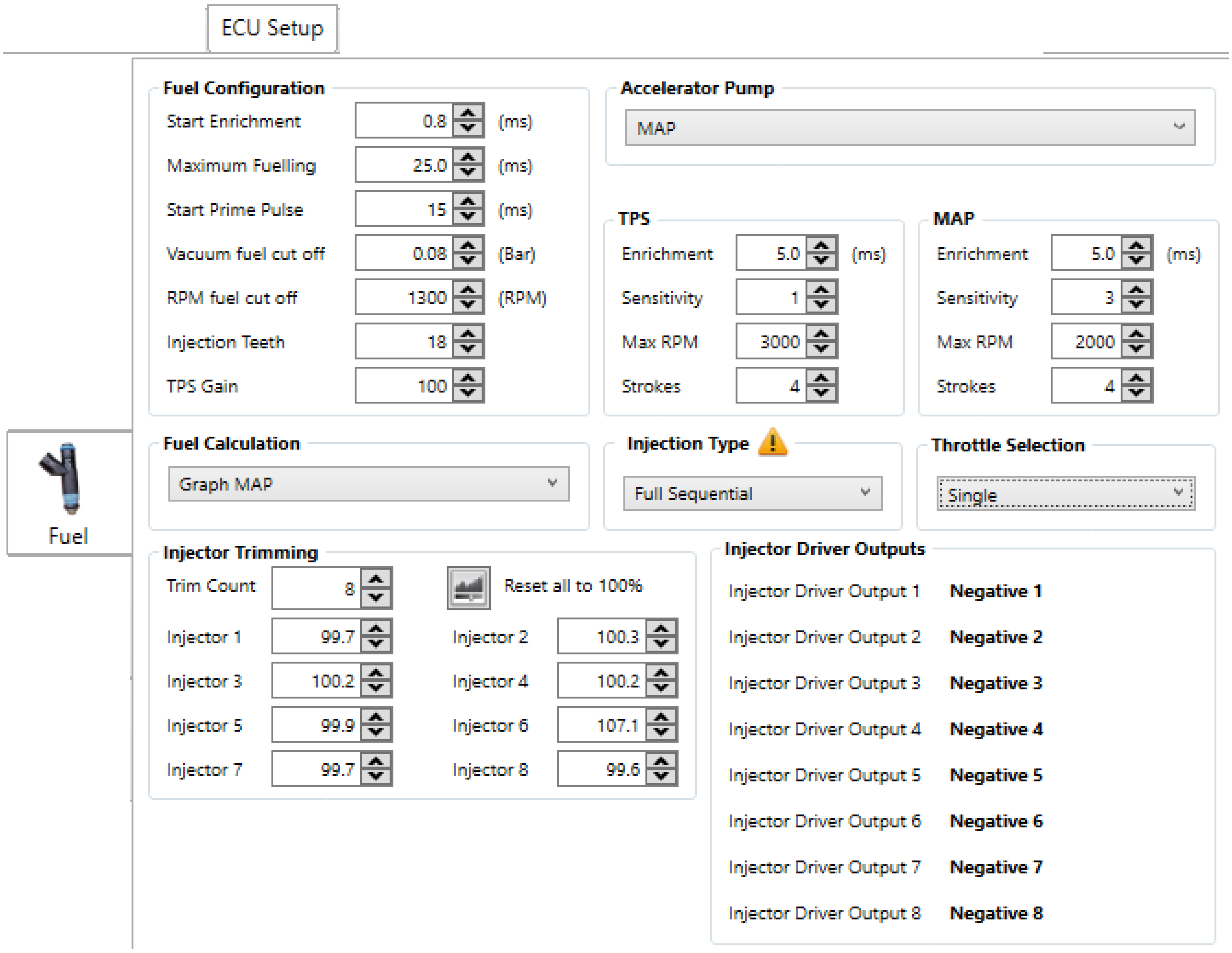
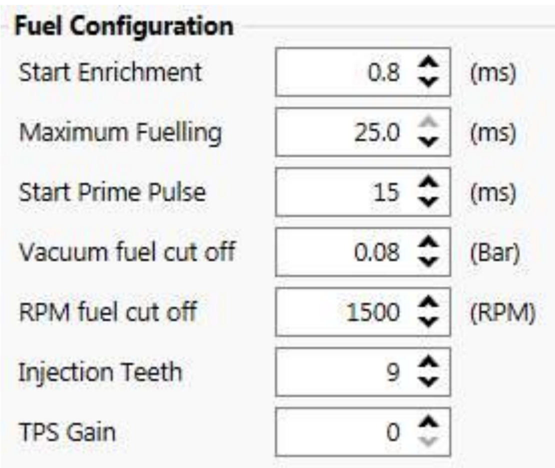
Fuel Settings



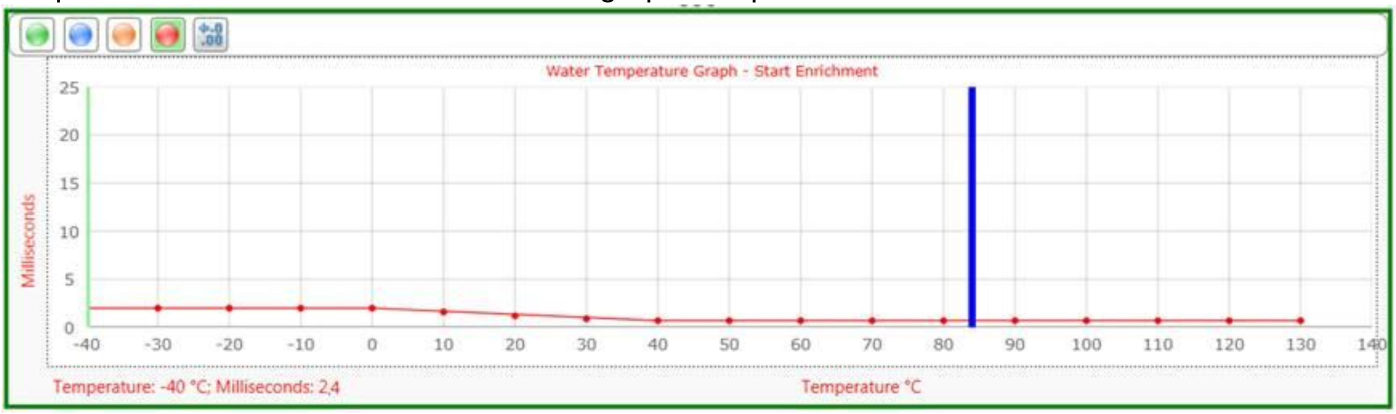
Note that in your product and application some settings may not be visible or adjustable. This is the offline image on that page which will show all the settings available for training purposes. Below is a detailed explanation of each section.

Fuel Configuration



Start Enrichment

This value will help an engine to stabilize after starting. This amount will be added to the injector time after the engine is started and reaches 500 RPM. It will then be phased out in a couple of revolutions. This value is also compensated with the water temperature %, and is not active in Expert mode. Then the Water Temperature graph is used. The value is set in milliseconds. In **Expert** mode this value for Start Enrichment will be blanked out and the graph value for that temperature interval will be used. See the graph sample below.

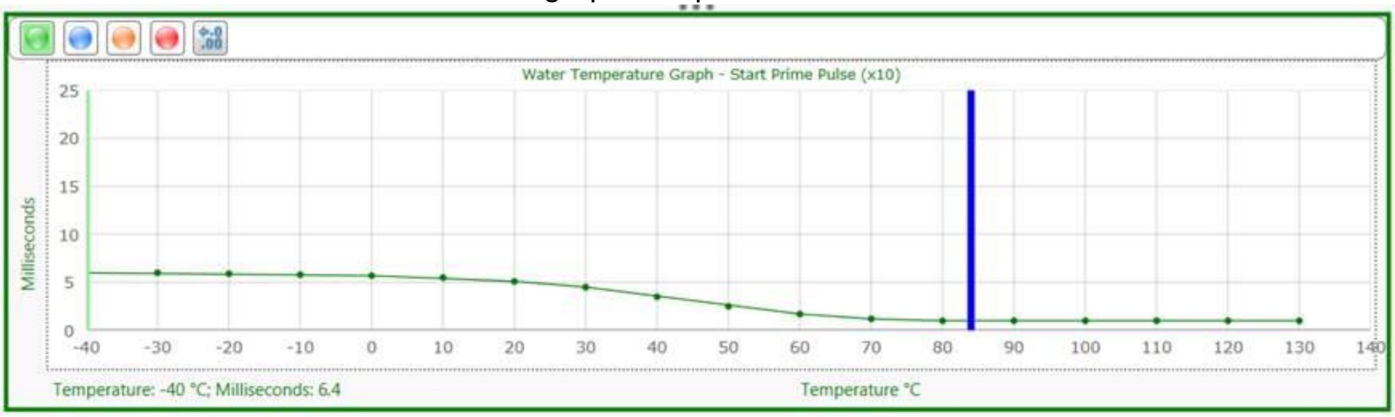


Maximum fueling

This setting is to protect against over fueling from all the graphs with accelerator pumps etc. It will limit the final injection time to this value if it is higher. This value can be calculated as the time it takes 1 revolution for 2-stroke engines, or 2 revolutions for 4-stroke engines. The calculation for 4 stroke engines at 7000RPM is seconds=60 * 2 / Max RPM=120/7000 = 0.017 = 17 milliseconds. For a 2 stroke it at 7000RPM is seconds=60 / Max RPM = 60/7000 = 0.085 = 8.5 milliseconds. The recommended injector time is 85% of that value which results in 14 and 7 milliseconds respectably. If your duty cycle of the injectors at full load max RPM reaches over 85% you may have to go for larger injectors or increase the fuel pressure to maximum safe pressures. On the Fuel Matrix this will also prevents the tuner from selecting higher values there. This value is set in milliseconds.

Start prime pulse

This setting is to assist in the starting of the engine. When the engine starts to crank and reaches 100 RPM a set amount of fuel is injected on all the injectors to get the first one with spark to ignite and turn the engine. A colder engine requires more initial fuel to start. This value is also compensated with the water temperature and is not active in Expert mode. Then the Water Temperature graph takes over this value. In **Expert** mode this value for Start Prime pulse will be blanked out and the graph value for that temperature interval will be used. Note that this value is x10 so 6.4 is 64 milliseconds. See the graph sample below.



The Spitronics ECU's have a manual prime function where you can press the accelerator pedal before starting to inject fuel in the system. This fuel is measured at 50% of the start prime pulse setting. It is injected each time the throttle is pressed more than 25 % opening.

Should the engine be flooded, you may keep the pedal fully pressed to the floor during cranking. This will indicate the ECU to cut injectors and only provide spark. Press the throttle in all the way before putting the ignition on. It will prevent the prime pulse from injecting more fuel when the pedal is pressed. Once the engine starts release the pedal and then injection will commence as normal.

Vacuum fuel cut off & RPM fuel cut off

This feature is useful in town and downhill driving and will save fuel. It will let the engine run against compression as you are decelerating. It will also prevent flaming in the exhaust during accelerator blip. Injectors will be cut when the MAP sensor value is below the vacuum setting and the engine RPM is above the RPM setting. There is a dead band feature built into these settings to prevent jerking when cruising close to the parameters. If you feel a jerk when the feature is activated or deactivated, adjust these settings till it changes over smoothly. This is normally where the change from positive to negative drive on the prop shaft is.

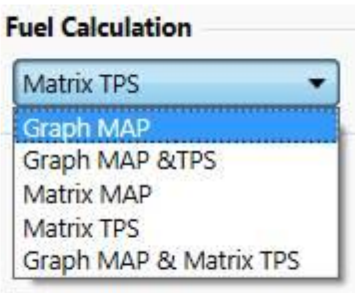
Injection teeth

This feature adjusts the start injection degrees. It is only available on gear type triggers as low as 12 teeth per revolution. Normal injection timing starts just after the intake valve closes. The warm valve helps atomizing the fuel and makes the engine use less fuel. Put the engine on the degrees where you want to start injection. Count the number of teeth from the slot or missing teeth in the gear, in an anti-clockwise direction, to the sensor. If the pickup is in the slot imagine the tooth there and count it as well. Even if it is 60. The firmware will move injection in the slot to the closest teeth as this is not as critical as spark timing. You may change this value during tuning to see if you get better atomization and performance increase. Usually this is best seen at idle. Find the spot where it runs rich and make idling leaner. Start with low teeth and move to larger numbers to see when the valve closes. It will go rich at that point.

TPS Gain

This setting will adjust the rate at which the TPS sensor will move the MAP bar to the right of the graph during Graph Map + TPS calculation mode. This will simulate a MAP signal and the gain adjustment will produce the right amount of fuel during pull-off. (For further details see the tuning section).

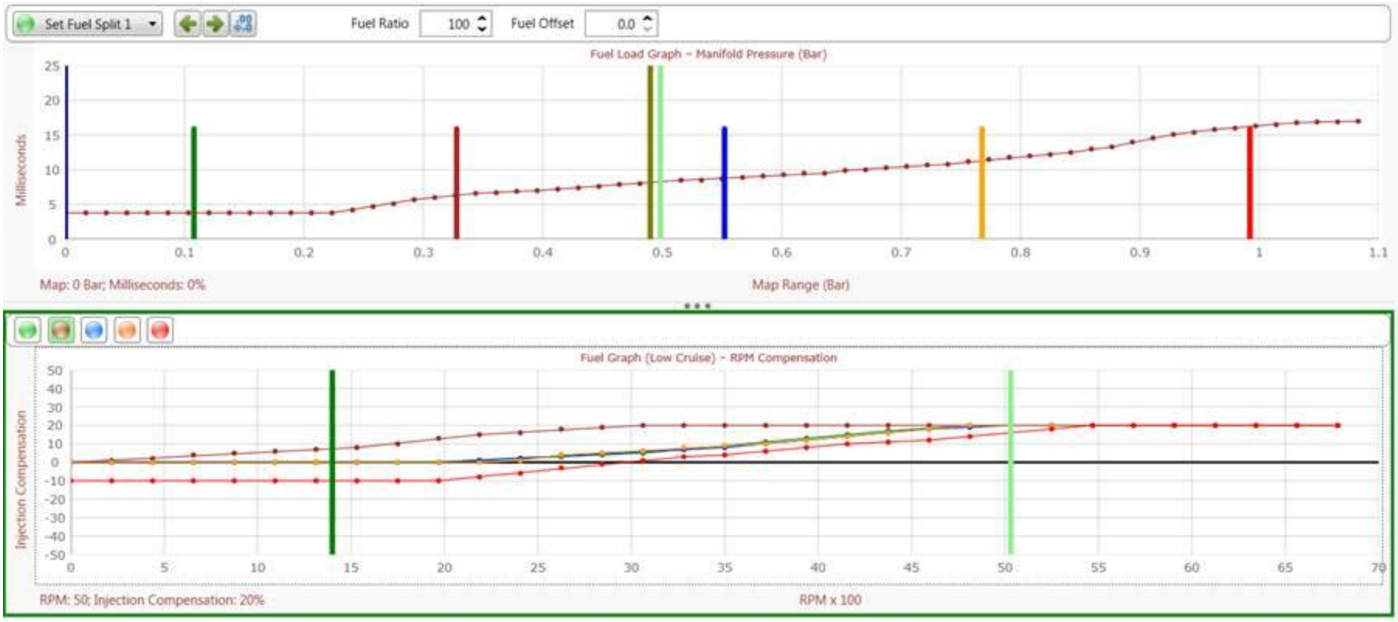
Fuel Calculation



This block will allow the tuner to choose different options to set up timing for this engine. Each of these methods will be discussed in detail under the tuning chapter further in the manual. You can see the ***Tuning*** section for detailed description on the tuning side.

Graph MAP

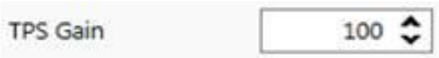
This is for standard engines with a good vacuum signal and allow for easy tuning in the street.



Graph MAP+TPS

This method is used for engines with a poor vacuum signal at low RPM's and it still allows for easy tuning in the street. The ECU will use the TPS signal to calculate a MAP signal at low RPM's when there is no or little vacuum. It is used for engines where the vacuum signal is correct and above 1500RPM's. The graphs are the same as above with the addition of the following settings:

When the RPM's are below the RPM fuel cut off, then TPS idle is activated. The Vacuum Fuel Cut off setting then becomes the minimum manifold pressure value to start off from.

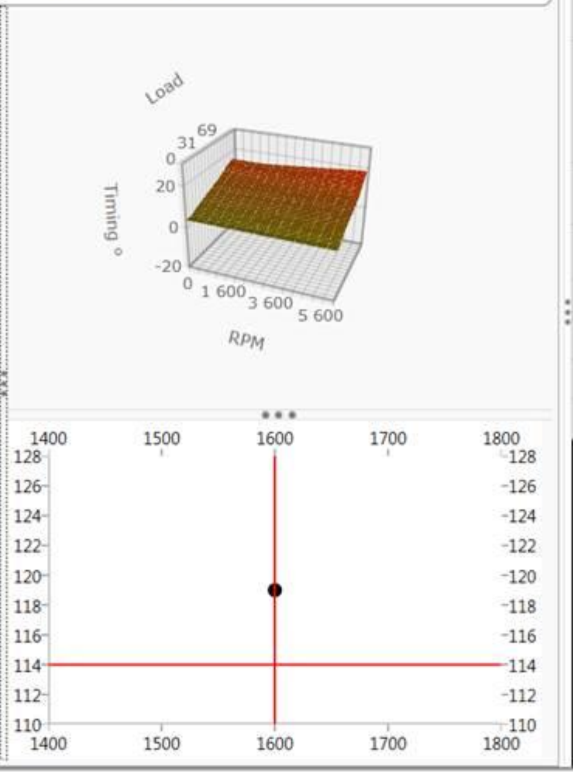


The TPS gain value will use the TPS signal to calculate a projected vacuum signal on the graph. When the actual vacuum is below the calculated vacuum then the ECU will use the lowest vacuum signal of the 2. Once RPM's is above the RPM fuel cut off, then TPS idle is de-activated.

Matrix MAP

RPM Increment 400 — Fuel Load Matrix (ms) – MAP vs RPM — Fuel Ratio 100

	0	400	800	1200	1600	2000	2400	2800	3200	3600	4000	4400	4800	5200	5600	6000
1.1	15.7	15.7	15.7	15.7	15.7	16.1	16.5	16.9	17.3	17.7	18.1	18.5	18.9	19.3	19.8	19.9
1.03	15	15	15	15	15	15.3	15.6	15.9	16.2	16.5	16.8	17.1	17.4	17.7	18	18.1
0.95	14.3	14.3	14.3	14.3	14.3	14.5	14.7	14.9	15.1	15.3	15.5	15.7	15.9	16.1	16.3	16.4
0.88	12.7	12.7	12.7	12.7	12.7	13.1	13.3	13.6	13.5	13.8	13.9	14.1	14.2	14.3	14.4	14.6
0.81	11.8	11.8	11.8	11.8	11.8	11.9	12	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9
0.73	10.7	10.7	10.7	10.7	10.7	10.8	10.9	11	11.1	11.2	11.3	11.4	11.5	11.6	11.7	11.8
0.66	9.9	9.9	9.9	9.9	9.9	10	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	10.9	11
0.59	9.1	9.1	9.1	9.1	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.9	10	10.1	10.2
0.51	8.4	8.4	8.4	8.4	8.4	8.5	8.6	8.7	8.8	8.9	9	9.1	9.2	9.3	9.4	9.5
0.44	7.5	7.5	7.5	7.5	7.5	7.6	7.7	7.8	7.9	8	8.1	8.2	8.3	8.4	8.5	8.6
0.37	6.7	6.7	6.7	6.7	6.7	6.8	6.9	7	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8
0.29	5.7	5.7	5.7	5.7	5.7	5.8	5.9	6	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8
0.22	4.5	4.5	4.5	4.5	4.5	4.6	4.7	4.8	4.9	5	5.1	5.2	5.3	5.4	5.4	5.4
0.15	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.9	3.9	4	4	4.1	4.1	4.2	4.2
0.07	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
0.00	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8

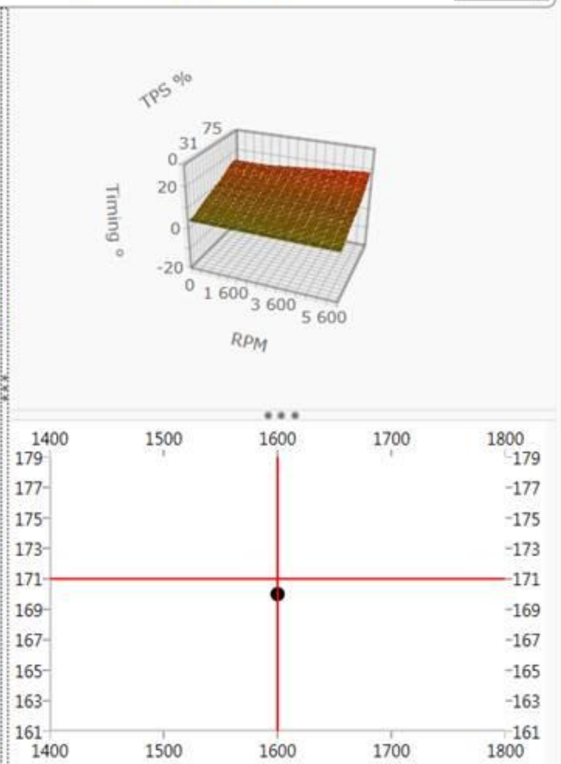


This is for standard engines with a good vacuum signal and allows for easy dyno tuning. Here the MAP sensor versus RPM is used and the blocks are set in 0.1 milliseconds resolution.

Matrix TPS

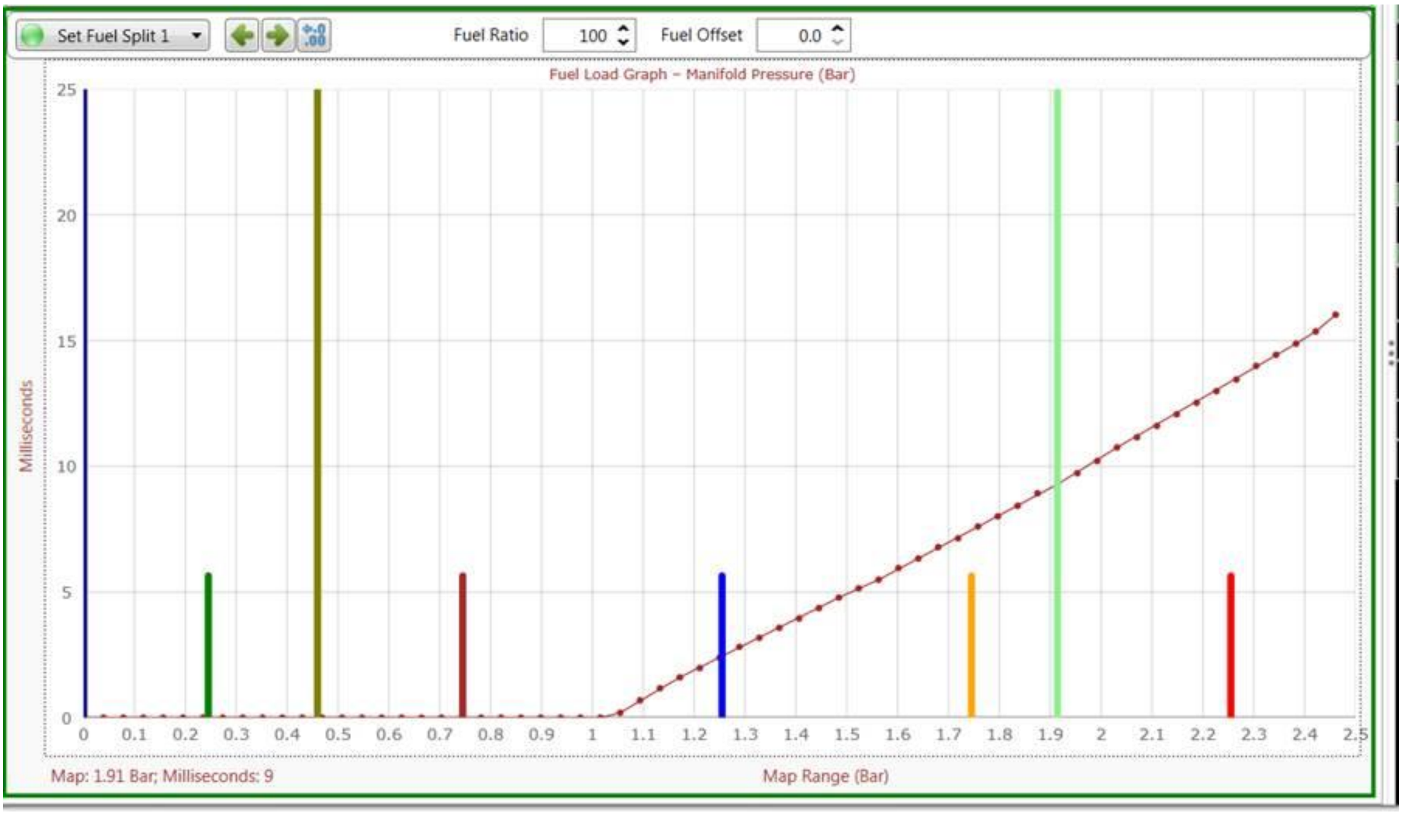
RPM Increment 400 — Fuel Load Matrix (ms) - TPS vs RPM — Fuel Ratio 100

	0	400	800	1200	1600	2000	2400	2800	3200	3600	4000	4400	4800	5200	5600	6000
100	15.7	15.7	15.7	15.7	15.7	16.1	16.5	16.9	17.3	17.7	18.1	18.5	18.9	19.3	19.8	19.9
93	15	15	15	15	15	15.3	15.6	15.9	16.2	16.5	16.8	17.1	17.4	17.7	18	18.1
87	14.3	14.3	14.3	14.3	14.3	14.5	14.7	14.9	15.1	15.3	15.5	15.7	15.9	16.1	16.3	16.4
80	12.7	12.7	12.7	12.7	12.7	13.1	13.3	13.6	13.5	13.8	13.9	14.1	14.2	14.3	14.4	14.6
73	11.8	11.8	11.8	11.8	11.8	11.9	12	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9
67	10.7	10.7	10.7	10.7	10.7	10.8	10.9	11	11.1	11.2	11.3	11.4	11.5	11.6	11.7	11.8
60	9.9	9.9	9.9	9.9	9.9	10	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	10.9	11
53	9.1	9.1	9.1	9.1	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.9	10	10.1	10.2
47	8.4	8.4	8.4	8.4	8.4	8.5	8.6	8.7	8.8	8.9	9	9.1	9.2	9.3	9.4	9.5
40	7.5	7.5	7.5	7.5	7.5	7.6	7.7	7.8	7.9	8	8.1	8.2	8.3	8.4	8.5	8.6
33	6.7	6.7	6.7	6.7	6.7	6.8	6.9	7	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8
27	5.7	5.7	5.7	5.7	5.7	5.8	5.9	6	6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8
20	4.5	4.5	4.5	4.5	4.5	4.6	4.7	4.8	4.9	5	5.1	5.2	5.3	5.4	5.4	5.4
13	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.9	3.9	4	4	4.1	4.1	4.2	4.2
7	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
0.00	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8



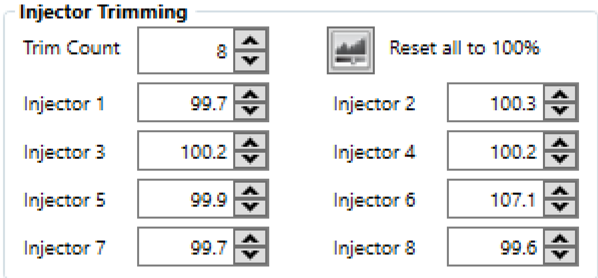
This is for normal aspirated engines with poor vacuum signal or throttle bodies and allows for easy dyno tuning. Note: It is recommended to add the altitude sensor to compensate for altitude pressure changes. TPS versus RPM does not compensate for pressure changes. Here the TPS sensor versus RPM is used and the blocks are set in 0.1 milliseconds resolution.

Graph MAP + Matrix TPS



The Matrix is the same as TPS Matrix above. This is for turbo racing engines with a good or poor vacuum signal and allows for easy dyno tuning. Note: It is recommended to add the altitude sensor to compensate for altitude pressure changes in the TPS matrix. Here the normal aspirated tuning is done on the matrix and the boost tuning is done on one Fuel Load graph. It will become visible in this mode. Here the TPS sensor versus RPM is used on the matrix and the blocks are set in 0.1 milliseconds resolution. Then Map sensor is used to modify fuel under boost. Notice how there is no fuel if there is no boost. This fuel is calculated as % boost compensation.

Injector Trim



This feature allows the tuner to trim each injector individually for the ultimate performance. This is done by individual Lambda or EGT sensor on the exhaust runner to measure individual air fuel ratios. It is only selected Mercury2 firmware that has this feature.

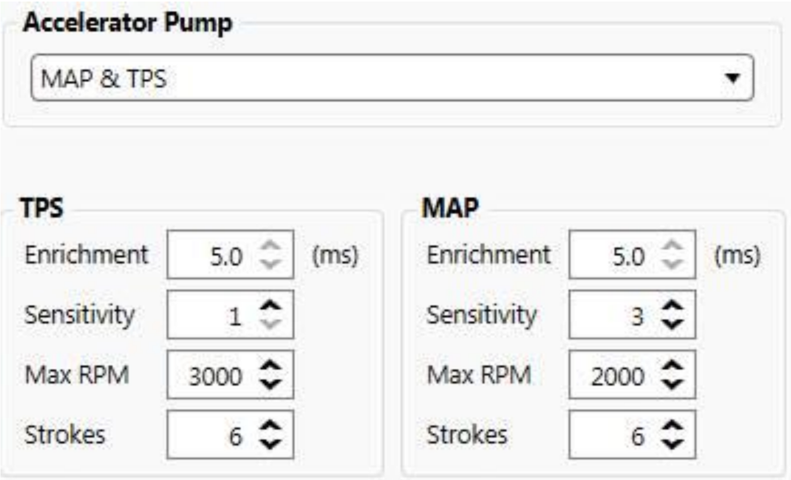
Trim Count

This is the number of drivers selected by the tuner. The Mercury2 has 8 injector drivers and can work full sequential for 8 cylinders. At can also run duel injectors full sequential for 4 cylinder engines. A setting of zero will disable this feature.

These tuning blocks allow the tuner to adjust the register from 90.0 to 110.0 % for each cylinder. Adjustments can be made in 0.5 % resolutions.

This block is to clear all the registers to 100.0 % to start with. First tune the engine is as good as possible, then do minor changes here to calibrate the injectors. A tip is to use the middle average of the injectors ant tune to that. Example if the injectors differ by 10 % between high and low. Then use the middle vale and some will be 5% high and some 5% low.

Accelerator pump tuning

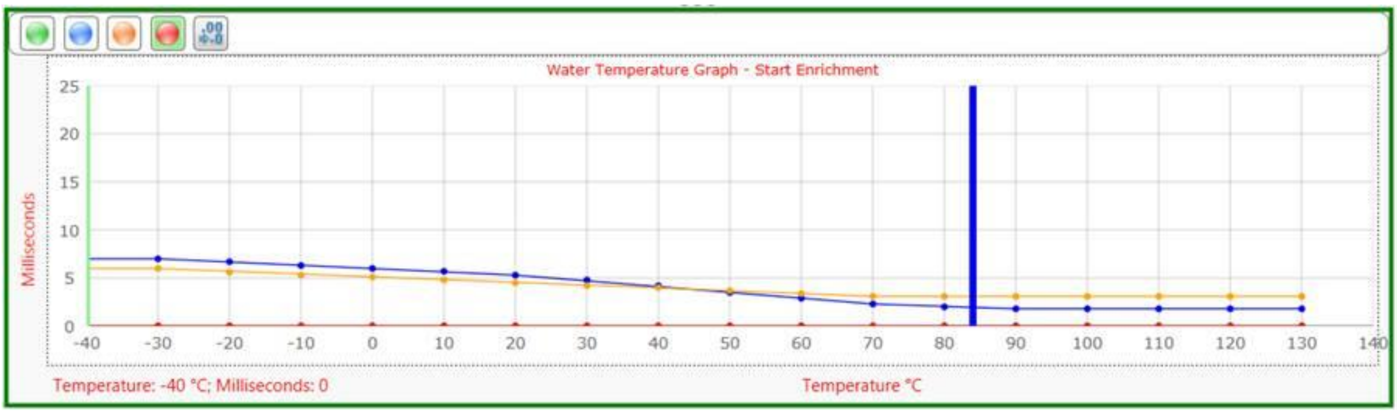


Accelerator pump selection

The accelerator pump setting is used to richen the fuel mixture when accelerating to avoid flat spots or bog. Here you can select not to use it, use either the TPS or MAP or both signals. Below is the selections to setup each pump for TPS and MAP.

Enrichment %

This is the amount of fuel that will be added momentarily when the accelerator pump is activated. This value is divided by the number of strokes and each stroke the value is reduced by the division value. It will start with 10 and reduce to zero so that fuel is gradually reduced. This value is also compensated with the water temperature graph value. In **Expert** mode this value for MAP and TPS will be blanked out and the graph value for that temperature interval will be used. See the graph sample below.



Sensitivity

The activation sensitivity can be adjusted from 1 to 10. The lower the value, the more sensitive the accelerator pump will be. If the accelerator pump is set too sensitive it will activate randomly and cause the vehicle to over fuel. Rather keep the activation sensitivity as high as possible to avoid this from happening. For the TPS signal this value can be lower as it is more stable than MAP value and it reacts faster.

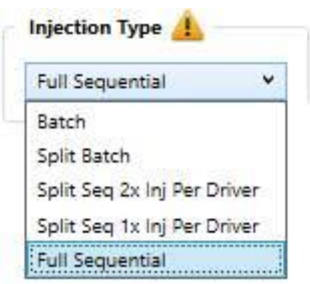
Max RPM

This is the maximum RPM that the pump settings will be active. At high RPM you do not need an accelerator pump. A standard is 1500 to 3000 RPM for TPS and 1500 to 2200 RPM for MAP. If a value was initiated before this limit was reached it will finish the decay cycle.

Strokes

This is the number of engine strokes that the fuel must be applied to and then decayed over the amount of cycles. If it is a 4 cylinder engine, a value 0f 8 will inject 4 full revolutions of fuel. There are two firing strokes per revolution. If it was a 6 cylinder engine, a value 0f 12 will inject 4 full revolutions of fuel. Always tune for the lowest value to eliminate flat spots. If a value of example 10 is selected it means that the enrichment amount will be decayed by a tenth every cycle till the tenth stroke.

Injection Type



This setting will allow different methods of fuel injection. The firmware in the ECU will blank out the methods that are not adjustable. In some firmware a refresh will be forced to reshuffle GP outputs or cancel an illegal setting.

Batch Injection

This method all the injectors are pulse at the same time. It is not good practice as the cylinders does not get the fuel under the same conditions or injection angle, and is poor on power and economy. Spitronics programs does not use the feature unless for specific tasks.

Split Batch Injection

This method will pulse two sets of injectors 180° apart from each other. It is used where the trigger has even pulses and no cam signal is present. It is used on the standard systems where budget is of importance. For a 4 cylinder, the injectors are paired so that each cylinder gets fuel under the same condition or injection angle.

<u>Split Sequential Injection</u>

This method will pulse two injectors per driver together for the two cylinders that move at the same crank degrees. It will follow the sequence of the firing order. There may be 2 to 6 drivers in the sequence. The injector will pulse once per revolution and the injection time on the software will be divided in two. With other words for each revolution only half the calculated fuel is injected. This method does not require a home pulse and is the popular choice. There is very little difference in power and economy to a full sequential system.

<u>Full Sequential Injection</u>

This method will pulse one injector per driver in the same sequence as the firing order. The injector will pulse once every two revolutions and it will inject all the fuel in one squirt. Here a cam pulse or home signal is required to sink the injectors with a certain stroke one the engine. If there is no home pulse it will still do full sequential injection, but stroke phasing may vary from start to start. Note that an engine is normally started in split sequential mode and then goes over to full sequential after 500 rpm is reached. This helps for faster starting. This feature is mostly for ECU's with enough drivers for injectors. make sure if firmware is available for your application before you buy.

<u>Throttle Selection</u>

This setting is developed to use a MAP signal on multiple throttle body engines. The problem with them is there is no intake plenum where the vacuum could be measured. The vacuum signal only makes a spike when the valve opens. This spike is also there only once in two RPM's on a four stroke engine. This makes it important to read the signal on crank degrees when the vacuum signal is present. This setting is only available for gear type triggers as low as 12 teeth.

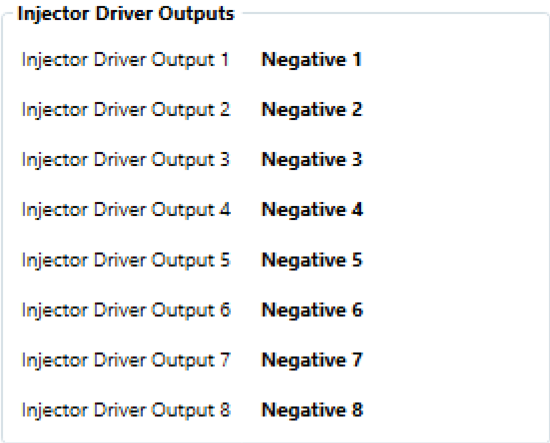
<u>Single</u>

Most engines have one throttle and an intake plenum where a map sensor is used. The map signal is read 2 or 3 times per revolution. It makes for a fast vacuum signal response. The map teeth can still be adjusted here as there is a small amount of pulsation in the intake plenum.

<u>Multiple</u>

To use this method a crank gear of min 12 teeth is required. The MAP sensor is only connected to cylinder 1 or the cylinder that shares the crank degrees on movement. With this feature the MAP sensor is read once per two RPM's when the vacuum signal is present. This makes for a slow response that may cause flat spots during blip. This however can be cured with the accelerator settings. One requirement is that the throttles are properly balanced as only one's vacuum is measured. The map teeth setting here is very important. When the engine idles it is adjusted to read the best vacuum. The more teeth on the crank gear the finer adjustment could be made to find the sweet spot. This sweet spot on the vacuum signal is around 90° after TDC. For a 36-1 gear 90° would be 9 teeth.

Injector Driver Outputs



This is only an indication block. It will indicate to the installer which outputs are used for the injector connections. This connections is not firing order but merely a sequence in which the injectors will be pulsed. Use the correct injector drawing for your product and application to determine the injection sequence.

Injectors Hardware

This folder contains all combinations of wiring options for injectors on the Mercury2. These drawings are made for the high end harness and may differ in wire colours to other harnesses. Consult your harness layout further in the manual. The main choices are, no of phases, low or high impedance, single or dual injectors per cylinder and the type of injection namely Batch, Split-sequential or Full sequential injection. Each folder contains its different variations for your engine. Note that the drawings are generic and you have to fill in your own firing order to see which wire colour goes to which injector. Print the document and write on it before you begin. Also note that combinations included in this manual may or may not be available for the hardware class.

See the sub folders for drawings.

Fuel Injector explanations

The fuel injector outputs drive the fuel injectors to allow measured amounts of fuel into the engine. These signals are on/off control signals that are varied by duty cycle. The more fuel is required the higher the duty cycle will be. The injectors are connected to common positive and the drive signals from the ECU is ground signals.

Operation
The injectors are solenoid valves that are opened by current to let fuel pass through the nozzle. The nozzle has a spray pattern that will help in atomizing the fuel with air. This in turn will make a combustible mixture.

Injection types

Batch Injection
With this method, injector drivers are being pulsed at the same time once or twice per revolution. Very rare firmware from Spitronics, although not preferred, can use this method. However, fuel metering and timing is done very accurately and should still give excellent results. Split the injectors in groups to divide the current evenly between the available driver outputs. For bigger engines keep the mean supply current below the current capability of the drivers of that product. (See specifications.) **Note**: More outputs are available in the intermediate and advance units. (See specific wiring diagram.) The biggest disadvantage with this method is the fuel pressure pulses due to uneven tapping. Advantage is easy wiring.

Split Batch Injection
With this method, two injector drivers are being pulsed 180° out of faze. Although not preferred, fuel metering and timing is done very accurately and should give excellent results. Split the injectors in two groups to divide the current on the 2 driver outputs. Put alternate numbers on the firing order together to ensure a more even fuel distribution. For bigger engines keep the mean supply current below the current capability of the drivers of that product. **Note**: More outputs are available in the intermediate and advance units. (See specific wiring diagram.)

Split Sequential Injection
This method will inject on the two cylinders that move up and down together simultaneously and then in sequence on the other cylinders at the same position. Injecting once per revolution and will start at BDC or it may be adjusted otherwise. Fuel is injected very accurately and excellent CO adjustments can be achieved. The advantage of this method is that each cylinder receives its fuel under the same conditions, resulting in very smooth idling and revving. It is definitely better on power and consumption than the batch injection method. Injectors are wired in the same sequence as wasted spark. The fuel is distributed more evenly from the fuel pump and pulsing of fuel pressure comes to a minimum. The ECU only requires half the amount of drivers than cylinders on the engine. (See driver selection chart on how to combine these injectors.)

Full Sequential Injection
With this method each injector requires a driver. Fuel is injected once in 2 revolutions and normally starts at Bottom Deck Centre (BDC). Note: This feature is mainly for engines up to 8 cylinders.

Disadvantage is that this method does require the Cam or home pulse to sink injection with fazes and low impedance injectors require a ballast resistor. Advantages are better fueling at lower RPM and longer duty cycle makes for more accurate measuring on large injectors. If you don't have a home pulse it can still do full sequential injection but injection is not slinked on stroke. In these cases, start injection degrees can be set at BTDC just after the intake valve closes. (See wiring diagram on how to combine the injection methods.)

Throttle Body Injection

With this method, injectors are situated at the throttle body. The first generation injection systems used this method. It is important to inject in the right sequence especially on the 4 barrel systems. Some injectors are aimed at certain ports and must be pulsed in sequence to get a smooth distribution of the fuel mixture. (See specific wiring diagram to ensure the correct injectors are on the correct drivers.) Advantage of this method is easy to convert carburetor engines to fuel injection.

Micro Fueling or Dual Injectors

The ECU allows for the use of dual injectors per cylinder to be used. This has the advantage for turbo and duel fuel applications. If the power range of an engine is very big, one injector is too small at maximum load or too large to control at minimum load. Then the ECU will use 1 injector for light loads and 2 for high loads. The second injector could also be phased in with a different fuel mix for racing. Wiring is done in two ways depending on how many drivers are available on the ECU. Some may require an electronic relay to power the second set. (See wiring methods in the sub folders.)

Injector Sizing

Sizing example: 5 cc fuel is required for every 1 HP. This means that an 8 cylinder 600 HP requires 600 HP x 5 cc / 8 injectors = 375 cc/min. This is assumed at Lambda 1.00 (14.7 AFR) so if you are running richer, the desired Lambda reading needs to be taken into account. This calculation is based on information from the internet and should be researched with other manufacturers. It is merely as an example.

Resistance & Current

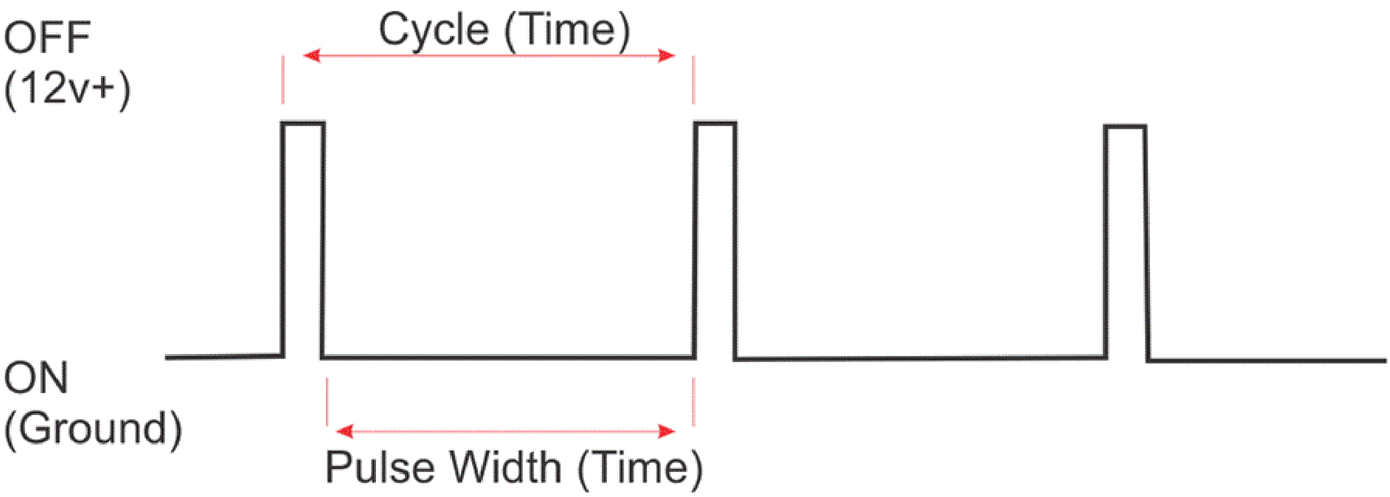
Different injectors have different resistance from 0.5 ohms to 16 ohms. This means that they require different operating currents and wiring circuits to open them. The Spitronics ECU's were designed for high impedance injectors. They draw 1 Amp each and can be connected together on the drivers in parallel. (See specifications on how much current the drivers can handle between the different products.) Low impedance, 3 to 5 ohm injectors, require current limited drivers to peak and hold drivers. With a minor wiring difference, the ECU's can do low impedance injectors connected in series. They draw 4 Amp each but in series they draw 2 Amp. Again, see the specifications on the ratings of the ECU's. If you want to do full sequential you need to add a 3.3 Ohm 10 Watt resistor in series to limit the current. Injectors with lower resistances like direct injection drivers cannot be used with the ECU's.

Dead Time

Dead time is the amount of time the injector takes to open from when the injector pulse starts. This varies with battery voltage and fuel pressure. Also varies between different kinds of injectors but is usually about 1 milliseconds or less at 14 volts. This dead time needs to be accounted for with Battery Voltage Compensation. But it is tuned in when the engine is mapped on the Dyno or street.

Spray Patterns

Some injectors have better spray patterns and atomize the fuel better than others. Injector position can dictate what type of spray pattern is required**.** Cycle, Duty Cycle and Pulse Width



$$\text{Duty Cycle} = \frac{\text{Pulse Width}}{\text{Cycle}} \times 100\%$$

A fuel injector is continuously powered by battery positive. The ECU output switch to ground to turn the injector 'on'.

Frequency: Number of complete cycles in one second, measured in Hertz. 1 Hz = 1 cycle/second. It is engine RPM / 60.

Cycle: Time from when an injector is turned 'on' until the next time it is turned 'on'.

Pulse Width: The time in seconds the injector is 'on'.

Duty Cycle: Percentage of time the injector is 'on' in one cycle.

Most injector ratings are to be used within 85% duty cycle. You may get more fuel through with higher fuel pressure but stay within the working limits of the injector.