How to Use This Course

This course is made up of eight sections. The sections are as follows:

- **Section A: Introduction.**
  - How to Use This Course
  - How Fuel Injection Works - before tuning, it is a good idea to read through this topic to confirm or understand where the various sensors are located and important definitions used in tuning.
  - Logic of the Computer within the Gen V Vehicle - a guide of the different models and controls of the computer.
  - Understanding the Virtual Torque System
- **Section B: Software Installation and Use.**
  - Installation and instruction on how to use the HP Tuners VCM Editor and VCM Scanner software.
  - The Tuning Tree™ - a map of table locations in the HP Tuners VCM Editor software.
- **Section C, D & E: Tuning Processes.** These three sections are the meat of the manual. They consist of checklists and detail pages on how to tune.
  - Section C is for bolt-on modifications
  - Section D is for heads/cam modifications
  - Section E is for forced induction modifications
- **Section F: VCM Scanner Topics.** This section explores and explains some of the various scanner parameter readings found in the HP Tuners VCM Scanner software.

◊ **Section G: Virtual Torque Tuning.**

◊ **Section H: Conclusion.** This section explains how to contact us for support.

Please use the following process when working with these course materials:

1. You will need your wideband O_2 sensor, tuning software and this course before you begin any tuning on a vehicle. You must always use a wideband O_2 sensor when you are doing wide open throttle tuning!

2. If this is your first time using the HP Tuners software or you are unsure of your knowledge on the software, read through Section A and B before beginning any tuning. Understanding how the software works is very important to avoid getting frustrated.

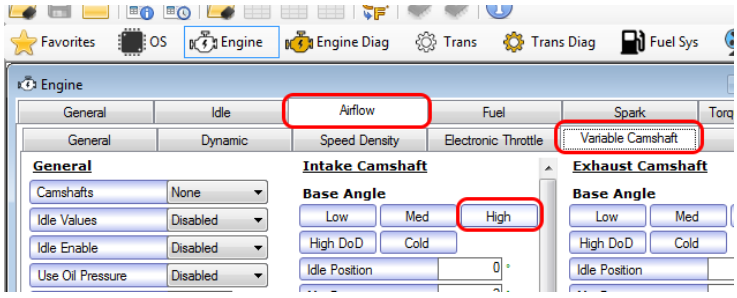
3. Choose the correct section for your vehicle modifications. Section C is for bolt-on vehicles, Section D is for heads/cam vehicles and Section E is for forced induction vehicles.

4. Follow the checklist for that section to tune the vehicle. Checklists can be found at the beginning of each vehicle modification section. An additional copy of each checklist is provided in a separate laminated format.

5. Use The Tuning Tree™ (section B.900) to locate hard to find tables. An additional copy of The Tuning Tree™ is provided in a separate laminated format.

6. Use the detail pages in the chosen vehicle modification section for more information on how each table works and how to update each table. In this course, we explain how to find each table by following this wording method: Example - "To locate the Intake Cam Position - High Baro table in the VCM Editor, click on the Engine icon. Select the Airflow tab and then select the Variable Camshaft sub-tab. The table is located by clicking on the High button under the Intake Camshaft then Base Angle section."

Looking at the screenshot to the right and following the wording, the name of the table is mentioned first (Intake Cam Position - High Baro). You are then told which icon to choose from the menu bar (Engine). You are then told which tab and



in some cases, sub-tab, to select. Finally the location of the button, scalar or field within the tab is explained (Intake Camshaft then Base Angle). In the VCM Editor, sections are underlined in the software and sub-sections within that section are not. We differentiate with a "then" statement between the section and subsection. In our example, the section within the tab is Intake Camshaft and the subsection is Base Angle.

7. Use the VCM Scanner Parameters section (section F) for additional information on various readings in the HP Tuners VCM Scanner software.

8. When called upon, use the Virtual Torque Tuning process (section G).

9. If you need help or support, see section H.100 for how to submit a support ticket. Your course comes with support for one year. Additional support is available once your initial support term has expired. Please contact us at (727) 264-8875 for more information on additional support terms.

How Fuel Injection Works

If you have little or no knowledge of how an automotive engine mechanically operates (movement of the pistons, etc.) please take a few minutes to review this knowledge online at http://www.howstuffworks.com/engine.htm. How Stuff Works has a very good description of how the internal combustion engine operates. You do not need to be an expert on this subject, but you should understand the basics.

The fuel injection system consists of many sensors, all with a specific purpose. To help you understand the fuel injection system, we will use an example of driving a fuel injected car. Please remember that this is a beginners' explanation; there is much more detail in how values are calculated, but if you are a beginner this information will provide you with what you need to know.

Key On

Switching the key to the on position causes the fuel pump to energize and pressurize the fuel system all the way up to the fuel rail where the injectors get their fuel supply. The vehicle's computer commands the idle air control motor (IAC, usually mounted directly into the throttle body) to open up to a set point, in order to be ready for startup airflow needs. The later model vehicles (ie: LS2 engines) have no IAC, but instead are fully electronically controlled throttle bodies. These would be commanded to open the throttle blade just enough to allow for the air needed for startup.

Startup and Idle

The engine fires up and it is now idling. The vehicle's computer can operate in one of two modes, open loop or closed loop. At this point, the computer is in open loop because some of the sensors are too cold to operate properly. Open loop means that the computer is simply referring to preprogrammed tables to run the engine because the oxygen sensors are not warmed up yet.

You sit in park and jab the throttle and watch the rpms rise and fall. When you pressed the gas pedal, what you actually did was open the throttle body up to allow more air into the engine. The vehicle's computer was monitoring the TPS (throttle position sensor, usually located at the throttle body cabling or near the gas pedal and monitors the gas pedal movement), and it noticed you pushed the gas pedal and it responded by opening the throttle body accordingly and it commanded the fuel injectors to put just the right amount of fuel in to match the airflow.

This leads to the most common beginners question - how did the computer know how much fuel to command to be put in? The answer is simple, but the computer uses a complex method to get that answer. In most late model GM vehicles, a sensor known as a mass airflow sensor (MAF located generally between the filter and throttle body) is monitoring the amount of airflow taken into the engine. The vehicle's computer knew how much air it took in and used a mathematical equation to figure out how much fuel it needed to command the injectors to put in to match. Therefore, using the MAF and TPS, your vehicle's computer was able to get the engine to respond the way you wanted.

Drive

Now, let's assume that the car is in drive and moving along at a steady 30 mph. The vehicle's computer is monitoring the TPS & MAF to give you the engine response that you want. The computer has been monitoring the coolant temperature sensor (CTS, located on the engine block typically) and determined the engine is sufficiently warmed up now to go into closed loop. Now that the vehicle has warmed up, another set of variables comes into the equation. The vehicle's computer is now operating in what is called "closed loop."

This sounds complicated but it is not at all. It simply means that the computer is monitoring all sensors now, and using them to tweak the air/fuel ratio constantly. Why would your computer need to start monitoring these other sensors at all? Couldn't your computer run the engine on just the MAF and TPS alone? Well, yes it probably could, but not very well; and that's why closed loop happens.

Now that the computer is in closed loop, it is monitoring the O_2 sensors (located in the exhaust system) and it can fine tune the air/fuel mixture to achieve optimal air/fuel ratio. The O_2 sensors measure the amount of oxygen leftover in the exhaust pipes and report that information to the vehicle's computer. For gasoline engines, the optimal air/fuel ratio for most conditions (other than wide open throttle) is 14.7:1, meaning 14.7 parts air to one part fuel. The technical term for this optimal air/fuel ratio is called Stochiometric, and it means that all the fuel AND all the oxygen is burned within the engine.

Acceleration

With the computer operating the engine so well now, fine tuning each and every time it injects fuel to try and achieve the perfect air/fuel ratio (Stochiometric), what could possibly be left? There is another sensor, known as the manifold absolute pressure sensor (MAP, typically located on the intake manifold). The computer monitors this sensor because it is a good measure of the amount of power the engine is making.

Typically as the engine is accelerating or put to wide open throttle, the MAP sensor increases as well. It measures

the air pressure in the intake manifold, and the computer also uses this sensor in its equation to determine the right amount of fuel for the moment. It's especially important as the engine transitions into wide open throttle. The computer also uses this sensor to help it reference the correct area of the spark advance tables programmed into it.

Wide Open Throttle

Now that the engine has been to wide open throttle, the computer has changed its method of operation to a new one. With the engine now at wide open throttle, the computer has switched out of closed loop and is now in open loop.

There are many reasons why the computer switches from closed loop to open loop, one major reason being that the O_2 sensors it was previously monitoring were only designed to watch for the air/fuel ratio as it moved around Stoichiometric. That makes the O_2 sensors "narrow band," and means that they won't report any good data for wide open throttle. Why is that? Simply because at wide open throttle, the typical air/fuel ratio for naturally aspirated engines is richer than Stoichiometric. See your specific tune file for your Stoichiometric value and the notes in throughout this course for expected air/fuel ratio ranges at wide open throttle for your modification types.

So how then does the computer know the amount of fuel to inject and tweak without looking at the O_2 sensors? At wide open throttle, the computer goes back to a programmed table which tells it exactly how much fuel to inject based on the amount of air it calculates is flowing into the engine. This is something you will be altering later, and is one of the most basic aspects of tuning. Getting the air/fuel ratio optimized can lead to much better and safer power.

Quick Reference Guide to Terms

Spark Advance

As the piston travels upward on its compression stroke (air and fuel have already been taken in on the previous strokes), the vehicle's computer is watching how many degrees before top dead center the piston is at. Once the piston arrives at a point just before top dead center (generally between 15° and 40° depending on throttle position), the computer will command the ignition coil to fire the spark plug.

The reason the spark happens before the piston reaches top dead center is because some time is needed for the spark to ignite the fuel and for the flame to travel and consume all the fuel in the chamber before it can build pressure to then push down on the piston. That is why the spark is called advance, as it is actually happening advanced or ahead of top dead center.

It is important to note that more is not always better with spark advance, as you could actually lose power with too much spark advance by lighting the fire off too soon. This can cause detonation and knock retard.

Detonation

Detonation is a harmful ignition of the air and fuel in the combustion chamber. It often sounds like a pinging noise. It occurs when the piston is on its way up during the compression stroke and there is too much heat already present in the chamber, or a hot spot has developed. Pre-ignition is when the mixture self-ignites the air and fuel that was already present before it has a chance to be ignited by the spark plug at the right time. Since this detonation of the air and fuel happens at the wrong time (as the piston is still traveling upward) the noise you hear is actually the piston getting smacked around in the block, banging left and right as it is still forcing its way upward against the force of the detonation explosion. You can see why this is dangerous.

Knock Retard

This is the amount of spark advance that is being removed (retard) because a knock sensor has detected harmful detonation. Typically less than 3° of spark retard is acceptable, but the goal is always 0. By retarding the spark advance, you can remove the harmful detonation, but you lose power as well. That is why the knock retard will eventually taper off, and you will have normal power again (assuming that the detonation is no longer present).

Understanding the Virtual Torque System

The Virtual Torque system is a part of the overall method by which the vehicle's computer calculates if it is meeting the overall targets of performance using torque as its reference point instead of airflow, like older computers did.

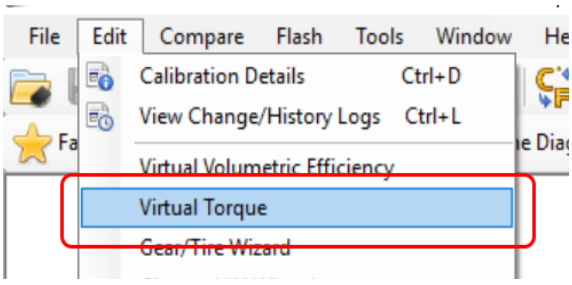
This system consists of tables that work as targets and also tables that work as limiters. We will teach you a method in the Virtual Torque Tuning section G.100 where you will be able to see which table is causing problems, such as throttle body closure as well as spark advance being higher or lower than commanded and subsequently how to fix the issues.

The primary goal when tuning the Virtual Torque system is to make an accurate representation, or model, of how the engine is actually making torque. You do not want to simply "max out" the system or tables to achieve a goal. When that happens, it creates other problems for the tuner. One example is that the system will prevent power enrichment at wide open throttle, as the system thinks it's not achieving the goals it should, thus creating a dangerous situation. Do not plan to "max out" tables in this system.

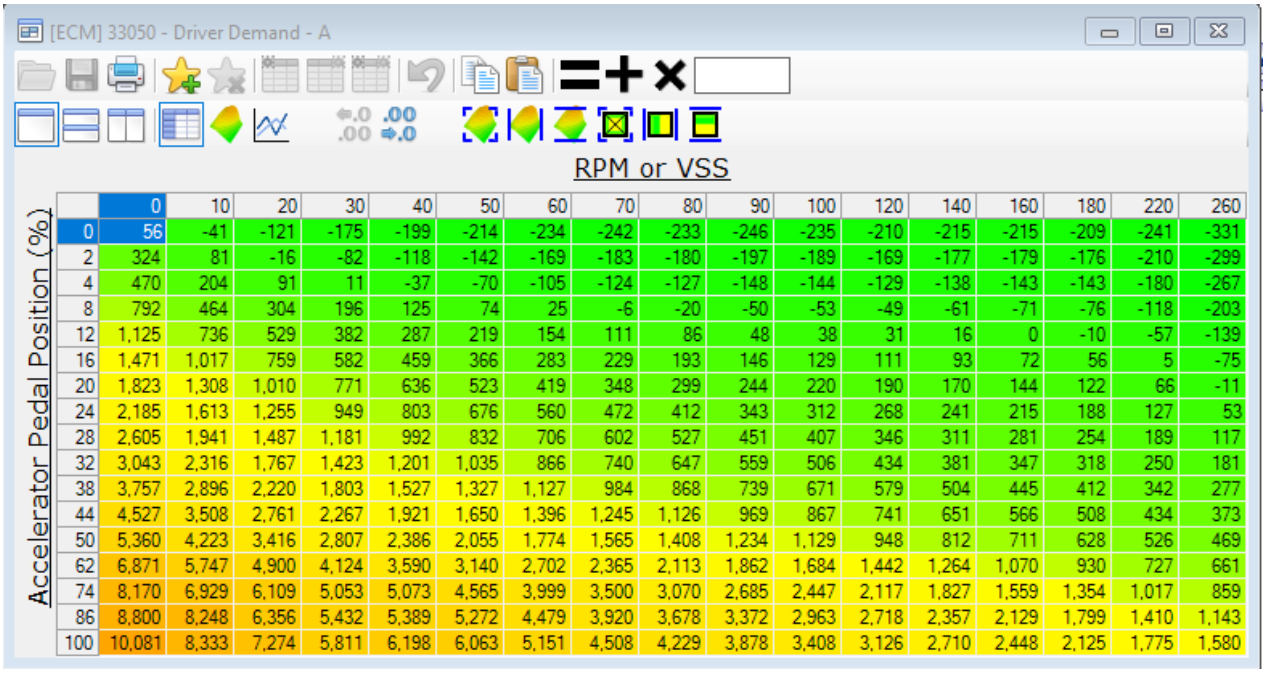
The easiest way to understand the Virtual Torque system is to think of it as a left hand and right hand working for the same goals but independently of one another. If one hand doesn't like something, it can wreck the outcome for both. Both hands must be working completely within their own bounds for the system to perform as you want it to and to also provide full throttle body opening and the spark advance you request.

Torque Target Side

On the left hand, the system controls the torque targets by way of the Virtual Torque maps found in the Virtual Torque Editor. You may wish to follow along as we explain how the Virtual Torque maps work. To do this, open the file 14 Corvette 6.2A.hpt included in your course downloads. With the Editor open, select Virtual Torque from the Edit drop down menu on the toolbar. The Virtual Torque pop-up box will appear. These tables make up a "map" of how much torque is expected to be made for a given engine rpm, cylinder airmass and spark advance.



through higher gears, the multiplication effect drops and thus the axle torque must drop as seen in the table as vehicle speed increases. This answers the common question of why the torque drops as speed increases in this table.



RPM or VSS

Accelerator Pedal Position (%)	0	10	20	30	40	50	60	70	80	90	100	120	140	160	180	220	260
0	56	-41	-121	-175	-199	-214	-234	-242	-233	-246	-235	-210	-215	-215	-209	-241	-331
2	324	81	-16	-82	-118	-142	-169	-183	-180	-197	-189	-169	-177	-179	-176	-210	-299
4	470	204	91	11	-37	-70	-105	-124	-127	-148	-144	-129	-138	-143	-143	-180	-267
8	792	464	304	196	125	74	25	-6	-20	-50	-53	-49	-61	-71	-76	-118	-203
12	1,125	736	529	382	287	219	154	111	86	48	38	31	16	0	-10	-57	-139
16	1,471	1,017	759	582	459	366	283	229	193	146	129	111	93	72	56	5	-75
20	1,823	1,308	1,010	771	636	523	419	348	299	244	220	190	170	144	122	66	-11
24	2,185	1,613	1,255	949	803	676	560	472	412	343	312	268	241	215	188	127	53
28	2,605	1,941	1,487	1,181	992	832	706	602	527	451	407	346	311	281	254	189	117
32	3,043	2,316	1,767	1,423	1,201	1,035	866	740	647	559	506	434	381	347	318	250	181
38	3,757	2,896	2,220	1,803	1,527	1,327	1,127	984	868	739	671	579	504	445	412	342	277
44	4,527	3,508	2,761	2,267	1,921	1,650	1,396	1,245	1,126	969	867	741	651	566	508	434	373
50	5,360	4,223	3,416	2,807	2,386	2,055	1,774	1,565	1,408	1,234	1,129	948	812	711	628	526	469
62	6,871	5,747	4,900	4,124	3,590	3,140	2,702	2,365	2,113	1,862	1,684	1,442	1,264	1,070	930	727	661
74	8,170	6,929	6,109	5,053	5,073	4,565	3,999	3,500	3,070	2,685	2,447	2,117	1,827	1,559	1,354	1,017	859
86	8,800	8,248	6,356	5,432	5,389	5,272	4,479	3,920	3,678	3,372	2,963	2,718	2,357	2,129	1,799	1,410	1,143
100	10,081	8,333	7,274	5,811	6,198	6,063	5,151	4,508	4,229	3,878	3,408	3,126	2,710	2,448	2,125	1,775	1,580

Keep in mind that these tables all work together in one long equation and if the system sees torque being delivered by the engine that is outside of these tables bounds, the result is typically closure of the throttle blade or adjustment of spark advance up or down to achieve the desired torque delivery dictated by these tables.

Forced induction applications will perform Virtual Torque Tuning because of the large increases in torque over stock engines. Most bolt-on's and heads/cam combinations will not need to adjust the Virtual Torque systems, however, you will know adjustment is needed if you experience throttle closures or spark issues. Our tuning process for each vehicle modification type will pinpoint within the checklist guidelines when and if Virtual Torque Tuning is necessary. The process for understanding which table is causing a problem and how to fix it will be discussed in section G.100, Virtual Torque Tuning.

HP Tuners VCM Suite Software Installation

The components included with your HP Tuners VCM Suite purchase are as follows:

- ◊ MPVI USB Interface
- ◊ USB Cable
- ◊ OBD-II Cable
- ◊ VCM Suite Installation USB Thumb Drive with Drivers

To install your software follow these steps:

- ◊ Turn your laptop on and close any programs that are currently running. Do not attach the USB cable and MPVI interface until instructed to do so.

- ◊ Remove the cap off the HP Tuners USB thumb drive and insert the USB thumb drive into your USB port on your laptop. From the pop-up box open the folder to view the files.

- ◊ Double click on VCM Suite. Select Next on the Installshield Wizard for VCM Suite 3.0. Read and accept the terms of the License Agreement. Select Next. Verify the folder location and select Next. Select Install. After a few minutes the Installshield will allow you to select the Finish button.

- ◊ Connect the MPVI Pro device to your laptop with the provided USB cable.

- ◊ With the VCM Scanner or VCM Editor open, select the VCM Suite Info icon. The VCM Suite Info pop-up box will appear. If you see "Interface Not Opened: Not Found," you will need to update the drivers.

- ◊ To update the drivers, click on the Start button on the task bar and type "Device Manager" into the search box. Select the Device Manager program from the list.

- ◊ With the Device Manager open, look for Unknown Devices, Other Devices or HP Tuners MPVI. It will have a yellow exclamation point next to it if the drivers need to be updated. Right click on the wording and select Update Driver Software from the drop down menu.

- ◊ Select the drive assigned to the USB thumb drive and locate the Drivers folder. Select the folder, click Ok and then select Next. Channel A will be successfully updated.

- ◊ Repeat the same process for the second driver with the exclamation point alert. This will be Channel B.

- ◊ Test that the HP Tuners unit is communicating with the software by going back to the VCM Editor or VCM Scanner and selecting the VCM Suite Info icon again. If you have successfully installed both drivers, the device will communicate and display the license information for your device.

How to Use the VCM Scanner 3.x to Review a Scan

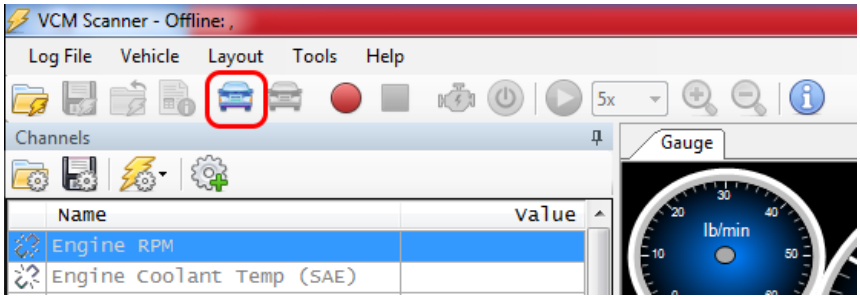
The VCM Scanner 3.x is vastly different from previous versions of the VCM Scanner. While this may appear daunting at first, after reading this section, you should have a much better understanding of how to use the Scanner to its fullest capability! To use the VCM Scanner, complete the following process:

Step 1: Open VCM Scanner 3.x

Open VCM Scanner 3.x. At this point, you should have already installed the VCM 3.x Suite, which includes the VCM Scanner and Editor. To open the VCM Scanner, find it in the appropriate folder that it was saved under during installation.

Step 2: Connect to the Vehicle

Connect to the vehicle you are tuning. Once you have opened the scanner, you will first need to connect to the vehicle and allow the Scanner to query the available channels for your specific vehicle's operating system. To do so, turn the key to the ON position and select the Connect to Vehicle icon on the toolbar. Once you do this, the Scanner will determine what specific channels or PIDs are available for your vehicle.



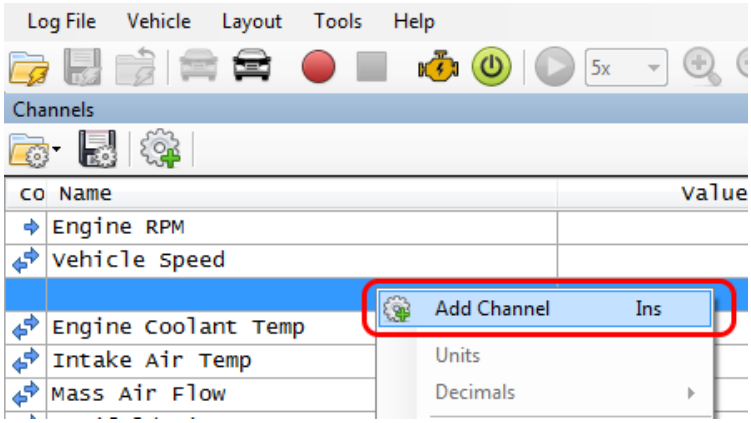
Step 3: Load Channels to View

Once the Scanner is connected to your vehicle, you will need to add any channel you would like to monitor while scanning the vehicle. When you connect initially, the Scanner should have already found basic SAE (Society of Automotive Engineers) channels such as Engine RPM, Mass Airflow lb/min, Engine Coolant Temperature, etc.

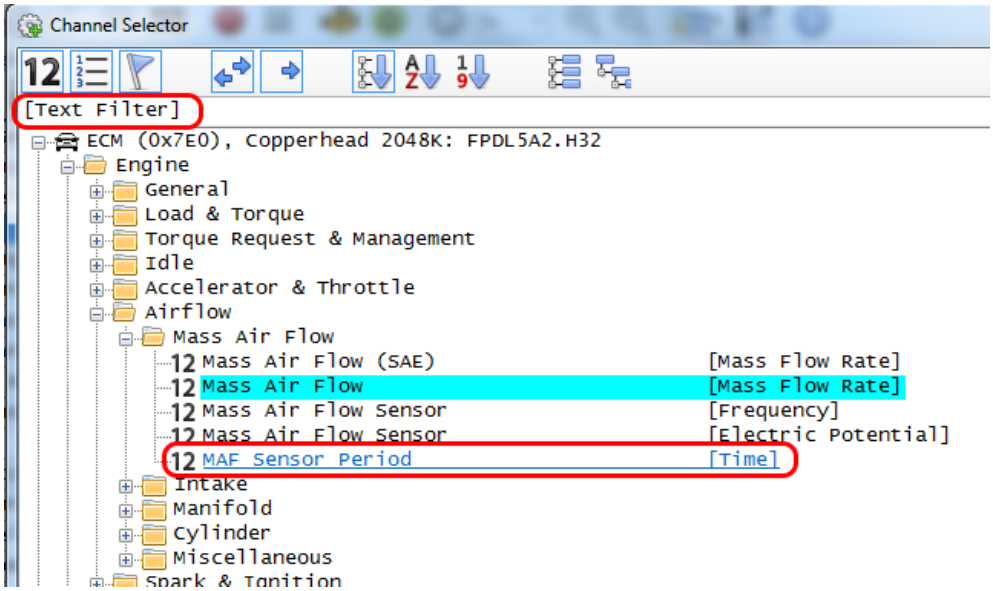
You can add other channels that were not already selected by default. To do this, right click in the Channels area and select Add Channel from the drop down menu. The Channel Selector pop up box will appear.

As an example, we can add Mass Airflow Period to our Channel list. To do this, look through the Channel Tree until you locate the Mass Airflow Period channel. This one can be found by drilling down through PCM, Engine,

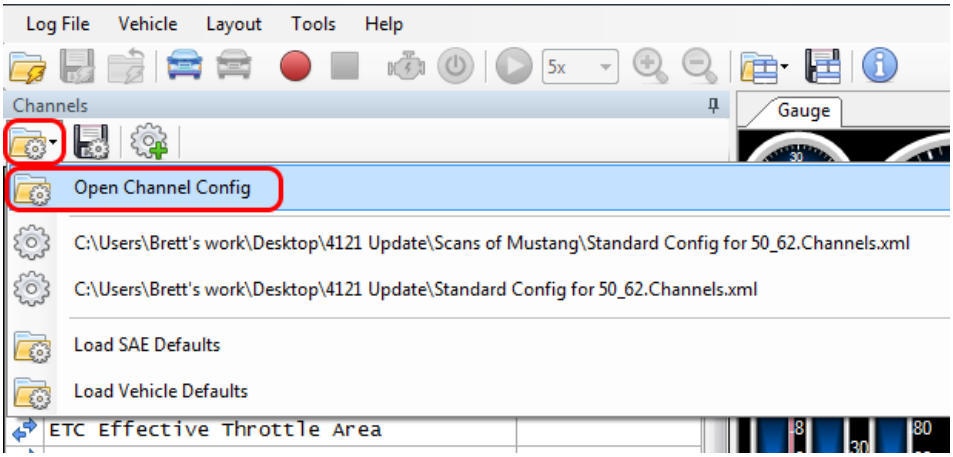
Airflow, Mass Airflow and then selecting MAF Sensor Period. You can also use the Text Filter area to type in Mass Airflow Period and find the channel that way.



Once you have located the appropriate channel, double click the channel (MAF Sensor Period in our example). The channel will highlight blue to indicate you have added the channel to the Channel screen. Close the Channel Selector pop up box and the new channel can now be viewed in the Channel area.



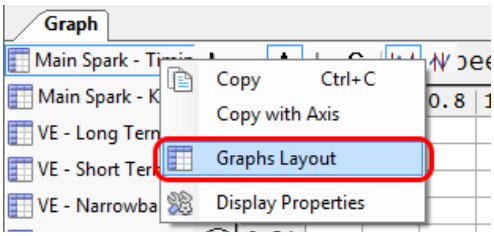
Another option to adding channels to the Channel List is to load a preconfigured file. The Tuning School, Inc. provides a channel config file with some preset channels that are useful when practicing the concepts in this course. You can locate this file by accessing your course downloads on The Tuning School's website. If you would like to load The Tuning School, Inc.'s provided channel config, you can do so by clicking on the Recent Channel Config icon on the toolbar and selecting Open Channel Config

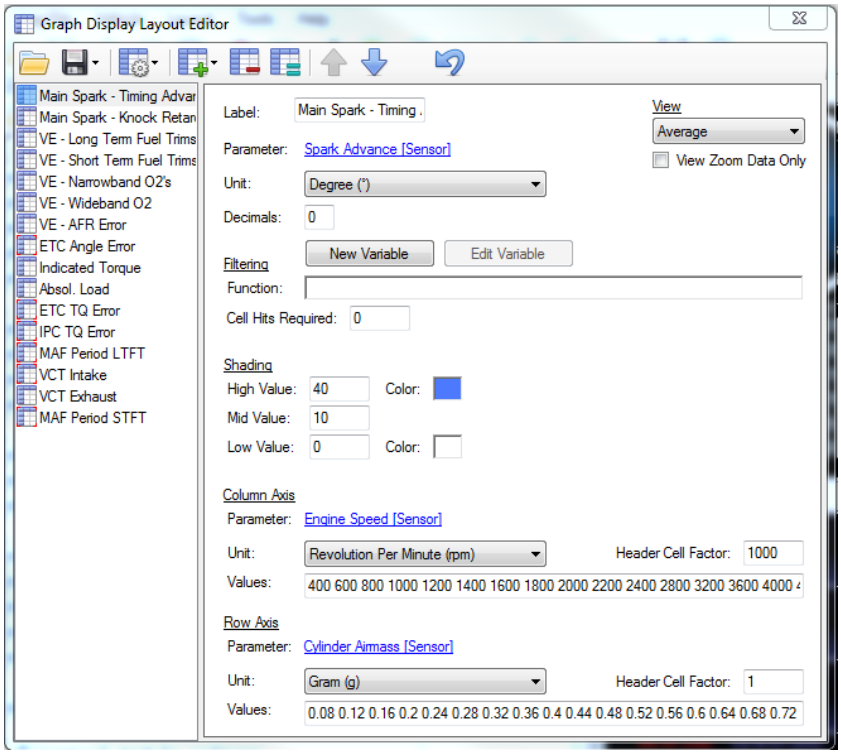


from the drop down menu. Besides opening a new chancel config file, the Recent Channel Config icon will also allow you to select recent channel configs that have been accessed previously, as well as load default config files provided within the software.

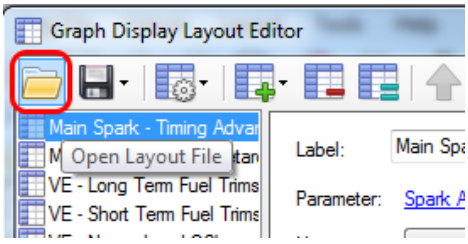
Step 4: Configure Graph Layout

Once you have loaded the appropriate channels, it will enable the graphs (previously known as histograms in VCM Scanner 2.24) to work properly. You can create your own graphs or you can load preconfigured graphs. To create your own graph, right click on the Graphs screen and select Graph Layout from the drop down menu. The Graph Display Layout Editor pop up box will appear. On this screen, you can custom configure any graph (histogram) based on any table within the VCM Editor. We will practice this concept in several sections of this course.





You can also load preconfigured graphs. To do this, from the Graph Display Layout Editor pop up box, select the Open Layout File icon. The Tuning School, Inc. provides preconfigured graph files that are useful when practicing the concepts in this course. You can locate these files by accessing your course downloads on The Tuning School's website. If



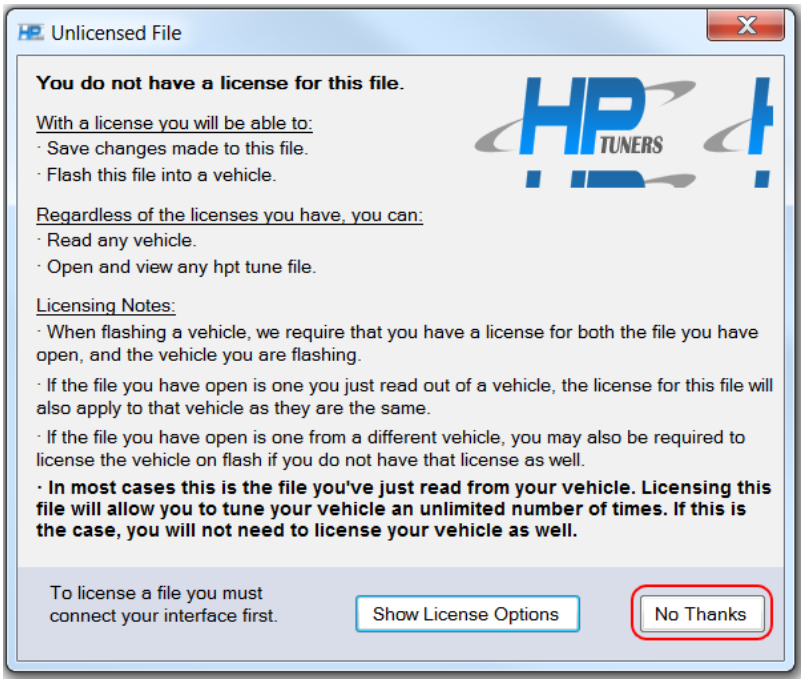
How to Use the VCM Editor

The VCM Editor software is used for making changes to tables within the tune file and downloading/uploading the tune file from your vehicle's computer to the laptop and vice versa.

Open the VCM Editor. If you are asked at any time to choose between Beginner, Intermediate or Advanced view, choose the Advanced view. Advanced view will be explained later in this chapter in the Features section. Please note that if you are following along in this course and you have not purchased the HP Tuners software, you will not be able to view license information. However, you can still view tune files. For now, click ok.

If you have purchased HP Tuners and would like to see your license information, click on the Help menu on the toolbar and select License Information from the drop down menu. Your license information will appear. You will most likely see text that shows the number of purchased, used and available credits on your interface. If you have not performed any tuning yet, your interface should show 8 purchased and available credits and 0 used credits. Close the License Info window. For more information about Licenses, see section B.500, License Information and How to Purchase Additional Credits.

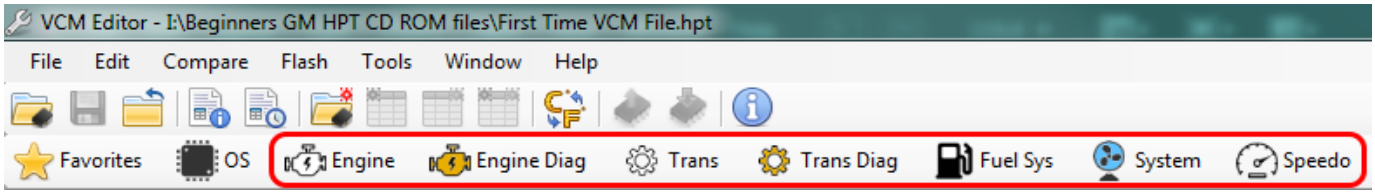
To get an idea of what a tune file looks like before you start editing your own, we have included an example tune file with your course contents. You can locate this file by accessing the course downloads on The Tuning School's website. Open the tune file called First Time VCM File.hpt. To do this, in the VCM Editor, click on the File menu on the toolbar and select Open from the drop down list. Navigate to the location where you saved your course contents, select the file and click the Open button. The Unlicensed File pop up box will appear. You will be asked if you want to see Licensing options for this file. Click the No Thanks button. This pop up box will appear every time you view a tune file that you haven't licensed.



NOTE: You never want to license a

file you do not intend to upload into your own vehicle. When you tune a vehicle you MUST start with the actual file in the vehicle's computer. If you use a file from a different vehicle, when you try to upload the new file, it will not work because the file will not match the VIN. You will also consume credits that you cannot get back. You can view files for free, but you must tell the software that you do not want to license the file. You will always get multiple warnings before using credits on a file.

Next, you will be brought to the main operating screen of HP Tuners. The tune file is identified on the top status bar. Tuning is performed through the icons on the toolbar. The icons consist of:



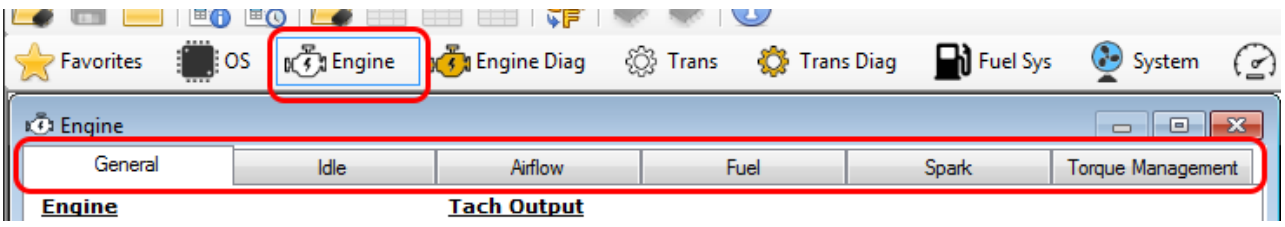
- ◊ Engine
- ◊ Engine Diagnostics
- ◊ Transmission
- ◊ Transmission Diagnostics
- ◊ Fuel System
- ◊ System
- ◊ Speedo

When tuning in the VCM Editor, you would select the table to adjust, make your adjustments and then save your file with a new name. To understand how the VCM Editor works, lets explore each icon.

Navigating in the VCM Editor

Engine Section:

All engine related parameters are found under the Engine icon. There are tabs for General, Idle, Airflow, Fuel, Spark and Torque Management. If you click on each tab, you will find tables that relate to the Engine portion of

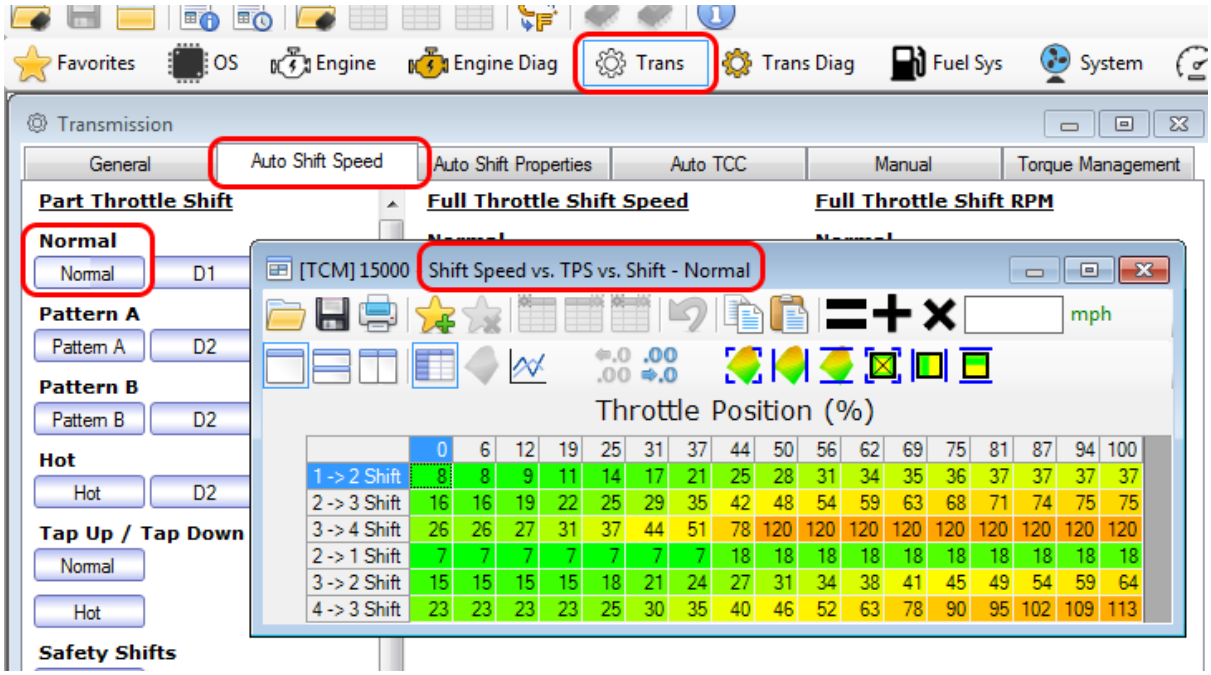


the tune. For example, in the Engine then Spark tab, you will find the Main Spark tables.

Transmission Section:

All transmission related parameters are found under the Trans icon. Close the Engine pop up box and click on the Transmission icon. Let's take a look at a specific table. Click on the Auto Shift Speed tab and then choose the Normal table under the Part Throttle Shift then Normal section. The Shift Speed vs TPS vs Shift - Normal table will appear.

See the screenshot below for an example of the Shift Speed vs TPS vs Shift - Normal table within the Transmission section.



This table is one we would commonly adjust to make changes to how the transmission behaves. We can alter the shift points and various throttle positions, making the vehicle drive much better. We can also control the torque converter, as well as shift times and pressures.

Speedometer Section:

All speedometer related parameters are found under the Speedo Icon. Close the Shift Speed vs. TPS vs. Shift - Normal table and Transmission pop up box. Click on the Speedo icon. The tabs located on the Speedo icon consist of Calibration and Limiter.

How to Read and Write to the VCM

The Flash menu on the toolbar contains the selections that allow you to read a tune and write a calibration. In this section we will discuss how to read the tune and write the calibration. Reading the tune is how you download the tune from the vehicle's computer to your laptop and writing the calibration is how you move the tune from your laptop to the vehicle's computer.

Reading the VCM

This section explains how to download the vehicle tune file from the vehicle's computer to your laptop.

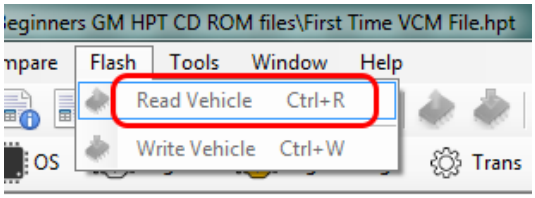
◊ Turn your laptop on and close all programs. Open the HP Tuners VCM Editor (all other programs need to be closed before continuing).

◊ Connect your interface cable to the laptop's USB port and then connect the other end of the cable to the vehicle port under the driver's dashboard area.

◊ Close all doors and turn off any items that are using power (i.e. radio, lights, etc).

◊ Turn the key to the ON position, but do not start the engine.

◊ In the VCM Editor, click on Flash on the menu bar and select Read Vehicle from the drop down list.



◊ On the Vehicle Reader window, click Read.

◊ If you do not have a license to tune the vehicle, you will be prompted to either license the vehicle or not. If you choose not to license the vehicle, you can still download the tune and look at the data, but you will not be able to save any changes made to the file. If you choose to license the vehicle and need additional information on how licensing works, please see section B.500, License Information and How to Purchase Additional Credits.

◊ After the download is complete, you will be asked to enter a filename and location to save the file. It is

recommended that you keep your tune files in one folder and always save your first file as "OEM" or "original." This will ensure that you have your original file if you ever need to go back to a stock tune or if you make mistakes while tuning. Additionally, when you make changes to the tune, it is a good idea to do a "save as" and enter a different filename each time you make changes to the tune (think of it as leaving a paper trail of changes).

◊ Once your OEM or original tune file is saved, you may proceed with the tuning process for your vehicle's setup.

Writing to the VCM

This section explains how to upload the vehicle tune file from your laptop to the vehicle's computer.

◊ Turn your laptop on and close all programs. Open the HP Tuners VCM Editor (all other programs need to be closed before continuing).

◊ Connect your interface cable to the laptop's USB port and then connect the other end of the cable to the vehicle port under the driver's dashboard area.

◊ Close all doors and turn off any items that are using power (i.e. radio, lights, etc).

◊ Turn the key to the ON position, but do not start the engine.

◊ In the VCM Editor, click on Flash on the menu bar and select Write Vehicle from the drop down list. The Vehicle Writer pop-up box will appear.

◊ On the Vehicle Writer window, click Write.

◊ If you do not have a license to tune the vehicle, you will be prompted to license the vehicle at this stage. If you choose to license the vehicle and need additional information on how licensing works, see section B.500, License Information and How to Purchase Additional Credits.

◊ It is normal for the vehicle to display messages on the dashboard, flash lights, etc. Do not be alarmed by this and do not interrupt the programming process. When the write (upload) is complete, click on Close and turn the ignition key to the OFF position.

- Your vehicle now has its new tune. Please adhere to the following BEFORE starting your vehicle:
  - Gen V Vehicles - open driver door and wait 20 to 30 seconds.
  - Gen IV and newer Gen III Vehicles - open driver door and wait 20 to 30 seconds.
  - Gen III Vehicles - wait 10 seconds.

License Information & How to Purchase Additional Credits

There are currently three license types.

◊ Specific: This license type is for a single license of one vehicle.

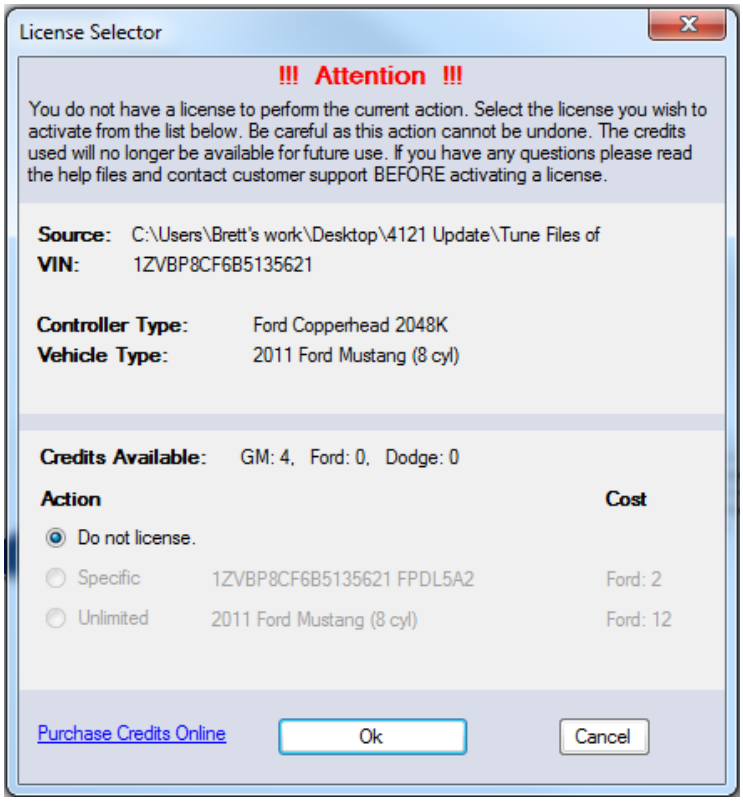
◊ Unlimited: This license type is for an unlimited number of vehicles of the same model and year. As an example, if you purchase the year/model license for a 2005 Corvette, you will be able to tune any 2005 Corvette.

◊ Unlimited: This license type allows you to license an entire vehicle group. Not all vehicles fall into an unlimited vehicle group, so this option will not always appear.

The VIN, serial number and year/model type of the vehicle that you are purchasing will appear on the screen. Additionally, your available credits will be displayed.

A list of available actions will also be displayed along with the cost associated with each action.

If you do not have enough credits, you will need to purchase some. Instructions on how to purchase additional credits are included in this section.



Important Notes:

◊ You must have a license for the file you are trying to write to the vehicle.

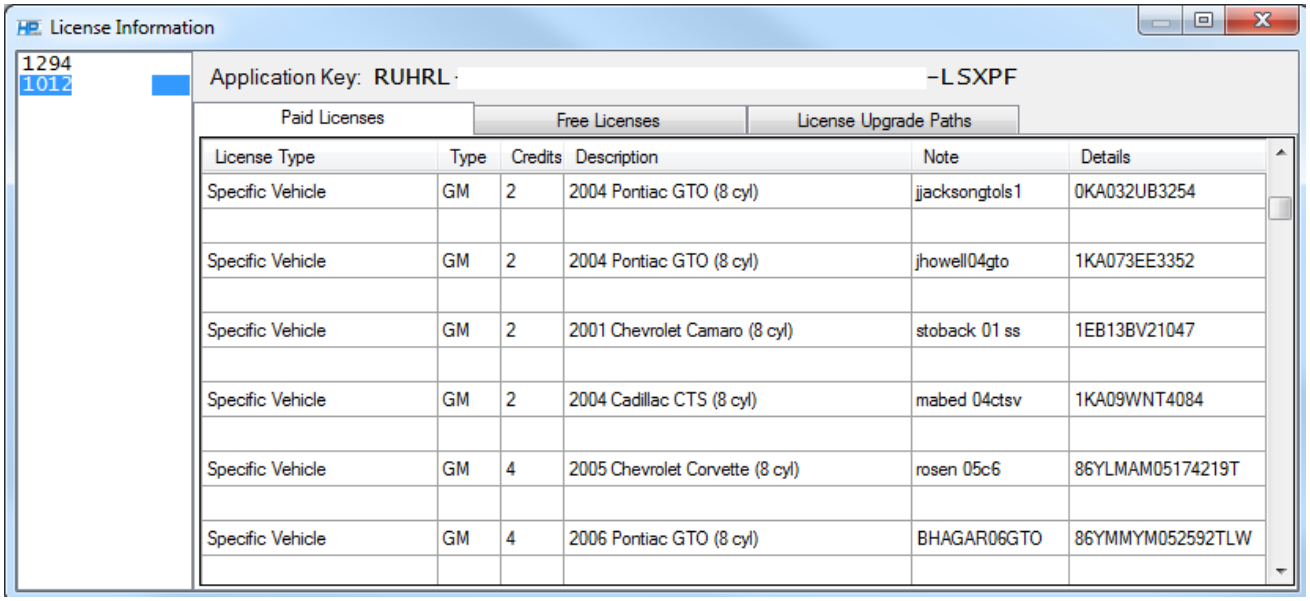
◊ You must have a license for the vehicle you are trying to write to.

◊ If you read (download) the vehicle's computer on your vehicle, you will be prompted to purchase a license. You then make changes to the file and write (upload) the file to the vehicle's computer. Because you are using the same file that came out of the vehicle you will not be prompted to purchase additional credits.

How to Find Your Current Licenses

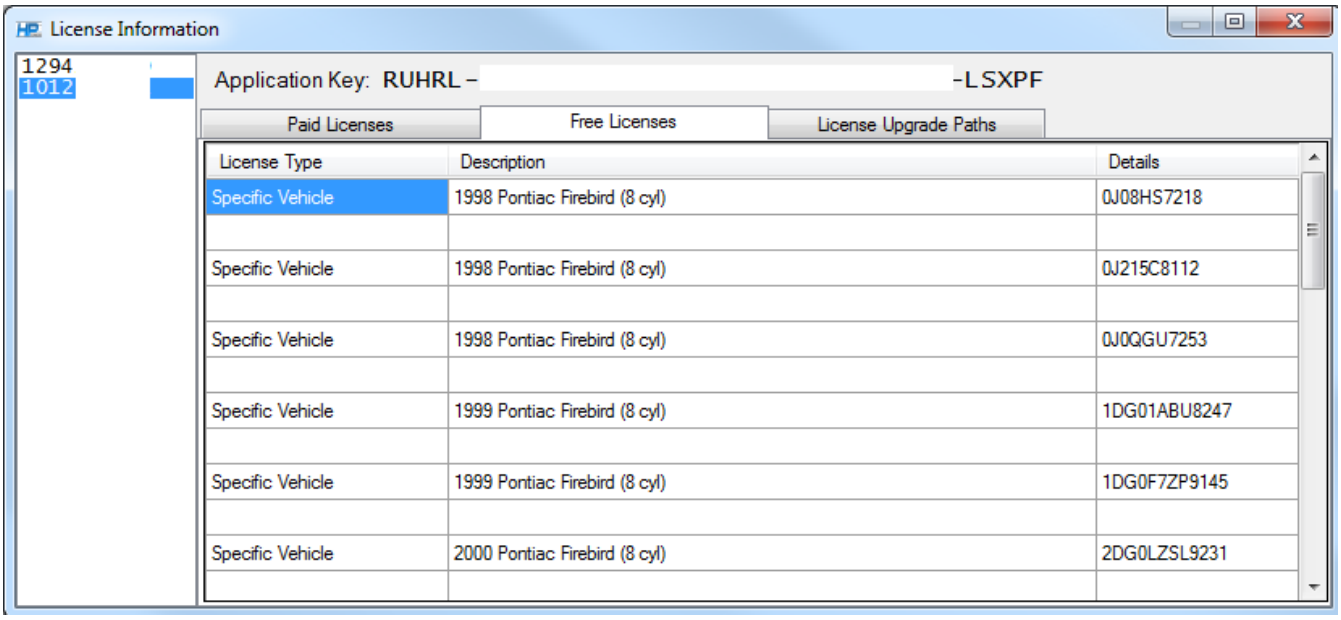
If you need to find out what licenses you have, perform the following steps. In the VCM Editor, click on Help on the menu bar and select License Information from the drop down menu. The License Information pop up box will appear. This pop up box has three associated tabs: Paid Licenses, Free Licenses and License Upgrade Paths.

Paid Licenses. This tab shows you all the current licenses that you have activated (used credits on). The License Type column will display Specific Vehicle, Unlimited (for year/make/model) or Unlimited (for platform). The Type column will display the make of the vehicle - GM, Ford or Dodge. The Credits column will display how many credits were used to purchase the license. The Description column will display the Year/Make/Model of the vehicle licensed. The Note column will display any notes that you typed if you entered a comment when licensing a single vehicle license. The Details column will list the Serial ID.

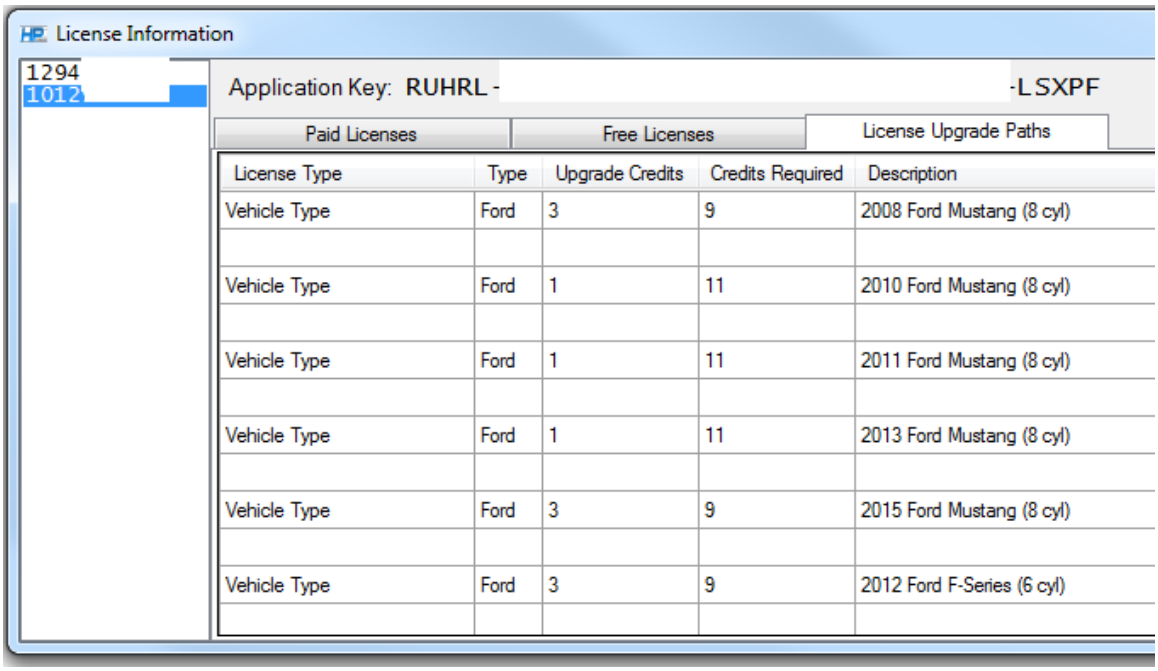


License Type	Type	Credits	Description	Note	Details
Specific Vehicle	GM	2	2004 Pontiac GTO (8 cyl)	jjacksongtols1	0KA032UB3254
Specific Vehicle	GM	2	2004 Pontiac GTO (8 cyl)	jhowell04gto	1KA073EE3352
Specific Vehicle	GM	2	2001 Chevrolet Camaro (8 cyl)	stoback 01 ss	1EB13BV21047
Specific Vehicle	GM	2	2004 Cadillac CTS (8 cyl)	mabed 04ctsv	1KA09WNT4084
Specific Vehicle	GM	4	2005 Chevrolet Corvette (8 cyl)	rosen 05c6	86YLMAM05174219T
Specific Vehicle	GM	4	2006 Pontiac GTO (8 cyl)	BHAGAR06GTO	86YMMYM052592TLW

Free Licenses. This tab shows you a list of vehicles that you have licensed that you did not have to buy credits for because you purchased an Unlimited (for year/make/model) License or an Unlimited (for platform) License. This is a great way to see your cost savings over time.



License Upgrade Paths. This tab shows you what Unlimited (year/make/model) Licenses you can purchase at a discounted credit price using your existing licenses as upgrade credits.



For example, we purchased a 2011 Ford Mustang Specific Vehicle License for two credits. We are automatically given 75% of that purchase (rounded down) as an upgrade credit to be used toward the 2011 Ford Mustang Unlimited (year/make/model) License. We now have one upgrade credit (2 credits x 75% = 1.5 rounded down to

1) for that Unlimited (year/make/model) License. You can see this by looking at the picture on the previous page on the third vehicle listed. It shows one upgrade credit for the 2011 Ford Mustang. The table also tells us that we need eleven more credits to unlock this Unlimited (year/make/model) License.

Continuing with this example, if you are going to tune more 2011 Ford Mustangs in the future, you can choose to continue purchasing Specific Vehicle Licenses at two credits each until you have purchased the Unlimited (year/make/model) License through upgrade credits (explained above) or you can automatically purchase the Unlimited (year/make/model) License at this time by spending eleven credits now.

Purchasing an Unlimited (year/make/model) License rather than Specific Vehicle Licenses is a great thing to do if you know that you will be tuning many vehicles of one model type with the same year in a short range of time. Continuing with the example above, if you plan on tuning more than six 2011 Mustangs in the near future, you would want to consider purchasing the Unlimited (year/make/model) License. Why is this? To answer, you could spend eleven credits now and have the Unlimited (year/make/model) License for the 2011 Ford Mustang or you could spend up to twenty-two credits (two each for eleven additional vehicles) over time licensing the 2011 Ford Mustangs to get to the Unlimited (year/make/model) License for this particular vehicle.

How to Purchase Additional Credits

Download our new Credits App on your computer, Apple iOS or Android compatible device. Credits purchased on our app process automatically within five to ten minutes. With our app, you have the ability to store your serial number and credit card information for one-click purchasing. The credit purchasing process is now faster than ever!

To download, please visit our website at http://www.thetuningschool.com.

Fuel Injector Sizing

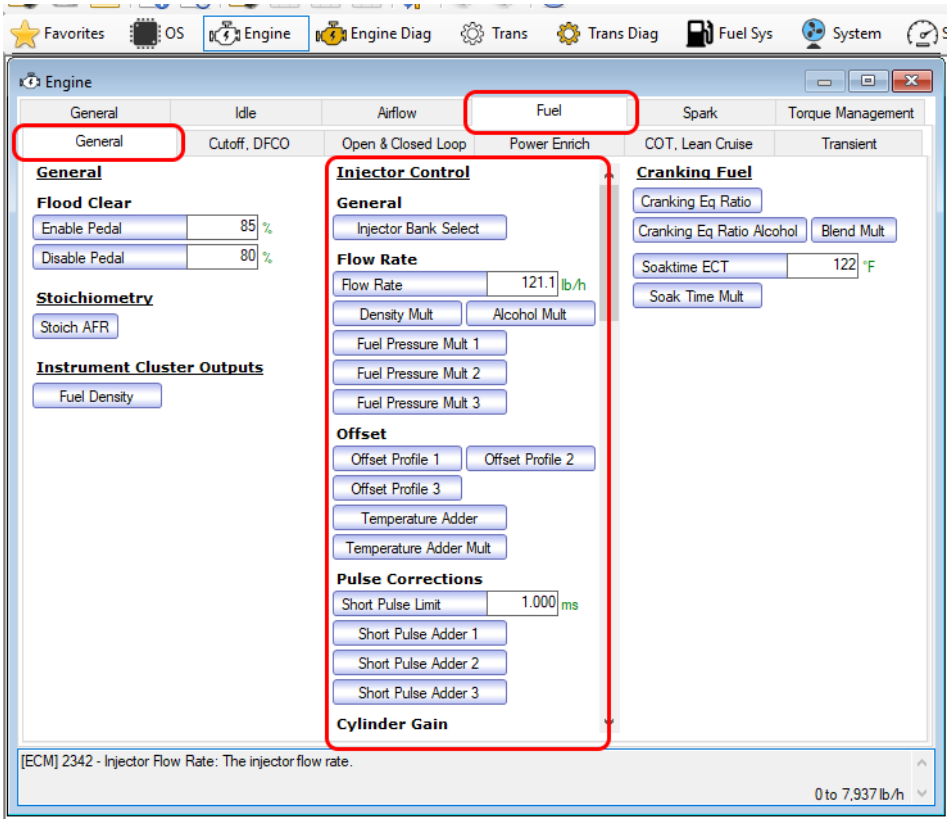
With a limited support of aftermarket fuel injectors available, shops are upgrading to the Chevrolet LT4 injectors and a high pressure fuel pump. If you've changed to LT4 injectors, we recommend you simply copy the injector data from an LT4 tune file to your tune file.

Typical injector data you need to copy includes the following:

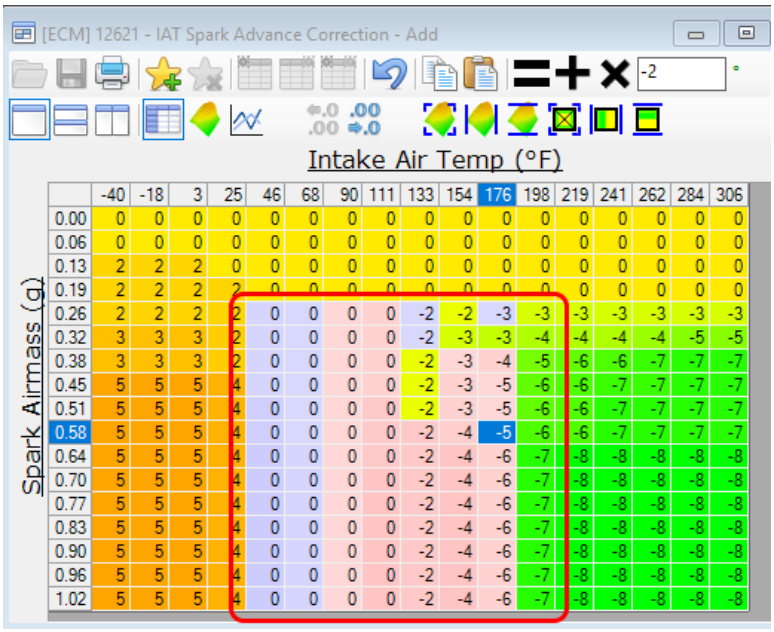
- ◊ Flow Rate and associated multipliers
- ◊ Injector Offset
- ◊ Pulse Corrections
- ◊ Limits
- ◊ Injector Profiles
- ◊ Pulse Parameters
- ◊ Split (Double) Pulse
- ◊ Lastly, if you are doing a complete LT4 conversion, copy all Injection Timing data as well.

To locate the listed sections in the VCM Editor, click on the Engine icon. Select the Fuel tab and then select the General sub-tab. The tables and fields are all located under the Injector Control section.

If you need added help with these changes, we recommend you contact us for further support or to help you verify you have copied all the data correctly.



temperature reading after the change you just made) column from 0.20 g/cyl airmass and up, enter -2 in the text box and select the equal icon to make these values -2. Last, we need to interpolate the values from approximately 131°F to 203°F. To do this, highlight the values from 131°F to 203°F and select the Interpolate Between Horizontal Bounds icon. This will smooth the values nicely. Your updated table will look similar to the screenshot below.



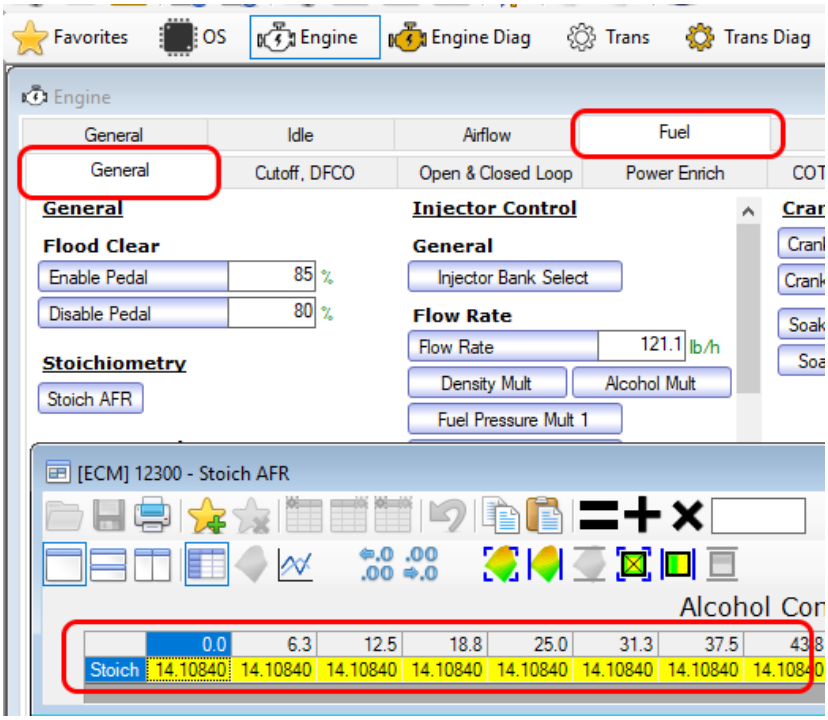
	-40	-18	3	25	46	68	90	111	133	154	176	198	219	241	262	284	306
0.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.13	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.19	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0
0.26	2	2	2	2	0	0	0	0	-2	-2	-3	-3	-3	-3	-3	-3	-3
0.32	3	3	3	2	0	0	0	0	-2	-3	-3	-4	-4	-4	-4	-5	-5
0.38	3	3	3	2	0	0	0	0	-2	-3	-4	-5	-6	-6	-7	-7	-7
0.45	5	5	5	4	0	0	0	0	-2	-3	-5	-6	-6	-7	-7	-7	-7
0.51	5	5	5	4	0	0	0	0	-2	-3	-5	-6	-6	-7	-7	-7	-7
0.58	5	5	5	4	0	0	0	0	-2	-4	-5	-6	-6	-7	-7	-7	-7
0.64	5	5	5	4	0	0	0	0	-2	-4	-6	-7	-8	-8	-8	-8	-8
0.70	5	5	5	4	0	0	0	0	-2	-4	-6	-7	-8	-8	-8	-8	-8
0.77	5	5	5	4	0	0	0	0	-2	-4	-6	-7	-8	-8	-8	-8	-8
0.83	5	5	5	4	0	0	0	0	-2	-4	-6	-7	-8	-8	-8	-8	-8
0.90	5	5	5	4	0	0	0	0	-2	-4	-6	-7	-8	-8	-8	-8	-8
0.96	5	5	5	4	0	0	0	0	-2	-4	-6	-7	-8	-8	-8	-8	-8
1.02	5	5	5	4	0	0	0	0	-2	-4	-6	-7	-8	-8	-8	-8	-8

Wide Open Throttle Fueling

This table simply commands the amount of fuel you want at wide open throttle only. The optimal air/fuel ratio when the vehicle is idling or cruising is the defined Stoichiometric ratio. When you are in wide open throttle, you want your air/fuel ratio to decrease because you'll need more fuel to match the increase in the amount of air. Engines make more power when they are in a little bit richer condition than normal at wide open throttle.

For vehicles with bolt on modifications, you want your target air/fuel ratio to be approximately 12.8:1 to 13.2:1 for cars and 12.2:1 to 12.8:1 for trucks and heavy vehicles (at wide open throttle only). The goal is to have a steady air/fuel ratio wideband reading across the entire rpm range. Your optimal safe air/fuel ratio may vary; however, be cautious when adjusting outside of these suggestions.

If you have previously tuned Gen III and Gen IV GM vehicles, then you know that the Stoichiometric ratio is almost always 14:7 to 1. Some newer model Gen V GM vehicles have a lower Stoichiometric ratio value due to modern ethanol content and E85 standards. You can find your vehicle's Stoichiometric ratio in the Stoich AFR table in the VCM Editor. To locate the Stoich AFR table, click on the Engine icon. Select the Fuel tab and then select the General sub-tab. The table is located by clicking on the Stoich AFR button under the Stoichiometry section. Viewing the data in this table, you can see that for our example vehicle, the Stoichiometric ratio is 14.108



MAF Tuning for Wide Open Throttle

Go to the separate MAF Tuning Guide (provided with your course materials) and turn to the second section in that manual. That section is called MAF Tuning for Wide Open Throttle. Follow the steps for MAF Tuning for Wide Open Throttle and then come back here and continue with the steps in your tuning checklist.

Virtual Torque Tuning

Go to section G.100 at the back of this manual for an explanation of the Virtual Torque System, issues you may face and how to resolve them through updating the Driver Demand tables, the Peak Engine Torque table and/or the Virtual Torque Map tables.

Trouble Codes

Use the trouble codes area to remove codes and trouble light problems (after researching them) that may occur. Determine what your trouble codes are by doing a live scan log file. You must review trouble codes live with the key in the ON position. Select the Diagnostics and Info icon on the toolbar in the VCM Scanner. Write down the codes that appear. We recommend that you research these codes as necessary to determine why they are occurring before you disable them.

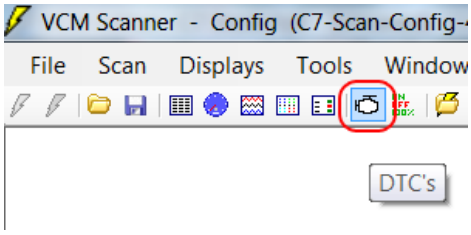
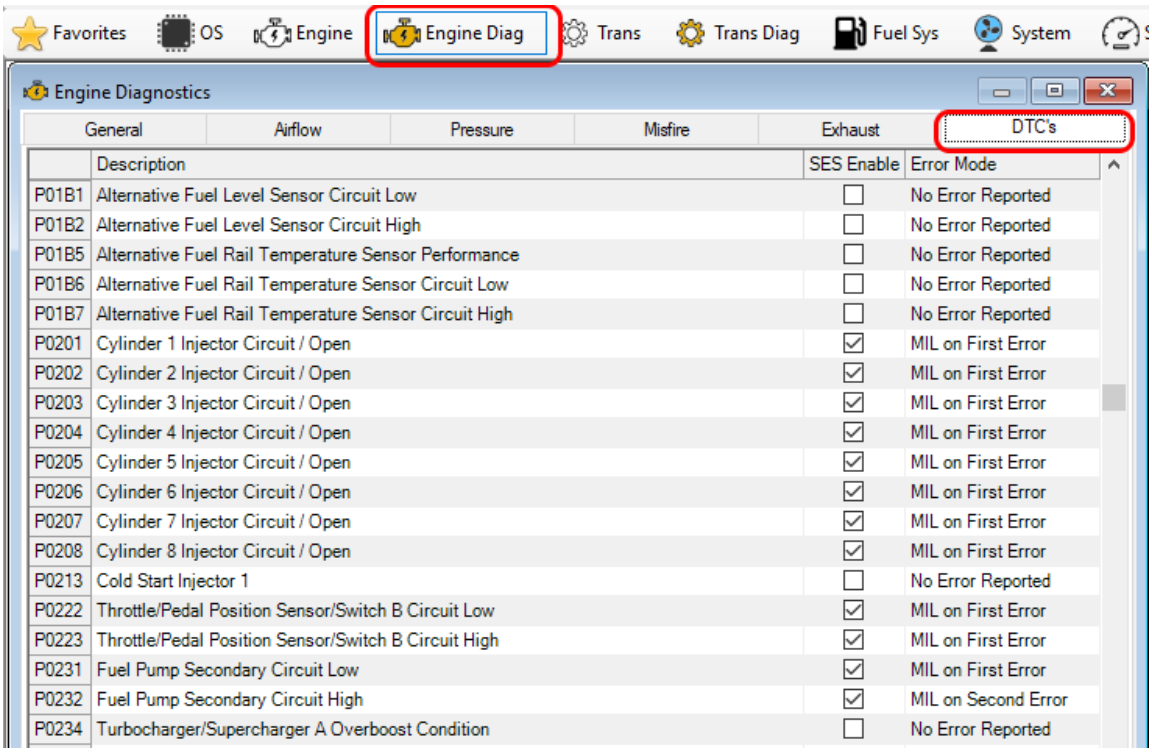


Table Update (Gen V Vehicles):

To locate the list of trouble codes in the VCM Editor, click on the Engine Diag icon and select the DTC's tab. The list of trouble codes by code will appear. Next to each code is a description, an SES Enable checkbox and an Error Mode. If you need to disable a trouble code, find it in the list. Uncheck the associated SES Enable checkbox and select "No Error Reported" from the drop-down menu in the Error Mode column.



	Description	SES Enable	Error Mode
P01B1	Alternative Fuel Level Sensor Circuit Low	☐	No Error Reported
P01B2	Alternative Fuel Level Sensor Circuit High	☐	No Error Reported
P01B5	Alternative Fuel Rail Temperature Sensor Performance	☐	No Error Reported
P01B6	Alternative Fuel Rail Temperature Sensor Circuit Low	☐	No Error Reported
P01B7	Alternative Fuel Rail Temperature Sensor Circuit High	☐	No Error Reported
P0201	Cylinder 1 Injector Circuit / Open	☑	MIL on First Error
P0202	Cylinder 2 Injector Circuit / Open	☑	MIL on First Error
P0203	Cylinder 3 Injector Circuit / Open	☑	MIL on First Error
P0204	Cylinder 4 Injector Circuit / Open	☑	MIL on First Error
P0205	Cylinder 5 Injector Circuit / Open	☑	MIL on First Error
P0206	Cylinder 6 Injector Circuit / Open	☑	MIL on First Error
P0207	Cylinder 7 Injector Circuit / Open	☑	MIL on First Error
P0208	Cylinder 8 Injector Circuit / Open	☑	MIL on First Error
P0213	Cold Start Injector 1	☐	No Error Reported
P0222	Throttle/Pedal Position Sensor/Switch B Circuit Low	☑	MIL on First Error
P0223	Throttle/Pedal Position Sensor/Switch B Circuit High	☑	MIL on First Error
P0231	Fuel Pump Secondary Circuit Low	☑	MIL on First Error
P0232	Fuel Pump Secondary Circuit High	☑	MIL on Second Error
P0234	Turbocharger/Supercharger A Overboost Condition	☐	No Error Reported

Tuning for Heads/Cam Vehicles

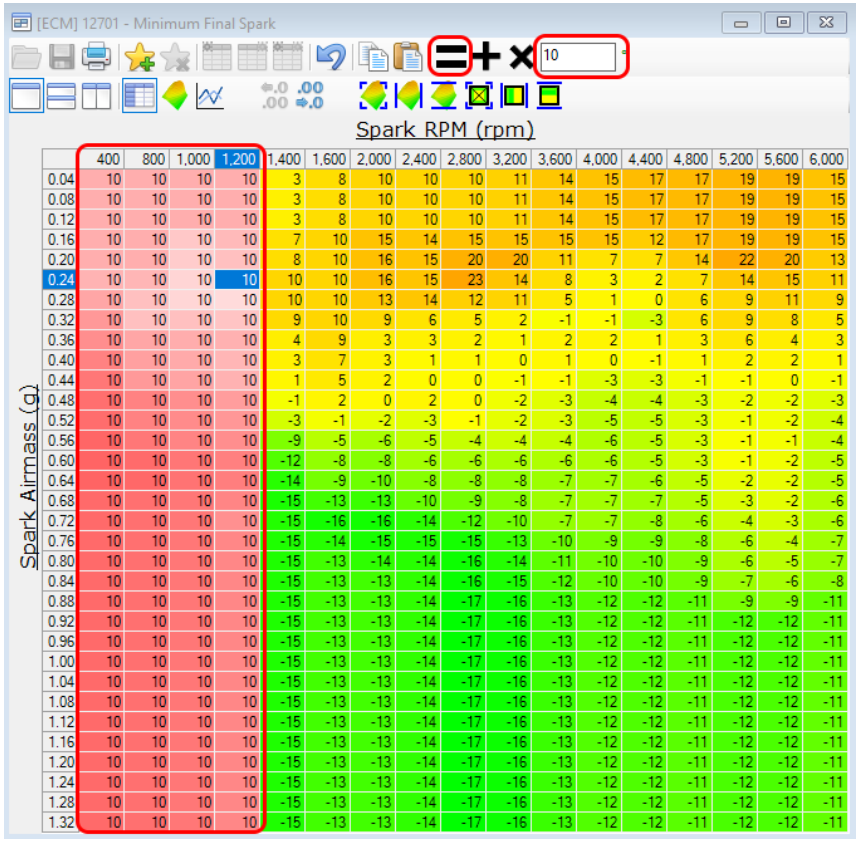
(Section D)

Tuning for Forced Induction Vehicles

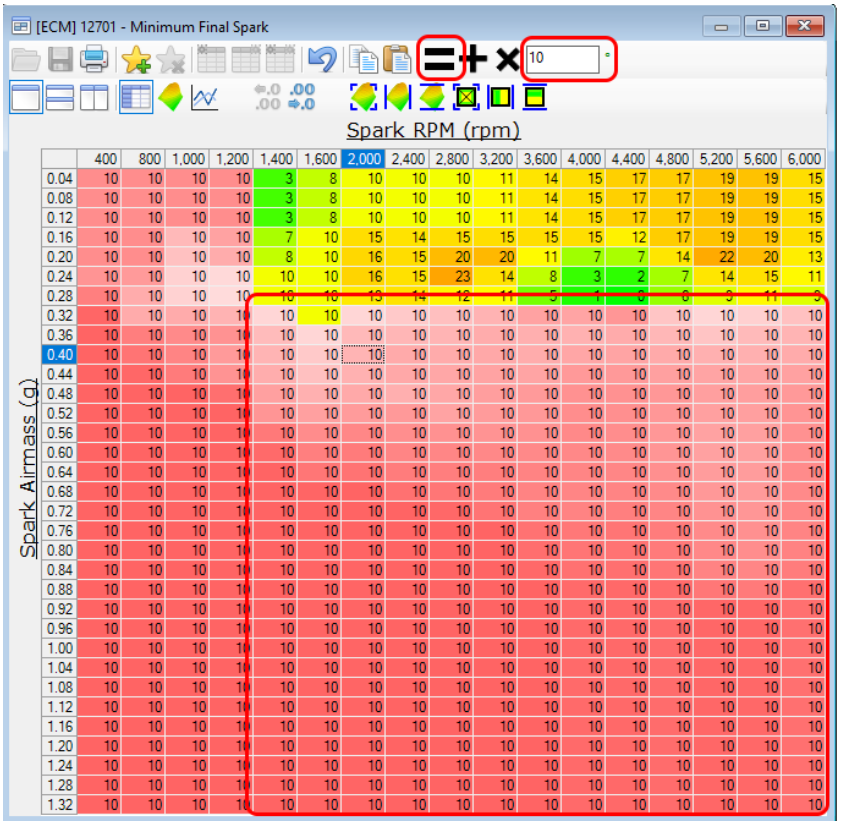
(Section E)

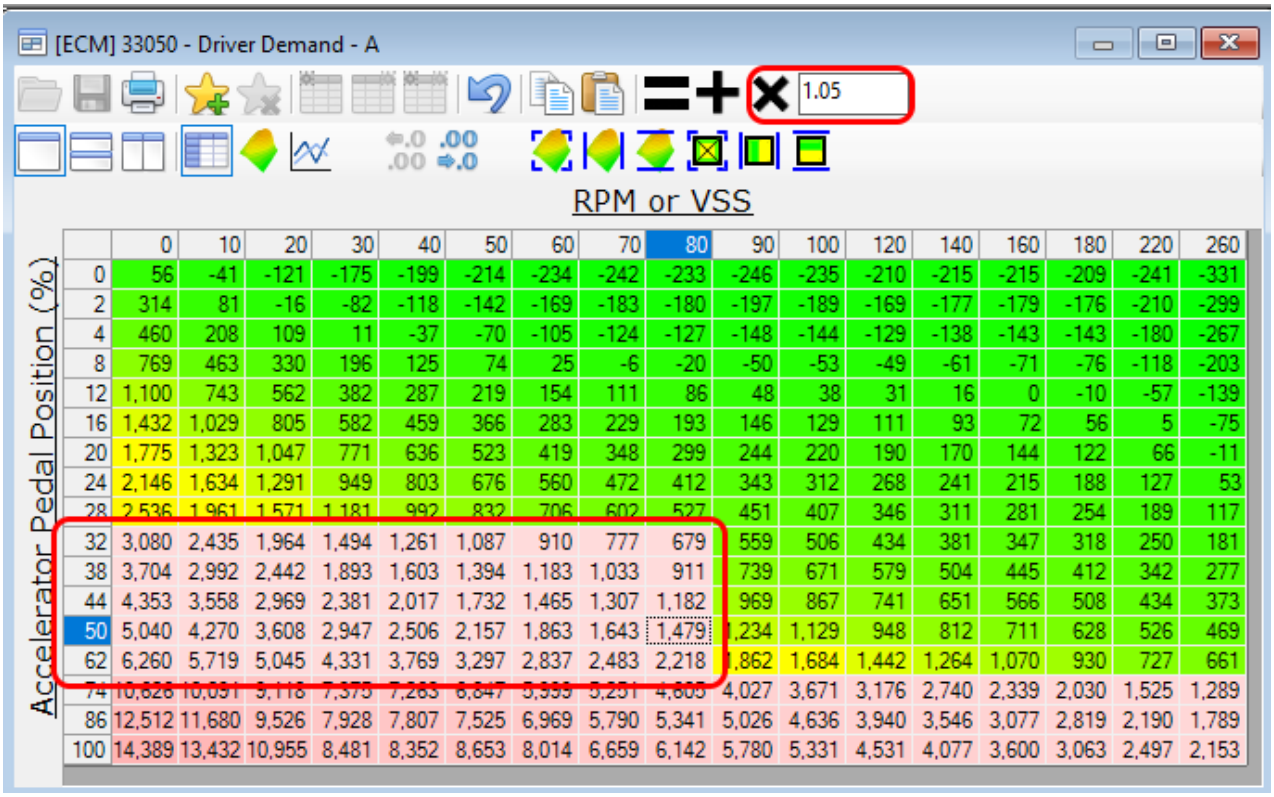
of the table to 10°, we will blend the changes into the values that are higher than 10°.

To do this, start by updating the area of the table from 400 rpm to 1,200 rpm. Select the columns from 400 rpm to 1,200 rpm, enter 10 in the text box and select the equal icon. See the screenshot on the right for an example.



Then, select the area starting at 1,400 rpm to 6,000 rpm and 0.32 airmass to 1.28 airmass, enter 10 in the text box and select the equal icon. Remember we selected this range because the values were lower than 10°. Your tune file might look slightly different.

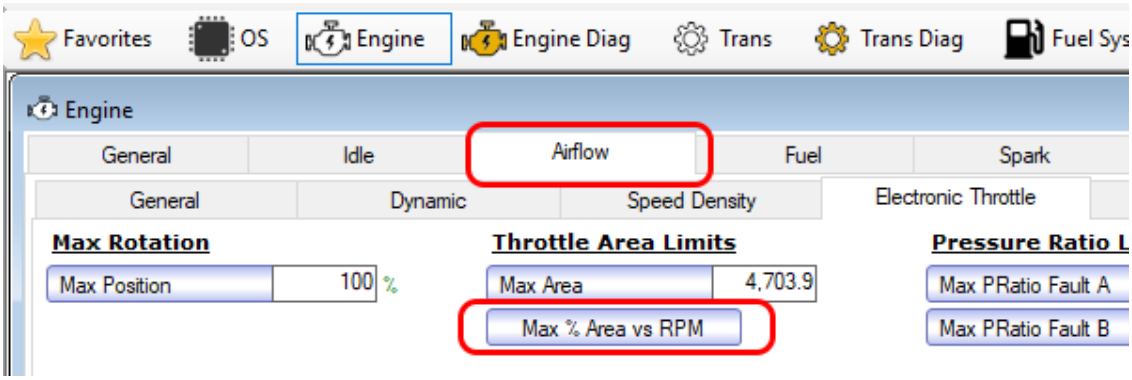


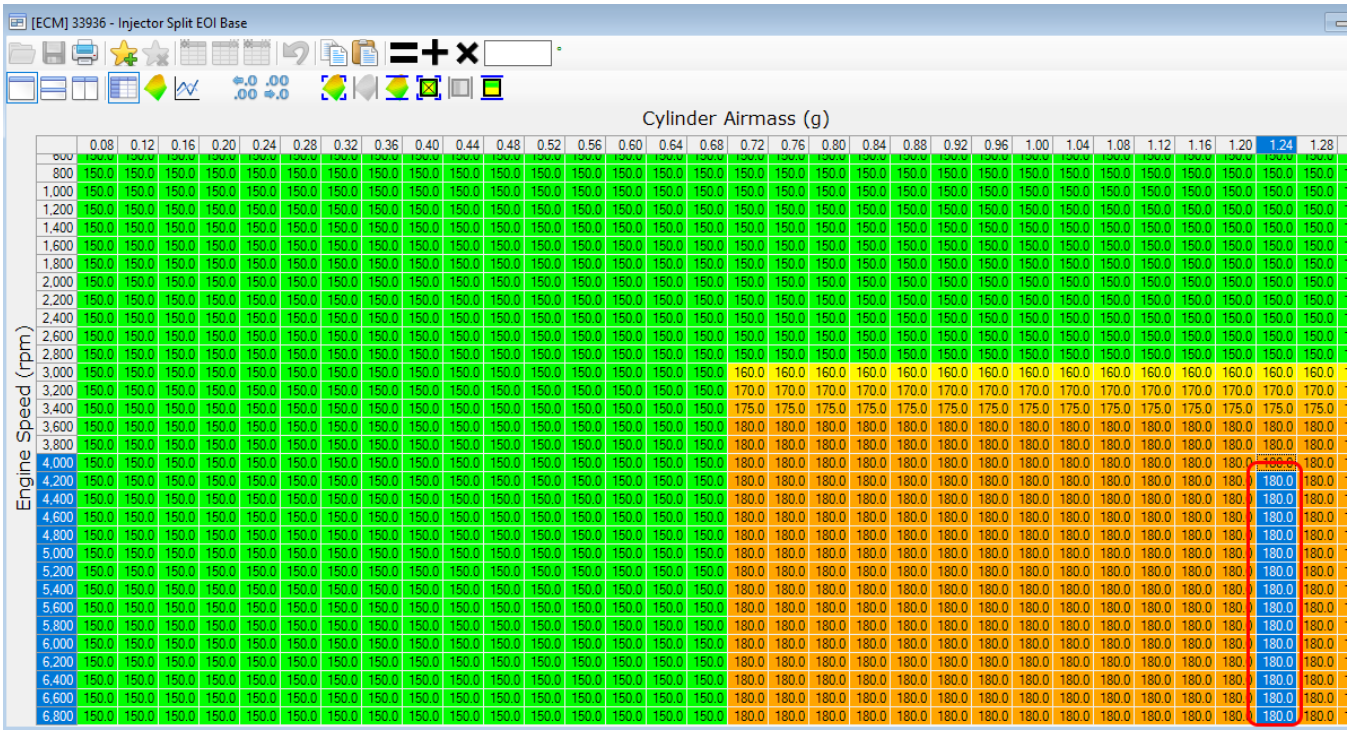


	0	10	20	30	40	50	60	70	80	90	100	120	140	160	180	220	260
0	56	-41	-121	-175	-199	-214	-234	-242	-233	-246	-235	-210	-215	-215	-209	-241	-331
2	314	81	-16	-82	-118	-142	-169	-183	-180	-197	-189	-169	-177	-179	-176	-210	-299
4	460	208	109	11	-37	-70	-105	-124	-127	-148	-144	-129	-138	-143	-143	-180	-267
8	769	463	330	196	125	74	25	-6	-20	-50	-53	-49	-61	-71	-76	-118	-203
12	1,100	743	562	382	287	219	154	111	86	48	38	31	16	0	-10	-57	-139
16	1,432	1,029	805	582	459	366	283	229	193	146	129	111	93	72	56	5	-75
20	1,775	1,323	1,047	771	636	523	419	348	299	244	220	190	170	144	122	66	-11
24	2,146	1,634	1,291	949	803	676	560	472	412	343	312	268	241	215	188	127	53
28	2,536	1,961	1,571	1,181	992	832	706	602	527	451	407	346	311	281	254	189	117
32	3,080	2,435	1,964	1,494	1,261	1,087	910	777	679	559	506	434	381	347	318	250	181
38	3,704	2,992	2,442	1,893	1,603	1,394	1,183	1,033	911	739	671	579	504	445	412	342	277
44	4,353	3,558	2,969	2,381	2,017	1,732	1,465	1,307	1,182	969	867	741	651	566	508	434	373
50	5,040	4,270	3,608	2,947	2,506	2,157	1,863	1,643	1,479	1,234	1,129	948	812	711	628	526	469
62	6,260	5,719	5,045	4,331	3,769	3,297	2,837	2,483	2,218	1,862	1,684	1,442	1,264	1,070	930	727	661
74	10,626	10,091	9,118	7,375	7,283	6,847	5,393	5,251	4,605	4,027	3,671	3,176	2,740	2,339	2,030	1,525	1,289
86	12,512	11,680	9,526	7,928	7,807	7,525	6,969	5,790	5,341	5,026	4,636	3,940	3,546	3,077	2,819	2,190	1,789
100	14,389	13,432	10,955	8,481	8,352	8,653	8,014	6,659	6,142	5,780	5,331	4,531	4,077	3,600	3,063	2,497	2,153

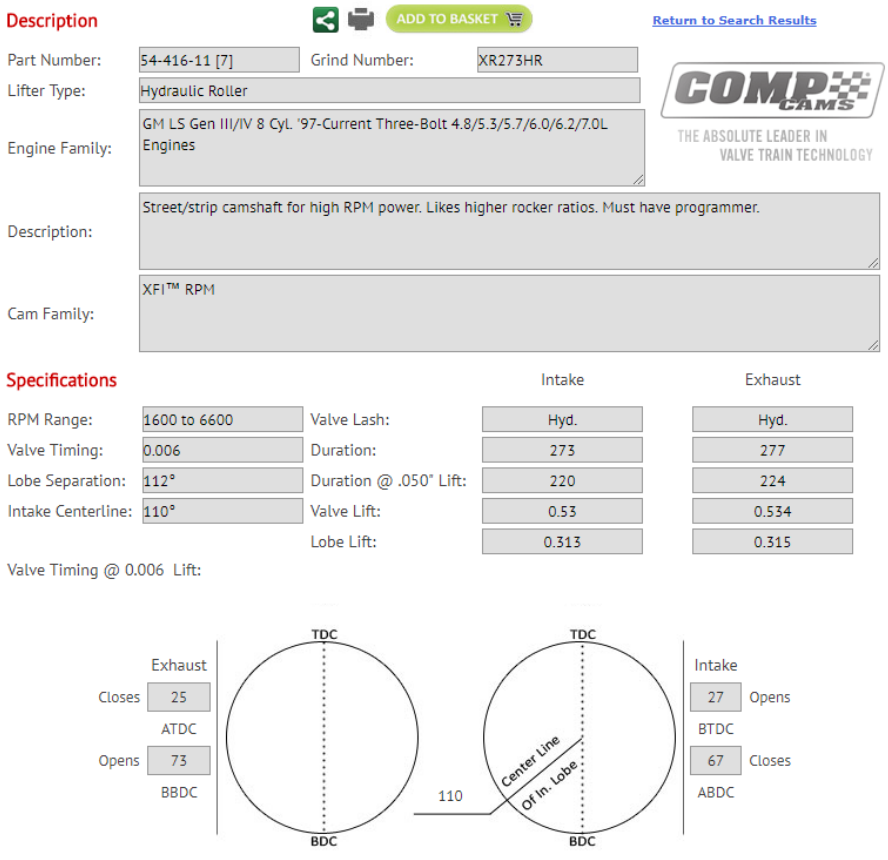
When you are done making changes to the Driver Demand A table, open the Driver Demand B and Driver Demand C tables and make the same changes. **NOTE: You cannot copy and paste between MAP tables - you must go to the next table and manually make the changes. DO NOT COPY BETWEEN MAP TABLES.**

The last table that needs to be adjusted for throttle controls is the Throttle Area % Max vs RPM table. To locate the table in VCM Editor, click on the Engine icon. Select the Airflow tab and then select the Electronic Throttle sub-tab. The table is displayed by clicking on the Max % Area vs RPM button under the Throttle Area Limits section.





The first step in updating these tables will be to overlay your actual camshaft timing events on our diagram to see where your valve events happen and determine how early and how late you can actually spray the fuel.

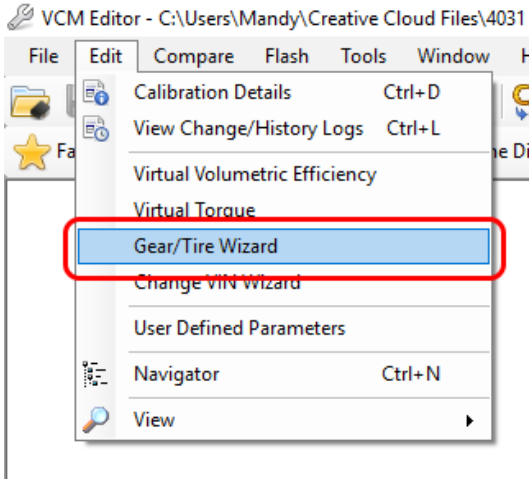


We will use the cam specs from the Comp Cams website for a Comp Cams XR273HR as an example. This cam would classify as a mild cam with a duration @.50 lift of 220/224. The real data we are interested in, however, is the Valve Timing located near the bottom next to the circles. Let's begin with the Intake Valve side (right side circle).

The Intake Valve opens (IVO) 27° before top dead center (BTDC) as indicated on the chart. To equate

Speedometer and Rear Gear Calibration

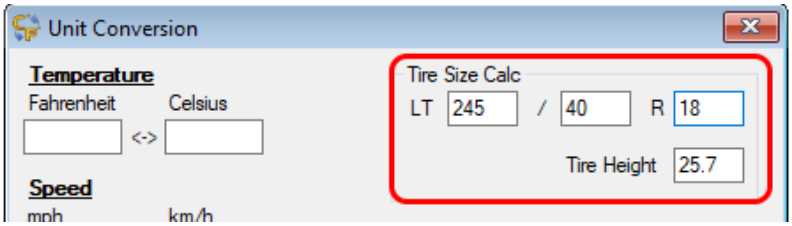
The VCM Editor has an area where you can change the speedometer calibration and rear gear size. Changes may be needed to this area if you've altered your gear ratio or your tire size. It is accessed by clicking on the Edit menu on the tool bar and selecting Gear/Tire Wizard from the drop down menu.



There are text boxes where you can enter a new tire size and new gear ratio. Once you have entered the information, select the Adjust button to save the changes. Doing so will update your transmission speed shift points and your speedometer will be corrected.

Tire Size:

If you have changed tire sizes, enter your new tire size in the tire size text box. Most tire manufacturers will reference this information on their websites. We recommend that you search for this information that way if you do not readily know the tire size. If you cannot find the manufacturers specifications on their website, HP Tuners has a built in tire size calculator. It is accessed by clicking on the Tools menu on the toolbar and selecting Unit Conversion from the drop down menu. You can then enter the tire specs and get the tire height that way. Here's what it looks like if you have 245/40-18 tires. The resulting tire height is 25.7. You would then enter this value (25.7) into the new tire size field on the Gear/Tire Calc tab.



Gear Ratio:

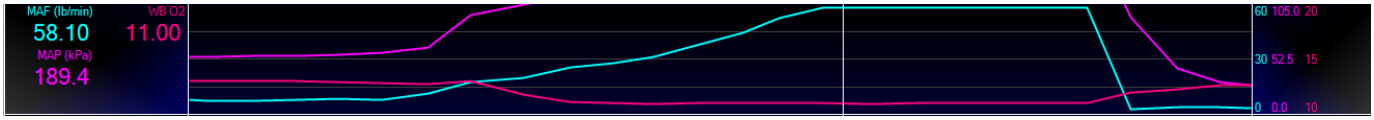
If you have updated your rear gears, you can enter the new gear ratio in the gear ratio text box.

◊ If you make a change to one field, you must also update the other field or you will receive an Invalid message. For example, if you change your tire size and input a new value in that field, but you have not

Throttle Position Sensor

The line representing throttle position appears green in the screenshot above. This data stream shows a measurement of throttle position. The throttle position sensor provides the vehicle's computer with a voltage signal. The vehicle's computer then translates this into throttle percentage. These readings are used in the tables to determine many factors such as when the vehicle goes into wide open throttle, when it is idling, and so on. One excellent way of telling when you are in wide open throttle in a run is that the throttle position sensor reading will spike upward rapidly. A common throttle position sensor reading for wide open throttle is 83 - 88%.

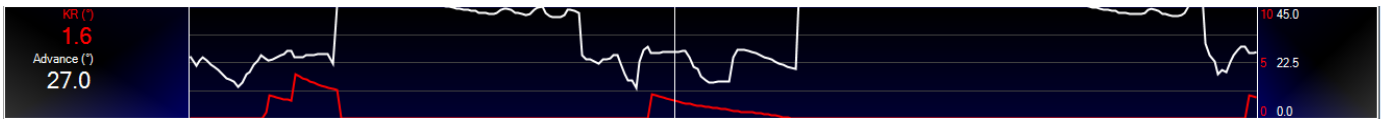
Wideband O_2



The line representing wideband readings appears pink in the screenshot above. The VCM scanner (PRO version only) shows the wideband air/fuel ratio here.

The wideband O_2 readings have no effect on the way the vehicle's computer works. These readings are strictly for the purpose of tuning the vehicle. You use the wideband readings to determine what the air to fuel ratio is during various points in a scan log file. The wideband O_2 readings are particularly useful when you are working with the PE Fuel table. You can watch the throttle position sensor readings to determine when you are at wide open throttle and then match up the wideband readings at that point and beyond in order to achieve the PE Fuel goals for your vehicle modification type.

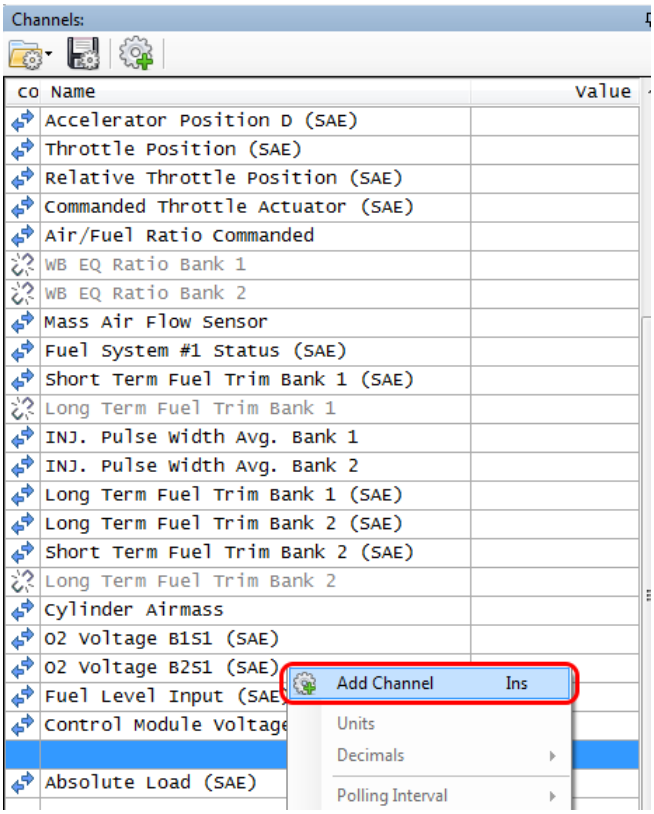
Knock Retard (KR)



The line representing knock retard appears red in the screenshot above. This data stream shows knock retard,

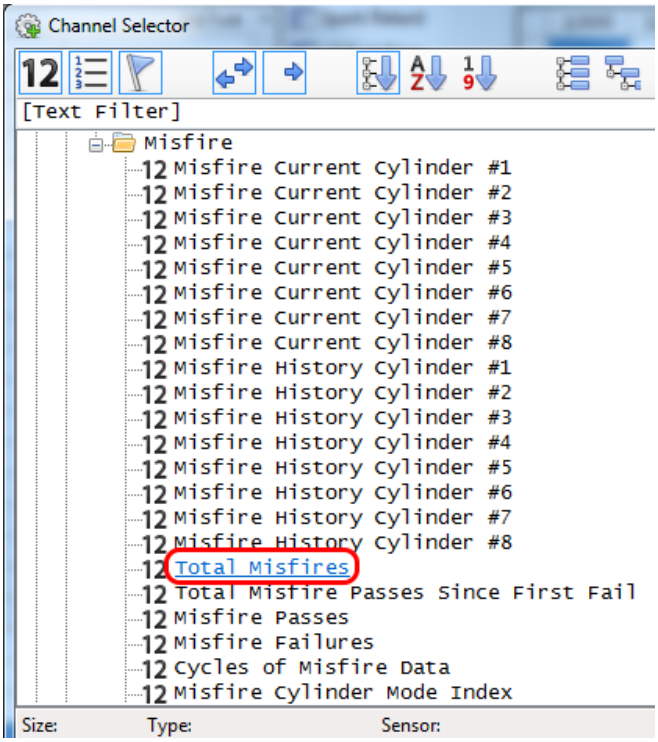
Misfire Detection

In some circumstances, it is helpful to create a channel config that will display misfires to help diagnose engine problems. To do this, have the VCM Scanner open and be sure that you are not connected to the vehicle and that you do not have a scan log file open. In the Channels display, pick any empty slot, right click and choose Add Channel from the drop down menu.



The Channel Selector pop up box will appear. Expand the Engine tree by clicking the "+" next to Engine. Expand the Misfire sub-tree. Find Total Misfires in the list and double click it to select it. Close the Channel Selector pop up box. Total Misfires will now be displayed and listed for your next scanning session.

If you find that your number of total misfires is abnormal (i.e. more than occasionally occurring, or a steadily increasing number of misfires) you may want to narrow the misfires down further to display misfires by cylinder. To do this, simply follow the process listed above again but select "Misfire History Cylinder X" for each of the 6-8 cylinders one at a time.



You should save this channel config with a new name, such as "Misfire Detection Channel Config" so you can use it in the future and not have to create the channel config again.

Virtual Torque Tuning

(Section G)