy and/or slow to respond, the frequency should be changed. Note: Most boost solenoids make some noise.

Min value = 0, Max value = 1000

### **Boost Solenoid Max Duty Cycle [%]**

**Units:** %

**Description:** This should be set to the manufacturer specifications. This sets the maximum duty cycle allowed.

Min value = 0, Max value = 100

### **Boost Duty Cycle Invert**

**Units:** On/Off

**Description:** This setting inverts the PID feedback logic.

### **Boost Integral Gain Low Clamp**

**Units:** Clamp

**Description:** This keeps the integral gain from winding down and limits its contribution. Min value = -10, Max value = 10. Note: BoostControlIntClampH must be greater than BoostControlIntClampL

### **Boost Integral Gain High Clamp**

**Units:** Clamp

**Description:** This keeps the integral gain from winding up and limits its contribution. Min value = -10, Max value = 10. Note: BoostControlIntClampH must be greater than BoostControlIntClampL

### **Boost Integral Gain High Clamp**

**Units:** Clamp

**Description:** This keeps the integral gain from winding up and limits its contribution. Min value = -10, Max value = 10. Note: BoostControlIntClampH must be greater than BoostControlIntClampL

### **Boost Solenoid Min Throttle**

**Units:** %

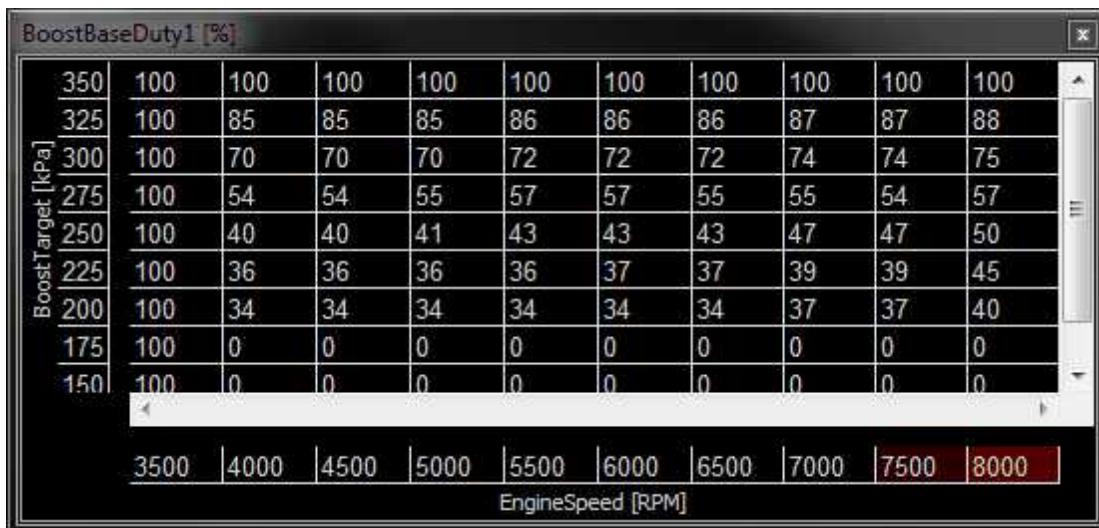
**Description:** Below this TPS value, the boost duty output is disabled.

Min value = 0, Max value = 100.

### **BoostBaseDuty1 [%]**

**Units:** Selectable via setup wizard

**Description:** Base wastegate duty cycle as a function of selectable axis inputs. This table is used to set the base duty cycle to the boost control solenoid. Set this by disabling the feedback controls first. This is done by setting the **BoostControl\_Kp**, **BoostControl\_Ki**, and **BoostControl\_Kd** all to zero. Adjust this table until the desired boost is as closely achieved as possible. The closer this table gets to the targeted boost pressure, the better the closed loop boost control feedback will work. This table determines the base duty cycle percentage used if or if not using closed loop boost control feedback. This is the first feature to tune when using boost control.



### **BoostBaseDuty2 [%]**

**Units:** Selectable via setup wizard

**Description:** Base wastegate duty cycle adder as a function of selectable axis inputs.  
The values in this table ADD TO the values in the BoostBaseDuty1 [%] table.

BoostBaseDuty2 [%]										
AirTemp [C]	80	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0

Gear      0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9

### BoostTargetTable1 [kPa]

**Units:** Selectable via setup wizard

**Description:** Base boost target values as a function of selectable axis inputs.

BoostTargetTable1 [kPa]											
Throttle [%]	100	200	200	200	200	200	200	200	200	200	200
90	200	200	200	200	200	200	200	200	200	200	200
80	200	200	200	200	200	200	200	200	200	200	200
70	200	200	200	200	200	200	200	200	200	200	200
60	200	200	200	200	200	200	200	200	200	200	200
50	200	200	200	200	200	200	200	200	200	200	200
40	200	200	200	200	200	200	200	200	200	200	200
30	200	200	200	200	200	200	200	200	200	200	200
20	200	200	200	200	200	200	200	200	200	200	200
10	200	200	200	200	200	200	200	200	200	200	200

FlexContent [%]      0 | 11 | 22 | 33 | 44 | 56 | 67 | 78 | 89 | 100

### BoostTargetTable2 [kPa]

**Units:** Selectable via setup wizard

**Description:** Base boost target adder values as a function of selectable axis inputs.  
The values in this table ADD TO the values in the BoostTargetTable1 [kPa] table.

BoostTargetTable2 [kPa]											
FlexContent [%]	0.0	25	50	75	75	75	75	75	75	75	75
1.0	0	25	50	75	75	75	75	75	75	75	75
0.9	0	25	50	75	75	75	75	75	75	75	75
0.8	0	25	50	75	75	75	75	75	75	75	75
0.7	0	25	50	75	75	75	75	75	75	75	75
0.6	0	25	50	75	75	75	75	75	75	75	75
0.4	0	25	50	75	75	75	75	75	75	75	75
0.3	0	25	50	75	75	75	75	75	75	75	75
0.2	0	25	50	75	75	75	75	75	75	75	75
0.1	0	25	50	75	75	75	75	75	75	75	75
0.0	0	25	50	75	75	75	75	75	75	75	75

ModeSwitch

### BoostGain\_Kp

**Units:** Proportional Gain vs RPM

**Description:** Proportional control is a pure gain adjustment acting on the error signal to provide the driving input. It is used to adjust the speed of the system and reach the target lambda quickly. The advantage of a proportional-only control is its simplicity. If boost target offsets can be tolerated, the use of a proportional controller may be optimal. However, it will not eliminate the steady-state error that occurs after a set-point change or a sustained load disturbance. Note: When tuning boost control and overshoot occurs, lower this value. If undershooting the boost target, raise this value.

0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
0	1000	2000	3000	4000	5000	6000	7000	8000	9000		

EngineSpeed [RPM]

### BoostGain\_Ki

**Units:** Integral Gain vs RPM

**Description:** Integral control is implemented through the introduction of an integrator. Integral control is used to provide the required accuracy for the control system. This is used to fine tune boost once the proportional has acted in getting close to the target. Note: start tuning the boost feedback with this option at zero. Once the proportional has the lambda close to the target, step this in slowly until the target is achieved.



### BoostGain\_Kd

**Units:** Derivative Gain vs RPM

**Description:** The derivative term slows the rate of change of the controller output. Derivative control is used to reduce the magnitude of the overshoot produced by the integral component and improve the combined controller-process stability. Note: start tuning the boost feedback with this option at zero. Once the proportional and internal term has the boost pressure close to the target, step this gain in slowly until the target is achieved.



### Tuning Tips for Boost Control

Tuning Boost Control can be the most time consuming of all the variables of tuning. After the following testing procedure commences on the dynamometer, note that the race track can create new "real-world" vehicle loads on the engine so boost control should always be reconfirmed.

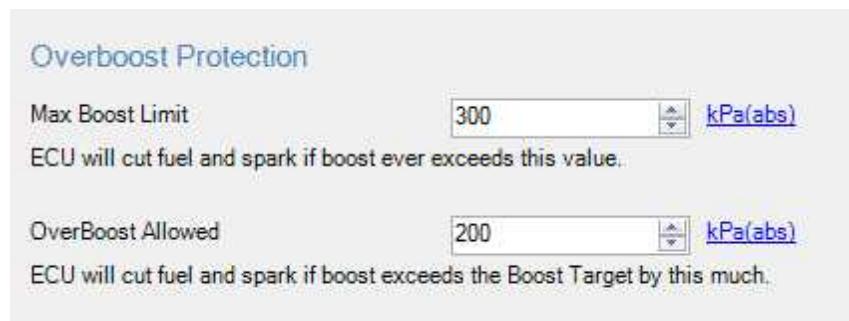
- Open Infinity Tuner software and connect to the Infinity
- Confirm that the throttle position is set properly (closed < 5%, WOT > 95%)
- Confirm the AFR so that the vehicle has sufficient fuel for boosting.
- Open the **Boost Control Wizard** and click the **Boost Output Enable** option ON.
- Uncheck **Boost Feedback Enable** to temporarily turn OFF closed loop boost control.

Next, determine if an increase in duty to the wastegate solenoid takes away boost pressure or makes boost pressure. To determine this, find the particular wastegate setup being used from the diagrams above. The language of the boost solenoid is in percent duty cycle. This is not percent open or percent of airflow, it is rather the full-scale percentage of the solenoid where 100% is fully closed or fully open depending on the solenoid used and how it is plumbed.

- If more duty decreases boost pressure, check **Boost Feedback Invert**.
- Set the **Boost Solenoid Control Frequency** channel according to the manufacturer specifications. Typical 30Hz

The next step before tuning boost is to set the max and overboost cut to eliminate any overshooting errors which can lead to catastrophic engine problems.

- In the **Wizard**, go to **Engine Protection** under **Setup**.
- In the Boost Protection section, set the **Max Boost Limit** and **Overboost Allowed** option to safe values.



- Open the **BoostTab** and set the entire **BoostBaseDuty1 [%] Table** to 0%.
- Start the engine
- Go to **Log | Start Recording**
- Using an dynamometer, cautiously go to full throttle but keep an eye on the viewable **MAP** channel.
- Go to **Log | Stop Recording**

From observing the log, the maximum boost pressure should be the same as the wastegate spring pressure. Keep in mind that there are other mechanical situations which can change the outcome. For instance, an improper exhaust manifold (or turbo) wastegate port can create "boost creep".

From the log, the proper open loop boost control duty cycle% can now be determined by viewing the **MAP** and **BoostControl** channels. It is a good idea to make a boost log sheet. This will speed up boost control tuning when feedback is used by giving you an idea of the duty cycle that will achieve each boost level. The chart will be dependant on the mechanics of the turbo system, including: wastegate spring, turbocharger, exhaust back pressure, etc. See the example below:

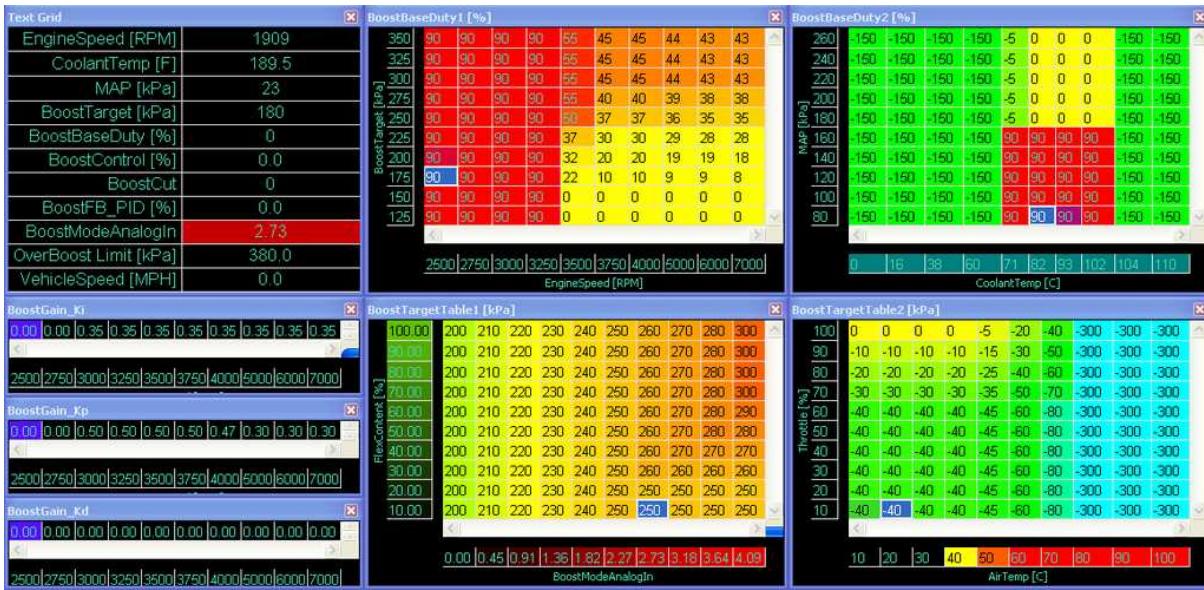
Boost WG Out	Engine Load
0%	7psi
10%	9psi
20%	11psi
30%	13psi
40%	15psi
50%	17psi
60%	19psi
70%	21psi
80%	23psi
90%	25psi
100%	27psi

After the appropriate duty cycle is found that is necessary to reach the desired boost target, the boost control feedback can be enabled. To do this, check the **Boost Feedback Enable** box in the **Boost Wizard**. Now enter the boost target in the **BoostTarget1 [%] Table**.

Below is an example of boost control on an AWD time attack vehicle (not traction limited) that doesn't need boost-by-gear (or speed). However, there is an AEM 12-position switch (p/n 30-2056) installed so the boost can be adjusted on the fly.

Notice that there are also several failsafe strategies that will limit boost if the charge air temperature is too high (heatsoak) or if the coolant temp is out of range (engine too cold or overheating). In addition, the boost target mapping for the 12-position switch only allows certain (higher) boost levels if the Ethanol content is high enough to support the boost. The boost target is also varied based on throttle position, to allow the driver to use the throttle for linear power delivery, which makes the car much easier to drive on a road course where part-throttle is common. To aid in spool, the duty-cycle is increased at lower RPM where the engine cannot attain full boost, and at lower boost pressures, again to keep the wastegate closed as long as possible to improve response.

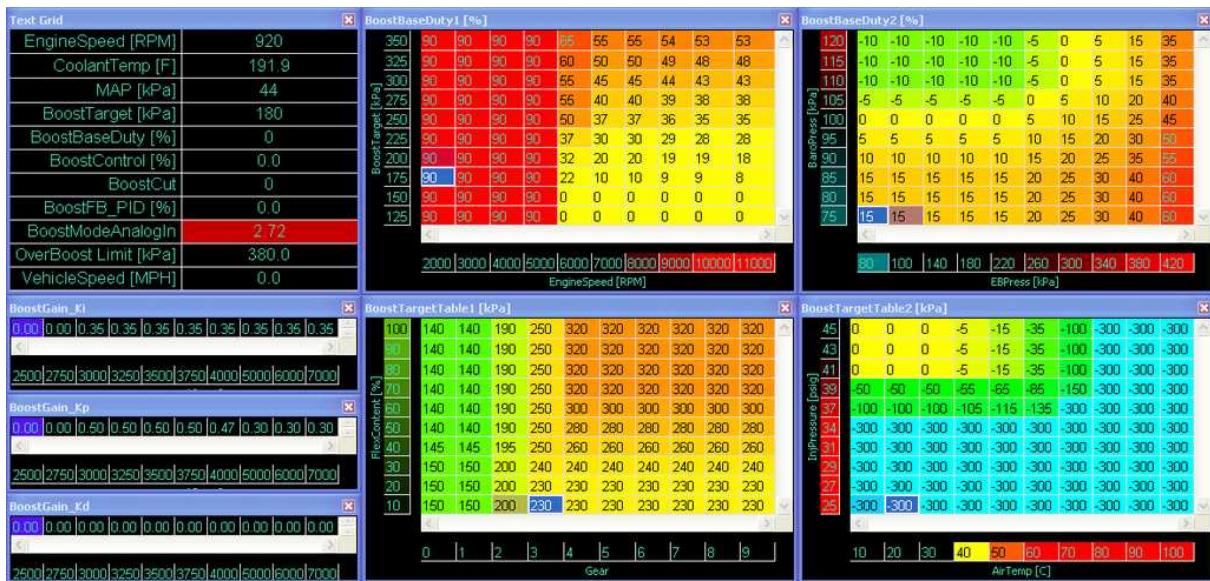
The PID system on the Infinity is extremely fast and you'll notice no Derivative Gain (BoostGain\_Kd) was needed.



The example below is a boost strategy for a high horsepower, severely traction limited drag car that runs on varying mixes of Ethanol. Boost compensated for changes in baro pressure (weather, altitude, etc) and changes in exhaust backpressure. Typically, higher duty cycle is needed to retain boost level as baro pressure is reduced and EBP is increased. However, due to the Infinity's advanced PID system, you could theoretically get away without having these sensors and still have consistent boost control by relying on boost feedback.

Failsafe strategies include injected pressure (this is the pressure delta between the fuel pressure and manifold pressure). On a manifold-pressure-referenced fuel pressure regulator, injected pressure should theoretically remain constant at all times, as the pressure regulator directly combats changes to manifold pressure by changing fuel pressure in a 1:1 ratio. However, if there is a pressure regulator failure, or a fuel flow issue (weak pump, restricted lines, etc) injected pressure can drop. The boost control is set up to automatically reduce boost in this condition. Side note: Due to the Infinity's model-based fuel calculations, any variation in injected pressure will also be compensated for in fueling.

You'll notice that the boost target increases with each gear, as it should. Also, with higher Ethanol contents, more boost can be run safely, but of course we only want this in the higher gears as we're traction limited. However, it was found on this car that higher ethanol contents (at the same boost level) caused an increase in torque due to the fuel/tuning, and this caused additional wheel spin. Therefore, boost target is actually reduced slightly in lower gears and higher ethanol contents to combat this tendency.



### 4.3.9 Engine Protection

#### Engine Protection

The ECU can cut fuel and/or spark to prevent engine damage during overboost, low oil pressure, and lean conditions. Use the Engine Protection Wizard to set criteria for which the Engine Protection will respond.

#### Overboost Protection

Max Boost Limit  kPa

ECU will cut fuel and spark if boost ever exceeds this value.

OverBoost Allowed  kPa

ECU will cut fuel and spark if boost exceeds the Boost Target by this much.

#### Oil Pressure Protection Basic Setup

Oil Pressure Protection Enable

#### Lean Protection Basic Setup

Lambda 1 Protection Enable

Lambda 2 Protection Enable

Lean Protect on Sensor Error

Lean Fuel Cut Enable

Lean Spark Cut Enable

Lean Protection Minimum Engine Speed  rpm

Lean Protection Minimum Throttle  %

Lean Protection Activation Delay  ms

Lean Protect Rev Limit  rpm

#### Overboost Protection

The overboost protection feature has two different ways of limiting engine damage from an overboost condition. Two cut limits are configurable and the system will select the resultant **lowest** boost cut MAP value.

##### Max Boost Limit:

A 100% fuel cut will be activated if manifold pressure in [kPa] exceeds this value regardless of the target boost value.

##### Overboost Allowed:

Useful for multi fuel setups where the user has a varying boost target that depends on ethanol content. The fuel cut will be dynamic and dependent on the target boost.

Cut activated at a manifold pressure value of:

BoostTarget [kPa] + Overboost Allowed [kPa]

### **Oil Pressure Protection Basic Setup**

The oil pressure protection strategy uses the following options along with the OilPressProtectTable. This is typically used to activate a light, buzzer, etc.

#### **Oil Pressure Protection Enable:**

Enable and disables the oil pressure protection feature

### **Lambda Protection Basic Setup**

The lambda protection basic strategy uses the following conditions to cut fuel and/or spark in order to prevent the engine from getting too lean and causing detrimental problems.

#### **Lambda 1 Protection Enable:**

Enable and disables the Lambda 1 protection feature

#### **Lambda 2 Protection Enable:**

Enable and disables the Lambda 2 protection feature

#### **Lean Protect on Sensor Error:**

Enable and disables the Lean Protect if the sensor is in Error Mode.

#### **Lean Fuel Cut Enable:**

Enable and disables the Lean Fuel Cut feature

#### **Lean Spark Cut Enable:**

Enable and disables the Lean Spark Cut feature

#### **Lean Protection Minimum Engine Speed (RPM):**

Only lean conditions above this set engine speed will be monitored for the lean protection feature.

Min value = 0, Max value = 20000, Resolution = 1.0

#### **Lean Protection Minimum Throttle (%):**

Only lean conditions above this set throttle position will be monitored for the lean protection feature.

Min value = 0, Max value = 100, Resolution = 1.0

#### **Lean Protection Target Max Engine Speed (RPM):**

This sets the engine speed limit when the lean protection is triggered.

Min value = 0, Max value = 20000, Resolution = 1.0

#### **Lean Protection Activation Delay:**

This can be used to cancel out any false spikes caused by excessive EMI signal noise.

Min value = 0, Max value = 2000, Resolution = 1.0

**Lean Protection Target Fuel Cut:**

This is amount of fuel cut percentage to use if the lean protection activates.  
Min value = 0, Max value = 100, Resolution = 1.0

**Lean Protection Target Spark Cut:**

This is amount of ignition cut percentage to use if the lean protection activates.  
Min value = 0, Max value = 100, Resolution = 1.0

#### 4.3.10 Exhaust Pressure

**Exhaust Pressure**

This wizard enters the correct Exhaust Pressure Min Volts, Exhaust Pressure Max Volts, Failsafe On, Exhaust Pressure Failsafe, Load Offset and Load Scalar.

---

Exhaust Pressure Sensor Installed

Exhaust Pressure Smoothing  %

Sensor Selection:

No wizard is selected or matched. Click the Browse button to select one.

\* deviates from the selection default values

**▼ Hide Details**

Exhaust Pressure Volts Min	<input type="text" value="0.00"/> <input type="button" value="V"/>
Exhaust Pressure Volts Max	<input type="text" value="0.01"/> <input type="button" value="V"/>
Exhaust Pressure Cal Min	<input type="text" value="101.0"/> <input type="button" value="kPa"/>
Exhaust Pressure Cal Max	<input type="text" value="689.5"/> <input type="button" value="kPa"/>
Exhaust Pressure Failsafe On	<input checked="" type="checkbox"/>
Exhaust Pressure Failsafe	<input type="text" value="101.0"/> <input type="button" value="kPa"/>

**Exhaust Pressure Sensor Installed**

If an exhaust back pressure sensor is installed, check this box

**Exhaust Pressure Smoothing**

Value used to smooth signal. Min value = 0, Max value = 98.

**Exhaust Pressure Wizard Selection**

Selecting this box will present a menu with multiple pre configured exhaust back pressure sensors to choose from.

**Show Details**

When selecting, the following options will be displayed.

**Exhaust Pressure Min Volts:**

This sets the minimum voltage capable from a properly working sensor. Check the manufacturer specifications for more information. Min value = 0, Max value = 5.

Exhaust Pressure Max Volts must be > Exhaust Pressure Min Volts. User entries that do not meet this criteria are not allowed.

**Exhaust Pressure Max Volts:**

This sets the maximum voltage capable from a properly working sensor. Check the manufacturer specifications for more information. Min value = 0, Max value = 5.

Exhaust Pressure Max Volts must be > Exhaust Pressure Min Volts. User entries that do not meet this criteria are not allowed.

**Exhaust Pressure Cal Min [psig]:**

This sets the minimum pressure capable, in psig, from a properly working sensor. Check the manufacturer specifications for more information. Min value = 0, Max value = 700.

Exhaust Pressure Cal Max must be > Exhaust Pressure Cal Min. User entries that do not meet this criteria are not allowed.

**Exhaust Pressure Cal Max [psig]:**

This sets the maximum pressure capable, in psig, from a properly working sensor. Check the manufacturer specifications for more information. Min value = 0, Max value = 700.

Exhaust Pressure Cal Max must be > Exhaust Pressure Cal Min. User entries that do not meet this criteria are not allowed

**Exhaust Pressure Failsafe On:**

When clicking, the failsafe feature is enabled. This is typically used when the sensor is mistakenly unplugged or has failed.

**Exhaust Pressure Failsafe:**

The value entered here will be displayed and used for the exhaust pressure corrections when the sensor has failed or is simply unplugged. Min value = 0, Max value = 700

#### 4.3.11 DBW Tuning

**DBW Tuning**

---

**DBW Throttle Body Selection**

No wizard is selected or matched. Click the Browse button to select one.

\* deviates from the selection default values

**DBW Idle Control**

DBW Idle Control Range  %

Typical value = 5 and represents 10% total control ability (-5% to +5%). The larger the throttle body compared to your engine size the smaller this number will be.

**▼ Hide Advanced Setup**

DBW Frequency  Hz

**DBW PID Settings**

DBW Proportional Gain

DBW Integral Gain

DBW Derivative Gain

**PID Integral Clamps**

DBW Integral Clamp High  Typical value is between 10 to 20

DBW Integral Clamp Low  Typical value is between -10 to -20

**Sensor Smoothing**

DBW Accel Pedal Smoothing  %

DBW Throttle Smoothing  %

**Mode Select**

ModeSelect\_DBW x-axis input

The ModeSelect\_DBW table is used to choose when to use the DBW\_ThrottleCurve1 table or the DBW\_ThrottleCurve2 table for calculating desired throttle position.

#### DBW Throttle Body Selection:

Selecting this box will present a menu with multiple pre configured DBW throttle bodies

to choose from.

### **DBW Idle Control:**

#### **DBW Idle Control Range:**

Set percentage of maximum throttle body movement for Idle control.

### **Advanced Setup:**

#### **DBW Frequency:**

Frequency in which ECU communicates with throttle body; this number varies by manufacturer and can cause errors or erratic behavior if not set properly.

### **DBW PID Settings:**

#### **DBW Proportional Gain:**

Proportional control is a pure gain adjustment acting on the magnitude of the target error to provide the system response. The advantage of a proportional-only control is it can respond quickly to large errors; when the error is large the proportional response will be large. The disadvantage of proportional gain for DBW control is the proportional response will decrease to zero as the engine speed gets closer to the idle target RPM, and this tends to result in 'hunting' or fluctuations in engine speed. It is recommended to begin tuning DBW feedback with this value set to zero or very low values. If the system responds too slowly to quick disturbances, increase this value slightly.

Min value = 0.000, Max value = 10.000

#### **DBW Integral Gain:**

Integral control uses an integrator or 'accumulator' method, essentially checking if the target error is positive or negative and then taking one step up or one step down every 400ms to reduce the target error. The advantage of integral response for DBW control is the throttle will be slowly and smoothly adjusted until the engine speed reaches the target, and then remain at whatever feedback value reached the target. Note: although Integral gain is less likely to cause hunting or fluctuations than Proportional or Derivative gains, excessively high Integral values will take steps that are too large which can result in instability.

Min value = 0.000, Max value = 300.000

#### **DBW Derivative Gain:**

The derivative term adjusts the feedback based on the rate of change of the target error. Derivative control is used to reduce the magnitude of the overshoot produced by the Proportional component and improve the combined controller-process stability. Note: for most setups, it is recommended to leave the Derivative gain set to zero. For tuners who are very familiar with PID feedback and are observing a situation that could be alleviated by adjusting Derivative gain, it is recommended to use the Idle\_Decel table rather than the Derivative gain.

Min value = 0.000, Max value = 1.000

### PID Integral Clamps:

#### **DBW Integral Clamp High:**

Maximum value for DBW Integral to prevent overshooting and better sync with target.

#### **DBW Integral Clamp Low:**

Minimum value for DBW Integral to prevent undershooting and better sync with target.

### Sensor Smoothing:

#### **DBW Accel Pedal Smoothing:**

Value used to smooth signal. Min value = 0, Max value = 85.

#### **DBW Throttle Smoothing:**

Value used to smooth signal. Min value = 0, Max value = 60.

### Mode Select:

#### **ModeSelect\_DBW x-axis input:**

Input for choosing between different DBW throttle curves. See [Advanced Tuning -> Multi-Map Features](#)<sup>243</sup> for details on changing throttle curves on the fly.

## 4.3.12 Engine Protection

### Oil Press Protect Table

**Units:** Pressure vs RPM

**Description:** This table allows users to protect the engine from low oil pressure. Note that an oil pressure sensor must be installed. Most OEM vehicles come standard with an oil pressure switch which is not as useful. To set all of the conditions related to the oil pressure protection strategy, go to [Engine Protection](#)<sup>194</sup>.

OilPressProtectTable [psig]									
20.0	20.0	40.0	50.0	60.0	70.0	80.0	100.0	100.0	100.0
0.0	1000.0	2000.0	3000.0	4000.0	5000.0	6000.0	7000.0	8000.0	9000.0
EngineSpeed [RPM]									

### Lean Protect Table

**Units:** Lambda vs MAP

**Description:** This table allows the user to protect the engine from a lean fuel mixture when under high engine load. To set all of the conditions related to the lean protection strategy, go to [Engine Protection](#)<sup>194</sup>.

LeanProtectTable [Lambda]									
1.1	1.1	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9
50.0	80.0	100.0	125.0	150.0	175.0	200.0	225.0	250.0	300.0
MAP [kPa]									
50.0	80.0	100.0	125.0	150.0	175.0	200.0	225.0	250.0	300.0

### **Coolant Protect RPM Limit Table**

**Units:** RPM vs Coolant Temp

**Description:** This table allows the user to preset an engine limiter based on coolant temperature just like many OEM vehicles use. The assumption is that if the coolant temperature is low, the oil temperature is most likely low as well. Oil viscosity is drastically affected by oil temperature.

CoolantProtectRPMLimit [RPM]									
4000.0	4000.0	5000.0	6000.0	6000.0	6000.0	6000.0	5000.0	4000.0	0.0
0.0	20.0	40.0	60.0	80.0	90.0	100.0	110.0	115.0	120.0
CoolantTemp [C]									
0.0	20.0	40.0	60.0	80.0	90.0	100.0	110.0	115.0	120.0

For more information, go to [Engine Protection](#).

#### 4.3.13 Knock Sensor Setup

The Infinity has 2 inputs for knock sensors. These can be passive, where data is displayed and/or recorded or the feedback knock control can be enabled, letting the Infinity take action to counter the knock. The Infinity ECU measures knock sensor activity during a specific window for each cylinder; this allows the ECU to detect individual cylinder knock levels using only one or two sensors. Because some sensors may be located nearer or further from the cylinder. Knock Noise Floor tables are available for each cylinder. When sensor activity exceeds the Noise Floor, ignition timing can be retarded for that cylinder.

##### **KnockNoiseFloor1 Table**

**Units:** Voltage vs Engine Speed

**Description:** The **KnockNoiseFloor1 Table** sets an RPM dependant threshold to filter out background noise from cylinder 1. Setting up this table is key to the success of this function. Whenever the knock sensor voltage input exceeds this table's voltage value, it is considered to be detonation. The difference between the detonation signal and this threshold value determines the severity of the knock.

KnockNoiseFloor1									
0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08
1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
EngineSpeed [RPM]									

### **KnockNoiseFloor2 Table**

**Units:** Voltage vs Engine Speed

**Description:** The **KnockNoiseFloor2 Table** sets an RPM dependant threshold to filter out background noise from cylinder 2. Setting up this table is key to the success of this function. Whenever the knock sensor voltage input exceeds this table's voltage value, it is considered to be detonation. The difference between the detonation signal and this threshold value determines the severity of the knock.

KnockNoiseFloor2									
0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08
1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
EngineSpeed [RPM]									

### **KnockNoiseFloor3 Table**

**Units:** Voltage vs Engine Speed

**Description:** The **KnockNoiseFloor3 Table** sets an RPM dependant threshold to filter out background noise from cylinder 3. Setting up this table is key to the success of this function. Whenever the knock sensor voltage input exceeds this table's voltage value, it is considered to be detonation. The difference between the detonation signal and this threshold value determines the severity of the knock.

KnockNoiseFloor3									
0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08
1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
EngineSpeed [RPM]									

### **KnockNoiseFloor4 Table**

**Units:** Voltage vs Engine Speed

**Description:** The **KnockNoiseFloor4 Table** sets an RPM dependant threshold to filter out background noise from cylinder 4. Setting up this table is key to the success of this function. Whenever the knock sensor voltage input exceeds this table's voltage value, it is considered to be detonation. The difference between the detonation signal and this threshold value determines the severity of the knock.

KnockNoiseFloor4									
0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08
1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
EngineSpeed [RPM]									

### **KnockNoiseFloor5 Table**

**Units:** Voltage vs Engine Speed

**Description:** The **KnockNoiseFloor5 Table** sets an RPM dependant threshold to filter out background noise from cylinder 5. Setting up this table is key to the success of this function. Whenever the knock sensor voltage input exceeds this table's voltage value, it is considered to be detonation. The difference between the detonation signal and this threshold value determines the severity of the knock.

KnockNoiseFloor5									
0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08
1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
EngineSpeed [RPM]									

### **KnockNoiseFloor6 Table**

**Units:** Voltage vs Engine Speed

**Description:** The **KnockNoiseFloor6 Table** sets an RPM dependant threshold to filter out background noise from cylinder 6. Setting up this table is key to the success of this function. Whenever the knock sensor voltage input exceeds this table's voltage value, it is considered to be detonation. The difference between the detonation signal and this threshold value determines the severity of the knock.

KnockNoiseFloor6									
0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08
1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
EngineSpeed [RPM]									

### **Tuning with Knock Sensor(s)**

To setup the knock sensor control, first identify which cylinders correspond to each knock sensor input. It must be understood that knock sensors can pickup a lot of noise depending on the type of sensor and engine setup. The only way the Infinity can determine when actual detonation occurs is by calibrating the knock sensor being used. The following is an ideal way to set up the **KnockNoiseFloor** tables.

- For this test, use high octane quality-grade fuel.
- Get the vehicle on a dynamometer to perform a few 4th and 5th gear power pull sweeps
- Temporarily add 10-15% more fuel in the **VE Table**
- Retard 2-4 degrees of ignition timing in the **BaseIgnMap** calibration file.
- Start the logger, **Log | Start Recording**
- At a very low engine speed in 4th gear, such as 1500RPM, depress the throttle completely to the floor (WOT).
- Monitor **Lambda1** (or 2) and confirm a safe rich mixture.
- If turbocharged, monitor **MAP** closely as the retarded ignition timing will naturally increase boost pressure.

- If wired and plumbed in, monitor the EGT sensor reading as the retarded ignition timing will increase exhaust temperatures.
- Stop the logger, **Log | Stop Recording**
- Perform the same test in 5th gear
- For every engine speed breakpoint in the **KnockNoiseFloor** tables, note the **KnockSense** channel's data. This is mechanical noise in the engine that is near the same frequency as knock but is not real knock.
- Draw an imaginary line about 10-25% above these values for every **KnockNoiseFloor** table breakpoint. It should start off very low and increase with RPM.

Everything below these points will be considered normal engine noise. Everything above these data points will be considered true detonation. When actual voltage values breach these points, knock control will be enabled. So now we need to define what exactly the Infinity should do when it sees knock.

#### 4.3.14 Knock Response

The setup wizard screen shot below describes each available setting for knock response. The text descriptions included in the setup dialog describe each tuning option in detail.

### Knock Setup

The Infinity ECU measures knock sensor activity during a specific window for each cylinder; this allows the ECU to detect individual cylinder knock levels using only one or two sensors. Because some sensors may be located nearer or further from the cylinder, Knock Noise Floor tables are available for each cylinder. When sensor activity exceeds the Noise Floor, ignition timing can be retarded for that cylinder.

Knock Feedback Enabled

Knock Feedback Minimum Throttle Position 40 %

Knock Feedback Ignition Gain 5.000

The ECU calculates the value 'KnockCylX' for each cylinder, which represents the amount of knock activity above that cylinder's KnockNoiseFloorX table. The ignition retard for each cylinder is calculated by multiplying the Knock Feedback Ignition Gain by the KnockCylX value. For instance, when KnockCylX is 0.2 and the feedback ignition gain is set to 5.0, the ignition retard KnockFB\_CylX will increase by  $(0.2 * 5.0) = 1.0$  degrees. If the sensor continues to indicate knock, the ignition trim will continue to increase until it hits the Maximum Ignition Retard Limit.

Knock Feedback Maximum Ignition Retard limit 8

Knock Feedback Ignition Decay Rate 0.010

When the sensor is not indicating knock, the ECU will decrease the knock ignition trim by this amount every ~2ms. Smaller numbers for Knock Feedback Ignition Decay Rate will result in a longer time for the ignition trim to decay back to zero, and larger numbers will remove the knock feedback more quickly.

Knock Global Feedback

When Knock Global Feedback is enabled, the largest calculated knock feedback ignition trim will be applied to all cylinders, even if only one cylinder is detected to be above the KnockNoiseFloor threshold.

Knock Feedback Lambda Gain 0.3

The ECU will calculate 'LambdaTrim\_Knock' by multiplying the largest KnockCylX value by the Knock Feedback Lambda Gain. This will modify the ECU's target Lambda value, for instance if the original target was 0.82 lambda and LambdaTrim\_Knock is 0.01, the new lambda target will be 0.81 lambda.

Knock Feedback Maximum Lambda Trim 0.140

Knock Lambda Trim Decay Rate 0.00020

[▶ Show Advanced Options: Noise Filter Settings](#)

[▶ Show Advanced Options: Sensor Assignment and Windowing Angle](#)

**Note that new features have been added. The response to knock detection is different in version 95 or later. Tuners should verify knock response on the vehicle. Contact AEM Tech Support for help if needed.**

#### 4.3.15 Advanced Knock Setup

### Advanced Options: Noise Filter Settings

#### Bandpass Center Frequency

**Units:** kHz

**Description:** The raw voltage from the knock sensor is sent through a software-adjustable filter chip before being measured by the ECU. It is assumed that the frequencies above or below this Center Frequency represents mostly noise and should be filtered out.

#### Amplifier Gain

**Units:** Scalar

**Description:** This is a tuner preference and is used to scale the knock sensor signal input(s). Depending on the knock sensor type, some output larger signals. This gain channel should be adjusted so that the Knock\_X\_raw channels are low when the engine is knocking but still below their maximum value in response to audible pinging or slight detonation observed in the power trace of a dyno plot.

#### Integrator (smoothing) Time

**Units:** uS

**Description:** This can be adjusted to dampen the response to background noise, but be careful not to increase this time to a point that the filter is too slow in responding to actual knock activity.

## Sensor Assignment and Window Angle

The table shown below assigns a knock sensor and a window range to each specific cylinder.

[▼ Hide Advanced Options: Sensor Assignment and Windowing Angle](#)

Cylinder	Sensor	Knock Window Start (degBTDC)	Knock Window Width (degBTDC)
Cylinder 1	Knock Sensor #1	0	50
Cylinder 2	Knock Sensor #1	0	50
Cylinder 3	Knock Sensor #1	0	50
Cylinder 4	Knock Sensor #2	0	50
Cylinder 5	Knock Sensor #2	0	50
Cylinder 6	Knock Sensor #2	0	50

### 4.3.16 Output Assignments

Most of the LowSide outputs include an output table for creating custom functions and all are capable of PWM. There is a 2D table with user adjustable x and y axis inputs for duty as well as a 1D table for controlling PWM. The axis selection and PWM frequency input must first be configured using the Setup Wizard on the LowSide Assignment Tables page:

#### LowSide Assignment Tables

All of the standard assigned functions are preconfigured and do not need to be adjusted if the vehicle's wiring matches the AEM pinout chart. Most of the ECU's Low-Side (switched ground) outputs can be reconfigured by reassigning the x- and y-inputs of LS\_Duty tables.

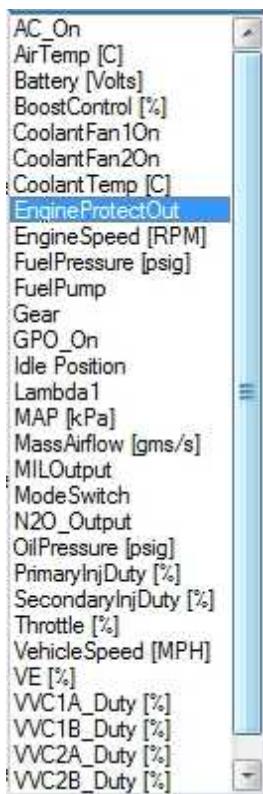
For activating simple on/off relay outputs, configure the LS\_Duty table to send 0% or 100% duty when the function is 0 (Off) or 1 (On). For variable duty cycle functions such as Idle control or Variable Cam control, configure the LS\_Duty table to match the duty cycle calculated by the function.

#### LS2 Setup

Lowside Switch 2 is located on pin C1-17. Configure the table 'LS2\_Duty [%]' to adjust the duty cycle of the output.

LS2 Frequency X-Axis	EngineSpeed [RPM]
LS2_Duty X-Axis	EngineSpeed [RPM]
LS2_Duty Y-Axis	CoolantFan1On

Clicking on any of the axis drop downs displays a list of possible channel inputs. These include most of the core data and logic flags:



Here's an example of combining the Coolant Fan control function with a LS Duty table to add an RPM dependent condition:

LS2_Duty [%]							
CoolantFan1On	3.0	0	0	100	100	100	100
	2.5	0	0	100	100	100	100
	2.0	0	0	100	100	100	100
	1.5	0	0	100	100	100	100
	1.0	0	0	100	100	100	100
	0.5	0	0	0	0	0	0
	0.0	0	0	0	0	0	0
EngineSpeed [RPM]							
0   499   500   1000   2000   4000   6000							

There is a trick or two here. To trigger a relay, we set the duty cycle to 100 when we want the relay to turn on, and 0 when we want the relay to turn off. In this case, we want the relay to turn on when the 'CoolantFan1On' condition is 1. Note that the second y-axis row is set to '0.5' and the third row is set to '1.0'. This is because the channel

'CoolantFan1On' is an internal logic flag that goes from 0 to 1 when the coolant fan temperature criteria are met. All of these tables include full interpolation between cells, so we set one of the RPM breakpoints to 499 and the next to 500 RPM to avoid spending much time between 0% and 100% duty cycle.

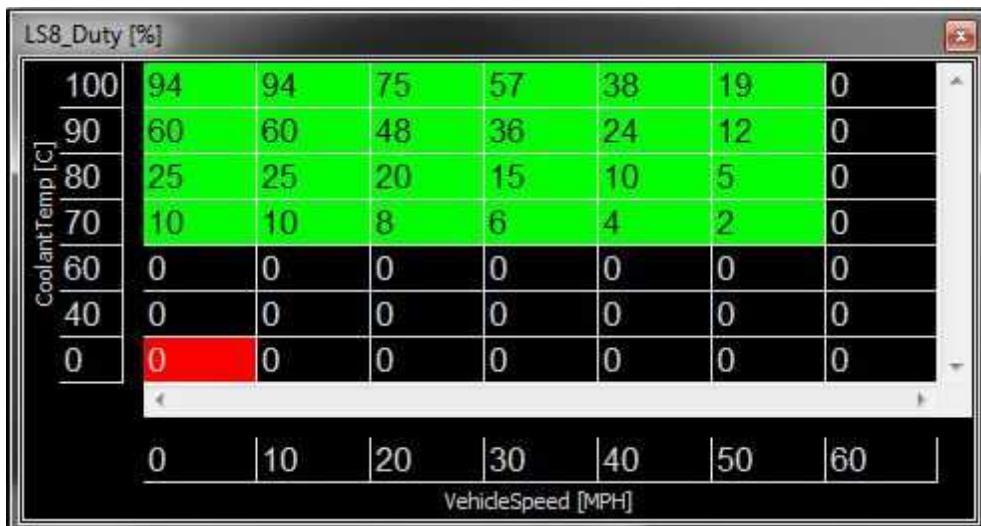
This will set the LowsideSwitch\_2 (LS2) output on pin C1-17 to trigger the relay when the CoolantFan1 condition is met and the EngineSpeed is 500 or greater. Always refer to the Infinity Pinout document located here --> \Documents\AEM\Infinity Tuner \Instructions for hardware limitations.

These tables are the last gate in the logic flow so regardless of anything that happens upstream, these tables can be used to tweak the logic as the user desires.

Here's an example using LS5 to control an alternator voltage regulator:



Here's an example using LS8 to control a PWM cooling fan function. The fan is disabled above 60 mph:



Here's an example that simply passes through the 'VVC1A\_Duty [%]' channel for VVC control:



Here is an example of controlling Frequency for LowSide2 using EngineSpeed [RPM]



A few additional tips:

1. After selecting your axis input and closing the wizard. Save your layout and reopen it in Infinity Tuner for the changes to sync live in the table controls.

2. The same features apply to the available HighSide outputs too. The HighSides are limited to simple on/off operation though and are not PWM-able. Select the axis inputs the same way in the Setup Wizard then configure the output tables:

The screenshot shows the 'HighSide Assignment Tables' section of the setup wizard. It includes a note about standard assigned functions and pinout charts, instructions for activating or deactivating outputs, and two sections for HS0 and HS1 setup with dropdown menus for X and Y axis assignments.

**HighSide Assignment Tables**

All of the standard assigned functions are preconfigured and do not need to be adjusted if the vehicle's wiring matches the AEM pinout chart. Most of the ECU's High-Side (switched +12V) outputs can be reconfigured by reassigning the x- and y-inputs of 'HS\_Table' tables.

- To activate the output type a '1' into the table cell. The output will send +12V.  
- To deactivate the output type a '0' into the table cell. The output will stop sending +12V.

**HS0 Setup**

HS0 (switched 12 volt) output is located on pin C1-44. Configure the 2D table 'HS0\_Table' to adjust when the output turns ON (1) or OFF (0).

HS0\_Table X-Axis: CoolantFan20n  
HS0\_Table Y-Axis: VTEC\_Active

**HS1 Setup**

HS1 (switched 12 volt) output is located on pin C1-43. Configure the 2D table 'HS1\_Table' to adjust when the output turns ON (1) or OFF (0).

HS1\_Table X-Axis: EngineSpeed [RPM]  
HS1\_Table Y-Axis: MAP [kPa]

3. Always refer to the Infinity Pinout sheet to note any hardware limitations.

#### 4.3.17 Lambda Control

When an O2 sensor is connected directly to the Infinity ECU, the ECU can use closed-loop feedback to react to changes in the engine's fuel delivery requirements, or to compensate for sections of the VETable that could still benefit from additional tuning. When Lambda feedback is active, the ECU compares the desired **LambdaTarget** value against the measured **Lambda1** value from the O2 sensor and then adjusts the fuel trim for each injector in an attempt to bring the measured value closer to the target value.

#### O2 sensor assignment:

Before enabling closed-loop lambda feedback, use the [Injector Setup](#) page in the wizard to assign each fuel injector's feedback to use the Lambda1 or Lambda2 sensor.

For most simple 4-cylinder engines, all four injectors will be assigned to use the same O<sub>2</sub> sensor for feedback. A more complex example would be a GM LS1 engine with two O<sub>2</sub> sensors; each sensor should be installed in the exhaust collector for each bank of cylinders. The left bank of cylinders (1,3,5,7) should be assigned to one Lambda sensor and the right bank of cylinders (2,4,6,8) should be assigned to the other Lambda sensor. This allows the ECU to trim each bank of injectors independently based on each of the two Lambda sensors. Before enabling feedback using multiple O<sub>2</sub> sensors, test that the Lambda1 / Lambda2 sensor assignment is correct for each injector by adjusting the values in the injector fuel trim tables (Inj1FuelTrimTable [%]) and confirming that the appropriate sensor indicates a change in measured AFR.

## Lambda Target Trims:

Aside from the main LambdaTargetTable, there are a few other functions that can alter the target lambda value:

### LambdaAfterStartTrim:

LambdaAfterStartTrim is a 2D table that allows the ECU to target a richer mixture for some time after the engine is started, or when the engine is cold. See the [Engine Start](#)<sup>[148]</sup> section for more details.

### LambdaTrimN2O:

LambdaTrimN2O is calculated by the ECU's Nitrous control function, to modify the target lambda value when nitrous is active. See [Nitrous N2O](#)<sup>[218]</sup> for more details.

**LambdaTrim\_Knock** is calculated by the ECU's Knock Control function, to modify the target lambda value in response to knock sensor activity. See [Knock Control](#)<sup>[203]</sup> for more details.

In addition to these lambda trims, the ECU can switch between multiple Lambda Target maps. See [Multi-Map Features](#)<sup>[243]</sup> for more details.

## Lambda Feedback Activation:

Use the wizard to configure the conditions that allow Lambda feedback to be activated. See [Lambda Control](#)<sup>[110]</sup> for details.

Please also note that there are some conditions that will cause Lambda Feedback to be disabled, such as DecelFuelCut or rev limiters (including the 2 Step limiter, 3step limiter and any fuel/spark cuts calculated by Traction Control). The ECU's channel

**LambdaFB\_Disabled** can be viewed or datalogged to see if feedback is disabled.

After lambda feedback has been disabled, the activation conditions must be met for 750ms before lambda feedback will turn back on.

## Lambda Feedback tuning:

The ECU uses PID feedback to make fuel corrections based on the measured lambda signal. When tuning the PID gains, it helps to understand how the O2 sensor measures the oxygen content of the exhaust gas. The sensing element is protected by a metal shield, and this shield has small holes which allow exhaust gas to flow across the sensing element. At low engine speeds, exhaust gas travels relatively slowly so the sensor will take more time to detect the air/fuel ratio of the exhaust. The sensor's distance from the exhaust ports is also a factor in response time. The sensor response time for your setup can be observed by datalogging the fuel injector pulselength **Inj1Pulse [ms]** and the **Lambda1** signal, then making a large change to the values in the **VETable** or **LambdaTargetTable**. Observe how the sensor's response time will be faster at higher RPM, especially at higher engine loads. Because of this slight delay in detecting the oxygen content of the engine's exhaust, Lambda feedback gains must be set to lower values at low RPM. If the feedback gains are too high at idle, the feedback will make corrections more quickly than the sensor can measure O2 changes in the exhaust and the engine RPM may 'hunt' due to fluctuating air/fuel ratios. At high engine speeds, the sensor detects changes in exhaust air/fuel ratio more quickly so the Lambda feedback gains should be increased for quicker feedback response.

### LambdaFB\_I

**Units:** Integral Gain vs RPM

**Description:** This table sets the feedback's Integral gain as a function of Engine Speed. Integral control uses an integrator or 'accumulator' method, essentially checking if the Lambda target error is positive or negative and then taking one step up or one step down every 10ms to reduce the target error. The advantage of integral response for Lambda control is the fuel trim will be smoothly adjusted until the measured Lambda value reaches the target, and then remain at whatever feedback value reached the target. Note: although Integral gain is less likely to cause hunting or fluctuations than Proportional or Derivative gains, excessively high Integral values will take steps that are too large which can result in instability.

Min value = 0.000, Max value = 6.375



The Proportional and Derivative gains for Lambda feedback can be adjusted in the wizard. See the [Lambda Control](#) section of the wizard for more details.

#### 4.3.18 2Step and Launch

##### 2StepTargetFuel Table

**Units:** RPM vs Launch Target Analog In

**Description:** This table sets a variable 2Step RPM fuel cut via a 0-5V analog input from a potentiometer.

2StepTargetFuel [RPM]												
4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
0	0.45	0.91	1.36	1.82	2.27	2.73	3.18	3.64	4.09	4.55	5	

##### 2StepTargetSpark Table

**Units:** RPM vs Launch Target Analog In

**Description:** This table sets a variable 2Step RPM spark cut via a 0-5V analog input from a potentiometer.

2StepTargetSpark [RPM]												
4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
0	0.45	0.91	1.36	1.82	2.27	2.73	3.18	3.64	4.09	4.55	5	

##### LaunchBoostTarget Table

**Units:** Boost Target vs Launch Target Analog In

**Description:** This table sets a variable launch boost target via a 0-5V analog input from a potentiometer.

LaunchBoostTarget [kPa]												
100	100	100	100	100	100	100	100	100	100	100	100	100
0	0.45	0.91	1.36	1.82	2.27	2.73	3.18	3.64	4.09	4.55		

### IgnTrimLaunch Table

**Units:** Ignition Degree Trim vs Launch Boost Error

**Description:** Retarding ignition timing will increase turbo response. On the other hand, advancing ignition timing will slow turbo response. This table can set an ignition retard based on the amount of undershooting of the launch boost target. Conversely, an ignition advance can be added based on the amount of overshooting of the launch boost target.

IgnTrimLaunchTable [degBTDC]									
-20.0	-15.0	-10.0	-5.0	-2.0	2.0	4.0	6.0	6.0	6.0
-50.0	-40.0	-30.0	-20.0	-10.0	10.0	20.0	30.0	40.0	5
LaunchBoostError [kPa]									

### 4.3.19 3Step

The 3Step Rev Limiter is a simplistic traction control system that is commonly used in race series that do not permit wheel speed sensors. Instead, this system uses the transmission's vehicle speed sensor along with the crank sensor (engine speed) to limit the amount of tire slip.

### 3StepTargetFuel Table

**Units:** RPM vs VehicleSpeed

**Description:** This table sets at what engine speed and vehicle speed the fuel will be cut in order to manage engine power and maintain traction.

3StepTargetFuel [RPM]									
8000	8000	8000	8000	8000	8000	8000	8000	8000	8000
0	20	40	60	80	100	120	140	160	180
VehicleSpeed [MPH]									

### 3StepTargetSpark Table

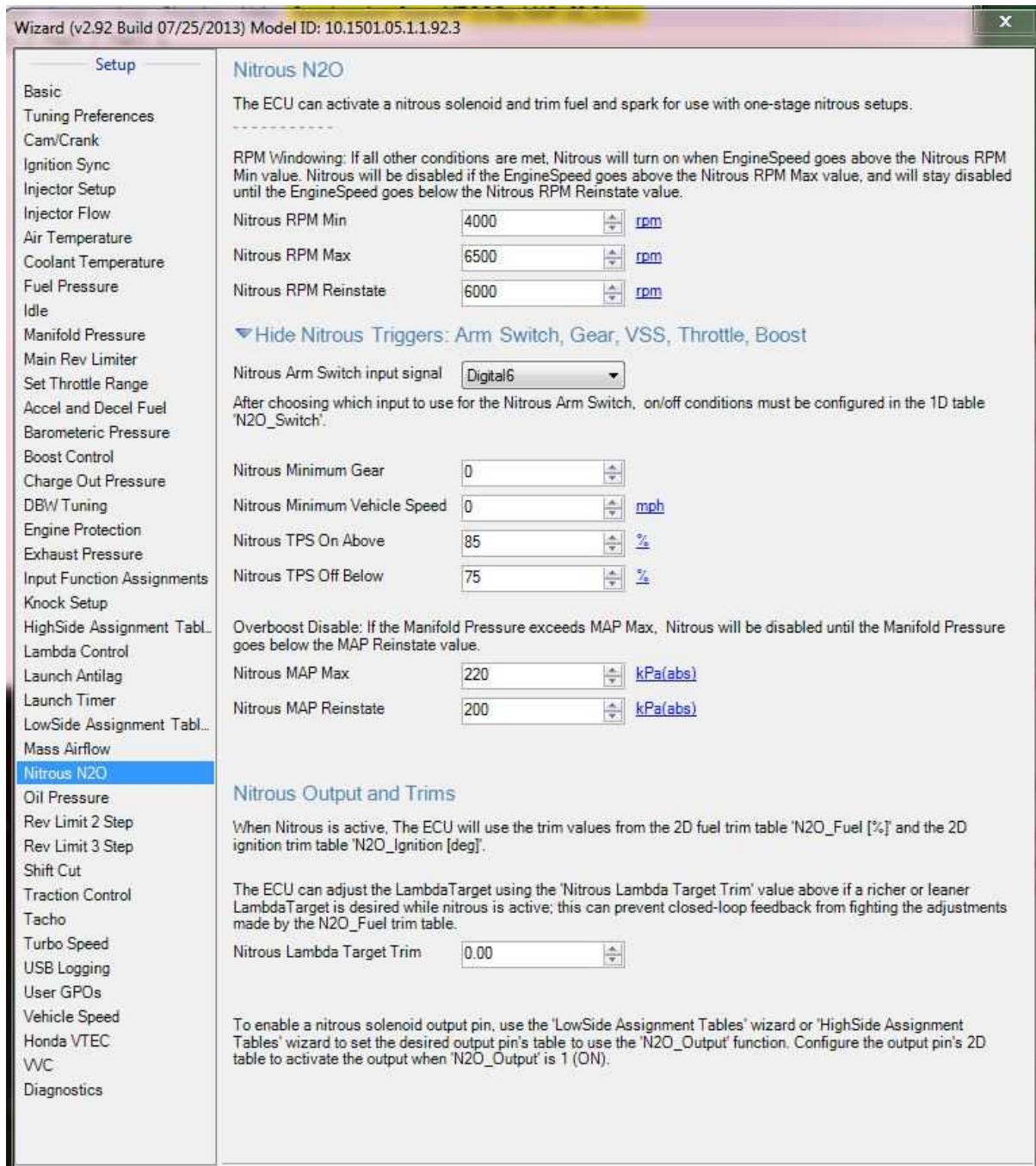
**Units:** RPM vs VehicleSpeed

**Description:** This table sets at what engine speed and vehicle speed the spark will be cut in order to manage engine power and maintain traction.

3StepTargetSpark [RPM]									
5000	5000	5000	8000	8000	8000	8000	8000	8000	8000
0	20	40	60	80	100	120	140	160	18
VehicleSpeed [MPH]									

For more information, go to [Rev Limit 3Step](#)<sup>170</sup>

### 4.3.20 Nitrous N2O



#### Nitrous RPM Min:

Units: RPM

If all other conditions are met, Nitrous will turn on when EngineSpeed [RPM] reaches this value.

**Nitrous RPM Max:**

Units: RPM

Maximum EngineSpeed [RPM] before Nitrous turns off.

**Nitrous RPM Reinstate:**

Units: RPM

EngineSpeed [RPM] to turn Nitrous back on.

**Nitrous Triggers: Arm Switch, Gear, VSS, Throttle, Boost:****Nitrous Minimum Gear:**

Units: Gear

Lowest gear for enabling Nitrous

**Nitrous Minimum Vehicle Speed:**

Units: Gear

Lowest vehicle speed for enabling Nitrous

**Nitrous TPS On Above:**

Units: Throttle %

Minimum value for TPS [%] to enable Nitrous

**Nitrous TPS Off Below:**

Units: Throttle %

Maximum value for TPS [%] before Nitrous is turned off

**Nitrous MAP Max:**

Units: Pressure

Maximum value for MAP before Nitrous is turned off.

**Nitrous MAP Reinstate:**

Units: Pressure

MAP must drop below this value before Nitrous is turned back on.

**Nitrous Output and Trims:****Nitrous Lambda Target Trim:**

Value to adjust LambdaTarget by leaving alone or leaning it out during Nitrous.

Min value = -0.2, Max value = 0.

**Nitrous Trims: Advanced setup:****Nitrous Output Delay:**

Units: Time

**Nitrous Trim Delay:**

Units: Time

#### Nitrous Trim Decay Time:

Units: Time

#### Associated Tables:

##### **N2O\_Switch:**

Units: Off = 0, On = 1

This table sets digital input condition to arm Nitrous. Set all cells to 1 if not using a digital input to arm.

##### **N2O\_Fuel:**

Units: Pressure vs Engine Speed vs Fuel % (decimal)

Range: Min value = -1.00, Max value = 1.55

This map allows a percentage of additional fuel to be added or subtracted from the base map when the nitrous options become active. This map allows adjustment over engine speed and manifold pressure.

##### **N2O\_Ign [deg]:**

Units: Pressure vs Engine Speed vs Degrees

Range: Min value = -43.75, Max value = 20.00

This map allows ignition timing to be advanced or retarded against the base ignition map when the nitrous control is active. This map is adjustable over engine speed and manifold pressure.

#### 4.3.21 Shift Cut Time

The Shift Cut feature allows no-lift-shifting for quick and consistent gear shifts without lifting the throttle. No-lift-shifting can also help minimize boost drop between gears for turbocharged vehicles. Power reduction can be achieved by a combination of ignition retard, fuel cut, and spark cut in response to a clutch switch, a clutch pressure sensor, or a switch or strain gauge mounted to the shift lever.

##### **ShiftSwitch**

**Units:** Voltage conditions for Switch On / Off

**Description:** This table allows the tuner to define which voltages represent the switch 'ON' position and which voltages represent the switch 'OFF' position. For instance, the example below would be useful for a strain gauge installed on the shift lever of an H-pattern gearbox. The resting voltage may be between 2.0 - 3.0V. When the shift lever is pressed forward, the strain gauge voltage go be below 1.99V, so we set the table to '1' because we want to trigger a ShiftCut event. When the shift lever is pulled back, the strain gauge voltage will go above 3.01V, so we set the table to '1' because we want to trigger a ShiftCut event. Please note the shift cut event will only be triggered if all other conditions including RPM and throttle position are met, see the [Shift Cut](#)<sup>167</sup> section of

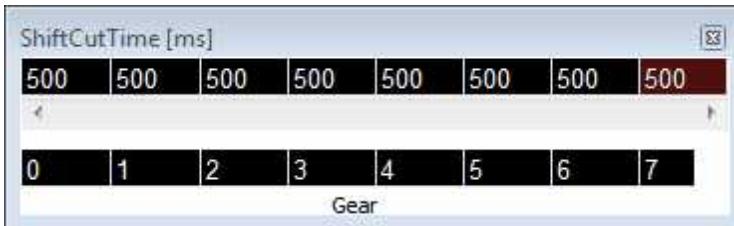
the wizard for further description of the other conditions.



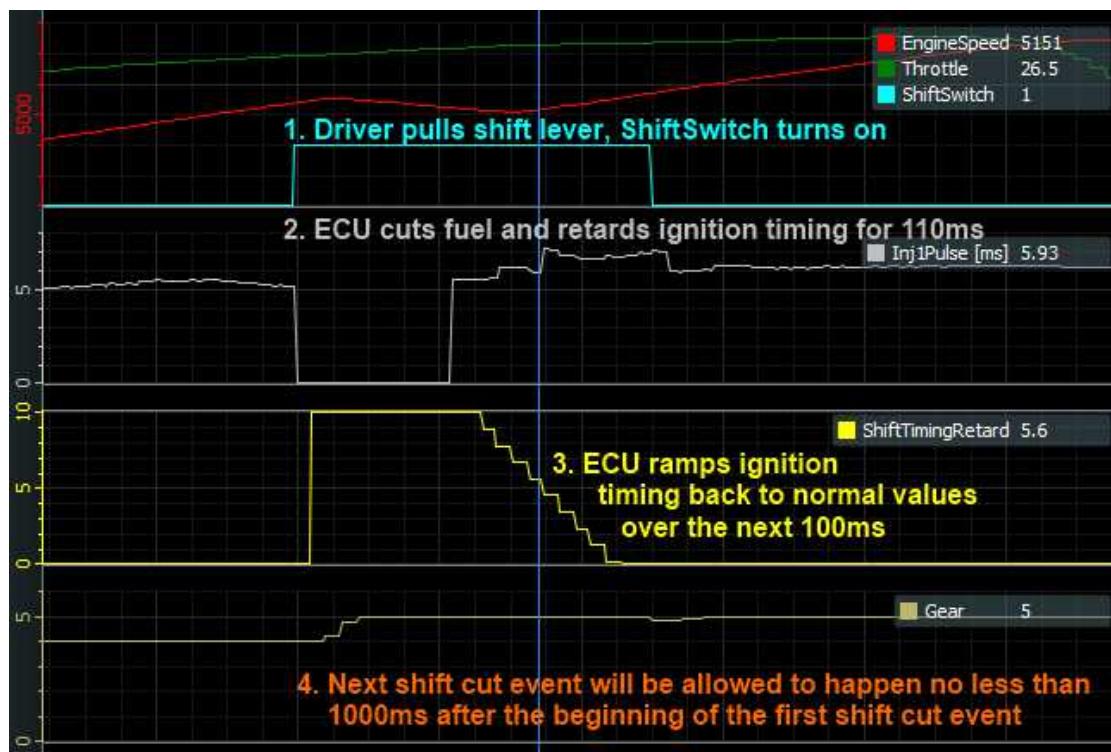
### **Shift Cut Time**

**Units:** mS vs Gear

**Description:** If all the conditions for shift cut are met, the Infinity ECU will cut fuel or spark and retard ignition timing for this amount of time once the ShiftSwitch turns on. The cut time depends on which gear the transmission is currently in. A typical conservative value is 300mS.



The datalog below shows a vehicle with a sequential gearbox shifting from 4th gear to 5th gear without lifting the throttle. On this vehicle, an on/off switch was installed on the shift lever so the switch sends ground when the lever is pulled to up-shift.



The following values were used in this example:

Shift Cut Minimum RPM = 3000 RPM

Shift Cut Minimum Throttle = 20%

Shift Cut Re-Arm Delay Time = 1000 ms

ShiftCutTime = table set to 110ms for 4th gear

Shift Cut Method = Ign Retard + Fuel Cut

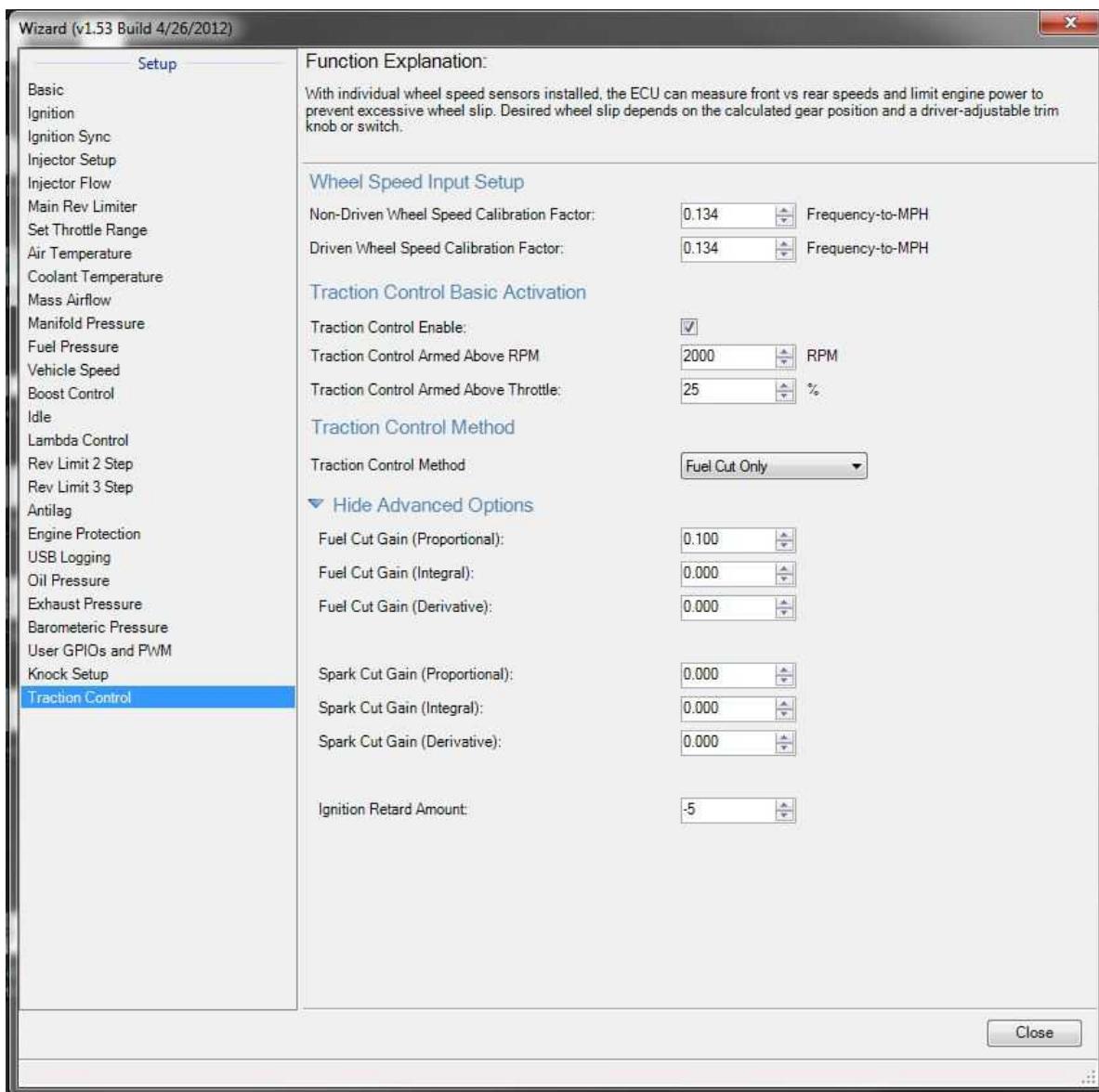
Ign Retard Amount = 10 degrees

Ign Retard Ramp-Out Time = 100ms

For more information, see the [Shift Cut](#)<sup>[167]</sup> section of the wizard.

### 4.3.22 Traction Control

With individual wheel speed sensors installed, the ECU can measure front vs rear speeds and limit engine power to prevent excessive wheel slip. Desired wheel slip depends on the calculated gear position and a driver-adjustable trim knob or switch.



## Wheel Speed Input Setup

### Non-Driven Wheel Speed Calibration Factor

**Units:** Frequency to MPH

**Description:** This calibrates the speed of the wheel that is not attached to the differential. This would be a rear wheel on FWD vehicles and a front wheel on RWD

vehicles.

#### **Driven Wheel Speed Calibration Factor**

**Units:** Frequency to MPH

**Description:** This calibrates the speed of the wheel that is attached to the differential. This would be a front wheel on FWD vehicles and a rear wheel on RWD vehicles.

### **Traction Control Basic Activation**

#### **Traction Control Enable**

**Units:** ON/OFF

**Description:** This enables the traction control feature.

#### **Traction Control Armed Above RPM**

**Units:** RPM

**Description:** This is the RPM activation threshold for traction control. When the engine speed is above this value, traction control will be active.

#### **Traction Control Armed Above Throttle**

**Units:** Throttle %

**Description:** This is the throttle activation threshold for traction control. When the throttle is above this percentage, traction control will be active.

### **Traction Control Method**

#### **Traction Control Method**

**Units:** Cut Selection

**Description:** In order to manage power and maintain traction, one of the following three engine cuts should be selected; fuel cut only, spark cut only, or fuel and spark cut.

### **Advanced Options**

#### **Fuel Cut Gain (Proportional)**

**Units:** Proportional Gain

**Description:** Proportional control is a pure gain adjustment acting on the error signal to provide the driving input. If overshooting occurs, lower this value. If undershooting occurs, raise this value.

#### **Fuel Cut Gain (Integral)**

**Units:** Integral Gain

**Description:** Integral control is implemented through the introduction of an integrator. Integral control is used to provide the required accuracy for the control system. This is used to fine tune once the proportional has acted in getting close to the target.

**Fuel Cut Gain (Derivative)****Units:** Derivative Gain

**Description:** The derivative term slows the rate of change of the controller output. Derivative control is used to reduce the magnitude of the overshoot produced by the integral component and improve the combined controller-process stability. Note: start tuning with this option at zero. Once the proportional and internal term has the lambda close to the target, step this gain in slowly until the target is achieved.

**Spark Cut Gain (Proportional)****Units:** Gain

**Description:** Proportional control is a pure gain adjustment acting on the error signal to provide the driving input. If overshooting occurs, lower this value. If undershooting occurs, raise this value.

**Spark Cut Gain (Integral)****Units:** Gain

**Description:** Integral control is implemented through the introduction of an integrator. Integral control is used to provide the required accuracy for the control system. This is used to fine tune once the proportional has acted in getting close to the target.

**Spark Cut Gain (Derivative)****Units:** Gain

**Description:** The derivative term slows the rate of change of the controller output. Derivative control is used to reduce the magnitude of the overshoot produced by the integral component and improve the combined controller-process stability. Note: start tuning with this option at zero. Once the proportional and internal term has the lambda close to the target, step this gain in slowly until the target is achieved.

**Ignition Retard Amount****Units:** Ignition degrees

**Description:** This is the amount of the ignition timing in degrees that will be pulled back in order to manage engine power and maintain traction.

#### 4.3.23 Traction Control Tuning Tables

##### TC\_SlipTrgtGear [MPH] Table

**Units:** Wheel Slip MPH vs Gear

**Description:** This is the main traction control target table. As an example, if the front tires (non-driven wheel speed) register 50mph and the rears (driven wheel speed) register 80mph, the channel TC\_SlipMeasured [MPH] will calculate 30 mph. If the TC\_SlipTarget [MPH] channel entered in this table is 20mph, the ECU will calculate a TC\_TqReduceReq value, to reduce engine torque.

TC_TargetGear										
20	20	15	10	5	5	5	5	5	5	5
0	1	2	3	4	5	6	7	8	9	Gear

##### TC\_TargetTrim Table

**Units:** Wheel Slip MPH vs Analog14 Volts

**Description:** This table allows for a programmable variable slip to be integrated via a dash mounted potentiometer. By default, this 0-5V signal needs to be input on Infinity pin function Analog-14. The value here will offset the TC\_SlipTarget [MPH] accordingly.

TC_TargetTrim											
0	1	2	3	4	5	6	7	8	9	10	11
0.1	0.45	0.91	1.36	1.82	2.27	2.73	3.18	3.64	4.09	4.55	4.9
Analog14 V											

### TC\_TqReduceFuel Table

**Units:** Gear vs Torque Reduction vs Fuel Cut%

**Description:** This table allows an array of fuel cut percentages to be defined depending on which gear the vehicle is in and how much torque reduction was requested. 100% is a full fuel cut and 0% is no fuel cut.

TC_TqReduceFuel [Cut%]										
Gear	7	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
	0	10	20	30	40	50	60	70	80	90
	TC_TqReduceReq									

### TC\_TqReduceSpark Table

**Units:** Gear vs Torque Reduction vs Spark Cut%

**Description:** This table allows an array of spark cut percentages to be defined depending on which gear the vehicle is in and how much torque reduction was requested. 100% is a full spark cut and 0% is no spark cut.

TC_TqReduceSpark [Cut%]										
Gear	7	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
	0	10	20	30	40	50	60	70	80	90
	TC_TqReduceReq									

### TC\_Gain\_P Table

**Units:** Proportional Gain vs Gear Ratio

**Description:** Proportional control is a pure gain adjustment acting on the error signal to provide the driving input. If overshooting occurs, lower this value. If undershooting occurs, raise this value.

TC_Gain_P										
3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	20	40	60	80	100	120	140	160	180	200
	GearRatio									

### TC Gain I Table

**Units:** Integral Gain vs Gear Ratio

**Description:** Integral control is implemented through the introduction of an integrator. Integral control is used to provide the required accuracy for the control system. This is used to fine tune once the proportional has acted in getting close to the target.

TC_Gain_I									
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	40	60	80	100	120	140	160	180	200
GearRatio									

### TC Gain D Table

**Units:** Derivative Gain vs Gear Ratio

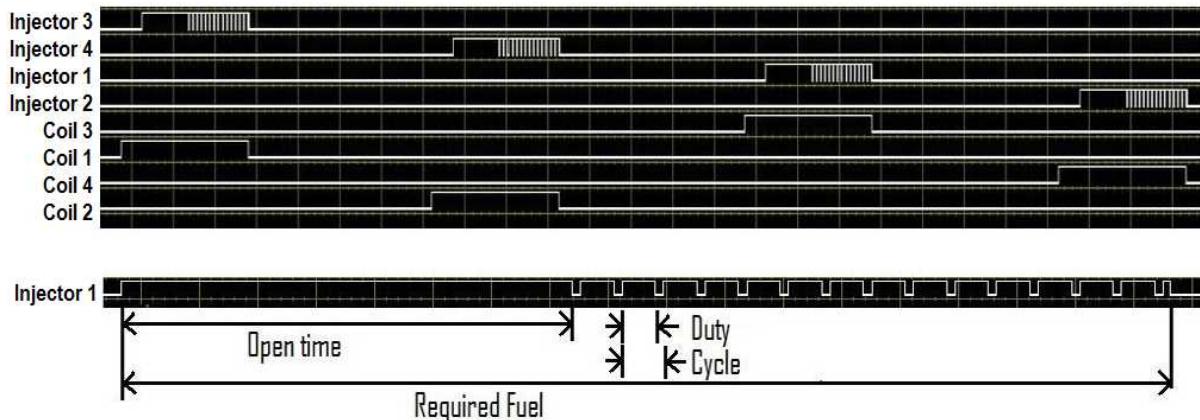
**Description:** The derivative term slows the rate of change of the controller output. Derivative control is used to reduce the magnitude of the overshoot produced by the integral component and improve the combined controller-process stability. Note: start tuning with this option at zero. Once the proportional and internal term has the lambda close to the target, step this gain in slowly until the target is achieved.

TC_Gain_D									
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	40	60	80	100	120	140	160	180	200
GearRatio									

For more information, go to [Traction Control](#) 223

#### 4.3.24 Injector Control

The Infinity Tuner has integrated peak and hold injector drivers. In order to benefit from this feature, low impedance injectors must be used for high current triggering. The image below shows a sample capture of a 4 cylinder engine setup.



The fuel injector control is flexible enough to drive any multi-port fuel injector. A high

impedance injector can be turned ON continuously whereas a low impedance injector would require a method to limit the current. A high impedance injector can set the duty time to 100% as this does not require a pulse width modulated current limiting phase. The injector waveform has several components that are controlled. Peak and hold control will hold the signal ON for the open phase and modulate the signal in order to limit the current.

**ReqFuelX**

**Units:** us/10

**Description:** This is the required fuel. The total time that the injector will be opened.

**FI\_OpenTimeX**

**Units:** us/10

**Description:** This is the open time when the ECU will enable the low side injector driver circuit in a continuous fashion as to provide the current to open the injector.

**FI\_CyclTimeX**

**Units:** us/10

**Description:** This is the cycle time of the PWM during the hold cycle of a low impedance injector. 1000 (0.1 milliseconds) would be a typical setting.

**FI\_DutyCycX**

**Units:** %high

**Description:** This is the duty time. It should be set to 100 for high impedance injectors. This depends on the particular injectors current for the hold cycle of the injector. 40-60 are generally acceptable.

#### 4.3.25 Injector Pressure

The fuel calculations in the Infinity ECU take fuel pressure into account as follows:

First the Manifold Pressure is calculated. MAP [psig] is calculated based on the MAP sensor and the Baro sensor (the baro sensor must be external, since the ECU enclosure is sealed).

Then, the Injector Pressure is calculated. InjPress [psig] is calculated based on the Fuel Pressure [psig] sensor and the MAP [psig] calculation. In other words, this is the pressure difference that is measured between the fuel rail (top of the injector) and the intake manifold (bottom of the injector).

Injector Pressure is used in a simple lookup table to determine InjFlowRate [cc/min]. Injector Pressure is also used as the y-axis of a simple lookup map to determine InjOffset[us]. InjOffset[us] is the injector response time, latency, offset, dead-time, etc.

If a fuel pressure sensor is not installed, or the fuel pressure voltage is outside the acceptable voltage range, the Infinity ECU will use a failsafe value for fuel pressure. When performing the failsafe calculations, the algorithm will check the fuel pressure regulator option (located in [Injector Flow](#))<sup>96</sup> which can tell the ECU that the fuel pressure regulator will be vacuum-referenced (FuelPressure failsafe will always assume X psi above manifold pressure, InjectorPressure will be constant) or atmosphere-referenced (FuelPressure failsafe will always assume X psi, and actual InjectorPressure will be influenced by MAP).

When using staged injection, there is a second set of InjFlowRate and InjOffset tables. Currently, the Infinity ECU assumes the fuel pressure is the same on both fuel rails.

#### InjectorOffset

**Units:** PSIG vs Volts

**Description:** If a fuel pressure sensor is installed (see Fuel Pressure), injector pressure can be calculated. This is simply the pressure difference between intake manifold and fuel rail pressure. This table is used to setup the injectors' latency (response time) based on the injector pressure and battery voltage.

InjectorOffset [ms]				
InjPressure [psig]	100.0	80.0	60.0	50.0
Battery [Volts]	10.0	12.0	14.0	16.0
100.0	3.000	1.900	1.400	1.200
80.0	2.300	1.600	1.200	1.000
60.0	1.900	1.400	1.100	0.800
50.0	1.800	1.400	1.000	0.800
40.0	1.600	1.200	1.000	0.800
	1.600	1.200	1.000	0.800

**InjSecOffset****Units:** PSIG vs Volts

**Description:** If a fuel pressure sensor is installed (see Fuel Pressure), secondary injector pressure can be calculated. This is simply the pressure difference between intake manifold and secondary fuel rail pressure. This table is used to setup the secondary injectors' latency (response time) based on the secondary injector pressure and battery voltage.

		InjSecOffset [us/10]				
		100.0	16000.0	11000.0	9500.0	7500.0
InjSecPressure [psig]	100.0	16000.0	11000.0	9500.0	7500.0	
	80.0	16000.0	11000.0	9500.0	7500.0	
	60.0	14000.0	10000.0	8000.0	6500.0	
	50.0	13000.0	9500.0	7000.0	6000.0	
	40.0	12000.0	9000.0	6000.0	5000.0	
	20.0	12000.0	9000.0	6000.0	5000.0	
		10.0	12.0	14.0	16.0	
Battery [Volts]						

**InjFlowRate****Units:** Injector Flow Rate vs Injector Pressure

**Description:** If a fuel pressure sensor is installed, injector pressure can be calculated. This is simply the pressure difference between intake manifold and fuel rail pressure. This table allows for an actual injector flow rate to be entered based on the injector pressure.

InjFlowRate [cc/min]						
20.0	40.0	50.0	60.0	80.0	100.0	120.0
60.0	180.0	350.0	500.0	770.0	770.0	770.0
InjPressure [psig]						

**InjSecFlowRate****Units:** Secondary Injector Flow Rate vs Injector Pressure

**Description:** If a fuel pressure sensor is installed, secondary injector pressure can be calculated. This is simply the pressure difference between intake manifold and secondary fuel rail pressure. This table allows for an actual secondary injector flow rate to be entered based on the injector pressure.

InjSecFlowRate [cc/sec]						
20.0	40.0	50.0	60.0	80.0	100.0	120.0
5.1	6.9	7.8	8.6	10.1	14.3	14.3
InjSecPressure [psig]						

#### 4.3.26 Staged Injection

Utilizing a 2D table labeled StagedSplit [%], injector flow can be controlled between primary and secondary injectors. A value of 100% means all flow will go to the primary injectors while 0% means all flow will go to the secondary injectors. To calculate equal flow from both injectors, take the primary injector flow and divide it by the total injector flow (eg. primary injector = Injector Dynamics 1000, secondary injector = Injector Dynamics 2000; obtain even flow with  $1000/(1000+2000) = .33333 = 33.33\%$ . This is the percent of flow for primary injector to have the same flow as a larger secondary injector).

StagedSplit [%]											
	100	100	100	100	100	100	100	100	100	100	100
MAP [kPa]	100	100	100	100	100	100	100	100	100	100	100
500	100	100	100	100	100	100	100	100	100	100	100
450	100	100	100	100	100	100	100	100	100	100	100
400	100	100	100	100	100	100	100	100	100	100	100
350	100	100	100	100	100	100	100	100	100	100	100
300	100	100	100	100	100	100	100	100	100	100	100
250	100	100	100	100	100	100	100	100	100	100	100
200	100	100	100	100	100	100	100	100	100	100	100
150	100	100	100	100	100	100	100	100	100	100	100
100	100	100	100	100	100	100	100	100	100	100	100
50	100	100	100	100	100	100	100	100	100	100	100
	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000	
	EngineSpeed [RPM]										

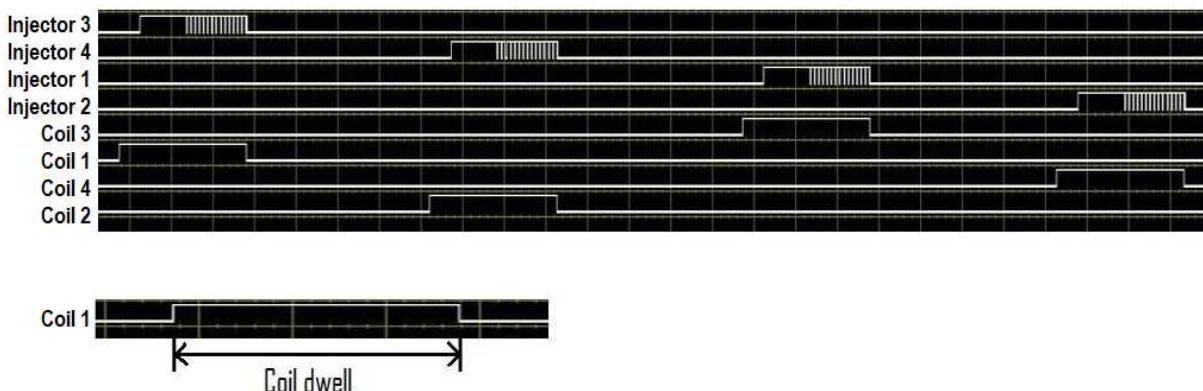
#### StagedSwitch table

StagedSwitch table values of '0' will force staged injection calculations to use primary injectors only, default table values '1' will allow staged injection. This allows the user to override the staged injection activation using a switched input if desired.

StagedSwitch			
0.000	0.000	0.000	0.000
0.000	0.100	0.200	0.300
ModeSwitch			

#### 4.3.27 Coil Dwell

The coil dwell is the time in which the control signal will charge the coil before the spark event. The image below shows a sample capture of a 4 cylinder engine setup.



Coil dwell is configured in the Infinity Tuner Software using the following table.  
***WARNING! INCORRECT IGNITION DWELL SETTINGS CAN LEAD TO COIL OVERHEATING AND A POTENTIAL FIRE HAZARD. CONTACT YOUR IGNITION COIL MANUFACTURER FOR RECOMMENDED DWELL SETTINGS.***

#### CoilDwellMap

**Units:** kPa vs. Volts vs. mS

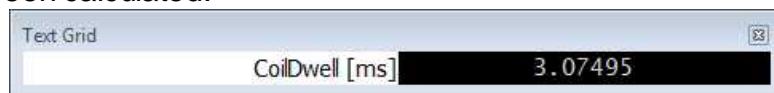
**Description:** This table sets the appropriate coil dwell at specific engine loads and battery voltage.

CoilDwellMap [ms]										
MAP [kPa]	400.0	5.00	5.00	5.00	4.00	3.50	3.00	3.00	3.00	3.00
400.0	5.00	5.00	5.00	5.00	4.00	3.50	3.00	3.00	3.00	3.00
300.0	5.00	5.00	5.00	5.00	4.00	3.50	3.00	3.00	3.00	3.00
200.0	5.00	5.00	5.00	5.00	4.00	3.50	3.00	3.00	3.00	3.00
100.0	5.00	5.00	5.00	5.00	4.00	3.50	3.00	3.00	3.00	3.00
50.0	5.00	5.00	5.00	5.00	4.00	3.50	3.00	3.00	3.00	3.00
20.0	5.00	5.00	5.00	5.00	4.00	3.50	3.00	3.00	3.00	3.00
	8	9	10	11	12	13	14	15	16	
	Battery [Volts]									

#### CoilDwell

**Units:** mS

**Description:** This channel represents the current coil dwell time after all lookup tables have been calculated.



#### 4.3.28 Flex Fuel

Flex Fuel is a fuel mixture of ethanol (alcohol) and gasoline. It is typically made from corn (or sugar cane) and is used for cleaner emissions, higher octane, and is less expensive per volume. However, ethanol's energy density is lower so gas mileage is compromised. But from a performance standpoint, the extra fuel lowers exhaust gas temperatures which is a benefit. Furthermore, ethanol has a higher latent heat of vaporization compared to gasoline so air charge cooling is further improved. When burning ethanol, the fuel tuning should be based on a oxygen sensor because reading spark plugs is much more challenging as the color is not as evident.

#### Flex Fuel Composition

Gasoline and ethanol have different compositions: Gasoline: H1.65C, Ethanol: C2H5OH. Ethanol has oxygen as part of its structure (gasoline does not) and is often referred to as "oxygenated gasoline". Because of this, the stoichiometry of the two fuels are drastically different.

#### Flex Fuel Stoichiometry

Gasoline stoichiometry: 14.68 AFR

"E85" stoichiometry: 9.87 AFR

Ethanol stoichiometry: 9.00 AFR

#### Flex Fuel Content

Most gas stations label their flex fuel as E85 (85% ethanol and 15% gasoline). However, this can be very misleading. Most cold climates use a winter blend which is E70. In order to determine the proper amount of blend that is being used at any given time, a FCS (fuel composition sensor) must be used.

#### Flex Fuel Sensor

Below is a list of part numbers associated with the GM FCS (Fuel Composition Sensor) unit:

GM 12570260, Fuel Composition Sensor, Quantity 1

Delphi 12146121, Connector, Quantity 1

Delphi 12048074, Terminals, Quantity 3

Delphi 12052845, TPA, Quantity 1

Delphi 15324973, Cable Seal, Quantity 3



### **Flex Fuel FCS Plumbing**

The FCS should be plumbed into the system, preferably before the fuel injectors. It consists of 5/16" and 3/8" quick disconnect fittings. The internal microprocessor of the FCS outputs a varying digital square wave frequency and pulse width. The AEM Infinity decodes this input and displays a flex fuel content percentage and fuel temperature.

### **Flex Fuel FCS Wiring**

There are 3 wiring terminals on the GM FCS. Pin A is Ground and should be connected to a clean chassis ground. Pin B is +12V and should be connected to a 12V ignition switch source. Pin C is the digital output signal and should be wired to AEM Infinity Pin C1-26 (Digital\_In\_5).

### **Flex Fuel FCS Output**

The frequency of the signal indicates the ethanol percentage. The output frequency is linear with respect to the percentage of ethanol content in the fuel. The fuel composition sensor normally operates between 50-150Hz, where 50Hz represents 0% ethanol and 150Hz represents 100% ethanol. If the output frequency goes up to 170Hz, the sensor has gone into a fail safe mode as it has indicated a fuel contamination such as methanol, water, salt, etc. The pulse width indicates the fuel temperature and normally operates between 1-5mS where 1mS indicates -40°C (-40°F) and 5mS indicates 125°C (257°F).

## Infinity Tuner Flex Fuel Tables

### FlexContent

**Units:** Flex Content % vs Frequency Hz

**Description:** This table is used to find the flex fuel (ethanol) content based on the frequency input from the flex fuel sensor.

FlexContent [%]		
0.0	0.5	1.0
50.0	100.0	150.0
FlexDigitalIn [Hz]		

### FlexCrankingAdder

**Units:** Flex Duty vs Flex Content % vs Injector Pulse us/10

**Description:** This table is used to increase the amount of engine cranking fuel injector pulse based on the fuel temperature and ethanol content. This an additional increase on top of the CrankVETable and LambdaCrankingTable.

FlexCrankingAdder [us/10]					
FlexDuty	0.0	0.3	0.5	0.8	1.0
120.0	0.0	0.0	0.0	0.0	0.0
80.0	0.0	0.0	0.0	0.0	0.0
40.0	0.0	0.0	0.0	0.0	0.0
20.0	0.0	0.0	0.0	0.0	10000.0
10.0	0.0	0.0	0.0	10000.0	10000.0
0.0	0.0	0.0	10000.0	20000.0	20000.0
-10.0	0.0	0.0	10000.0	30000.0	30000.0
-20.0	0.0	0.0	20000.0	30000.0	30000.0
FlexContent [%]					

### LambdaFlexTargetTable

**Units:** MAP (kPa) vs RPM vs Lambda

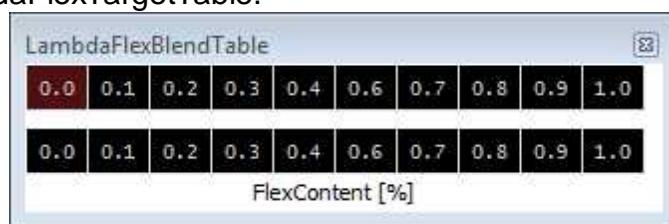
**Description:** This is a secondary Lambda target table. However, this table should be set assuming there were 100% ethanol (flex fuel) content. The final lambda target is determined using the LambdaFlexBlendTable (described below).



### LambdaFlexBlendTable

**Units:** Blend Factor vs FlexContent %

**Description:** This table is used to determine the final lambda target when using flex fuel. It blends the target lambda values between the LambdaTargetTable and the LambdaFlexTargetTable. The X-axis represents (ethanol) fuel content 0.0-1.0 (or 0-100% Ethanol). A value of 0.0 means 100% of the lambda target value will come from the LambdaTargetTable. A value of 1.0 means 100% of the lambda target value will come from the LambdaFlexTargetTable. As an example, a value of 0.3 means that 70% of the lambda target will come from the LambdaTargetTable and 30% from the LambdaFlexTargetTable.



## FlexIgnMap

**Units:** MAP (kPa) vs RPM vs Spark Timing

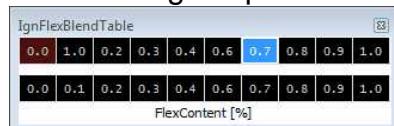
**Description:** This is a secondary ignition map. However, this table should be set assuming there were 100% ethanol (flex fuel) content. The final ignition timing value is determined using the IgnFlexBlendTable (described below).



## IgnFlexBlendTable

**Units:** Blend Factor vs FlexContent %

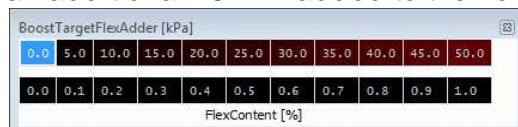
**Description:** This table is used to determine the final ignition timing when using flex fuel. It blends the ignition timing values between the BaselgnMap and the FlexIgnMap. The X-axis represents (ethanol) fuel content 0.0-1.0 (or 0-100% Ethanol). A value of 0.0 means 100% of the ignition timing value will come from the BaselgnMap. A value of 1.0 means 100% of the ignition timing value will come from the FlexIgnMap. As an example, a value of 0.3 means that 70% of the ignition timing will come from the BaselgnMap and 30% from the FlexIgnMap



## BoostTargetFlexAdder

**Units:** Boost Target kPA vs FlexContent %

**Description:** This table is used to determine the final boost target when using flex fuel. It adds an additional boost pressure target, measured in kPA, to the current boost target. The X-axis represents (ethanol) fuel content 0.0-1.0 (or 0-100% Ethanol). A value of 0.0 does nothing and means 100% of the boost target will still come from the normal boost target algorithm. A value of 15.0 (at 0.3 Flex Content %), for instance, means that there will be an additional 15kPA added to the normal boost algorithm.



#### 4.3.29 FuelTrim\_1 Table

FuelTrim_1										
MAP [kPa]	320	0.100	0.100	0.080	0.020	0.000	0.000	0.000	0.000	0.000
300	0.100	0.100	0.080	0.020	0.000	0.000	0.000	0.000	0.000	0.000
280	0.100	0.100	0.080	0.020	0.000	0.000	0.000	0.000	0.000	0.000
260	0.100	0.100	0.080	0.020	0.000	0.000	0.000	0.000	0.000	0.000
240	0.100	0.100	0.080	0.020	0.000	0.000	0.000	0.000	0.000	0.000
220	0.080	0.080	0.060	0.010	0.000	0.000	0.000	0.000	0.000	0.000
200	0.020	0.020	0.010	0.000	0.000	-0.010	0.000	0.000	0.000	0.000
180	0.000	0.000	0.000	0.000	-0.050	-0.060	-0.050	0.000	0.000	0.000
160	0.000	0.000	0.000	-0.010	-0.070	-0.090	-0.070	-0.010	0.000	0.000
140	0.000	0.000	0.000	-0.020	-0.080	-0.100	-0.080	-0.020	0.000	0.000
120	0.000	0.000	0.000	-0.010	-0.070	-0.090	-0.070	-0.010	0.000	0.000
100	0.000	0.000	0.000	0.000	-0.050	-0.060	-0.050	0.000	0.000	0.000
80	0.000	0.000	0.000	0.000	0.000	-0.010	0.000	0.000	0.000	0.000
60	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

500 | 750 | 1000 | 1250 | 1500 | 2000 | 2500 | 3000 | 3500  
EngineSpeed [RPM]

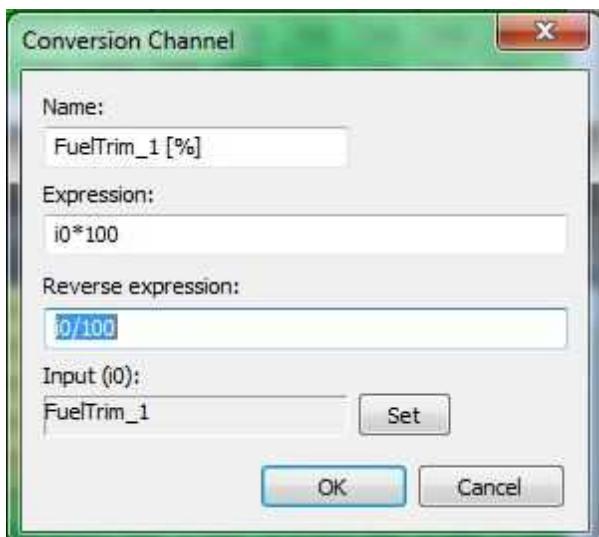
A generic fuel trim modifier is available called the FuelTrim\_1 Table. The data can be viewed differently using a conversion channel. If no conversion channel is applied to the data as shown in the example above, the multiplier is applied as follows:

Fuel pulse modified = Fuel pulse x (1 + FuelTrim\_1)

In this format, a value of 0.100 in the table will result in a 10% addition to the base fuel pulse calculation.

Alternatively, the user can apply a conversion channel. See the [Layout Menu](#)<sup>21</sup> topic for more information on conversion channels.

A conversion channel of the following format will allow the user to view the data in [%] modifications.



When this conversion channel is applied, the data will be represented as follows.



#### 4.3.30 VVC

The Infinity ECU supports up to 4 channels of variable valve control (VVC). This support is application dependent. Contact AEM Tech Support for more information. The setup wizard UI pages contain text descriptions of all features and functions.

## VVC

This wizard is used to configure Variable Valve Control (supports up to 4-cam VVC).

Assign the cam digital inputs used to their corresponding VVC name. Cams not used may be left on any selection. Failure to set VVC cam assignments properly may result in improper VVC function and possible engine damage!

### VVC Enable

VVC1A Enable	<input type="checkbox"/>	Intake - Bank 1
VVC1B Enable	<input type="checkbox"/>	Intake - Bank 2
VVC2A Enable	<input type="checkbox"/>	Exhaust - Bank 1
VVC2B Enable	<input type="checkbox"/>	Exhaust - Bank 2

### VVC Cam Sync

Cam sync is similar to ignition sync on an engine. Before setting cam sync be sure VVC cam assignments are properly setup. With all VVC channels disabled, start and idle the engine. The intake cam should be at full retard and the exhaust cam should be at full advance. These points will serve as the VVC cam zero reference. View the channels 'Cam0\_Timing [deg]', 'Cam1\_Timing [deg]', 'Cam2\_Timing [deg]', 'Cam3\_Timing [deg]' and enter the value of these channels here. View the cam timing channels again, they should all read zero or close to zero. If they do not read zero, add what they currently read to the current value below and check again.

Failure to set cam sync properly may result in improper VVC function and possible engine damage!

Cam 0 Sync [deg]	<input type="text" value="0"/>
Cam 1 Sync [deg]	<input type="text" value="0"/>
Cam 2 Sync [deg]	<input type="text" value="0"/>
Cam 3 Sync [deg]	<input type="text" value="0"/>

### VVC Hardware Outputs

Use the Lowside Assignment Tables setup wizard to configure the Lowside outputs for the desired frequency [Hz] and duty [%]

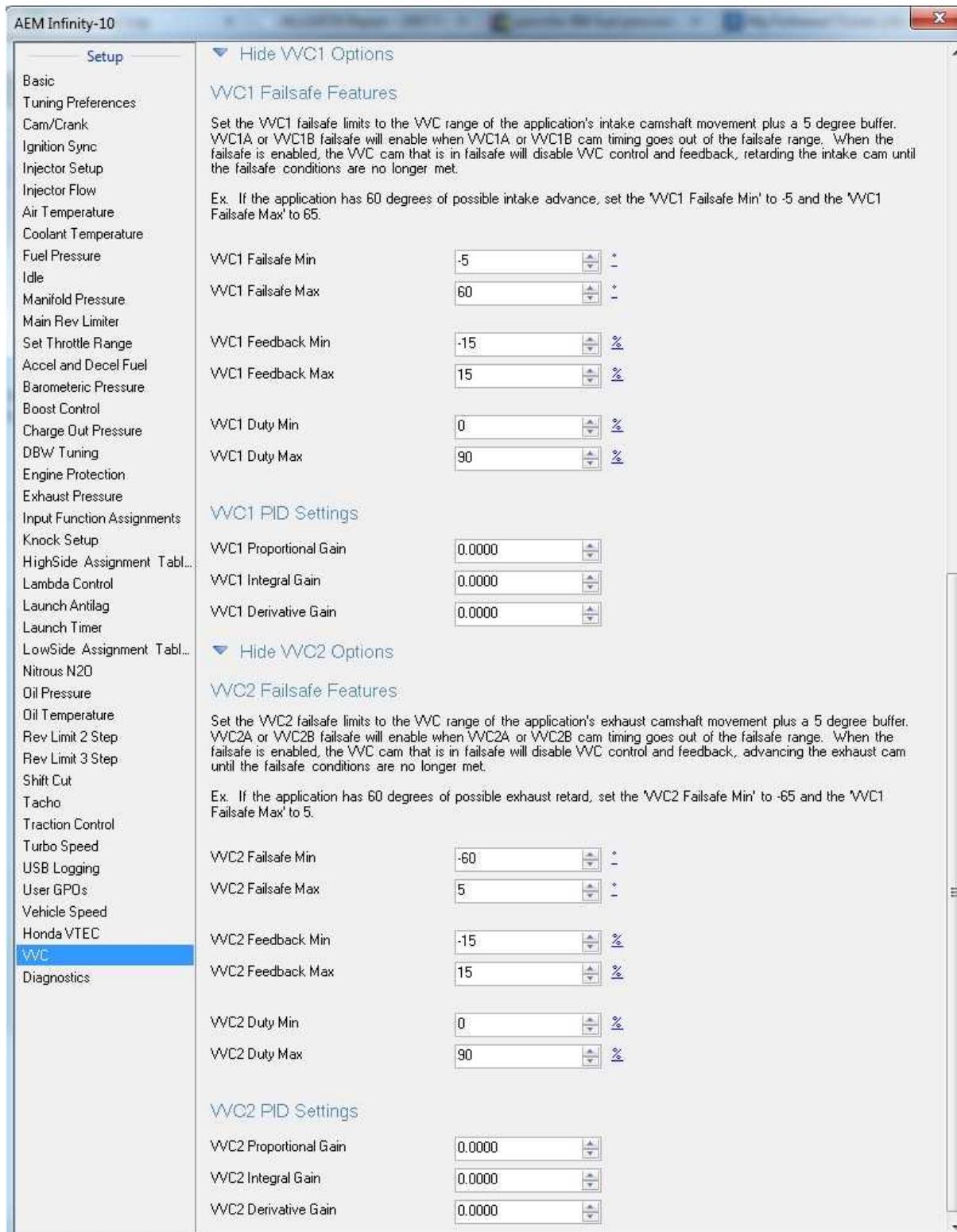
### VVC Target Table

VVC Target Table Load Axis Selection	<input type="button" value="MAP [kPa]"/>
VVC Minimum Coolant Temperature	<input type="text" value="-999.0"/> °C

Remember to use the Lowside Assignment tables in the [Output Assignments](#) [209] wizard page to configure the outputs properly. Remember these output frequency and duty tables are the last gate in the logic sequence and must be set correctly for proper

function.

Configure the failsafe options and PID settings using the options below.



#### 4.3.31 Multi-Map Features

Multiple maps can be utilized on the fly such as VE, Lambda, and Ignition to be switched manually with analog input or various conditions such as MAP [kPa] or gear. Several of these options are described in the Setup Wizard under Advanced Setup of Input Function Assignments. The following text describes examples of how this feature can be used. Many different options are possible and not all of them are described below.

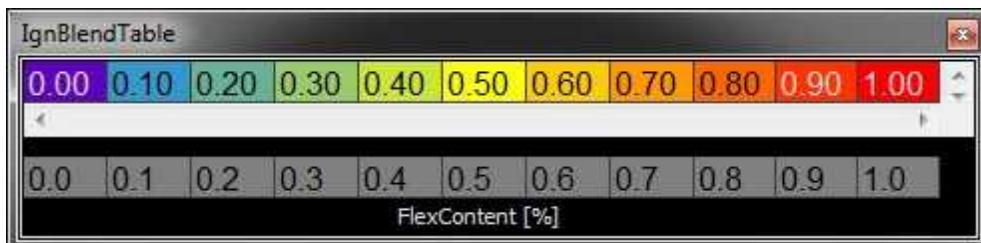
##### **Blending between multiple maps using ModeSwitch and FlexContent:**

For Ignition, your calibration is already using the 1D table 'ModeSelect\_Ign' to switch between two ignition maps:

When ModeSwitch =1, use IgnMap

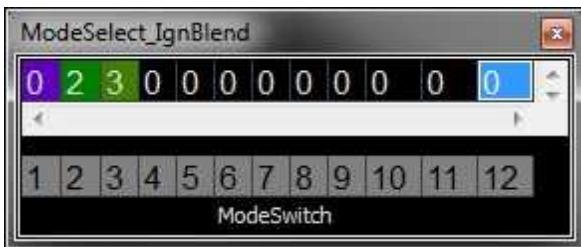
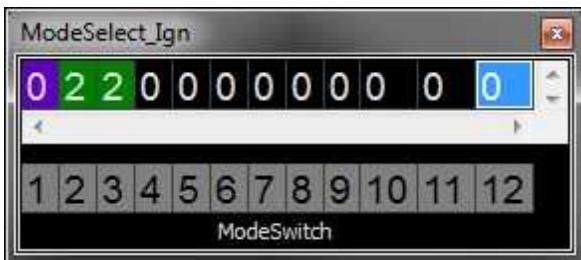
When ModeSwitch = 2, use IgnMap\_2

There are two more things you need to configure. First, you need to understand how the ECU blends because of the ethanol content. There is a 1D table called 'IgnBlendTable.' The input to the table is FlexContent [%], and the output is a blend amount.



For now, let's assume you leave the original numbers in the 'IgnBlendTable' and it will blend smoothly and evenly between the 'pump fuel' timing numbers when FlexContent = 0 (0% ethanol) and the 'flex fuel' timing numbers when FlexContent = 1.0 (100% ethanol). You could however, change the values in the table so the ECU uses 'pump fuel' timing numbers when Ethanol Content is 0-40% and switches to 'flex fuel' timing when Ethanol Content is 40% or greater. Do that by setting the table cell values to '0.00' for FlexContent breakpoints 0.0 - 0.4 , and '1.00' for FlexContent breakpoints 0.4 - 1.0. But let's not touch that table at all yet, let's assume you want it to blend smoothly depending on ethanol content, as long as your ModeSwitch is in position 3.

With the flex fuel sensor, the ECU will blend between whatever map is defined in the 1D 'ModeSelect\_Ign' table and whatever map is defined in the 'ModeSelect\_IgnBlend' table. One way you could do it is set the tables to these values:



When ModeSwitch =1 the ECU will blend between IgnMap\_1 (the top table) ModeSelect\_Ign gets used when the FlexContent is low), and IgnMap\_1 (from the bottom table, ModeSelect\_IgnBlend when FlexContent is high). In other words, there won't be any blend, it will use the main IgnMap timing values regardless of flex fuel content.

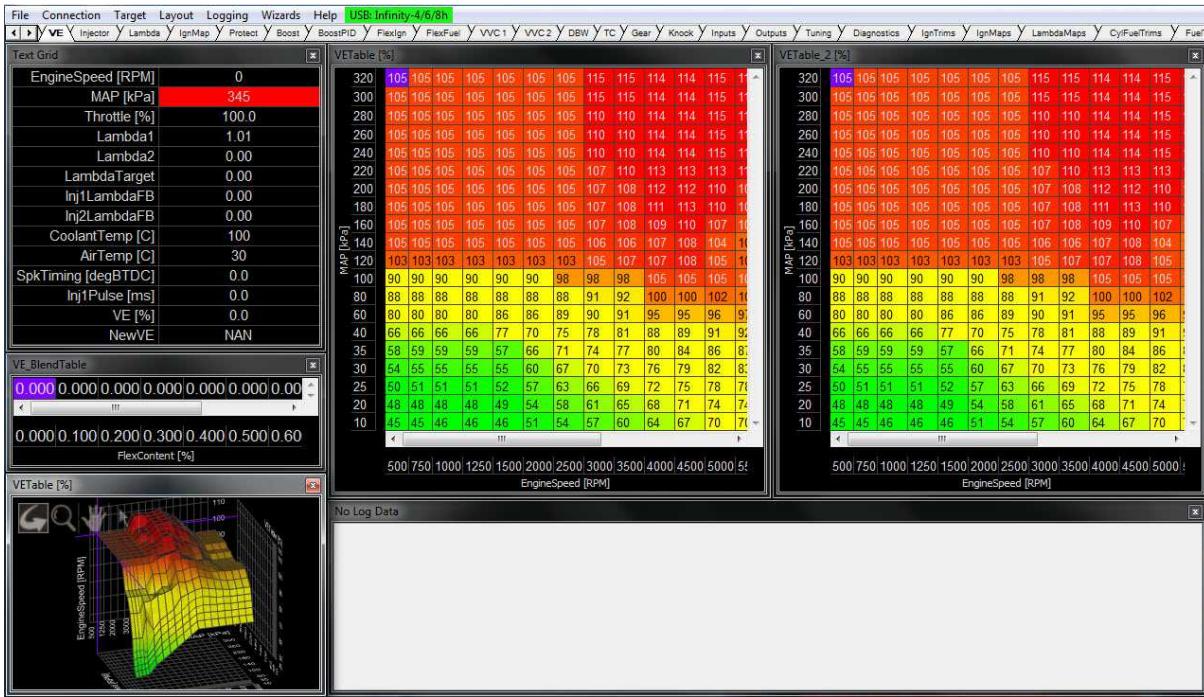
When ModeSwitch = 2 the ECU will use blend between IgnMap\_2 (the top table) ModeSelect\_Ign gets used when the FlexContent is low), and IgnMap\_2 (from the bottom table, ModeSelect\_IgnBlend when FlexContent is high). Again, there won't really be any blending here, because we've told it to use the same map in both conditions.

When ModeSwitch =3 the ECU will blend between IgnMap\_2 (from the top table, ModeSelect\_Ign which gets used when FlexContent is low), and IgnMap\_3 (from the bottom table, ModeSelect\_IgnBlend when FlexContent is high). You can put the most aggressive timing numbers in IgnMap\_3, and that timing map will only get used if the ModeSwitch = 3 and the FlexContent is high.

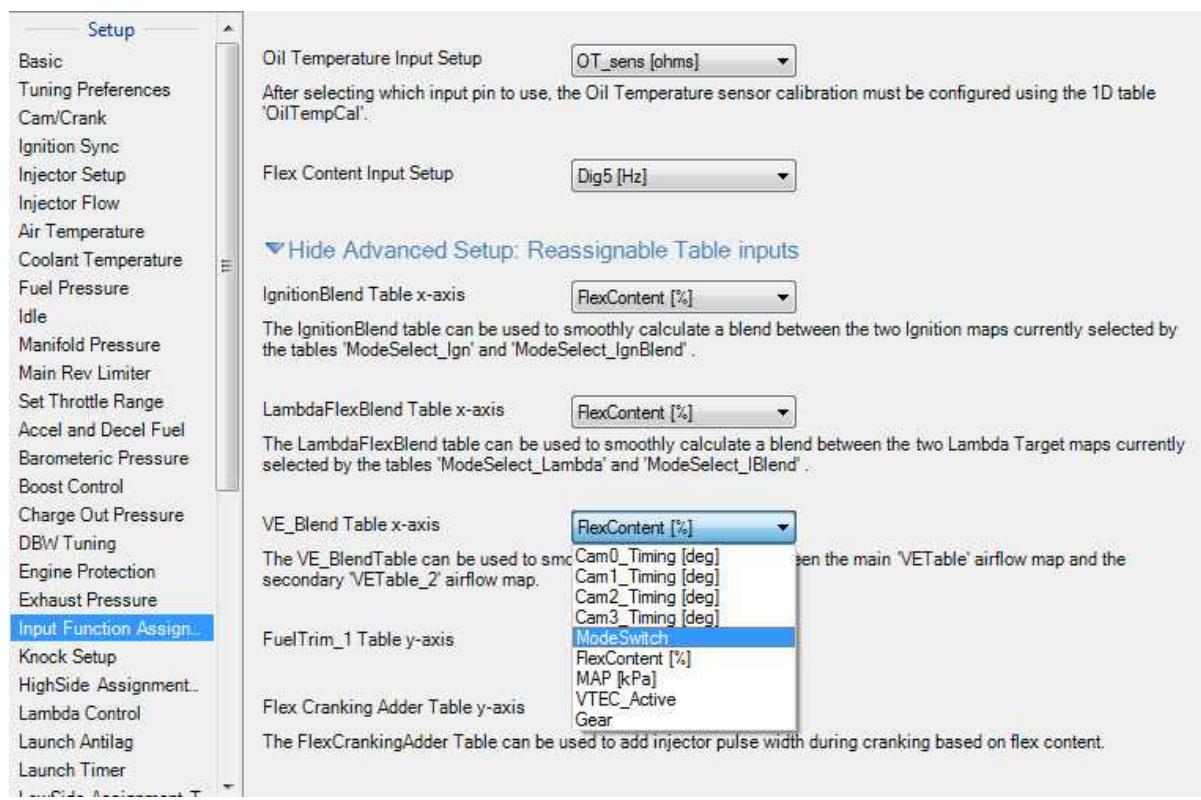
There are similar tables for LambdaTargets, you can adjust these if you want to run more aggressive lambda targets depending on ethanol content or other variables.



There are two different VE tables that can be used as well. Example screenshot below.

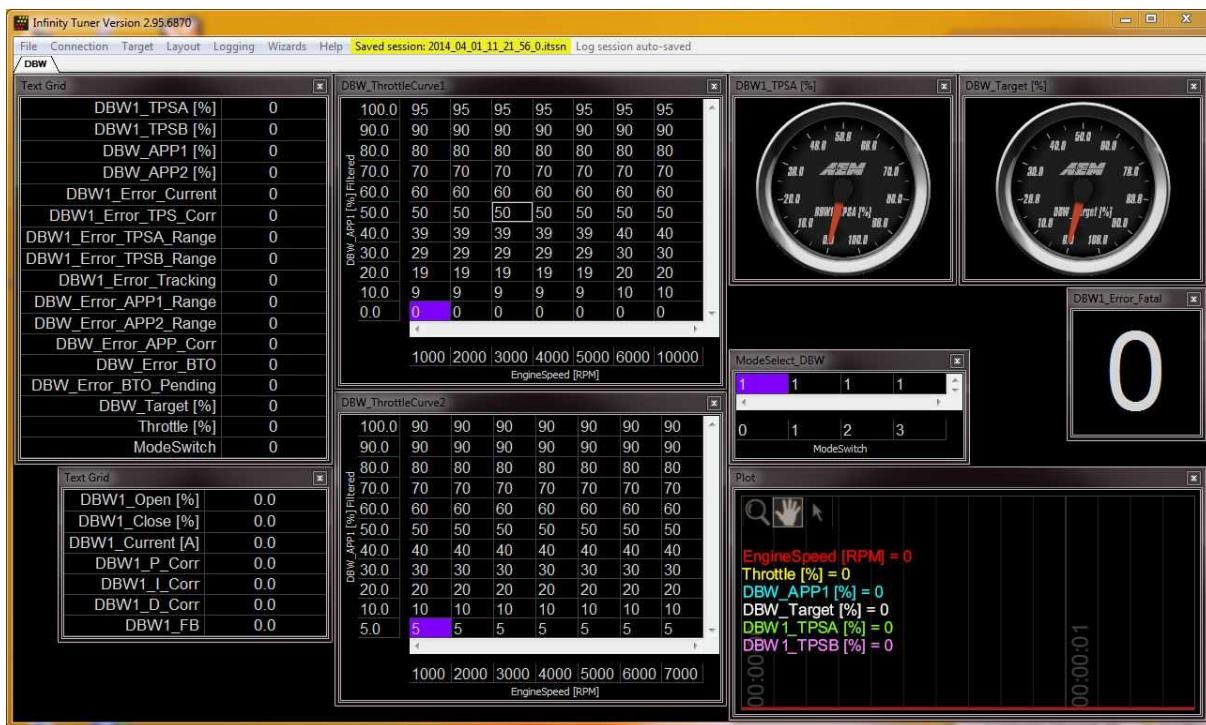


Note that the input axis data for the VE\_BundleTable is user selectable in the setup wizard as shown below.



It might be beneficial to blend between the two available VE maps based on either CamX\_Timing [deg] or VTEC state as these certainly influence the engine's VE.

Two different DBW target tables are available.



If the output from the Mode\_Select\_DBW channel is 1, the system will use the values in the DBW\_ThrottleCurve1 table as shown below.

DBW_ThrottleCurve1								
DBW_APP1 [%] Filtered	1000	2000	3000	4000	5000	6000	7000	10000
100.0	95	95	95	95	95	95	95	95
90.0	90	90	90	90	90	90	90	90
80.0	80	80	80	80	80	80	80	80
70.0	70	70	70	70	70	70	70	70
60.0	60	60	60	60	60	60	60	60
50.0	50	50	50	50	50	50	50	50
40.0	39	39	39	39	39	40	40	40
30.0	29	29	29	29	29	30	30	30
20.0	19	19	19	19	19	20	20	20
10.0	9	9	9	9	9	10	10	10
0.0	0	0	0	0	0	0	0	0

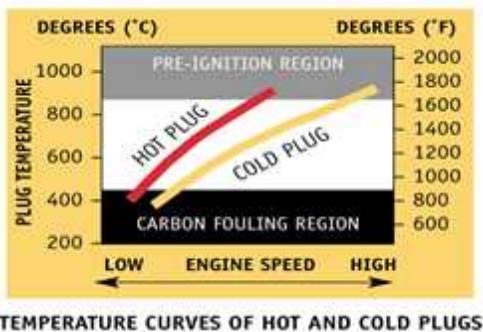
If the output from the Mode\_Select\_DBW channel is 2, the system will use the values in the DBW\_ThrottleCurve2 table as shown below.

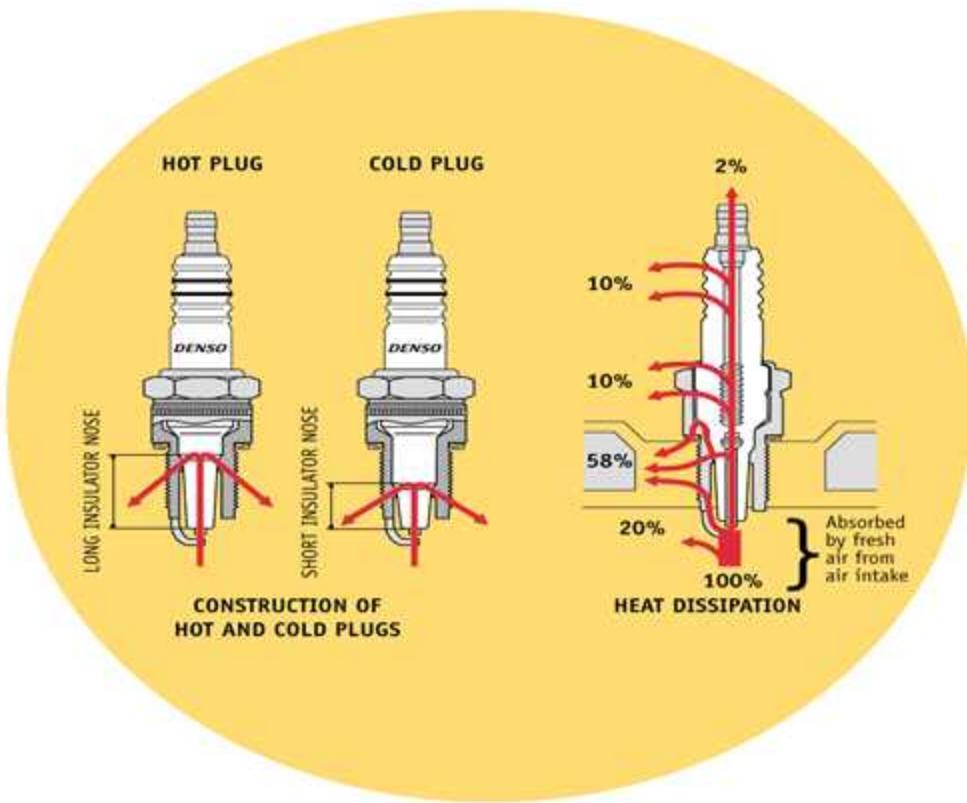
DBW_ThrottleCurve2								
DBW_APP1 [%] Filtered	1000	2000	3000	4000	5000	6000	7000	10000
100.0	90	90	90	90	90	90	90	90
90.0	90	90	90	90	90	90	90	90
80.0	80	80	80	80	80	80	80	80
70.0	70	70	70	70	70	70	70	70
60.0	60	60	60	60	60	60	60	60
50.0	50	50	50	50	50	50	50	50
40.0	40	40	40	40	40	40	40	40
30.0	30	30	30	30	30	30	30	30
20.0	20	20	20	20	20	20	20	20
10.0	10	10	10	10	10	10	10	10
5.0	5	5	5	5	5	5	5	5

## EFI Components

## 5.1 Spark Plugs

Spark plug selection affects engine performance. On forced induction engines, it is critical that the proper heat range and gap is used. Heat range refers to the ability of the spark plug to conduct heat away from the electrode to the engine. A plug that has high thermal conductivity has a short insulator that comes in contact with a large portion of the metallic plug shell. This large area allows the combustion heat to be carried through the plug shell to the cooling jacket of the cylinder head. In the case of a hot plug, the insulator is recessed deeply into the plug shell with minimal contact to the shell. The plug has low thermal conductivity due to the lack of contact with the shell. The nose of the insulator should operate at between 400 – 850 degrees C. Temperatures above 400 degrees C are desirable because at higher temperatures deposits from carbon, lead or soot are burnt off. Temperatures of 850 degrees C and over should not be exceeded because this is typically the point where detonation or auto ignition can occur. Lower heat range plugs have a higher resistance to auto ignition while higher heat range plugs have less tendency to foul.





The spark plug gap on forced induction engines should be reduced REGARDLESS of the type of ignition system. We have read many instruction manuals for aftermarket ignition systems that recommend that the plug gap be opened up for better flame propagation. Although this recommendation may have had some merit when vehicles had carburetors, it does not apply to modern engines with electronic engine management systems. The smaller gap on forced-induction engines requires less spark energy to arc across the ground and the electrode and has a lesser tendency to misfire under the extreme pressures of a racing engine combustion chamber. Also there are spark plugs made with exotic fine wire highly conductive center electrodes that require less energy to fire such as the Denso Iridium that are well suited to racing conditions. The following is a chart of gap sizes for various engines on gasoline:

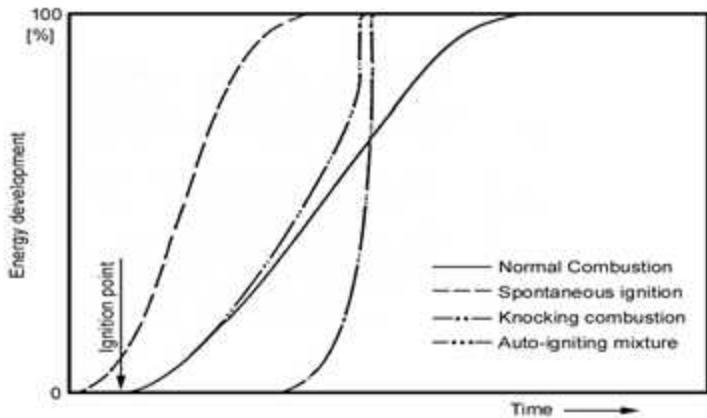
Naturally Aspirated up to 11.0:1 CR:	1.1mm (.044")
Naturally Aspirated 11.0:1 to 14.0:	0.8mm (.032")
Forced Induction to 20-PSI:	0.7mm (.028")
Forced Induction to 40-PSI:	0.6mm (.022")



The color or condition of the spark plug is a general indicator of how rich or lean the engine is running and also if the engine is exhibiting signs of detonation if it is not audible. This is a plug color chart (supplied courtesy of Denso) of plug conditions.

### Detonation and Pre ignition

It is important to understand the mechanisms that cause knocking and pre ignition to set up an ignition map that is suitable for the engine. Auto ignition, also known as knocking, pinging, or detonation, is generally caused by improper combustion in an engine. An internal combustion engine runs properly when the spark-initiated combustion wave expands rapidly but smoothly throughout the combustion chamber. Combustion knock is caused by spontaneous ignition in the hot unburned portion of the fuel mixture (typically referred to as end gas) in the combustion chamber. The remaining charge portion is compressed first by the upward piston movement and then by the moving flame front. Knocking is the almost instantaneous ignition of part of the remaining mixture. This mixture auto ignites because the rapidly rising pressure and temperature caused by the piston movement and the expanding gas from the flame front are sufficient to ignite the remaining gasses. To illustrate the loads imposed on the engine components by knocking, note that normal combustion speeds are about 12-25 m.s<sup>-1</sup> while knocking combustion speeds may be as high as 250-300 m.s<sup>-1</sup>. The next illustration depicts the difference between a normal and abnormal combustion process.



If the gasoline-air mixture auto-ignites somewhere in the cylinder (other than at the spark plug) just after spark ignition, the auto-ignition combustion wave can collide with the spark-initiated combustion wave, causing the vibration we hear as a knock or ping. Depending on its intensity, knocking combustion may range from barely audible "pinging" to a rather violent thumping. The point at which the knocking becomes damaging to the engine is dependent on the components used in the engine. If sustained knocking occurs, then the pistons may be damaged. When knocking reaches a violent thump, engine operation should be ceased or at minimum the load and temperature reduced to prevent engine damage. Light knocking that happens during acceleration is less harmful and may not damage the engine. Knocking tendency is increased by the following design or operational characteristics:

- High Engine loads encountered while towing a vehicle.
- Using low octane gasoline in a high-compression engine.
- Too much timing advance for the type of fuel being used.
- Higher air density, (this can be caused by starting a calibration at high altitude and then traveling to a lower one, or the addition of forced induction).
- Increased temperatures and pressure in the combustion chamber due to inadequate engine cooling.
- Excessive inlet air temperature.
- Spark plugs with an improperly high heat range.
- A non-central spark plug location in the combustion chamber.
- An elongated combustion chamber design.
- Too lean of an air/fuel mixture.

The following tuning adjustments can be performed on an engine to reduce or eliminate knocking:

- Reduce ignition timing.
- Verify that the air/fuel mixture is adequate for your engine set up.
- Verify that the spark plugs are of proper heat range.

Pre ignition is the ignition of the charge in the combustion chamber before the spark occurs. This type of ignition is caused by a very hot, or even incandescent surface in the combustion chamber. These “hot spots” can be an overheated spark plug, a glowing remnant of carbon in the chamber or even a hot exhaust valve edge. The pre ignition condition flame front rapidly expands while the piston is still on its way up the bore. Due to the very high pressure generated by the expanding flame front and the piston approaching TDC, the combustion chamber pressure rises rapidly causing audible knocking. Detonation and pre ignition typically have a cause and effect relationship; when detonation is prolonged and overheats the spark plug to the point where the tip glows, pre ignition occurs. Preventative measures can be taken to avoid pre ignition by using spark plugs with the correct heat range, avoiding detonation by using fuel with the correct octane rating for your application, and when building an engine, ensuring that there are no machined components with sharp corners in the combustion chamber. Also, the cooling system must be in good working condition to effectively cool the combustion chamber. Sustained operation of an engine in either of these conditions can result in severe engine damage.

At low manifold pressure the flame front is slower due to the low density of mixture in the combustion chamber. Because peak manifold pressure is optimal at 15-20 degrees ATDC and the burn rate is slower at very low manifold pressure, the ignition point must be started earlier. The main ignition map typically has high ignition timing values during times of low manifold pressure and high RPM, which gradually decreases at load increases.

As the throttle is opened, the density of the mixture increases and the flame propagation increases in speed. The timing must be reduced as load and RPM increase to keep the peak pressure at approximately the same point and reduce the chances of knocking.

With forced induction engines, the burn rate increases as charge density is increased. In this example, timing must be reduced because of the faster burn rate, and to further reduce the chances of knocking. On forced induction engines, the inlet charge temperature is elevated because of the heat generated by compressing the air. Utilizing an intercooler or after-cooling system usually helps reduce the inlet charge temperature. But in many cases this still will not bring the inlet charge down to ambient temperature, making the engine more susceptible to knocking.

Remove the spark plugs each time the timing is increased to a higher value and check for signs of detonation. The spark plug is the best indicator of what is happening in the engine because it is such an integral part of the combustion chamber. If you see small flecks of black deposits, or very small shiny beads on the porcelain of the plug, there is a good chance that the engine is knocking. Retard the timing to eliminate the knocking, enrich the mixture, or use a higher octane of fuel.

## 5.2 Ignition Coils

An ignition coil is charged when current flows through the primary side of the coil. A coil driver is required to sink the current and dissipate the heat generated during operation. The coil outputs from the Infinity are used to trigger the drivers. The drivers can either be contained within the coils themselves or they can be contained within a stand-alone device installed between the Infinity and the coils.



There are several different types of ignition systems in use on modern cars. They are:

- Distributed spark using a single coil and a distributor for all cylinders.
- Wasted spark using one coil for two cylinders.
- Direct Fire using one coil on plug of each cylinder.

### Distributed Spark

Distributed spark systems have been around the longest. As the name implies, the spark is distributed to the plugs via a coil output to a rotor, then through the distributor cap to the appropriate plug via a high-tension (HT) lead. This is the most complex system because of the relationship that has to be maintained between the firing point, rotor to cap terminal angle, and engine position. Distributed spark systems also rely on a mechanical link between the engine and ignition output, which adds another dimension of unreliability-and to a minor extent-inaccuracy in timing. In addition to these problems, distributed spark systems typically produce the least intense spark of all ignition systems. The time to achieve full charge diminishes as engine speed

increases; therefore the coil charge is reduced as a function of RPM. In spite of the potential problems with distributed spark systems, they have been used successfully for many years on high-performance engines. Distributed spark ignition systems respond well to spark amplification within their design limits.

### **Wasted Spark**

Wasted spark systems employ one coil for two cylinders. The term “wasted spark” comes from the fact that each plug fires every engine revolution. On a 4-cycle engine, the piston is at Top Dead Center (TDC) two times for every cycle; once for firing and again during the overlap phase. The wasted spark coil fires one plug Before Top Dead center (BTDC) and another plug just before the overlap phase (at the latest part of the exhaust stroke before the exhaust valve closes). Wasted spark systems have a higher potential for spark intensity because the duty of charging and discharging is split between the coils, which allows for more charge time per coil. Additionally, wasted spark systems build up less heat in the coil, making it more reliable. Wasted spark systems have been in use since the mid 80's on GM cars and on motorcycles for considerably longer than that. There are no moving parts, no complicated relationships with a cap and rotor to maintain, and they deliver very accurate spark timing. Furthermore, multi-channel spark amplification systems to enhance spark duration or intensity are available for wasted spark ignition systems.

### **Direct Fire**

Direct fire systems employ one coil on each spark plug and is the most reliable system used today, (this type of system is used on most modern cars). Each coil fires sequentially in the cylinder firing order. The charge time for each coil is twice as long as those of a wasted spark system, which allows direct-fire, coil manufacturers to build compact, lightweight coils that retain sufficient spark energy. There are no moving parts to wear out and no HT leads that will deteriorate. The lack of HT leads in direct fire systems is a major advantage for an EFI-equipped car because there is a very low incidence of noise due to leaking or improperly routed wires. There have been incidences of the terminal from a direct-fire coil (that attaches to the spark plug) cracking and subsequently causing Radio Frequency Interference (RFI) or “noise” to the ECU. This will cause engine operation problems, but it should be noted that these cases are extremely rare.

### 5.3 Combustion Chamber

The combustion chamber plays an important role in the amount of ignition timing that can be used for the various operational phases of an engine. The most common type of combustion chamber design used in contemporary engines is a four-valve/cylinder, pent roof chamber. There are many other types of combustion chambers, such as a wedge, hemispherical, and canted valve, to name a few. Ideally, it is best to initiate flame propagation at the geometric center of the chamber. However, this is typically impossible to do because the spark plug is usually located at the top or edge of the combustion chamber. The reason it is desirable to have the flame front start at the geometric center of the combustion chamber is because there is less chance of auto ignition of the mixture.



A pent roof combustion chamber places the spark plug near the center of the combustion chamber. Wedge combustion chambers are the most sensitive to spark knock because of the distance the flame front must travel within the bore prior to the power stroke.

When ignition occurs, a flame kernel starts at the spark plug electrode and expands

across the combustion chamber. As the front progresses across the chamber, the hot expanding gas compresses and heats the end gasses and mixture at the opposite end of the chamber. If the pressure, and consequently temperature, inside the chamber increases beyond the flash point of the end gas, auto ignition occurs. Because the pent roof type of chamber has a spark plug that is nearer to the geometric center of the chamber, the flame travels more evenly across the combustion chamber, leaving very little end gas that can be compressed or ignited by the advancing flame front. Thanks to the short distance the flame front has to travel in pent roof type chambers, ignition timing usually does not have to be as advanced as much as a wedge type chamber, to achieve maximum torque. We find that there is usually about five to eight degrees less timing required for pent roof combustion chambers than for wedge types.

Charge motion, which is comprised of intake swirl and squish; increase combustion speed when compared to a standard combustion chamber. The combination of these factors increases the mean effective pressure (MEP), lowers fuel consumption, and delivers smaller cycle-to-cycle variations at full throttle operation.

In addition to the performance benefit of effective charge motion, the resulting factors reduce Hc emissions, with a slightly increased Nox component. At partial load the benefits of charge motion vs. a standard combustion chamber are similar, but due to the decrease in density of the intake charge, not very.

The combination of swirl and squish is greater than either squish or swirl alone. Swirl improves mixture preparation and is mostly responsible for reducing ignition delay and cycle-to-cycle variations. Swirl is accomplished through the inlet port design or by using shrouded valves in the combustion chamber. As engine speed increases, the swirl motion increases along with it. Cycle-to-cycle variations decrease with increasing swirl action.

Squish is accomplished via a small gap between the head deck and the piston top. The decrease of this gap drives the inlet charge toward the spark plug electrode. An additional benefit of having this small gap is the reduction of end gas volume at the extreme edges of the cylinder. This reduces the tendency for spark knock and leads to a reduction of Hc emissions.

Cycle-to-cycle variation refers to a situation where an engine operates on the threshold of knocking or detonation throughout the engine cycles and is based on the average peak pressure of all of the cycles. The cycles with lower peak pressures may not be prone to detonation, while those with higher peak pressures may detonate with increasing intensity as peak pressure increases. Increasing this cyclic variation will increase the number of cycles that detonate, and decreasing the number leads to less cycles that detonate.

Ignition Delay is the point at which perceptible inflammation of the mixture and a

pressure rise in the combustion chamber occurs. The time between when spark occurs at the spark plug and when inflammation of the mixture occurs is the delay time. This delay is caused by the chemical reactions that take place when the rate of reaction after the delay accelerates to an extent that noticeable combustion and a rise in cylinder pressure and temperature occurs. The chemical reaction within and on the surface of the initial flame kernel causes energy to be released during the ignition delay period. When the flame front is at this initial stage of propagation there are energy losses via conduction, radiation, and convection of heat. If too much of this energy is lost, the mixture will fail to propagate and a misfire will result.

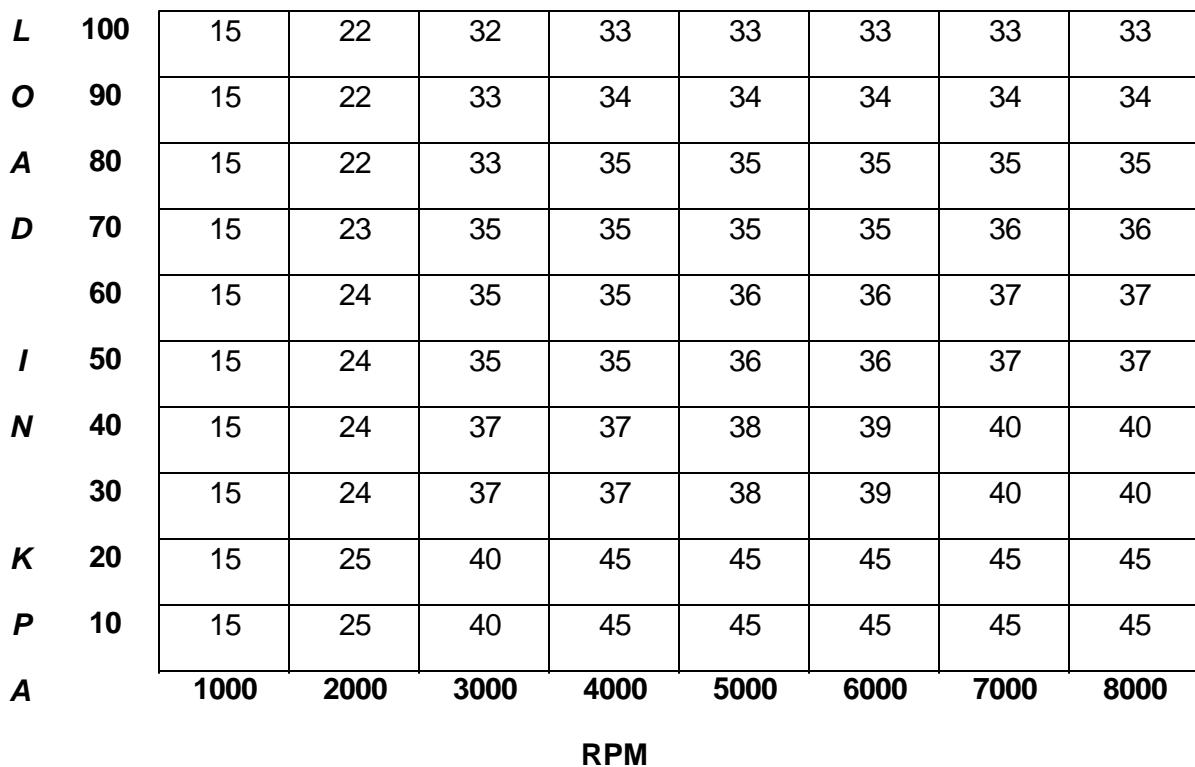
As compression ratio increases the requirement for charge motion in the chamber is reduced. Engines that have high compression ratios generally require reduced ignition timing requirements due to the increased flame speed. The design of the combustion chamber in a high compression engine is necessarily small. The compactness of the chamber imparts its own charge motion and squish into the mixture.

We have included some sample ignition timing maps for gasoline engines that are typical for use on a street car. These examples include a naturally aspirated engine, forced-induction engine, and a high-compression engine. **These are conservative samples that should be used as a starting point only.**

***The tuner of the engine must use good judgment when selecting the appropriate timing map for the engine.***

*Naturally Aspirated Piston Engines W/ Pent roof  
Combustion Chamber*

**Ignition Timing**



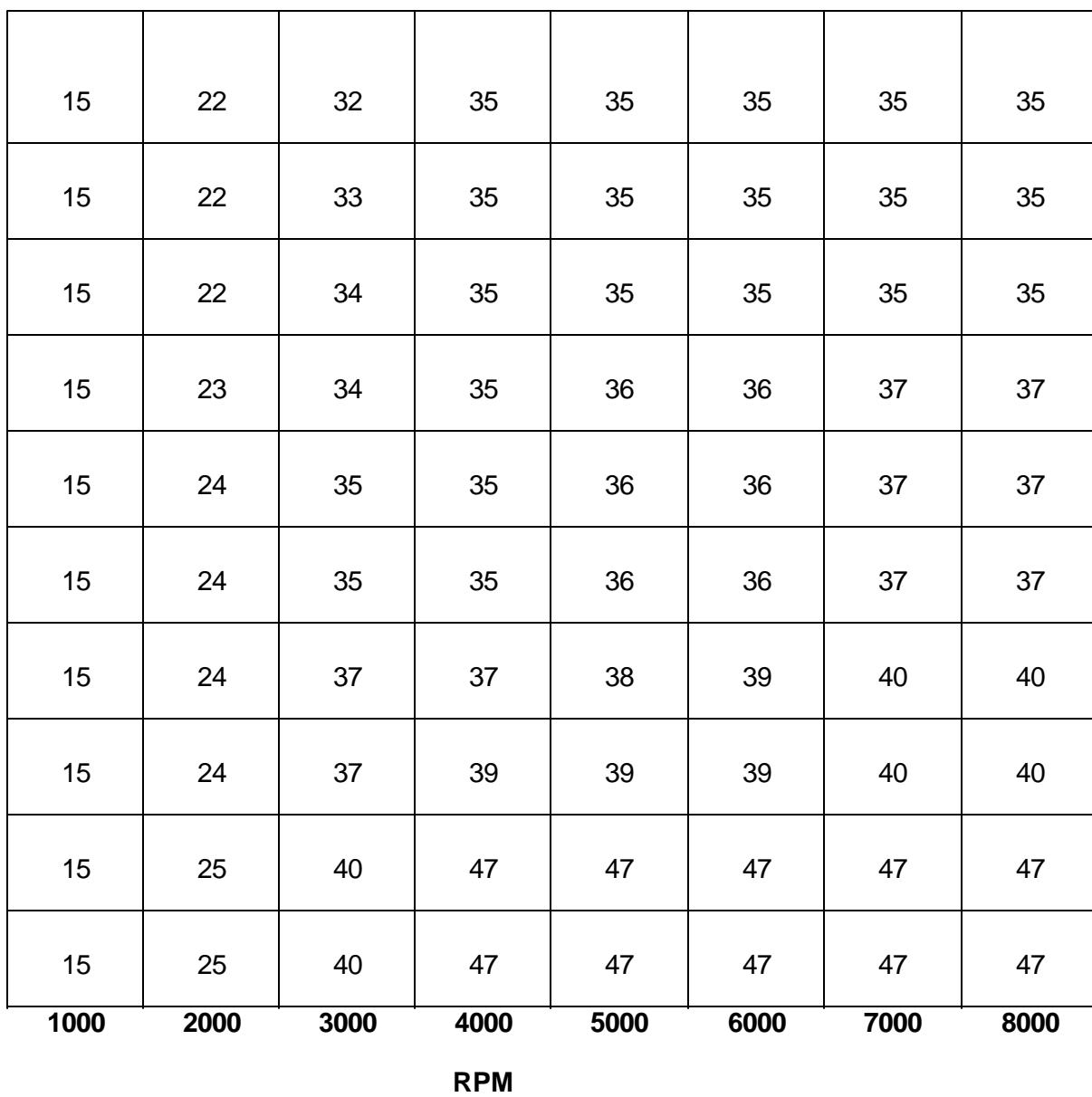
*Turbocharged Piston Engines W/ Pent roof Combustion Chamber*

**Ignition Timing**

L	300	11	14	23	23	24	24	24	24
O	275	11	15	24	24	25	25	25	25
A	250	11	15	24	24	26	26	26	26
D	225	11	16	24	26	27	27	27	27
	200	12	17	26	27	27	27	27	27
	175	12	19	28	29	29	29	29	29
I	150	12	20	29	30	30	30	30	30
N	125	12	20	30	30	31	31	31	31
	100	15	22	32	33	33	33	33	33
K	75	15	23	35	35	35	35	36	36
P	50	15	24	35	35	36	36	37	37
A	25	15	25	40	45	45	45	45	45
		1000	2000	3000	4000	5000	6000	7000	8000
		RPM							

**Naturally Aspirated Piston Engines W/Wedge  
Combustion Chamber**

**Ignition Timing**



*Turbocharged Piston Engines W/Wedge Combustion  
Chamber*

**Ignition Timing**

<i>L</i>	<b>300</b>	11	14	23	23	24	24	24
<i>O</i>	<b>275</b>	11	15	24	24	25	25	25
<i>A</i>	<b>250</b>	11	15	24	24	26	26	26
<i>D</i>	<b>225</b>	11	16	24	26	27	27	27
	<b>200</b>	12	17	26	27	27	27	27
	<b>175</b>	12	19	29	30	30	30	30
<i>I</i>	<b>150</b>	12	20	30	31	31	31	31
<i>N</i>	<b>125</b>	12	20	32	32	33	33	33
	<b>100</b>	15	22	34	35	35	35	35
<i>K</i>	<b>75</b>	15	23	34	35	36	36	37
<i>P</i>	<b>50</b>	15	25	40	47	47	47	47
<i>A</i>	<b>25</b>	15	25	40	47	47	47	47
		1000	2000	3000	4000	5000	6000	7000
					8000			
						<b>RPM</b>		

## 5.4 TPS (Throttle Position Sensor)

The TPS determines the position of the throttle blade in the throttle body. This input is used to determine rate of throttle angle change (both positive and negative), idle position, and discrete throttle opening for TPS-based calibrations. The TPS typically is a potentiometer bolted to the end of the throttle shaft. Rotating the throttle varies the resistance, and consequently, the voltage returned to the ECU is a function of that resistance. The rate of change is measured to determine whether a vehicle is accelerating or decelerating. Based on this rate of change, the proper amount of fuel is either added or subtracted from the base calibration to achieve the proper amount of fuel for the operating condition.



The TPS is also used to determine if the vehicle is idling. When the throttle is at rest, the vehicle is considered to be either idling or under heavy deceleration, and the fuel and ignition calibrations are adjusted for optimum idle characteristics. The TPS can be used as a calibration input if the AEM Infinity is set up to be a throttle position vs. RPM based mapping scheme. This type of mapping allows the tuner to set up the fuel map based on the throttle angle from 0 to 100% on the Y-axis of the map, with the X-axis being RPMs. This type of mapping is usually best for naturally aspirated racing engines with individual runner inlet manifolds and no plenum chamber or very aggressive cams.

While on the subject of throttle opening we must caution you to make sure that full throttle is achieved by having someone verify that the throttle blade is opening fully and up against the stop on the throttle body while you depress the throttle. Also, make sure that nothing interferes with the full range of the throttle opening, such as a floor mat.

## 5.5 MAP (Manifold Absolute Pressure)

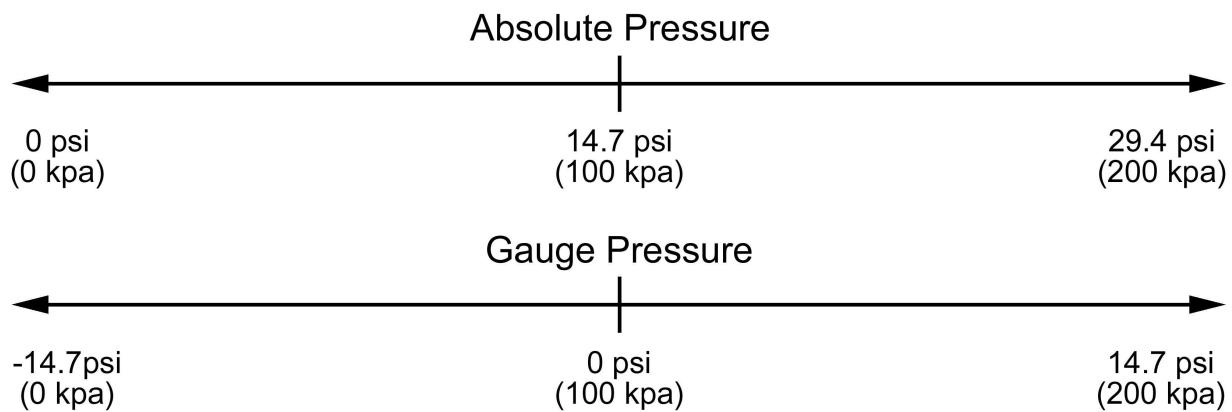
Before any discussion is held of what a MAP sensor is, it is necessary to understand what manifold pressure is. The definition of pressure is the force per unit area, thus it is an intensive quantity formed as a ratio force and area. So if a 100-pound force is exerted on a piston that has a total area of 100 in<sup>2</sup> the pressure acting on each square inch is 100lb/100 in<sup>2</sup> or 1 PSI. If the same force were to be applied to a piston with an area of only 1 in<sup>2</sup> the pressure exerted on the piston would be 100 lb/ 1 in<sup>2</sup> or 100 PSI. Now consider if a 100-pound person stepped on a nail that has a tip that is only .010" diameter. This would yield a pressure of 10,000 pounds. (100 lb / .010 in<sup>2</sup> = 10,000 pressure)

Realistically, there is no such thing as "manifold vacuum," just low manifold pressure. The average air pressure exerted on Earth under standard conditions is 14.7 psi or 101.325 kilopascals (kpa). An engine ingests air by creating a differential of pressure across the engine via the movement of the pistons in their bores. When a piston moves down the bore, pressure in the bore is reduced. When the inlet valve opens, the awaiting relative higher-pressure air above the inlet valve enters the chamber and fills the void caused by the motion of the piston in the bore. On an engine without a means of forcing air into the engine, the most this pressure can be is whatever the atmospheric pressure of the day is. At sea level the average pressure is 14.7 psi.

It is common to refer to low manifold pressure as vacuum, which is how we will refer to low pressure for the purposes of this discussion. Pressure is measured in two ways: one is absolute pressure, and the other is gauge pressure. The difference between these is where the zero point of each scale starts. With absolute pressure, zero is a complete void of all pressure. With the more common gauge pressure, zero is at standard atmospheric pressure (14.7 psi). Anything below 14.7 psi is referred to as vacuum and anything above that is referred to as boost or positive pressure.

Closed or very small throttle angles are associated with low manifold pressure (a vacuum on the gauge measuring style), and large throttle angles or full throttle is considered high manifold pressure (0 on the gauge measuring style).

Typical boost or vacuum gauges used in automotive applications use the gauge type of readout. In automotive engineering, the absolute method of measuring pressure is used. To illustrate the different ways to read manifold pressure refer to the accompanying chart.



We find it easiest to work with the accepted standard of kilopascals (kpa) of absolute pressure. It is important to know the relationships of the various nomenclatures of pressure. The units of pressure in use today are;

1 bar (b) = 100 kilopascals (kpa) = 14.5 psi = 29.529" Hg  
1 atm. = 101.325 kpa = 14.7 psi = 29.92" Hg = 1.01325 b

PSI Absolute	Kpa	Inches Hg	Bar	Pressure Gauge
1.00	6.89	2.04	0.07	-27.89 in Hg
2.00	13.79	4.07	0.14	-25.86
3.00	20.68	6.11	0.21	-23.82
4.00	27.58	8.14	0.28	-21.79
5.00	34.47	10.18	0.34	-19.75
6.00	41.37	12.22	0.41	-17.71
7.00	48.26	14.25	0.48	-15.68
8.00	55.16	16.29	0.55	-13.64
9.00	62.05	18.32	0.62	-11.61
10.00	68.95	20.36	0.69	-9.57
11.00	75.84	22.40	0.76	-7.53
12.00	82.74	24.43	0.83	-5.50
13.00	89.63	26.47	0.90	-3.46
14.00	96.53	28.50	0.97	-1.43
<b>14.70</b>	<b>101.35</b>	<b>29.93</b>	<b>1.01</b>	<b>0</b>
15.00	103.42	30.54	1.03	0.3 psi
16.00	110.32	32.58	1.10	1
17.00	117.21	34.61	1.17	2
18.00	124.11	36.65	1.24	3
19.00	131.00	38.68	1.31	4
20.00	137.90	40.72	1.38	5
21.00	144.79	42.76	1.45	6
22.00	151.68	44.79	1.52	7
23.00	158.58	46.83	1.59	8
24.00	165.47	48.86	1.65	9
25.00	172.37	50.90	1.72	10
26.00	179.26	52.94	1.79	11
27.00	186.16	54.97	1.86	12
28.00	193.05	57.01	1.93	13
29.00	199.95	59.04	2.00	14
30.00	206.84	61.08	2.07	15
31.00	213.74	63.12	2.14	16
32.00	220.63	65.15	2.21	17
33.00	227.53	67.19	2.28	18
34.00	234.42	69.22	2.34	19
35.00	241.32	71.26	2.41	20
36.00	248.21	73.30	2.48	21

**Bold type is standard atmosphere**

Vacuum in Hg"

Standard ATM

Pressure in PSI

The MAP sensor provides manifold pressure information to the ECU for calibration based on MAP vs. RPM. The MAP information is used in both the fuel and ignition Y-axis of their respective maps. On racing engines that use individual runner manifolds, a TPS based fuel map can be used while the ignition can be MAP based. This is desirable because the ignition should always be load based to provide knock free operation.

A MAP sensor reads in absolute pressure, just like the name implies. The amount of pressure indicated by the sensor depends on the amount of voltage feedback delivered to the ECU. As the throttle is opened and closed, or boost is built up in the manifold, the sensor reacts to the changing pressure and outputs a voltage signal to the ECU based on the given pressure.

The MAP sensor has three leads: 5V+ into the MAP sensor, a return to the ECU based upon the resistance of the MAP sensor, and a ground. A MAP sensor MUST have a hose routed to it from the inlet manifold in order to read manifold pressure and it MUST receive a constant pressure signal to it at all times. If the pressure signal fluctuates, the calibration will be adversely affected because the fuel and ignition values will cycle with the MAP signal.



To avoid varying MAP signals, the pressure line must be connected to the intake plenum. In the case of individual runner manifolds, TPS-based mapping is best.

If a MAP sensor is used for boost compensation or load sensitive ignition timing, an accumulator must be used. An accumulator is a common closed container that has a hose from each runner routed to it. An accumulator dampens the pulsing commonly found in this type of manifold set up, which will aid in the delivery of a steady MAP signal. Note: A fuel pressure regulator can have its pressure source routed to an accumulator for the same reasons.

The AEM Infinity has a variety of MAP sensor ranges to suit everything from naturally aspirated engines, to forced induction engines up to whatever boost can be generated by the turbo or supercharger(s).

## 5.6 IAT (Inlet Air Temperature)

Manifold Air Temp Sensors (MAT) and Inlet Air Temp Sensors (IAT) are variable resistance thermistors that send a return voltage signal back to the ECU based on the inlet air temp either in the inlet manifold or in the inlet duct to the throttle body. The ECU outputs a +5V power to the sensor and the return voltage is based on the resistance of the sensor. These sensors are also used as auxiliary temp sensors for any air temp measurement, such as intercooler inlet and outlet temps.



The AEM Infinity is compatible with virtually all MAT & IAT sensors. Based on the inlet air temp readings provided by an MAT or IAT, an ECU can add or subtract fuel or

ignition timing depending on the given conditions. For example, a typical use for an IAT sensor is to change the ignition timing and fueling of an engine based on inlet air temp. This is particularly useful on forced induction engines where inlet air temps can increase dramatically.

**For more information, go to Air Temperature**

## 5.7 CLT (Coolant Temperature)

The coolant temperature sensor (CLT) is a variable resistance thermistor (thermal resistor) that sends a return voltage back to the ECU based on the temperature of the engine coolant. This sensor can also be used for virtually any other type of automotive fluid if it is located in that liquid's respective reservoir. Unlike other types of sensors that emit voltage signals to the ECU, with CLTs the ECU outputs a +5V signal to the CLT and the sensor's resistance determines the return voltage. The AEM Infinity is compatible with virtually all CLT sensors.



The CLT provides the ECU with engine temp information. The AEM Infinity modifies the base fuel calibration during start and warm up based on the CLT input. In addition to adding fuel, a CLT can signal to the ECU to modify ignition timing at varying engine temps for optimum performance. On race cars, ignition timing is typically advanced during warm up to heat the engine faster. Race cars use an ignition based warm up because usually idle speed motors are not used. On streetcars, where clean emissions are important, we reduce timing based on CLT input to light the catalytic converter(s) off sooner.

**For more information, go to Coolant Temperature**

## 5.8 O2 (Oxygen Sensor)

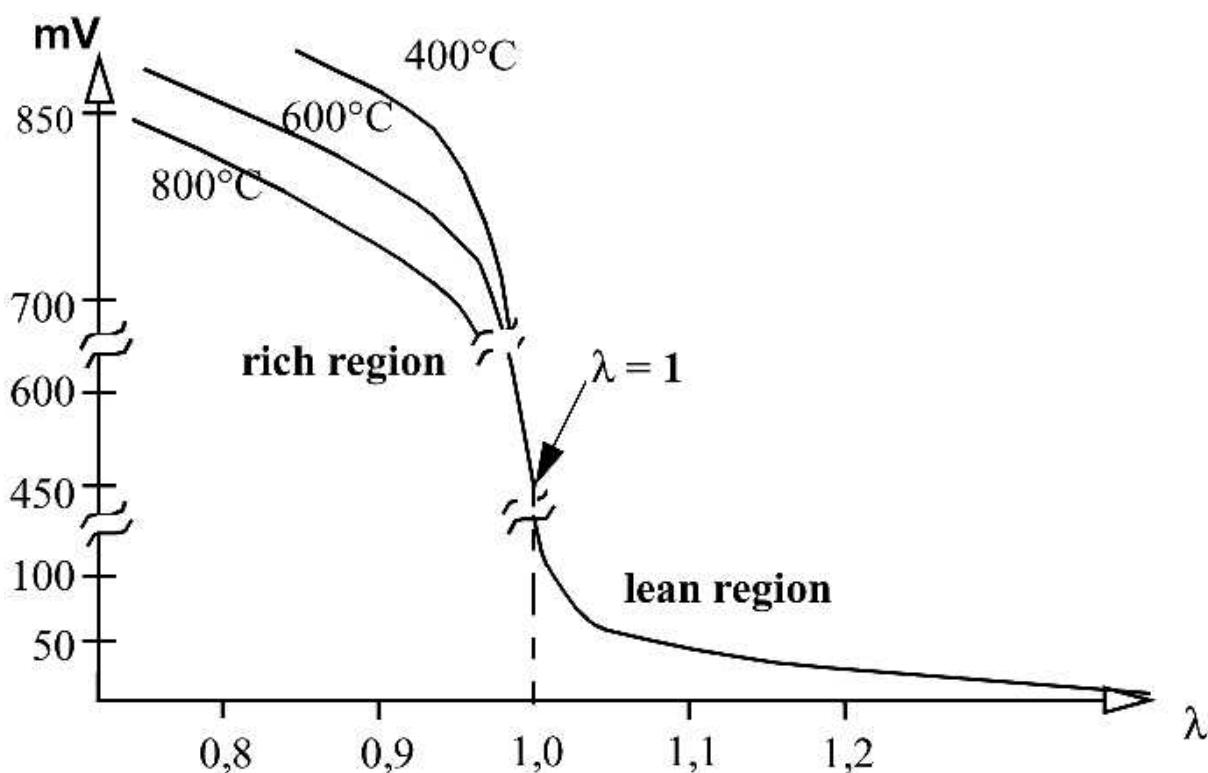
There are many types of O2 sensors that are employed by vehicle manufacturers, and it is well beyond the scope of this manual to describe all of them. An O2 sensor provides a reading of the air/fuel ratio (AFR) to the ECU so that it can make the necessary fuel calibration corrections to achieve a desired Air Fuel Ratio (AFR).



An O2 sensor works by sensing whether there is an abundance or lack of oxygen in the exhaust gases, depending on whether the gas mixture is too rich or too lean. If there is excess oxygen and the mixture is too lean, output voltage from the O2 sensor to the ECU will be high. The ECU may then compensate by adding fuel. The converse is true of rich mixtures.

Common O2 sensors include 3, 4, and 5-wire heated or wide-band sensors. Three- and 4-wire sensors are ideal for determining whether a vehicle's AFR is at the optimum stoichiometric ratio. Stoichiometric ratio refers to the ideal mixture of fuel and air by mass to completely consume both reactants (gas and air) with nothing left over. Based on the properties of most pump gasoline used today this ratio is typically a 14.64:1 air/fuel ratio. Although this ratio provides the best combustion characteristics with the least emissions output and optimum catalytic converter performance, it is NOT the best AFR for maximum power at full throttle or under boost. This mixture is too lean and may cause engine damage.

Typical production vehicle oxygen sensors rely on "Nernst Cell" technology, commonly called "Narrow Band" and sometimes erroneously described as "Wide Band". This is a very cost effective method that outputs a voltage based on the oxygen content of the gas being sampled. It is accurate in the region surrounding stoichiometric operation and leaner. Unfortunately, in the rich region where high performance engines usually operate, their accuracy and repeatability is virtually non-existent.



### Characteristic curve of a Nernst Cell O<sub>2</sub> Sensor

The rich region output of narrow band O<sub>2</sub> sensors is temperature dependent, which renders it useless if an accuracy better than 1.5:1 AFR is desired. This is immediately obvious given the fact that a single output voltage actually represents wildly different air fuel ratios depending on the unregulated and unmeasured sensor temperature. These sensors were designed for operating closed loop around stoichiometry (14.64:1 for gasoline), and for performance tuning they are useless.

The AEM Infinity includes dual internal UEGO controllers. Only a Bosch LSU4.2 UEGO Sensor may be used. This system is accurate and repeatable to 0.1 of an air/fuel ratio point. With this, there is no abrupt oscillation as found in many competitor systems, which typically utilize a narrow band oxygen sensor detecting only stoichiometry. This type of UEGO sensor is commonly referred to as “laboratory grade” and works on a different principle than the narrow band oxygen sensor found in most vehicles. Its unique design makes precision AFR measurements possible over the entire operating range.

UEGO sensors use a “current pump” to determine the actual oxygen concentration within the sensing element or. The output is in the form of a very small current, which varies depending on the air-fuel ratio. This is completely different from a narrow band oxygen sensor, which directly outputs a voltage. The UEGO sensor design allows measurement of the exact air fuel ratio over the entire operating range.

The following is a chart of typical AFRs. **Note that every engine is different and this may not be the optimum set up for your particular vehicle.** The AFRs on this chart are very conservative to minimize the potential for engine damage. These AFRs depend on the condition that ignition timing and fuel octane are adequate enough to prevent knocking. The very low loads found in the lower right corner occur during deceleration, and because there is no “work” being done by the engine, AFRs during deceleration can be very lean. We have seen AFRs of 20.0:1 during deceleration runs.

### *Naturally Aspirated Piston Engines W/ Pent roof Combustion Chamber*

		<i>Air/Fuel Ratio</i>							
		13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	12.8:1	12.8:1
<b>L</b>	<b>100</b>	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	12.8:1	12.8:1
<b>O</b>	<b>90</b>	13.5:1	13.5:1	13.5:1	13.5:1	13.5:1	13.5:1	13.5:1	13.5:1
<b>A</b>	<b>80</b>	14.0:1	14.0:1	14.0:1	14.0:1	14.0:1	14.0:1	14.0:1	14.0:1
<b>D</b>	<b>70</b>	14.0:1	14.2:1	14.2:1	14.2:1	14.2:1	14.2:1	14.2:1	14.2:1
	<b>60</b>	14.0:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1
<b>I</b>	<b>50</b>	14.0:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1
<b>N</b>	<b>40</b>	14.0:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1
	<b>30</b>	14.0:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1
<b>K</b>	<b>20</b>	14.0:1	14.7:1	14.7:1	14.7:1	14.7:1	15:1	15:1	15:1
<b>P</b>	<b>10</b>	14.0:1	14.7:1	14.7:1	15:1	15:1	15:1	15:1	15:1
									<b>Maximu</b>
<b>A</b>	<b>Idle</b>								
<b>RPM</b>									

### *Turbocharged Piston Engines W/ Pent roof Combustion Chamber*

#### Air/Fuel Ratio

<b>L 300</b>	13.0:1	12.5:1	12.2:1	12.2:1	12.2:1	12.2:1	12.2:1	12.2:1
<b>O 275</b>	13.0:1	12.8:1	12.5:1	12.5:1	12.2:1	12.2:1	12.2:1	12.2:1
<b>A 250</b>	13.0:1	12.8:1	12.5:1	12.5:1	12.2:1	12.2:1	12.2:1	12.2:1
<b>D 225</b>	13.0:1	12.8:1	12.8:1	12.8:1	12.5:1	12.5:1	12.5:1	12.5:1
<b>200</b>	13.0:1	12.8:1	12.8:1	12.8:1	12.5:1	12.5:1	12.5:1	12.5:1
<b>I 175</b>	13.0:1	13.0:1	13.0:1	12.8:1	12.8:1	12.8:1	12.8:1	12.8:1
<b>N 150</b>	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	12.8:1	12.8:1
<b>125</b>	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	12.8:1	12.8:1
<b>K 100</b>	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	13.0:1	12.8:1	12.8:1
<b>P 75</b>	14.0:1	14.2:1	14.2:1	14.2:1	14.2:1	14.2:1	14.2:1	14.2:1
<b>A 50</b>	14.0:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1
<b>25</b>	14.0:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1	14.7:1

**Maximu  
m**

**Idle**

**RPM**

The AFR is often referred to as a Lambda ( $\lambda$ ) number. A Lambda of 1.00 is equal to the stoichiometric ratio for the reactants in a system. For our purposes, the stoichiometric ratio is the ratio for the amount of ANY fuel used in an internal combustion engine. With Lambda measurement, any number higher than 1.00 is considered lean (more air than necessary to react with the fuel) and any number lower than 1.00 is considered rich.

Although Lambda is the term most often used when working with O<sub>2</sub> sensors, we will use AFR in this manual because it is the most common term used when referring to internal combustion engines. The following is a chart for converting Lambda values to AFRs.

**Lambda to AFR conversion chart**

Lambda	AFR	Lambda	AFR	Lambda	AFR	Lambda	AFR
1.3	19.03	1.14	16.69	0.98	14.35	0.82	12.00
1.29	18.89	1.13	16.54	0.97	14.20	0.81	11.86
1.28	18.74	1.12	16.40	0.96	14.05	0.8	11.71
1.27	18.59	1.11	16.25	0.95	13.91	0.79	11.57
1.26	18.45	1.1	16.10	0.94	13.76	0.78	11.42
1.25	18.30	1.09	15.96	0.93	13.62	0.77	11.27
1.24	18.15	1.08	15.81	0.92	13.47	0.76	11.13
1.23	18.01	1.07	15.66	0.91	13.32	0.75	10.98
1.22	17.86	1.06	15.52	0.9	13.18	0.74	10.83
1.21	17.71	1.05	15.37	0.89	13.03	0.73	10.69
1.2	17.57	1.04	15.23	0.88	12.88	0.72	10.54
1.19	17.42	1.03	15.08	0.87	12.74	0.71	10.39
1.18	17.28	1.02	14.93	0.86	12.59	0.7	10.25
1.17	17.13	1.01	14.79	0.85	12.44	0.69	10.10
1.16	16.98	1	14.64	0.84	12.30	0.68	9.96
1.15	16.84	0.99	14.49	0.83	12.15	0.67	9.81

## 5.9 KNK (Knock Sensor)

The knock sensor is like a microphone mounted to the engine block that is used to detect combustion knock. Every engine is different with respect to the amount of noise it generates. In most production engines, the sensitivity of the knock sensor is based on an average noise profile generated during dyno testing. A knock sensor that has a slightly lower threshold of sensitivity to knock is used to compensate for variances in engine noise. When the engine makes noise in frequencies and amplitude higher than the baseline noise profile, the sensor senses knock and the ECU reduces ignition timing until the noise (knock) is suppressed. Engines that have knock sensors on them from the factory need to have the baseline noise profile recorded when setting up the AEM Infinity.

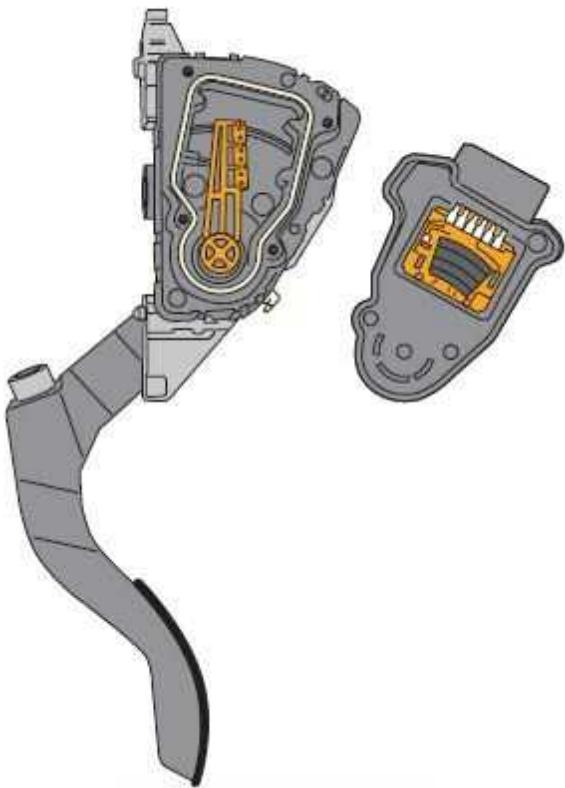


For information on tuning with knock sensors, go to [Knock Control](#) [203]

## 5.10 PPS (Pedal Position Sensor)

For safety, modern cars use electronic throttle control (ETC) or sometime called drive-by-wire (DBW) throttle bodies. The butterfly valve is no longer directly controlled by the throttle pedal via a simple cable. The ECU relies on inputs from the pedal position sensors and other inputs from various sensors. An output is then provided to control the DBW motor.

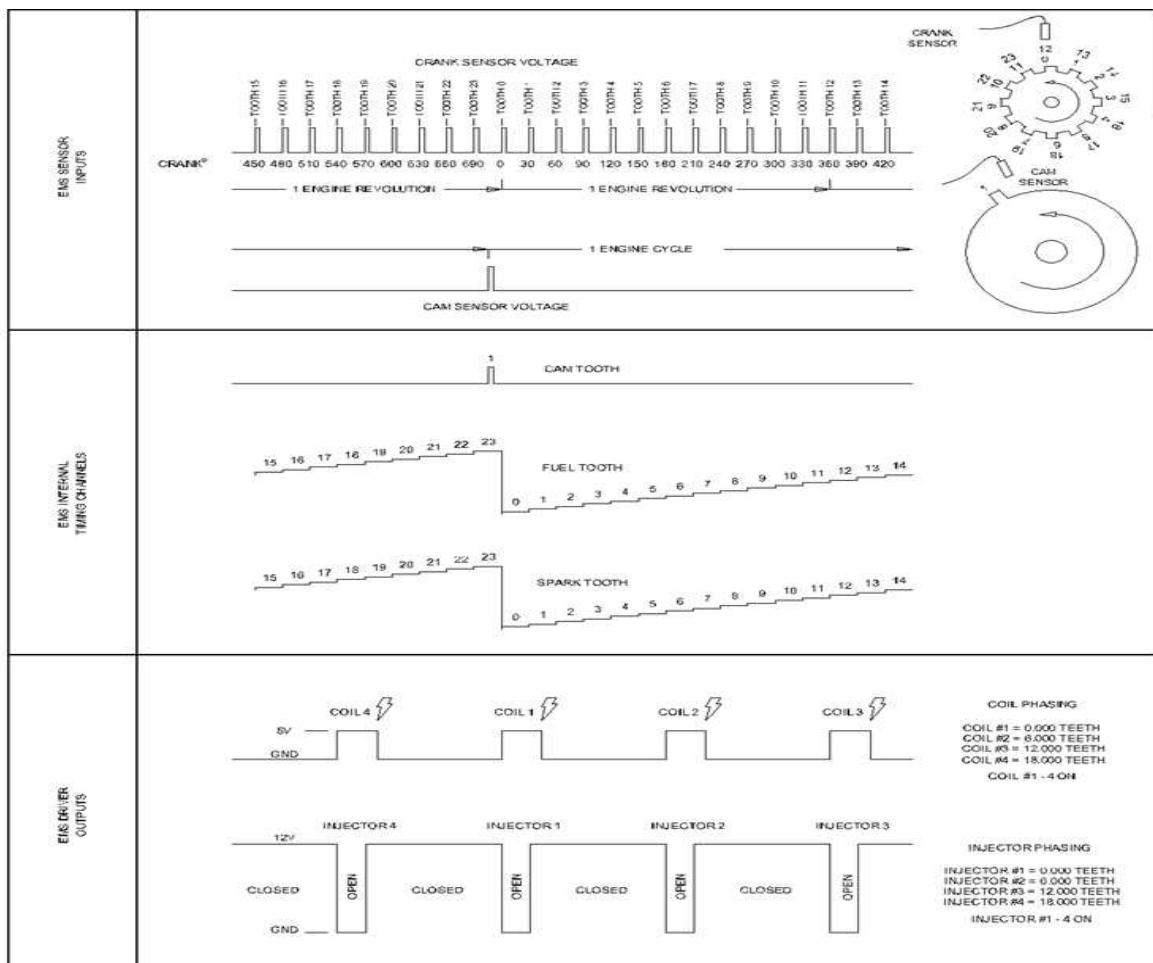
The PPS is similar to a TPS as they are both potentiometers. However, instead of mounted on the butterfly valve, PPS are mounted on the throttle pedal. Pushing in the "gas" affectively rotates the pedal and varies the resistance. Consequently, the voltage returned to the ECU is a function of that resistance. The rate of change is measured to determine whether a vehicle is accelerating or decelerating. Based on this rate of change, the proper amount of fuel is either added or subtracted from the ECU calibration to achieve the proper amount of fuel for the operating condition.



## 5.11 CMP/CKP (Cam/Crank Position)

Cam and crank position sensors are typically either VR (Variable Reluctance) "Mag" or Hall Effect. Hall Effect sensors use three wires and produce a digital square wave. VR sensors use two wires and produce an analog sinusoidal wave. VR sensors are better for high temperature applications and are less expensive than "Hall" sensors.

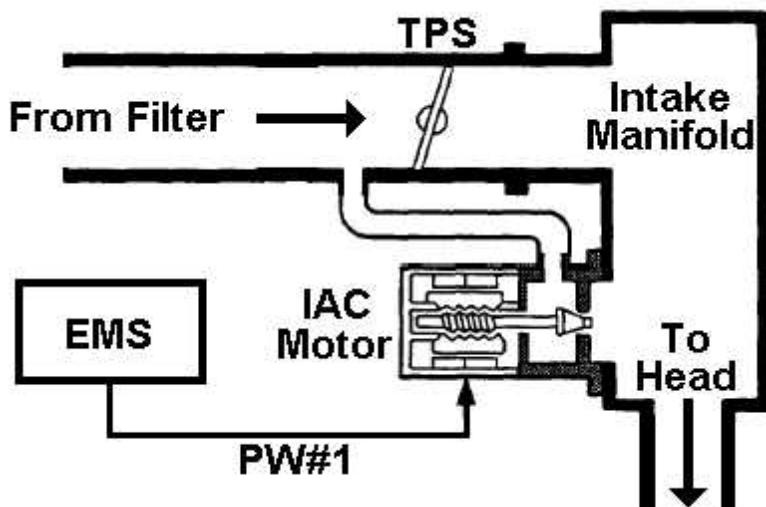
When the "teeth" on a toothed wheel pass by a sensor, the sensor creates a voltage pattern that is used by the ECU for many important calculations. The example above shows two different toothed wheels, one that rotates with the crankshaft. The other rotates with the camshaft (1/2 engine speed). Representative voltage signal patterns for one complete engine cycle (2 revolutions) are also shown. The calibration file must contain the proper settings to define this pattern for the ECU.



The diagram above illustrates a very basic even tooth pattern along with fuel output phasing and spark output phasing setups. Many different crank and cam input configurations are possible with an AEM Infinity, however, the firmware used is specific to the timing pattern.

## 5.12 IAC (Idle Air Control)

Idle air control (IAC) systems are used to stabilize idle speed during cold engine and after warm-up operations. The IAC system regulates the volume of air bypassed around a closed throttle butterfly valve. The Infinity controls the IAC system by applying various input signals from the user-programmable software file. There are two major types of IAC systems. The stepper idle air control motor is, typically used by Toyota, Dodge, Mitsubishi, etc. The pulse width idle air control valve is commonly used by Honda, Subaru, Ford, Nissan, Volkswagen, etc. This instruction manual will address both types of IAC systems.



The stepper motor IAC valve (shown below) consists of a step-motor with a seat, magnetic rotor, valve, four wires to each of the four coils and can vary bypass airflow by positioning its valve into one of many possible steps. Basically, the higher the IAC valve step number, the larger the airflow opening and the greater the volume of air bypassed around the closed throttle. However, if a voltage pulse is applied backwards, the motor will step in the other direction. The motor step will open or close, based on the number of pulses and the direction desired.



The advantage of a step type IAC motor is that once the motor is in the proper location, no signal or power is required to maintain this position. The only time action needs to be taken is when changing the location of the motor. The downside is there is an uncertainty to where the motor is at any given time. This can be overcome by routinely resetting the IAC motor to a known location. With tuning, this is achieved by stepping the motor all the way to its limit. However, this may damage the motor if not set correctly. This will reset the motor.

Stepper motors do not have a position sensor. The location at engine start has to be assumed since there is no time for it to reset. Therefore, it must be parked in a known location when the engine is turned OFF. Parking of the stepper motor is crucial. After the engine is shut off, the Infinity keeps power to the main relay and then resets and parks the stepper motor. This takes about 5-7 seconds and is usually unnoticed by the user.

The other major IAC system is a pulse width duty cycle valve, shown below. This system regulates air bypass volume by utilizing a duty cycle controlled solenoid. This electric solenoid controls an air valve which blocks passage of air from the intake pipe to the intake manifold. Since this solenoid is incapable of flowing high air volume, a separate mechanical air valve is typically used to perform cold fast idle. With this type system, the Infinity varies bypass airflow by changing the duty ratio of the command signal to the IAC valve. By increasing the duty ratio, the Infinity holds the air bypass valve open longer, causing an increase in idle speed.



The advantage of this type of IAC system is that it does not need to park and because it does not take steps, the valve is always at a known position. The disadvantage of this type of IAC system is that power is required to maintain idle unlike the stepper motor type. Pulse width idle air control systems also require specific frequencies to operate.

**For more information, go to [Idle](#)**

## 5.13 FCS (Fuel Composition Sensor)

The Fuel Composition Sensor (FCS) is used for "flex" fuel. These vehicles can run on a more environmental friendly ethanol based fuel which is commonly made from sugar cane or corn. It has roughly 30% less energy than standard pump gas, depending on the blend. E85 is the most common blend, which consists of 85% ethanol and 15% petroleum. This lack of energy does a couple things; causes an increase in fuel consumption, but increases the air/fuel cooling characteristics as more fuel is required. Furthermore, ethanol has a much higher latent heat of evaporation than gasoline which also increases the cooling efficiency properties.

The Infinity flex fuel system is based around the use of GM sensor P/N: 12570260 (shown below) which outputs a varying frequency signal depending on the fuel composition and temperature.



This information can then be used to add more injector pulse width, advance the ignition timing, and add boost pressure, if applicable.

For more information, go to [Flex Fuel](#) 

## Fuel System Setup

### 6.1 Fuel Plumbing

Even with proper injector and fuel pump sizing, a fuel system will not flow adequately unless the hoses that deliver the fuel to the fuel rail are of sufficient size and are routed properly. On systems that use the PNP version of the AEM Infinity, there is no need to replace the fuel delivery hoses unless the engine is heavily modified.

**NEVER** route fuel hoses through the interior of a car. Put bluntly, this is a **dangerous** thing to do. Whenever possible, use a delivery tube to make the connection from the pump discharge to the filter in the front of the car. The lines should be rated to withstand at least twice the maximum pressure of the EFI system.

Using the above parameters of our sample engine with moderate boost, we expect to see pressures in the 65-70 psi range. This will require a line with at least 140-psi rating (most AN hoses exceed this by a large margin). When routing fuel lines, it is imperative that they are protected from road hazards and the exhaust system. The fuel line should **NEVER** be routed near battery cables. Use clamps to secure AN hose every 15 inches, or 24 inches if a rigid tube is used.

The following table will help you determine which hose size is correct for your application: These sizes are based on a nominal fuel pressure of 40 psi.

### Fuel Delivery Hose Sizes

#### Gasoline Powered Engines

Up to 499 HP	.344" hose	-6 AN
500 - 799 HP	.437" hose	-8 AN
900 - 1100 HP	.562" hose	-10 AN

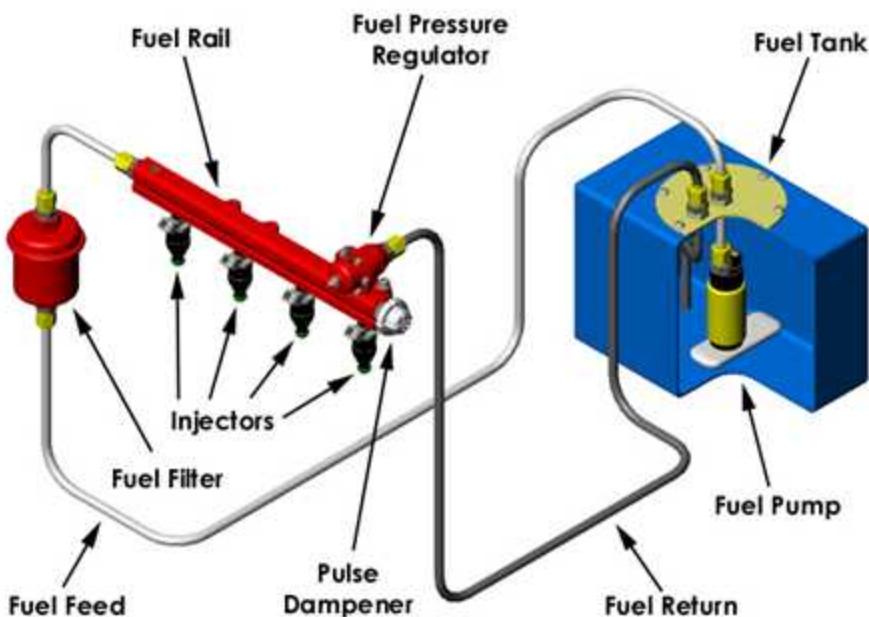
#### Methanol Engines

Up to 499 HP	.437" hose	-8 AN
500 - 799 HP	.562" hose	-10 AN
900 - 1100 HP	.687" hose	-12 AN

The above table should be used for typical passenger car applications. However, for custom applications the hose run length will affect fuel delivery. If you have a long hose run, then the actual flow will have to be determined by running the fuel pump into a graduated cylinder, then measuring the flow vs. time and calculating the flow in gallons per hour (g/h). Also note that if fuel banjos are used in the system be sure they have adequate fuel flow capability.

The fuel return hoses should be one size smaller than the delivery hose. For the sample engine described above, we would use a .437" (-8 AN) delivery hose and a .344" (-6 AN) return hose.

Before a fuel system is assembled in the vehicle, inspect for debris and damages. Make sure to have a fire extinguisher near by in case of fire when inspecting. After the fuel system is installed you must inspect the integrity of the entire system. Begin by purging the lines. To do this, run the fuel pump with the hose that connects to the fuel rail placed in a grounded container. This will eliminate any debris left in hose during its manufacturing process. Inspect the fuel rail for cleanliness before starting the engine. Make sure that the fuel pressure is set correctly for your application. Then, reattach all of the hoses and run the fuel pump by switching the ignition to the "ON" position (**DO NOT** turn over the engine at this time), and visually inspect all of the connections for fuel seepage or leaks. If any seepage or leaks are present in the system, repair them before proceeding.



## 6.2 Fuel Pump

To achieve proper fuel delivery, you must select the right fuel pump for your vehicle. In most cases, where the engine has been modified only with “bolt on” performance items, there is rarely need for a larger fuel pump or larger injectors. Vehicle manufacturers typically design a “safety factor” into the fuel pump to accommodate the deterioration of the fuel system over time. This safety factor is intended to compensate for a fuel filter that is nearing the end its life, or for deposits in the injector orifice. Our research has revealed that generally there is about a 15%-20% oversize in most factory fuel pumps.



If the engine is enhanced via forced induction or nitrous oxide, the stock fuel pump is inadequate. **If the engine's power is increased more than 15-20% fuel delivery must increase as a factor of the power gain.**

The way to determine the proper-size fuel pump is based on the desired brake specific fuel consumption (BSFC) of the engine. This term refers to how much fuel in pounds per hour (pph) the engine consumes per horsepower and is a measure of the efficiency of the engine. It is a useful term in determining the total fuel requirement of the engine. On vehicles equipped with forced induction or nitrous oxide, higher BSFC's are required as an added measure of safety to prevent detonation or high combustion chamber temperatures. Below is a guide of BSFC's with standard CR that AEM uses for various engines that run on gasoline:

- Naturally Aspirated engines have a BSFC of .48 to .50
- Forced Induction engines have a BSFC of .65 to .68

Methanol (alcohol) powered engines require twice the amount of fuel so the BSFC's are doubled.

Calculating the total fuel requirement of an engine requires simple equations that we outline in the following section. You must know how much power the engine is anticipated to make and we recommend that you guess on the high end. The fuel requirement will be determined in pounds per hour of fuel flow. Since most pumps are rated in gallons/hour you must know the weight of your fuel/gallon. (The vast majority of gasoline based fuels run at 7.25 lbs./gallon.) The equations to determine your fuel requirement is as follows:

- **(Power x BSFC) x (1 + Safety Margin) = pounds/hour**
- **Pounds/hour / 7.25 = gallons/hour.**

An example of this equation is:

- 500 hp gasoline engine using moderate boost with a 30% safety margin
- $(500 \times .625) \times 1.30 = 406.25 \text{ lbs./hr.}$
- $406\text{lbs}/7.25 = 56 \text{ gallons/hour.}$
- If the pump that is being considered is rated in liters per hour, use the conversion factor of 3.785l/gallon. The pump described above would be rated at  $56 \text{ gallons} \times 3.785 \text{ liters} = 211.96 \text{ liters/hour.}$

In the fuel pump sizing, always use a safety margin greater than 20%.

The fuel pump should be located at a level that corresponds to the lowest part of the fuel tank. This does **NOT** mean that the pump should be in a vulnerable position such as hanging below the tank. The pump should also be positioned so that it is protected from the road hazards (speed bumps, curbs, road debris etc.). In the event of an accident, the vehicle structure around the fuel pump should not deform to a point where the pump and its electrical connections are compromised.

The wiring for the fuel pump **MUST** be rated for the amperage of the pump. As with all high current wiring, a fuse rated for the amperage of the pump should be used. It is always better to err on the large side for the wire size. The ground for the pump must be the same size as the power lead and be mounted to a location that is clean and clear of any undercoating or paint.

### 6.3 Fuel Injector

A fuel injector is a valve that can be opened and closed very quickly. To open the valve, current must flow through a solenoid contained in the upper part of the injector assembly.

The Infinity triggers the injector by providing a ground path to the negative terminal. Fused power is provided to the other terminal from the harness.



The Infinity is compatible with both high and low impedance injectors. To utilize the features of the Infinity's internal peak and hold injector drivers, low impedance injectors must be used to increase the current draw properly.

To determine the size of the injectors, the total engine power must be estimated or known. The fuel pump calculations and BSFC information mentioned in the Fuel Pump Sizing section on page 135 provides a good understanding of the fuel requirements for an engine. The following equation will allow you to determine the requirements of your injectors:

$$\text{((Power x BSFC) x (1 + Safety Margin))/Number of Injectors = pounds/hour}$$

An example of this equation is:

6 CYL. engine rated at 500 hp on gasoline using moderate boost with a 15% safety

margin on the injector

$$500 \times .625 = 313 \text{ lbs}/6 = 52 \text{ lbs}/\text{hr} / \text{injector. } 52 \times 1.15 = 60 \text{ lbs}/\text{hr} / \text{injector}$$

If we take the flow of the injector (60 lbs/hr) and multiply it by the number of cylinders (6), we arrive at a total of 360 lbs/hr of flow. As you can see, the fuel pump described in the fuel pump sizing section referenced above has enough capacity to feed the engine with a little room to spare.

It is a good idea to know the maximum operating pressure of the fuel injectors. In some cases the fuel injector will not open if the fuel pressure exceeds the design limit of the injector. Also, at the higher pressures the injector fuel flow may become non-linear and cause inconsistent fuel delivery, usually creating a lean condition. Most injectors can withstand up to 70 psi. Many of the pintle style injectors can withstand higher pressure.

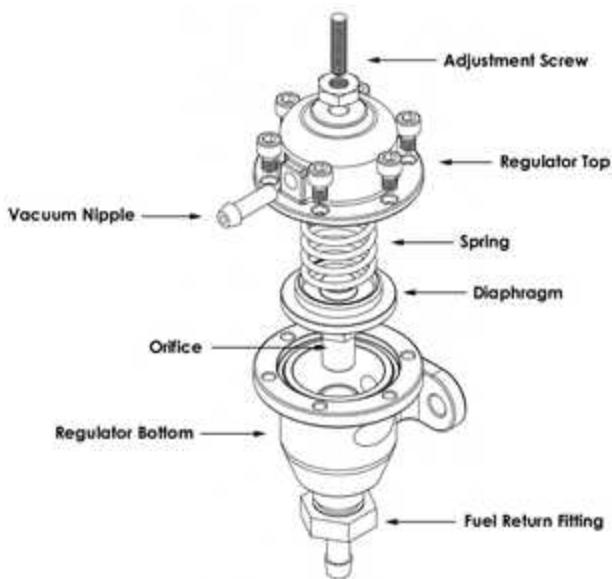
In the fuel injector sizing, always use a safety margin between 15-20%.

For more information, go to [Injector Setup](#) 86

## 6.4 Fuel Pressure Regulator

The fuel pressure regulator maintains a constant pressure across the fuel injector. The inlet manifold pressure varies with throttle angle, and engine speed. Small throttle angles and high engine speed produce low manifold pressure (high vacuum). While high throttle angles and low rpm give high manifold pressure. In addition to these conditions, low manifold pressure is associated with idle and high manifold pressure is at full throttle. It is the fuel pressure regulators job to keep a constant fuel pressure across the injector(s) regardless of manifold pressure.

Currently, there are several types of fuel pressure regulators in use. Many late model cars use a return-less system where the fuel pressure regulator is mounted in the fuel tank adjacent to the fuel pump (and therefore requires no return line back to the fuel tank). In most naturally aspirated applications these types of systems are adequate. With forced induction or heavily modified engines, an adjustable fuel pressure regulator with manifold vacuum reference must be fitted.



The two common types of fuel pressure regulators used are non-adjustable and adjustable. As the name implies, a non-adjustable regulator is set at a fixed value and is manifold-vacuum referenced (whenever a regulator is said to be vacuum referenced, this means that the inlet manifold vacuum/pressure is ported into the chamber above the regulator diaphragm).

As manifold pressure increases, the pressure in the top chamber of the pressure regulator increases along with it, allowing the regulator to compensate for the increased demand of the fuel delivery system.

Keep in mind that at idle or low throttle openings with high rpm, there is very low manifold pressure (vacuum). This tends to literally draw fuel from the injector. As manifold pressure increases (as the throttle is opened), this vacuum dissipates and it is harder for the fuel to discharge from the injector. The regulator reacts to the differences in manifold pressure to maintain constant fuel pressure across the injector. There is a spring in the vacuum (top) chamber of the fuel pressure regulator. The spring's pressure on the diaphragm determines the fuel system's static pressure. The system's static pressure is the amount of pressure measured with the vacuum hose disconnected or with the engine turned off. The fuel system's static pressure is higher than the fuel pressure at idle or under high vacuum conditions.

When the engine is running, the engine vacuum acts against the spring and the effect of the vacuum diminishes as the throttle is opened. At idle, there is a high amount of fuel returned to the tank because the vacuum is pulling the diaphragm seat off of the fuel return orifice, reducing fuel pressure. As the throttle is opened, the diaphragm seat starts to close off the orifice, restricting the amount of fuel flow through the return line.

An adjustable regulator allows the static pressure to be raised or lowered via an adjusting screw that acts on the diaphragm spring. On most adjustable regulators, when the screw is turned IN pressure raises and when it is turned OUT pressure is reduced. Although we highly recommend installing a proper fuel delivery system, raising or lowering fuel pressure *can* compensate for fuel injectors that may not be properly sized for an application.

Most aftermarket fuel pressure regulators (and OEM regulators) use a 1:1 ratio of fuel to boost pressure for increasing fuel pressure in applications where forced induction is used. This means that for every psi of boost, fuel pressure is increased one psi. This ensures adequate fuel delivery under boosted conditions.

**For more information, go to Fuel Pressure**

## 6.5 Fuel Filter

Often overlooked in EFI installations, the fuel filter must have the capacity, filtering efficiency and burst strength to withstand the pressures of an EFI system. It must be able to flow the amount of fuel that matches the maximum fuel pump output. The filter is always located after the fuel pump, however it does not matter if it is positioned in the front or rear of the vehicle (we prefer to put it toward the front for easy serviceability). AEM carries fuel filters for high-powered engines, which use an easy to find, high volume, replaceable element.

It is imperative that a pre-filter be mounted to the fuel pick up in the tank. These filters are very high volume and create very little pressure drop. The use of a pre-filter ensures long fuel pump life and can eliminate low flow conditions caused by debris entering the pump inlet.



## 6.6 Fuel Rail

The fuel rail should be consistent with, or larger than, the hose size. The additional capacity of a large-diameter fuel rail helps to dampen the pulsations created by the fuel injectors and ensures even fuel delivery under all conditions.



Many vehicle manufacturers use a pulse dampener to reduce the pulsations in the fuel rail caused by the opening and closing of the injectors (a dampener also reduces the noise of the injectors). In applications where a new fuel system must be installed, a fuel pressure dampener is integral to ensuring consistent fuel flow to the injectors. AEM fuel rails have a provision for a pulse dampener. The dampener assembly part numbers are:

Honda PN: 16680-PE7-661	Dampener
Honda PN: 16705-PD1-003	Inner Gasket
Honda PN: 90428-PD6-003	Outer Gasket
AEM PN: 2-602	Fitting for Rail

# Wiring, Pinouts and Schematics

## 7.1 Wiring

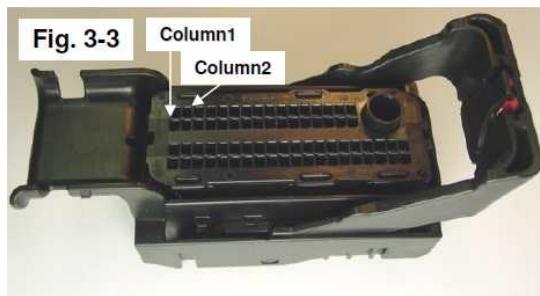
### 7.1.1 Wire Harness Options

#### 7.1.1.1 General

The Infinity-10 uses the MX123 Sealed Connection System from Molex. The following sections include excerpts from the Molex MX123 User Manual illustrating the basic procedures for working with these high density connectors. AEM strongly recommends that users become familiar with the proper tools and procedures before attempting any modifications. The entire user manual can be downloaded direct from Molex at [http://www.molex.com/mx\\_upload/family//MX123UserManual.pdf](http://www.molex.com/mx_upload/family//MX123UserManual.pdf)

#### Terminal Installation

- For ease of assembly, it is recommended that when populating the connector, wires be populated in the following manner (see Fig 3-3): 1) Fully populate down Column 1 and then 2) continue on to Column 2 and so forth until the entire connector is populated. Refer to Fig 3-4 for proper terminal orientation.



### Terminal Installation (continued)

- With TPA still in pre-lock position, orient terminal to rear of connector.
- Grip the wire (Fig. 3-5) and insert terminal through appropriate circuit opening (Fig. 3-6). If resistance is encountered, retract the terminal and adjust the angle of insertion. Continue inserting the terminal until it stops and locks up on the lock finger with an audible click. Tug slightly on wire to ensure terminal is locked.

Fig. 3-5

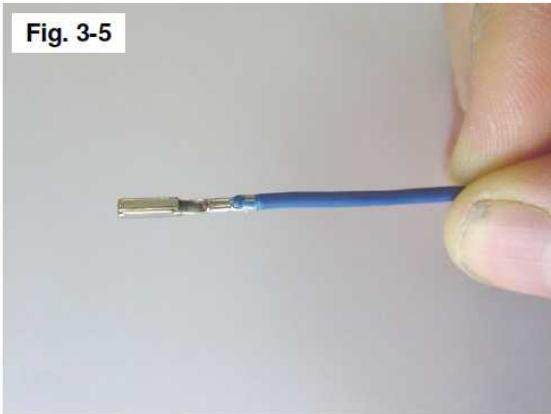
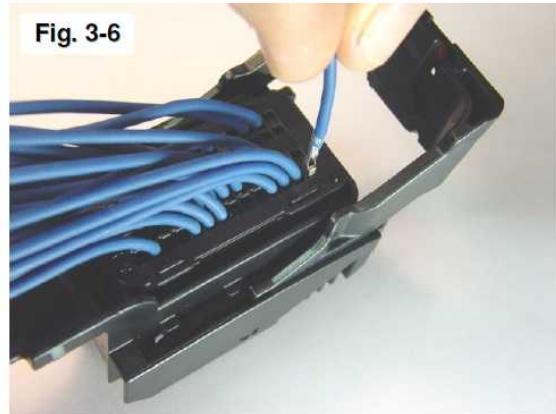


Fig. 3-6



### TPA - Seating

- With the terminals fully installed, the TPA can be seated into its final lock position by applying an even force to both ends (Fig. 3-7) until it comes to a stop (Fig. 3-8). If the TPA resists, it may be detecting a partially installed terminal. Pull the TPA back into its pre-lock position and make sure all terminals are fully seated. Upon completion, the TPA can be seated.

Fig. 3-7

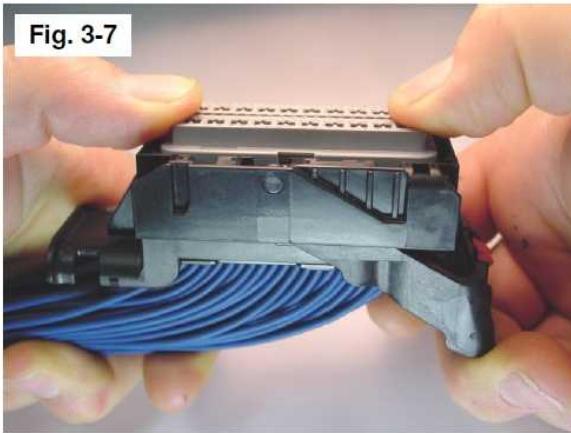
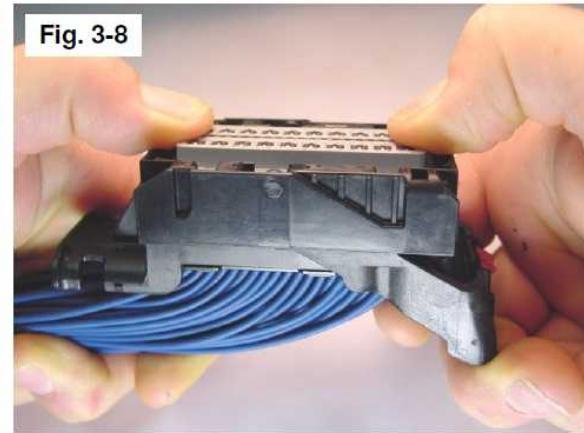


Fig. 3-8



### Dress Cover Installation

- After tie-wrapping the wire bundle, install dress cover by inserting the front of the dress cover into the connector housing (Fig. 3-13) and pushing the opposite end (Fig. 3-14) until it snaps into position. **Fully seated dress cover and TPA can be verified by ensuring MAX. height dimension (Fig. 3-14).**

Fig. 3-13



Fig. 3-14



Step 1: Insert front end into housing.

Step 2: Press down to lock position.

### Harness Connector To Header/Controller Color Identification

- The harness connector TPA will be color-coded to match the appropriate controller header (Fig. 4-1)



### Harness Connector to Header/Controller Installation Into Pre-Lock

- Correctly orient the harness connector (align keying features) onto the controller connector (Fig. 4-2). Grip the top of the harness connector and evenly push the connector downward until the lever moves slightly forward (Fig. 4-3).

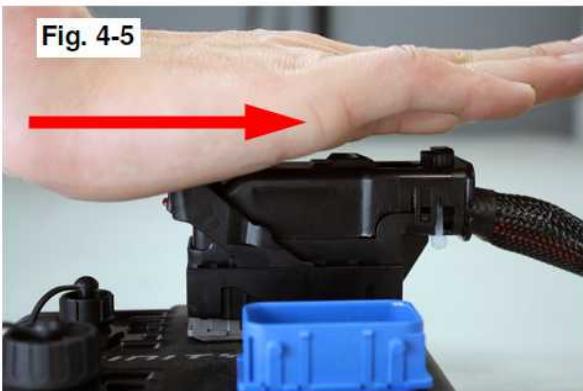


- **Caution!**
- **Installing the harness connector at an extreme angle (see fig 4- 4 ) may result in seal “scooping” creating an environment for fluid ingress.**
- **Damage to the header, or connector is possible if excessive force is used.**



### Harness Connector to Header/Controller Mating To Final Lock

- To begin mating the harness connector to the header/controller, place the palm of your hand on the face of the lever. Push back the connector lever towards the wire bundle to engage the harness connector to the controller header (Fig. 4-5). Mating force should be smooth and continuous. If not, remove the connector and repeat step B.
- Continue to rotate the lever arm (Fig. 4-6).



### Harness Connector to Header/Controller Mating To Final Lock (continued)

- Continue to rotate the lever until you hear the primary latch click into final lock over dress cover primary latch (Fig. 4-7a and 4-7b).



Primary Latch Engaged

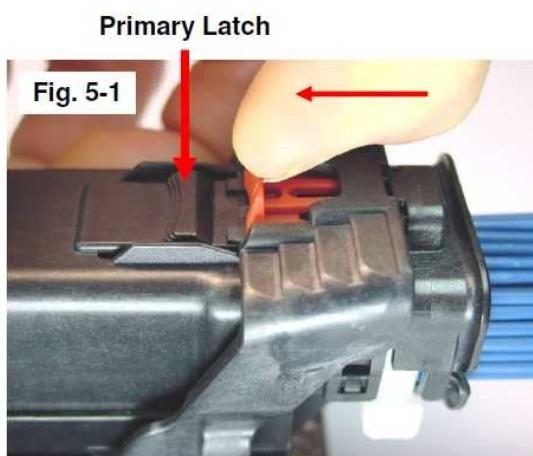
### Connector Position Assurance (CPA)

- With the harness connector lever arm in its latched position, the CPA can now be engaged. Push the CPA toward the wire bundle (Fig. 4-8) until it clicks into its final locked position (Fig. 4-9).



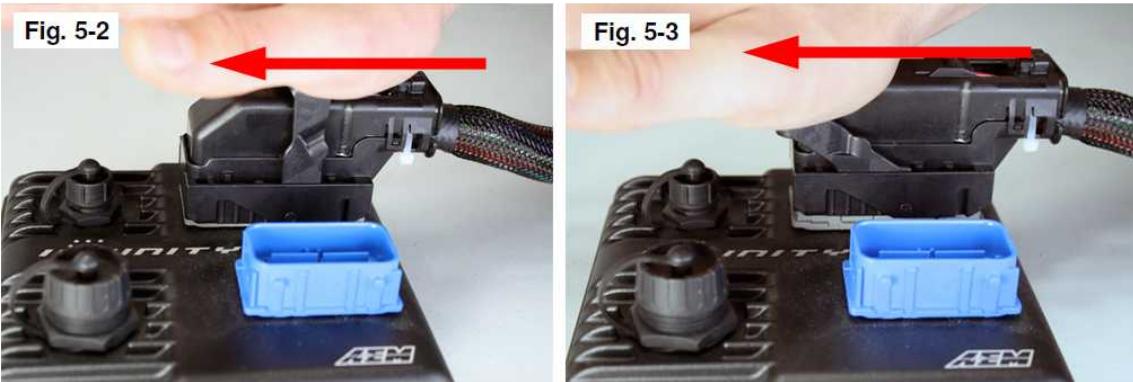
### Harness Connector Removal From Module

- To un-mate the harness connector from the header/controller, push the CPA away from the wire bundle. Depress the primary latch on the top of the harness connector so the lever arm releases from the harness connector (Fig. 5-1).



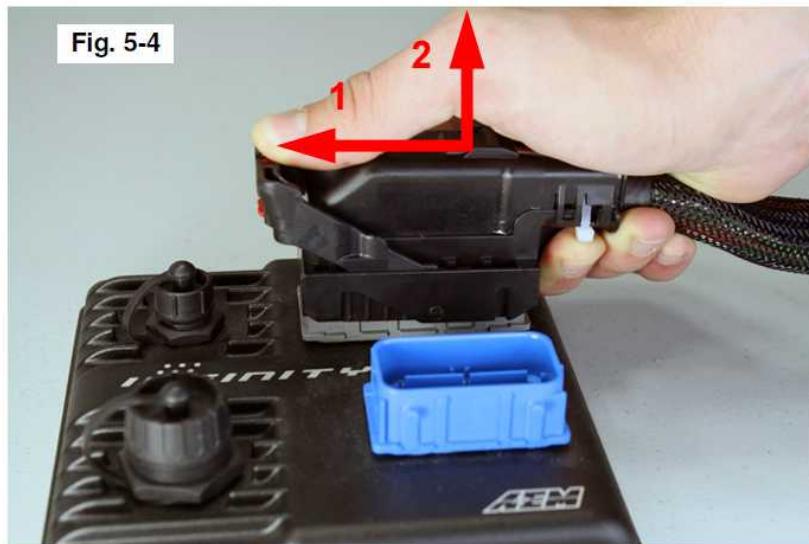
### Harness Connector Removal From Module (continued)

- Push the top of the mate lever arm away from wire bundle using the palm of your hand (Fig. 5-2).
- Continue to rotate the lever until the connector lifts into pre-lock (Fig. 5-3). The lever MUST be in the pre-lock position or the connector can not be easily removed from the module. The lever must be fully forward for the harness connector to be in pre-lock position.



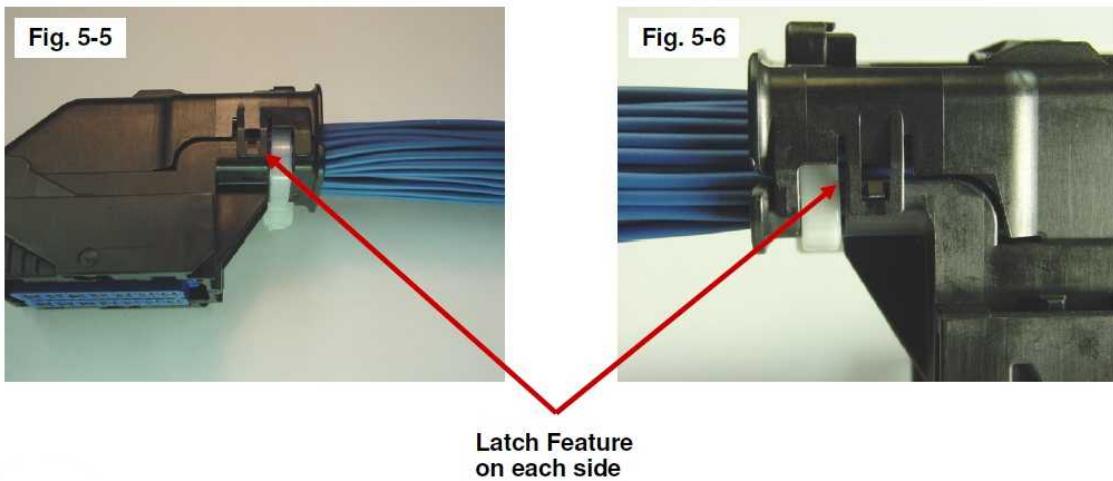
### Harness Connector Removal From Module (continued)

- While pushing forward on the lever, grip the back of the harness and evenly pull straight upwards and away from the module (Fig. 5-4).



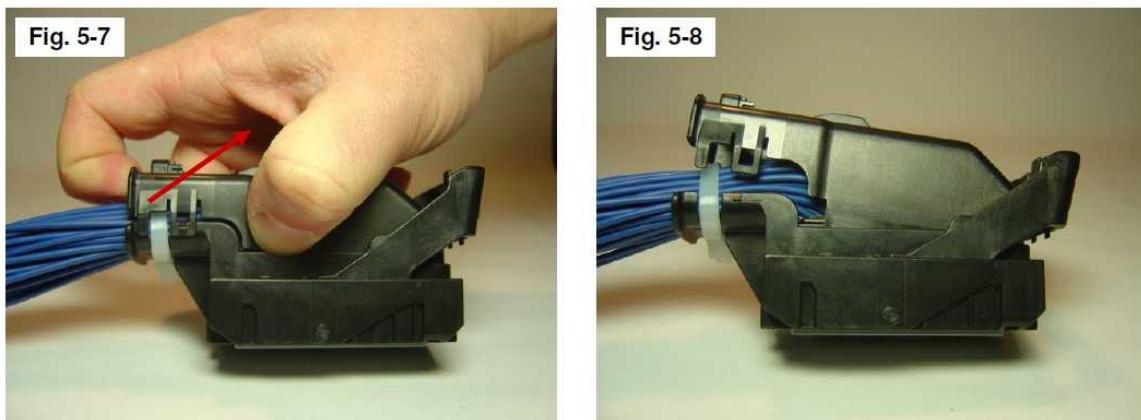
### Dress Cover Removal

- With the harness connector removed from header/controller (Fig. 5-5), unlatch the dress cover latch features on each side of the dress cover guide (Fig. 5-6). A small screwdriver or similar tool can be used to release the latches.



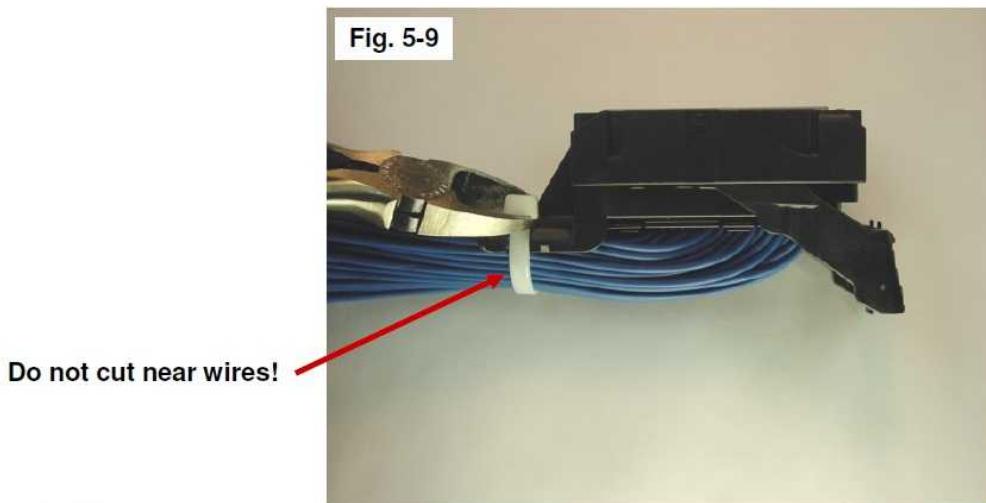
### Dress Cover Removal (continued)

- With the dress cover latch features unlatched, insert your finger into dress cover (Fig. 5-7) and pull up and away from the wire bundle. The dress cover can be completely removed at this point (Fig. 5-8).



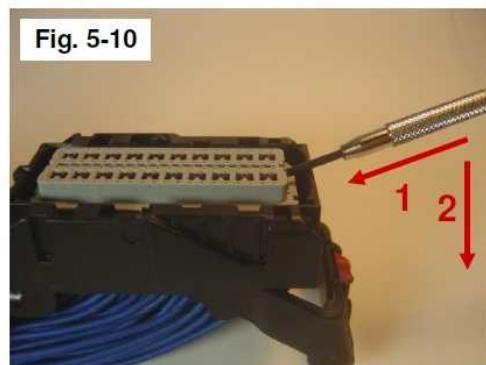
## Tie-Wrap Removal

- The tie-wrap can now be removed from the wire bundle (Fig. 5-9) for easier access to the wire to be serviced. **The tie-wrap MUST be cut under the wire dress tab to prevent damage to the wires!**

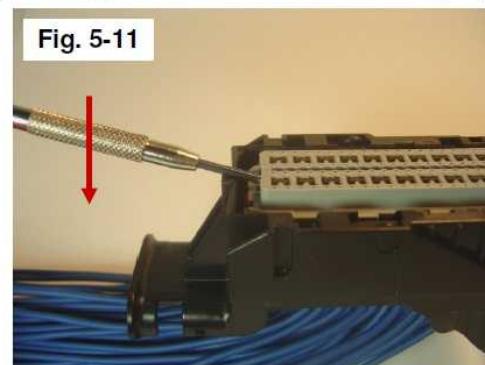


## TPA Servicing

- TPA should never be removed from the connector.**
- Step 1: Insert a small (2.0mm maximum) flat blade screwdriver into the TPA service hole at one end of the connector (Fig. 5-10) and pry up. The TPA will stop when it reaches its pre-lock position for terminal servicing.
- Step 2: On the other end of the TPA, repeat Step 1 (Fig. 5-11) until the TPA reaches its pre-lock position at both ends of the harness connector.
- Approximate TPA travel will be 5.0mm (See Figs. 5-12 and 5-13 on next page).



Step 1: Pry up TPA



Step 2: Pry up opposite end of TPA

## MX64 Receptacle Terminal Removal

- Ensure TPA is in pre-lock position!
- Holding the 0.64mm service tool (Fig. 14: Molex part no. 63813-1400 or alternate GM part no. J-38125-213) between middle finger and thumb, with index finger on top of the tool, insert the tip of the tool into the terminal service hole adjacent to the terminal to be serviced (Fig. 5-15).
- After first pushing the wire/terminal forward, use your index finger to push the service tool (Fig. 5-15) until a large amount of resistance is felt. This wedges the service tool between the terminal and the lock finger, therefore deflecting the lock finger. (Fig. 5-16).

Fig. 5-14



Fig. 5-15

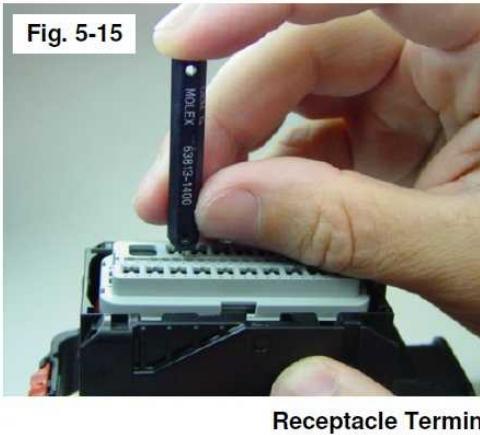
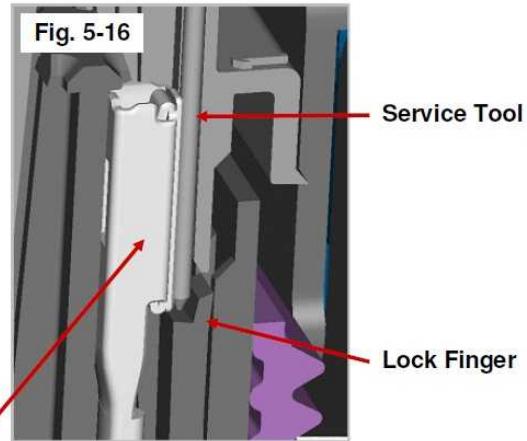


Fig. 5-16



## MX64 Receptacle Terminal Removal (continued)

- Fig. 5-17a shows proper insertion of the service tool. Avoid inserting the service tool into the terminal opening (Fig. 5-17b) as this may damage the terminal.

Fig. 5-17a

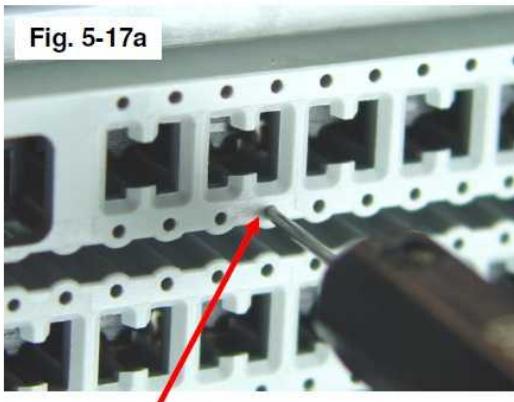


Fig. 5-17b



Proper Insertion

Incorrect Insertion

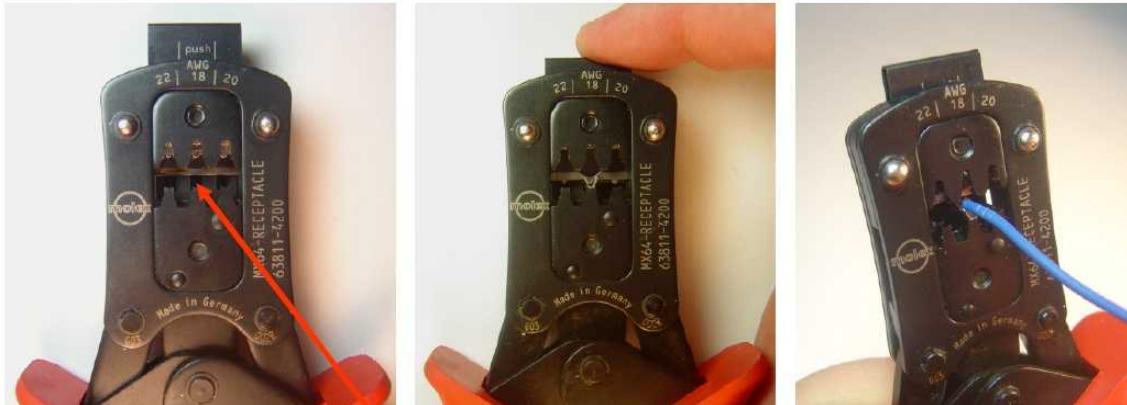
### MX64 Receptacle Terminal Removal (continued)

- Once the terminal lock finger has been disengaged, transfer middle finger and thumb to connector housing, while maintaining index finger pressure on the tool. Pull on the wire to remove the terminal (Fig. 5-18). If the terminal resists, the service tool may not be fully engaged. Repeat the servicing instructions, starting at page 33.
- Do not use excessive force. Excessive force can damage the lock finger. Do not apply any lateral force. The lock finger is displaced by linear insertion alone.



### Terminal Crimping

- If the 0.64mm receptacle terminal needs to be replaced, a new one can be hand crimped using GM Crimp Tool #XX019825 or Molex Crimp Tool #63811-4200.



1.) Identify the wire gauge you need to crimp. Notice the rectangular shape of the terminal cavity.

2.) Insert the correct terminal and press the wire-stop down.

3.) Insert the wire until the wire hits the wire stop. Squeeze the handles through the last "click" until they release.

### Terminal Crimping (continued)

- Contact Molex for terminal sales drawings. Hand crimp instructions, strip length recommendations, and crimp height requirements are available in the Molex Spec. Sheet for Tool #63811-4200.
- If the Yazaki 2.80mm receptacle terminal needs to be replaced, a new one can be hand crimped with the appropriate cable seal using crimp tools #J-38125-6 and #J-38125-7. These tools can be ordered from SPX Kent-Moore (1-800-345-2233).

### 7.1.1.2 Universal

Several harness build options are available for the Infinity.

#### Universal Wiring Options

- 30-3705 - Harness, Infinity-6 and Infinity-8H Flying Lead (sold separately)
- 30-3704 - Connector Kit, Infinity-6 and Infinity-8H
- 30-3703 - Harness, Infinity-10 Flying Lead (sold separately)
- 30-3702 - Harness, Infinity-10 Mini Flying Lead (sold separately)
- 30-3701 - Connector Kit, Infinity-10 (sold separately)

#### Plug and Play Wiring Options (Infinity-10 and Infinity-8)

- 30-3500 – Harness Kit, Infinity Supra (sold separately)
- 30-3510 – Harness Kit, BMW E46 M3 (sold separately)
- 30-3520 – Harness Kit, Nissan 350Z / G35 (sold separately)

#### Plug and Play Wiring Options (Infinity-6 and Infinity-8H)

- 30-3501 – Harness Kit, Infinity Honda OBD1 (sold separately)
- 30-3501-00 – Coil adapter Honda distributor applications (sold separately)
- 30-3502 – Harness Kit, Honda K Series engines (sold separately)
- 30-3508 – Harness Kit, Honda S2000 '00-'05 (sold separately)
- 30-3509 – Harness Kit, Honda OBD2B (sold separately)

#### Plug and Play Wiring Options (GM LS Engines)

- 30-3532 – Harness Kit, Infinity LS 24X engines (sold separately)
- 30-3530 – Harness Kit, Infinity LS 58X engines (sold separately)

#### Accessories

- 30-3600 - O2 Sensor Ext Harness, Infinity
- 30-3601 - IP67 Comms Cable, Infinity
- 30-3602 - IP67 Logging Cable, Infinity
- 30-3604 – IP67 Comms Cable, 9.8' Infinity

### 7.1.2 Wiring Conventions

A proper wiring job includes proper termination of the wire at the sensor. The wire terminal end must be moisture tight where it plugs into the sensor and it must have strong, electrically sound terminals. The preferred method of securing a wire to a terminal is to use a crimp terminal with NO solder. It is important to use the proper crimping tool for sound terminal construction. Plastic terminal plugs must have moisture tight seals. Inspect each plug to make sure the seals are in place. Also, before the plug

is installed on the sensor, apply a dab of di-electric grease in the terminal slots to further aid in corrosion resistance.

If a splice into a wire must be made and no solder-less terminals are available, then you must properly solder the splice.

Noise can be a serious problem and can cause intermittent misfiring of the engine. Every precaution should be taken to prevent interference to the ECU's operation. Resistive plug leads are REQUIRED, and shielded cables from the crank and cam angle sensor inputs are highly recommended. All AEM Infinity wire harnesses come with properly shielded cables and are color coded for easy identification of circuits. They are also shrink wrapped for abrasion protection. The crank and cam angle sensor wire has a bare wire running down the length of it. It is NOT terminated at the sensor end of the cable because we ground it at the plug end of the harness. DO NOT GROUND THIS WIRE! This will cause a condition called ground looping and will remove any noise protection the cable has.

To eliminate or reduce the chance of EMI, wires that carry high current must run in twisted pairs. An example of this would be the power leads from a multiple spark ignition system. These ignition systems can carry up to 100 amps for a couple milliseconds at the time of discharge, which induces a strong magnetic field in close proximity of the wires.

The routing of the wire loom is critical to EFI system performance and safety. The following safety considerations should be made when installing the wire loom:

- Heat protection: the loom should be placed away from or insulated from sources of heat. The obvious item(s) that should be avoided are the exhaust manifolds, EGR delivery tubes, and turbochargers. If it is absolutely necessary to route a wire in close proximity to any of these items, then a suitable insulator must be used.
- Noise suppression: do not route wires near the HT leads. For coil-on-plug ignition systems this is not as critical.
- Moving component protection: route wires away from moving components such as fans, the blower belt, or the throttle linkage. Also, make sure the wires are not under any strain when the engine is at full deflection on the motor mounts (we have seen map sensor wires disconnect while under full acceleration because the motor mounts were bad).
- Never have the wires in exposed bundles throughout the engine compartment. A professional harness has shrink tube over it to resist abrasion and chemical damage to the wire loom.

### 7.1.3 Tools

AEM recommends using the following proper crimp tool for all Infinity ECU terminations. **Molex Part No:** 63811-4200. This tool is available in many places. One is shown below. Web address - <http://www.newark.com>

The screenshot shows the Newark element14 website. At the top, there's a search bar with 'Product Search' and 'Find' buttons, and a checkbox for 'RoHS compliant items only'. Below the search is a navigation bar with links for HOME, PRODUCTS, SERVICES, SOLUTIONS, COMMUNITY, ORDER, MY ACCOUNT, and LIVE SUPPORT. A 'New to Newark/element14?' link with a 'Start here' button is also present. The main content area displays the product details for the MOLEX 63811-4200 hand crimp tool. On the left, there's an image of the red-handled crimp tool and the Molex logo. To the right, the manufacturer is listed as MOLEX, and the Newark part number is 81H6890. The Molex part number is 63811-4200. The availability section indicates 1 item available to ship today, with a 'Check more stock...' link. The price is \$360.06 for 1 unit. A quantity selector shows 'Qty 1' and a 'Buy' button. The price table shows two rows: 1 - 4 units at \$360.06 and 5+ units at \$339.85. Below the product information, there's a section for 'Product Information' with a list of specifications.

Qty	Price
1 - 4	\$360.06
5+	\$339.85

A cheaper, but lower quality, alternative is the following crimp tool. **Molex Part No:** 63811-1000. This tool is available in many places. One is shown below. Web address - <http://www.newark.com>

**Newark element14**

**Product Search**  
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**MOLEX - 63811-1000 - Hand Crimp Tool**

Customer Rating: ★★★★☆ [Be the first one to review this product](#)

There is 1 question and 1 answer on this product [Read all the Q&As](#) | [Ask a question about this product](#)



**molex**

Manufacturer: **MOLEX**  
 Newark Part Number: 85C2464  
 Manufacturer Part No: 63811-1000

*Image is for illustrative purposes only.  
 Please refer to product description*

**Availability**

Availability: 33  
 33 available to ship today  
[Check more stock...](#)

Price For: 1 Each  
 Minimum Order Quantity: 1  
 Order Multiple Quantity: 1  
 Price: \$49.49

Qty	<input type="text" value="1"/>	<b>Buy</b>
-----	--------------------------------	------------

**Price**

Qty	Price
1 - 4	\$49.49
5+	\$44.82

### Product Information

- Hand Crimp Tool
- Crimp Size: 24AWG to 18AWG
- For Use With: Molex 0.062" Pin & Socket Crimp Terminals
- Series: 63811
- RoHS Compliant: NA

### 7.1.4 Grounding

The Infinity must have an electrically secure ground connection, which means that the battery negative must be properly grounded to the chassis AND engine. The ground wire, whether it is from the battery or to the chassis and engine, must have perfect electrical conductivity. This means that there must not be any paint or rust under the wire terminal. Make sure to install the ground wire to contact bare/exposed metal of the vehicle component. To prevent rust build up, we recommend applying a protective layer of dielectric grease, such as Standard Ignition SL-4, to the bare metal surface. The ground wire must be **at least** the same gauge as the power lead to the ECU. AEM also recommends that the ground wire be as short as possible.

### 7.1.5 Power Requirements

The Infinity requires a minimum supply voltage of 10V or greater to run. We recommend that the Infinity be supplied with 13.8V nominal operating voltage. Ensure that the vehicle's charging system is in perfect operating condition prior to installing. Like most modern OEM ECUs, the Infinity requires a main relay for proper power distribution. Please refer to the diagram below for the minimum connection required for power and ground. The system WILL NOT function correctly unless wired exactly as below.

#### **Power and Ground Distribution**

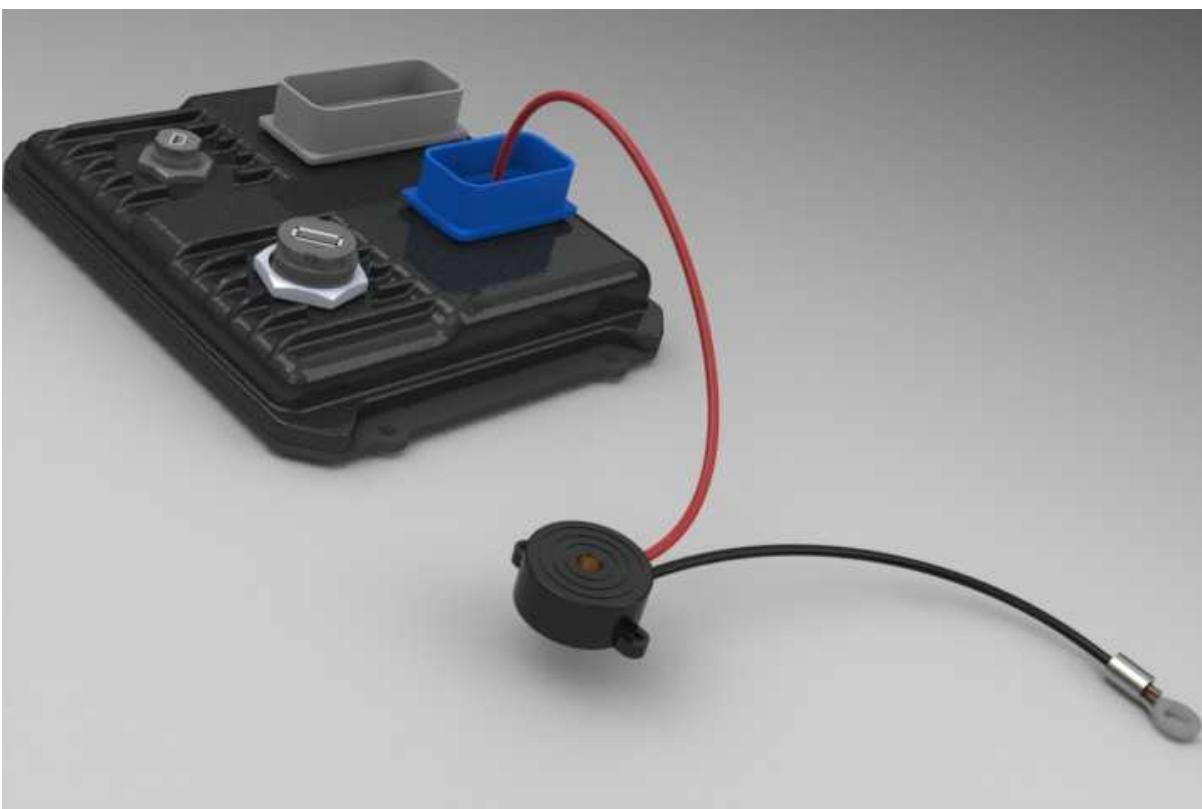
[Power and Ground Distribution - Schematic Link](#)

### 7.1.6 General Purpose Outputs

General purpose outputs (GPO) are one of the many things that separate a programmable ECU from a chipped or reflashed ECU. These outputs can be triggered for multiple actions based on engine speed, throttle position, engine load, coolant temperature, vehicle speed, etc.

Before proceeding, check the Application Notes included with your Infinity ECU to see which, if any, spare GPOs are available. Some vehicles will use more outputs than others. For instance, there are many outputs required to drive the various solenoids associated with an automatic transmission.

There are two types of GPOs; LowsideSwitch and HighsideSwitch outputs. The Infinity LowsideSwitch outputs a 4A (max) capable ground signal. The HighsideSwitch outputs a 0.7A (max) capable 12V signal.



The picture above depicts a HighsideSwitch output controlling a low current buzzer. This is similar to how a LowsideSwitch would be wired, except it would be connected to a 12V source instead of a ground lug ring terminal.

If the component being driven runs higher than the specified driver's capability, it is recommended to wire in a relay to the circuit.

### 7.1.7 Injectors

The Infinity ECU has integrated peak and hold injector drivers. This means the Infinity can drive high impedance or low impedance fuel injectors without using resistors to keep the current low. Note: With fuel injectors, polarity does not matter. This means the positive and negative wires can go on either injector pin.

#### AEM P/N 30-2020 (Optional)

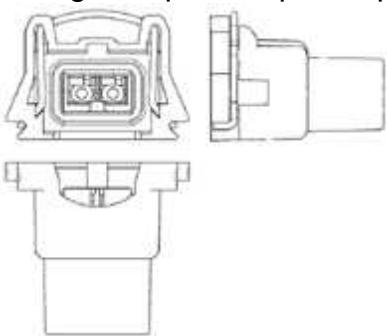
This Bosch Style Injector Connector Kit contains the parts to assemble 4 injector connectors. The kit contains Four Bosch style female injector connectors and 10 contacts (2 extra contacts are included for spares).

#### IMPORTANT!

The contacts are "Pull to Seat" meaning you must feed the wire through the connector housing BEFORE you crimp on the contacts. The wire is then pulled back into the housing and the contact locks in place. The contact cannot be inserted or removed from the rear (wire side entry) of the housing.

#### Contacts (10 Included)

Plating	Tin Plated
Cable Range	1.00 - 0.05 mm <sup>2</sup>
Outside Cable Diameter	2.40 - 2.03 mm <sup>2</sup>
Temperature Range	-40 to 125 C
Resistance in mOhms at 20 mV	> 10.0 Ohms
Voltage Drop in mV per amp	> 3.0 Ohms

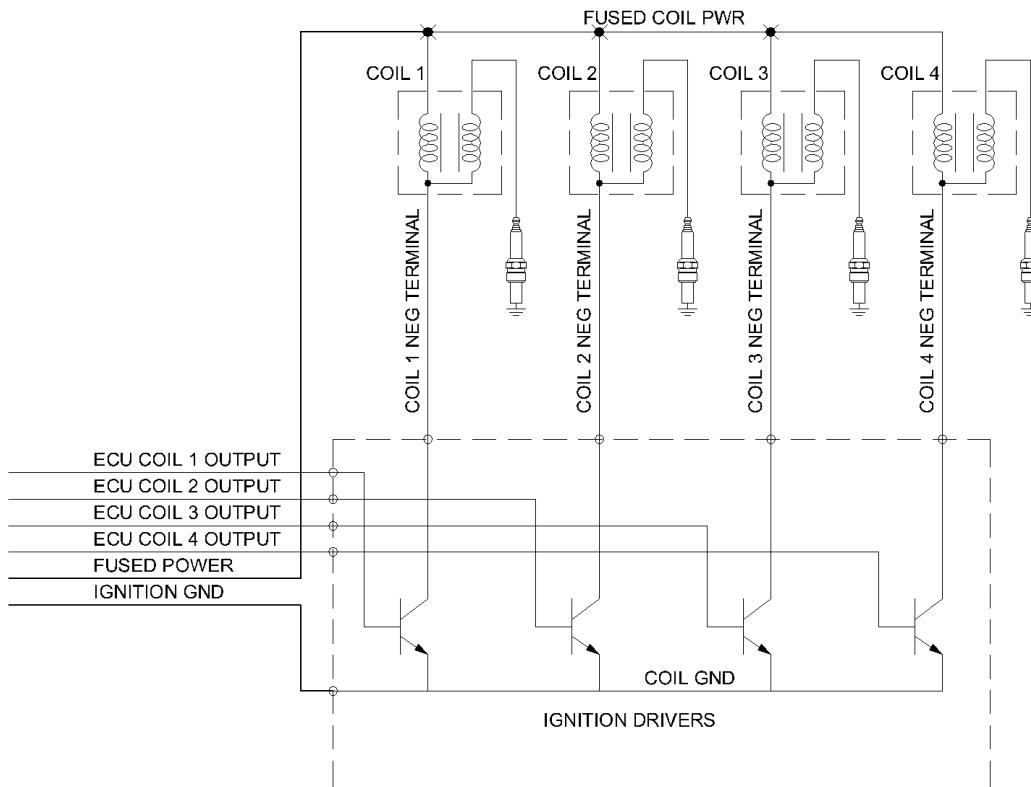


#### Housing (4 Included)

Color	Black
Cavities or Contacts	2
Gender	Female
Temperature Range	-40 to 125 C
Resistance at 20 mV	> 10.0 mOhm
Voltage Drop per amp	> 3.0 mV
Exterior Dimensions	27.8L X 29.6W X 20H
Seating Process	Pull To Seat

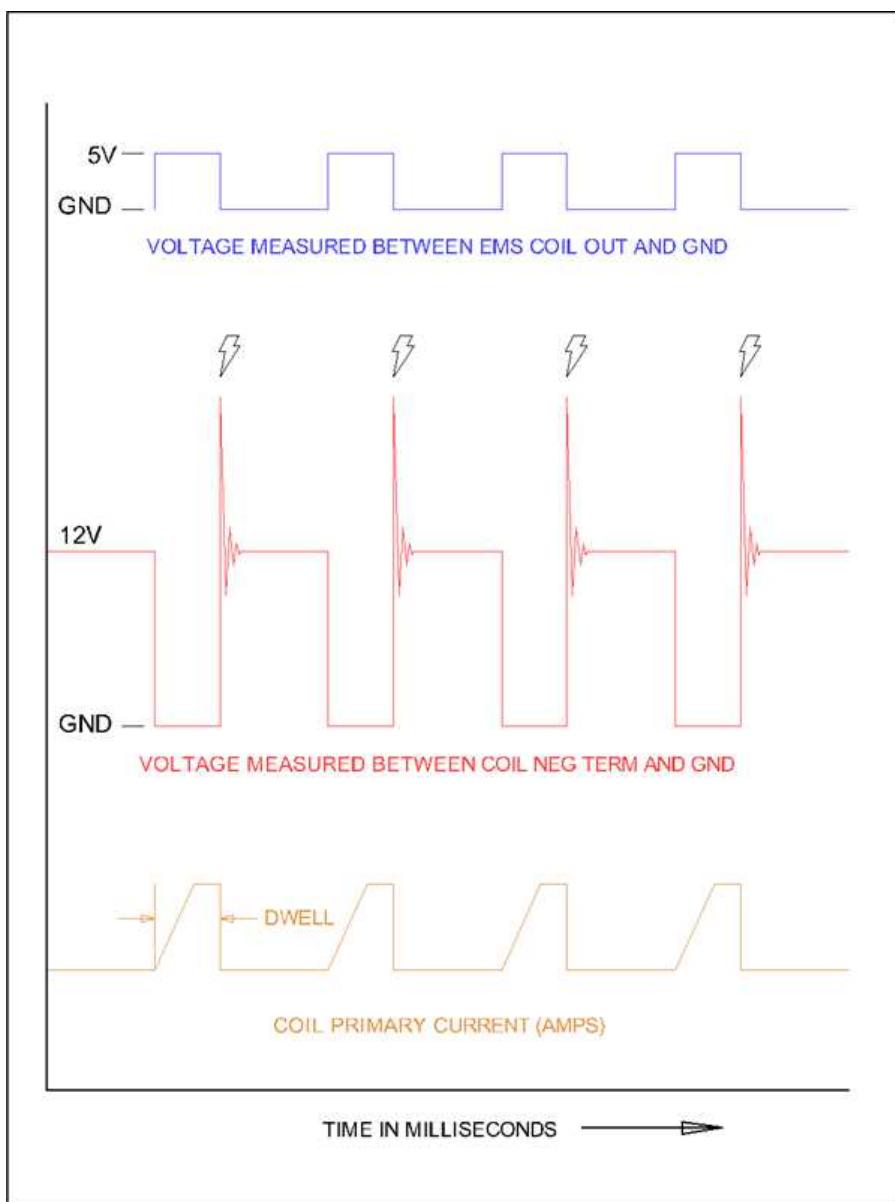
### 7.1.8 Ignition System

The diagram below illustrates a basic inductive ignition system setup with four independent ignition outputs (Coils 1 – 4).



Transistors serve many functions but in this case they are applied as *Power Drivers*. The input circuit to the transistor from the ECU requires very little current flow to turn the transistor ON. When the transistor is ON, a high current capacity path is created between the coil negative terminal and ground. High current means more temperature to dissipate. A stand-alone ignition driver module or a driver module built into a coil assembly is designed to efficiently dissipate this heat. The more current flow, the more heat must be dissipated. The amount of current the drivers must sink to ground during each charge and fire event is determined by the *dwell time settings*. What is Dwell Time? The diagram below describes dwell time.

The process begins when the ECU sends a signal to the transistors turning on the current to the ignition coils primary winding. This 'charging' stores energy in the coils magnetic circuit. The current is then switched off. As the magnetic field begins to collapse the coil tries to resist the drop in current causing the voltage in the secondary winding to rise rapidly, this high voltage breaks down the air/fuel mixture in the spark gap allowing a spark to pass, causing ignition of the air/fuel mixture.

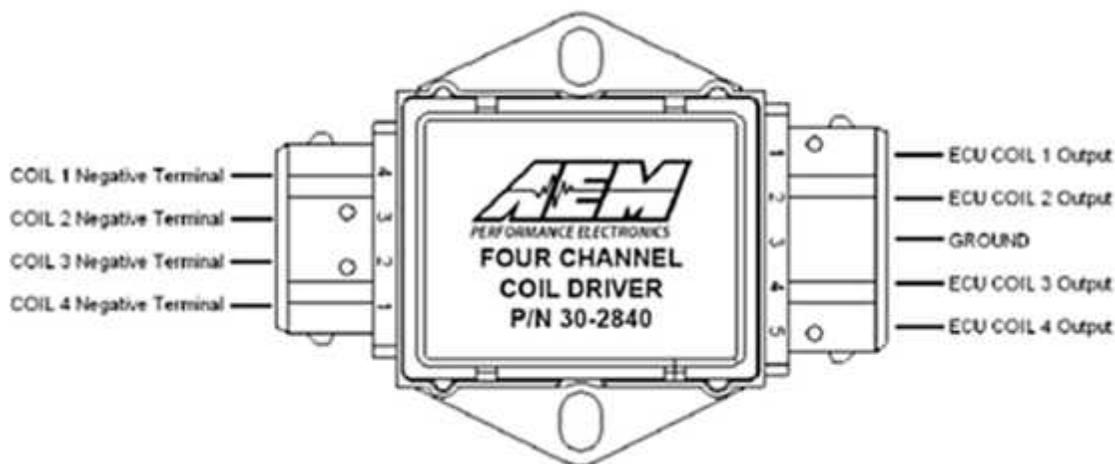


## AEM P/N 30-2840 (Optional)

This Four Channel Coil Driver is custom manufactured to AEM's specifications by HÜCO Electronic GmbH in their ISO 9001 facility in Germany. It has been specially designed by AEM for driving the high power dwell controlled ignition coils commonly found on performance engines.

The 30-2840 Kit contains:

- Four Channel Coil Driver
- Five Pin Mating Connector
- Four Pin Mating Connector
- 10 Terminals & Wire seals (one extra of each as a precaution)
- Mounting hardware
- Thermal Grease

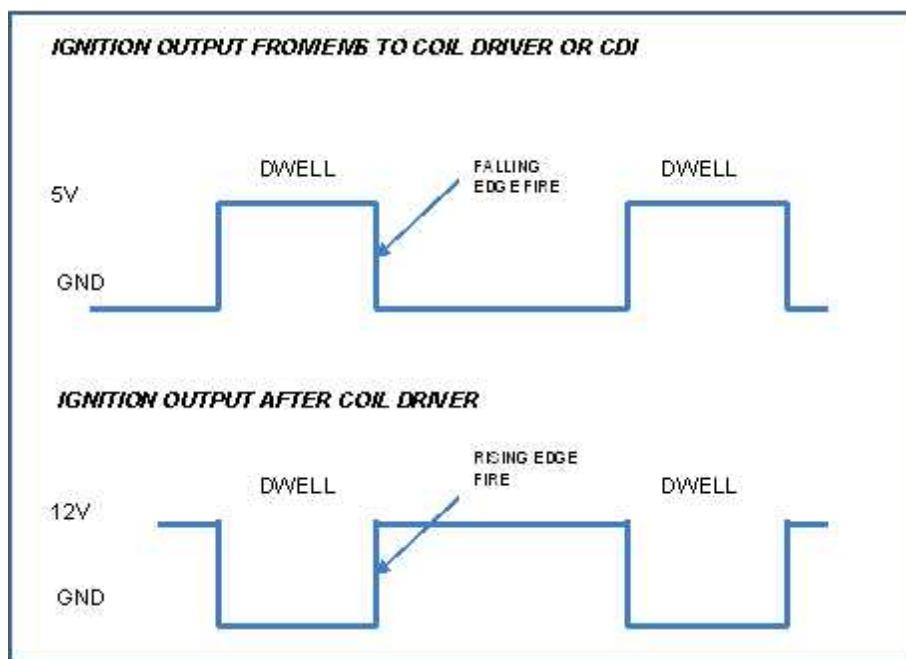


### Four Channel Coil Driver Connections

Coil Driver	Connect to
ECU Coil 1 Output	Infinity harness, IGN 1
ECU Coil 2 Output	Infinity harness, IGN 2
ECU Coil 3 Output	Infinity harness, IGN 3
ECU Coil 4 Output	Infinity harness, IGN 4
Ground	Infinity harness, PWR GND
Coil 1 Negative Terminal	Coil 1 Negative Terminal
Coil 2 Negative Terminal	Coil 2 Negative Terminal
Coil 3 Negative Terminal	Coil 3 Negative Terminal
Coil 4 Negative Terminal	Coil 4 Negative Terminal

## CDI Installations

The ignition outputs from the Infinity are considered a falling edge fire signal where signal high is dwell time. A coil driver will invert the signal from the Infinity pulling the signal low (ground) and allowing current to flow through the coil primary windings. Some CDI ignition boxes are only capable of triggering on the “rising edge” or “Points Trigger” signal. These systems will still require an in-line coil driver to invert the ignition output to fire on the correct edge. The AEM Twin Fire CDI system P/N 2820 (8 channel) and 2821 (4 channel) can be configured to fire on either a rising or falling edge. Applications using an AEM Twin Fire will not require an in-line coil driver. Contact your CDI manufacturer for more information.



Signal comparison – before and after coil driver

### 7.1.9 Noise

Electrical noise can cause the Infinity ECU to see more tooth edges than there are in reality. This will result in excessive misfires during normal running. Misfire caused by “noise,” (commonly referred to as radio frequency interference {RFI}, or electro magnetic interference {EMI}), is usually due to routing the input signal leads in close proximity of the HT leads. Typically, spark plug wires cause RFI or primary ignition wires arcing to an engine component, which causes a frequency that interferes with the ECU. Routing two wires that carry high current parallel to each other cause EMI. The strength of current necessary to incur “noise” is dependent on the sensitivity of the device the wires are connected to. A common preventative measure for eliminating “noise” is to twist the wires together to minimize the electromagnetic field near the wires.

**On any EFI system, resistive spark plug leads are REQUIRED to suppress noise!** Common resistive spark plug leads include those with a carbon impregnated fiberglass core or spiral wound filament around a carbon core wire. Another source of noise that can cause a misfire is an electrical “leak” in a plug wire or boot. Even a very small pinhole in a spark plug insulator or boot will allow electricity to arc to the cylinder head and interfere with the ECU signal.

### 7.1.10 Sensors

#### MAP Sensor

##### Optional AEM MAP Sensor Listing:

**AEM P/N 30-2130-30** "MAP Sensor Kit, 2 BAR"

Typically used to measure intake, air box and crankcase pressures.

**AEM P/N 30-2130-50** "MAP Sensor Kit, 3.5 BAR"

Typically used to measure intake & exhaust back pressures.

**AEM P/N 30-2130-75** "MAP Sensor Kit, 5 BAR"

Typically used to measure intake & exhaust back pressures.



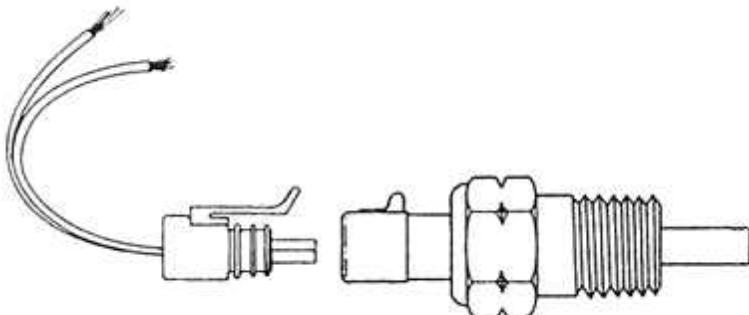
**Red Wire:** 5V Reference

**Black Wire:** Sensor Ground

**Green Wire:** MAP Signal

## Air Temp Sensor

AEM P/N **30-2010 (Optional)** Air Temp Sensor kit is specifically designed for temperature measurements in automotive systems. The kit contains One GM style temperature sensor, one "6" Flying Lead" mating connector assembly and a weld in aluminum bung.



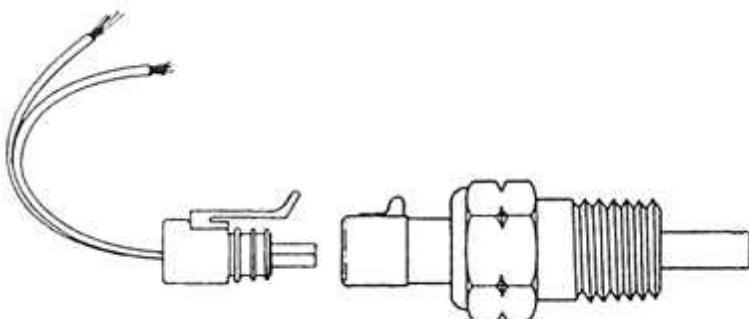
**Housing Material:** Brass with 3/8" NPT Thread (Torque to 25 Ft-Lbs)

**Elec. Termination:** Integral weatherproof connector, Includes mating connector with 6" leads, 18 AWG.

**Wiring to the Infinity:** Polarity does not matter. Connect one wire to harness AIR TEMP lead and the other to harness SIG GND lead.

## Coolant Temp Sensor

AEM P/N **30-2011 (Optional)** Water Temp Sensor kit is specifically designed for temperature measurements in automotive systems. The kit contains One GM style temperature sensor, one "6" Flying Lead" mating connector assembly and a weld in aluminum bung.



**Housing Material:** Brass with 3/8" NPT Thread (Torque to 25 Ft-Lbs)

**Elec. Termination:** Integral weatherproof connector, Includes mating connector with 6" leads, 18 AWG.

**Wiring to the Infinity:** Polarity does not matter. Connect one wire to harness COOLANT lead and the other to harness SIG GND lead.

## Crank Sensor

The crank sensor is used to calculate engine speed, ignition timing and injection phasing angles. Shown below, it senses a toothed wheel (reluctor wheel, reluctor ring, etc.) and converts this pattern into a voltage/frequency signal that the Infinity uses for basic calculations.



Either on its own, or combined with the cam position sensor, it is the most important input to the system. There are two basic types of crank sensors, variable reluctance (VR or "mag") and hall-effect.



VR Sensor Voltage Signal



Hall Effect Voltage Signal

The internal circuitry on the Infinity is different depending on what type of sensor is being used. Note that there are two different inputs on the Infinity for crank and cam position. One for a Hall Effect type pickup. The other for a VR or "mag" pickup. The Infinity crank sensor VR inputs go through a signal conditioning chip on the circuit board that converts the raw (zero crossing) signal into a clean 0-5V square wave signal as shown below.

## Cam Sensor

The cam sensor is typically very similar to the crank sensor but is used to calculate engine position. It is necessary for sequential fuel calculations. It senses a toothed wheel (reluctor wheel, reluctor ring, etc.) and converts this pattern into a voltage/frequency signal that the Infinity uses for basic calculations. Combined with the crank position sensor, it is one of the most important inputs to the system. There are two basic types of cam sensors, variable reluctance (VR or "mag") and hall-effect. The oscilloscope frequencies are similar to the crank sensor shown above but typically with less pulses (teeth).

Shown below is a cam and crank sensor that integrates into one AEM trigger wheel (24 and 1). The perimeter has 24 crank teeth. The 1 long tooth is used for the cam sensor.



## Vehicle Speed Sensor (VSS)

The vehicle speed sensor can be VR or a hall-effect device. It is similar in function and wiring as the cam and crank sensor but instead is used to detect wheel speed. This input is used for various Infinity software functions. There are two basic types of vehicle speed sensors, variable reluctance (VR or "mag") and hall-effect.

Shown below is a Nissan vehicle speed sensor.



### 7.1.11 Digital Switch Inputs

Common digital switch inputs used in electronic fuel injection applications are oil pressure switches, clutch switches, A/C request input, hi/lo boost switch, race gas switch, etc. For all digital inputs that will be used with a switch, the wiring is simple.

Source any SPST (single pole single throw) switch. Note: normally open (N.O.) and normally closed (N.C.) switches can both be used. The Infinity Tuner software can invert the logic to exactly what the user needs.

Find a good ground source near the switch mounting location. If there is oil, rust, paint, etc. present, use a wire brush to clean the area for a proper connection. Most ground connections are used with a ring terminal (as shown below). Route one of the switch terminal to this ground point.

In the Application Notes, find an available unused Digital\_In\_X input on your specific Infinity. Route the other terminal of the switch to this Infinity ECU pin.



### 7.1.12 USB & CAN Connector

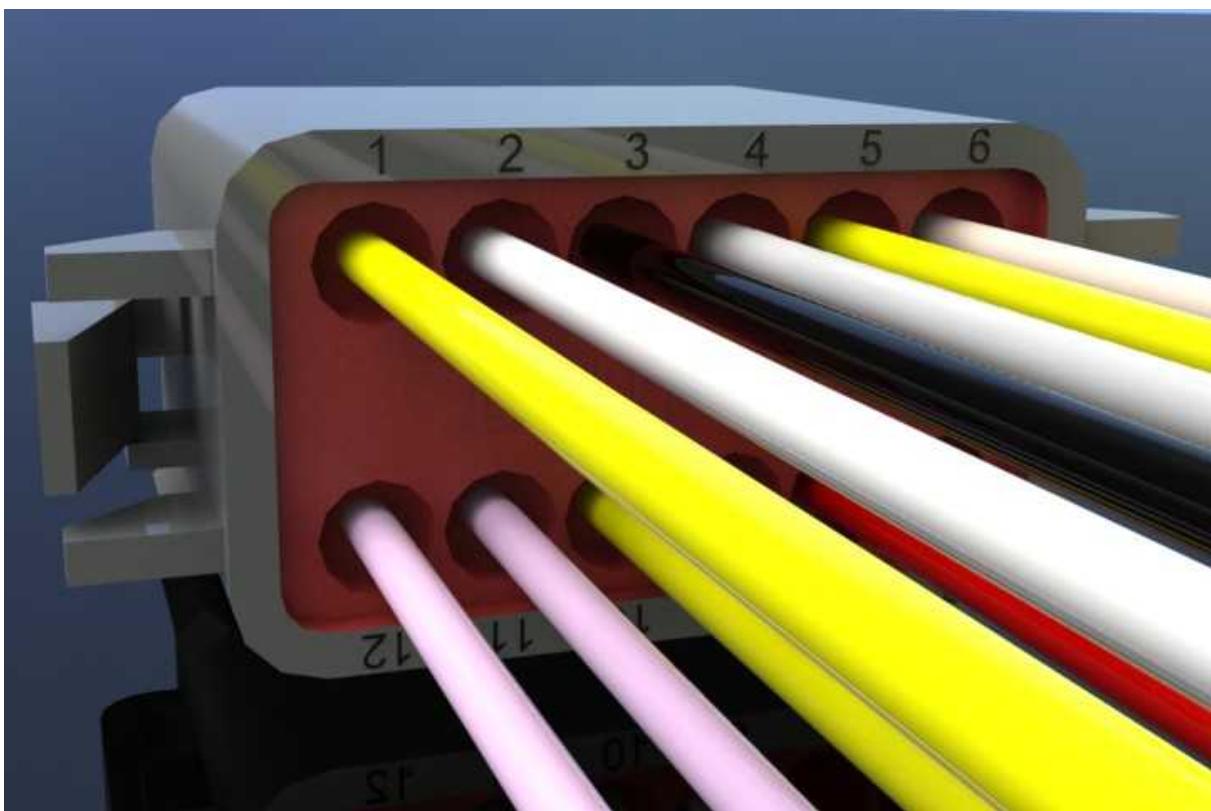


The Infinity ECU includes high quality weatherproof bulkhead USB and CAN communications. Plug one end of a standard USB extension cable (included) into the ECU connector and the other end into an open USB port on the PC. Communications is possible only when the ECU is powered up.

### 7.1.13 Auxiliary Connector

All Infinity PnP Harnesses include a 12pin "auxiliary" Deutsch connector. This male pinned connector is used to adapt the most common ancillary inputs and outputs easily.

AEM carries the mating connector (sold separately) in a universal format, where all 12 pins are stuffed with flying leads (shown below). However, depending on the PnP application many of the I/Os found on this aux connector may already be used in the factory engine harness. Furthermore, some of these I/Os may be used for other vehicle functions. In these cases, the PnP harness may not have all 12 pins stuffed. See the specific Application Notes that came with for more information.



### Deutsch Pin Numbering and Wire Colors

Deutsch Pin	Infinity Pin	Pin Name	Default Pin Function	Wire Color
1	C1-37	Analog_In_9	Fuel Press	Yellow
2	C1-67	Temperature_In_2	Air Temp	White
3	C2-32	Sensor GND	Sensor Ground	Black/White
4	C1-41	+5V_Out	5V Reference	Gray
5	C1-36	Analog_In_8	MAP (Manifold Press)	Yellow
6	C1-26	Digital_In_5	Ethanol Sensor	Tan
7	C1-17	LowsideSwitch_2	Boost Control Solenoid	Brown
8	C1-61	+12V	Power from Relay	Red
9	C2-38	Digital_In_7	Meth Boost Safe / Clutch Switch	Tan
10	C1-40	Analog_In_12	Boost Target Trim Selector Input	Yellow
11	C1-18	LowsideSwitch_3	Shift Light / Warning Light	Pink
12	C2-44	LowsideSwitch_7	Radiator Fan 2	Pink

## Fuel Press

- Typical Use: This is used for monitoring fuel pressure input to the Infinity. It can also be used to increase or decrease injector fuel pulse to compensate for a failing fuel pump.
- Notes: Typical electronic fuel injection fuel pressure varies from 30-100psi.
- Component: AEM carries 0-5V fuel pressure sensors (sold separately).
- Wiring: This wire goes directly to the signal wire of the pressure sensor.

## Air Temp

- Typical Use: Air temperature is typically used for fuel and ignition timing correction.
- Notes: This is commonly not stuffed in the PnP aux connector because many vehicles come standard with an intake air temperature sensor. These sensors are normally thermistors.
- Component: AEM carries air temperature sensors (sold separately). However, the Infinity can accept any thermistor sensor and can be calibrated in the Infinity Tuner software.
- Wiring: Intake air temp sensors have two wires and have no polarity.

## Sensor Ground

- Typical Use: Isolated ground for inputs.
- Notes: This is not the same as a power ground or chassis ground.
- Component: This is shared for the **Fuel Press**, **Air Temp**, **MAP (Manifold Press)**, **Ethanol Sensor**, and the **Spare 1-Power Selector / Oil Press** inputs.
- Wiring: This should be wired to the ground pin of the following **Fuel Press**, **Air Temp**, **MAP (Manifold Press)**, **Ethanol Sensor**, and the **Spare 1-Power Selector / Oil Press** sensors.

## 5V Reference

- Typical Use: 5 volt supply for the following aux inputs.
- Notes: When measured with a voltmeter, it is normally to not measure exactly 5V.
- Component: This is shared for the **Fuel Press**, **MAP (Manifold Press)**, **Ethanol Sensor**, and the **Spare 1-Power Selector / Oil Press** inputs.
- Wiring: This should be wired to the voltage reference pin of the following **Fuel Press**, **MAP (Manifold Press)**, **Ethanol Sensor**, and the **Spare 1-Power Selector / Oil Press** sensors.

## MAP (Manifold Press)

- Typical Use: Manifold pressure is used for speed density fuel calculation and is used for ignition timing correction, O2 feedback, boost control, variable valve control, ancillary outputs, etc.
- Notes: This is not always stuffed in the PnP aux connector because some

vehicles come standard with an manifold absolute pressure sensor.

- Component: AEM carries MAP sensors (sold separately). However, the Infinity can accept any 0-5V pressure sensor and can be calibrated in the Infinity Tuner software.
- Wiring: This should be wired directly to the MAP sensor's signal pin.

### Ethanol Sensor

- Typical Use: This is used for customers that are converting their vehicle to utilize ethanol fuels such as E85 or E98.
- Notes: This digital input can be used for other functions as well.
- Component: The GM Fuel Composition Sensor (FCS) is the most commonly used for converting a vehicle to flex fuel.
- Wiring: This pin needs to be wired directly to the signal pin of the fuel composition sensor.

### Boost Control Solenoid

- Typical Use: This is used to operate a 12V PWM solenoid.
- Notes: Boost control solenoids can be normally open (NO) or normally closed (NC). This will change the duty cycle strategy but is also dependant upon how the wastegate is plumbed with hoses.
- Component: AEM carries boost control solenoids (sold separately). However, the Infinity can control most factory boost control solenoids.
- Wiring: Solenoids have two wires and have no polarity.

### Power from Relay

- Typical Use: Can be used for many things, however, this 12V source was implemented to be paired with the **Boost Control Solenoid**.
- Notes: This 12V is coming through the vehicle's main relay.
- Component: Because of using shared power, this should only be used for low current electronics.
- Wiring: N/A

### Meth Boost Safe / Clutch Switch

- Typical Use: Can be wired to the AEM Water Meth Kit to deactivate high boost pressure. Can also be used for a 2step rev limiter.
- Notes: This digital input can be used for other functions as well.
- Component: AEM Water Meth Kit or simple On-Off Clutch Switch
- Wiring: Directly to the AEM Water/Meth Boost Safe Output. If used as a clutch switch, wire this to the switch and ground the other side of the switch for a proper input trigger.

### Boost Target Trim Selector Input

- Typical Use: Can be used for to trigger multiple boost targets.
- Notes: This analog input can be used for other functions as well.

- Component: AEM 12 Position Universal Trim Pot (or typical potentiometer). Can also be used with any simple ON/OFF switch.
- Wiring: This wire should be routed to the signal output of the component. If used with a simple ON/OFF switch, route the opposite terminal to an Infinity sensor ground.

### Shift Light / Warning Light

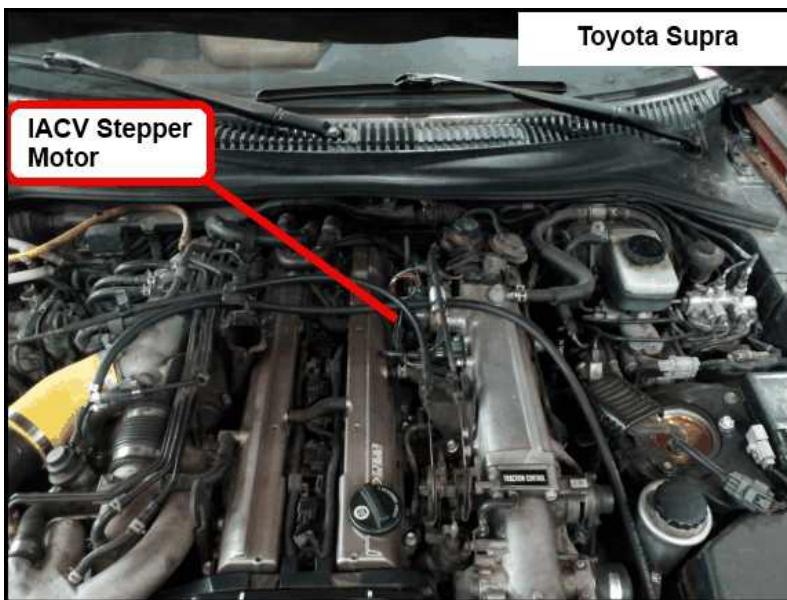
- Typical Use: Can be used to warn the driver of any engine parameter.
- Notes: This low side (ground) output can be used for other functions as well. If attempting to drive a component over 4amps, a relay must be used.
- Component: The Infinity can directly drive an electronic component up to 4amps max.
- Wiring: For a relay, this should be wired to terminal 85 (or 86). Supply 12V to the opposite terminal 86 (or 85). If directly driving a low current component, wire this to the ground terminal.

### Radiator Fan 2

- Typical Use: Can be used to operate an auxiliary fan for a radiator, intercooler, etc
- Notes: This low side (ground) output can be used for other functions as well. If attempting to drive a component over 4amps, a relay must be used.
- Component: The Infinity can directly drive an electronic component up to 4amps max.
- Wiring: For a relay, this should be wired to terminal 85 (or 86). Supply 12V to the opposite terminal 86 (or 85). If directly driving a low current component, wire this to the ground terminal

### 7.1.14 Idle Air Control Valve Requirements

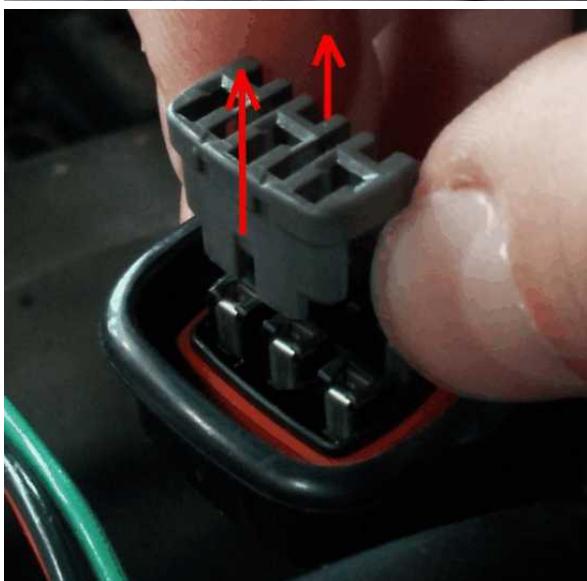
Many Toyota, Mitsubishi, and other vehicles use an Idle Air Control Valve with a Unipolar Stepper Motor (6-pin connector) and MUST be modified. See picture below. A Bipolar Stepper Motor (ex. GM) will have a 4-pin connector and DOES NOT need to be modified. \*This info does not apply to vehicles that utilize IACV solenoids.



The 2 center pins (Black-Red wires) supply 12V power to the stepper motor in the factory setup, however these pins MUST BE DISCONNECTED before powering on the AEM Infinity ECU.



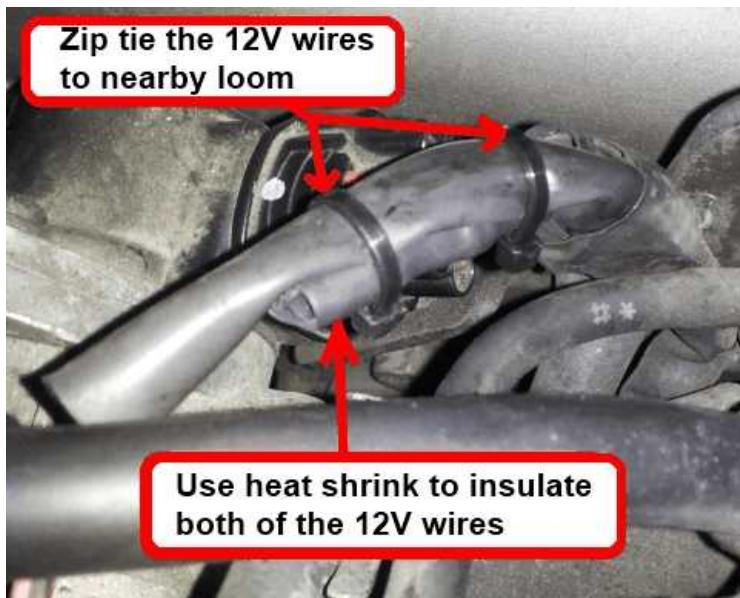
Step 1: Disconnect connector from IACV housing and gently remove the retainer from the connector.



Step 2: Use a small flat-blade screwdriver/pick to move the terminal locks while pulling the Black-Red wires out from the backside of the connector.



Step 3: Use heat shrink to insulate both 12V wires and then zip tie the insulated wires to a nearby loom.



Step 4: Reinstall the retainer, and then plug the connector back into the IACV.





## 7.2 Universal Pinout, Infinity-8/10/12

Infinity Pin	Hrdwr Ref.	Hardware Specification	Notes
C1-1	LowsideSwitch_4_Out	Lowside switch, 4A max, NO internal flyback diode.  No pullup	Normally used as A/C Relay Control output.
C1-2	LowsideSwitch_5_Out	Lowside switch, 4A max with internal flyback diode. Inductive load should NOT have full time power.  No pullup	See Setup Wizard Page "LowSide Assignment Tables" for output assignment and 2D table "LS5_Duty [%]" for activation.
C1-3	LowsideSwitch_6_Out	Lowside switch, 4A max with internal flyback diode. Inductive load should NOT have full time power.  No pullup	See Setup Wizard Page "LowSide Assignment Tables" for output assignment and 2D table "LS6_Duty [%]" for activation.
C1-4	UEGO 1 Heat_Out	Bosch UEGO controller	Lowside switch for UEGO heater control. Connect to pin 4 of Bosch UEGO sensor. NOTE that pin 3 of the Sensor is heater (+) and must be power by a fused/switched 12V supply.
C1-5	UEGO 1 IA_In		Trim Current signal. Connect to pin 2 of Bosch UEGO sensor
C1-6	UEGO 1 IP_In		Pumping Current signal. Connect to pin 6 of Bosch UEGO sensor

Infinity Pin	Hrdwr Ref.	Hardware Specification	Notes
C1-7	UEGO 1 UN_In		Nernst Voltage signal. Connect to pin 1 of Bosch UEGO sensor
C1-8	UEGO 1 VM_In		Virtual Ground signal. Connect to pin 5 of Bosch UEGO sensor.
C1-9	Flash_Enable_In	10K pulldown	Not usually needed for automatic firmware updates through Infinity Tuner. If connection errors occur during update, connect 12 volts to this pin before proceeding with upgrade. Disconnect the 12 volts signal after the update.
C1-10	+12V_R8C_CPU_In	Dedicated power management CPU	Full time battery power. MUST be powered before the ignition switch input is triggered (See C1-65).
C1-11	Coil 4_Out	25 mA max source current	0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.
C1-12	Coil 3_Out	25 mA max source current	0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.
C1-13	Coil 2_Out	25 mA max source current	0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.
C1-14	Coil 1_Out	25 mA max source current	0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.
C1-15	Coil 6_Out	25 mA max source current	0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.
C1-16	Coil 5_Out	25 mA max source current	0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.
C1-17	LowsideSwitch_2_Out	Lowside switch, 4A max, NO internal flyback diode.  No pullup	See Setup Wizard Pages "User GPOs" for activation criteria and "LowSide Assignment Tables" for output assignment
C1-18	LowsideSwitch_3_Out	Lowside switch, 4A max with internal flyback diode. Inductive load should NOT have full time power.  No pullup	Normally used as MIL output. See Wizard page "LowSide Assignment Tables" for output assignment.

Infinity Pin	Hrdwr Ref.	Hardware Specification	Notes
C1-19	AGND_1_Out	Dedicated analog ground	Analog 0-5V sensor ground
C1-20	AGND_1_Out	Dedicated analog ground	Analog 0-5V sensor ground
C1-21	Crankshaft Position Sensor Hall_In	10K pullup to 12V. Will work with ground or floating switches.	See Setup Wizard page Cam/Crank for options.
C1-22	Camshaft Position Sensor 1 Hall_In	10K pullup to 12V. Will work with ground or floating switches.	See Setup Wizard page Cam/Crank for options.
C1-23	Digital_In_2	10K pullup to 12V. Will work with ground or floating switches.	See Setup Wizard page Cam/Crank for options.
C1-24	Digital_In_3	10K pullup to 12V. Will work with ground or floating switches.	See Setup Wizard page Turbo Speed for calibration constant.
C1-25	Digital_In_4	10K pullup to 12V. Will work with ground or floating switches.	See Setup Wizard page Vehicle Speed for calibration constant.
C1-26	Digital_In_5	10K pullup to 12V. Will work with ground or floating switches.	See channel FlexDigitalIn [Hz] for raw frequency input data.
C1-27	Knock Sensor 1_In	Dedicated knock signal processor	See Setup Wizard page Knock Setup for options.
C1-28	Knock Sensor 2_In	Dedicated knock signal processor	See Setup Wizard page Knock Setup for options.
C1-29	+12V_Relay_Control_Out	0.7A max ground sink for external relay control	Will activate at key on and at key off according to the configuration settings.
C1-30	Power Ground_In	Power Ground	Connect directly to battery ground
C1-31	CANL_A_Out	Dedicated High Speed CAN Transceiver	Recommend twisted pair (one twist per 2") with terminating resistor. Contact AEM for additional information.
C1-32	CANH_A_Out	Dedicated High Speed CAN Transceiver	Recommend twisted pair (one twist per 2") with terminating resistor. Contact AEM for additional information.

Infinity Pin	Hrdwr Ref.	Hardware Specification	Notes
C1-33	LowsideSwitch_1_Out	Lowside switch, 4A max with internal flyback diode. Inductive load should NOT have full time power.  No pullup	See Setup Wizard page Boost Control for options. Monitor BoostControl [%] channel for output state.
C1-34	LowsideSwitch_0_Out	Lowside switch, 4A max, NO internal flyback diode.  No pullup	Switched ground. Will prime for 2 seconds at key on and activate if RPM > 0.
C1-35	Analog_In_7	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. See the Setup Wizard Set Throttle Range page for automatic min/max calibration.
C1-36	Analog_In_8	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. See the Setup Wizard Set Manifold Pressure page for setup and calibration.
C1-37	Analog_In_9	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. See the Setup Wizard Fuel Pressure page for setup and calibration.
C1-38	Analog_In_10	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. See the Setup Wizard Barometric Pressure page for setup and calibration.
C1-39	Analog_In_11	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. Normally used as Shift Switch input.
C1-40	Analog_In_12	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. Normally used as Mode Switch input.

Infinity Pin	Hrdwr Ref.	Hardware Specification	Notes
C1-41	+5V_Out_1	Regulated, fused +5V supply for sensor power	Analog sensor power
C1-42	+5V_Out_1	Regulated, fused +5V supply for sensor power	Analog sensor power
C1-43	HighsideSwitch_1_Out	0.7A max, High Side Solid State Relay	See Setup Wizard page 'HighSide Assignment Tables' for configuration options.
C1-44	HighsideSwitch_0_Out	0.7A max, High Side Solid State Relay	See Setup Wizard page 'HighSide Assignment Tables' for configuration options.
C1-45	Crankshaft Position Sensor VR+_In	Differential Variable Reluctance Zero Cross Detection	See Setup Wizard page Cam/Crank for options.
C1-46	Crankshaft Position Sensor VR-_In	Differential Variable Reluctance Zero Cross Detection	See Setup Wizard page Cam/Crank for options.
C1-47	Camshaft Position Sensor 1 VR-_In		See Setup Wizard page Cam/Crank for options.
C1-48	Camshaft Position Sensor 1 VR+_In		See Setup Wizard page Cam/Crank for options.
C1-49	VR+_In_2	Differential Variable Reluctance Zero Cross Detection	See Non Driven Wheel Speed Calibration in the Setup Wizard Vehicle Speed page.
C1-50	VR-_In_2	Differential Variable Reluctance Zero Cross Detection	
C1-51	VR-_In_3		
C1-52	VR+_In_3	5.0A max Throttle Control Hbridge Drive	+12V to close.
C1-53	DBW1 Motor _Out		
C1-54	DBW1 Motor +_Out	5.0A max Throttle Control Hbridge Drive	+12V to open.
C1-55	Power Ground_In	Power Ground	Connect directly to battery ground
C1-56	Injector 6_Out	Saturated or peak and hold, 3A max continuous	Injector 6
C1-57	Injector 5_Out	Saturated or peak and hold, 3A max continuous	Injector 5
C1-58	Injector 4_Out	Saturated or peak and hold, 3A max continuous	Injector 4
C1-59	Injector 3_Out	Saturated or peak and hold, 3A max continuous	Injector 3
C1-60	Power Ground_In	Power Ground	Connect directly to battery ground

Infinity Pin	Hrdwr Ref.	Hardware Specification	Notes
C1-61	+12V_In	12 volt power from relay	12 volt power from relay. Relay must be controlled by +12V Relay Control signal, pin C1-29 above.
C1-62	Injector 2_Out	Saturated or peak and hold, 3A max continuous	Injector 2
C1-63	Injector 1_Out	Saturated or peak and hold, 3A max continuous	Injector 1
C1-64	+12V_In	12 volt power from relay	12 volt power from relay. Relay must be controlled by +12V Relay Control signal pin C1-29 above.
C1-65	+12V_SW_In	10K pulldown	Full time battery power must be available at C1-10 before this input is triggered.
C1-66	Analog_In_Temp_1	12 bit A/D, 2.49K pullup to 5V	See "Coolant Temperature" Setup Wizard for selection.
C1-67	Analog_In_Temp_2	12 bit A/D, 2.49K pullup to 5V	See "Air Temperature" Setup Wizard for selection.
C1-68	Analog_In_Temp_3	12 bit A/D, 2.49K pullup to 5V	Normally used for Oil Temp input.
C1-69	Stepper_2A_Out	Automotive, Programmable Stepper Driver, up to 28V and $\pm 1.4A$	Be sure that each internal coil of the stepper motor are properly paired with the 1A/1B and 2A/2B ECU outputs. Supports Bi-Polar stepper motors only.
C1-70	Stepper_1A_Out	Automotive, Programmable Stepper Driver, up to 28V and $\pm 1.4A$	Be sure that each internal coil of the stepper motor are properly paired with the 1A/1B and 2A/2B ECU outputs. Supports Bi-Polar stepper motors only.
C1-71	Stepper_2B_Out	Automotive, Programmable Stepper Driver, up to 28V and $\pm 1.4A$	Be sure that each internal coil of the stepper motor are properly paired with the 1A/1B and 2A/2B ECU outputs. Supports Bi-Polar stepper motors only.
C1-72	Stepper_1B	Automotive, Programmable Stepper Driver, up to 28V and $\pm 1.4A$	Be sure that each internal coil of the stepper motor are properly paired with the 1A/1B and 2A/2B ECU outputs. Supports Bi-Polar stepper motors only.
C1-73	Power Ground_In	Power Ground	Connect directly to battery ground
C2-1	DBW2 Motor +_Out	5.0A max Throttle Control Hbridge Drive	+12V to open.
C2-2	DBW2 Motor -_Out	5.0A max Throttle Control Hbridge Drive	+12V to close.
C2-3	Power Ground_In	Power Ground	Connect directly to battery ground

Infinity Pin	Hrdwr Ref.	Hardware Specification	Notes
C2-4	Injector 7_Out	Saturated or peak and hold, 3A max continuous	Injector 7
C2-5	Injector 8_Out	Saturated or peak and hold, 3A max continuous	Injector 8
C2-6	Injector 9_Out	Saturated or peak and hold, 3A max continuous	Injector 9.
C2-7	Injector 10_Out	Saturated or peak and hold, 3A max continuous	Injector 10.
C2-8	Power Ground_In	Power Ground	Connect directly to battery ground.
C2-9	+12V_In	12 volt power from relay	12 volt power from relay. Relay must be controlled by +12V Relay Control signal, pin C1-29 above.
C2-10	Injector 11_Out	Saturated or peak and hold, 3A max continuous	Not used
C2-11	Injector 12_Out	Saturated or peak and hold, 3A max continuous	Not used
C2-12	Analog_In_17	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. Normally used as A/C Analog Request input.
C2-13	Analog_In_18	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. Normally used as DBW APP1.
C2-14	Analog_In_19	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. Normally used as DBW APP2.
C2-15	Analog_In_Temp_4	12 bit A/D, 2.49K pullup to 5V	Normally used as Charge Out Temperature input.
C2-16	Analog_In_Temp_5	12 bit A/D, 2.49K pullup to 5V	Normally used as Airbox Temperature input.

Infinity Pin	Hrdwr Ref.	Hardware Specification	Notes
C2-17	Analog_In_Temp_6	12 bit A/D, 2.49K pullup to 5V	Normally used as Fuel Temperature input.
C2-18	Analog_In_13	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. See Setup Wizard Oil Pressure page for setup options. See OilPressure [psig] for channel data.
C2-19	Analog_In_14	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU.
C2-20	Analog_In_15	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. Normally used as Exhaust Back Pressure input.
C2-21	Analog_In_16	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. Normally used as DBW1_TPSB input.
C2-22	+5V_Out_2	Regulated, fused +5V supply for sensor power	Analog sensor power
C2-23	+5V_Out_2	Regulated, fused +5V supply for sensor power	Analog sensor power
C2-24	+5V_Out_2	Regulated, fused +5V supply for sensor power	Analog sensor power
C2-25	VR+_In_5	Differential Variable Reluctance Zero Cross Detection	See Driven Wheel Speed Calibration in the Setup Wizard Vehicle Speed page.
C2-26	VR-_In_5		
C2-27	VR-_In_4	Differential Variable Reluctance Zero Cross Detection	See Non Driven Wheel Speed Calibration in the Setup Wizard Vehicle Speed page.
C2-28	VR+_In_4		

Infinity Pin	Hrdwr Ref.	Hardware Specification	Notes
C2-29	LowsideSwitch_9_Out	Lowside switch, 4A max with internal flyback diode, 2.2K 12V pullup. Inductive load should NOT have full time power.  12V pullup	See Setup Wizard page Tacho for configuration options.
C2-30	AGND_2_Out	Dedicated analog ground	Analog 0-5V sensor ground
C2-31	AGND_2_Out	Dedicated analog ground	Analog 0-5V sensor ground
C2-32	AGND_2_Out	Dedicated analog ground	Analog 0-5V sensor ground
C2-33	Analog_In_20	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU.
C2-34	Analog_In_21	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. Normally used as 3 Step Enable Switch input.
C2-35	Analog_In_22	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. Normally used as USB Logging Request input.
C2-36	Analog_In_23	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. Normally used as Charge Out Pressure input.
C2-37	Digital_In_6	No pullup. Will work with TTL signals.	Input can be assigned to different pins. See Setup Wizard page Input Function Assignments for input mapping options.

Infinity Pin	Hrdwr Ref.	Hardware Specification	Notes
C2-38	Digital_In_7	No pullup. Will work with TTL signals.	See ClutchSwitch 1-axis table for setup options. Input can be assigned to different pins. See Setup Wizard page Input Function Assignments for input mapping options.
C2-39	Power Ground_In	Power Ground	Connect directly to battery ground
C2-40	Power Ground_In	Power Ground	Connect directly to battery ground
C2-41	CanH_B_Out	Dedicated High Speed CAN Transceiver	Not used
C2-42	CanL_B_Out	Dedicated High Speed CAN Transceiver	Not used
C2-43	LowsideSwitch_8_Out	Lowside switch, 4A max with internal flyback diode. Inductive load should NOT have full time power.  12V pullup	Activates if any of the following flags are true: OilPressProtectOut, LeanProtectOut, CoolantProtect. Output can be assigned to other functions. See Setup Wizard page LowSide Assignment Tables for additional options.
C2-44	LowsideSwitch_7_Out	Lowside switch, 4A max with internal flyback diode. Inductive load should NOT have full time power.  No pullup	Normally used as Spare GPO1 output.
C2-45	UEGO 2 VM_In	Bosch UEGO Controller	Virtual Ground signal. Connect to pin 5 of Bosch UEGO sensor.
C2-46	UEGO 2 UN_In		Nernst Voltage signal. Connect to pin 1 of Bosch UEGO sensor
C2-47	UEGO 2 IP_In		Pumping Current signal. Connect to pin 6 of Bosch UEGO sensor
C2-48	UEGO 2 IA_In		Trim Current signal. Connect to pin 2 of Bosch UEGO sensor
C2-49	UEGO 2 HEAT_Out		Lowside switch for UEGO heater control. Connect to pin 4 of Bosch UEGO sensor. NOTE that pin 3 of the Sensor is heater (+) and must be power by a fused/switched 12V supply.
C2-50	+12V_R8C_CPU_In	Dedicated power management CPU	Full time battery power. MUST be powered before the ignition switch input is triggered (See C1-65).
C2-51	Coil 7_Out	25 mA max source current	0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.

Infinity Pin	Hrdwr Ref.	Hardware Specification	Notes
C2-52	Coil 8_Out	25 mA max source current	0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.
C2-53	Coil 9_Out	25 mA max source current	0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.
C2-54	Coil 10_Out	25 mA max source current	0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.
C2-55	Highside Fuel Pump Switch_Out	Highside switch, 0.7A max, Solid State Relay, NO internal flyback diode.	+12V High Side Drive. Will prime for 2 seconds at key on and activate if RPM > 0.
C2-56	Not used	Not used	Not used

## 7.3 Universal Pinout, Infinity-6/8h

Infinity Pin	Hardware Ref.	Hardware Specification	Notes
C1-1	LowsideSwitch_4_Out	Lowside switch, 1.7A max, NO internal flyback diode. 12V pullup	See Setup Wizard Pages "User GPOs" for activation criteria and "LowSide Assignment Tables" for output assignment
C1-2	LowsideSwitch_5_Out	Lowside switch, 6A max with internal flyback diode. Inductive load should NOT have full time power. 12V pullup	See Setup Wizard Page "LowSide Assignment Tables" for output assignment and 2D table "LS5_Duty [%]" for activation.
C1-3*	LowsideSwitch_6_Out (*Infinity-6 Only)	Lowside switch, 6A max with internal flyback diode. Inductive load should NOT have full time power. No pullup	Available on P/N 30-7106 only. See Setup Wizard Page "LowSide Assignment Tables" for output assignment and 2D table "LS6_Duty [%]" for activation.
C1-3**	Injector 7_Out (**Infinity-8H Only)	For use with high impedance (10-15 ohms) injectors only, 1.7A max.	Available on P/N 30-7108 only
C1-4*	LowsideSwitch_7_Out (*Infinity-6 Only)	Lowside switch, 6A max, NO internal flyback diode. No pullup	Available on P/N 30-7106 only. See Setup Wizard Page "LowSide Assignment Tables" for output assignment and 2D table "LS7_Duty [%]" for activation.
C1-4**	Injector 8_Out (**Infinity-8H Only)	For use with high impedance (10-15 ohms) injectors only, 1.7A max.	Available on P/N 30-7108 only
C1-5	UEGO1 Heat_Out	Bosch UEGO controller	Lowside switch for UEGO heater control. Connect to pin 4 of Bosch UEGO sensor. NOTE that pin 3 of the Sensor is heater (+) and must be power by a fused/switched 12V supply.
C1-6	UEGO1 IA_In		Trim Current signal. Connect to pin 2 of Bosch UEGO sensor
C1-7	UEGO1 IP_In		Pumping Current signal. Connect to pin 6 of Bosch UEGO sensor
C1-8	UEGO1 UN_In		Nernst Voltage signal. Connect to pin 1 of Bosch UEGO sensor
C1-9	UEGO1 VM_In		Virtual Ground signal. Connect to pin 5 of Bosch UEGO sensor.
C1-10	+12V_R8C_CPU_In	Dedicated power management CPU	Full time battery power. MUST be powered before the ignition switch input is triggered (See C1-48).
C1-11	Coil 4_Out	25 mA max source current	0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.
C1-12	Coil 3_Out	25 mA max source current	0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.
C1-13	Coil 2_Out	25 mA max source current	0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.
C1-14	Coil 1_Out	25 mA max source current	0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.

Infinity Pin	Hardware Ref.	Hardware Specification	Notes
C1-15	Coil 6_Out	25 mA max source current	0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.
C1-16	Coil 5_Out	25 mA max source current	0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.
C1-17	Crankshaft Position Sensor VR+_In	Differential Variable Reluctance Zero Cross Detection	See Setup Wizard page Cam/Crank for options.
C1-18	Crankshaft Position Sensor VR-_In		See Setup Wizard page Cam/Crank for options.
C1-19	Camshaft Position Sensor 1 VR-_In	Differential Variable Reluctance Zero Cross Detection	See Setup Wizard page Cam/Crank for options.
C1-20	Camshaft Position Sensor 1 VR+_In		See Setup Wizard page Cam/Crank for options.
C1-21	LowsideSwitch_2_Out	Lowside switch, 1.7A max, NO internal flyback diode.  No pullup	See Setup Wizard Pages "User GPOs" for activation criteria and "LowSide Assignment Tables" for output assignment
C1-22	LowsideSwitch_3_Out	Lowside switch, 6A max with internal flyback diode. Inductive load should NOT have full time power.  No pullup	See Wizard page "LowSide Assignment Tables" for output assignment.  MIL Activates when any of the following flags are true: ErrorAirTemp, ErrorBaro, ErrorCoolantTemp, ErrorEBP, ErrorFuelPressure, UEGO_0_Diag_error, UEGO_1_Diag_error, ErrorMAFAnalog, ErrorMAFDigital, ErrorMAP, ErrorOilPressure, ErrorThrottle.
C1-23	AGND_1_Out	Dedicated analog ground	Analog 0-5V sensor ground
C1-24	AGND_1_Out	Dedicated analog ground	Analog 0-5V sensor ground
C1-25	Crankshaft Position Sensor Hall_In	10K pullup to 12V. Will work with ground or floating switches.	See Setup Wizard page Cam/Crank for options.
C1-26	Camshaft Position Sensor 1 Hall_In	10K pullup to 12V. Will work with ground or floating switches.	See Setup Wizard page Cam/Crank for options.
C1-27	Digital_In_2	10K pullup to 12V. Will work with ground or floating switches.	See Setup Wizard page Cam/Crank for options.
C1-28	Dig3 [Hz] / Dig3_Duty_In	10K pullup to 12V. Will work with ground or floating switches.	Frequency input can be assigned to Wheel Speed, TurboSpeed, Flex Fuel or other functions. See Setup Wizard page Input Function Assignments for mapping options.
C1-29	Dig4 [Hz] / Dig4_Duty_In	10K pullup to 12V. Will work with ground or floating switches.	See Setup Wizard page Vehicle Speed for calibration constant.
C1-29	RS232 Rx_In	RS232 Line Driver/Receiver	Future expansion
C1-30	Digital_In_5	10K pullup to 12V. Will work with ground or floating switches.	See ClutchSwitch 1-axis table for setup options. Input can be assigned to different pins. See Setup Wizard page Input Function Assignments for input mapping options.
C1-30	RS232 Tx_Out	RS232 Line Driver/Receiver	Future expansion

Infinity Pin	Hardware Ref.	Hardware Specification	Notes
C1-31*	Dig6 [Hz] / Dig6_Duty_In (*Infinity-6 Only)	10K pullup to 12V. Will work with ground or floating switches.	Available on P/N 30-7106 only. Frequency input can be assigned to Wheel Speed, TurboSpeed, Flex Fuel or other functions. See Setup Wizard page Input Function Assignments for mapping options.
C1-31**	Coil 7_Out (**Infinity-8H Only)	25 mA max source current	Available on P/N 30-7108 only. 0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.
C1-32*	Digital_In_7 (*Infinity-6 Only)	10K pullup to 12V. Will work with ground or floating switches.	Available on P/N 30-7106 only. Input can be assigned to different pins. See Setup Wizard page Input Function Assignments for input mapping options.
C1-32**	Coil 8_Out (**Infinity-8H Only)	25 mA max source current	Available on P/N 30-7108 only. 0-5V Falling edge fire. DO NOT connect directly to coil primary. Must use an ignitor OR CDI that accepts a FALLING edge fire signal.
C1-33	Power Ground_In	Power Ground	Connect directly to battery ground
C1-34	CANL_A_Out	Dedicated High Speed CAN Transceiver	Recommend twisted pair (one twist per 2") with terminating resistor. Contact AEM for additional information.
C1-35	CANH_A_Out	Dedicated High Speed CAN Transceiver	Recommend twisted pair (one twist per 2") with terminating resistor. Contact AEM for additional information.
C1-36	CanL_B_Out	Dedicated High Speed CAN Transceiver	Not used, reserved for future expansion.
C1-37	CanH_B_Out	Dedicated High Speed CAN Transceiver	Not used, reserved for future expansion.
C1-38	Analog_In_Temp_1	12 bit A/D, 2.49K pullup to 5V	See "Coolant Temperature" Setup Wizard for selection.
C1-39	Analog_In_Temp_2	12 bit A/D, 2.49K pullup to 5V	See "Air Temperature" Setup Wizard for selection.
C1-40	Analog_In_Temp_3	12 bit A/D, 2.49K pullup to 5V	See 1D table OilTempCal table for calibration data and OilTemp [C] for channel data.
C1-41	Lowside Fuel Pump drive_Out	Lowside switch, 1.7A max, NO internal flyback diode.  No pullup	Switched ground. Will prime for 2 seconds at key on and activate if RPM > 0.
C1-42	LowsideSwitch_1_In	Lowside switch, 6A max with internal flyback diode. Inductive load should NOT have full time power.  No pullup	See Setup Wizard page Boost Control for options. Monitor BoostControl [%] channel for output state.
C1-43	Power Ground_In	Power Ground	Connect directly to battery ground
C1-44	Knock Sensor 1_In	Dedicated knock signal processor	See Setup Wizard page Knock Setup for

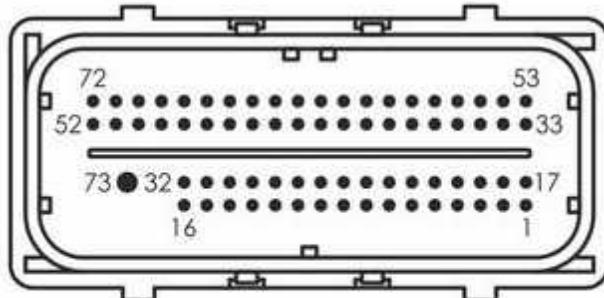
Infinity Pin	Hardware Ref.	Hardware Specification	Notes
			options.
C1-45	Knock Sensor 2_In	Dedicated knock signal processor	See Setup Wizard page Knock Setup for options.
C1-46	Power Ground_In	Power Ground	Connect directly to battery ground
C1-47	+12V_Relay_Control_Out	0.7A max ground sink for external relay control	Will activate at key on and at key off according to the configuration settings.
C1-48	+12V_SW_In	10K pulldown	Full time battery power must be available at C1-10 before this input is triggered.
C1-49	+5V_Out_1	Regulated, fused +5V supply for sensor power	Analog sensor power
C1-50	+5V_Out_1	Regulated, fused +5V supply for sensor power	Analog sensor power
C1-51	Analog_In_7	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. See the Setup Wizard Set Throttle Range page for automatic min/max calibration. Monitor the Throttle [%] channel. Also DB1_TPSA [%] for DBW applications.
C1-52	Analog_In_8	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. See the Setup Wizard Set Manifold Pressure page for setup and calibration. Monitor the MAP [kPa] channel.
C1-53	Analog_In_9	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. See the Setup Wizard Fuel Pressure page for setup and calibration. Monitor the FuelPressure [psig] channel.
C1-54	VR+_In_2	Differential Variable Reluctance Zero Cross Detection	See Non Driven Wheel Speed Calibration in the Setup Wizard Vehicle Speed page.
C1-55	VR_-In_2		
C1-56	VR_-In_3	Differential Variable Reluctance Zero Cross Detection	See Driven Wheel Speed Calibration in the Setup Wizard Vehicle Speed page.
C1-57	VR+_In_3		
C1-58	HighsideSwitch_0_Out	2.6A max, High Side Solid State Relay	See Setup Wizard page 'HighSide Assignment Tables' for configuration options. See 2D lookup table 'HS0_Table' for activation settings. See Setup Wizard page 'VTEC' for default activation criteria.
C1-59	Stepper_1B_Out	Automotive, Programmable Stepper Driver, up to 28V and ±1.4A	Be sure that each internal coil of the stepper motor are properly paired with the 1A/1B and 2A/2B ECU outputs. Supports Bi-Polar stepper

Infinity Pin	Hardware Ref.	Hardware Specification	Notes
			motors only.
C1-60	Stepper_2B_Out	Automotive, Programmable Stepper Driver, up to 28V and $\pm 1.4A$	Be sure that each internal coil of the stepper motor are properly paired with the 1A/1B and 2A/2B ECU outputs. Supports Bi-Polar stepper motors only.
C1-61	DBW1 Motor _Out	5.0A max Throttle Control Hbridge Drive	+12V to close
C1-62	DBW1 Motor +_Out	5.0A max Throttle Control Hbridge Drive	+12V to open
C1-63	+12V_In	12 volt power from relay	12 volt power from relay. Relay must be controlled by +12V Relay Control signal, pin C1-47 above.
C1-64	Injector 6_Out	Saturated (P/N 30-7108) or peak and hold, 3A max continuous (P/N 30-7106)	Injector 6
C1-65	Injector 5_Out	Saturated (P/N 30-7108) or peak and hold, 3A max continuous (P/N 30-7106)	Injector 5
C1-66	Injector 4_Out	Saturated (P/N 30-7108) or peak and hold, 3A max continuous (P/N 30-7106)	Injector 4
C1-67	Power Ground_In	Power Ground	Connect directly to battery ground
C1-68	+12V_In	12 volt power from relay	12 volt power from relay. Relay must be controlled by +12V Relay Control signal, pin C1-47 above.
C1-69	Analog_In_19	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU.
C1-70	Analog_In_18	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU.
C1-71	Analog_In_16	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU.
C1-72	Flash_Enable_In	10K pulldown	Not usually needed for automatic firmware updates through Infinity Tuner. If connection errors occur during update, connect 12 volts to this pin before proceeding with upgrade. Disconnect the 12 volts signal after the update.
C1-73	Analog_In_13	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power

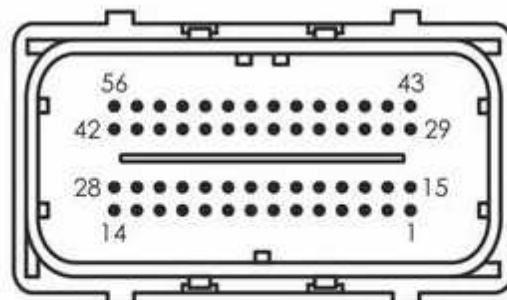
Infinity Pin	Hardware Ref.	Hardware Specification	Notes
			supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. See Setup Wizard Oil Pressure page for setup options. See OilPressure [psig] for channel data.
C1-74	Analog_In_11	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. See the 1D lookup table 'ShiftSwitch' for setup. Also assignable to multiple functions. See Setup Wizard for details.
C1-75	Analog_In_10	12 bit A/D, 100K pullup to 5V	0-5V analog signal. Use +5V Out pins as power supply and Sensor Ground pins as the low reference. Do not connect signals referenced to +12V as this can permanently damage the ECU. See the Setup Wizard Barometric Pressure page for setup and calibration. Monitor the BaroPress [kPa] channel.
C1-76	Injector 3_Out	Saturated (P/N 30-7108) or peak and hold, 3A max continuous (P/N 30-7106)	Injector 3
C1-77	Injector 2_Out	Saturated (P/N 30-7108) or peak and hold, 3A max continuous (P/N 30-7106)	Injector 2
C1-78	Injector 1_Out	Saturated (P/N 30-7108) or peak and hold, 3A max continuous (P/N 30-7106)	Injector 1
C1-79	Stepper_2A_Out	Automotive, Programmable Stepper Driver, up to 28V and ±1.4A	Be sure that each internal coil of the stepper motor are properly paired with the 1A/1B and 2A/2B ECU outputs. Supports Bi-Polar stepper motors only.
C1-80	Stepper_1A_Out	Automotive, Programmable Stepper Driver, up to 28V and ±1.4A	Be sure that each internal coil of the stepper motor are properly paired with the 1A/1B and 2A/2B ECU outputs. Supports Bi-Polar stepper motors only.

## 7.4 Connector Views

**Infinity-8/10/12 ECU Connectors**

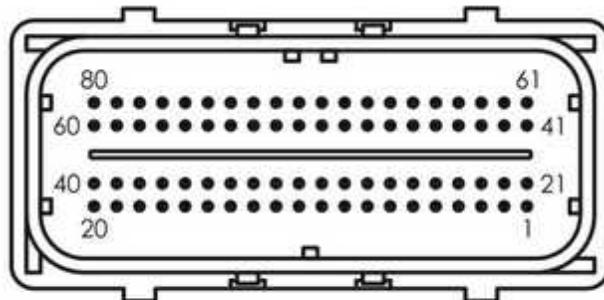


INFINITY "C1" 73 PIN



INFINITY "C2" 56 PIN

**Infinity-6/8h ECU Connector**



INFINITY "C1" 80 PIN

## 7.5 Example System Schematics

***Custom wiring harness projects should only be undertaken by experienced harness builders. If in doubt, please contact AEM for recommendations.***

For users wishing to build their own wiring harnesses from scratch, the following kits are available to help.

### **30-3701 Infinity-8/10/12 Plug & Pin Kit**

Bare necessities to begin a custom wire harness design. Includes 73 and 56 pin Molex MX123 harness connectors, terminals and sealing plugs, main relay and relay socket.

### **30-3702 Infinity-8/10/12 Mini-harness**

This harness is intended to be used as a starting point by experienced harness builders. It saves time by including basic power distribution features that can be expanded to suit many application requirements. It allows the harness builder to populate the ECU connector with only the features needed by the application. Includes 100 96" pre-terminated leads.

### **30-3703 Infinity-8/10/12 Mini-harness**

This harness is intended to be used as a starting point by experienced harness builders. It saves time by including basic power distribution features that can be expanded to suit many application requirements. It allows the harness builder to populate the ECU connector with only the features needed by the application.

### **30-3704 Infinity-6/8h Plug & Pin Kit**

Bare necessities to begin a custom wire harness design. Includes 80 pin Molex MX123 harness connector, terminals and sealing plugs, main relay and relay socket.

### **30-3805 Universal modular V8 harness system for Infinity-8/10 systems**

The Infinity Universal Modular V8 Harness system consists of a universal core harness and optional application specific extensions. It was designed with flexibility in mind. The harness system includes many features and it can be used in many different applications.

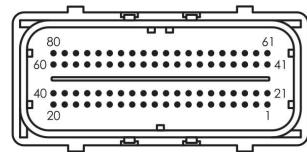
### **30-3705 Universal Mini Harness for Infinity-6/8h systems**

This harness is intended to be used as a starting point by experienced harness builders. It saves time by including basic power distribution features that can be expanded to suit many application requirements. It allows the harness builder to populate the ECU connector with only the features needed by the application.

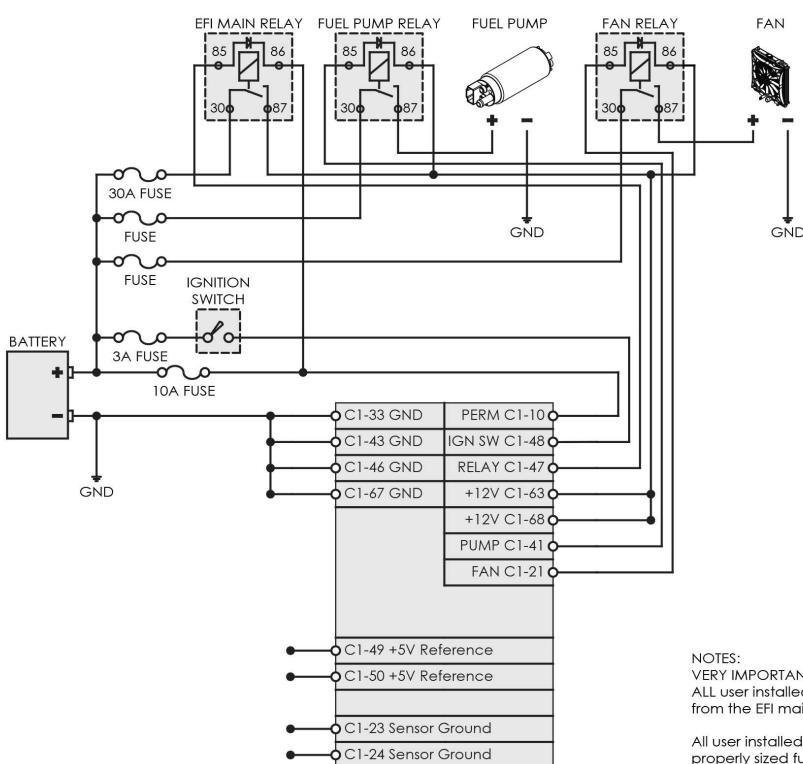
The following schematics show examples for wiring a basic Infinity system. Examples are included for both Infinity-6/8h and Infinity-8/10/12 hardware platforms. ***The power, ground and accessory relay sections of the following schematics must be strictly followed to avoid inconsistent power sequencing and possible ECU damage.***

## 7.5.1 Power Distribution, Infinity-6/8h

NAME	FUNCTION
GND	Battery ground
PERM	Fused connection to battery positive terminal (+12V, always hot)
IGN SW	Fused connection to vehicle ignition switch (+12V in RUN/CRANK only)
RELAY	Switched ground from ECU connected to relay coil primary negative
+12V	Relay driven +12V power source for ECU power and auxiliary outputs
+5V Reference	+5V supplied by ECU
Sensor Ground	Analog ground used as ground point for sensors



INFINITY "C1" 80 PIN



NOTES:  
VERY IMPORTANT  
ALL user installed auxilliary relays must be powered by the output from the EFI main relay.

All user installed auxilliary circuits should be protected with a properly sized fuse as shown.

Relays with internal diodes must have the anode side of the coil connected to the ECU.



Drawing: Power Distribution

ECU: Infinity-6/8h

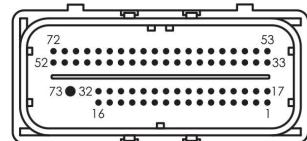
Date: 08/05/2014

Rev: A

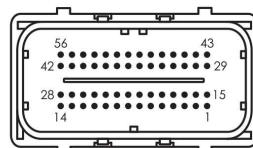
Engineer: Nakano

## 7.5.2 Power Distribution, Infinity-8/10/12

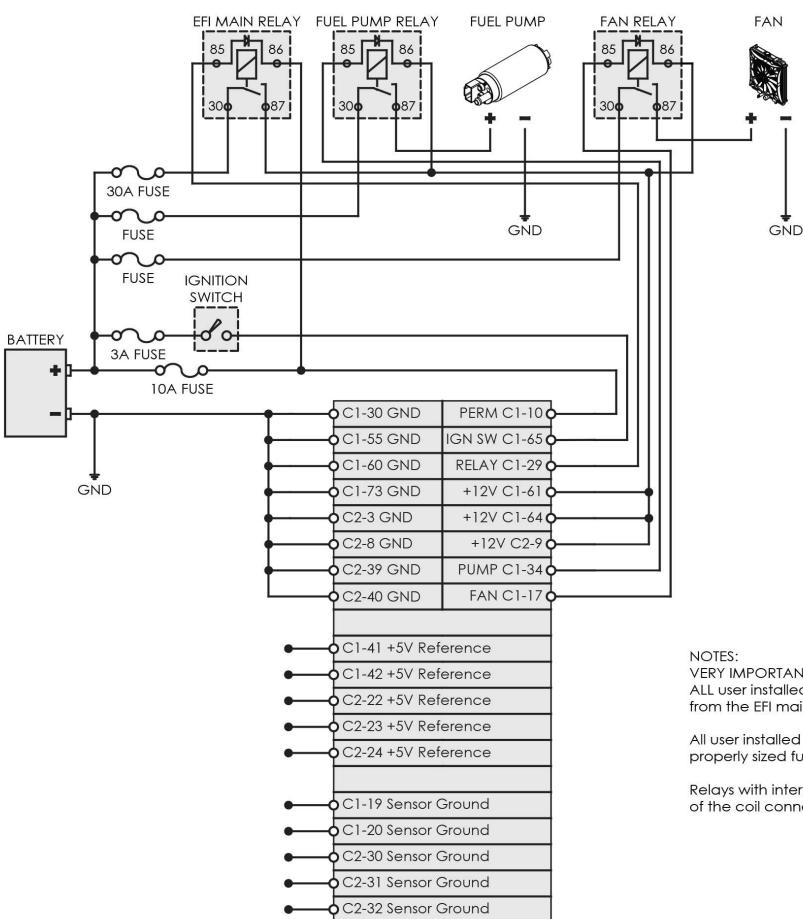
NAME	FUNCTION
GND	Battery ground
PERM	Fused connection to battery positive terminal (+12V, always hot)
IGN SW	Fused connection to vehicle ignition switch (+12V in RUN/CRANK only)
RELAY	Switched ground from ECU connected to relay coil primary negative
+12V	Relay driven +12V power source for ECU power and auxiliary outputs
+5V Reference	+5V supplied by ECU
Sensor Ground	Analog ground used as ground point for sensors



INFINITY "C1" 73 PIN



INFINITY "C2" 56 PIN



## NOTES:

VERY IMPORTANT

ALL user installed auxilliary relays must be powered by the output from the EFI main relay.

All user installed auxilliary circuits should be protected with a properly sized fuse as shown.

Relays with internal diodes must have the anode side of the coil connected to the ECU.



Drawing: Power Distribution

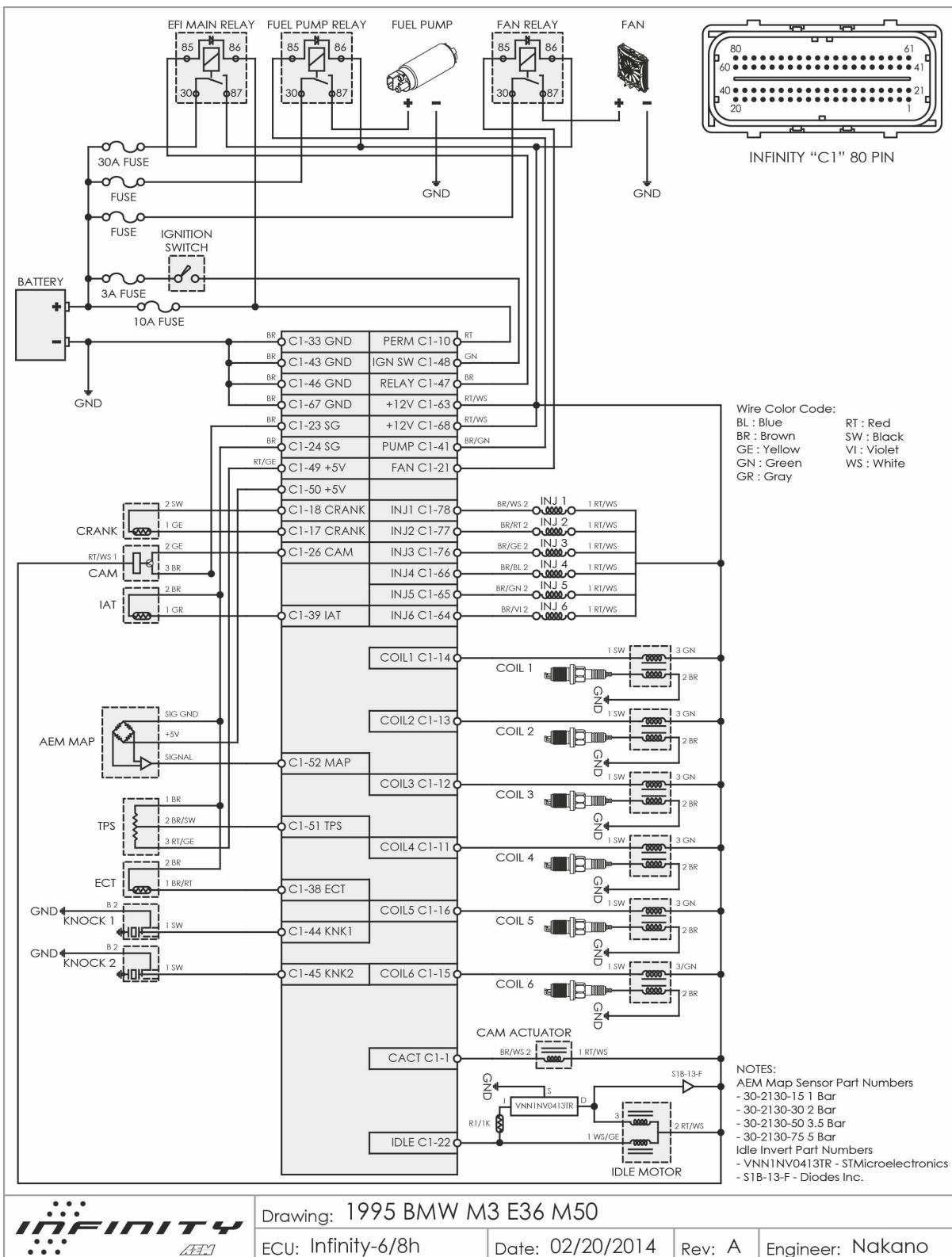
ECU: Infinity-8/10/12

Date: 08/05/2014

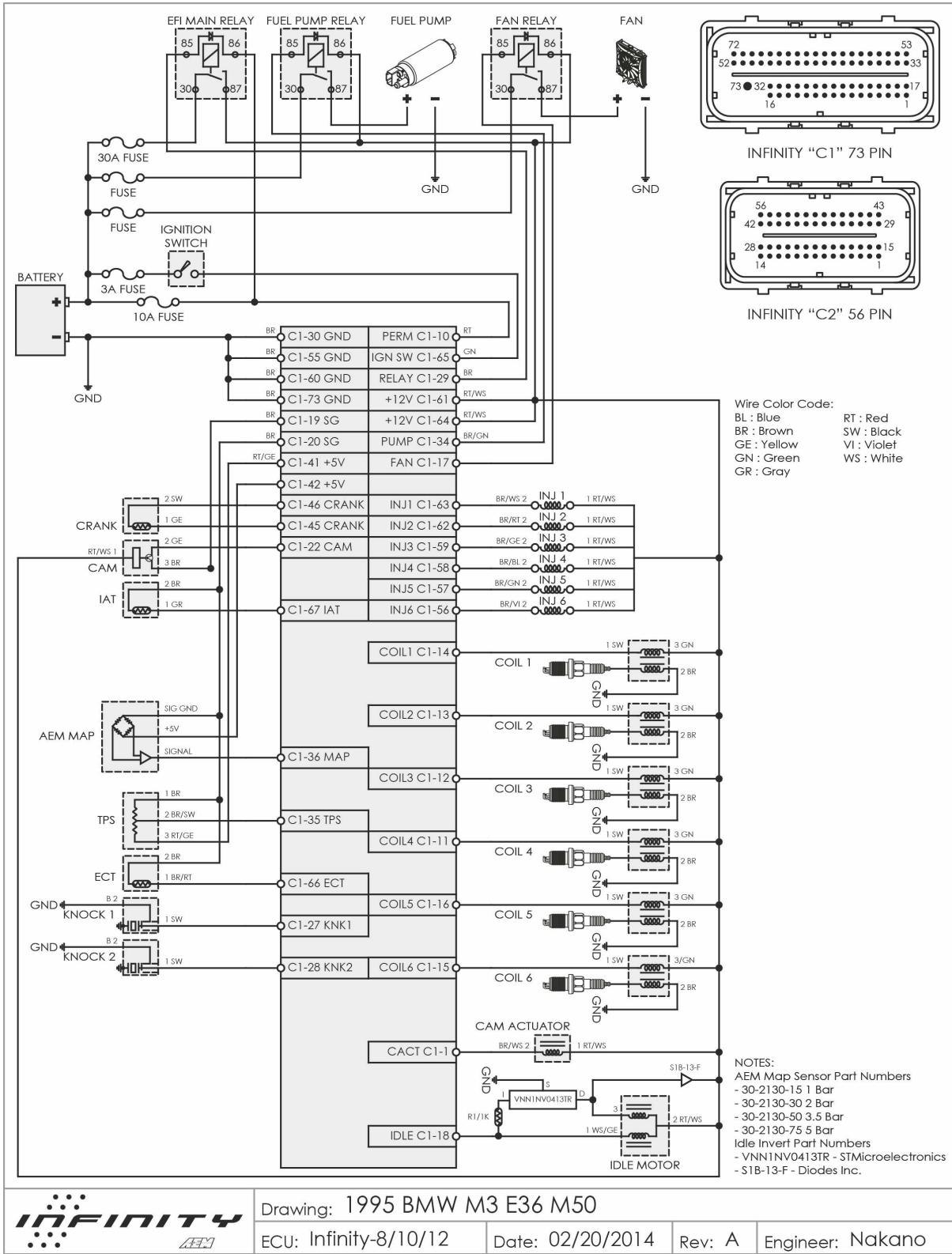
Rev: A

Engineer: Nakano

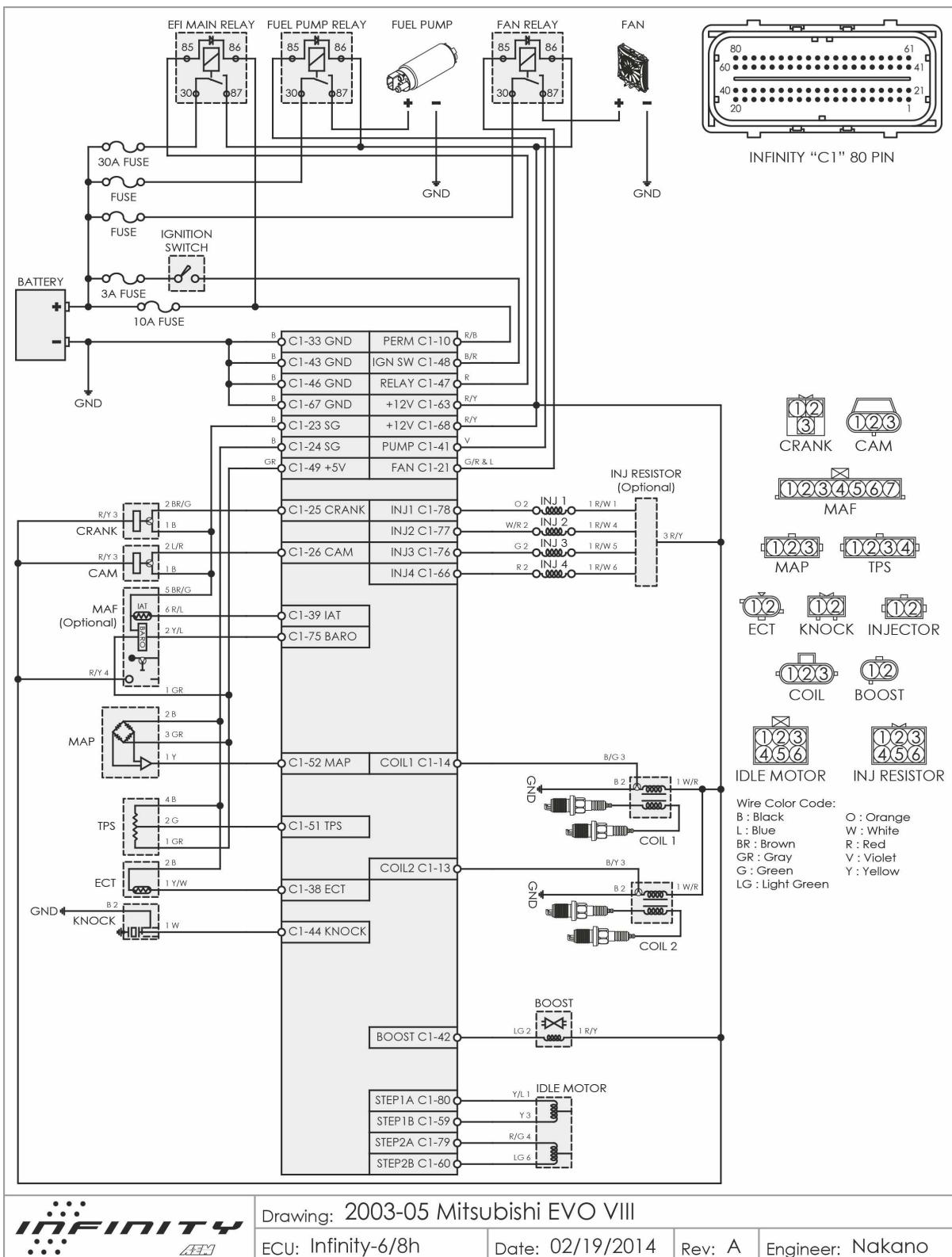
### 7.5.3 95 BMW E36 M3, Infinity-6/8h



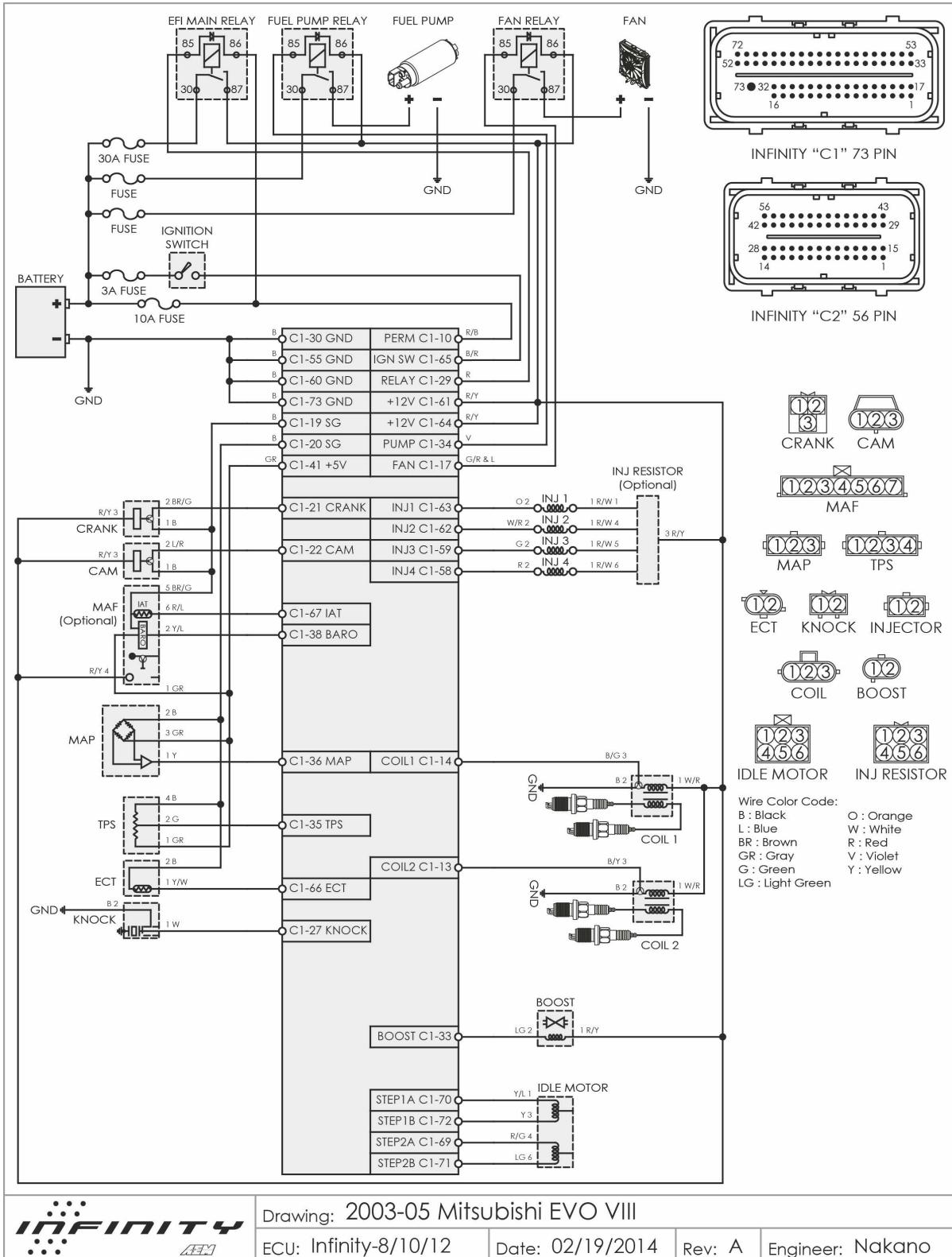
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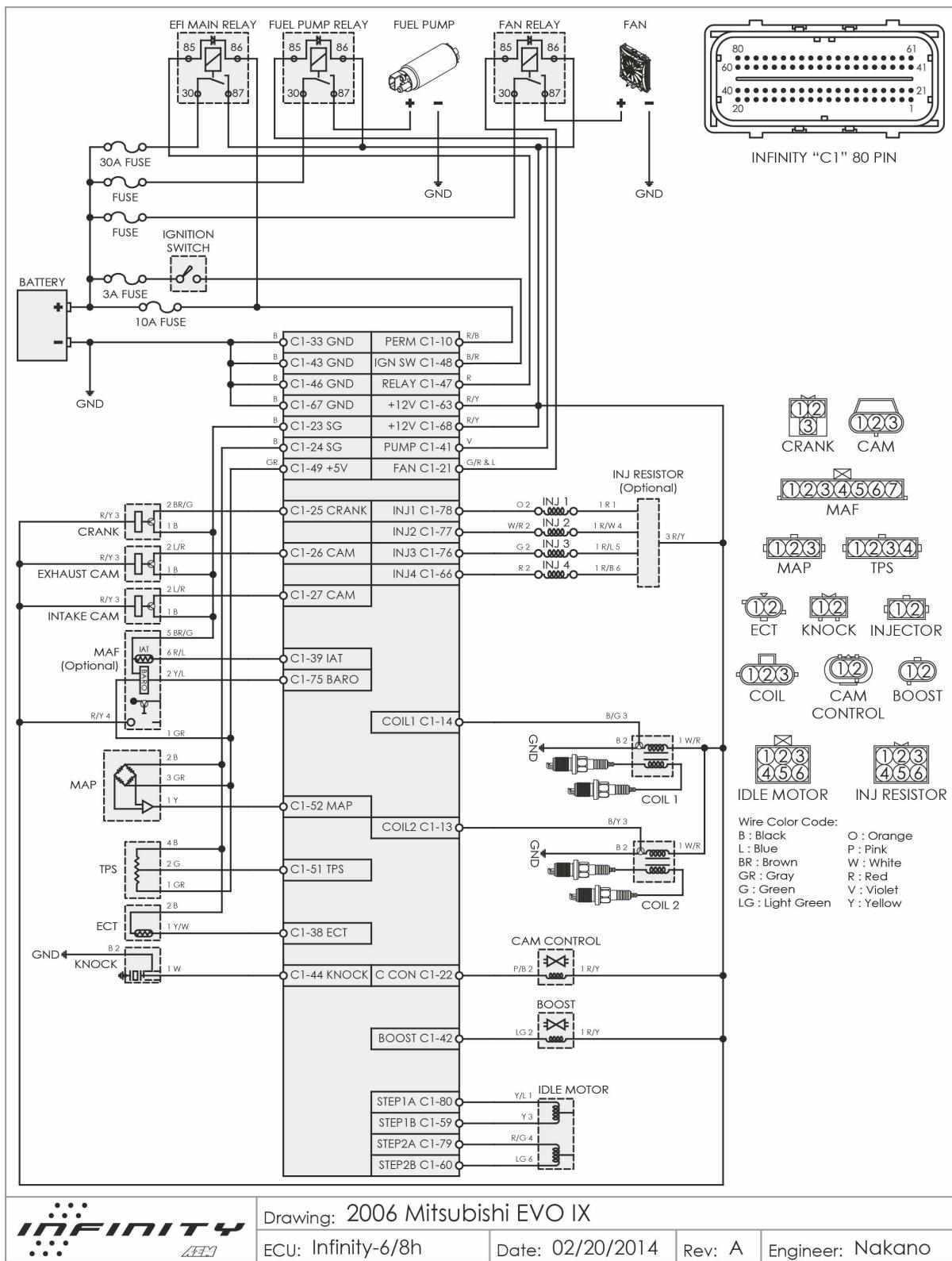
### 7.5.5 EVO VIII, Infinity-6/8h



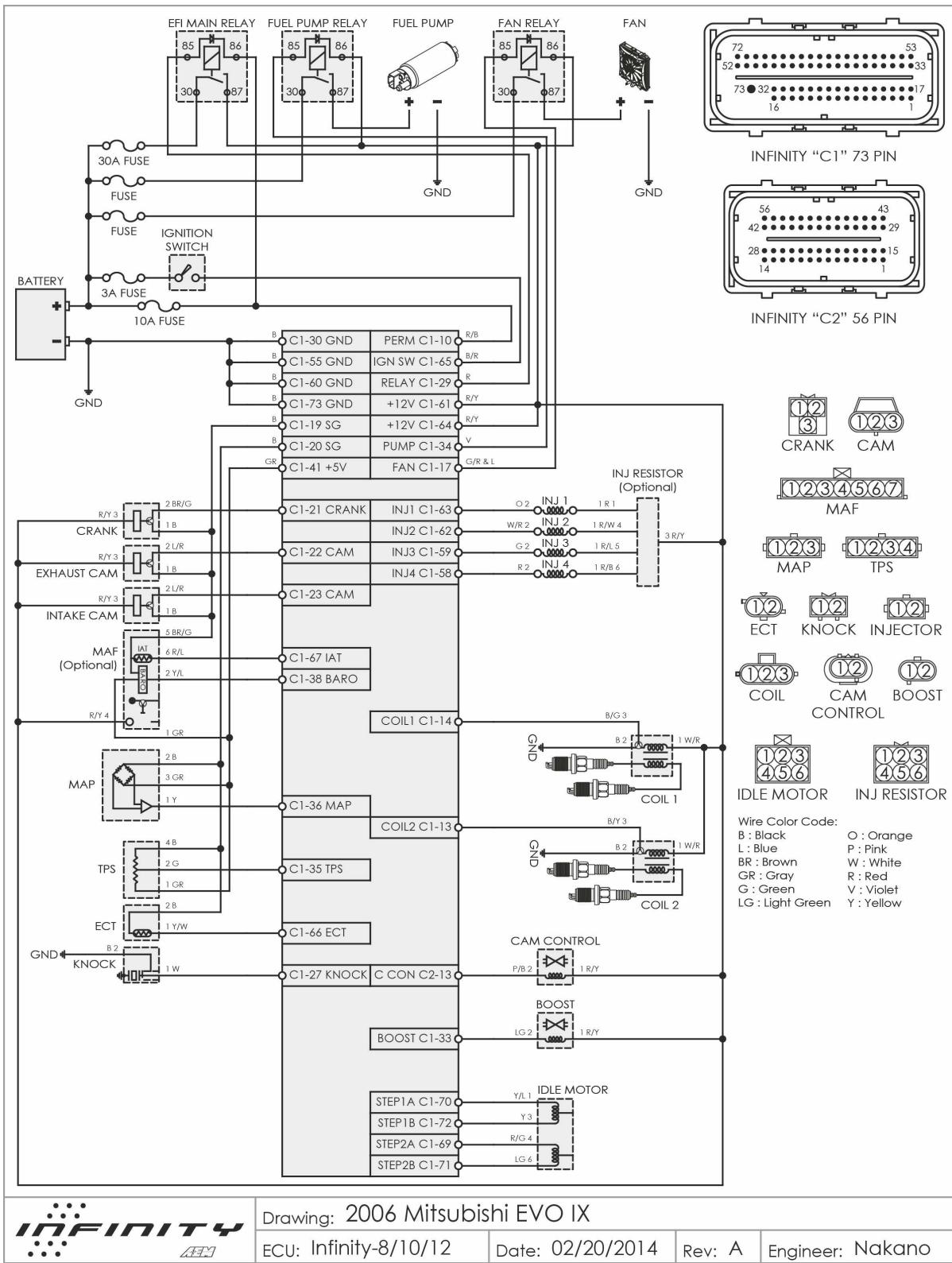
### 7.5.6 EVO VIII, Infinity-8/10/12



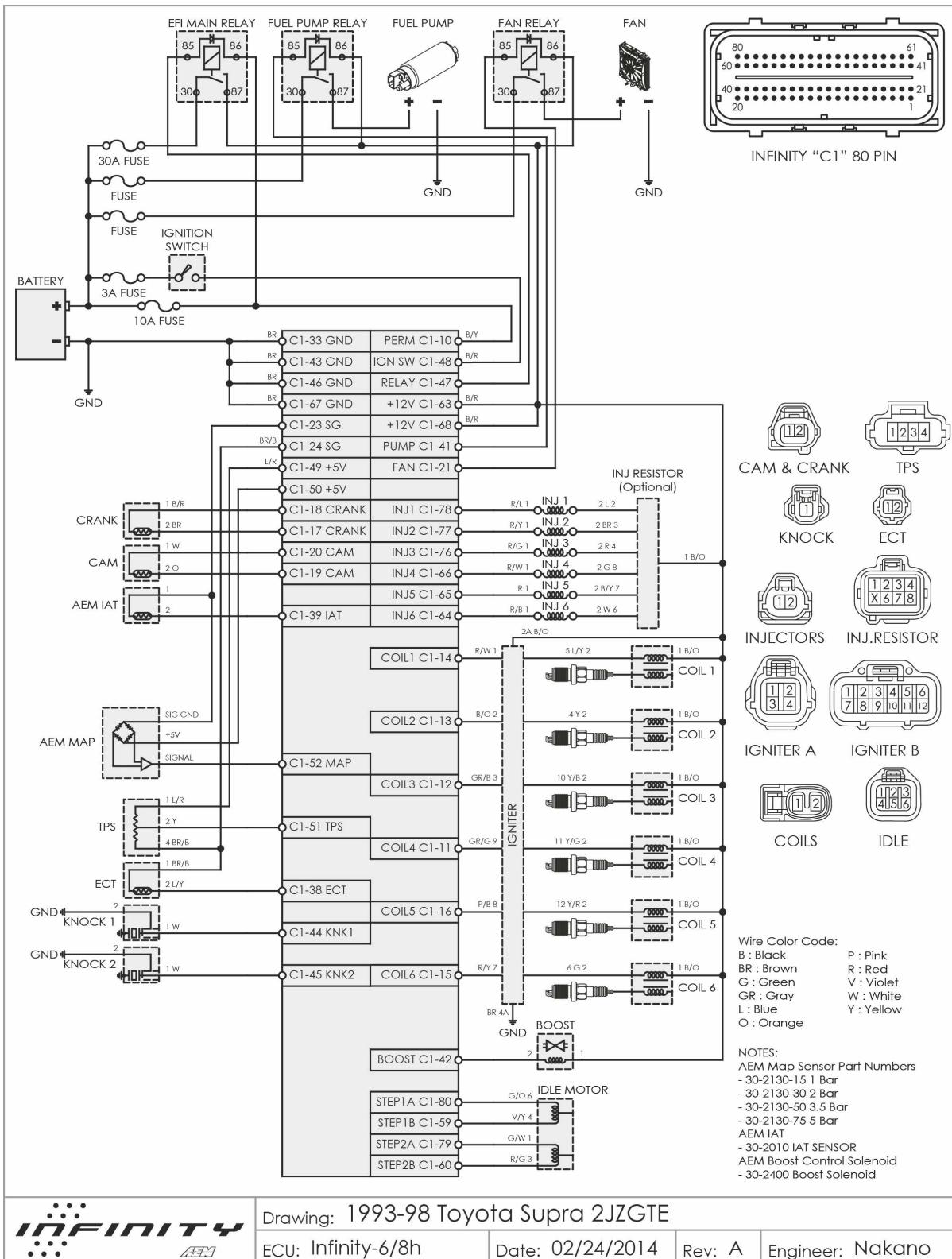
### 7.5.7 EVO IX Pinout, Infinity-6/8h



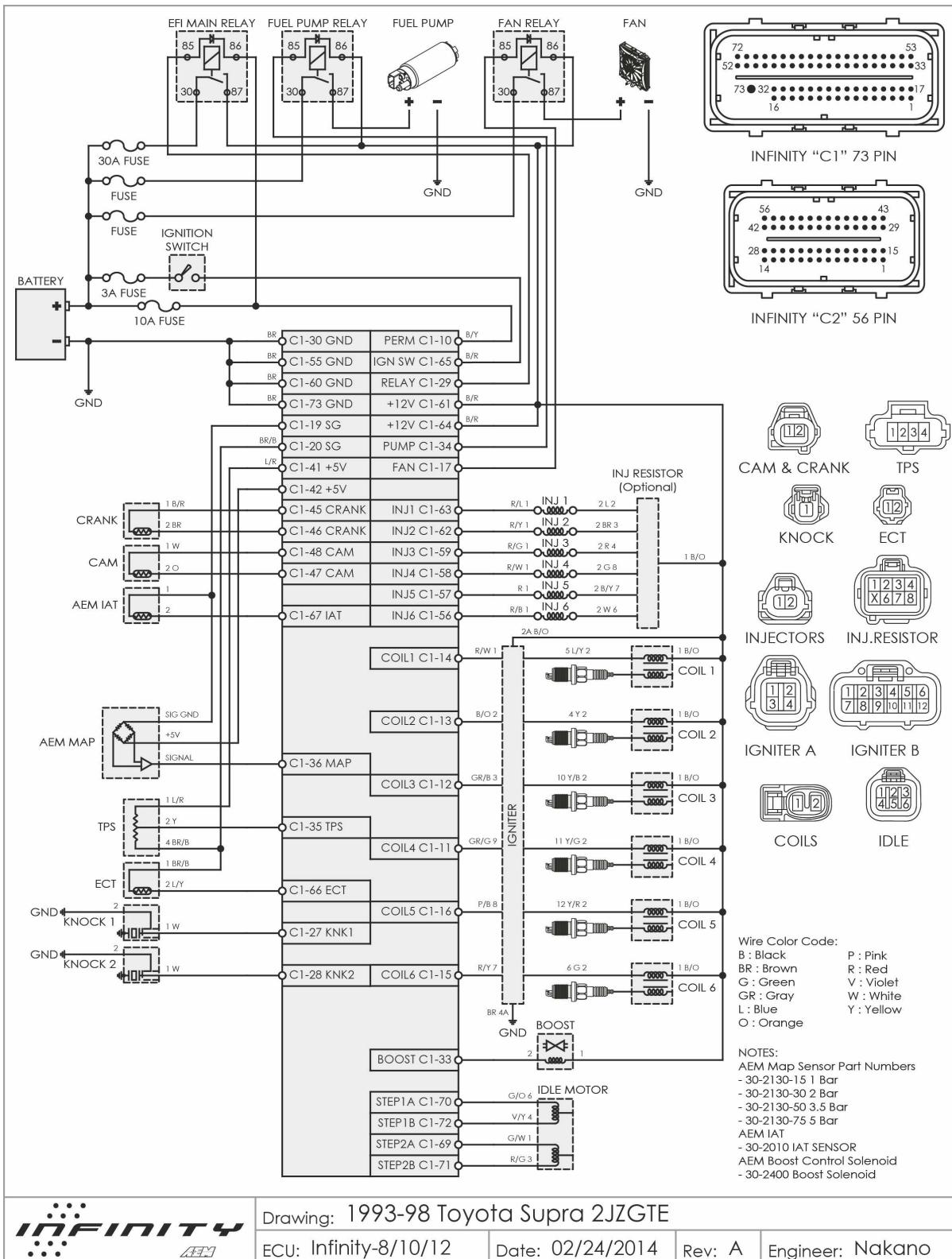
### 7.5.8 EVO IX Pinout, Infinity-8/10/12



### 7.5.9 93-98 Toyota Supra 2JZGTE, Infinity-6/8h



## 7.5.10 93-98 Toyota Supra 2JZGTE, Infinity-8/10/12



Drawing: 1993-98 Toyota Supra 2JZGTE

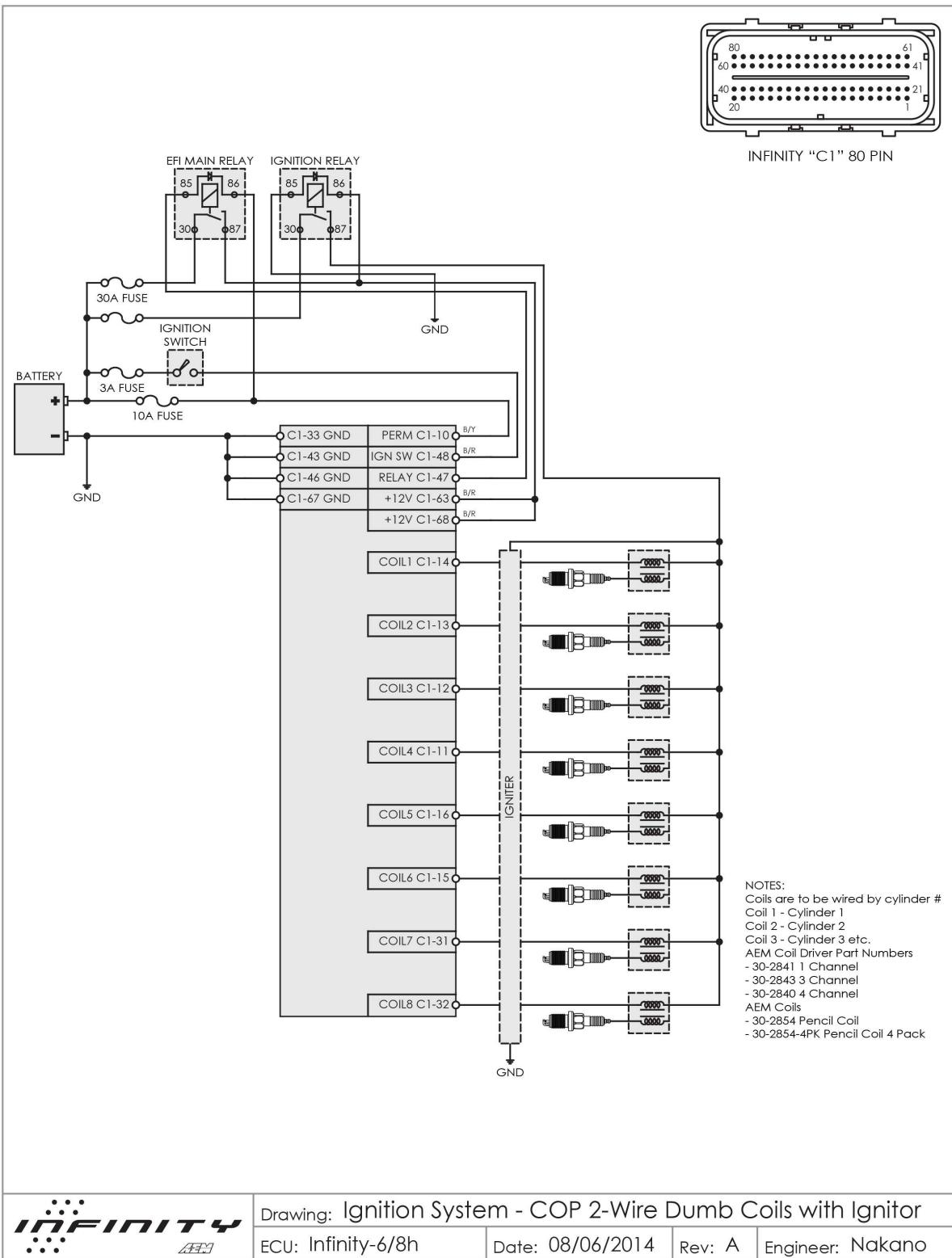
ECU: Infinity-8/10/12

Date: 02/24/2014

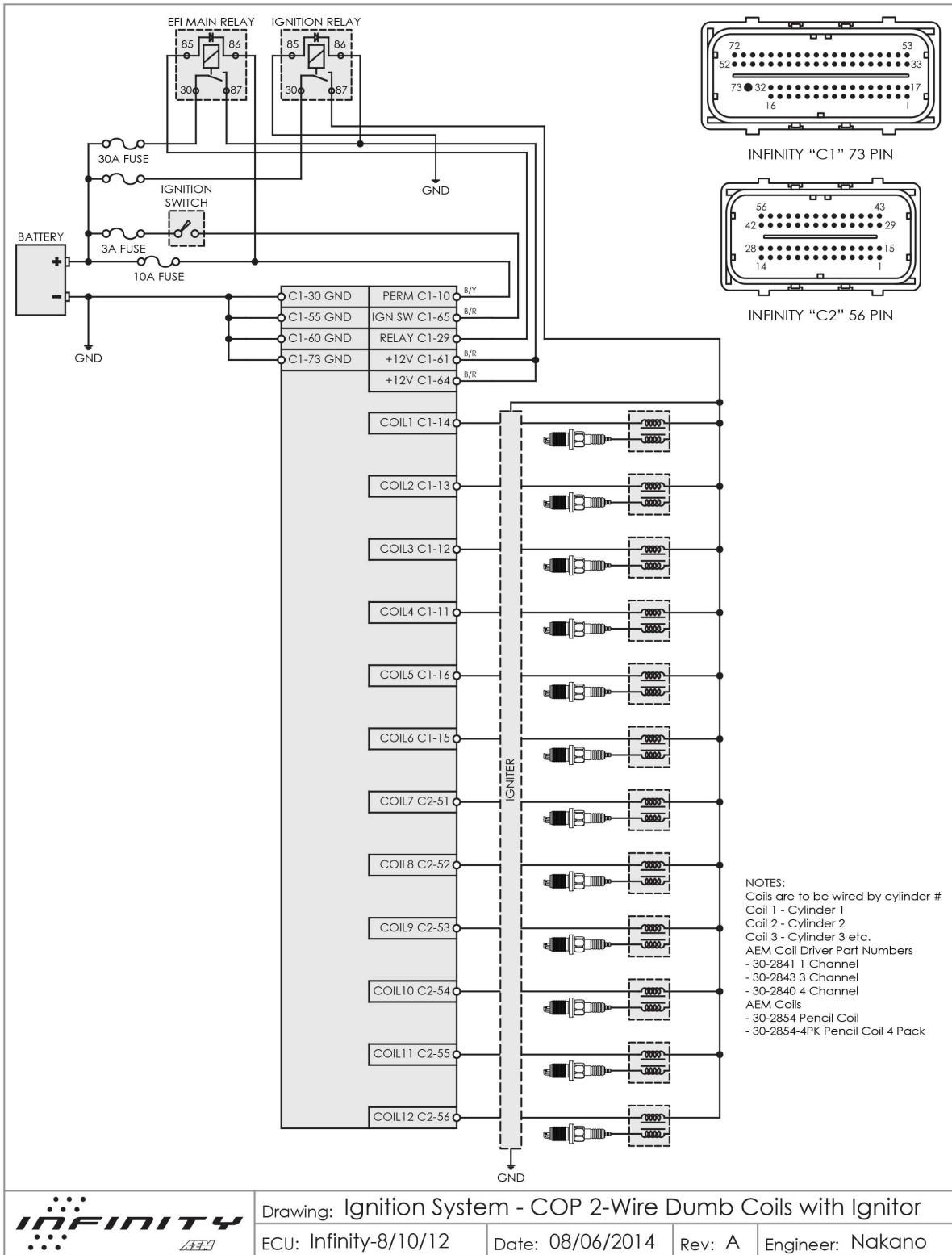
Rev: A

Engineer: Nakano

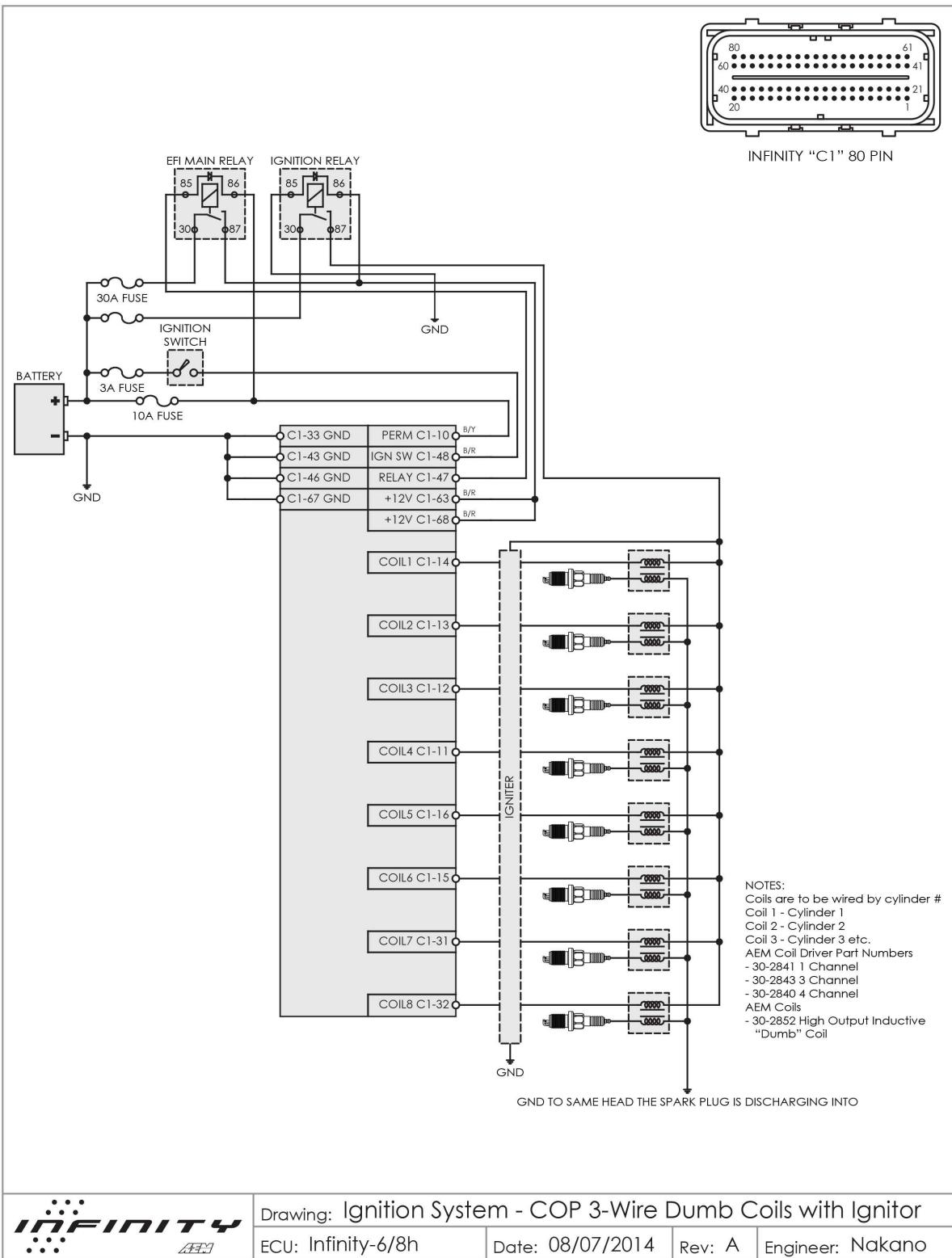
### 7.5.11 Ignition System - COP 2 Wire "Dumb" Coils with Ignitor, Infinity-6/8h



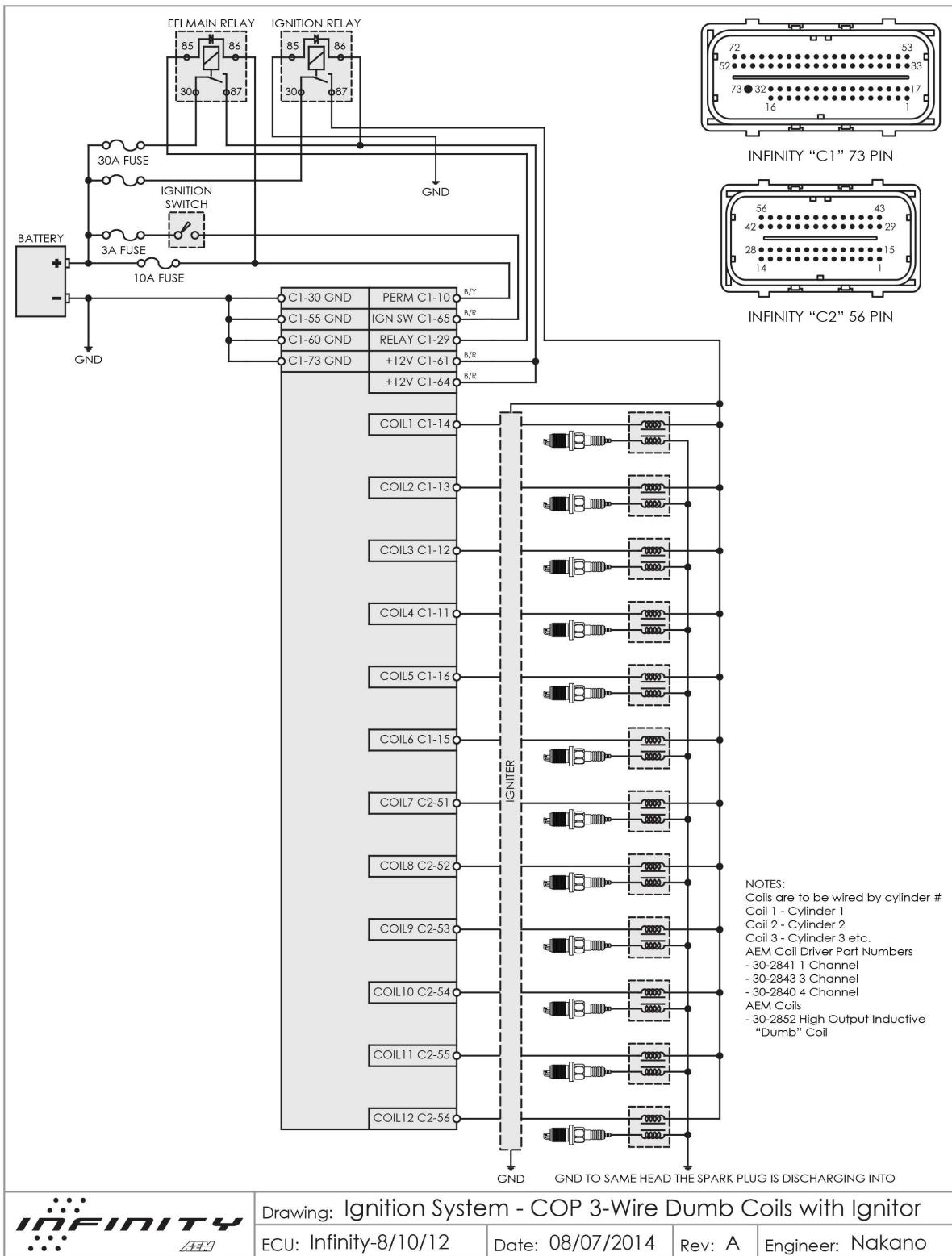
### 7.5.12 Ignition System - COP 2 Wire "Dumb" Coils with Ignitor, Infinity-8/10/12



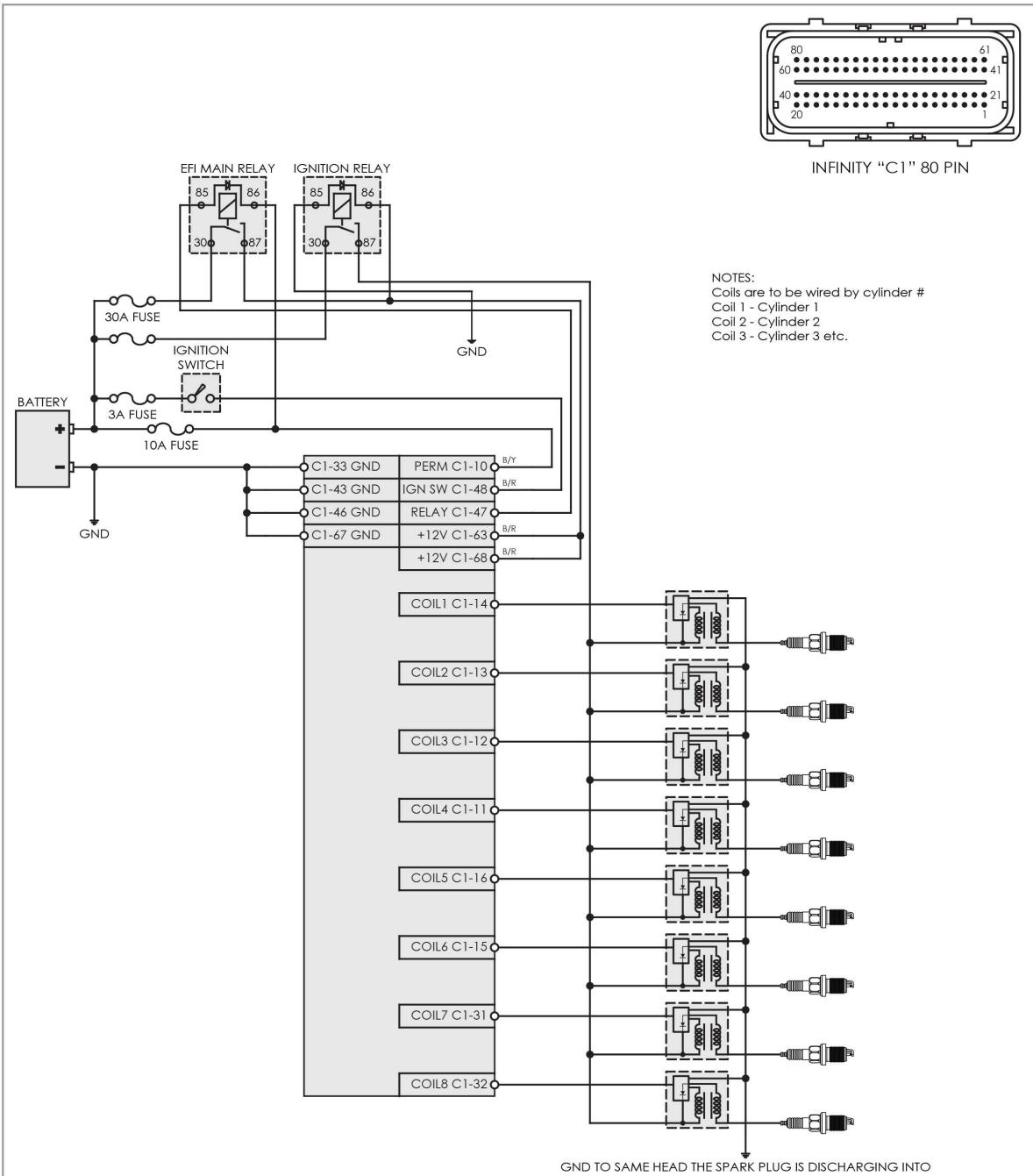
### 7.5.13 Ignition System - COP 3 Wire "Dumb" Coils with Ignitor, Infinity-6/8h



### 7.5.14 Ignition System - COP 3 Wire "Dumb" Coils with Ignitor, Infinity-8/10/12



### 7.5.15 Ignition System - COP 3 Wire "Smart" Coils, Infinity-6/8h



Drawing: Ignition System - COP 3-Wire Smart

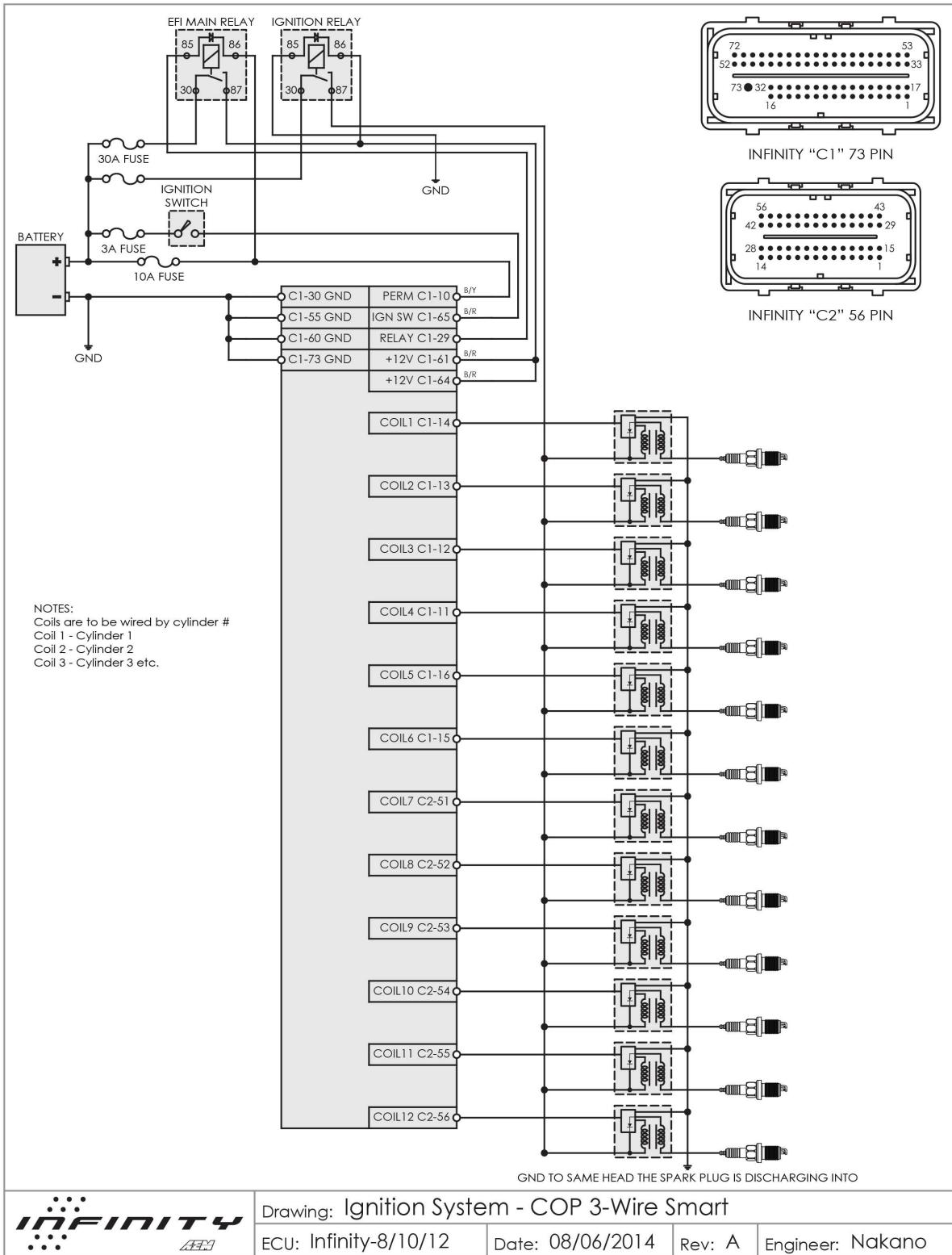
ECU: Infinity-6/8h

Date: 08/06/2014

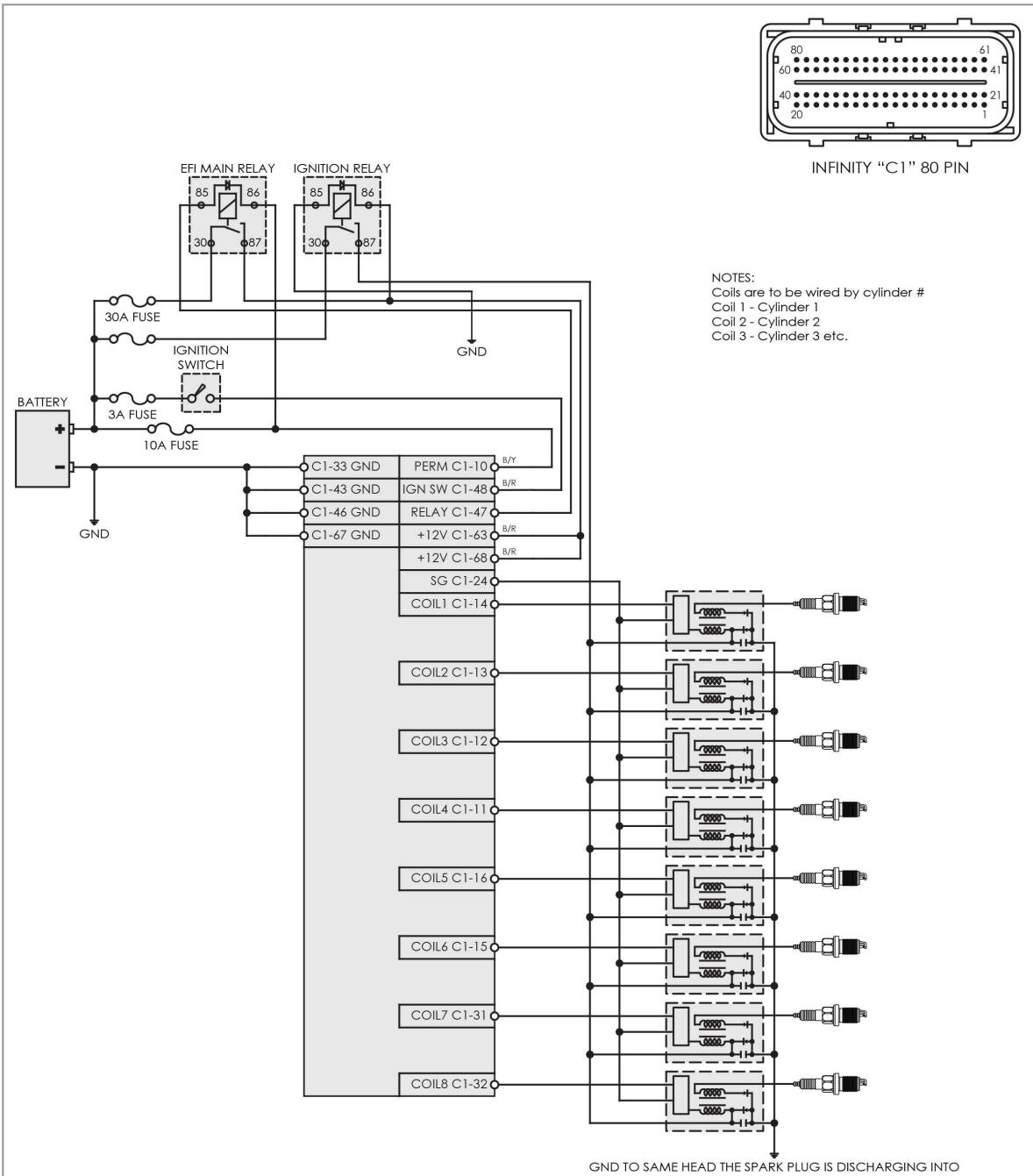
Rev: A

Engineer: Nakano

### 7.5.16 Ignition System - COP 3 Wire "Smart" Coils, Infinity-8/10/12



### 7.5.17 Ignition System - COP 4 Wire "Smart" Coils, Infinity-6/8h



Drawing: Ignition System - COP 4-Wire Smart

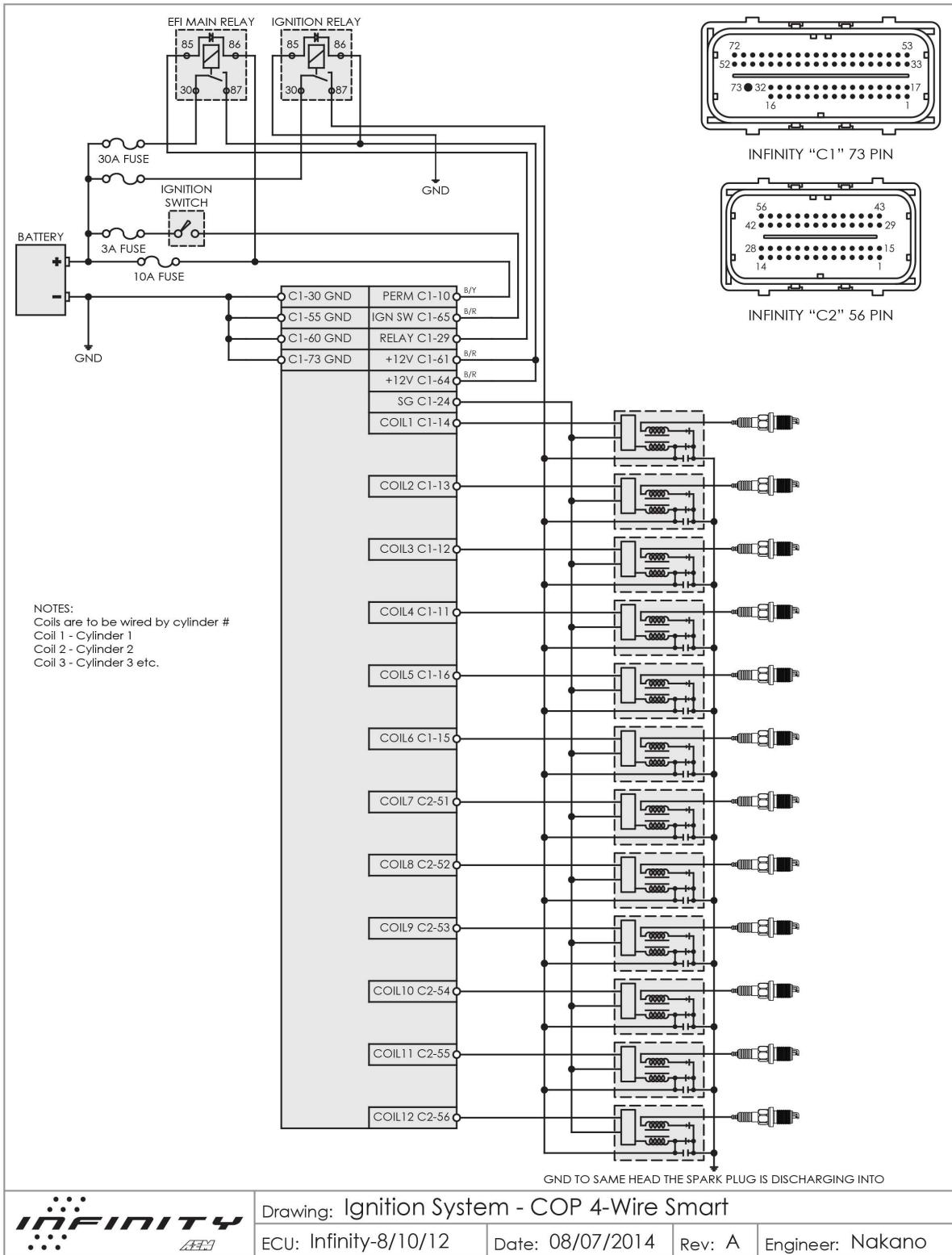
ECU: Infinity-6/8h

Date: 08/07/2014

Rev: A

Engineer: Nakano

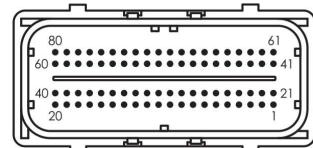
### 7.5.18 Ignition System - COP 4 Wire "Smart" Coils, Infinity-8/10/12



### 7.5.19 GM LS3 DBW Wiring, Infinity-6/8h

ACCELERATOR PEDAL POSITION (APP) SENSOR

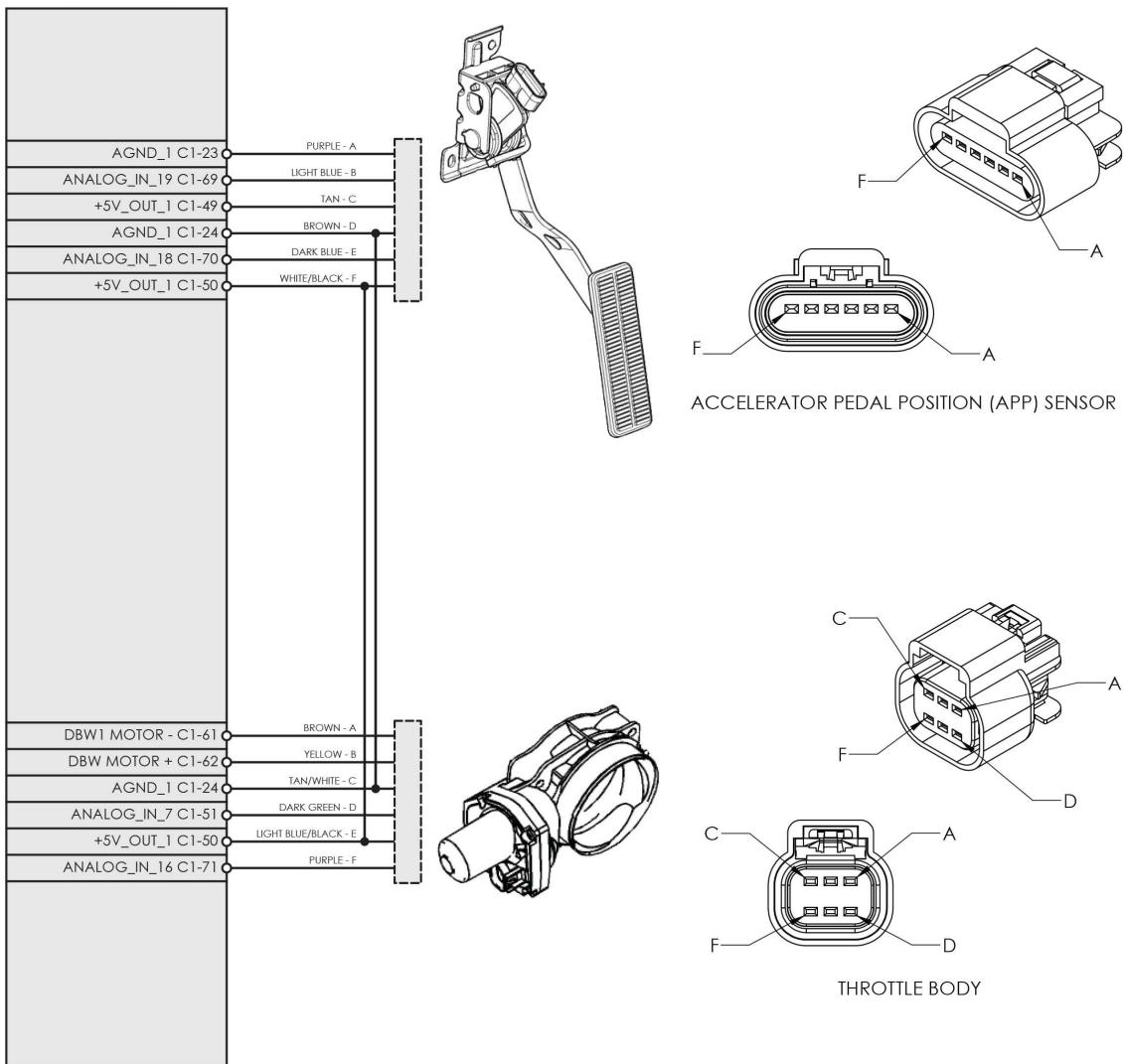
GM PIN	INFINITY PIN	WIRE COLOR	FUNCTION
A	C1-23	Purple	Sensor Ground
B	C1-69	Light Blue	Accelerator Pedal Position (APP) Sensor 2 Signal
C	C1-49	Tan	+5 Volt Reference
D	C1-24	Brown	Sensor Ground
E	C1-70	Dark Blue	Accelerator Pedal Position (APP) Sensor 1 Signal
F	C1-50	White/Black	+5 Volt Reference



INFINITY "C1" 80 PIN

THROTTLE BODY

GM PIN	INFINITY PIN	WIRE COLOR	FUNCTION
A	C1-61	Brown	Throttle Acuator Control (TAC) Motor Control - 2
B	C1-62	Yellow	Throttle Acuator Control (TAC) Motor Control - 1
C	C1-24	Tan/White	Sensor Ground
D	C1-51	Dark Green	Throttle Position Sensor 1 Signal
E	C1-50	Light Blue/Black	+5 Volt Reference
F	C1-70	Purple	Throttle Position Sensor 2 Signal



Drawing: GM LS3 ACCELERATOR PEDAL &amp; DBW THROTTLE BODY

ECU: Infinity-6/8h

Date: 08/04/2014

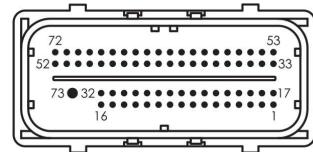
Rev: A

Engineer: Nakano

### 7.5.20 GM LS3 DBW Wiring, Infinity-8/10/12

ACCELERATOR PEDAL POSITION (APP) SENSOR

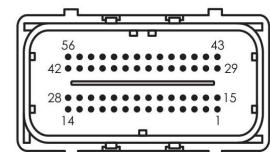
GM PIN	INFINITY PIN	WIRE COLOR	FUNCTION
A	C1-19	Purple	Sensor Ground
B	C2-14	Light Blue	Accelerator Pedal Position (APP) Sensor 2 Signal
C	C1-42	Tan	+5 Volt Reference
D	C1-20	Brown	Sensor Ground
E	C2-13	Dark Blue	Accelerator Pedal Position (APP) Sensor 1 Signal
F	C2-22	White/Black	+5 Volt Reference



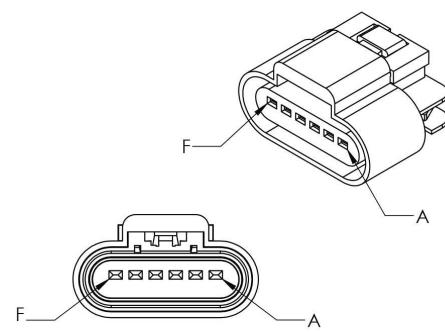
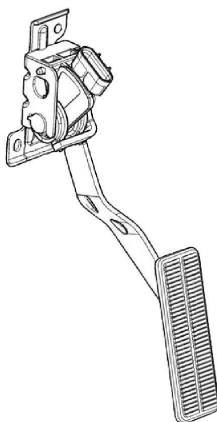
INFINITY "C1" 73 PIN

THROTTLE BODY

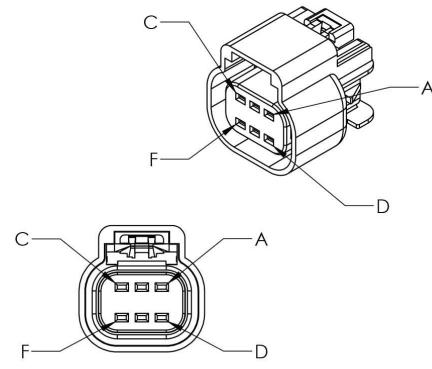
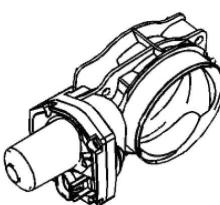
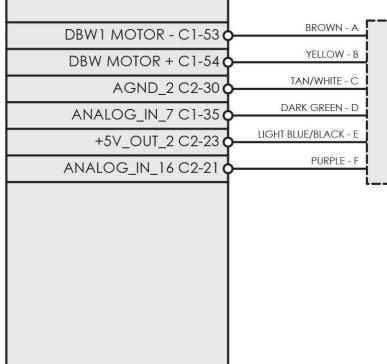
GM PIN	INFINITY PIN	WIRE COLOR	FUNCTION
A	C1-53	Brown	Throttle Acuator Control (TAC) Motor Control - 2
B	C1-54	Yellow	Throttle Acuator Control (TAC) Motor Control - 1
C	C2-30	Tan/White	Sensor Ground
D	C1-35	Dark Green	Throttle Position Sensor 1 Signal
E	C2-23	Light Blue/Black	+5 Volt Reference
F	C2-21	Purple	Throttle Position Sensor 2 Signal



INFINITY "C2" 56 PIN



ACCELERATOR PEDAL POSITION (APP) SENSOR



THROTTLE BODY



Drawing: GM LS3 ACCELERATOR PEDAL &amp; DBW THROTTLE BODY

ECU: Infinity-8/10/12

Date: 08/04/2014

Rev: A

Engineer: Nakano

## Glossary of Terms

### 8.1 Glossary

#### 4 Stroke Cycle

Intake - During the intake stroke, the piston is moving from top to bottom and the intake valve is open. As the piston moves down, a vacuum is created which draws the air/fuel mixture into the combustion chamber. The intake valve is closed after the piston reaches the bottom. This position is normally called bottom dead center (BDC)

Compression - During the compression stroke, the piston moves up and compresses the air/fuel mixture against the cylinder head. When the piston is near the top of the stroke (the top of the stroke is typically called top dead center, TDC), the ignition system produces a spark at the spark plug. The spark ignites the mixture which creates a rapid rise in cylinder pressure.

Power - During the power stroke, the high pressure gases produced by the burning of air/fuel mixture force the piston back down the cylinder bore. This is the only stroke that actually produces useable power from the engine.

Exhaust - During the exhaust stroke, the piston moves upward. The exhaust valve is open and the piston forces the spent gases out the exhaust port and into the exhaust system.

#### 5 Volt Reference

The high voltage reference for most automotive analog sensors. Typical three wire sensors will have a high reference, a low reference and a signal output. The signal output will always fall between the low and high reference points.

#### Air / Fuel Ratio

In engine testing, both the air mass flow rate and the fuel mass flow rate are normally measured. The ratio of these flow rates is useful in defining engine operating conditions. The normal operating range for a conventional spark ignited gasoline burning engine is between 12:1 and 18:1. Turbo/supercharged engines typically operate even richer with air/fuel ratios as low as 11:1. The most common way to measure Air/Fuel ratio for engine calibration work is by using an oxygen sensor in the exhaust stream.

#### Analog Circuits

Electrical circuits that amplify or alter a voltage signal to represent some physical quantity.

**Atmospheric Pressure**

Normal pressure in the surrounding atmosphere generated by the weight above us pushing down. At sea level, in average weather conditions, atmospheric pressure is approximately 100 kPa (about 14.5 psi) above vacuum or zero absolute pressure.

**Base Idle**

Idle RPM when the throttle lever is at rest on the throttle stop and the idle speed control function is disabled.

**BDC**

Bottom dead center; the extreme lowest position of the piston during its stroke.

**Boost**

Describes positive pressure in the intake manifold relative to atmospheric pressure. Standard atmospheric pressure is 14.5 psia. 10 psi of boost would result in 24.5 psia in the manifold.

**Breakpoints**

Define the axis values on two dimensional or three dimensional lookup tables

**BSFC**

Brake Specific Fuel Consumption or BSFC is the fuel flow rate per unit power output. It measures how efficiently an engine is using the fuel supplied to produce work.

**Calibration**

Engine calibration in its most basic form is the setting of the air/fuel ratio and ignition timing for the engine. Modern electronic engine control systems serve many more functions though. These can include: idle control, automatic transmission control, turbocharger boost control and knock control. The engine controller can also be used to enable/disable ancillary functions like emissions control solenoid valves (EVAP/purge, air injection), air conditioner compressor clutch relays, etc. The engine calibrator is responsible for configuring and tuning all of these items to satisfy the performance requirements for the engine.

**Capacitor**

An electronic device that stores electrical charge.

**Closed Loop Fuel Control**

An engine control mode of operation where the air/fuel ratio is controlled by varying the fuel flow rate in response to the rich/lean indication from an exhaust

**Coil**

The ignition system is comprised of two sets of insulated wire wound around a common ferrous core. The primary winding is typically made up of tens or hundreds of turns of course wire. The secondary winding is made up thousands of turns of fine wire. A single set of coil windings can be used to build a solenoid that converts electrical field energy into mechanical movement.

**Coil on Plug**

Refers to ignition systems that include one coil for each spark plug. Most modern automotive ignition systems are of this type.

**Cold Start**

Starting the engine when it is cold; when the engine has not run for several hours.

**Combustion**

The burning of the fuel-air mixture in the cylinder.

**Combustion Chamber**

Space left between the cylinder head and the top of the piston at TDC; where combustion of the air-fuel mixture takes place.

**Compression Ratio**

The ratio of the cylinder volume at BDC to the volume at TDC.

**Options**

Single value in an engine calibration. Can sometimes be referred to as an option. Options and tables (2D and 3D) make up the tunable portion of an engine calibration file.

**Continuity**

Little or no resistance in an electrical circuit to the flow of current. A solid electrical connection between two points in a circuit. The opposite of an open circuit.

**Controller**

In automotive electronics, refers to a module made up of semiconductor circuits sometimes containing imbedded software code.

**Data**

Information calculated or obtained directly from sensor inputs to a controller.

**Data Analysis**

The task of interpreting information obtained from engine sensors and controller calculations.

**Density**

The ratio of the mass of something to the volume it occupies. Air has less density when it is warm and less density at higher altitudes.

**Digital Circuit**

Electronic circuits whose outputs can change only by specific amounts and between a limited number of different voltages.

**Stoichiometric**

The air/fuel ratio for complete combustion; all the fuel is burned using exactly all the oxygen in the air. For gasoline, this ratio is 14.7:1 or 14.7 parts of air to 1 part fuel.

**Display**

Device used to indicate information in a human readable form.

**Drivability**

Condition describing a car in which it starts easily and idles, accelerates and shifts smoothly and with adequate power for varying temperatures.

**Driver**

In automotive electronics, refers usually to a transistor circuit that is designed to either source or sink electrical current.

**Duty Cycle**

In components which cycle on and off at a given frequency, the measurement of the amount of time the component is on versus the time it is off.

**Dwell**

The amount of time that current is flowing through the primary side of the ignition coil. Dwell measurements can be expressed in either units of time (usually milliseconds) or crankshaft degrees.

**ECU**

Engine Control Unit. Refers to an electrical module that receives inputs from sensors and outputs signals to actuators on an engine. Can also be referred to as EMS, PEMS, etc.

**Emissions**

Chemical by-products of combustion; comprised primarily of carbon monoxide (CO), hydrocarbons (HC) and nitrous oxides (NO<sub>X</sub>).

**Engine Calibration**

The values contained in the controller program that are adjustable by the tuner and are used to control engine operation, primarily fuel and spark requirements.

**Engine Mapping**

A procedure of experimentally determining the performance of an engine at selected operating points and recording the results.

**Equivalence Ratio**

Actual air/fuel ratio divided by the air/fuel ratio at stoichiometry.

**Export**

To output information or data from one piece of computer software for use in another.

**Gain**

In closed loop control terminology, refers to constants that vary the magnitude of each term in the manipulated variable calculation or algorithm.

**Hall Effect Position Sensor**

Type of sensor used in all Pro Flo distributors for measuring crankshaft position. Outputs a square wave signal pattern that is either low (ground) or high (reference voltage) depending on whether or not a tooth is passing near the sensor.

**Hg**

The chemical representation for the element Mercury.

**High Impedance**

Refers to injectors that have coil resistance values of 12.0 ohms or more

**Hot Keys**

Single or combinations of key strokes that can be programmed to perform certain tasks.

**Import**

To receive information or data from one piece of computer software for use in another.

**Inches Hg**

A relative measure of pressure or vacuum.

**Injector**

Solenoid actuated fixed orifice valve used to inject precise amounts of fuel

**Integrated Circuit**

A semiconductor device that contains many circuits on a single chip.

**Lambda**

Term referring to the oxygen sensor itself or the data obtained from an oxygen sensor that represent the air / fuel ratio of the engine. The lambda value is a ratio and is therefore unit-less.

**Load**

In fuel injection calibrations, a term used to scale the demand on an engine. Commanded fuel, spark and other variables are assigned in the calibration file based on the load and current operating mode of the engine.

**Lookup Table**

A table in software that equates one variable to another.

**Low Impedance**

Refers to injectors that have coil resistance values of 2.5-3.0 ohms

**Macro**

A feature of some computer software programs that allows a number of repeated tasks to be combined and performed on command.

**Math Channel**

In data analysis software, a channel calculated using raw data and mathematical functions. Can be included in a plot with other data.

**mS**

Abbreviation for millisecond or one thousandth, 0.001 seconds.

**Open Loop Fuel Control**

Method of controlling fuel flow without modification from a feedback variable such as oxygen content.

**Outing**

In data analysis software, refers to a complete set of data.

**Parallel Circuit**

Contains two or more circuit elements that have the same voltage measured across each.

**Peak and Hold Driver**

A driver that uses two levels of current to operate the injector. The driver circuit applies battery voltage to the injector until a predetermined current level is reached. The current is then reduced and held at a lower level for the duration of the PW. This type of driver is normally used with injectors having low resistance coils (typically around 2 ohm). The accuracy of the driver peak current level ( $I_p$ ) and the hold current level ( $I_h$ ) is held to  $\pm 0.50\%$ .

**Permanent Power**

Sometimes referred to as "Perm" power. This is uninterrupted battery power. Typically a direct connection to the battery positive terminal.

**Pickup**

Term that sometimes refers to frequency measurement sensors such as crank or cam position.

**Pigtail**

One or more wires terminated only on one end. Sometimes specialized automotive connectors are supplied with a short piece of wire installed in each cavity. Can be spliced into an existing harness.

**Pinout**

Refers to the description of each circuit or pin on a connector.

**Power**

Power is the rate at which work is done. It is the product of torque and angular speed.

**psi**

Abbreviation for pounds per square inch, a unit of pressure measurement.

**psia**

Abbreviation for pounds per square inch absolute. A unit of pressure measurement relative to a perfect vacuum.

**RS232**

A common standard used in serial communication between a PC and an engine controller.

**RXD**

Abbreviation for Receive Data.

**Saturated Driver**

A power transistor driver that turns fully on for the entire duration of the injector PW. This type of driver is used with injectors having high resistance coils (typically 12 to 16 ohm) or with injectors having low resistance coils in combination with a ballast resistor

**Sensor Calibration**

Sensors used on EFI systems output a voltage that is proportional to whatever the sensor is monitoring, manifold pressure, coolant temperature, etc. A calibration curve is a 2 dimensional lookup table that assigns sensor voltage settings to values in particular engineering units. Manifold pressure will be calibrated in units of pressure, coolant temperature will be calibrated in units of temperature, either Fahrenheit or Celsius, etc.

**Sensor Ground**

Also known as analog ground or low reference. The voltage output from a sensor is always relative to some reference. Most analog sensors use a clean 5 volt high reference and a clean low reference or sensor ground. Sensor grounds are actually outputs from the ECU. The engine controller isolates and filters these reference grounds so they are not affected by stray electrical noise.

**Serial**

In communication hardware, serial refers to sending data sequentially, one bit at a time over a communication channel or cable.

**Series Circuit**

Two or more circuit elements are said to be in series if the same current flows through each of the elements.

**Spark Timing**

Time measured in degrees of crankshaft rotation between the spark plug firing event and top dead center for that cylinder.

**Stoichiometric**

The air/fuel ratio for complete combustion; all the fuel is burned using exactly all the oxygen in the air. For gasoline, this ratio is 14.7:1 or 14.7 parts of air to 1 part fuel.

**Switch**

A device that can break an electrical connection interrupting the current or diverting it from one conductor to another.

**Switched Ground**

Using an electromechanical or electronic switch to connect a circuit element to a ground reference.

**Switched Power**

Battery power provided to the system when the ignition switch is in both the "run" and "start" positions.

**Tile**

Software feature allowing multiple windows to be displayed at once.

**Torque**

Torque is a measure of an engine's ability to do work. Engine torque is normally measured with an engine dynamometer.

**Trims**

Alternate term used to describe correction tables in an engine calibration file.

**TXD**

Abbreviation for Transmit Data

**uS**

Abbreviation for microsecond or one ten thousandth of a second or 0.0001 seconds.

**USB**

Universal Serial Bus (USB) is a serial bus standard to connect devices to a computer. Other convenient features include providing power to low-consumption devices, eliminating the need for an external power supply; and allowing many devices to be used without requiring manufacturer-specific device drivers to be installed.

### Vacuum

Vacuum is measured in units of pressure. In automotive technology, vacuum is often measured using inches of mercury on the barometric scale or as a percentage of atmospheric pressure in bars or atmospheres. Low vacuum is often measured in inches of mercury (inHg) below atmospheric pressure. "Below atmospheric" means that the absolute pressure is equal to the current atmospheric pressure (e.g. 29.92 inHg) minus the vacuum pressure in the same units. Thus a vacuum of 26 inHg is equivalent to an absolute pressure of 4 inHg (29.92 inHg - 26 inHg). The reciprocating motion of the pistons in an internal combustion engine create a vacuum in the manifold.

### Volumetric Efficiency

The intake system on a spark ignited engine, restricts the amount of air that an engine of a given displacement can flow. The parameter used to measure the effectiveness of an engine's induction process is the volumetric efficiency. It is defined as the volume flow rate of air into the intake system divided by the rate at which volume is displaced by the piston.

### Wasted Spark

A wasted spark is when in an ignition system in a four-stroke cycle internal combustion engine spark plugs fire in pairs, on both the exhaust and compression strokes. The extra spark on the exhaust stroke has no effect and is thus "wasted". This design is simpler than a conventional ignition system, but the extra sparks reduce the lifespan of components (contact breaker, spark plugs).

### XY Plot

In data analysis, a plot of one variable versus another rather than time.