Roe Racing USA
VEC2 System and Software Operating Instructions
Ver.3.5.0

Features & Benefits:

- Manifold pressure and RPM referenced fuel calibration.
- Manifold pressure and RPM referenced ignition timing calibration.
- Internal 2.5 bar pressure sensor.
- Analog input from external 0-5V sensors (allows utilization of stock sensors for reference input).
- Analog output voltage limit function (useful on forced induction using stock MAP sensor).
- Allows for the use of significantly larger fuel injectors while retaining proper air / fuel ratios.
- Individual cylinder fuel trim.
- Internal injector drivers operate high resistance fuel injectors, while using external resistors will allow the VEC2 to run low resistance injectors.
- Smart Card programmable. No need to link to VEC2 to make program changes.
- Allows for stock-like drivability on heavily modified engines.
- Programmable RPM limit.
- Utilizes factory PCM adaptive capability to properly adjust for various operating conditions, such as altitude, engine coolant temperatures, intake air temperatures, etc.,
- Programmable output signal (12V- negative) can be used to activate a switched component or PWM (pulse width modulation) controlled component.
- Plugs into factory wiring harness for easy installation.
- Does not alter other stock PCM functions, allowing for full OBD2 functionality.
- Full data logging system with graphing screen.
- 3D mapping view of VEC2 fuel and ignition programs.
- Active fuel and ignition cells are highlighted in the VEC2 software while linked to the system in the logging mode.

System Overview:

The VEC2 Viper Engine Calibrator allows precise tuning of the air to fuel ratio and ignition timing over the entire operating range of the engine. Simply inserting a pre-programmed Smart Card immediately changes the program settings for the current driving situation or octane of fuel as desired.

The unit contains its own fuel injector drivers and is wired in between the factory PCM and engine. It is especially useful for recalibration of both forced induction engines and those with extensive modifications, allowing the tuner to quickly get the engine running correctly. Stock engines can also benefit greatly from improving the ignition timing and fuel curves.

The VEC2 is similar to a stand-alone engine management system, but also has similarities to a piggyback system. We consider it as working “in series” with the factory PCM.

In a true stand-alone system, you must program for every operating condition the engine will experience, such as load, throttle position, RPM, engine temperature, air temperature, etc. These systems can be quite complex to tune. Most PCM’s also control radiator fan operation, A/C operation, emissions operation and diagnostic functions. Stand-alones are generally not compatible with OBD2 emissions testing in that they replace the factory PCM and will not link up with state run emissions equipment. These systems are best suited for racetrack use where engine tuners can fine-tune the program to the environment of the moment for optimal performance.

In a typical piggyback system, control over the engine is done by manipulating inputs to the stock PCM. Manifold air pressure and oxygen sensor voltages can be altered in order to make the PCM change its load calibration, thus altering fuel and ignition advance curves. Reducing MAP sensor voltage has the effect of reducing injector pulse width by making the PCM “think” the engine is under greater vacuum than actual. At the same time, ignition timing is advanced due to the PCM believing the engine is under a lower load. Conversely, increasing voltage has the opposite effect, increasing fuel and reducing timing advance. When tuning with systems of this type, you can find yourself in situations where you can have proper part throttle tuning, or proper full throttle tuning, but rarely both if the engine is heavily modified or has forced induction.

The VEC2 offers the best of both worlds. Stand alone system control, but with the simplicity of a piggyback system. The VEC2 controls fuel and timing, leaving the stock PCM to handle all other functions, such as idle speed, A/C control, emissions operation, etc.

System Description:

The VEC2 uses the factory PCM injector pulse output as a timing reference, which can be scaled within a range of 0% to 199%. This is beneficial in that if you’re using larger injectors, you can use a calculated percentage of the stock PCM pulse to make the larger injectors flow the same as the stock ones. This allows the engine to start up and immediately operate with the proper air/fuel ratio in closed loop operation. For use under a heavier load (full throttle / boost), you can create a fuel curve that begins adding milliseconds of injector pulse width as the load / boost increases. The fuel curve can be further trimmed based on the engine RPM, since the engine efficiency / fuel demand can change with RPM. Negative values can also be placed in load and RPM tables, allowing you to shut off injectors under deceleration and trim down fuel when it is otherwise too rich (both very beneficial for naturally aspirated engines)

Ignition timing can be controlled within a range of 25 degrees advance to 25 degrees retard from the factory settings. The curve can be configured based on engine load and RPM. The factory PCM continues to drive the coils, though the input and resulting delivered spark advance is controlled by the VEC2. In places where the factory programmed timing curve was too advanced for an engine, such as under boost, it can be retarded, while leaving normal timing in vacuum conditions. You can also add timing advance in areas where the factory programmed timing advance was insufficient, such as for naturally aspirated engines.

The VEC2 has a programmable 12V- output wire. The output can be used to operate a relay, turn on a shift light, operate a PWM injector circuit, etc. The output is signal (manifold pressure or voltage) and engine RPM referenced. For example, you can create a program which will turn on a Nitrous relay, increase the injector pulse and decrease the ignition advance all at the same time.

For use on engines that pressurize the stock intake manifold, the VEC2 has a programmable analog output signal limiting function. This allows the MAP sensor signal to be processed by the VEC2 before going to the original equipment PCM. The tuner can adjust the maximum allowable voltage that will go out to the stock PCM in an RPM referenced table, keeping check engine lights from occurring due to the PCM seeing a MAP sensor voltage higher than normal when under boost.

The different fuel and timing programs are written using the VEC2 software. Program files can be modified, saved, e-mailed and written to Smart Cards with serial and USB plug reader / writers. The VEC2 has an internal Smart Card reader and writer. To change the program, simply slide the card into the slot and wait for the green ready light to blink (typically 1-2 seconds). Using Smart Cards allows you to quickly change the program without having to link up to the VEC2. You can have an unlimited number of Smart Card programs (they are rewrite-able) and they are compact enough to put in your wallet.

The VEC2 can be linked to via a serial cable connection. From this connection, the VEC2 program can be read and modified. Additionally, the VEC2 is also a full-featured data logger (see separate instructions).

Front Panel Indicator Lights and Smart Card Write Button Functions (from left to right):

- LED #1, Green, Power. Indicates power is on.
- LED #2, Red, User selectable features (activated in the Box Configuration menu).
- LED #3, Red, System busy or error. Lights steady during the reading or writing of a Smart Card. Flashes if there is a system or card error. Steady on with the #4 green LED indicates the last card function was a write to the card.
- LED #4, Green, Smart Card read / write. Flashes when card read complete. Steady on after a card writes with the #3 LED.
- Pushbutton, writes current settings from the VEC2 to Smart Card (allowed only in UNLOCKED mode). Push button before sliding card into slot, otherwise, it will read the card instead of writing.

Software requirements:

- CD Rom reader
- Serial or USB port
- Windows operating system win95, win98, win2000 and winXP
- 5Mb of hard drive free space.

CD Contents:

- VEC2 software with setup installation program
- Sample program files for naturally aspirated and forced induction Viper engines.
- Chipdrive and Todos (card reader / writer) drivers.
- Firmware loader program.

Software Installation:

1. Insert the CD into your disc drive.
2. Allow the computer to Auto Open the CD, or open it through “My Computer” or “Windows Explorer”.
3. Click and open the “VEC2-CD” folder.
4. Click and open the “VEC2-Gen-1-2-3-Viper” folder.
5. Select “Setup” and follow the on screen prompts to create your directory path and complete the installation.
6. From The CD, click and open the foldre named “Card-Drivers”.
7. Select and open the folder for the reader / writer brand you have (if applicable). Click on the “Setup.exe” file and follow the onscreen prompts. Allow the system to reboot when finished.

Software Use and Operation

The VEC2 software is written using a standard Windows based format, with taskbar menus at the top. Clicking on the page tabs at the bottom of the window accesses individual pages. There are hot keys, such as F2 and F3, which take you directly to desired menus. A single field or item can be selected by left clicking on it, or a range by left clicking and dragging.

Section 1
VEC2 and PC Settings

1. Begin by opening the VEC2 software and setting your preferences. You can access the preference menus by clicking on “Settings”.

2. Set the VEC2 box preferences by clicking on “Box Settings”, or by pressing F2.

Fig. 1A Box Settings Menu

3. Determine the model year of the Viper the VEC2 will be running on. Gen1 are 1992-1995 RT/10 engines. Gen2 and Gen3 are 1996-2002 GTS, 1997-2002 RT/10 and 2003-2005 SRT/10's.
   With the model year determined, select the manifold pressure signal input you will be using to base your fuel and timing maps on. For naturally aspirated, you may choose to use the stock MAP sensor input to base your curves on (Analog1). For naturally aspirated or forced induction, you can also use the VEC2's 2.5 bar (30" Hg vacuum to 21 PSI boost) internal MAP sensor (Anaolg3). Note that stock Gen3 intake manifolds have no pressure port to plug into for the VEC2 internal MAP sensor, so most will use the stock MAP sensor setting.
   When you make your selection, a window may pop up alerting you that you're about to change the settings, click OK. The preferences selected will be displayed on the "General" page.

4. Also within the Box Settings menu, you may specify between setting the timing degree value in the Ignition Load or Ignition RPM table. Fuel RPM table resolution (points in the curve set every 250 or 500 RPM) and the RPM at which the #2 LED comes on (shift light) is also specified in this menu. Some of these settings will be discussed later, with more detail.

Fig.1B PC Settings Menu

5. In the settings menu, select "PC Settings", or press F3 to display the menu. Choose the COM port your computer will be using and card writer type. Generally, you will leave the Com port on COM 1 and it will only need to be changed if there is a problem communicating with a reader or the VEC2.
6. The settings summary and system information can be viewed by opening the "View" menu and selecting Setting Summary, or by pressing F12 on your keyboard.

Verify Installation of Card Driver (as applicable):

1. Plug in your Smart Card reader / writer. The serial model Micro 120, has an internal battery that will need to be charged (2 hours) by the serial port before it can be used. The Micro 100 must be plugged into both the serial port and PS2 port to operate. The USB models have no batteries and are ready to use, though your computer will need to setup the new hardware preferences before use.
2. Open the VEC 2 program. At the upper left of the software screen you will find the communication area of the screen. Select the "Card" tab if not already selected. Set the system for the type of reader you have by opening the Communication menu and clicking "Toggle between card writers" or Ctrl-T until your type of reader is displayed.

3. Click on "Find Reader". The status screen will display "Card Reader OK" when found. If the reader could not be found, check / change your Com port settings.
4. If the card reader is found, then the driver installations are complete and were successful.

Section 2
Opening An Existing Program From A Disc / Saving To A Disc

1. Click on "File, Open", then select the *.cbc file desired. Your product CD has sample files on it that were saved as "Uncoded", which can be opened without a serial number or code. If the program was saved with a specific box serial number, you must enter the box serial and encryption code numbers in the Data Protection fields on the left side of the screen. Once the correct serial number and encryption code were entered, the file can be read and the program information will be displayed on the individual pages.

2. When opening a file from disc, the file name will be displayed in the top bar of the VEC2 software screen.

3. When ready to save a file, click on “File, Save As”, then choose the name and location.
   - Be aware weather you’re saving a file as “Uncoded”, or with a specific VEC2 serial number. An “Uncoded” file can be opened without having to enter your BC codes.
   - Be aware of the Box Setting for; Fuel RPM table resolution, Ignition tables and RPM indicator light settings. **Only** these Box settings will be saved to the program you create. The model year and input settings will **not** be saved in the file (as this is a software setting) and you **must** make sure they are correct for your application before reading or writing a program (read the text below our logo on the General page).

Fig. 2 General Information Page

Section 3
Opening An Existing Program From A Coded / Uncoded Smart Card

1. Begin by clicking on the “Find Reader” button at the top left. If your card reader / writer is plugged in and driver is properly loaded, the text box will display “Card Reader OK”.

2. Insert a Smart Card into the reader and click on the “Read Card” button. If the card was Uncoded, it will be read and “Card Read OK” will be displayed in the text box. The actual program information will be displayed on the individual Ignition, Fuel, and etc. pages.

3. If the card was coded, a message will appear on the screen. Enter the box serial number and encryption code numbers in the Data Protection fields on the left side of the software screen (see Fig. 2). The BC serial number and encryption code is written at the bottom of your instructions on page 1.
   - The serial number and code from the last system opened with the software will be saved in the drop down portion of the “box serial number” field, under “Uncoded”. You can access the number by clicking on the down arrow to the right of the serial number field. You can save several box and encryption code numbers in a separate text file and access all of them by clicking on “Open code file” (save the BC number with a space in between it and the encryption code, then another box and code number on the next line down).

4. If the correct serial number and encryption code were entered, the card will be read and “Coded Card Read OK” will be displayed. The actual program information will be displayed on the individual Ignition, Fuel, and etc. pages.
   - Note that the program name in the title bar at the top of the VEC2 software screen will not change when a Smart Card is read. It will only change when a file is opened from / saved to a disc or folder within the computer.

Section 4
Writing A Program To A Smart Card

1. When you are ready to write a program to a card, make sure that the box serial number and code are correct for the VEC2 it is to be used in. The VEC2 will not accept an Uncoded Smart Card if the system is in the “Lock after upload” mode.
   - The Lock or Unlock option takes effect **after** a card is read by the VEC2. If you want to lock the VEC2 so it will only accept cards with the correct serial number and code, choose the “Lock after upload” option.
   - If you want to unlock the VEC2 so that someone may be able to make changes to the programming without using or knowing your codes, choose the “Unlock after upload” option. When you load this card, it will allow the VEC2 to read “Uncoded” cards.

2. You must make sure the Box Settings are what you want before writing a Smart Card. If the settings (read on the General page) are incorrect, the engine will not run properly. For example, you can save a program with the preferences set for a Gen1 Viper using internal MAP sensor, but open the program later with the preferences set to a Gen2 Viper using stock MAP sensor and it will not change back to Gen1 internal MAP, causing the VEC2 to run the engine incorrectly.

3. Insert a Smart Card and click on the “Write Card” button. The text box will display “Coded Card Write OK” for a card using a specific box number, or “Card Write OK” when the box serial number field displays “Uncoded”.

Section 5
Direct Connection Communication With VEC2

In the upper left area of the VEC2 program screen, there is a table labeled “Direct”. This tab allows you to connect to the VEC2 directly using a standard 9 pin serial cable.

Fig. 5 Direct Communication Menu

1. Connect the serial cable from your PC to the D-sub connector, which is plugged into the back of the master connector of the VEC2. If your computer does not have a serial connector, you can purchase a USB serial adapter from most computer stores for approximately $39 (for example, a Keyspan brand adapter, part # USA-19HS is available at CompUSA). If the system does not connect, check your computers Com port settings and the Com port settings of the Vec2 software. Some USB to serial adapters default to Com Port 5.

2. With the VEC2 powered, you can read the settings out of the VEC2 by clicking the “Read settings” button.

3. To write a program to the VEC2, click on the “Write settings” button. The dialog window will display a message when the writing is finished. A program cab be written to the VEC2 while the engine is running.

4. You can verify that the program curves in your software screen are the same as what is loaded into the VEC2 box by clicking on the “Verify” button. If the programs match, the message in the dialog box will read “verify ok”.

5. Press the info button to get information about your VEC2, such as the firmware version (top line, 5.xx), box serial number and software dataset (SC ID 10x).

Section 6
Creating A New Program – Fuel Mapping

1. When creating a new program, begin by correctly setting the Box preferences (press F2). In addition to setting the model and MAP sensor input, you have the ability to choose a fuel table resolution of every 500 RPM, or every 250 RPM. 500 RPM is common. Switching to every 250 RPM doubles the number of individual cells that must be filled.

2. Click on the Fuel table tab. Subsection tabs become available. Go to Fuel options.

Fig. 6A Fuel Options Page

3. Set your engine Rev Limit value. This is the RPM at which the VEC2 will turn the injectors off.

4. Set your base fuel calibration. This is a reference relative to the stock PCM injector output signal. The range is 0-199%. The stock PCM output pulse provides the trigger for the VEC2 injector pulse.
   - If using stock injectors, set the value to 100%.
   - If using a larger than stock injector, take the flow rate of the stock injectors (Gen1 approximately 26 lbs/hr, Gen2 approximately 30 lbs / hr) and divide it by the flow rate of the new injectors. This will give you the percentage offset needed to make the new injectors pulse at a shorter time so they match the flow of the stock ones.

5. Brands, types and sizes of injectors vary in how fast they open or close, which affects flow. Different cylinders get different amounts of air, resulting in different fuel requirements. You can make additional changes to the injector pulse to compensate for these differences, adding or taking away fuel in increments as fine as two hundredths of a millisecond.
   - Choose the “Trim same” button to set all cylinders to the same injector offset. Adjustments can be made up or down as necessary.
   - Choose the “Trim individual” button to display the individual trim adjustment available for each cylinder (shown in Fig. 5A). Adjustments can be made up or down as necessary.
   - Your first program should use an injector pulse offset of zero on all cylinders with adjustments being made when tuning.

6. Click on the Fuel Load tab. The voltage scale is the output voltage of either the VEC2 internal MAP sensor or the stock MAP sensor, depending on the preferences chosen. Each sensor has a range of 5 volts, though the internal VEC2 MAP sensor reads boost as well as vacuum. Manifold pressure is expressed in inches of Mercury for vacuum and PSI for boost under the “Inches or in_PSI” heading.

Fig. 6B Fuel Load Page, Forced Induction Example

7. With the Fuel Load table, you may create a fuel enrichment curve based on manifold pressure. The value expressed will be the injector pulse in milliseconds. **The injector milliseconds can be expressed in a positive or a negative value (i.e. 5, 0, -5)**. **A positive sign does not need to be put in front of a number to make it a positive, but a negative sign must be placed before a number to make it a negative. This value will be scaled by a percentage on the Fuel RPM page and then added to the base fuel calibration.**

8. Much like standard Windows programs, you can highlight a single field or range of fields by left clicking and dragging. The first field clicked on will show a gray highlight around it while all others selected will turn blue. Use the **Table Control buttons** to edit fields, or edit each field individually by typing in a new value using your keyboard.
   - The **+** button increases the selected field(s) by 0.2 for each click.
   - The **/** button increases the selected fields (other than the first field) by a multiplier. Each filed selected will get 0.2 more ms than the field above it.
   - The **-** button decreases the selected field(s) by 0.2 for each click.
   - The **** button decreases the selected fields (other than the first field) by a multiplier. Each filed selected will get 0.2 less ms than the field above it.
   - The **Scale %** button allows you to alter a field, or range of, by a specified percentage offset
   - The **Set value** button allows you to specify a value and set all highlighted fields to that value.

9. Fig. 5B shows a sample graph of a forced induction application, which provides for additional fuel injector pulse as engine load and boost increases (using internal MAP sensor). Fig. 5C shows a sample graph for a naturally aspirated application, allowing for more injector pulse as the engine approaches wide open throttle (0” vacuum using the stock MAP sensor). Both

graphs display a typical negative fuel value in deep vacuum, which shuts the injectors off when the engine is decelerating (eliminates backfiring in the exhaust).

Fig. 6C Fuel Load Page, Naturally Aspirated Example

10. Click on the Fuel RPM tab. You will use this page to adjust the amount of fuel enrichment based on RPM. The percentage value you specify will be a percentage of the milliseconds in the fuel load table. **The Fuel RPM percentage can be set to a positive or a negative value.** Changes can be made using the Table Control buttons.

Fig. 6D Fuel RPM, Forced Induction Example

11. Following are some examples of how the Fuel load and Fuel RPM tables interact:
    - You have 0ms at 10" of vacuum on the Fuel load page. You have 100% enrichment at 2,000RPM on your Fuel RPM page. 100% of 0 = 0. In this example, no fuel enrichment is programmed in for this vacuum condition, no matter what the RPM percentage is.
    - You have 3ms at 0" vacuum on the Fuel load page. You have 100% at 2,000 and –20% at 5,500 on the Fuel RPM page. At 0" vacuum (full throttle) you would be adding 3ms at 2,000 RPM and taking away 0.6 ms at 5,500 RPM.
    - You have a rising scale of fuel enrichment as you go into boost (Fig. 5B). You have values of 100% across the Fuel RPM scale. In this case, you would be setting your fuel enrichment directly based on boost, adding a set amount of fuel as the boost increased, regardless of RPM as you have values of 100% in the fields.

12. The net resulting value from the Fuel load and Fuel RPM tables will be added to / subtracted from the Base Fuel Calibration specified on the Fuel options page.

Fig. 6E Fuel RPM, Naturally Aspirated Example

Section 7
Creating A New Program - Spark Advance Mapping

1. When starting a new program, begin by correctly setting the system Preferences and Box Configuration. On the configuration page, you have the option of swapping the degrees and percent between ignition tables. For all examples in this section, the box configuration has been set to "Degrees in Load table, Percent in RPM Table".

2. Click on the Ignition tab, then Ignition Load. Here you may create a curve, which can change ignition timing based on manifold pressure. **The value expressed will be scaled using the Ignition RPM table, to a positive or negative (advancing or retarding timing)**. The values placed in the fields of the Ignition Load table are only expressed as positive.

3. In Fig. 6A, a forced induction example is shown, where we created a timing value curve that increases with boost. We are not specifying advance or retard at this time, only the value that can be used relative to the manifold pressure.

4. In Fig. 6B, a naturally aspirated example is shown, where we created a timing value available only at wide-open throttle. We are not specifying advance or retard at this time, only the value that can be used relative to the manifold pressure.

Fig. 7A Ignition Load, Forced Induction Example

Fig. 7B Ignition Load, Naturally Aspirated Example

5. Click on the Ignition RPM tab. Specify the percentage of the available timing value (from Ignition Load) that you want the timing to change. **This will be the change from stock ignition timing. Positive numbers advance timing and negative numbers retard timing.**

Fig. 7C Ignition RPM, Forced Induction Example

6. In Fig. 6C we show the example of a forced induction application where varying amounts of timing are being removed. As with fuel, this is a percentage of the value at a given manifold pressure specified in the Ignition Load table.

Fig. 7D Ignition RPM, Naturally Aspirated Example

7. In Fig. 6D we show the example of a naturally aspirated engine where varying amounts of timing are being added. As with fuel, this is a percentage of the value at a given manifold pressure specified in the Ignition Load table.

Section 8
Creating A New Program – PWM Output

1. Click on the PWM/Boost tab, then PWM Load. This is a programmable output from the VEC2 to a switched device. You can use it to control an injector, relay, shift light, etc.

2. Like the fuel and ignition, PWM Load and PWM RPM tables each control the PWM output, but in a different way. The pulse you will be setting a percentage of is preset at 30 milliseconds. With the PWM output, you will be setting a percentage in both the load and RPM tables. PWM is an abbreviation for Pulse Width Modulation and the output is 12V-negative.

Fig. 8A PWM Load

3. Begin by specifying the signal input you want to use in the "Base PWM Load on" field. Analog 1 is designed for the stock MAP sensor and Analog 3 is the internal MAP sensor.

4. If you choose to use the PWM output to activate a relay or switched device, check the "Run PWM as on/off switch" box. Any combined percentage above 50% between the load and RPM tables will turn on the ground output. In Fig. 8A we have set the device to turn on at approximately 2.9 PSI if the programmed RPM range is also met from Fig. 8B. A value of 50% will be met midway between 2.3 PSI (00%) and 3.4 PSI (100%).

5. To set the PWM output to control a shift light, set all the fields in the load table to 100% and set the RPM you want the light to come on at 50%.

6. To use the PWM output in conjunction with a Nitrous system, use the same input signal as you're using for fuel and ignition. You can then create parameters that when met will activate the Nitrous relay, add additional injector pulse and retard timing. See the sample NOS programs on the CD-ROM as an example.

Fig. 8B PWM RPM Table

Section 9
Creating A New Program – Analog 1 Output Limiting

1. Click on the “Analog out” tab. The purpose of this control is to limit the output voltage of a sensor to the stock PCM. It is primarily designed for forced induction applications where the stock MAP sensor would be subject to positive manifold pressure. As the engine goes into boost, this keeps the PCM from receiving a MAP sensor voltage higher than what it read at key on, which would set a check engine light.

Fig. 9A Analog Output Limiting

2. Set the maximum voltage output to the desired level. The output voltage will be 100% of the input any time the voltage is lower than the limit set. Using Fig. 9A as an example, if the voltage input from the stock MAP sensor was 3.8V, the output to the PCM would be 3.8V. If the voltage input from the stock MAP sensor were 5V, the output to the PCM would be 4.86V.

Section 10
Writing VEC2 Programs Relative To The Stock PCM Program

In order to create the proper programs, you have to understand how the VEC2 and factory PCM work together. The reason we want them to work together is because the factory PCM has been programmed fairly well by the factory to begin with. They have created tables that make changes based on coolant temperature, air temperature, barometric pressure etc. Using the VEC2 to tune with the factory PCM reference gives us the ability to correctly set the programming for all driving conditions very quickly and efficiently.

Generally, we want the engine to run just like the factory programmed it in all closed loop conditions. Closed loop is a term used to indicate that the stock PCM is monitoring the oxygen sensors and making constant changes to the injector pulse to keep the air / fuel ratio in the factory programmed range. Closed loop operating conditions are when the engine has warmed up and throttle is less than approximately 80%. When in closed loop, the PCM has the ability to make adaptive changes, increasing or decreasing fuel injector pulse automatically. Adaptives have a specified range and once the range limit is reached, a check engine light will come on for a rich or lean condition (due to an abnormally lean or rich correction factor). Long-term fuel adaptives generally have a range of 33% positive to 33% negative.

When you accelerate the engine hard, such as at full throttle, the PCM goes into what is called “open loop” mode. In open loop, input from the oxygen sensors is ignored and adaptives are locked out. There are preset curves that the factory PCM uses every time you are accelerating in open loop. The curve is only slightly altered by temperature (i.e. less timing advance with more coolant temperature).

Fig. 10, 3D Mapping View

To view the program curves created in a 3D format, click on the “View” menu, then 3D map, or press F6. Here you have the choice of viewing Fuel, Ignition and PWM curves. The graph screen can be enlarged by maximizing the window, clicking on the graph and utilizing the edit boxes to drag the graph larger. The graph can be rotated in all axis’ by pressing the Ctrl button on your keyboard, pressing your left mouse button, then moving the mouse around.

Fuel

Generally, the stock PCM injector pulse is too low in the lower RPM range when at full throttle, until approximately 4,000 RPM. This curve can be viewed by recording a full throttle pull on a stock Viper. You will see in both the PCM injector output and the actual air / fuel ratio graphs that the engine is too lean at low RPM / full throttle. You can correct the factory fuel curve in the Fuel RPM table, by adding a greater amount of fuel pulse in the lower RPM area.

Conversely, the factory injector pulse is typically too long (rich) in the upper RPM range. This is corrected by reducing the percentage used in the upper RPM area of the Fuel RPM table.

For reference, the factory PCM injector output values at full throttle are approximately:
1996-2002: 13ms at 1,500 RPM, 16ms at 2,500 RPM, 19ms at 3,500 RPM, 21ms at 4,500 RPM and 21 ms at 5,500 RPM. Typical idle injector pulse (from the stock PCM) is 5ms to 6ms.
All 1992-2004 Viper PCM's have a similar fuel curve at wide open throttle, too lean at low RPM and too rich in the upper RPM.

Ignition Timing

As with the fuel, we want the engine to predominately use the factory program for most driving conditions (closed loop). Like fuel, the factory PCM spark advance curve has areas where improvements can be made while in open loop.

For reference, the factory PCM spark advance values at full throttle are approximately:

- **1992-1995 RT/10:** 26 degrees at 2,000 RPM, 28 degrees at 2,500 RPM, 28 degrees at 3,000 RPM, 26 degrees at 3,500 RPM, 24 degrees at 4,000 RPM, 25 degrees at 4,500 RPM, 29 degrees at 5,000 RPM and 30 degrees at 6,000 RPM.
- **1996-2002 GTS, 1997-2002 RT/10:** 24 degrees at 2,000 RPM, 29 degrees at 2,500 RPM, 28 degrees at 3,000 RPM, 25 degrees at 3,500 RPM, 22 degrees at 4,000 RPM, 22 degrees at 4,500 RPM, 25 degrees at 5,000 RPM and 31 degrees at 6,000 RPM.
- **2003-2004 Viper & Ram SRT:** 21 degrees at 2,000 RPM, 22 degrees at 2,500 RPM, 20 degrees at 3,000 RPM, 19 degrees at 3,500 RPM, 19 degrees at 4,000 RPM, 21 degrees at 4,500 RPM, 26 degrees at 5,000 RPM and 31 degrees at 6,000 RPM.

Typical cruise spark advance is approximately 45 degrees and idle varies between 4 and 14 degrees.

Section11

Sample Programs

On the CD-Rom is a folder named "Sample_Files". Copy this folder to your desktop. It contains sample programs that you can use as a baseline. The programs are written with the factory PCM program curves taken into account. You will find folders for different applications. In each folder, there is a text document with program descriptions.

Section 12

Tuning Overview

When tuning, there are several factors that work together to produce proper engine running and maximum power. This section is not meant to replace the many books on engine tuning and the years of experience most professionals have. Rather, it is a guide based on our experience.

The VEC2 system and software has no "safeguard" settings. There is an opportunity to dial an engine in, as well as dial it out. We strongly suggest you save all your programs with names that imply what they do. If you dial your engine out of tune, simply slide in a previous program burned onto a Smart Card.

Special tools may be required for fine-tuning, such as a scan tool and A/F ratio logging system. These items are readily available through Roe Racing and other suppliers (most dyno's have A/F ratio monitoring equipment).

Ignition timing and fuel delivery work together. A change in one has an impact on the other. For example, an area at full throttle where the A/F ratio may be too rich may indicate too little spark advance rather than too much fuel pulse (lighting the fuel later does not allow as much of it to

burn in the combustion chamber, hence there is more unburned fuel in the exhaust). In an area like this, you may either reduce fuel injector pulse or increase spark advance.
Increasing the spark advance will generally increase the power as more fuel is burned and its energy is released in the combustion chamber. The fuel octane and cylinder pressure are usually the determining factors of how far you can increase the spark advance before pre-ignition / detonation occurs. Higher-octane fuel is harder to ignite, so it can generally take more spark advance. Other factors, such as piston construction should also be taken into consideration.

When tuning on a forced induction engine, transitions from vacuum to boost play an important role in vehicle drivability. In the case of a positive displacement Supercharger, boost can come on very fast and at a low RPM. The factory PCM was not originally programmed for such engine load changes so quickly. This means that we must go deeper into the engine vacuum table when making our spark advance and fuel calibrations, in order to "stay ahead of" the factory PCM referenced curves.

Section 13

Tuning – Fuel

In regard to the air / fuel ratio, there are different optimal settings for different applications and loads. At low load cruise, most engines prefer a 14.7:1 air / fuel ratio. Under load, a naturally aspirated engine may perform best at 12.9:1, while a forced induction application can range from 11.5:1 to 12.5:1 depending on the air charge temperature (sometimes fuel is used to cool the air).

Regarding temperature, the VEC2 itself has no temperature input. It uses the offsets of the stock PCM to compensate for temperature. The stock PCM has been properly programmed at the factory to decrease its injector pulse output (which the VEC2 references) as air temperature increases / density decreases. However, for forced induction, you may want to make different boost enrichment programs if the vehicle is used in a wide range of temperatures (for example, the program for 40 degrees F may have 5% more enrichment than the program for 100 degrees F).

There is a finite time available to inject fuel into a cylinder while the intake valve is open. Generally, you have 20ms of injector pulse time available at 6,000 RPM. At half the RPM (3,000), you would have twice the amount of time available (40 ms available at 3,000 RPM). To determine the time available for other RPM's, simply follow this example for determining the pulse available for 5,000 RPM:
6,000 divided by 5,000 = 1.2, 1.2 x 20ms = 24ms (available injector pulse width at 5,000 rpm).

To determine how long you are pulsing an injector at a given RPM, use the factory injector pulse reference we provide on page 17 to get your base figure (let's use 19ms at 3,500 RPM). Follow along with the example below:

1. Multiply 19ms by the base fuel calibration from the Fuel Options page. Let's use a forced induction example with 50 lb/hr injectors using 61% of the stock pulse. 61% of 19ms = 11.6ms. This is the baseline VEC2 injector output.
2. Go to the Fuel Load page and choose a manifold pressure that has additional pulse programmed in. Lets use a manifold pressure of 5.7 PSI with an enrichment of 4.6ms available.
3. Go to the Fuel RPM page and get the enrichment percentage you have programmed in at 3,500 RPM. In this example we will use 111%. Take the value from the Fuel load page and multiply it by the fuel RPM percentage. 4.6ms X 111% = 5.1 ms. This is the amount of additional injector pulse being added on top of the base fuel calibration.
4. Add the enrichment pulse to the base calculation and you get the total time the current program is pulsing the injector.

19ms X 61% = 11.6ms.   4.6ms X 111% = 51 ms. 11.6ms + 5.1ms = 16.7ms total injector pulse.

There is a term called "duty cycle", which refers to how long an injector is pulsed relative to the amount of time available. If you pulsed an injector 20ms at an engine RPM of 6,000, you would be at 100% duty cycle. If you pulsed the same injector 20ms at 3,000 engine RPM, you would be at 50% duty cycle. If you need to inject more fuel than the time available, you will need larger injectors as their spray can produce greater volume in the same amount of time.

Section 14
Tuning – Timing

When setting up the spark advance curves, there are many factors that are involved. The compression ratio, fuel octane, camshaft profile, cylinder head design, etc. must all be considered. The factory timing curve at full throttle is outlined in section 10.

Generally, there is considerable power to be gained by optimizing the spark advance. However, you can get spark knock if you ignite the fuel too early, which can cause damage to the engine. We suggest starting cautiously on your first new programs, using close to the stock timing curve to begin with under naturally aspirated conditions. If the engine has forced induction or Nitrous Oxide, you will want to start by reducing the timing advance under boost / NOS use.

To determine the spark advance at a given RPM, use the timing pulse reference we provide on page 17 to get your base figure (let's use 32 degrees at 6,000 RPM). Follow along with the example below:

1. Go to the Ignition Load page and choose a manifold pressure that has a timing value other than 0. Lets use a manifold pressure of 9 PSI with a timing change value of 9 degrees available.
2. Go to the Ignition RPM page and get the percentage change you have programmed in at 6,000 RPM. In this example we will use -100%. Take the value from the Ignition load page and multiply it by the Ignition RPM percentage. 9 degrees X -100% = -9.0 degrees retard. This is the amount the timing is being changed from stock (retarding 9 degrees in this example as we specified a – sign in front of the Ignition RPM percentage).
3. Subtract the timing change from the stock timing to get the actual delivered spark advance.

9 degrees X -100% = -9 degrees   32 degrees –9 degrees = 21 degrees total spark advance.

Section 15
Tuning – Putting It All Together

The first things we generally do when tuning is to make sure PCM long-term fuel trim adaptives are correct. The main reason we start with checking the long-term adaptives is to ensure that we have the correct base calibration and offset when using larger injectors. For a stock injector application, this is not as important. Getting the adaptive values close to zero means we have the engine running properly in closed loop and have the full range of adaptive capability to use.

To check adaptives, you will have to link a scan tool program to the factory PCM. Start the engine and monitor the PCM long-term adaptives (actively adjusting 2 minutes and 30 seconds after engine start up).

- If the PCM adaptives are negative on B1 (left bank) or B2 (right bank), the PCM is reducing fuel injector pulse. Go to the Fuel options table and begin reducing the injector offset.
- If the adaptives are positive, the PCM is adding fuel. Begin increasing the injector offset
- If necessary, click on the trim individual option and make adjustments to the left and right banks independently.

The goal is to achieve a zero (0) long-term adaptive figure at idle.

Once the adaptives are correct, we rev the engine, quickly accelerating it to a mid RPM range (about 3,500 RPM). This helps us determine how close we are on the transition from vacuum to acceleration. If The A/F ratio is too lean, the engine will backfire in the intake manifold. If the engine is too rich, it will backfire in the exhaust. Use the sample programs we provide as a reference to determine enrichment curves in the fuel load table. Make changes if necessary.

At this point you are ready to drive the car or put it on the dyno. You'll want to drive it in normal vacuum conditions, making sure it's running properly at cruise first. If you have an A/F ratio gauge or monitor, make sure the engine is running in the normal 14.7-15.5:1 range (cycling back and forth). If all is well, lightly accelerate a few brief times. The PCM adaptives may begin to make minor changes and the engine will run smoother with each throttle application. Note how the engine accelerates. If it is anything other than smooth, add or decrease fuel in you Fuel load and Fuel RPM curves accordingly.
The next step is to do a short full throttle pull. We usually do a pull up to about 4,000 RPM on a new program. If the air / fuel ratios are in the acceptable range, we continue with another pull to about 5,000 RPM.

Now is the time to begin looking at making tuning adjustments in the high load part of your program. If the A/F ratio needs minor adjustment, begin by increasing or decreasing the percentages accordingly in the Fuel RPM table. If the A/F ratio is very far off, you may need to make adjustments to your Fuel load table also. Generally, you can gauge the adjustment you need to make based on how far off the actual A/F ratio is from the desired ratio. If the ratio is 13.5:1 and you want it to be 12.5:1, start by adding about 8% to the applicable RPM area. This is done quickly by highlighting the field(s) where the change is to be made and using the table control buttons to scale the area by 108%. Continue tuning until the A/F ratio is at the desired levels.

During the time you are fine tuning you're A/F ratio, you can begin setting the timing advance change from stock. If the engine is naturally aspirated and you have sufficient fuel octane, you can begin increasing timing advance. Improvements can generally be made where the factory timing is low. If you increase advance in an area and ignite the fuel earlier, you will probably need to add fuel as well. There will be an optimum spark advance for each RPM. Advancing earlier that what is optimum can result in no further gain or spark knock.

If the engine you're tuning has forced induction, you'll create a timing curve that has more retard in the areas where the factory timing curve was more advanced. Where the factory timing is already low, the amount of timing change may be less. This can result in Ignition RPM graphs that swing up and down quite a bit. However, the actual delivered spark advance curve may be quite flat.

If the A/F ratio and timing close to correct, but finer adjustments are needed in the fuel curve, you may switch your Fuel table resolution to every 250 RPM in the Box Configuration menu. Changing to 250 RPM resolution doubles the number of cells in the Fuel RPM table. If a program was written in 500 RPM increments and you change the mode to 250 RPM, **only half of the entire table will be filled and you will need to rearrange and fill the fields accordingly** (a value at 5,000 RPM now becomes the value at 2,500 RPM). The opposite is true when changing from a 250 RPM table to a 500 RPM (your value at 4,000 RPM now becomes your value at 8,000 RPM).

When tuning is complete, the engine should run as stock in all conditions except full throttle. At full throttle, you will have optimized you're A/F ratio and spark advance, increasing torque and horsepower.

For troubleshooting, general questions, comments or assistance, you may contact us at:
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