TxW Throttle by Wire Controller

This chapter explains all the drawings instructions and tuning around TxW Management. View the sub folders for different sections.

Precautions / Disclaimer

This product is very critical in a vehicles controls and could cause accidents and death or injury. Spitronics carry no responsibility in this regard as it is a DIY product that is installed by third parties. If you are an installer then read the instructions carefully and communicate the fact that it is used at your/his own risk, to the customer. Strictly abide by the wiring ruses as this may cause accidental opening. It is your responsibility as an installer and make the customer sign a disclaimer should something go wrong.

Introduction

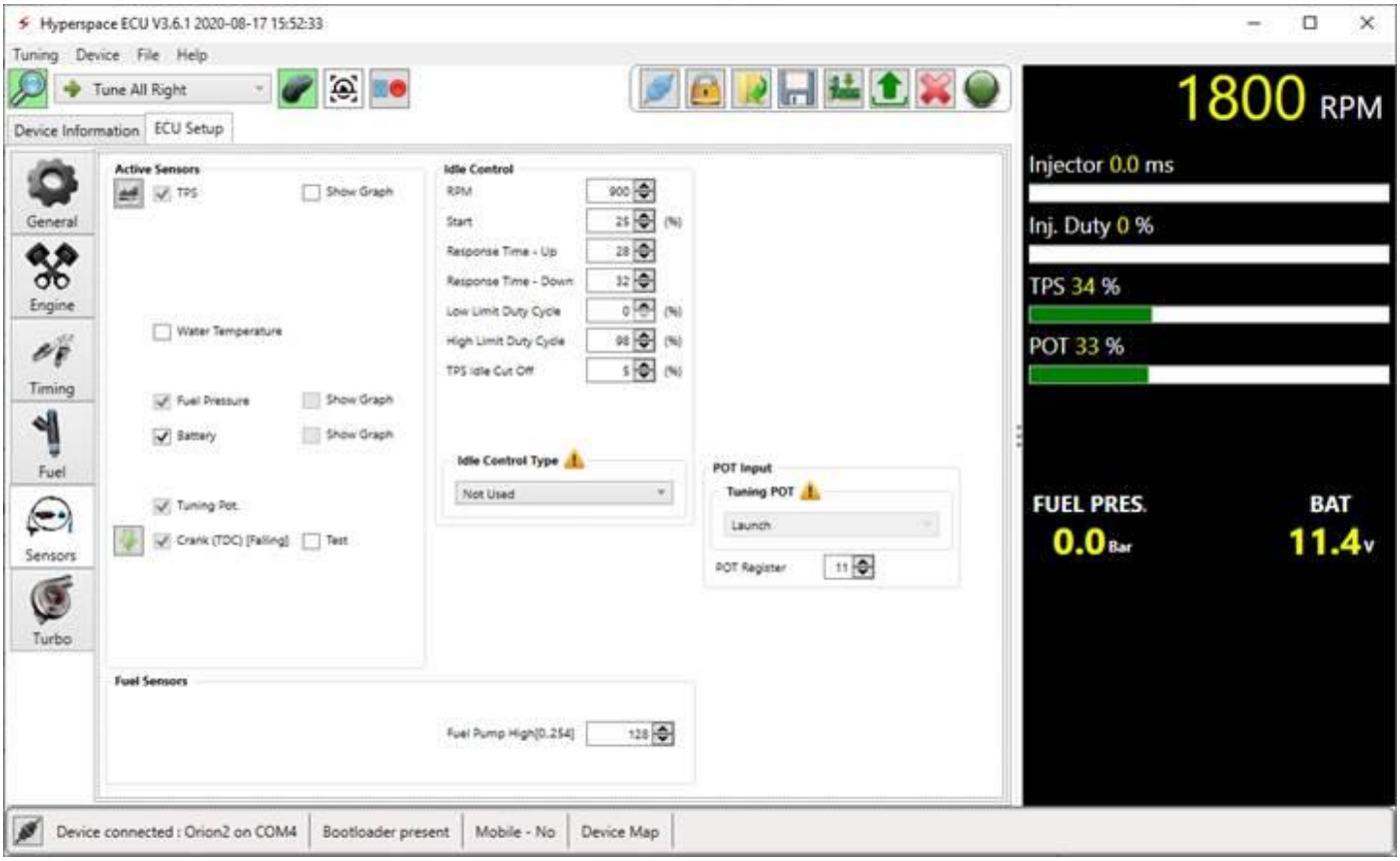
The Mercury2 or Orion2 can be used as throttle by wire controller. It can be used for single acting throttles or dual acting throttles. Dual acting throttles require positive and negative drivers to form an H-bridge. This will allow current to change direction to open or close the butterfly. Dual throttles have a rest position that is partially open to act as limp mode power during electronic failure. This product is in prototype status and use the Hyperspace ECU Ver 3.6 software for now. Dedicated TxW software will follow soon.

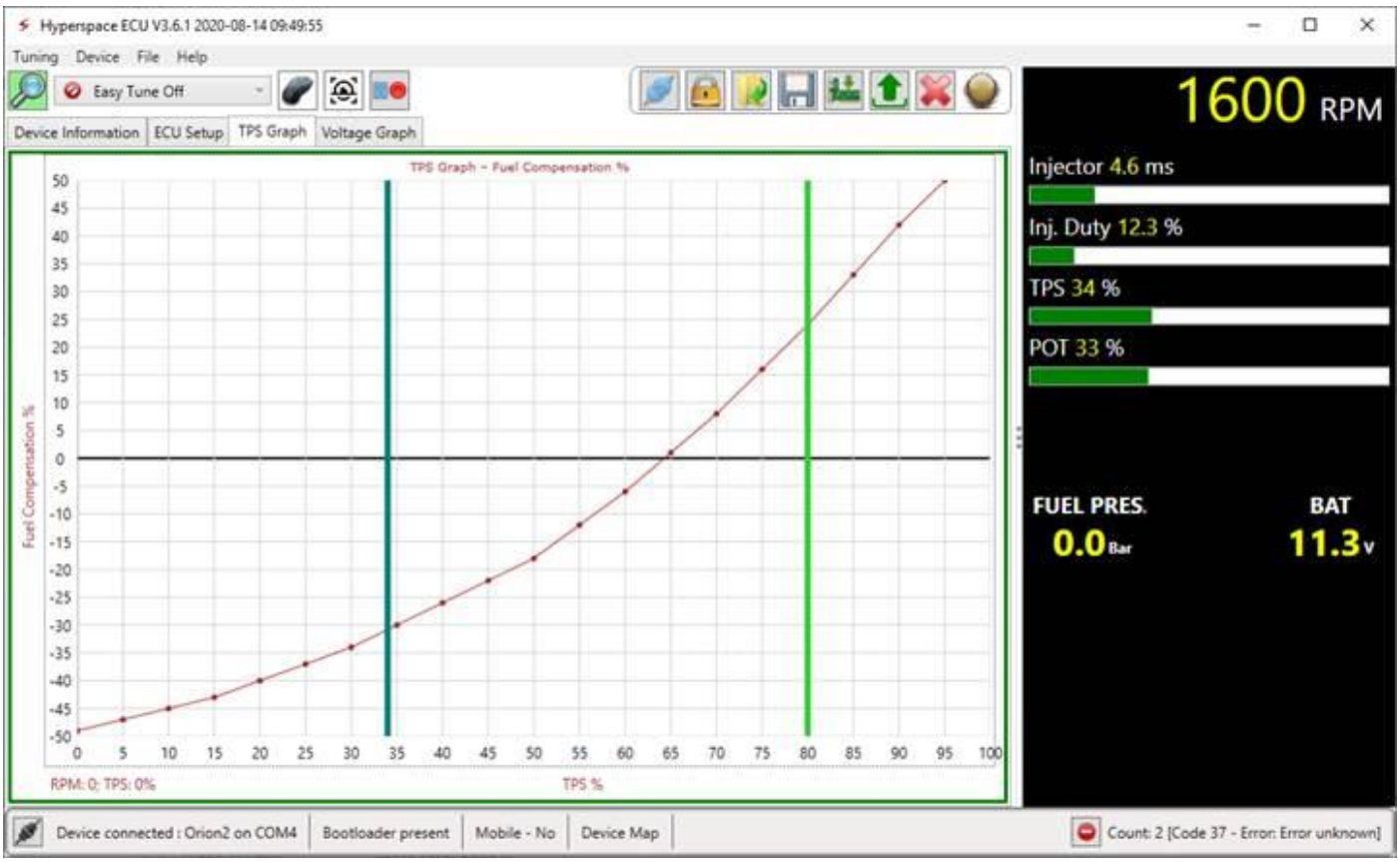
These units are standalone units and can operate without the engine running. It may also be used with other management systems. There are protection diodes and resistors wired into the harness. It also has its own relay to power the throttle. These modifications is to ensure lockout of the power to the throttle during malfunction of the sensors, harness or electronics. Do not power the unit via another source by bypassing the relay etc.

TxW Software Description

This TxW software use the current Hyperspace ECU Ver 3.6 software. It uses certain blocks in the ECU software that may not have the correct terminology. Blocks that is not relevant is blanked out to prevent confusion. Dedicated TxW software will follow soon which will address this problem. The amount of products sold is still too low to justify the development cost. This way we can do the product at a low cost. So please bear with us.

There is information, setup, and graph screens. Please read the sub folders for more information on this software. Below are the sample screens.





Firmware File Name

Mercury2 TXW Combo 1 Ver 3.6B 27_03_2021.HEX
Orion2 Combo 1 Ver 3.6A 12_08_2020.OTfirm

The dates may differ but Ver 3.6B if discussed here in this manual.

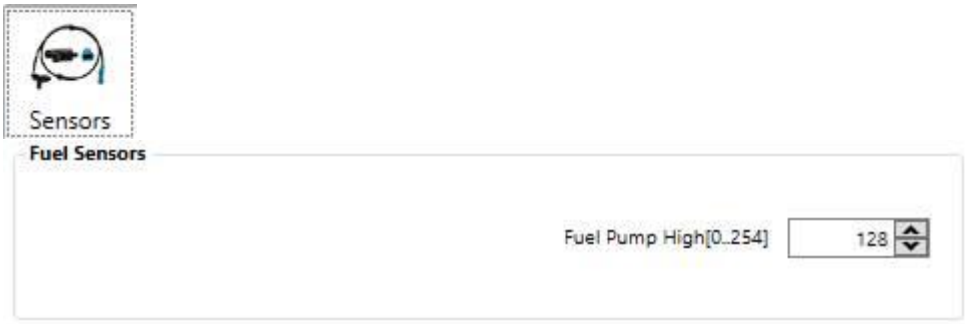
Pedal and Throttle Test

This step is will allow you to test the Pedal and Throttle TPS operation. It also determines the maximum power allowed on the throttle motor. Most throttles have plastic gears and will be damaged if too much power is applied to them. The butterfly may also hit the barrel too hard causing damage that can lead to a sticky throttle body. The throttle TPS calibration are done automatically by the TxW which means you do not have to open it up to see if it is working correctly.

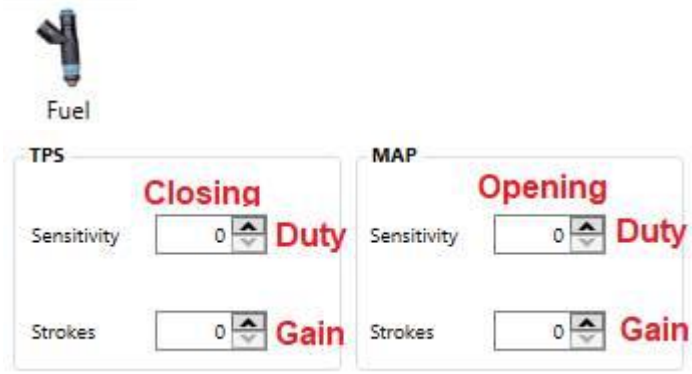
NB! Do not attempt to calibrate the TPS before this procedure is done.

First set the following values before proceeding:

Under the Sensors tab, use the fuel pressure block to set the maximum power allowed to the motor in duty cycle PWM. On the Fuel Pump High, set a safe value of 128 which is 50% power. A value of 254 = 100% Power. This value may be changed later in the program to less or higher values.



Now go to the fuel pages and set the ACC values to Zero. This represents opening and closing PWM or Duty Signals and then Gain or Proportional settings.

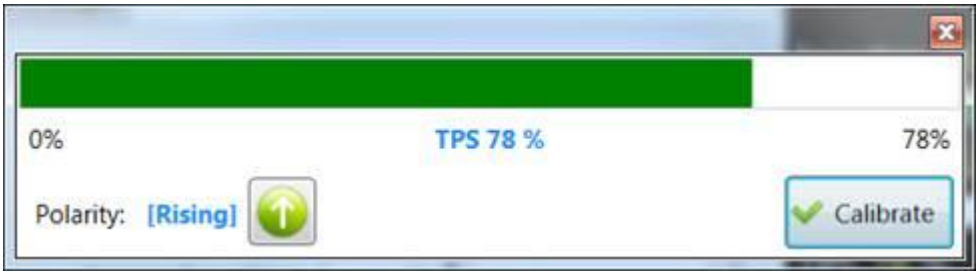


Now go to the Sensors page and set the Check the Crank Test signal to On. This will deactivate throttle control and calibration, and will display the actual values of the Pedal TPS and the Throttle TPS on the real-time bars. The Throttle TPS is displayed on the POT bar and the Pedal TPS is displayed on the TPS bar. On simulators it may use different potentiometers as we use different inputs on the TxW.

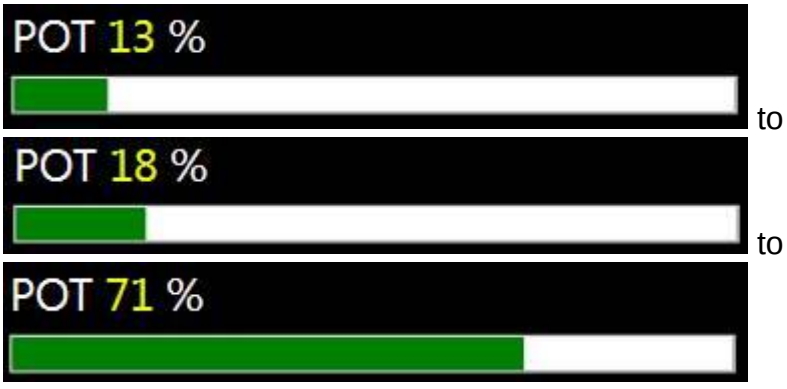
NB! Disconnect your engine ECU outputs as this setup requires the pedal to be moved plenty of times which will activate the prime function and inject petrol into the intake manifold.

To test the Pedal TPS look at the real time display and press the pedal fully and then release it again. The TPS bar should move a fair distance in the display but should not reach maximum or minimum limit. If it does, then use the other signal on the Pedal TPS, or adjust the sensor inside so that it has free play. See min and max example below.

Also note if the action is inverted. This will help setup the pedal logic on rising- or falling edge later during calibration. The standard setup is rising volts with throttle depression. It may be an incorrect connection of the 5 volt and ground wires which may be swopped around. Below is the calibration tab when it is opened to indicate rising edge.



To test the throttle TPS for correct operation you need to manually press the throttle open and close. This must be done by finger or soft plastic so that you don't damage the butterfly or tube. First press it close, then leave it at rest point, then open it fully. The POT bar should move a fair distance in the display but should not reach maximum or minimum limit. If it does, then use the other signal on the throttle TPS or adjust the sensor inside so that it has free play. You should see some results like below:

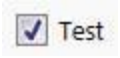


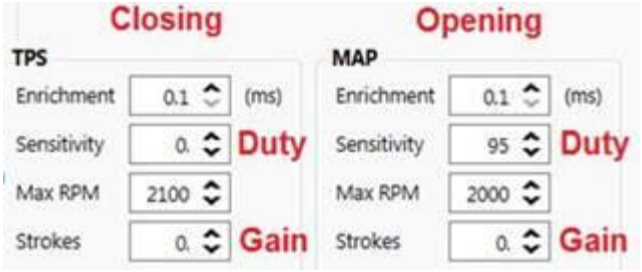
Also note if the action is inverted. It must be rising in value with increase of throttle. If it is falling volts with opening, then it may be incorrect connection of the 5 volt and ground wires.

Note. If you can't get to the throttle to test the TPS then you can skip to the next step and open it from the TxW side and see if it functions correct. You will only be able to see the rest and open position.

to

Determine Maximum Duty cycle.

Make sure Test is on.  Now adjust the Opening Duty with the arrow and increase it gradually till the throttle opens.



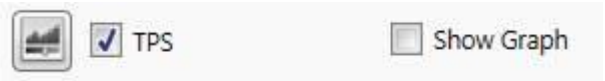
Look carefully at the throttle TPS on the POT bar. Adjust it ill it reaches the maximum determined in the previous test which was 71%. If you could not do the previous test, then adjust it till you don't see any more increase in throttle movement on the POT bar. Adjust it lower again till you can see throttle movement so that you don't have too much power on it. Then slightly up so that you can assure maximum opening.

Now put the Test off.  If you put Test back on, then the throttle will open again. It may be slow to react as it gets just enough power to its motor. Now increase the Opening Duty more and testing throttle response every time you alternate the Test function. Do this till the throttle responds just fast enough without making the value more than is needed. You should hear it reaching its full open limit but not too hard. If you make the duty more, then you may risk damaging the plastic gears. If it is too slow then it may respond sluggish in blip conditions. If this value increase more than 128 then you may need to increase the Fuel Pump High value.

Now take this Opening Duty value and type it in the High Limit Duty Cycle block. This will prevent the TxW to ever exceed this amount of power to the unit.

Now put the Test function off and proceed with the next Step.

Pedal TPS



The TPS selection is forced on. The electronic pedal signal is wired to the TPS input so that the calibration feature and TPS graph can be utilised. This signal is only connected to the TxW and it must not be used for the ECU etc. It is an indication to the firmware what the driver requires and it could be modified in relation to actual throttle movement. This mean the

pedal could be 50% depression but the actual throttle opening could be 35%. This will have the ECU reacting on false information regarding throttle opening.

 Calibration of the TPS.

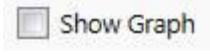
Once wiring and connections are done, and the ***maximum duty power in previous step*** is set, then you may proceed to calibration. Click on the calibrate tab next to the TPS signal and then on the Calibrate tab in the calibration window.

Calibration is done by stepping on the pedal and releasing it. The min and max values will be populated in two positions in the calibration window.

Now press the Save button and the Orion2 will do an automatic calibration of the throttle. It will open the throttle completely and take a reading. Then close it completely and take another reading. Then switch power off and take a reading of the rest position. It happens in half second intervals but you should see the action as it happens. The throttle TPS is now also calibrated but the throttle control power still needs to be setup. This is described further in the manual. If you are not sure on TPS calibration, then see the ECU manual for calibration procedure.

Click on the Map save button to save your calibration values at this stage.

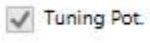
 or CTRL S



Show graph is used for pedal profile change and is discussed in another sub folder.

Throttle TPS

The Throttle TPS input is wired on the MAP sensor input of Orion2. It will relay the actual throttle position to the TxW controller. This signal is also connected to the ECU and TCU as a TPS input. In some cases, the ECU may supply the power to the throttle TPS, and in other cases it may be the TxW that supply the power of 5 volts. Do not connect both supplies together as it may damage some of the devices. The other systems must tap in to the TPS signal only. Note that systems that share sensors requires the same earth connection to ensure signal accuracy.



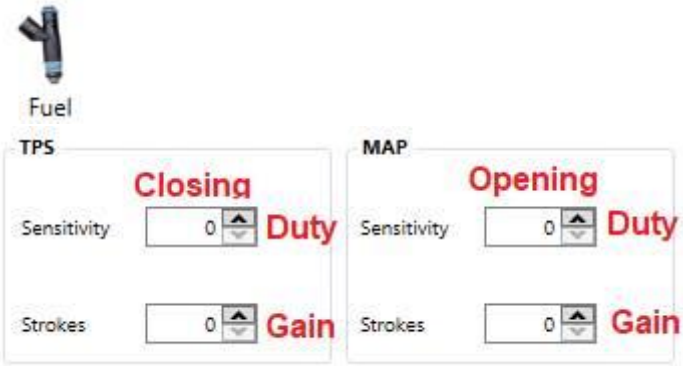
The Tuning Pot input is forced On and selected on launch. The POT register is used as a Dashpot damper in % throttle opening. When the throttle is blipped it will dampen the return to let the engine return to idle more gradually. This is very useful with automatic transmissions to prevent stalling. If the Pedal TPS value is greater than TPS idle cutoff, and revs is 500 rpm more than target RPM, then the throttle minimum opening is set to this POT Register %. When the pedal is release below TPS idle cutoff, then the throttle will be momentarily stopped at this opening and then returned slowly. Start with a small value and blip the throttle. See the effect of dampening at a slighter higher than idle RPM.

Throttle Setup.

After TPS calibration you need to set the throttle control parameters. This is done manually because throttles differ in power requirements. Some use more power to open than others and this is universal firmware to cater for most variations. There may be some throttles that cannot be controlled by this firmware but we will determine that in this process.

The throttle TPS range limits are calculated by the device automatically during Pedal TPS calibration. This setup procedure will determine opening and closing power required to control the throttle gently. It differs between different throttle manufacturers and must be adjusted for each type. If you load a map from a similar throttle then it should be working.

The Accelerator Pump in the ECU software is used for the throttle adjustments. Click the Fuel Tab. Note that the text in Red is not in the software but only for explanation which blocks to adjust. First zero Duty and Gain settings for both sides.



The throttle will then have no power on it and it should show the resting %.

If you open the throttle by finger completely it should go to 100% and closing completely should indicate 0%. Which means it was calibrated correctly.

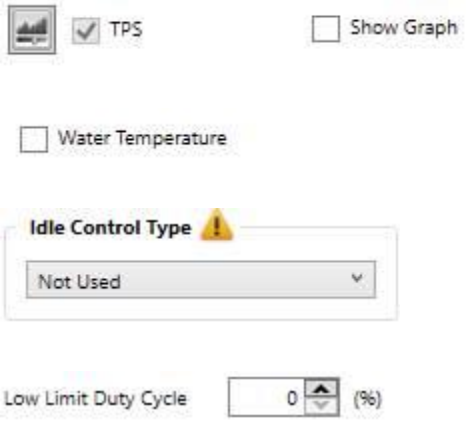
Click on the Engine Tab.

This POT or throttle value at resting position of 9% in this case, multiplied by 2.55 should be roughly the same as the Map Teeth value that was calculated by the Orion2. Map Teeth setting is the rest position of the throttle and is a value from 0 to 255 which represent 0 to 100% throttle.
Map Teeth = POT * 2.55

This is handy to know later if you want to fine tune erratic movement around the rest position.

To adjust throttle opening and closing duty.

Put the ignition on. Do not start the engine.
Put the TPS graph, Water Temperature and Idle-control off. Also put the Idle Control Low Limit Duty Cycle to 0.



Now press and keep the pedal in completely. Look at the throttle TPS in the real time screen on the POT bar. Now use the arrows of Opening Duty and increase the value till the throttle opens above 95%. Remember this value. Now reduce this value till the throttle close to 5% above the rest position (less than 9 + 5 =14%) Take the average of the two values and set opening duty to that value. In this example 115(to open) + 75(to close) = 190 / 2 = 95. Now release the throttle. If you press the throttle again, it should not open. This means you have determined neutral duty cycle where the throttle will not open or close. It will stay in any position if you press it with your finger while the pedal is pressed. If the difference in open and closing duty cycle are very small, then this neutral zone will not happen. For these throttles you will require different firmware.

Now release the throttle and increase the Closing Duty till the throttle close to 1 or 2 %. Then lower the Closing Duty till the throttle open to 8 %. (About 1% lower than rest position) Take the average of the two values and set closing duty to that value. It should be similar than the opening duty.

To adjust throttle opening and closing gain.

Now press the pedal fully and increase the Opening gain slightly. The throttle should open to about 99%. You may increase the value till you get a fast enough response and the throttle follow the pedal value. If the gain value is too high the throttle will vibrate. It should be around 4.

Now release the pedal and increase the Closing Gain till the throttle is about 1% value. The closing values should be the same value as the opening duty and gain. It should look like the example below.

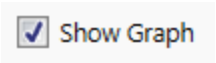
Now press the pedal slowly so that the throttle read the same as rest point. Take it slowly above the rest point and back. Notice if the throttle shudder excessively on the transition point. If it does vibrate or seem to have a dead band, increase or decrease the Map Teeth and see where the throttle is smooth when it passes the rest point with the least amount of shutter. Save the settings to the device.

Idle setting

This value is the minimum opening for the TxW to control the butterfly. Now you may start the engine and adjust the Low Limit Duty Cycle till the engine idles on its own. Let the engine get up to working temperature and adjust this setting till the engine runs at the desired idle RPM. If you are going to activate Idle control, then let it idle at Idle RPM minus 100. This will allow the TxW to control the idle faster. You may now proceed to idle control setup.

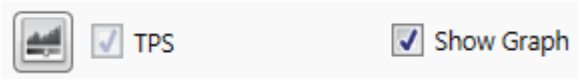
Note that if your throttle requires only one direction of movement then you can skip the closing settings. You may also disconnect TxW Motor Neg2 and TxW Motor Pos2. Look at the difference in wiring diagrams.

Throttle Modulation

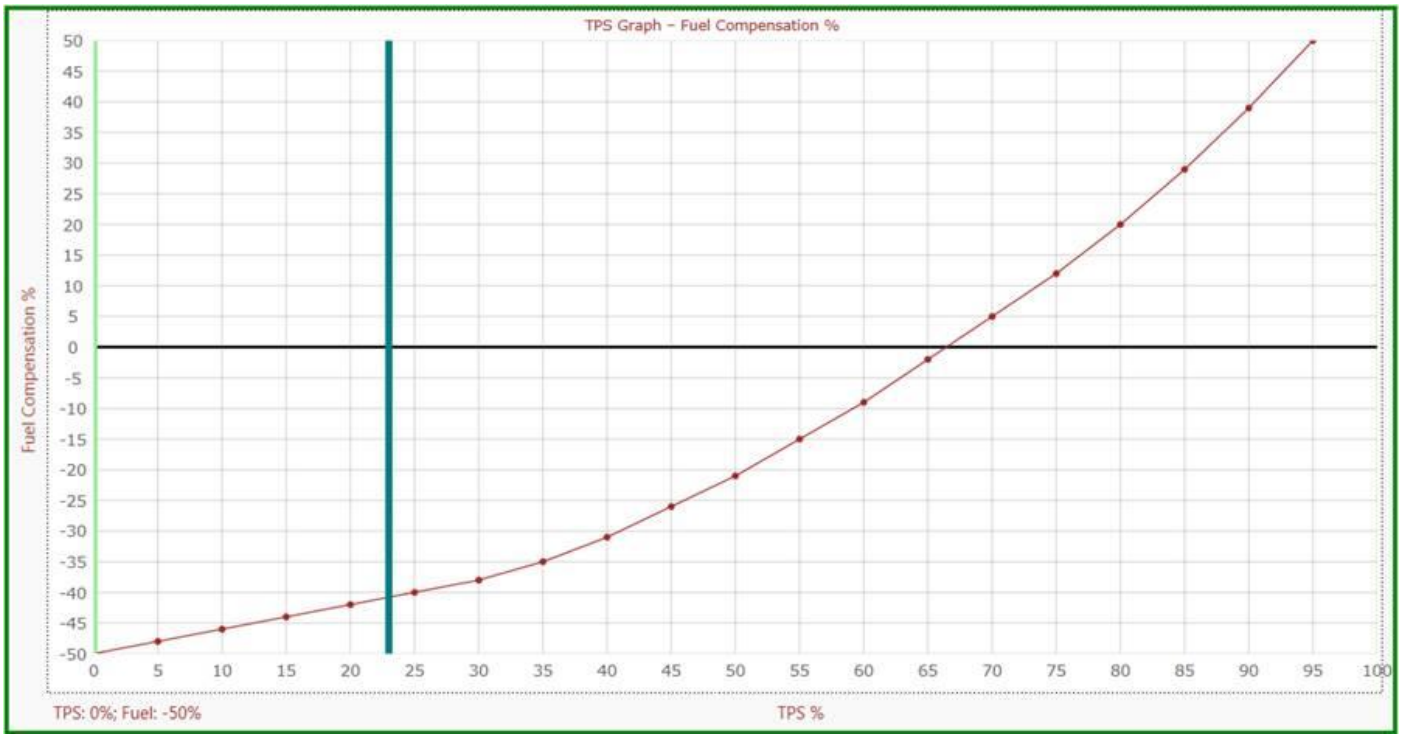


The throttle movement can be adjusted to open on a different value than the pedal set point. This is handy when large throttles are used. Then when it is used in town you can select more pedal movement than throttle movement which will make the car more drivable or the pedal less sensitive. Then on last movement to full throttle, the throttle will move more than the pedal and give the extra power required.

Select the *Show Graph* next the TPS selection.



Click on the TPS Graph Tab. See the graph below. The X Axis is pedal TPS movement and the Y axis is throttle movement set point. The range is from 0 to 100. -50 is 0% and +50 is 100% throttle. If Show Graph is off then throttle movement set point will be the same as pedal TPS %.



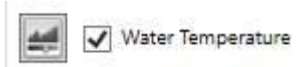
After setting, make sure the throttle can move over the whole scale range. Note that *Low Limit Duty Cycle* will cause the throttle to not go to 0% but remain it idle %. You may start the graph at a higher value than -50% so that the throttle moves more instantly when the pedal is pressed. Make sure not to set it too high, as it will then overcome the min duty cycle and the engine will idle faster.

Cold Start Compensation

The TxW can do cold start compensation. It compensates by increasing the min opening of the throttle. It is more stable than to lift the target RPM's. It will operate even if idle control is not used.

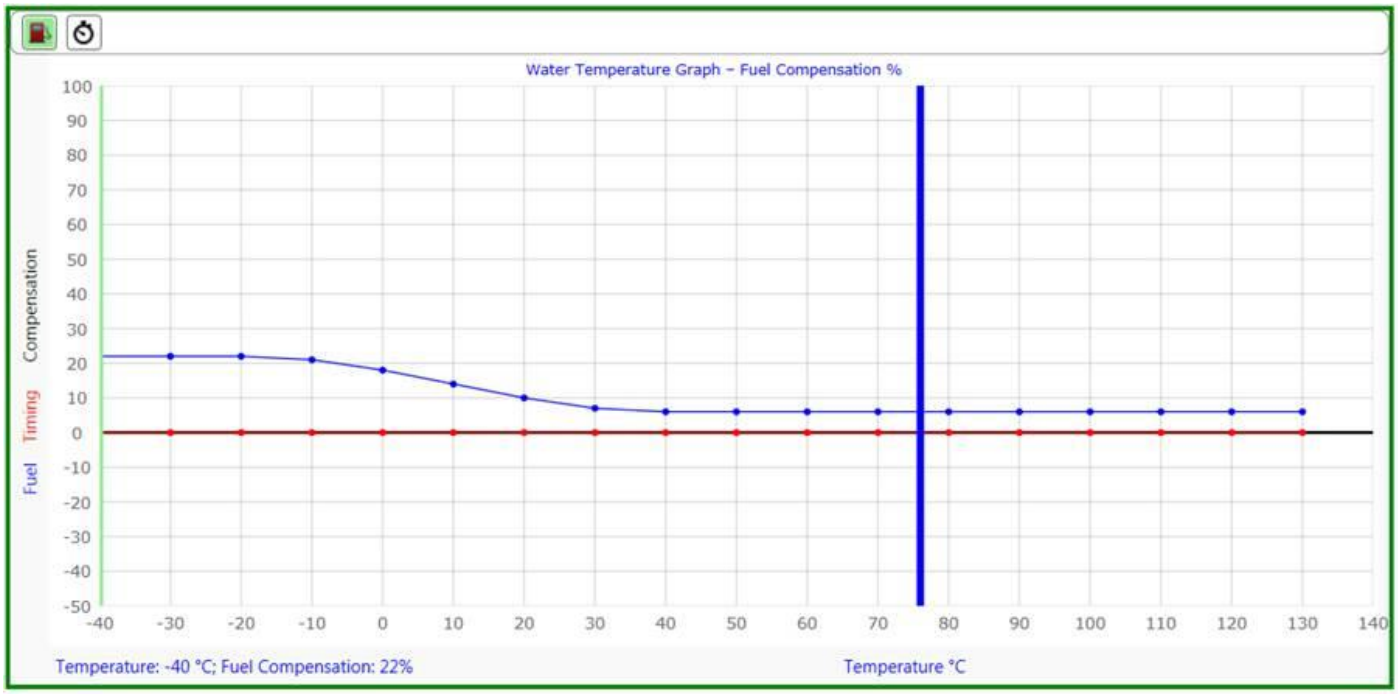
To use cold start control, the unit requires a water temp sensor. Orion2 has a jumper for the pull-up resistor for the water temperature sensor. If you have a standalone sensor, then the jumper must be on. If you want to tap into another sensor, then the jumper must be off. Note that the curve for both sensors is for the 2K NTC resistors.

Put the option On for the Water Temperature. Put the calibration value on 100. The water compensation graph will replace the Low Limit Duty Cycle value as idle setting.



With temperature compensation selected, the water graph for fuel will be used as the minimum closing duty cycle with temperature compensation. Note that the graph on the Y-Axis is used from 0 to 100 which means 0% to 100% opening. For a cold engine you can raise the value which will

let in more air to compensate for poor fuel burn. This feature can also be used without idle control. See the graph below.



If the Water Temperature setting is off, then there will be no water temperature compensation for cold start. The Idle Control Low Limit Duty Cycle value will be used as idle setting.

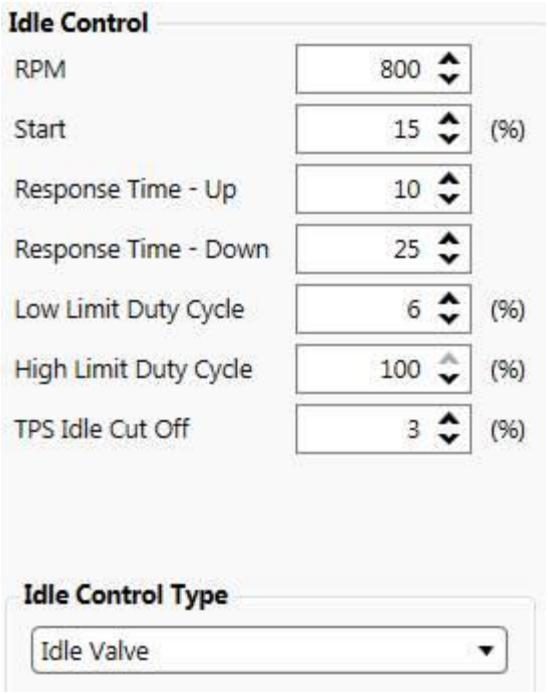
Note that a big part of idle control lies in fuel and timing tuning. See the section in the ECU manual how to compensate for that.

Idle Control

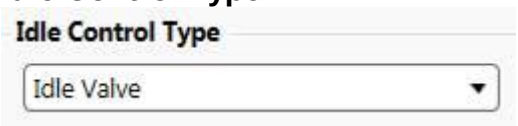
To use idle control, the unit requires an RPM pulse. Any number of pulses per revolution could be used up to 60. This will calibrate the rev counter in the software easily. You may compare it to the ECU Tachometer. Ex. Should you use a 36-2 trigger wheel then select 34 pulses which will represent one engine revolution.
Note that a big part of idle control lies in fuel and timing tuning. See the section in the ECU manual how to compensate for idle control. Otherwise the ECU and TxW may end up amplifying control parameters and then oscillate the idle control.

The Gear Teeth block is used for this value.

The rest of the idle control settings is the same as is used in the ECU. See description below.



Idle Control Type



If idle control is used, then select Idle Valve. Otherwise select Not Used. If idle valve is selected, then the RPM signal will become active. Otherwise it is disabled because it is not required.

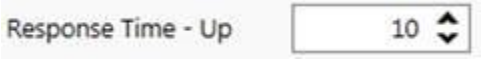
RPM

This setting is the target idle RPM's when the engine is on running temperature. Note that the min idle setting or the cold temperature compensation may cause the engine to idle at a higher value.

Start %

This setting is used to increase the air intake when the engine is started hot or cold. The ECU will open the idle valve to this %. Once the engine reaches 500 RPM it will cancel this setting and go to normal throttle operation. If you press the pedal, then this setting will be override.

Response Time Up



This setting will determine the rate at which the valve opens when the actual RPM's fall below the set point in *Idle RPM*. The further the RPM fall below the set point, the faster the ECU will open the valve to let in more air. Low values will create a faster response time and high values will create a slower response time. This setting must prevent the engine from stalling when you switch the air conditioner on, or put it in drive.

Response Time Down

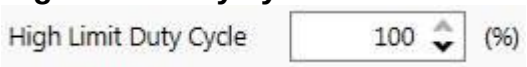
This setting will determine the rate at which the valve closes when the actual RPM's go above the set point in *Idle RPM*. The further the RPM goes above the set point, the faster the ECU will close the valve to decrease airflow into the engine. This value is set higher than the *Response Up* value, to eliminate hunting. Low values will create a faster response time and high values will create a

slower response time. This setting must bring fast idling down as fast as possible without hunting the engine.

Low Limit duty cycle

This setting will preload the TxW so that the valve does not close beyond this value. It is used as min idle when there is no temperature sensor connected. To set the value start with a larger % and decrease until the desired idling RPM is reached in neutral when the engine is on working temperature. Note that the throttle modulation or cold start compensation may override this value.

High Limit duty cycle



This setting is used to limit the maximum throttle opening. It is set at 100 to open the throttle fully. It may be used as power limiter by entering lower values.

TPS Idle Cutoff %

This value is used to disable the idle control when the driver touches the throttle. The reason is that the ECU must know when not to control idle as the driver may need just a minimal amount of revs with slight throttle.

Limp Mode testing

It is good practice to test the TxW for sensor failure. Any one of the 3 wires of the Pedal or Throttle TPS sensors can fail and then the TxW must react and put itself in limp mode. To test this operation lightly connect the 2 TPS sensors. After throttle setup, put the ignition on and press the pedal 50%. The throttle will open some way depending on setting. Now take the 6 wires to the 2 TPS sensors off only one at a time. Each time the throttle must fall out and go in limp mode. Limp mode means the butterfly is in rest position. If it goes fully open or fully close, then there is a wiring problem. Some single action throttle may close completely. After fixing the problem then solder the joints and cover them properly. Remember this throttle control the power of the engine and it could cause the car leaping forward and into an accident or leaving the road. So make sure wiring is done according to recommendations.

Trouble shooting

There are common problems that installer make that hinder proper operation and reliability. Especially if custom harnesses are made. Below are a few examples:

- Make sure the TxW earth and ECU earth is mounted on a proper place on the body of the car. Do not make long earth leads to the battery. See the power wiring section in the ECU manual.
- The power on the relay pin 30 must come from the battery with thick wires. Do cot connect pin 87 to the ECU relays.
- If the power wires are too thin, then the throttle calibrations change once you start the engine. This may also be due to the alternator wiring that connects with the power harness.
- The ECU power comes from the key power circuit and not the same power that supply the throttle. This usually make interference in the RPM signal.
- Make sure the RPM signal is constant and stable. Erratic behavior will result in incorrect idle control.

- The free-wheel diodes must also have a proper earth and power wire. Earth must go to the ECU earth point and positive to pin 87.
- Do calibration and setup in the same order as discussed in the manual. Make sure the throttle flap open, close and rest after you calibrated pedal TPS.
- If you set up the system and it does not perform like the document say investigate or contact your dealer for support. Do not let a half done project go into the street.
- Make sure you wire the resistors in as the harness drawing suggest. The reason is that it is fail safe resistors in case a wire breaks off. See the Limp Mode Testing section.
- Throttle is hunting on idle control. Make sure the ECU settings on idle fuel and timing settings is correct. See the idle control tuning section. It could also be incorrect settings of gain and rest position.

Error Codes

Two error codes are implemented to show common cutout issues. This is due to the TPS value that went outside the calibration limits. It could be due to a faulty wire to a TPS Sensor or voltage drops on wires due to incorrect thickness or power sharing. Filter diodes could also be the culprit.

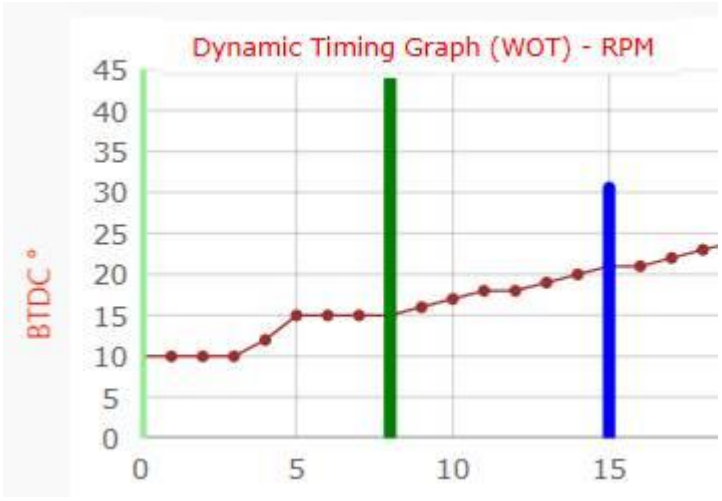
Error Value 29 – Pedal TPS Sensor Failure or Calibration limits breached.
Error Value 37 – Throttle TPS Sensor Failure or Calibration limits breached.

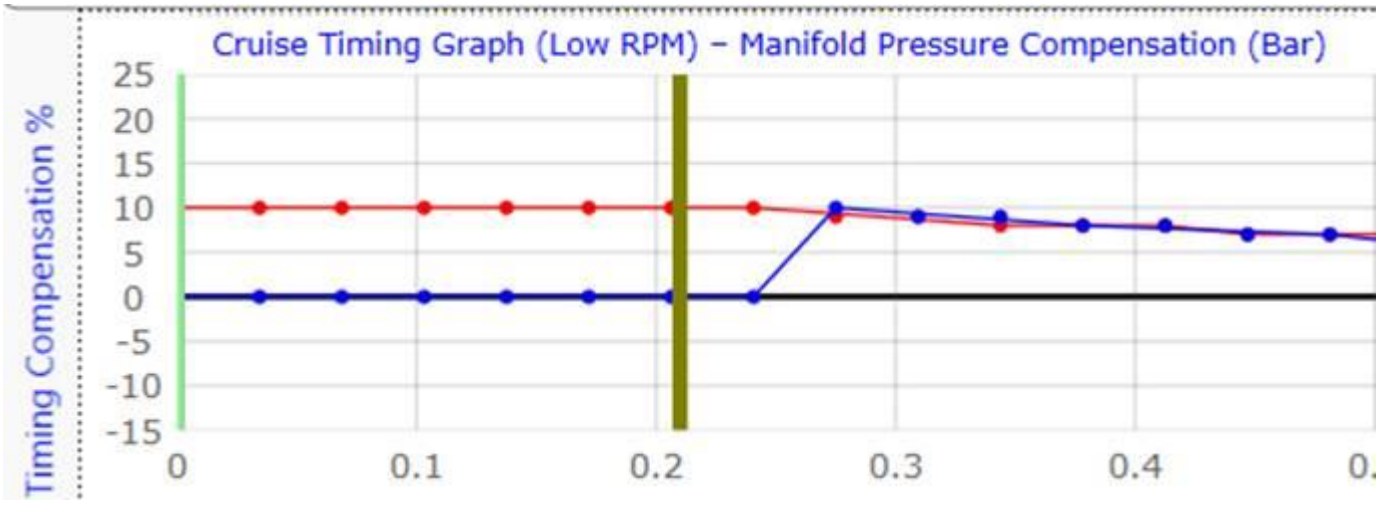
ECU Idle control Tuning

Idle control is done with different methods. It could be external idle valve or stepper motor or it could be done with partial throttle motor or full drive by wire throttle. Due to the delay in mechanical control to stabilise idle, you need to tune the ECU and idle valve together. The reason is that the ECU can react faster than a mechanical air restrictor valve. And most of the times hunting is a result of incorrect engine tuning. If idle drops then the valve opens to correct. That adds more air resulting in a worst effect and it comes with a delay. Then the ECU will add fuel due to more air resulting in high rpm which in turn close the idle valve and this repeats out of control. Also after blip the idle valve must capture the engine rpm before it stalls. Again here the ECU can react faster by adding timing and fuel to assist in this process. This section describe what needs to be done on the ECU side to help smooth idle control. See the different types of idle control and how to adjust their settings in the idle control setup section.

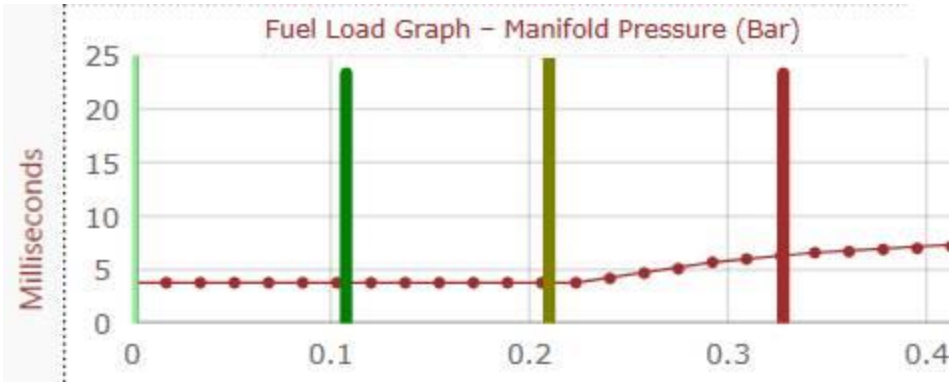
Setting the Idle Jet for Time & Fuel
When an engine idles in neutral and is at working temperature, the idle timing should be around 15 to 18 degrees depending on altitude. This may vary from engines but this is a basic guideline. Increasing idling degrees usually result in higher RPM's. Do not confuse this thinking it is what the engine needs. All you will do is lowering the air volume to bring idle down. This will result in very poor power and engine will easily die off when you put a bit of load on it. The lower the engine timing the slower the engine idles and the more idle air it requires. It will also require a slightly richer mixture. Now if you put a little load on the engine you immediately add timing which will make more power due to the rich mixture with more air. Adjusting timing is immediate and there is no mechanical delay. Now when an engine wants to hunt you can effectively control power to it without the idle control valve or throttle movement. Below is some basic ECU settings.

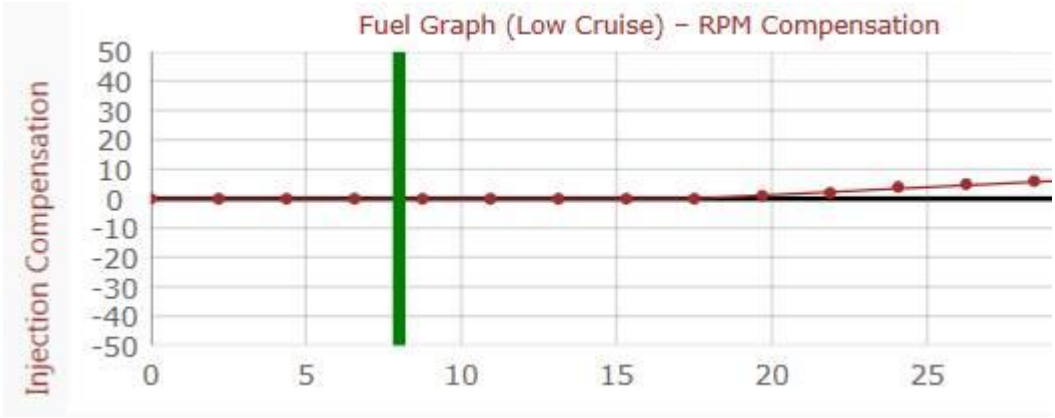
First adjust the timing so that at idle there is 15 degree dynamic timing and no vacuum timing.



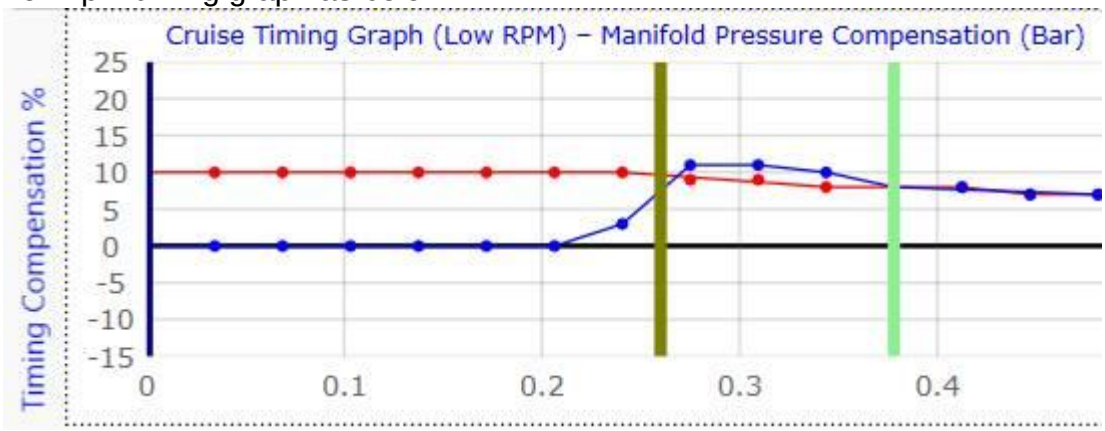


Adjust the Idle fuel so that the engine has just enough fuel to idle constant. Do not make it too rich. It should be close to avalanche point where if you go leaner the engine will lose power. The best way to see this point is where the vacuum signal will be at its lowest point for normal engines. Any more or less fuel will results in higher vacuum. Racing cams and matrix tuning will be saver to look at A/F ratio. Idling RPM's should be on your Target RPM value. In this example 800 RPM. Notice that the green and brown graph below on RPM compensation is at zero compensation. Only the main graph determine idle fuel. Also make sure water and air compensation is zer0.

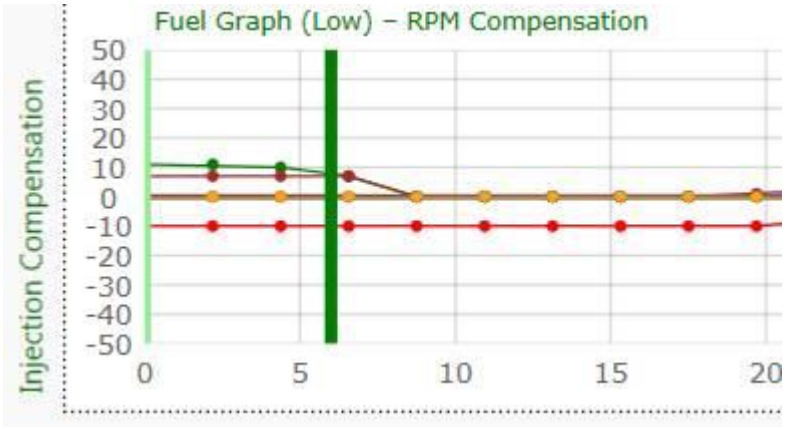


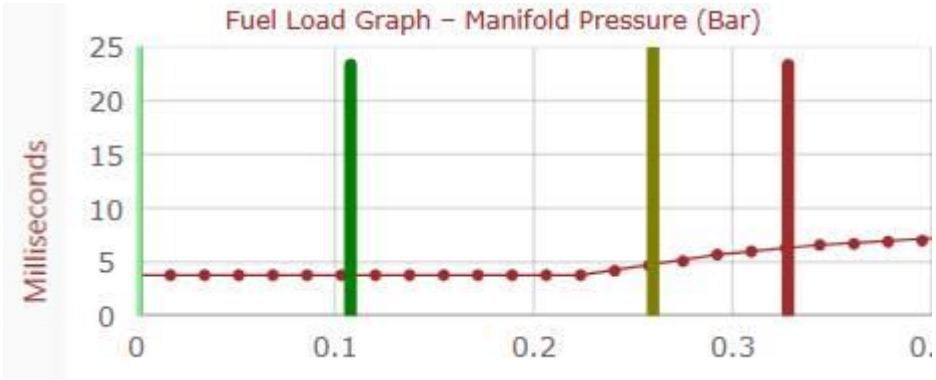


Now when the engine hunts we will use timing to control it before the idle valve needs to act. First you must understand what happens in hunting. The engine will lose power resulting in an increase in manifold vacuum. The vacuum bar will move to the right and the RPM bar will move to the left. Due to our slower timing we can increase timing to add power which will increase RPM. Adjust the Low rpm timing graph as below.

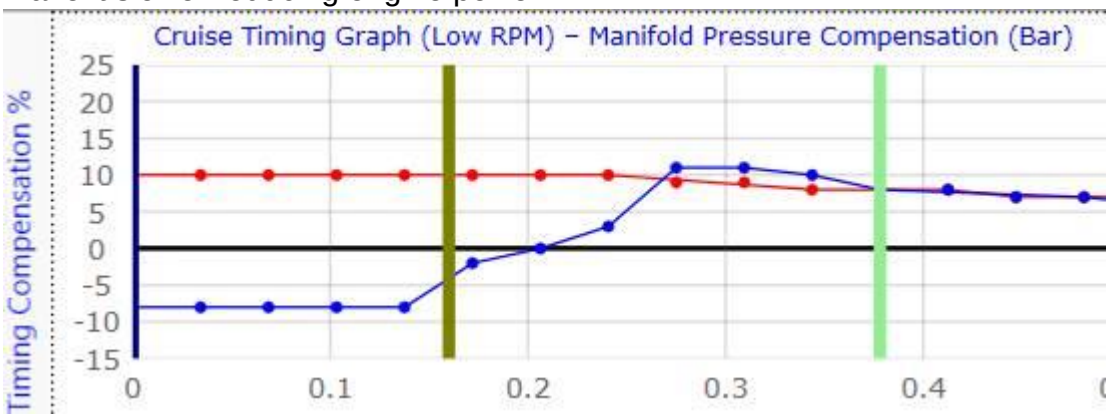


Lower rpm also brings more air in the manifold which requires a bit more fuel to make the mixture a power mix. Adjust the green and brown graph on the RPM graph ay the lower rpm range to add a certain % fuel. Note on the fuel load graph we already should have a slight increase in fuel.

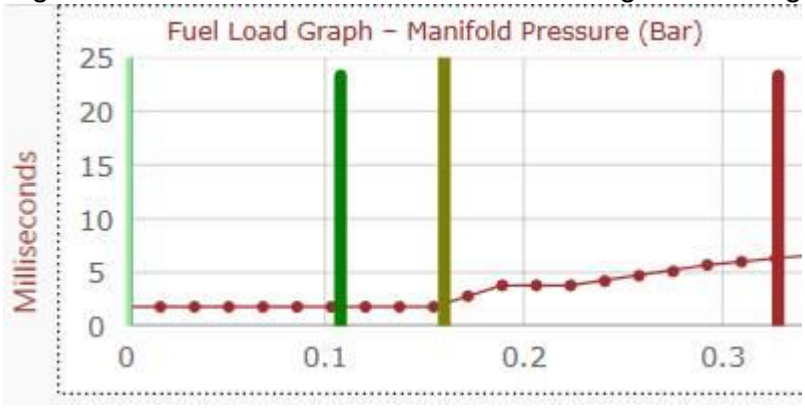




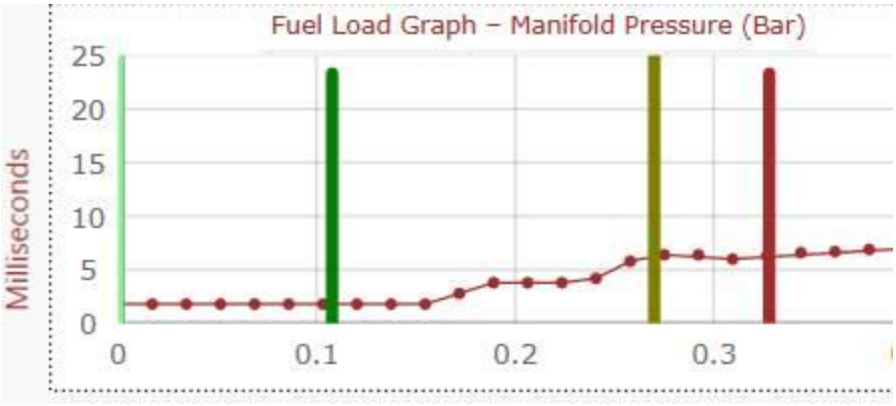
Now the above adjustments will capture falling RPM's and it may now cause the idle control valve to react as well adding air. This will increase RPM above target. There is an up and down response on the idle valve control settings. As a rule we make up response faster to ensure that the engine does not stall. Then we make down response slower to prevent hunting. Will result in more vacuum which makes the vacuum bar move left and the RPM bar moving right. First we use timing again to make it slower reducing engine power.



Then less air also needs less fuel. This time we adjust the fuel load graph as the engine don't use this part for normal riding. Note however, that deceleration will cause the vacuum to move in this region. If the mixture is too lean then the engine to being jerking due to too lean mixture.



Automatic Transmissions
For automatic transmissions tuning principles are the same as above. But there are two load steps that differs for neutral and drive. After you do the neutral tuning, then put the engine in drive. The load on the engine from the transmission will cause the vacuum bar to move to the right quite a bit. RPM is controlled and will stay the same. So you need to make sure that the idle fuel will increase for the added load.

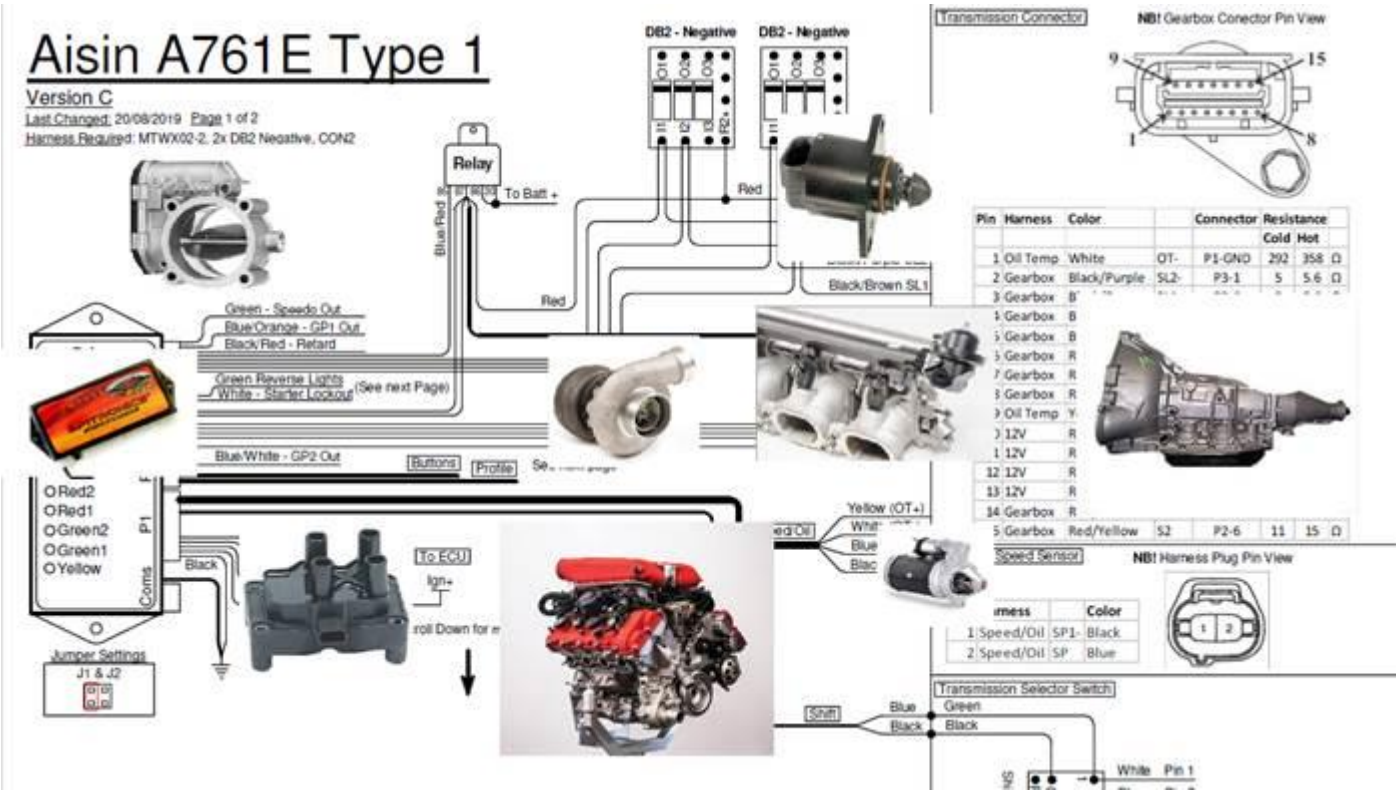


Drawings and Explanations

This chapter has all the wiring diagrams and explanations on how to connect the device with the default harnesses. Make sure which drawings suit your application. Print them and work from them to eliminate confusion. Some pages require input from you like firing order. Be sure to use the right specifications of your engine to compile your documents.

Note: If a Hyperlink is not attached to a drawing or file, please ask your dealer or look on the Web if the firmware is available before wiring. This manual will include future development as well.

See the sub folders for explanation.



Wiring

See the wiring diagrams in the sub folders for each type of throttle valve. There may also be custom firmware for different models like the Citroen TxW. Make sure to connect the free wheel diodes correctly and let the Mercury2 or Orion2 power its own relay as per drawing. Note that the dual throttle requires 4 diodes to eliminate spikes. After the unit is tuned you may load the lock file which means the firmware does not have the ability to write to memory during interference spikes on the micro. If you need to make adjustment reload the normal firmware.

Mercury2 Drawings

Standard Universal drawing
Mercury2 Reference Wiring Diagram

Specific models drawings
Mercury2 Lexus 3UZ Wiring Diagram
Mercury2 Citroen Wiring Diagram
Electronic Relay Amplifier

Harness design drawings
X05 Harness
X06 Harness

GP Priority Layout
Mercury2 TxW Ver 3.6B GP Output Priority Layout

Orion2 Drawings

Standard Universal drawing
Orion2 Universal Wiring Diagram

Specific models drawings

Harness design drawings
OTX01 TxW Standalone
OTX02 TxW