

# SE-EFI

Small Engine Electronic Fuel Injection

# Tuning Guide

V2.7.3

ECOTRONS

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**Note: this tuning guide will be under continuous improvements.  
Contact us for the latest version.**

**Note: only use this Tuning Guide after you finished the installation  
of the EFI Kit, by following Ecotrons Installation Manual.**

- Quick Tips .....3
- Chapter 1 System Requirements .....6
  - 1.1 Laptop ProCAL.....6
  - 1.2 12V battery and charging Power .....7
  - 1.3 Fuel supply system ..... 10
  - 1.4 Pickup to TDC angle for CDI controls ..... **Error! Bookmark not defined.**
- Chapter 2 Engine Start..... 13
  - 2.1 How does ECU sense the engine timing by the Pickup sensor..... **Error! Bookmark not defined.**
    - 2.1.1) Hall sensor and VRS sensor installation..... **Error! Bookmark not defined.**
    - 2.1.2) Check start issues .....41
  - 2.2 Map sensor installation .....44
  - 2.3 Global fuel tuning .....45
  - 2.4 Start fuel factor.....47
  - 2.5 After-Start and Warm-up fuel factor .....49
  - 2.6 Start ignition angle .....56
- Chapter 3 Engine idle tuning .....57
  - 3.1 Idle Speed adjustment .....57
    - 3.1.1 Single cylinder idle air screw adjustment .....58
    - 3.1.2 Adjust two cylinders balance and idle RPM if need .....60
    - 3.1.3 Idle Air Control – IAC motor .....76
  - 3.2 Idle ignition angle .....89
  - 3.3 Minimum injection pulse width limit .....92
- Chapter 4 Open-loop and closed-loop fuel control .....97
  - 4.1 Open Loop Fuel Control .....97
  - 4.2 Closed Loop fuel control .....98
- Chapter 5 VE table and Load table tuning.....103
- Chapter 6 Ignition Angle tuning .....118
- Chapter 7 Advanced tuning.....122
  - 7.1 Transient fuel .....122
  - 7.2 Decel-Fuel-Cut-Off .....128
  - 7.3 Driver desired lambda .....129

- 7.4 Advance Calibration for engine timing..... 132
- Chapter 8 Sensors and actuators..... 141
  - 8.1 Sensors' characteristics calibration ..... 141
    - 8.1.1 Injector characteristics ..... 141
    - 8.1.2 Engine displacement..... 142
    - 8.1.3 MAP sensor ..... 143
    - 8.1.4 IAT sensor ..... 144
    - 8.1.5 ECT sensor..... 146
    - 8.1.6 TPS sensor ..... 147
  - 8.2 Diagnostic and Heal ..... 151
    - 8.2.1 TPS sensor diagnostic..... 152
    - 8.2.2 MAP sensor diagnostic ..... 161
    - 8.2.3 Temperature sensor (IAT & ECT) diagnostic ..... 165
    - 8.2.4 NB O2 sensor diagnostic ..... 165
    - 8.2.5 VRS signal diagnostic ..... 166
    - 8.2.6 Battery diagnostic ..... 166
    - 8.2.7 Actuator Diagnosis diagnostic..... 166
- Chapter 9 Advance function of EFI ..... 167
  - 9.1 Fuel Dial Function ..... 167
  - 9.2 Traction Control function ..... 168
- Chapter 10 Auto-tuning with ALM ..... 172
- Chapter 11 How to check a broken ECU..... 190
- Chapter 12 On-the-fly Calibration Data ..... 196
- Chapter 13 about Ecotrons software tools ..... 198
  - 13.1 Flash ECU..... 198
  - 13.2 Check A2I or CAL is matching ECU ..... 207
  - 13.3 Burn to ECU successfully..... 209
  - 13.4 load configuration in variables list ..... 209
- Appendix I: ECU main connector pin-out (24-pin) ..... 214
- Appendix II: ECU main connector pin-out (20-pin) ..... 216

## Quick Answers

### Q: I finished the EFI installation; my engine does not start, why?

A: Go back to your installation manual, in the last chapter, there are detailed procedures for you to trouble-shoot the starting problem. If still cannot find answers there, you can jump to chapter 2 of this manual for further trouble shooting on engine start issues.

### Key points to check for start issues:

(1): Power on the EFI system (Key On), you will hear the fuel pump running for a few seconds. If not, please check the all wire connection of EFI first.

**Note:** 12V+ (red) and 12V- (black) go to the battery; KEYSW (pink) goes to the key-on switch; and the fuel pump terminal + / - are connected.

(2): Key on, is the MIL lamp (LED) on or not? If it is ON, please use ProCAL to read the DTC and find out which error is reported, and check the component connection or find out whether it is broken. DTC stands for Diagnostic Trouble Codes.

(3): Try to start your engine, is it successful to start? If it doesn't start, does the fuel pump turns on while cranking? If the fuel pump doesn't turn on, it means there is an error in CKP signal. Check the connection between the harness and pick-up sensor. CKP stands for Crank Position Sensor (SAE terminology).

There are 2 wires that must be correctly connected: CKP wire (orange) which should read the pickup pulse; and the ground wire (green) which must share the common ground with the pickup ground (or pickup negative). CKP wire connection is the most critical one for EFI. Without the correct CKP input, ECU will do NOTHING.

If you cannot make CKP to work, which shows as no injection, no fuel pump during crank, and you don't know what to check, you need to take some pictures of your CKP wire and ground wire connections; and you need to log data for cranking process with ProCAL and send us; we can help you to find the reason of problem.

**Q: How do I log data and send the data files?**

Assuming you have installed the ProCAL (default directory should be C:\ProCAL or D:\ProCAL). Otherwise, install the ProCAL to your laptop. ProCAL is coming in the CD with the EFI kit or you can download it from our website. Details on how to use ProCAL can be found in our ProCAL manual, also downloadable.

- 1) Run ProCAL (load the correct A2L and CAL file);
- 2) Key on, and key on only;
- 3) Go to menu -> run -> connect;
- 4) Go to menu -> run -> start measuring and start recording
- 5) Do your test, or start the engine;
- 6) When done the test, go to menu -> run -> stop recording
- 7) go to menu -> run -> Play back;
- 8) A window pops-up, and click "open", it will take you to where the logged files are. All files are in a folder called "**C:\ProCALrecord**", assuming C:\ProCAL is where you installed the ProCAL. All files are recorded in a sub-folder names as " dd-mm-yyyy-hh-mm-ss".
- 9) You need to copy all 3 logged files and send to us. (Every time there are 3 CSV files logged); you can even zip the whole "record" folder and send to us, we can help you to analyze it.

**Q: How do I change a calibration?**

Assume you want to change the value of the calibration variable "VAL\_XXXX" to "1234":

- 1) Key-ON, run ProCAL with the correct A2L/CAL files, connect it to ECU;
- 2) In ProCAL menu, go to: "Advanced" -> "add advanced calibrations";
- 3) Pop up a window, type in "VAL\_XXXX", select it, and click "add to", and then click "OK".
- 4) Back to ProCAL window, "VAL\_XXXX" should be displayed in a small window. Double click it and change its value to "1234". Hit "Enter";
- 5) Go to menu; "run" -> "burn to ECU".
- 7) Download.....completed.

8) Start the engine, see the effect.

## Chapter 1 System Requirements

### 1.1 Laptop tuning software ProCAL

#### How to run ProCAL in Windows Vista or Win7?

**Note:** if the ProCAL runs good already in Win7 or vista, skip the following:

1. Right click on the ProCAL icon on the Desktop
2. Choose properties
3. Click compatibility tab
4. Check: Run this program in compatibility mode
5. Choose XP service pack 2
6. Check: run this program as administrator
7. Apply

**Note,** Recent ProCAL versions like 7.1.8 or later will automatically set the compatibility mode during the installation process

#### 1.1.1 Smart Phone tuning software Ecotrons DroidCAL

**Note:** we have developed an Android system based tuning software and data logging software, for any Android based phones, tablet, etc.

**On your phone, you can directly search “Ecotrons” in “Google Play Store” and it is free download.**

## 1.2 Power supply: 12V battery and charging system

The EFI kit needs 12V power supply. It means by default, a 12v battery is needed. It also requires the charging system to maintain the 12V power. The EFI system power consumption is about 40W to 80W dependent on different sizes of EFI components. The stock charging system must provide enough power to run both stock electrical system and the EFI system.

We do have a **battery-less EFI system**, but it requires an even stronger 12V charging system to start and maintain the engine running. And this system is usually customer specific and it is more expensive.

Most stock charging system provides 80W or more charging power and it has enough buffering to add the EFI system. The only problem is with the extended long idle, like more than 10-minute idle. Long idle will drain you battery for some small charging systems.

Usually the smaller the engine size, the smaller the charging power is.

How do you find out whether your charging system is enough or not?

If you run your engine as regular driving, not just idling, and your 12v battery is less than 13V when the engine is running, you have the charging deficiency!

We have found, in general, any engine that is 150cc or bigger should have enough charging power for our EFI system.

The biggest “consumer” of electrical power in the EFI system is the fuel pump. We have 4 sizes of the fuel pumps:

- 1) Small fuel pump: 25L/H flow rate, support engine sizes from 50cc to 400cc. It draws 2A current in average, which is equivalent to 30W.
- 2) Medium fuel pump: 45L/H flow rate, support engine sizes from 400cc to 1200cc. It draws 3A current in average, which is equivalent to 45W.

- 3) Large fuel pump: 120L/H flow rate, support engine sizes 1000cc up. It draws 5A current in average, which is equivalent to 70W.
- 4) Mini plunge type fuel pump, controllable flow rate, max 10L/h, current draw 1A average; support engine sizes of 10cc to 125cc. This type of fuel pump is only available for small OEMs and it is customer specific.

Other electrical power consumers include injectors, ignition coils, relays, O2 sensors, etc. Adding together, the EFI power consumption would be in 40W to 80W range.

Usually the super small engines (50cc or below) would have charging power deficiency. For example, a 50cc scooter engine, the stock charging system usually provides about 80W power in total. After the stock electrical system, like the head lamp, and the brake lamp, takes the power, there is not enough power left for EFI. For this case, there are 2 ways to fix it:

- 1) Change all your lamps to LED lamps. This saves enough power for EFI. This has been proved an efficient way.
- 2) Upgrade your charging system. For example, the stock stator is only 6 poles or 8 poles. You can buy an aftermarket stator with 12 poles or even 18 poles etc. If you are really good at electrical staff, you can upgrade the stock rectifier from the half-wave to full-wave which theoretically doubles the stator output.

Some engines do not have a meaningful charging system. For example, some small 2 stroke engines, and some racing engines, which only have a few charging coils to provide the power to the ignition system. There is no meaningful 12V DC charging power. There is no lamp used with these applications. In this case, you must upgrade the charging system for EFI system.

Some people want to run the EFI with just a battery pack, like a Lithium battery. It is do-able if you only run your engine for an hour, for example, but it's not preferred. The issue is once the battery starts to be lower than 12V, the fuel supply system will not maintain the enough fuel pressure (3 bar) and your engine could run lean and unstable.

For many installations, after you installed the EFI system and tried to crank a few times, your battery can be drained already. The best way is to put a charger on the 12V battery to trouble shooting starting issues.

Also, if you have leaved your engine off for a long time, the chance that your battery is low is high. You better charge your 12v battery before you run your engine again. Or at least put the charger on during the engine start.

**Last but not the least, when you try to program the ECU or burn the new calibration data into ECU, you better make sure the battery is not low before you do that. Low battery can leave your ECU half-way programmed and basically brain dead. You need to put the charger on, and re-program it to 100% completed.**

You can use a voltage meter to measure the voltage of the battery. The value should be higher than 12V when engine is not running, and it should be higher than 13v when the engine is running.

You can also use ProCAL (laptop or Droid phone app), to read the battery voltage:

Power on ECU and connect to ECU. Go to menu "Variables->Display Type->List". Then "Run->Start measuring" "UbAdc" is the battery voltage read by the ECU.

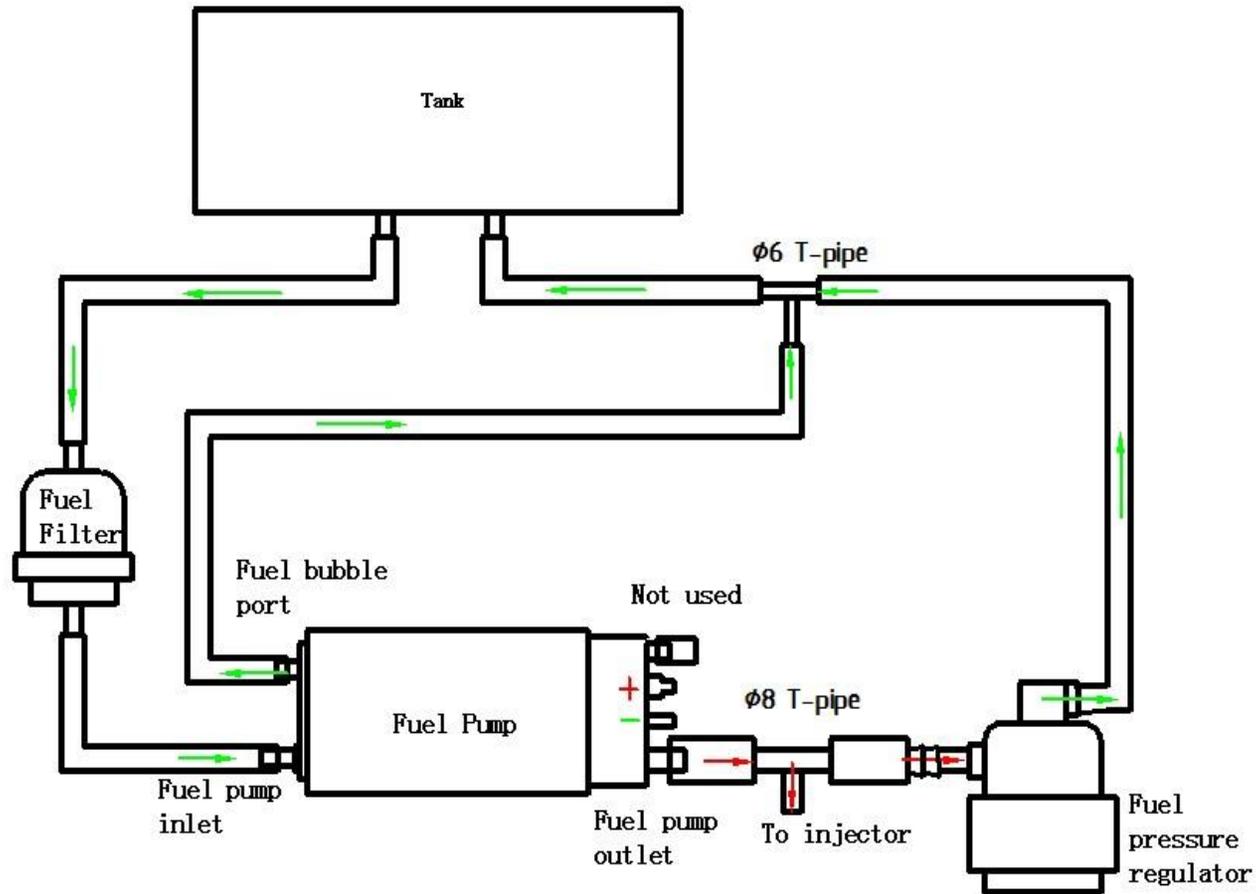
### 1.3 Fuel supply system

The fuel supply system must be installed correctly to provide the fuel to injector, and maintain the fuel pressure. If the fuel supply system is not installed correctly, you could have fuel starving issue, showing as some erratic problems, or not able to start the engine at all.

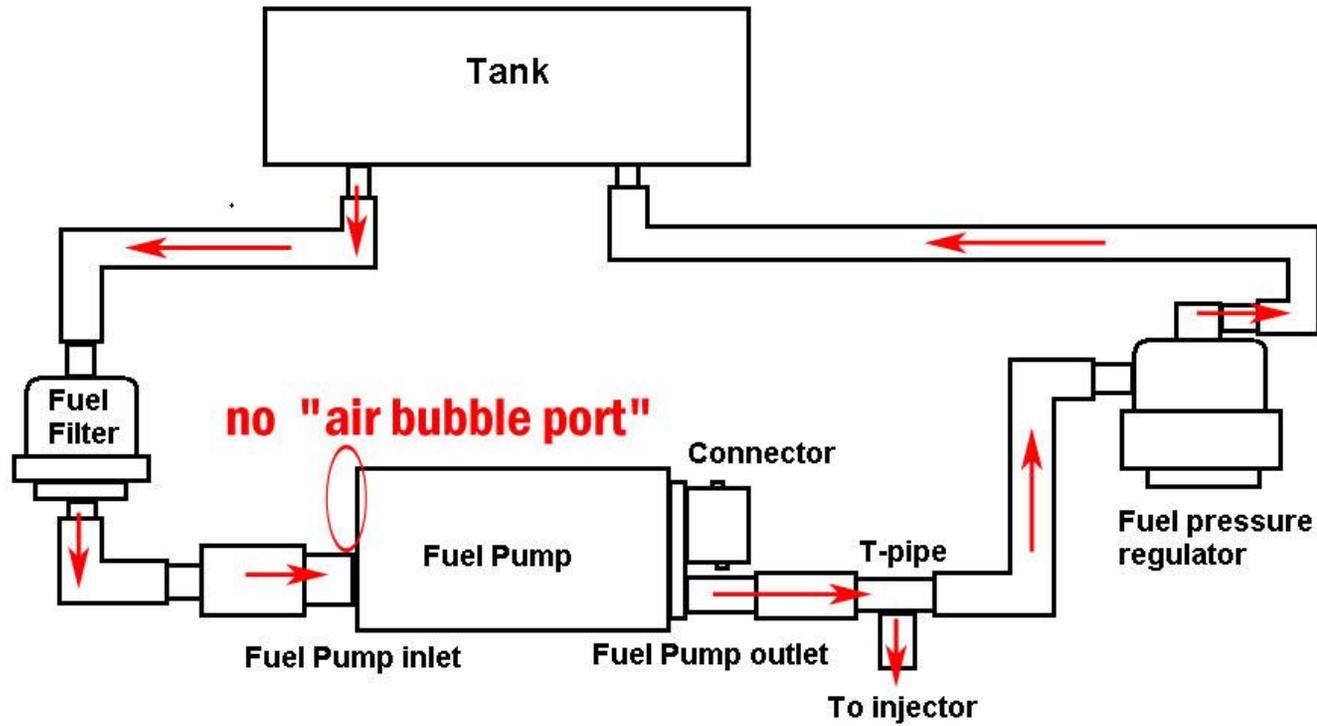
- 1) The fuel pump must be installed below the fuel tank; or at least at the bottom level of the fuel tank, because the fuel pump does not have enough sucking power, it could be starving if it is located higher than the tank.
- 2) The fuel pressure regulator must be connected correctly (inlet vs outlet). Or you will not get any fuel pressure.
- 3) The fuel return line must be routed back to fuel tank correctly, otherwise you could have air bubbles in the fuel supply system, and not able to provide the fuel to the injector.

A normal fuel supply system installation, after you key cycle a few times, should show that the fuel flows from tank to the fuel pump, then through the pressure regulator and then the fuel return line and back to the tank. You shall hear fuel pump turning on for a few seconds every time you key on, and see fuel flowing back to the tank, and no bubbles in the fuel lines.

**For the detail of fuel pump installation, please read the installation manual.**



Old small Fuel pump system schematics



New small fuel pump system schematics

## 1.4 How does ECU sense the engine timing by the Pickup sensor

### Why need the pick-up sensor?

SAE name of the pickup signal is CKP (Crank Position Sensor).

Crank-shaft pick-up signal is the most important for EFI system. It tells the ECU the engine TDC position, and the ECU uses it to calculate the crankshaft rotation speed (RPM); to trigger the fuel injection once per cycle, and to command the spark event at the specific ignition angle.

**Without the correct pickup signal (or CKP signal), EFI will NOT work, period.**

There are a few types of pickup signals our EFI can work with. Depending on what type of ignition system is on your engine, EFI can use the below pickup signals:

#### 1.4.1 CDI ignition system

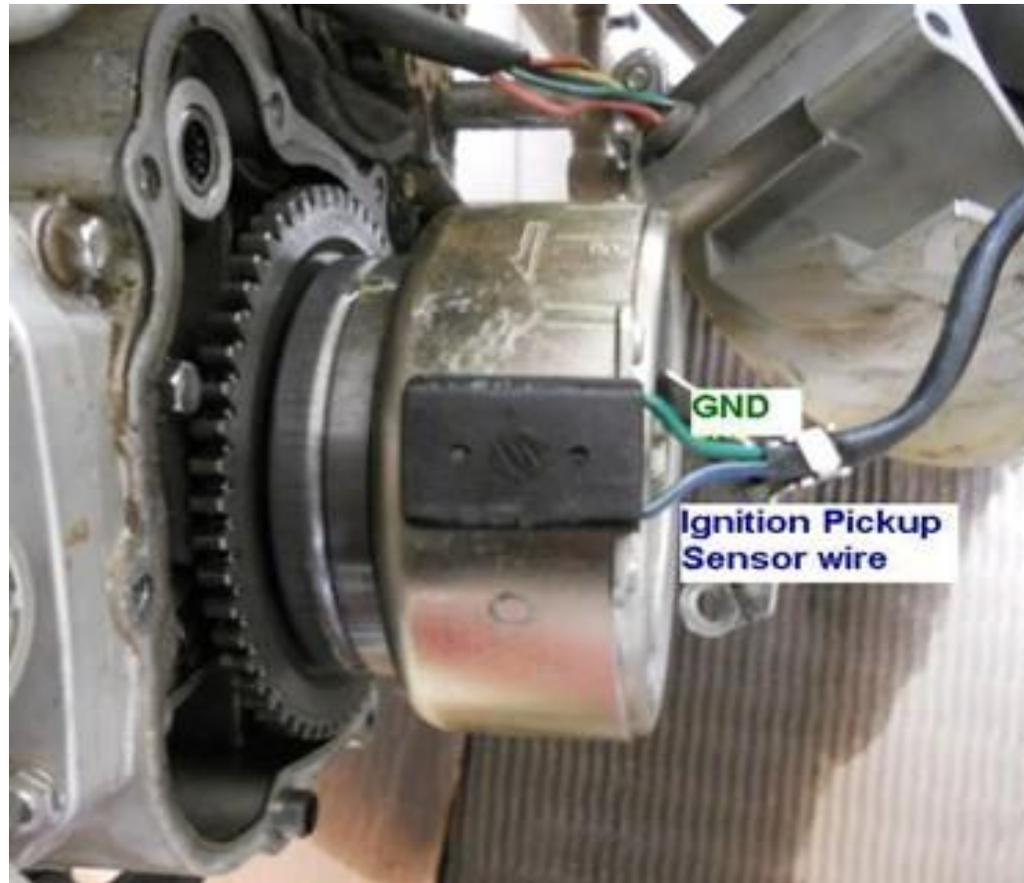
CDI stands for Capacitor Discharge Ignition system.

Most small engines use a small pickup coil as the trigger source to send a pulse to the CDI. The CDI then fires the spark. This is the default and the easiest option for our EFI to use as the pickup signal. You just need to connect the CKP wire from the EFI harness to the CDI pickup source.

This pickup coil is usually installed on the crankcase, or the stator, next to the flywheel. There is one metal tab or a magnet on the rotor (some engines have two), or on the flywheel external surface; and when this metal tab passes by the

pickup coil, it generates a pulse, and triggers the CDI. This is how CDI knows when to fire the ignition. Our ECU uses this same pickup as the timing input to determine when to fire the injector and ignitions.

There are usually 2 wires coming out of this pickup sensor. One is trigger wire, the other is usually grounded.



With this pick-up sensor, you just need to connect our orange wire, labeled as CKP, from the EFI harness to the stock pickup sensor wire. The ground wire shall be connected to stock CDI ground wire.

## 1.4.2 Pickup (sensor) to TDC angle

If you are using our ECU and our CDI to control the ignition timing (spark advance), based on a single pickup (sensor), you must identify the offset angle between the pickup pulse and the engine TDC.

Only by knowing this offset angle can the ECU control the CDI to fire the ignition at the right timing. This offset angle is usually about **29** degree crankshaft angle before the TDC, for most CDI ignition systems.

If you don't know this offset, or if you have trouble to figure out this offset angle, you better keep the stock ignition system and use the EFI to control fuel only. This way, you can start the engine, and worry about the ignition system later.

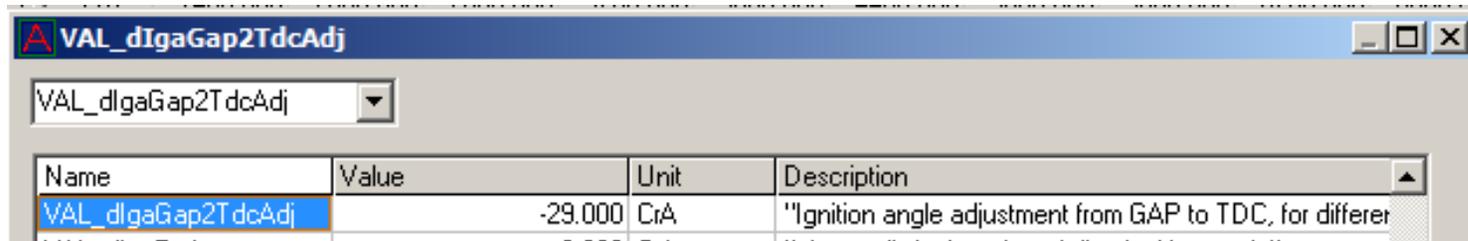
For how to configure a Crank sensor with a multi-tooth trigger wheel, refer to Chapter 2.

### How do I set the offset angle in ProCAL?

Please add this advanced calibration variable in ProCAL:

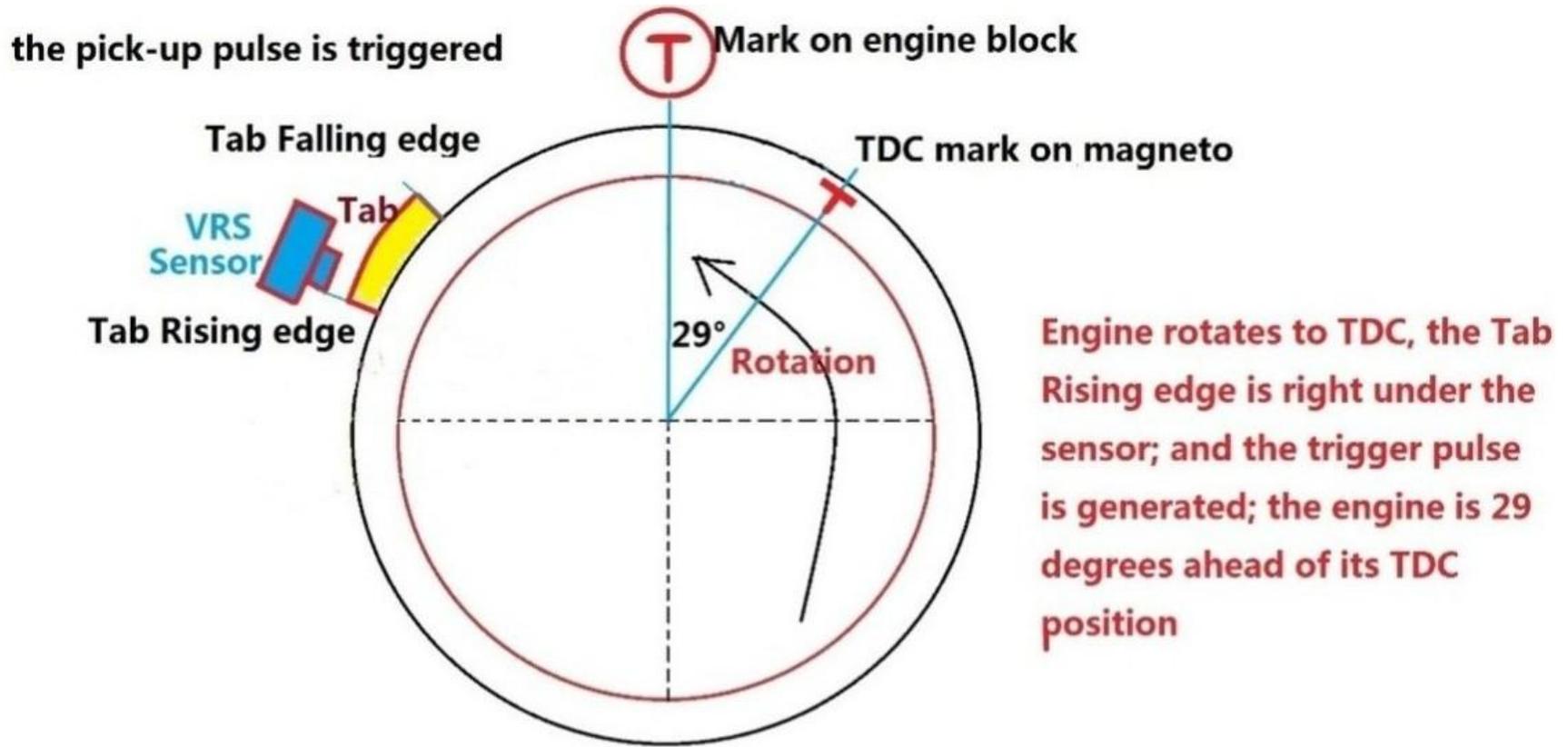
ProCAL → Advanced → Add Advanced Calibrations:

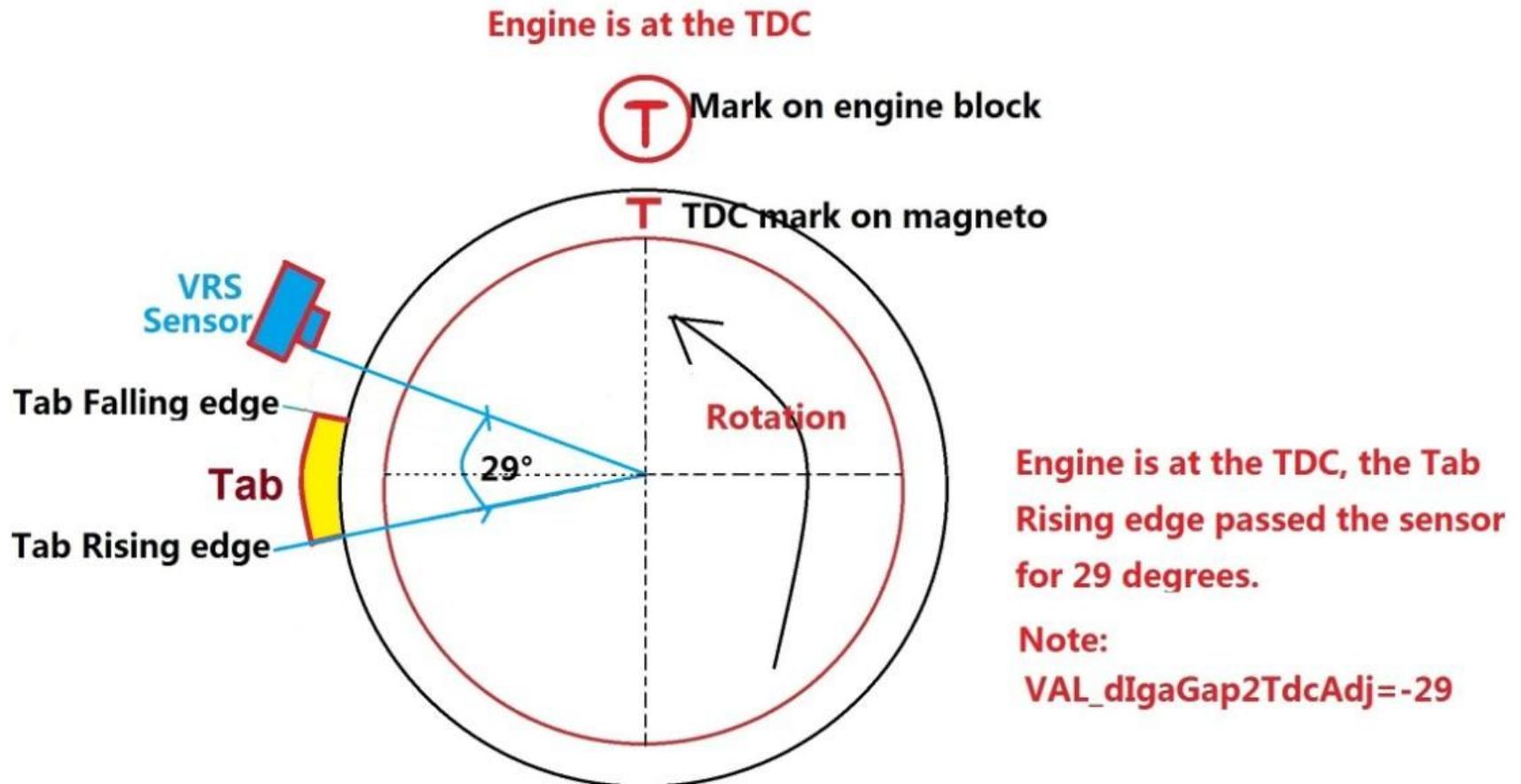
Default: VAL\_dIgaGap2TdcAdj = **-29** CrA (crank-shaft angle)



This defines the offset between your trigger pulses to TDC.  
 The default is -29 CrA. That means 29 degrees in advance to the TDC.

**How to find the offset angle:**





**Note:** It is a negative value. -29 degree of crankshaft angle (CrA); here negative means before TDC.

This number (-29) is OK for most scooter/bike engines, so you don't have to change.

You can use a timing light to verify whether the ignition angle is close to what should be.

**Note:** VAL\_dIgaGap2TdcAdj has been changed to the positive value with our newest software. You can find out whether it should be a positive value with your A2L file, such as: "S33\_H1\_L48\_Cr17\_AT3.4\_E4.a2I" if the number is bigger than "Cr17", for example, "Cr18 or Cr19...." it means it is the newer software; the VAL\_dIgaGap2TdcAdj should be positive value.

### 1.4.3 Integrated ignition coil (TCI) system

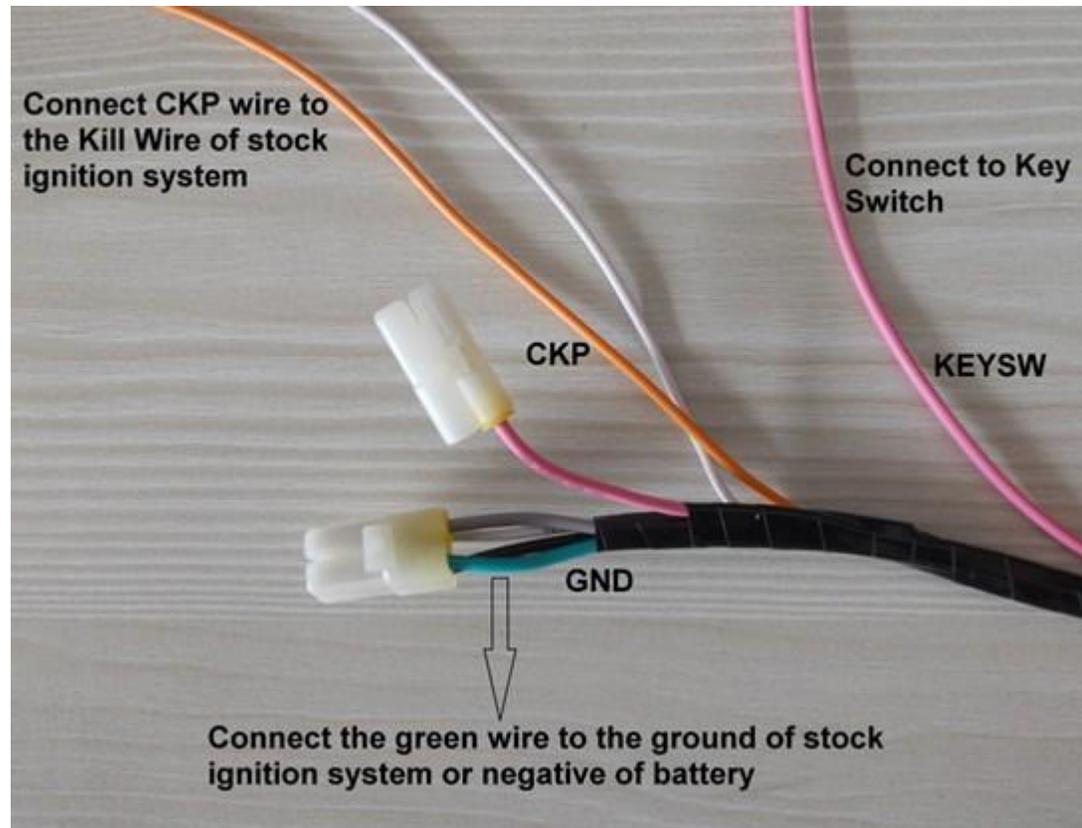
TCI stands for Transistorized Charging Ignition system. Many small engines, like Honda GX series, as GX50, GX200, etc.; Briggs and Stratton engines; have an integrated ignition coil installed next to the flywheel; and use a magnet to trigger the coil and fire the spark plug directly, there is no CDI, and no standalone ignition coil. There is no dedicated pickup signal on this type of ignition system.

1) For this type of ignition system, you can use the signal from kill switch wire as the pick-up signal. Keep the stock ignition system, and the EFI just controls the fuel.

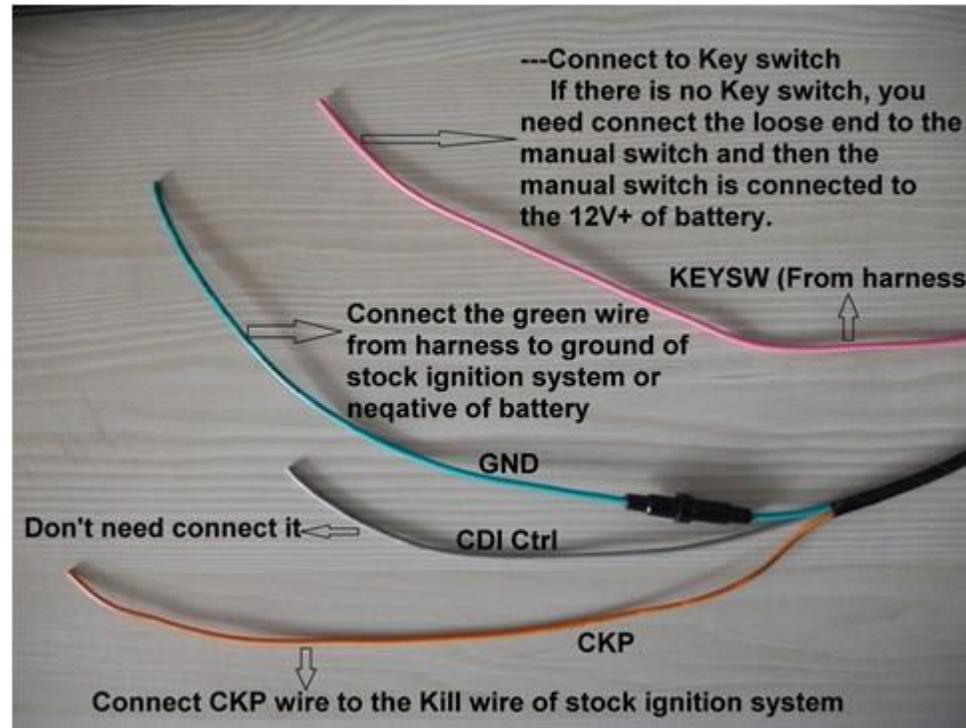
You need to connect the orange wire labeled as CKP from the EFI harness to the kill wire and connect the EFI green wire which labeled as GND to the ground of your ignition system.

1.1) If you have the below version harness, please connect it as below.

**Note:** The 2 small white connectors are for Ecotrons CDI. You don't have to connect them if you are not using Ecotrons CDI.



1.2) If you have the below harness, please connect it as the picture.

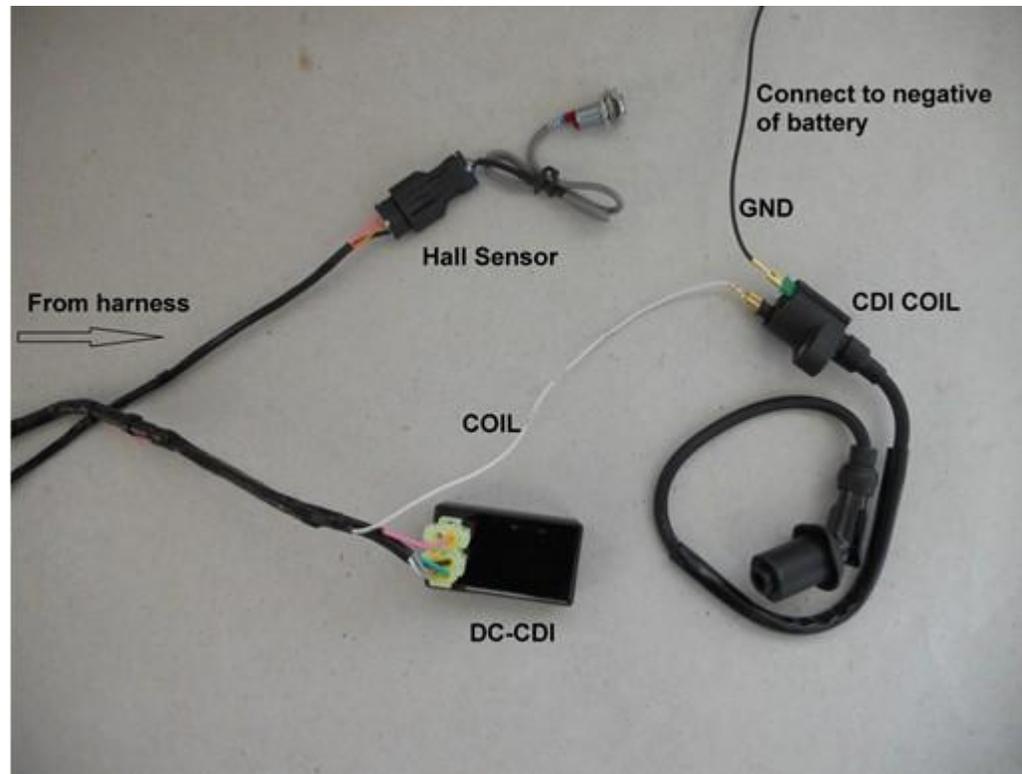


2) Because the kill switch wire from this type coil can have a lot of noise, it may not work completely. You can convert this type ignition system to CDI ignition system.

To convert, you can use 3 of our components to replace this one integrated ignition coil, namely: Hall-effect sensor, CDI, and a coil.

The Hall-effect sensor acts like a pickup; it shall be installed at the same location as the stock ignition coil. A bracket may be needed. The CDI is controlled by our ECU; and the coil is driven by the CDI, and fires the spark plug. It





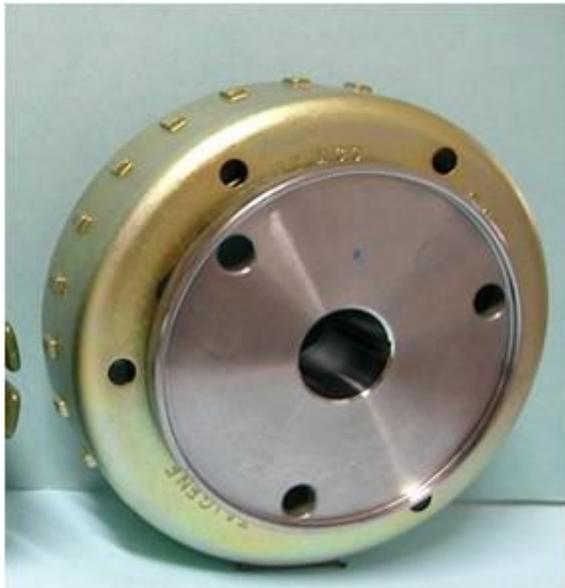
#### 1.4.4 Mechanical break-point style ignition system

There are still a lot of vintage bikes (vehicles) that are running on break-point style ignition systems. In this case you may have to convert it to electrical ignition system. You may want to convert it anyway, since it has already created a lot of headache to you. There are 2 ways to convert this type of ignition system:

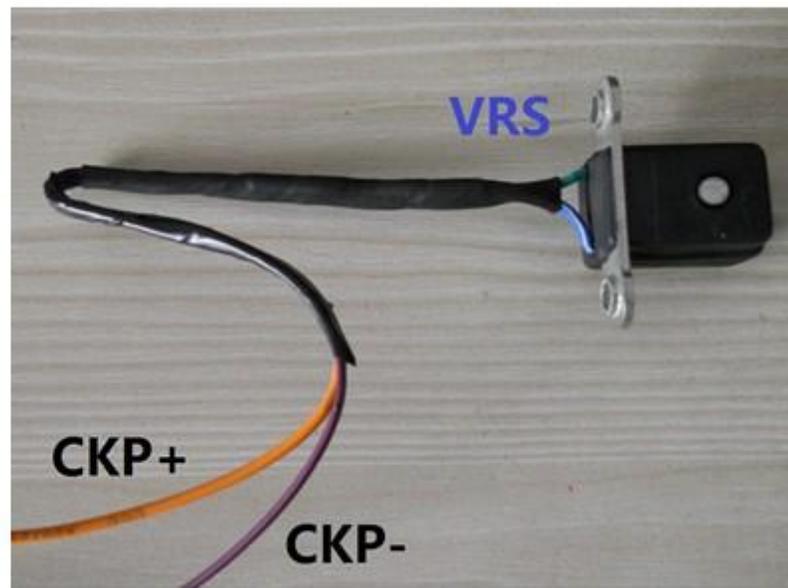
- Convert it to CDI system: good for single engines; you need to install a magnet on the flywheel, or somewhere

that synchronizes with the crankshaft; and install our Hall effect sensor to be triggered by the magnet; then our CDI and coil will be controlled by our ECU;

- Install a high-tooth trigger wheel on the crankshaft: good for 2 cylinder or multi-cylinder engines. You need to get a multi-tooth trigger wheel, like a 12-1, 24-1, 36-2; or even 60-2 tooth wheel; and then install a VRS type sensor (variable reluctant sensor, which we can provide). The VRS sensor will read the crankshaft position. Then our ECU will control our inductive coils directly and fire the spark plugs, like most modern cars! This is the best solution though requiring most efforts!



Example:Multi-tooth trigger wheel (built-in on the flywheel)



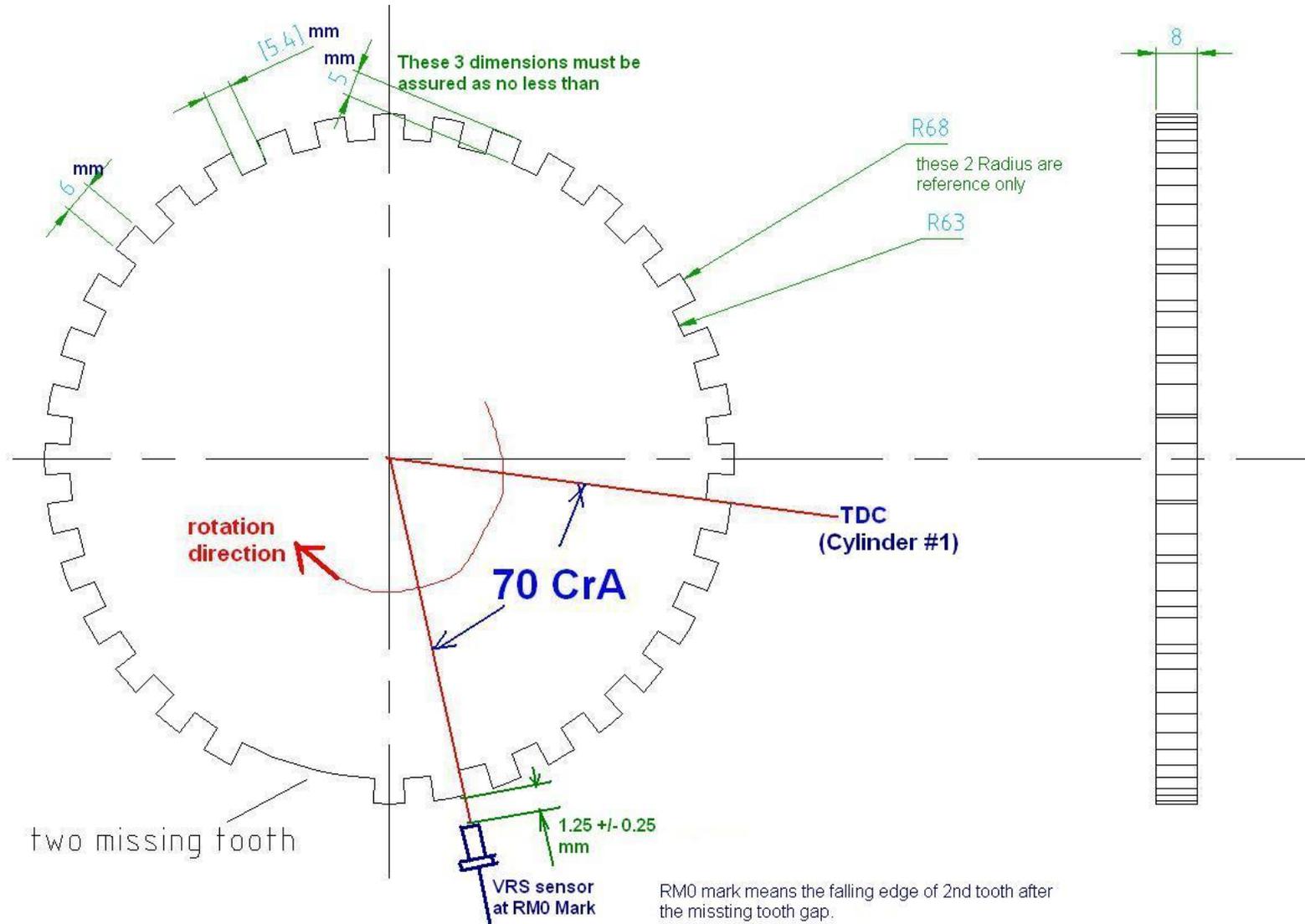
VRS sensor

**VRS sensor for multi-tooth-trigger-wheel installation**

VRS need be installed the same way as the Hall Effect sensor. It generates AC pulses instead of square waves. The metal sensing element (sensor head) needs to align well with the multi-tooth wheel.

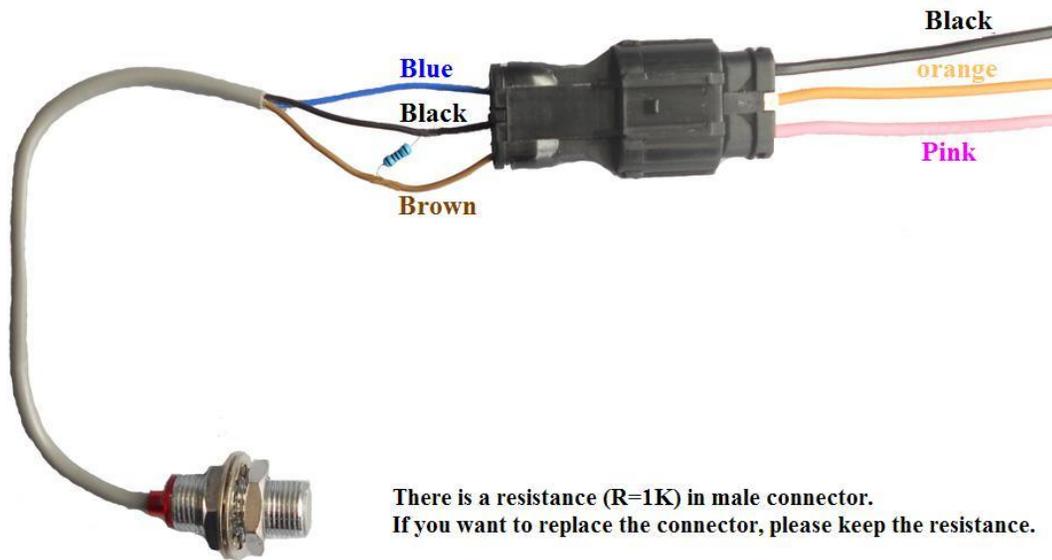
And the tooth width must be bigger than the sensing head.

If you want to fabricate your own multi-tooth-trigger-wheel for the EFI system, you can refer to the following picture as an example to machine the tooth wheel.



## 1.4.5 Hall sensor installation

### Hall Effect sensor pin-out:

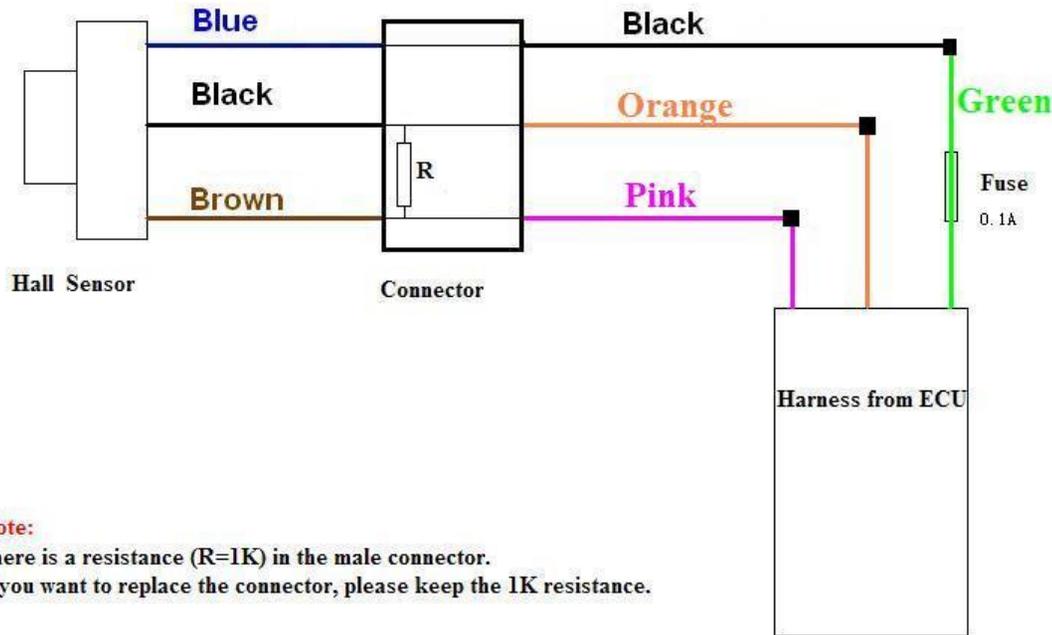


There is a resistance (R=1K) in male connector.  
If you want to replace the connector, please keep the resistance.

**Pink** wire: power 12+ ( to **Brown**)

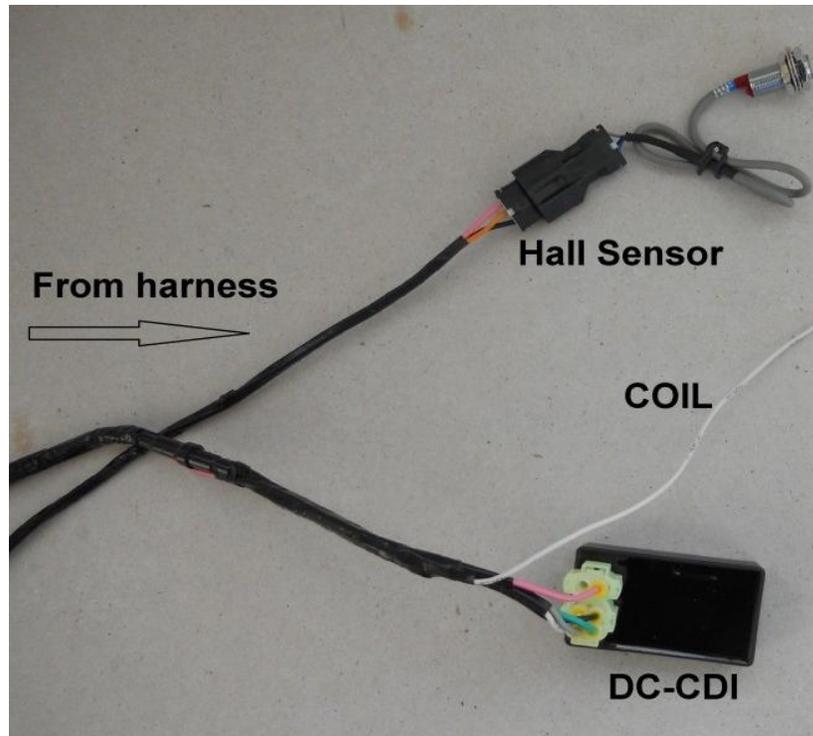
**Black** wire: power – / ground (to **Blue**)

**Orange** wire: signal wire (to **Black**)



**Note:**  
There is a resistance (R=1K) in the male connector.  
If you want to replace the connector, please keep the 1K resistance.

For the customers that ordered our Hall sensor together with the EFI, the EFI harness will come with the Hall sensor connector, and CDI connectors, you don't need install the 1K resistor again. See below for the simplified version of the harness.



**Hall Effect sensor installation:**

For some engines, such as Honda GX160, GX390, or similar, the stock magnet is North polarity. And for some other engines, such as Honda Gx35, the stock magnet may be the South polarity.

Our Hall Effect Sensor by default works with a South-Pole Magnet. If you install this Hall sensor to an engine which has a North-pole magnet, you will have 2 pulses per revolution, one at the leading edge of the magnet; one is at the trailing

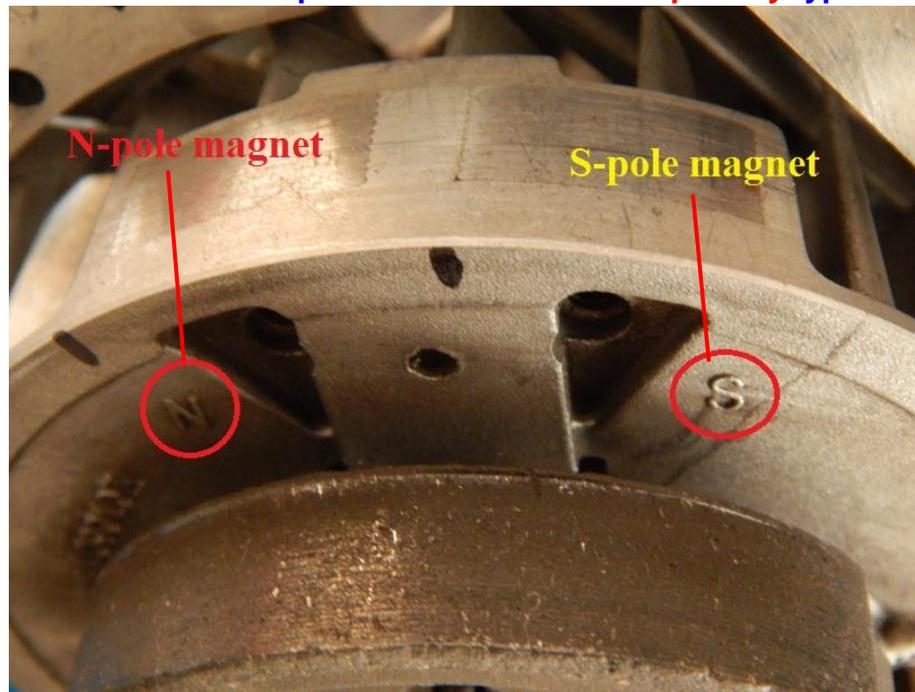
edge. This will confuse the ECU and you may not even be able to start the engine. You may start the engine, sometime, but the running may be unstable or stall at high RPM.

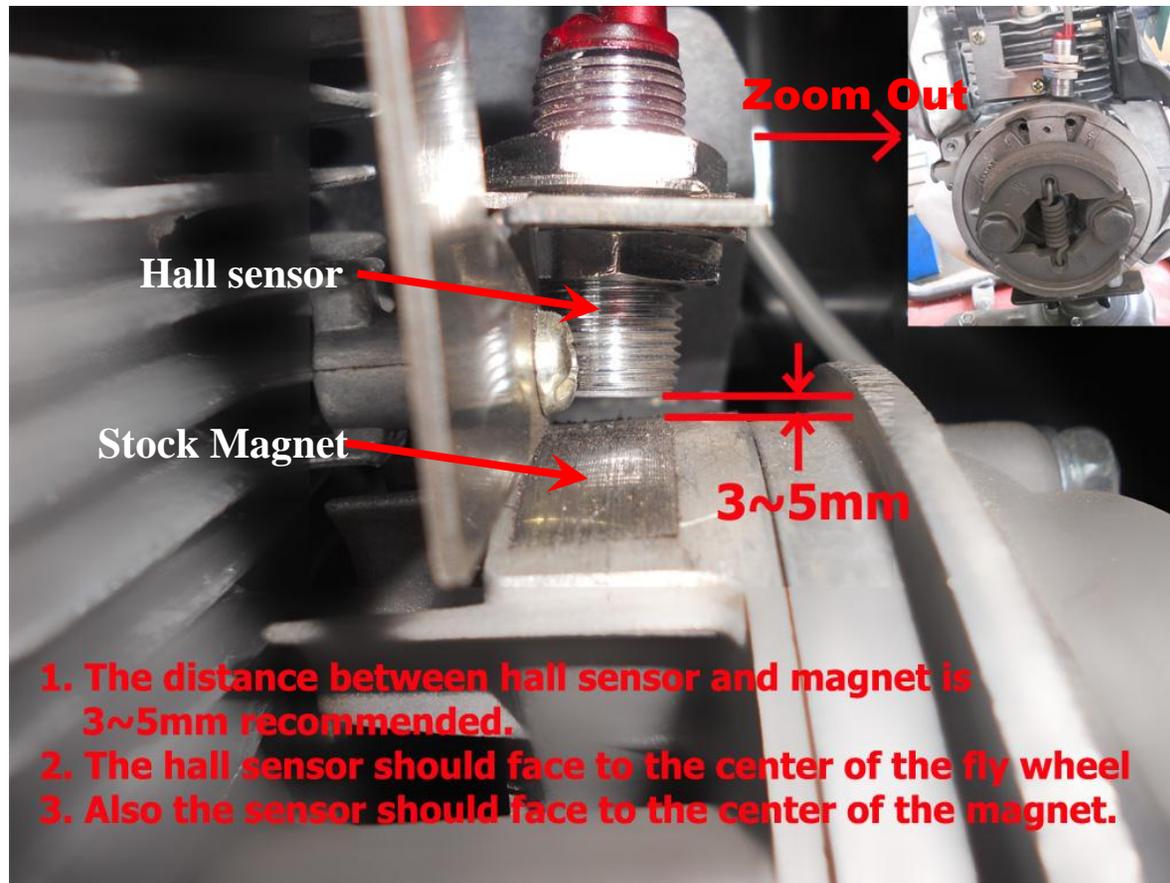
To fix this, we can provide a North Pole Hall effect sensor as the pick-up sensor, so you don't need to install an extra South Pole magnet. But you must tell us before the shipping of the EFI kit.

So we can replace the S-pole Hall sensor with an N-pole sensor.

**Example of Hall sensor installation on Honda GX35 engine with a S-pole magnet:**

**Note:** Hall Effect sensor from Ecotrons is preferred to work with **S polarity** type of the magnet to trigger.

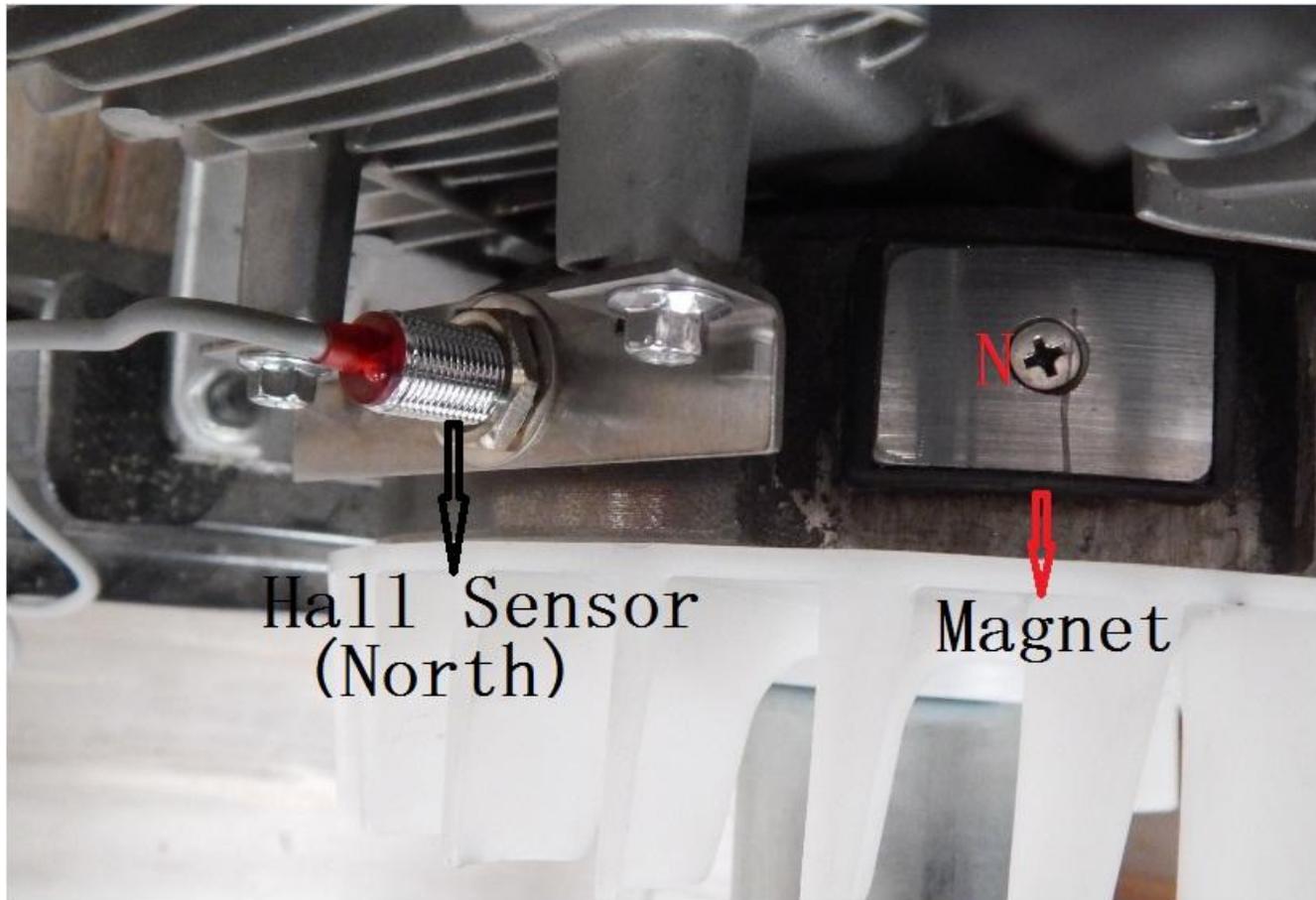




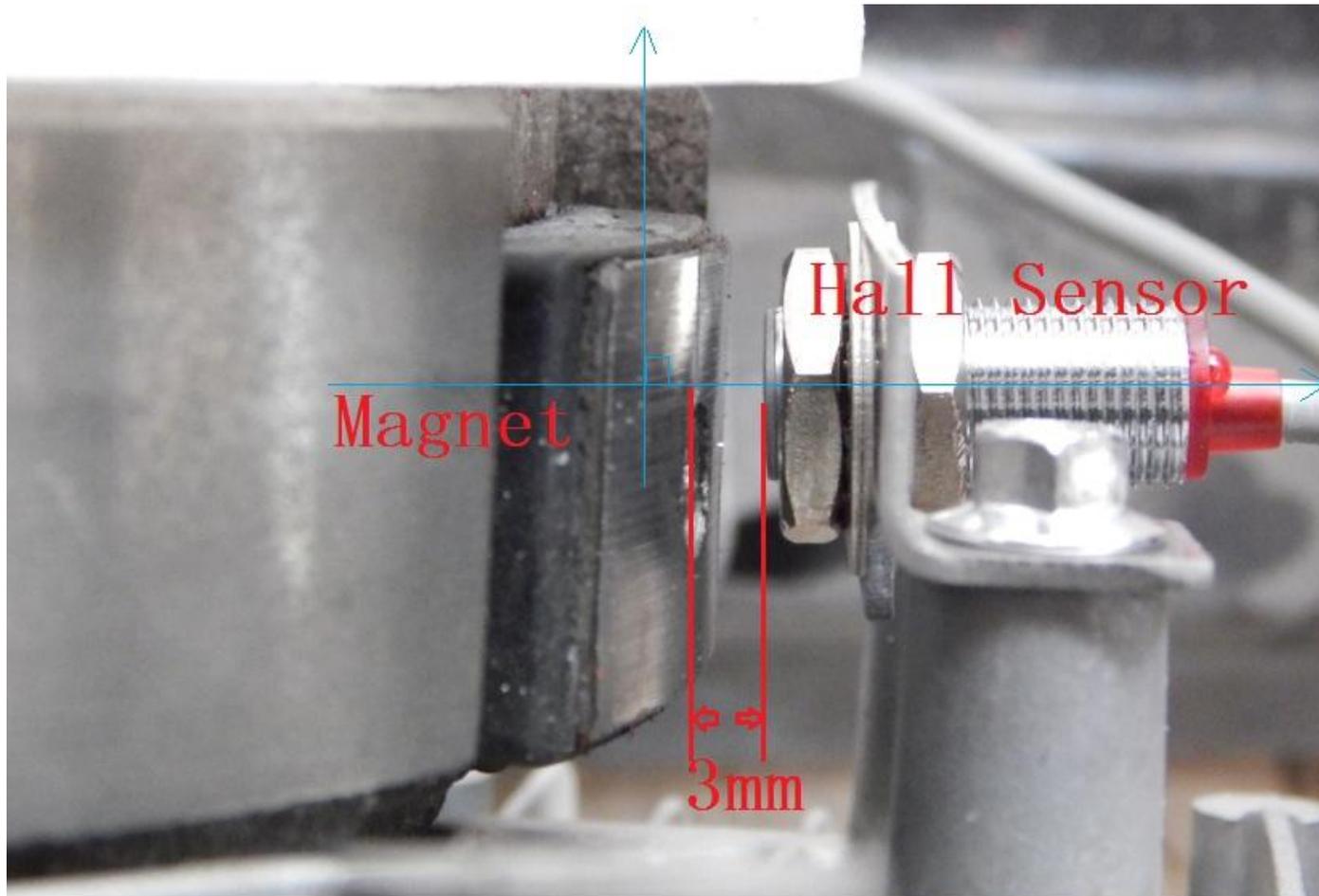
The Hall sensor works with a S polarity of magnet, when it works, the LED will be on.

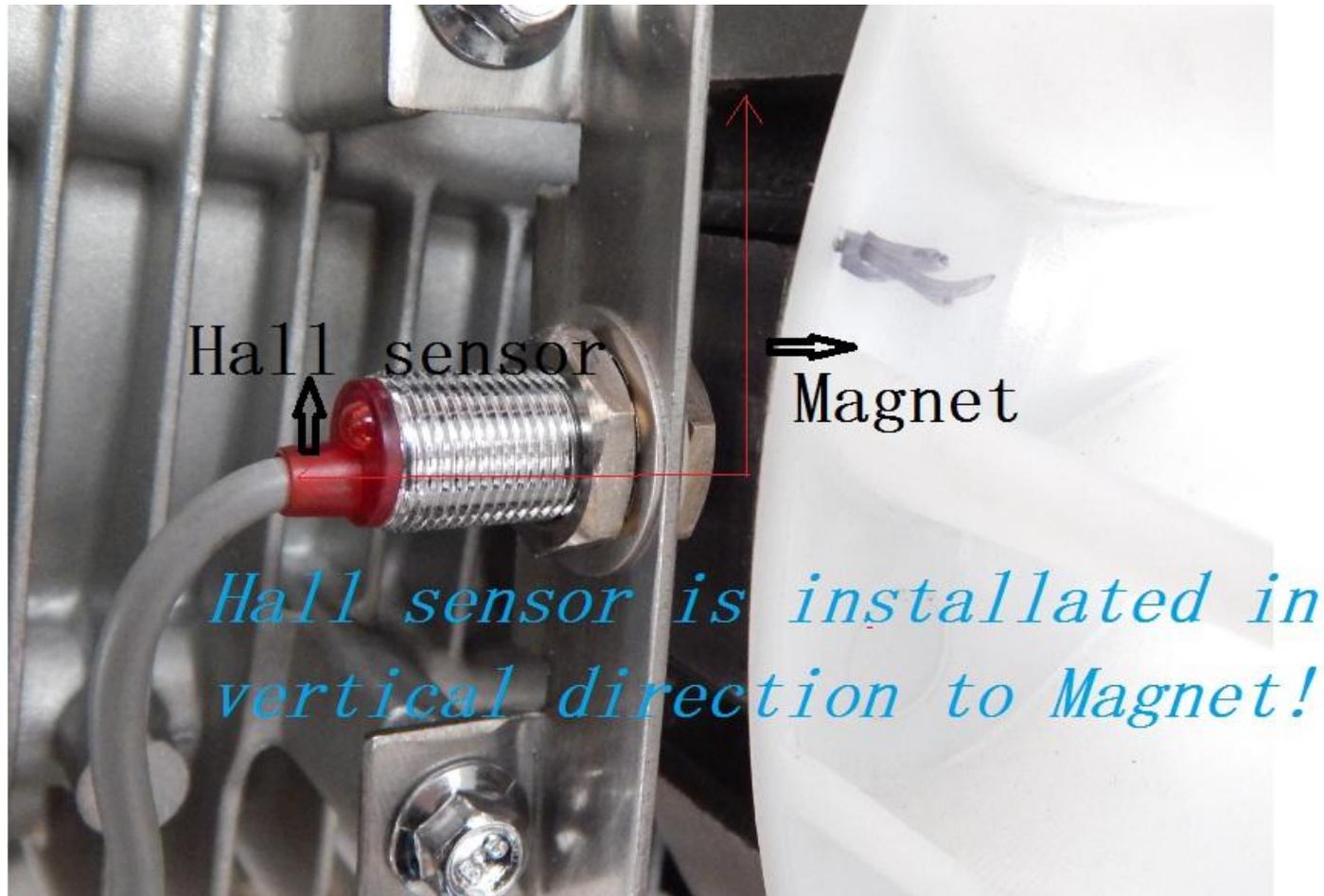
The Hall sensor location and the clearance between the sensor and the magnet are critical for the Hall sensor to generate the correct pulse signal.

Example of Hall sensor installation on Honda GX390 engine with a N-pole magnet:

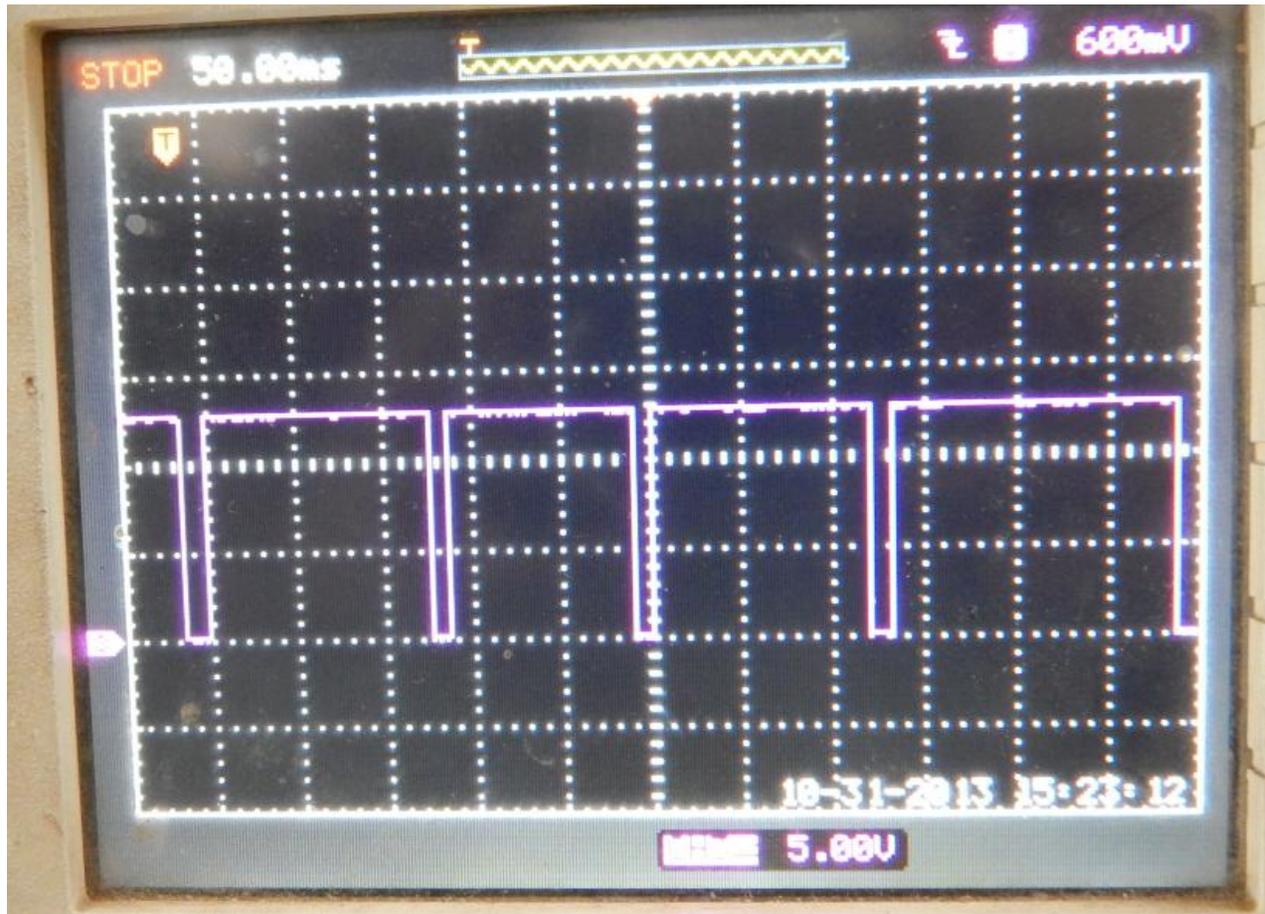


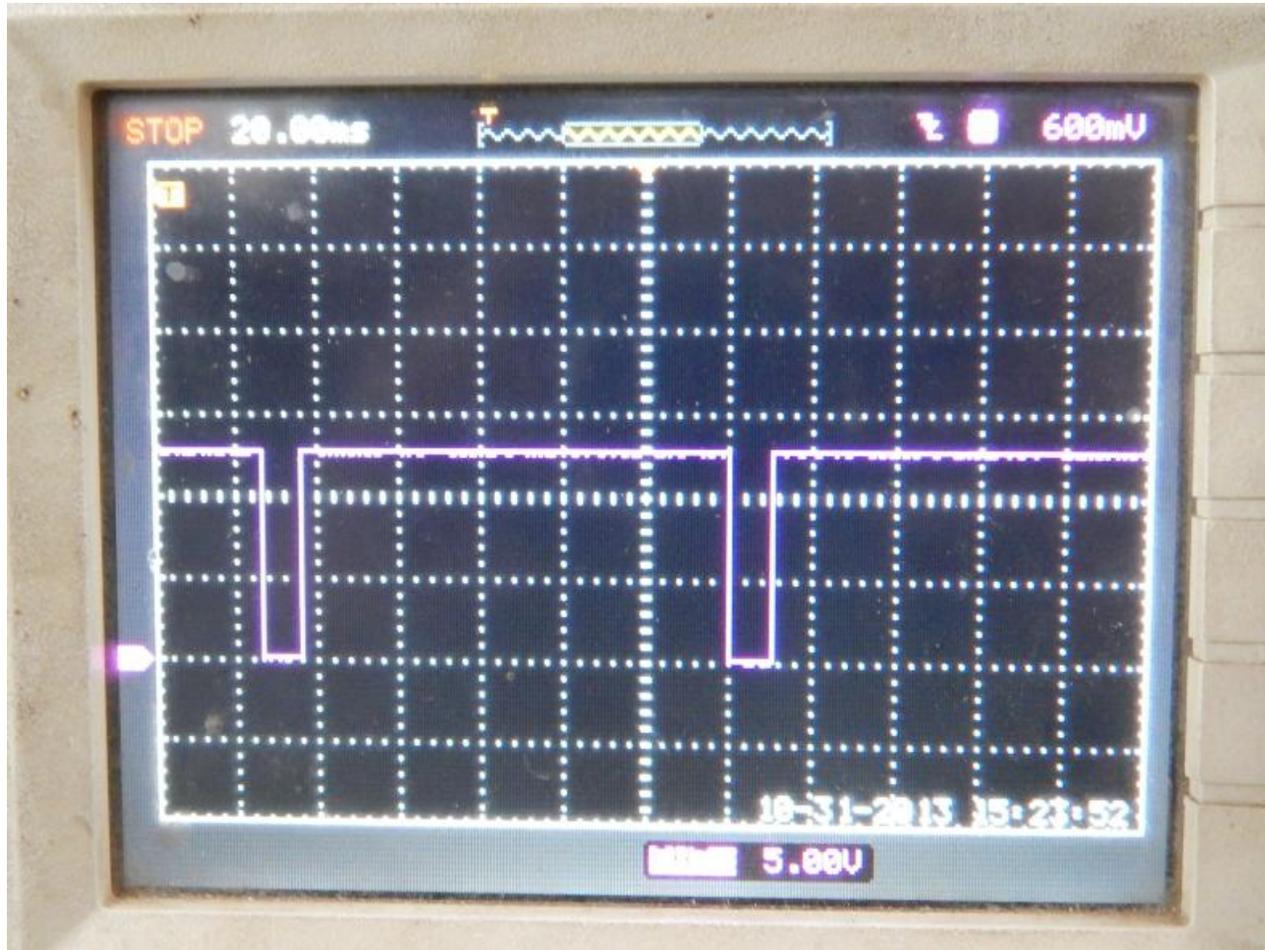
**Install Hall Sensor:**





You can verify the Signal of Hall sensor with an Oscilloscope when cranking to start:





Typical signal

**Note:** The clearance between the Hall Effect Sensor to the magnet should not be too small or too big, and the range from 3mm to 5mm is normal. The hall sensor must be vertical to the magnet, not tilted.

The pulse width of the Hall sensor signal should be bigger than 60 us (micro second) and smaller than 15ms (millisecond). This means the magnet width should be in the range of 10mm to 50mm depending on the RPM range.

**Why the EFI doesn't work after the Hall Effect Sensor installed?**

**Q: After installing the Hall sensor, and if I rotate the crankshaft, the LED is On and Off when the magnet passes through the Hall sensor. But EFI does not do anything.**

**A: Step 1:** If you ordered the EFI without the Hall sensor but added the Hall sensor later, likely you do not have the right ECU software. Please check the A2I and CAL file and make sure it is suitable for the Hall Sensor. Or contact us and send back the A2I and CAL file, we will help you to check it.

**Step 2:** Check whether the Hall sensor polarity is same as the magnet polarity. If the sensor LED only turns on at the edge of the magnet, but turns off in the center of the magnet, this means they have opposite polarity. You need contact us to get a different polarity Hall sensor, like a N-pole sensor.

**Step 3:** Double check the wire connection if it is yourself who connected the individual wires. The power wire of Hall sensor, and the signal wire to CKP (Orange) wire; the ground wire to harness ground or 12v negative. You can take some photos and send to us for confirmations.

If you ordered the EFI with the Hall sensor and the harness comes with the Hall sensor connector, then you don't need to worry this step.

**Step 3:** The ultimate check: use an oscilloscope to measure the signal from the CKP wire. Most people don't have a scope, Some may have it in the lab. It is a bullet proof way for those who have a scope.

When the Hall sensor is aligned with the magnet, the LED is on, the voltage should be 0V (low voltage); and when the Hall sensor is not aligned with the magnet, the LED is off, the voltage of the signal should be 12V (high voltage).

**Q: After installing the Hall sensor, ECU can read the RPM signal, but it is not easy to start or it is not running stable**

**A:** Likely the installation of Hall sensor is not perfect. The sensor may be mis-aligned with the magnet, or skewed against the flywheel. Please double check the alignment, and please read closely the previous section, and pictures there; and adjust the Hall sensor position precisely.

**Note:** The clearance between Hall sensor and Magnet is better at 3-5mm

Hall sensor is installed as vertical to magnet.

Also the sensor should face to the center of the magnet.

Both length and width of the magnet must be 12mm at least.

**Q: I use the stock magnet, but there are two magnets on the flywheel, the engine can't start**

**A:** The 2 magnets may have different polarity. One is N-pole, one is S-pole. Check which magnet turns the Hall sensor LED on. If the LED turns on more than once in a full revolution, then ECU gets confused, In this case, you need to identify what are the polarity of the leading magnet, and get a Hall sensor for that magnet, If the LED only turns on only once, and it turns on during full magnet length, not just at the edges of the magnet, the sensor is matching, and you may need a correct software ( CAL file).

So, please use the corresponding Hall sensor to match the stock magnet, for example, the stock magnet is N-pole, you need use a N-pole Hall sensor; the stock magnet is S-pole, you need use a S-pole Hall sensor.

Another way, you can get rid of the stock magnets, or not to use the stock magnets, and use the magnet comes with the EFI kit (if you ordered the Hall sensor with the EFI, there is one magnet included).

**Q: I didn't order a Hall sensor, but I installed a Hall sensor later**

**A:** please install the Hall sensor in the correct method, and contact us for the correct software for the Hall sensor system. Our generic EFI kit comes by default to work with a VRS type of sensor, Variable Reluctant Sensor. It generates a positive pulse to ECU. It is High assertive.

The Hall effect sensor generates a reversed polarity pulse, and it is low assertive.

So in this case, you need a new CAL file from us (software file).

You may be able to change the CAL if you can find it: VAL\_CKP\_Pulse\_Polarity = 0 or 1.

## Chapter 2 Engine Start

### 2.1 Start issue trouble shooting

#### After install the EFI system, the engine doesn't start, why?

There are some questions need to be answered first:

##### 1 .which signal is used as the pick-up signal?

Is it the stock pickup (coil), or a Hall Effect Sensor? or is it from the Kill witch wire?

If it is a stock pickup (coil) signal, connect the orange wire labeled as CKP from the ECU harness to the pick-up signal of your stock CDI ignition. The other wire of the pickup sensor usually is grounded in your stock system. Connect the green GND wire from the EFI harness to the pickup ground.

If it is a hall sensor, please check: is the hall sensor installed correctly (see Chapter 1)? You need find out what polarity the magnet has. Usually our Hall sensor is triggered by the S polarity magnet; and the distance from the hall sensor to the magnet should be in the range from 2mm to 5mm,.

If it is the stock kill switch wire, you need connect the orange CKP wire to the kill wire, and connect the green wire from the ECU harness to the chassis or the ground of the stock system. If possible, use a scope to check the kill wire signal is clean, meaning, only one pulse per revolution.

**Make sure your engine block is connected to the 12V negative, so all grounds are common!**

## **2. The pickup is correct, but the engine still doesn't start, why?**

Do you have the MAP sensor connected to the intake manifold for 4 stroke engines? The Map sensor needs to measure the vacuum for 4 stroke engines to start.

For 2 stroke engines, MAP sensor can be hanged in the air and measure the ambient pressure only.

## **3. Does the fuel pump turn on for a few seconds when powering on the ECU?**

If the fuel pump does not turn on after the ECU power is on, then check your wire connection. Or if the fuel pump does not turn on when the engine is spinning, you need to check the CKP wire connection.

## **4. Is there a RPM reading by ECU ?**

Start to use ProCAL to read the RPM. Connect your laptop to the ECU. If there is no RPM reading when the engine is spinning; that means something wrong with the CKP signal, or the MAP sensor signal for 4 stroke engines.

## **5. Is there any fuel injection when cranking?**

1) un-screw and pull out the injector, 2) seal the hole of injector mount; 3) hold the injector in air, point the injector to a safe direction, and use a cloth to block fuel jet! 4) crank the engine;

If there is no injection, Please check the CKP wire connection. And/or MAP sensor connection

Have you connected the engine chassis to the negative of the battery?

Have you connect the green wire labeled GND to the negative of the battery or to the chassis?

All grounds must be ended with the negative terminal of the 12V battery.

## **6. No spark?**

Do you use the stock ignition system or use Ecotrons ECU to control the ignitions?

If stock ignition system, check your stock CDI, coil, and spark pug.

If use Ecotrons CDI to control the ignition, please check the installation of Ecotrons CDI and Coil, and make sure the high voltage cable is fully plugged to the spark plug. Please see the installation manual for details.

If you are using a multi-tooth trigger wheel, and an Ecotrons VRS sensor, please double check the installation, and the setting of the trigger wheel in the ProCAL software. (details in the later chapter).

## **7. No fuel flow?**

When the fuel pump is running, (with key on), do you see fuel flowing in the fuel line? Are there bubbles in the fuel hose?

Is the pressure regulator installed correctly?

Can you see the fuel flowing back to the tank in the return line after a couple of times of key-cycles?

One way to check fuel supply system is to unplug the high pressure fuel line to the fuel injector, point it to a fuel bottle, and turn on the power; you should see fuel sprout out of the high pressure line.

## **8. Is the fuel pressure enough?**

This is a frequent happening issue mostly because of the low battery, or incorrect installation of the fuel supply system. All these problems end up as the low fuel pressure. The best way to trouble shooting the fuel supply system is to install a fuel pressure gauge, which can be bought in any auto parts store.

When the power is on, the fuel pressure should reach 3 bar or 43 psi normally. If the pressure is significantly low, then check your battery voltage, or fuel supply system.

## **9. Is the idle air enough?**

You may not have enough idle air, to start the engine. Try crack-open the throttle a little, like 2%-5% opening, and then crank the engine. Does it fire ?

### **10. Is there enough starting fuel?**

The start fuel may not be enough, give a quick enrichment by using “VAL\_fFIApp” ( see Section 2.3 for details) ?

### **11. Log data and send us.**

“ I have checked all the above items, and I think they are all normal, but I still can't start the engine”.

Please log some data with ProCAL and send us; and we will help you to trouble shoot. Note, when logging data for start issue, follow these steps: Key on → connect ProCAL to ECU → start recording → crank engine → engine not started → stop recording → find the data log files → send by email.

Some engines have 2 pulses per revolution, and some engines have some unique pulses like negative pulses only. All these need to be identified to have the correct CKP signal. One way is to log data with ProCAL and send to us.

It is also helpful to send us some pictures of your EFI installation, especially on how you connect the loose end wires.

## **2.2 Map sensor installation**

For 4 stroke engines, you need to connect the MAP sensor to the intake manifold. And the intake manifold is sealed and air tight; MAP sensor must read the vacuum during engine start process.

[Incorrect installation of the MAP sensor can cause not-able-to-start engine, or it can short the MAP sensor life.](#)



The example to install the MAP sensor

**Note:** Important Notes for installation of the MAP sensor:

- Connect the Map sensor to the manifold or the throttle body (downstream of the throttle plate), and make sure it is air tight! MAP sensor is meant to measure the pressure between the throttle plate and the intake valve.
- You need a short hose to connect; less than 2 inches or 5cm long, no longer than 4 inches or 10cm. Too long a hose can cause some deviation of the sensor reading.
- The MAP sensor should not be too closed to the engine block. Air cooled engine block can get to 200 degree C which is much higher than the MAP sensor working temperature. This can damage the Map sensor.
- MAP sensor itself is not fuel proof. You shall avoid fuel getting into the MAP sensor chamber. This means you shall install the MAP sensor on top of the throttle body or manifold, so that the gravity will pull the fuel down to the manifold, in case the fuel gets into the tube.
- Make sure the MAP sensor hose is not severely bent, or not routed in circle; otherwise a pocket could be created and the fuel puddle gets stuck there. Fuel puddle could also get into the MAP sensor and damage it.

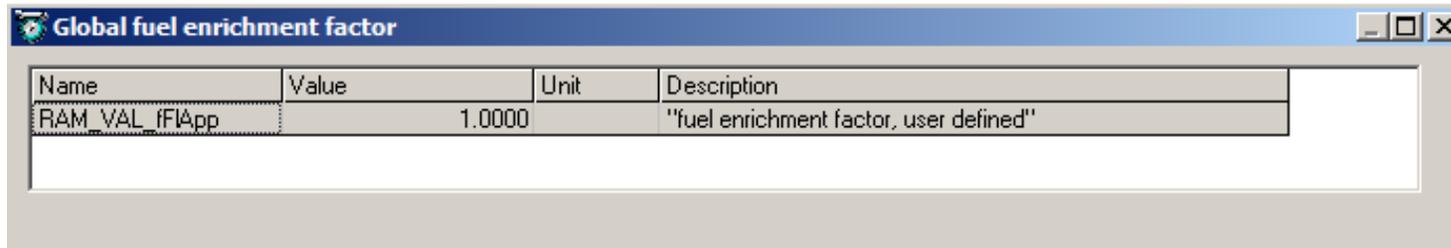
## 2.3 Global fuel tuning

**VAL\_fFIApp** (RAM\_VAL\_fFIApp) - "global fuel enrichment factor, user defined"

In ProCAL:

Menu → Calibrations → Fuel system → Global fuel enrichment factor →

VAL\_fFIApp = 1.0 (default).



Name	Value	Unit	Description
RAM_VAL_fFIApp	1.0000		"fuel enrichment factor, user defined"

It's a global enrichment factor multiplied on the base fuel, meaning, if you change it to 1.5, you'll get 1.5 times of the fuel everywhere. And it applies to all operating conditions (start, warm-up, and steady-state, transient). It has a range of 0-4.0.

This factor is only supposed to be used temporarily. It's kind of "quick and dirty" fix just for you to fire the engine up and not to stall. The change should be removed once you know the system better, and tune the engine with appropriate parameters.

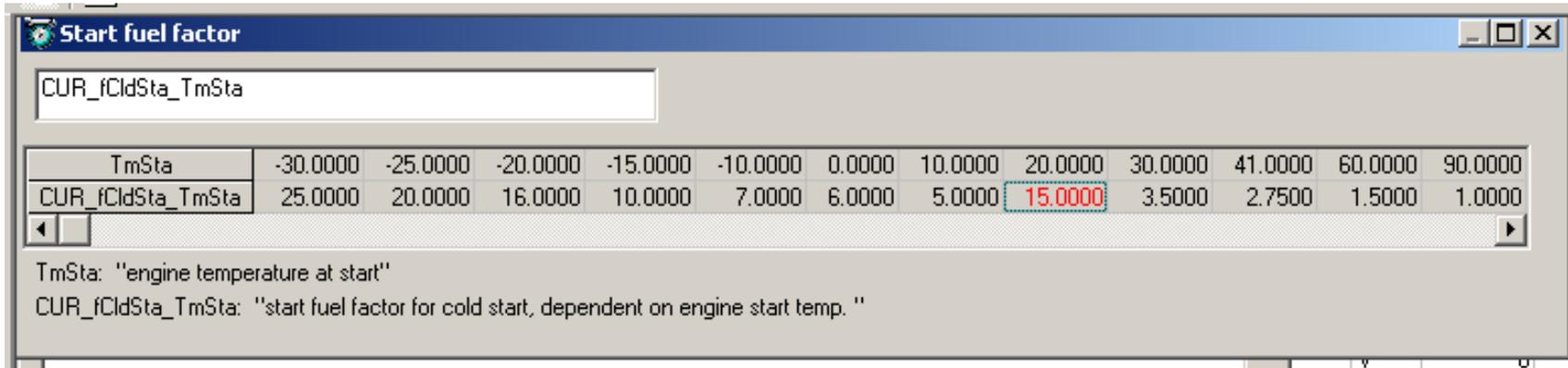
Certainly you can enlean the fuel global-wise, by setting it to smaller than 1.0.

## 2.4 Start fuel factor

**CUR\_fCldSta\_TmSta** - "start fuel factor for cold start, dependent on engine start temperature."

In ProCAL:

Menu → calibrations → fuel system → start fuel factor →



This is probably the most important tuning parameter for engine start.

- 1) Start fuel can NOT be self-tuned by the ECU. Self-tuning is only possible in the "close-loop" control, which is only active after the engine is fully warmed up. ECU cannot learn the engine during the start.
- 2) Every engine can be different. The start fuel could be different from one to the other. Especially if you have modified the intake manifold or added an adaptor for the throttle, or simply because your engine is different than ours, the base calibration engine, which is a 125cc GY6 engine. The initial wall wetting and the amount of lost fuel during start could be significantly different from engine to engine.

- 3) Good news, we tried to calibrate the start fuel to be a little rich, and to cover more engines, and to make your initial fire-up successful. So most likely, you can start your engine after a few tries, if your intake air system is not modified significantly. Yet, you could end up tune your start fuel by your-self. Because this part can only be done via trials.
- 4) Tuning tips: read your engine temperature before start, "Tm", in ProCAL, locates the closest break point of "TmSta" in the table, and change the associated start fuel factor value. Try to start the engine, after a few trials; you identify the best value for that temperature. Then you can apply the similar changes to the neighbor points.
- 5) Start fuel only applies during start. Once the start of engine is ended, indicated by that the engine speed (N) is greater than 1000rpm; the start fuel will be inactive. The after-start fuel and warm-up fuel will take over.

**Example:** Early in the morning, Key on, connect your laptop, read the Tm (or ECT), in ProCAL, say, it's 9 deg C. Then find the cell in the table where the break point is the closest, 10C in this case; and the existing value is 5.0; meaning, 5 times enrichment is the pre-set.

Most likely you are starting a little leaner at that temperature; so you would increase the value to 5.5; and then "burn to ECU".

Then you crank the engine again; see if the starting is better. If not, you may have to wait for next day morning, and increase it to 6.0; and try it again.

You may end up over-enriching the start fuel, which causes black smokes, and strong smell, and even engine flooding. In that case, you may go to the other direction, reducing the enrichment factor.

The challenge is that there is no direct measure which tells you whether it's too rich or too lean. It's really based on your feeling and experiments.

## 2.5 After-Start and Warm-up fuel factor

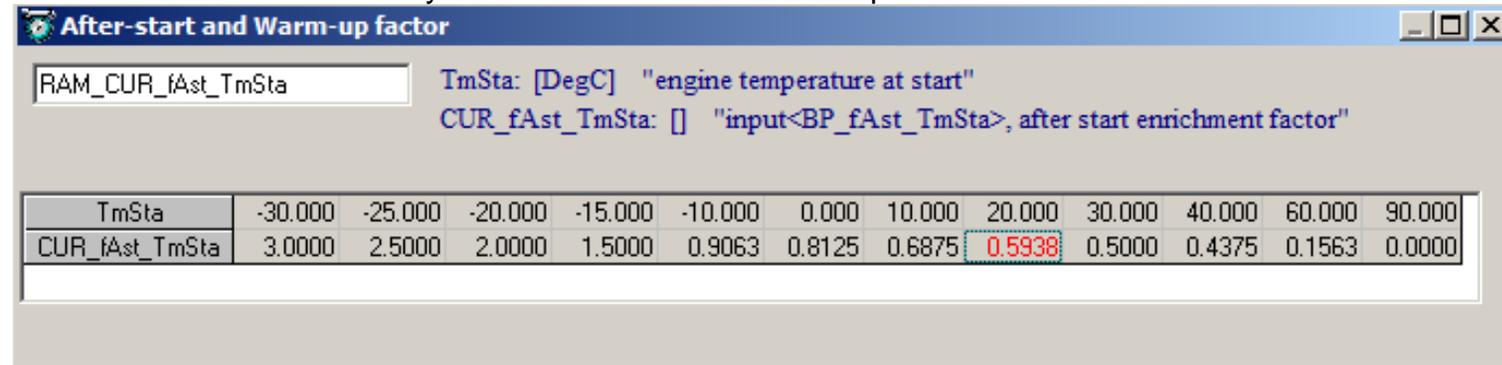
**CUR\_fAst\_TmSta** - "after-start fuel enrichment factor, dependent on engine start temp."

The output of this Curve will be added on top of 1.0 as the after-start factor.

It will be ramping down to 1.0 with the engine running time increased after start.

In ProCAL:

Menu → calibrations → fuel system → after start and warm-up factor →



**Note:** After-start factor is actually = 1 + look-up table value.

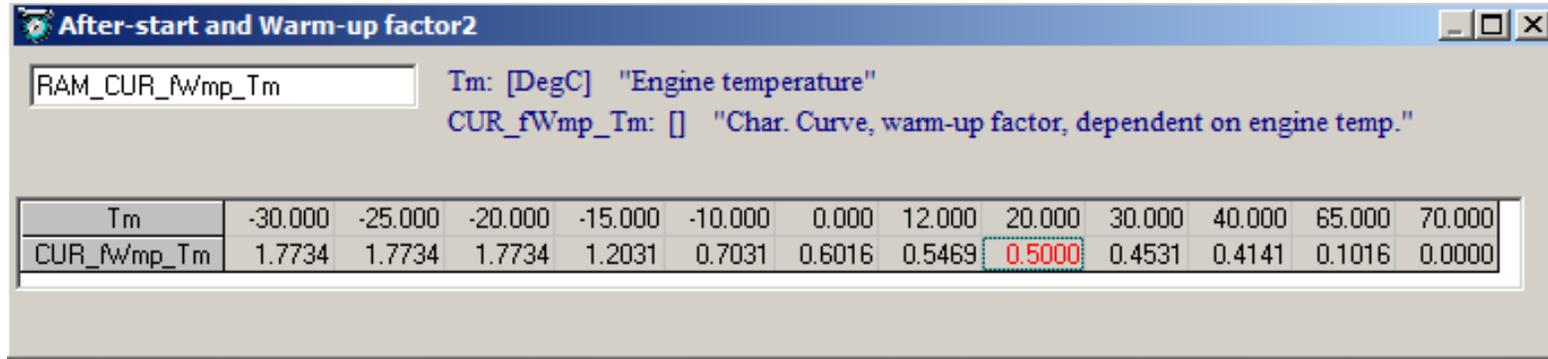
For example, if you set the table value as 0.6; the after-start factor is = 1.6.

Why? It is easy for software implementation.

**CUR\_fWmp\_Tm** - "Warm-up fuel enrichment factor, dependent on engine temp."

In ProCAL:

Menu → calibrations → fuel system → after start and warm-up factor →



Same: warm-up factor is actually = 1 + look-up table value.

**For example, if you set the table value as 0.6; the warm-up factor is = 1.6.**

Why? It is easy for software implementation.

**Q: What is the difference between after-start fuel and warm-up fuel?**

After-start fuel is carrying over the start-fuel enrichment, and quickly ramping down to 1.0. It is dependent on the engine start temperature only.

Warm-up fuel is dynamically adjusting the fuel dependent on how fast the engine temperature warms up. It also takes into account of the impact of engine load and speed.

**Q: Tips for after-start and warm-up fuel**

Too complicated? Good news! You do NOT have to tune these 2 factors in most cases, because:

- 1) They are normalized for most engines, close to good for most engines.

- 2) They are designed for emission reduction purposes. For after-market conversions, pre-set data are often good enough.
- 3) Exceptions #1: if you notice the engine clearly fires for the start (during first couple of revolutions), and the RPM rises quickly to more than 800rpm, but then stalls immediately; this tells you that the after-start fuel is not enough. You will need to increase the after-start fuel factor.
- 4) Exception #2: if you notice that the engine starts, and idles at relatively good rpm, like 1800rpm, but then slowly it dies with engine warms up. This tells you that you may need to enrich the warm-up fuel to keep engine running after the start-up and after-start fuel factors ramping out.

**Q: Engine starts, and idling, and can stay running, but kind of rough. What's next?**

As long as you can start the engine and let the engine running and not stalling. You are fine for now. Engine will warm itself up, and quickly the warm-up fuel factor will ramp down to 1.0 (neutral). Next we will make sure the engine can be run in open-loop mode comparatively stable.

**Note:** once engine can stay running, then wait for engine warmed up, and tune the base fuel mapping first (VE table, Load table, see later chapters). Don't do fine-tuning on the start fuel factor, after-start, and warm-up fuel factors before you have a good base fuel mapping, because these factors are nothing but a multiplicative factors on the base fuel.

**More on Start, After-Start, Warm-up process:**

See below the 2 graphs of start and warm-up process from a real scooter engine:

Descriptions:

- 1) The engine starts at 30C degree; and idles up to 70C degree (where the warm-up process is ended);
- 2) Start fuel factor starts at 3.2 (fFISta), for example; and drops to 1 as soon as the RPM > 1000rpm (start ended); this only takes a few seconds;
- 3) After-start fuel factor starts to take over when start is ended ( fFISta =1); and for example, it starts at 1.23; and quickly ramps down to 1; and this takes about 1 minute (or 60s); This factor is dependent on the engine start temperature only (30C);
- 4) Warm-up fuel factor happens simultaneously with the after-start factor, but it ramps down very slowly; it starts at 1.4; and takes about 6 minutes (360s) to ramp down to 1, when ECT is 70C deg. This factor depends on real-time engine temperature (changing from 30C to 70C).
- 5) The close-loop fuel only happens 3 minutes after start, where the O2S signal starts to oscillate.
- 6) Overall fuel enrichment factor, fPreCtl, is the results of all 3 factors, start factor, after-start factor, warm-up factor:

**fPreCtl = fFISta \* VAL\_FIApp** (during start)

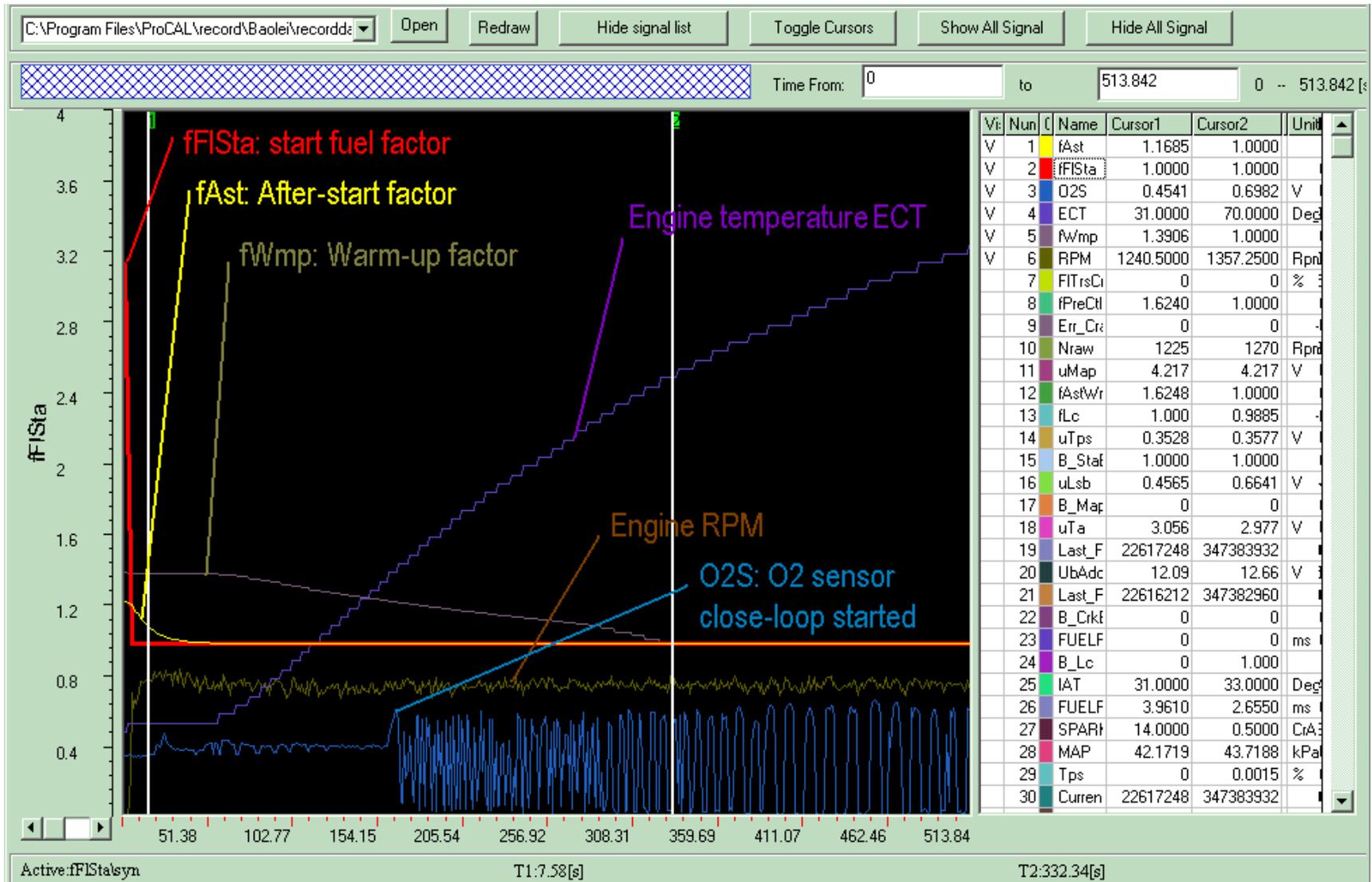
**fPreCtl = fAst \* fWmp\* VAL\_FIApp** (during after-start, warm-up)

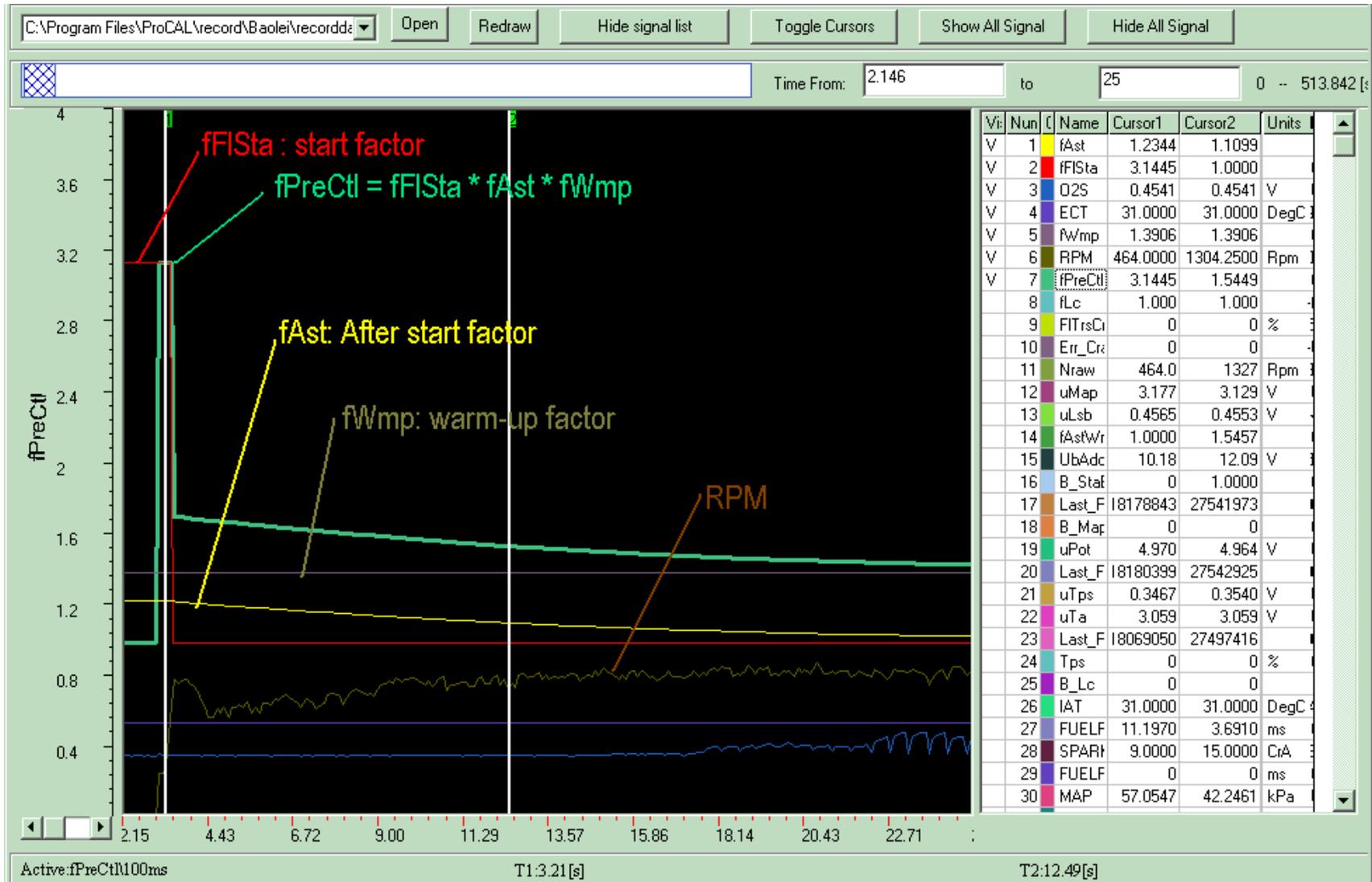
**Note:** During start, fAst and fWmp are not used; meaning they are equivalent to 1; VAL\_FIApp is the global enrichment factor.

**fPreCtl** is the overall enrichment factor.

It is the green line in the second graph.

**Note:** In your logged data, you can only see this variable plotted. It tells you how your starting-warm-up fuel is controlled.



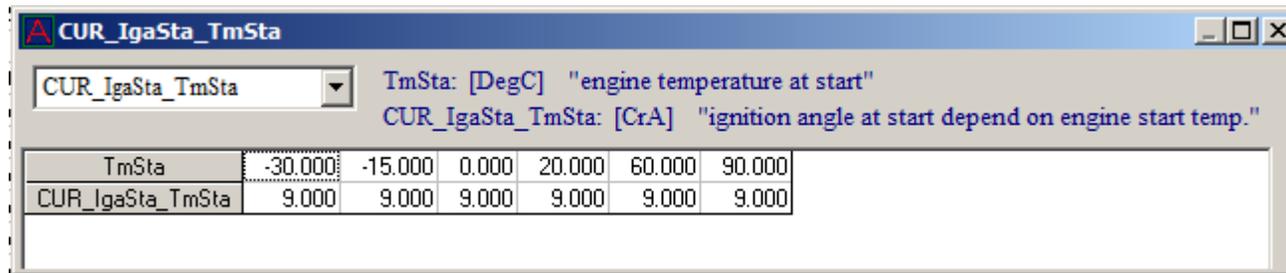


## 2.6 Start ignition angle

If you use Ecotrons' CDI to control ignition, the default start ignition angle may be not suitable, if it has start ignition issue, you can try to modify the start ignition angle table Ignition; it is based on the engine temperature at start.

Please add this advanced calibration variable in ProCAL:

ProCAL → Advanced → Add Advanced Calibrations:



Angle in start: CUR\_IgaSta\_TmSta

When engine go to start, the ignition angle is the value of CUR\_IgaSta\_TmSta

## Chapter 3 Engine idle tuning

### 3.1 Target Idle Speed

If your engine's idle RPM is not stable, or too high, or too low, it may be because of the idle air, so you need to adjust it as the below methods.

**Certainly, you must make sure the whole air intake system is air-tight first!**

Past experience shows that during initial installations, some users forgot to make sure the air-tight of the system, and end up high "idle" RPM, like 4000rpm; and which actually leads to RPM oscillations! Because our ECU is trying to cut the fuel to lower downs the idle RPM.

So if you see an oscillating idle RPM from 4000rpm to 1000rpm that tells you that you should check your intake air system, and find out air leakage!

**Note:** The idle speed with a cold engine could be lower than the warmed-up engine, especially if you do not use the EFI to control the ignition system.

If your engine idle speed is already high after warmed up, do not make the idle air too high in the cold.

If you notice that you have to hold the throttle to open a little to start the engine and keep the engine running, and as soon as you let the throttle go, the engine stalls. This means you may have too less idle air. This could be the case especially for the big engines, where more idle air is needed than for the small engines.

If you do not have our ECU-controlled CDI to control the ignition angles, you will have comparatively low idle speed at cold start and higher idle speed after warm-up. This is normal.

How do you have a constant idle RPM, regardless of a cold or hot engine? You need to have our ECU-controlled ignition system.

See the chapter of "Ignition Angle Tuning".

## **3.2 Idle speed adjustment via Mechanical methods**

### **3.2.1 Single cylinder idle air screw adjustment**

Our 28mm throttle body comes with an idle screw; if your idle speed is too low, or too high, you can adjust the idle screw to get more or less idle air.



Adjust the idle screw:

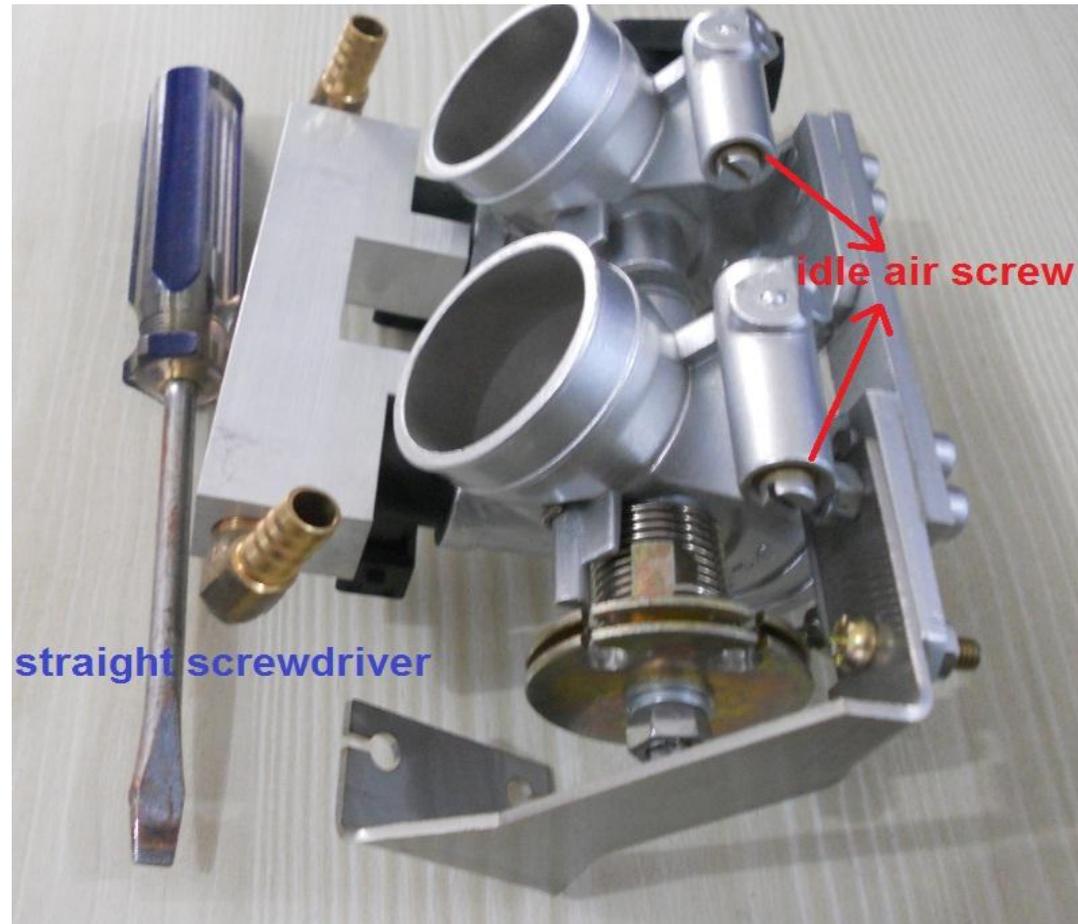


### 3.2.2 Adjust idle air for two cylinder balance and idle RPM if need

If you have our dual throttle body for a parallel twin engine (like Ninja 250r), and you want to adjust idle air by adjusting the screws, **you must make sure the adjustment of both idle screws are same**. Otherwise, you could have unbalanced idle air between 2 cylinders.

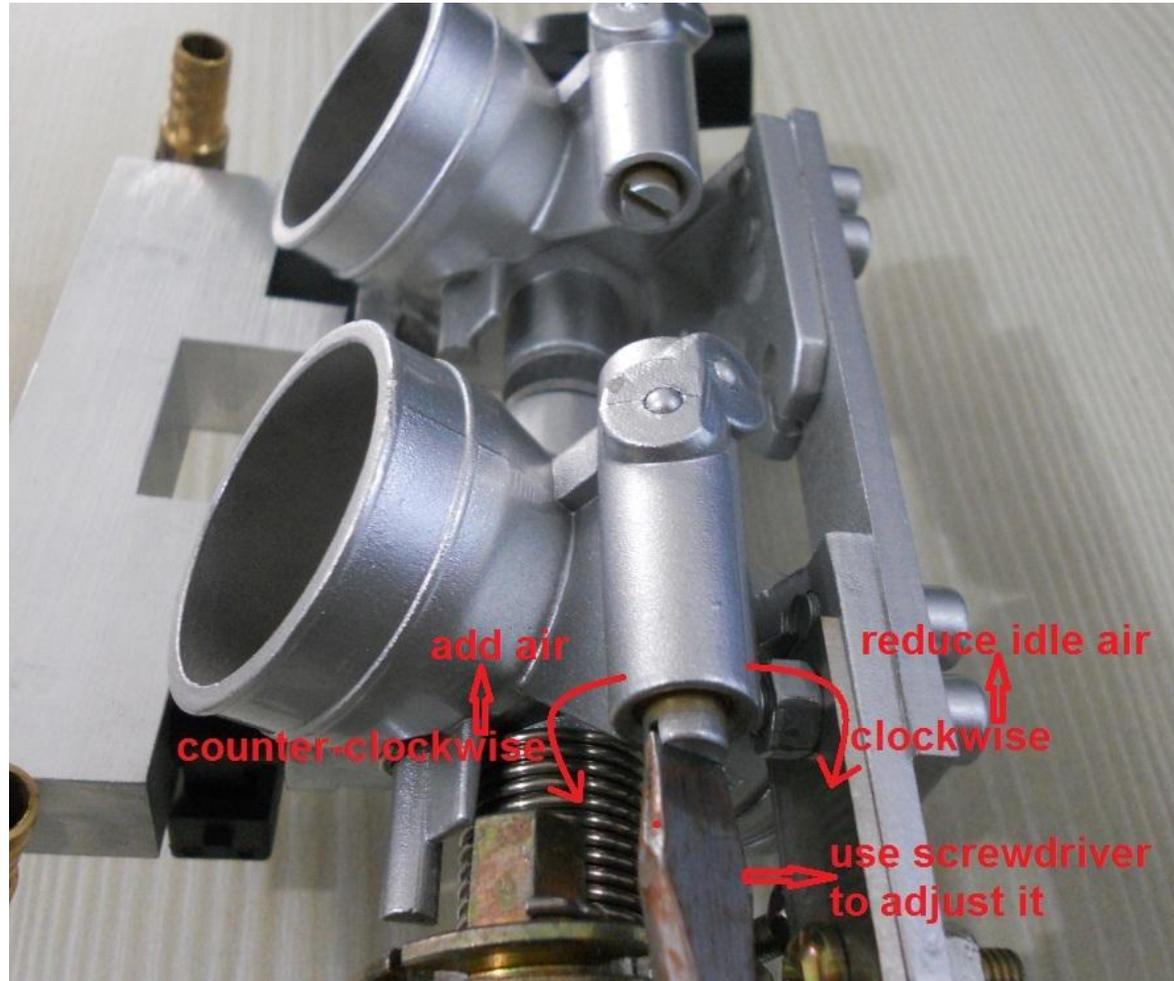
1) Adjust the idle air screw

1.1) Adjust the idle air screw in throttle body. If your idle is too high or too low, or the two cylinders are not in balance, you need to adjust the intake air by adjusting the idle air screw.



If you want to reduce the idle air, turn the idle screw in clockwise.

And if you want to get more idle air, turn the idle screw out in counter-clockwise. See below picture.



2) Which signals can you use in ProCAL software when you adjust the balance?

Here are some ProCAL data analysis and see how much you are interested. In the end, attached is a plot of the signals from the logged data.

And it shows how I find out your cyl # 2 has more idle air than cyl #1.

Mainly, there are 4 signals from O2 sensors you can check:

**uLsb**: voltage signal of lambda sensor #1

**uLsb2**: voltage signal of lambda sensor #2

**fLc**: factor of lambda control cyl #1

**fLc2**: factor of lambda control cyl #2.

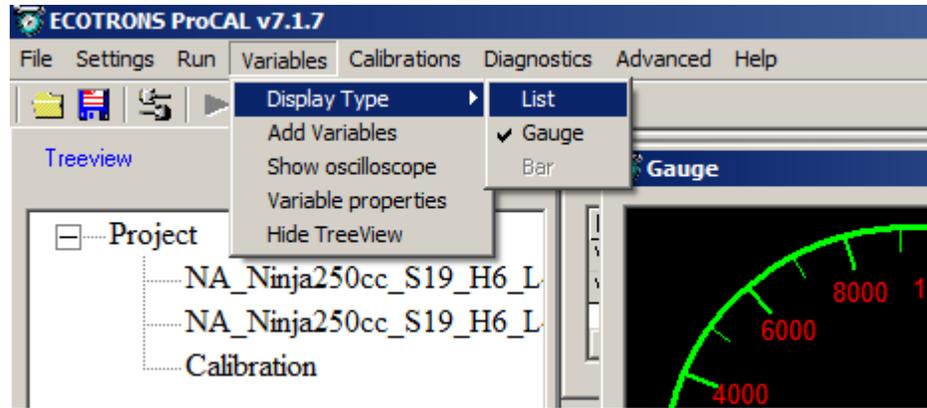
Lambda means equivalent air fuel ratio.

The laptop tuning is all about data analysis. You need to know what signals to look at in the logged data.

All the signals (variables) have descriptions in ProCAL, if you only put your mouse onto it.

(1). Open ProCAL, load the A2I and CAL file that we sent you. Then change the Display Type from Gauge to List.

(Go to menu->Variables->Display Type->list.)



Then, you will see below window

Vis	Col	Name	Value	Rate	Unit	Min	Max	Description
		FI		Syn	%	0	3072	"Relative fuel mass"
		IgaOut		Syn	CrA	-96	95.25	"Ignition angle output value"
		Ld		Syn	%	0	1536	"Load, or relative air charge"
		LdPrd		Syn	%	0	1535.977	"load predicted for injection"
		LdTp		Syn	%	0	1535.977	"Load through throttle valve"
		Maf		Syn	kg/h	0	1572	"Mass air flow"
		Map		Syn	hPa	0	2560	"Intake manifold pressure me"
		N		Syn	Rpm	0	16383	"Engine speed in Rpm"
		nInj		Syn		0	65535	"number of injections "
		tInj0		Syn	ms	0	65.535	"injection time for injector #0"
		fLc		20ms	-	0	2	"Lambda controller output (w"
		Nraw		20ms	Rpm	0	16383.75	"Engine speed in rpm from L"
		Tps		20ms	%	0	100	"throttle position with respec"
		UbAdc		20ms	V	0	25.6	"battery voltage; scanned va"

(2). Find the useful variables for adjustment, right-click on the "Selected variables" window, and then choose "Show All Variables".

Maf	Syn	kg/h	0	1572
Map	Syn	hPa	0	2560
N	Syn	Rpm	0	16383
nInj	Syn		0	65535
thj0	Syn		0	65.535
fLc				
Nraw			0	16383.75
Tps			0	100
UbAde			0	25.6
uLsb			-1	
uMap	20ms	V	0	
uPot	20ms	V	0	
uTps	20ms	V	0	
B_CrkErr	100ms		0	
R_ManDrmFrr	100ms		0	

- Add Variables
- Show All Variables
- Show Oscilloscope
- Decimals Display
- Hide Descriptions
- Sort
- Variable properties

fLc and fLc2 are the factor of lambda sensor, you can see whether it is rich or lean.

LdPrd	Syn	%	0	1535.977	"loa
LdTp	Syn	%	0	1535.977	"Loa
Maf	Syn	kg/h	0	1572	"Ma
Map	Syn	hPa	0	2560	"Inta
N	Syn	Rpm	0	16383	"Enr
nInj	Syn		0	65535	"nur
PId	Syn	hPa	0	2559.961	"pre
thj0	Syn	ms	0	65.535	"inje
thj1	Syn	ms	0	65.535	"inje
Current_Timer	20ms		0	94967E+09	"cur
Err_Cranksensing_Flag	20ms	-	0	65535	"bitF
fLc	20ms	-	0	2	"Lar
fLc2	20ms	-	0	2	"Lar
LowPas	20ms	-	0	2	"bas
LamW02	20ms		0	16	"Acl
Last_Falling_Edge_Tim	20ms		0	94967E+09	"LLI
Last_Rising_Edge_Tim	20ms		0	94967E+09	"LLI

(3). After start the engine, engine runs about 3 minutes in idle, closed-loop control of lambda sensor will work. O2 sensor factor fLc and fLc2 will be changed; you can know it is rich or lean according the factor.

If the factor “fLc” is more than 1, it means the default calibration is lean, otherwise, it is rich.

**For example:**

**uLsb**, voltage of lambda sensor, (O2 sensor); if it is less than 0.45V, it means lean. If it is more than 0.45V, it means rich.

uLsb and uLsb2 should oscillate between rich and lean all the time, because that is how the close loop works. But if you see one of them stays low or high for too long, which means you have too lean or too rich conditions.

O2 Sensors are used to read the Rich/Lean conditions, and that's how ECU knows. And that's also how you can read it.

**Note: Engine runs in idle.**

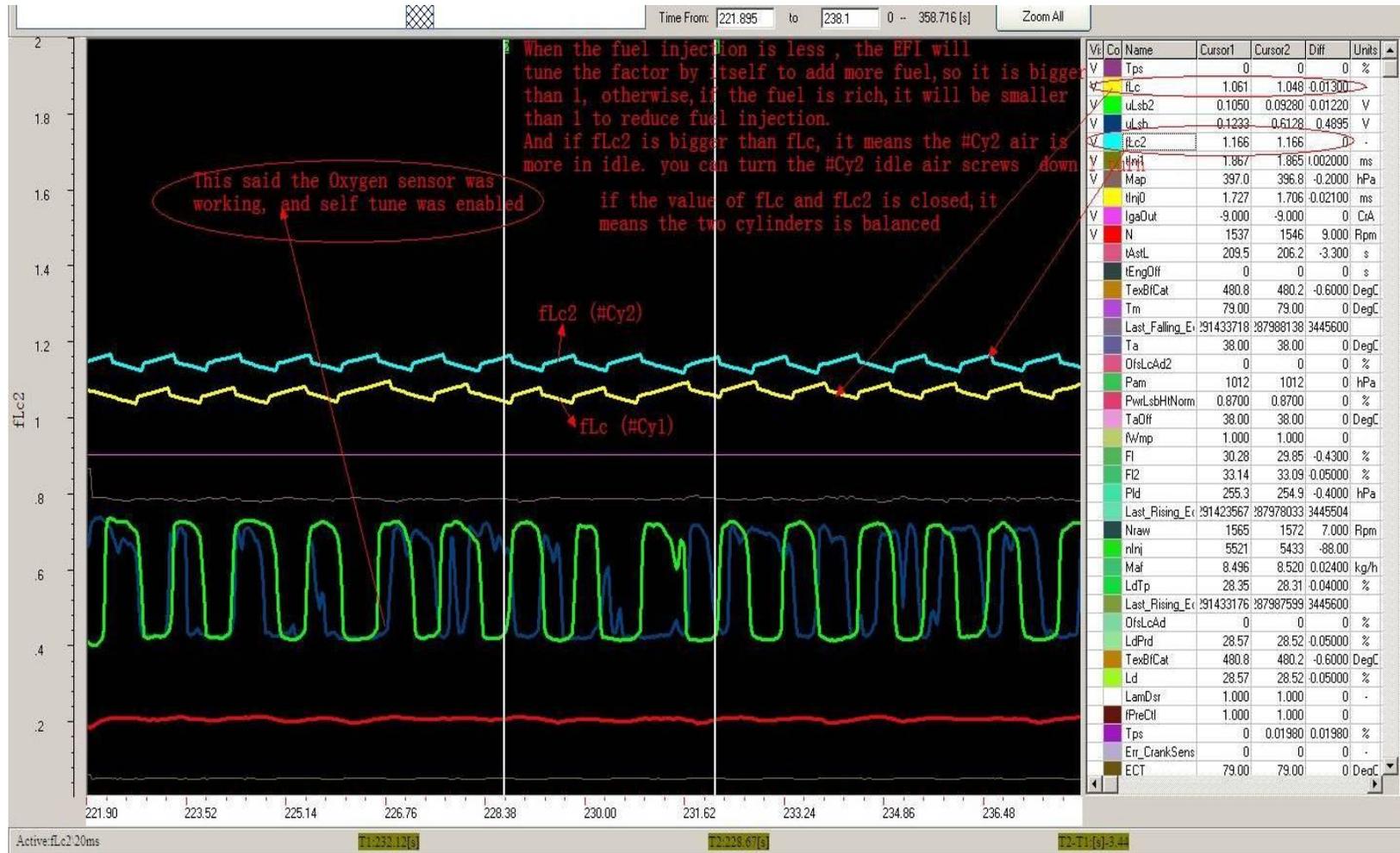
If fLc is bigger than fLc2, it means cly1 gets more air than cly2; you can turn the cly2 idle air screw of throttle body out, to get more air.

If fLc is smaller than fLc2, it means cly2 gets more air than cly1; you can turn the cly1 idle air screw of throttle body out, to get more air.

The target is to make fLc is closed to fLc2, which means the two cylinders are in balance.

Vis	Col	Name	Value	Rate	Unit	Min	Max	Discription
		FI	34.69	Syn	%	0	3072	"Relative fuel mass"
V		IgaOut	-9.75	Syn	CrA	-96	95.25	"Ignition angle output v
		Ld	37.22	Syn	%	0	1536	"Load, or relative air ch
		LdPrd	37.22	Syn	%	0	1535.977	"load predicted for injec
		LdTp	37.41	Syn	%	0	1535.977	"Load through throttle v
		Maf	10.70	Syn	kg/h	0	1572	"Mass air flow"
		Map	472.46	Syn	hPa	0	2560	"Intake manifold pressu
V		N	1486.25	Syn	Rpm	0	16383	"Engine speed in Rpm"
		nInj	4847.00	Syn		0	65535	"number of injections "
		PId	327.62	Syn	hPa	0	2559.961	"pressure in combustion
		tInj0	1.87	Syn	ms	0	65.535	"injection time for inject
		tInj1	1.74	Syn	ms	0	65.535	"injection time for inject
		Current_Time	1557468695.00	20ms		0	.294967E+09	"current timer of LLD "
		Err_CrankSer	512.00	20ms	-	0	65535	"bitFields crank sensing
V		fLc	0.9519	20ms	-	0	2	"Lambda controller outp
V		fLc2	0.9658	20ms	-	0	2	"Lambda controller outp
		FITrsCr	0.00	20ms	%	-1536	1536	"rel. fuel mass transitor
		LamW02	1.00	20ms		0	16	"Actual Lambda measu

**Note:** when the engine runs lean, the ECU will tune the factor (fLc or fLc2) to add more fuel by closed-loop control, so the factor will be bigger than 1, otherwise, if the engine runs rich, the factor will be smaller than 1 to reduce the fuel injection. If fLc2 is bigger than fLc, it means the idle air of Cyl#2 is more than Cyl#1; you can tune the idle air screw in to reduce idle air. And if fLc is closed to fLc2, it means, the two cylinders are nearly balance.



Another way to make sure the idle air is enough is to read the idle ignition angle after warm up, the ignition angle (IgaOut) should be -6 to -10 degree during stable idle after engine warmed up.

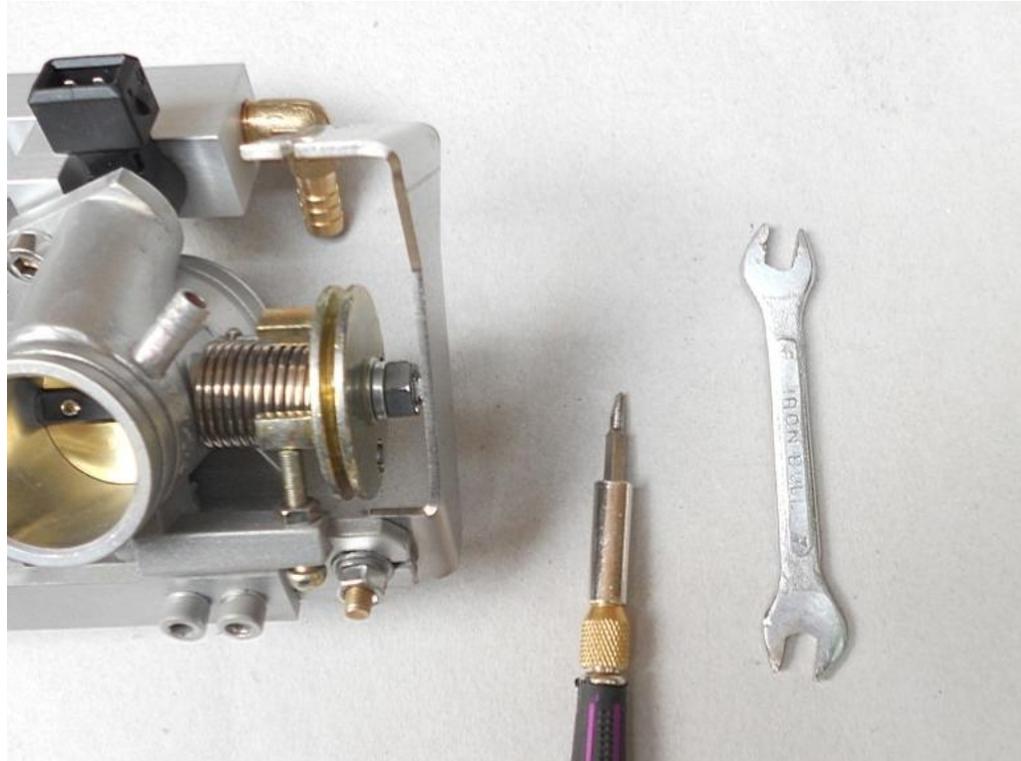
## Further mechanical idle Air adjustment

If by only adjusting the idle air screws can't meet your idle air requirements, such as the idle RPM is still too low, you need adjust the mechanical stop position of the throttle valve (this is not preferred, unless you have no other options). The factory setting of the throttle plate is usually optimized. You need to be careful on this mechanical adjustment.

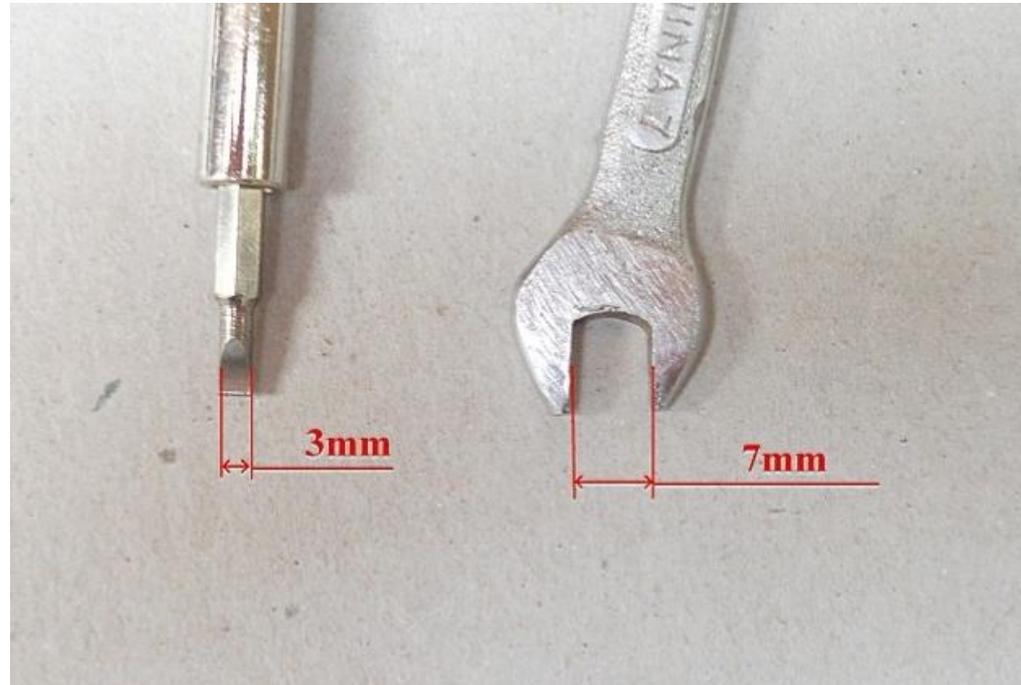
Basically the idea is to open the throttle plate a little tiny bit, so there is more idle leaking air.

The steps are below:

(1) Please prepare two tools: one is screwdriver, and the other one is wrench.

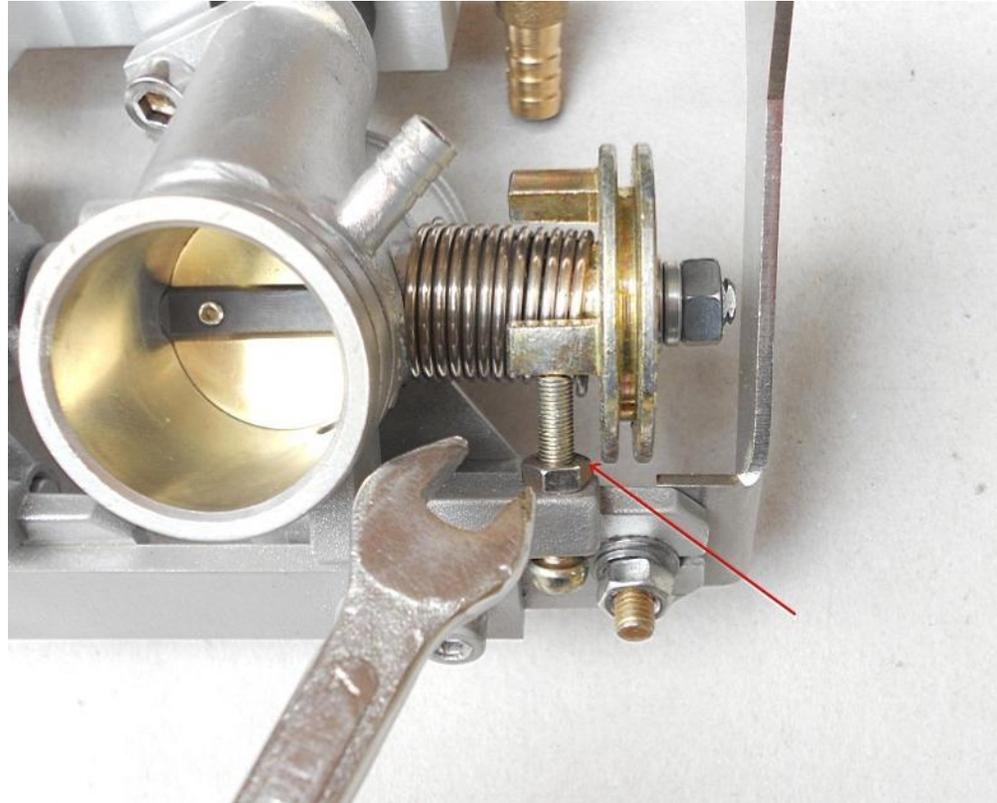


For the size of the each tool, you can see in the below picture.

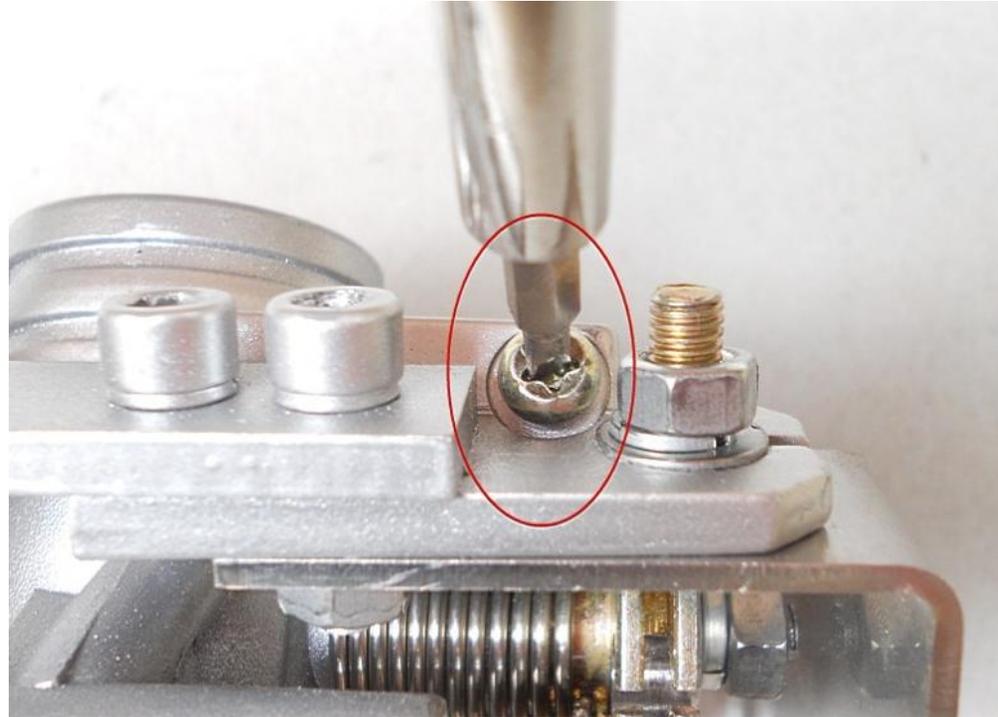


(2) Begin to adjust now, please see the below pictures.

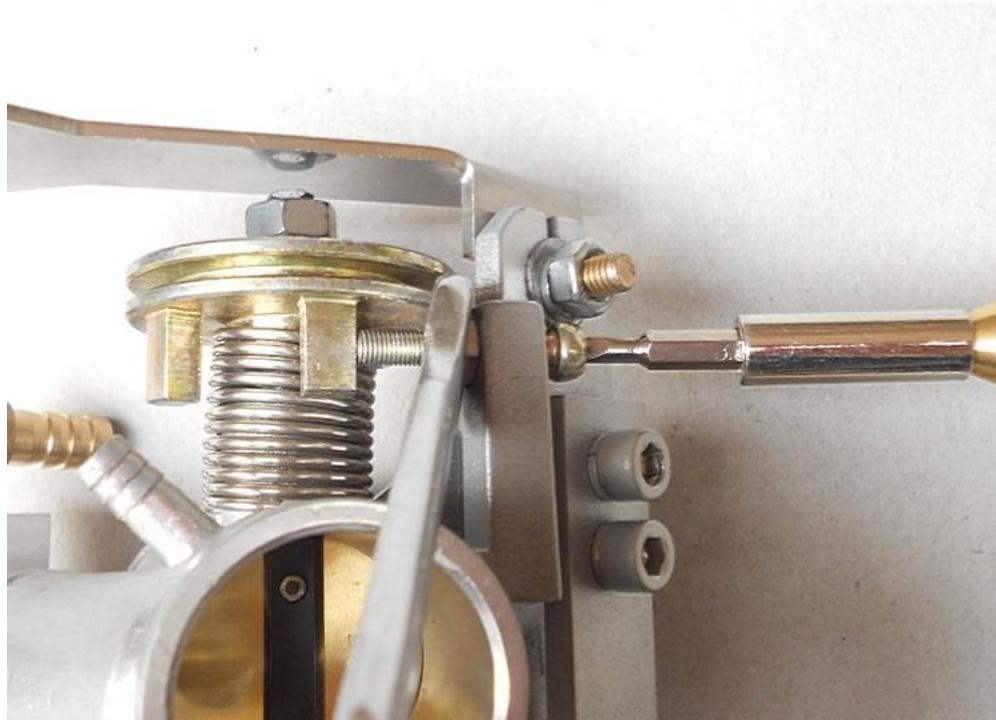
First, loose the nut



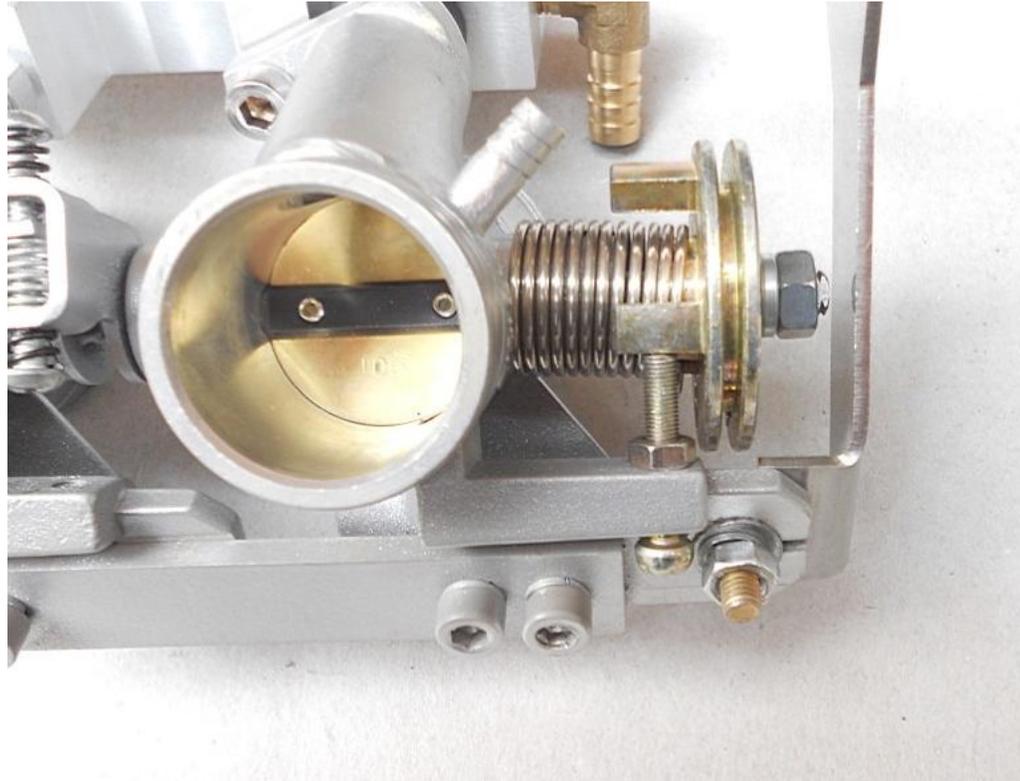
Then, use the screwdriver to turn the screw; if you want more idle air, you need turn the screw in clockwise, and if you want less idle air, you need turn the screw in counter-clockwise.



Last, when you are done adjusting the screw, please tight the nut by using the 2 tools.



Finished



### 3.3 Electronic Idle Air Control – IAC motor

Our 34mm size and bigger throttle bodies all come with an Idle Air Control (IAC) motor, which is a stepper motor, with 4 wires.



With these throttle bodies, you can set the target idle speed, and ECU will control the stepper motor to reach that speed.

#### **Q: How to tune the idle RPM with an IAC motor?**

If your engine idle RPM is too high, or too low, you need to adjust the desired stepper motor position (MAP\_StepPrePos\_Tm\_N) according to the actual position “StepPos”; which can be logged via ProCAL..

**Note:** The stepper motor position has an inverse logic to the idle RPM. By increasing the stepper motor position values in the table, you are reducing the idle air; and idle RPM will be lower.

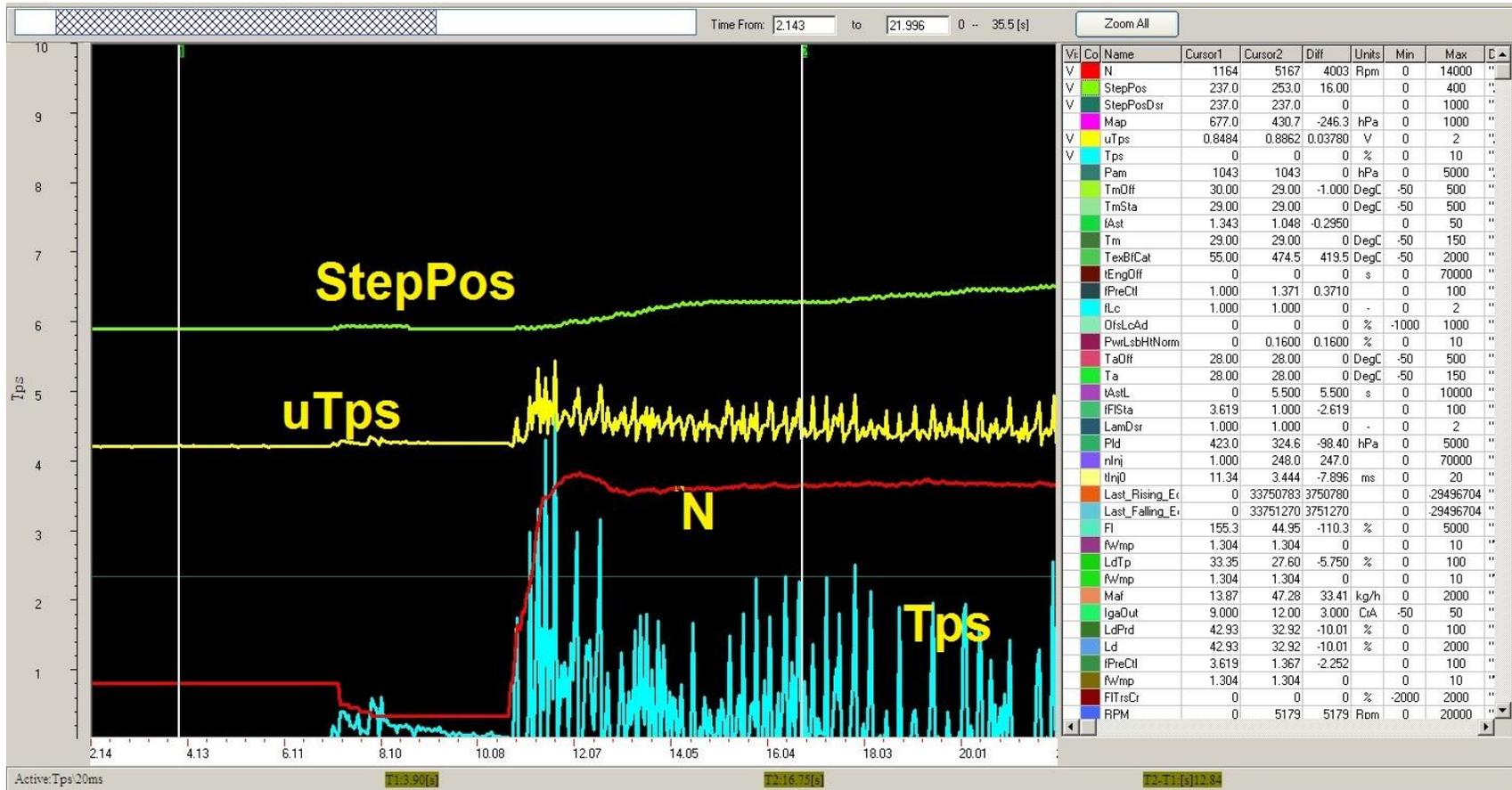
**Note:** If your engine idle speed stays higher than your target speed, and no matter what you do with an IAC system, you may have air leak in your intake air system.

The stepper motor comes with the throttle bodies is designed for certain range of engine displacements (engine cc sizes). If you use these throttle bodies (34mm or 42mm or 50mm or 55mm) on too big engines or too small engines, the idle motor may reach its physical max/min limits, and the idle air cannot be adjusted anymore by the IAC. You could also end up with too high or too low idle RPMs.

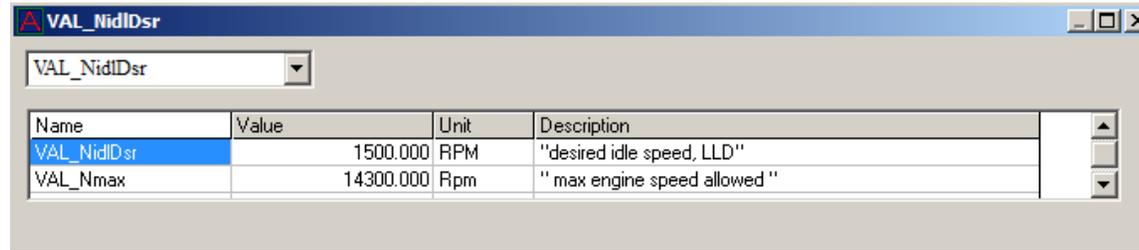
**Note:** IAC based idle controls only work if your TPS sensor reads 0%; meaning throttle body fully closed. Sometime your throttle cable is stuck and throttle plate is not fully closed.

If your engine idle RPM is not stable, or stays high for a long time, and it still can't go down to the desired RPM, then check your TPS signal. Maybe the TPS sensor signal is too noisy. Or the value of TPS is not 0 when engine runs in idle. TPS signal must have a stable value at 0 when engine is running in idle. If this is not the case, you better check the TPS sensor installation and also the throttle cable returning spring, etc.; make sure mechanically the TPS position is fixed at 0 when in idle. Also check the TPS connector and wire connections, make sure they are secured.

Below is a plot of noisy TPS signal example.



How to set the target idle speed in ProCAL?



**VAL\_NidIDsr** - "Desired idle speed"

In ProCAL:

Menu → Advanced, add this variable.

By default, it is set as 1500 RPM, if your engine has a different idle RPM, you need to change it.

For newer software version, the desired idle speed is dependent on the engine temperature. You will need to calibrate the CURVE: **CUR\_NidIDsr\_Tm**

Our idle speed controls via IAC motor is a close-loop control. It reads the actually engine RPM and compares it to the target idle speed, and adjust the idle air correspondingly, and maintain the target the idle speed.

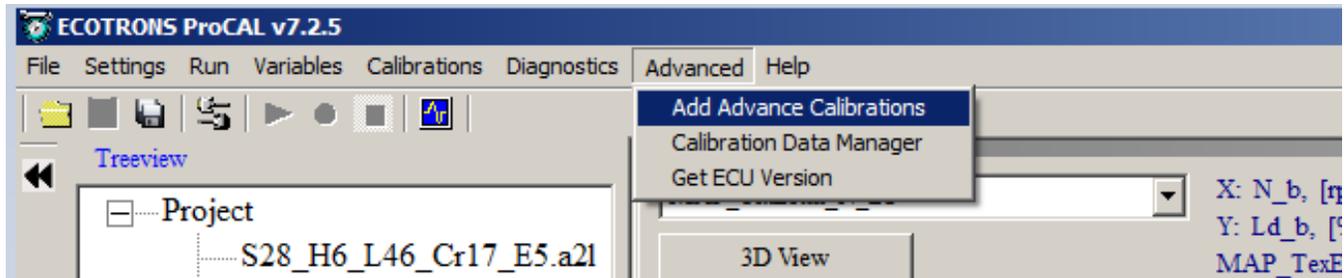
**Note:** The idle speed certainly cannot be set too high or too low. For example, if your engine idle RPM (OEM setting) is 1500 RPM, and you change it to 3000RPM, it will not work, and you may have an oscillating RPM.

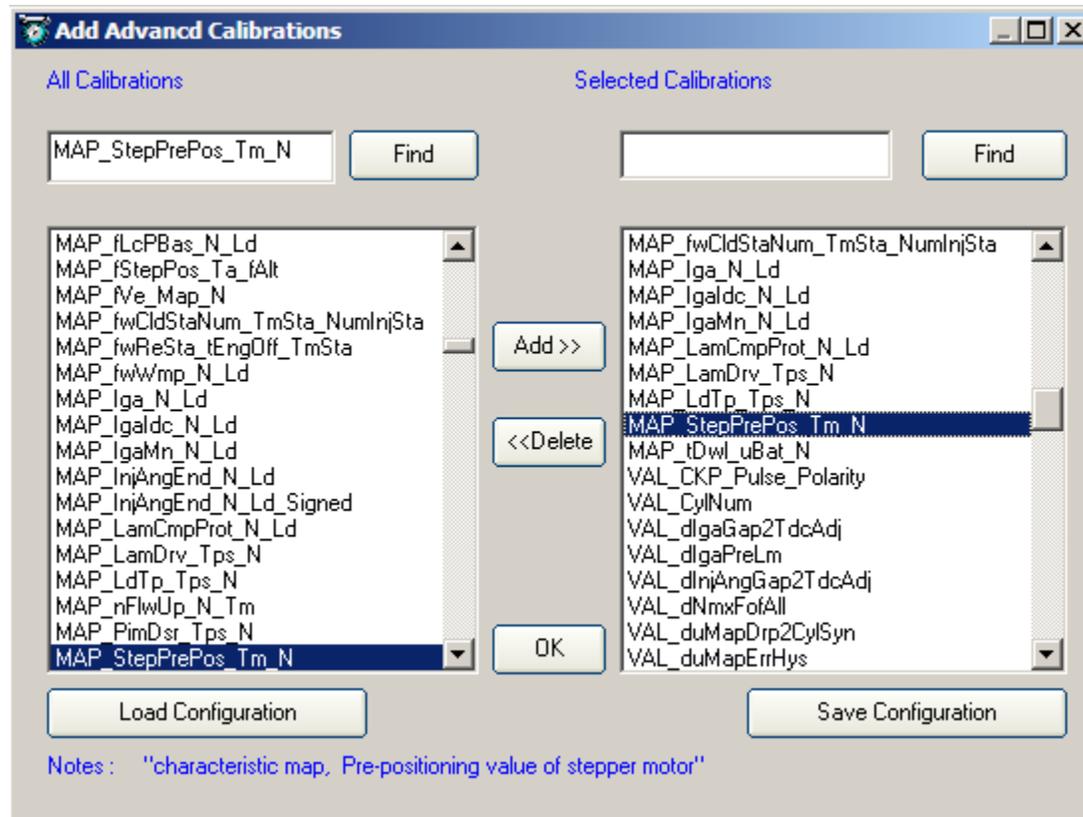
If you set the idle RPM too low, like 1000rpm, it may end up stall frequently.

**How to calibrate the stepper motor position to get a desired RPM?**

Adjust idle motor desired position; you need to do some advanced tuning, follow the below steps.

(1) Add advance calibration: MAP\_StepPrePos\_Tm\_N





Find the variable: MAP\_StepPrePos\_Tm\_N on the left side, then click “Add>>”. The variable appears on the right window. Click "OK"

Y/X	500.00	800.00
-30.00	110.00	110.00
-20.00	115.00	115.00
-10.00	120.00	120.00
0.00	125.00	125.00
10.00	130.00	130.00
20.00	140.00	140.00
30.00	150.00	150.00
40.00	160.00	160.00
50.00	170.00	170.00
60.00	180.00	180.00
70.00	190.00	190.00
90.00	190.00	190.00
99.00	190.00	190.00
110.00	190.00	190.00
125.00	190.00	190.00

(2) Choose "list": In the interface Right Click, then click "Display type->List"



In the list view, right-click, to Click "Show All Variables"

Map	Syn	hPa	0	2560	"Intake manifold pressure measured with M"
N	Syn	Rpm	0	16383	"Engine speed in Rpm"
nInj	Syn		0	65535	"number of injections "
tInj0	Syn	ms	0	65.535	"injection time for injector #0 "
fLc		20ms	-	0	2 "Lambda controller output (word)"
Nraw		20ms	Rpm	0	16383.75 "Engine speed in rpm from LLD"
Tps		0ms	%	0	100 "throttle position with respect to lower mec
UbAdc		0ms	V	0	25.6 "battery voltage; scanned value of microp
uLsb		0ms	V	-1	4 "Voltage signal from the lambda sensor be
uMap		0ms	V	0	5 "Voltage signal of manifold pressure sensc
uPot		0ms	V	0	5 "ADC-voltage of potentiometer sensor "
uTps		0ms	V	0	5 "ADC-voltage of throttle position sensor "
B_CrkErr		0ms		0	1 "Error condition for crank sensor"
B_MapDrpErr		100ms		0	1 "Error condition for MAP sensor, no droppi
B_StaEnd		100ms		0	1 "condition: end of start "
fPreCtl		100ms		0	64 "factor: pre-control fuel"
LamDsr		100ms	-	0	16 "Desired Lambda"
OfsLcAd		100ms	%	-768	767 "additive adaptive correction of the relativ
Pam		100ms	hPa	0	2560 "Ambient pressure"
Ta		100ms	DegC	-50	205 "Intake air temperature"

- Add Variables
- Show All Variables
- Show Oscilloscope
- Decimals Display
- Hide Descriptions
- Sort
- Variable properties

Then

Err_CrankSensing_Flag		20ms	-	0	65535 "bit-ields crank sensing errors, stored i
fLc		20ms	-	0	2 "Lambda controller output (word)"
FITrsCr		20ms	%	-1536	1536 "rel. fuel mass transition compensation
LamW02		20ms		0	16 "Actual Lambda measured by W02 co
Last_Falling_Edge_Timer		20ms		0	.294967E+09 "LLD timer"
Last_Rising_Edge_Timer		20ms		0	.294967E+09 "LLD timer"
Last_Rising_Edge_Timer		20ms		0	.294967E+09 "LLD timer"
Nraw		20ms	Rpm	0	16383.75 "Engine speed in rpm from LLD"
V StepPos		20ms		0	640 "Actual position of stepper motor"
V StepPosDsr		20ms		0	640 "Desired position of stepper motor"
Tps		20ms	%	0	100 "throttle position with respect to lower r
UbAdc		20ms	V	0	25.6 "battery voltage; scanned value of mic
uLsb		20ms	V	-1	4 "Voltage signal from the lambda sensoi
uMap		20ms	V	0	5 "Voltage signal of manifold pressure se

**Note:** The value of "StepPosDsr" is from the table of "MAP\_StepPrePos\_Tm\_N", based on the engine temperature "Tm". "StepPos" is the actually stepper motor position when engine is running at idle with the desired RPM. You want tune the "StepPosDsr" as close as possible to "StepPos" at certain engine temperatures.

**For example:**

If engine temperature is 50 degree, the "StepPosDsr" value is 170 from the table, when engine is at idle with the desired RPM; the "StepPos" value is 290. So you can change the table value to 240 in 50 degree (the value is smaller than 290, the difference is about 50, it will get a better engine start).

MAP\_StepPrePos\_Tm\_N

X: N, [Rpm], "Engine speed in Rpm"  
 Y: Tm, [DegC], "Engine temperature"  
 MAP\_StepPrePos\_Tm\_N: [] "characteristic map, Pre-positioning value of stepper"

Y/X	500.00	800.00
-30.00	110.00	110.00
-20.00	115.00	115.00
-10.00	120.00	120.00
0.00	125.00	125.00
10.00	130.00	130.00
20.00	140.00	140.00
30.00	150.00	150.00
40.00	160.00	160.00
50.00	240.00	240.00
60.00	180.00	180.00
70.00	190.00	190.00
90.00	190.00	190.00
99.00	190.00	190.00
110.00	190.00	190.00
125.00	190.00	190.00

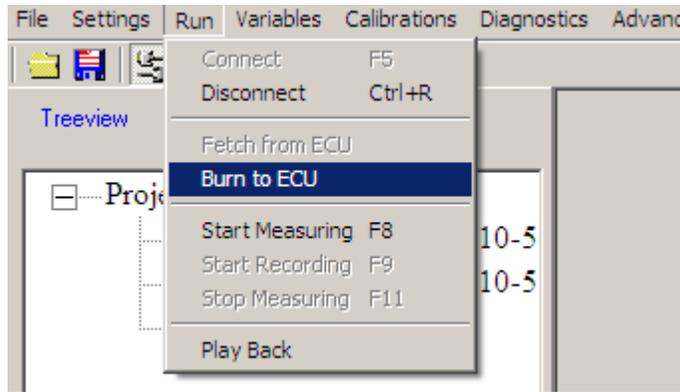
And you also can change the value in the table when "Tm" is higher than 50 degree

The screenshot shows a software window titled "MAP\_StepPrePos\_Tm\_N". It contains a dropdown menu with the text "MAP\_StepPrePos\_Tm\_N". Below the menu, there are three lines of text: "X: N, [Rpm], 'Engine speed in Rpm'", "Y: Tm, [DegC], 'Engine temperature'", and "MAP\_StepPrePos\_Tm\_N: [] 'characteristic map, Pre-positioning value of stepper'". Below this text is a table with three columns: "Y/X", "500.00", and "800.00". The table contains 14 rows of data, with the last three rows highlighted in red.

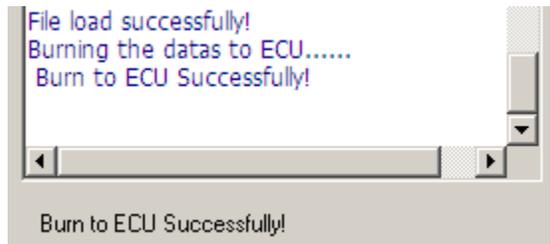
Y/X	500.00	800.00
-30.00	110.00	110.00
-20.00	115.00	115.00
-10.00	120.00	120.00
0.00	125.00	125.00
10.00	130.00	130.00
20.00	140.00	140.00
30.00	150.00	150.00
40.00	160.00	160.00
50.00	240.00	240.00
60.00	245.00	245.00
70.00	250.00	250.00
90.00	260.00	260.00
99.00	260.00	260.00
110.00	260.00	260.00
125.00	260.00	260.00

**Note:** Increase the values in the table; you will get lower RPM, meaning the bigger stepper motor position, the less air.

(3) After you change the value, then "Burn to ECU"



If the file downloaded successfully, lower left corner will pop up message "Burn to ECU Successfully"



### 3.4 Idle Controls via ignition timing

**Note:** If you do not have our ECU-controlled CDI, or if your engine is not recommended for ECU-controlled CDI (2-stroke engines, for example). Or our ECU does not support ignition controls for your engine; skip the rest of this part (ignition controls).

For throttle bodies (28mm for example) that do not have an IAC motor. The idle speed can be controlled by the ECU via ignition angle adjustment. This is only to adjust the small idle RPM deviation.

The mechanical idle air screw must be adjusted to a good position that your idle RPM is a little higher than you desired when it's warmed up.

Then the idle ignition angle can step in to retard the ignition, and reduce the idle RPM at fully warmed up. At cold engine, idle ignition angle is likely at optimum advanced angle, so that the idle RPM can be at your desired RPM even with cold engine. For example, your idle ignition angle will be 7 degree CrA positive when it's cold. And it could be -9 degree CrA, a negative value, when it is fully warmed up.

**Idle speed controls via ignition angle controls (only possible if you have ECU-controlled ignition system).**

**Why do you need the ECU-controlled CDI for idle speed control?**

After you have a stable running engine with the fuel control only, now it's time for you to add our CDI box. Because it will help to lower down the idle RPM after engine warm-up. The strategy is to have enough idle air to start in cold and

stable idle in cold first. But that amount of air is a little more than necessary for the warm engine. (That's why you get a high idle rpm at hot but a low idle rpm at cold.)

Then the strategy is to retard the spark advance to lower down the idle rpm once the engine is warmed up. It reduces the engine torque because of later sparks. (This also indirectly helps to reduce the emissions).

Further more, this gives some torque reserve for possible high idle requests (for example, to prevent undercharging).

And this also helps the launch, because once you open the throttle, the spark advance can be immediately goes to the optimum, and you get big torque increase!

Pre-defined idle ignition angle map [MAP\\_IgaIdc\\_N\\_Ld](#) : when engine runs in idle, (throttle body is fully closed).

Y/X	1200.000	1320.000	1380.000	1500.000	1620.000	1800.000
18.000	9.750	9.750	9.750	9.750	9.750	9.750
24.750	9.750	9.750	9.750	9.750	9.750	9.750
30.000	9.750	9.750	9.750	9.750	9.750	9.750
35.250	9.750	9.750	9.750	9.750	9.750	9.750
40.500	9.750	9.750	9.750	9.750	9.750	9.750
45.000	9.750	9.750	9.750	9.750	9.750	9.750

There are also two correct ignition factors based on battery voltage and engine temperature.  
[CUR\\_dlgaldc\\_Tm](#), [CUR\\_dlgaldc\\_Ub](#)

**CUR\_dIgaIdc\_Ub**

Ub\_b: [V] "Battery voltage, byte value"  
 CUR\_dIgaIdc\_Ub: [CrA] "Characteristic Curve, delta ignition angle of battery voltage effect"

Ub_b	8.000	9.000	10.000	10.500	11.000	11.500	12.400	13.000	14.000	15.000
CUR_dIgaIdc_Ub	15.000	15.000	15.000	15.000	15.000	15.000	21.000	0.000	0.000	0.000

**CUR\_dIgaIdc\_Tm**

Tm: [DegC] "Engine temperature"  
 CUR\_dIgaIdc\_Tm: [CrA] "Characteristic Curve, delta ignition angle of engine temperature effect"

Tm	-30.000	-25.000	-15.000	-10.000	0.000	10.000	20.000	45.000	70.000	90.000
CUR_dIgaIdc_Tm	30.000	24.750	24.750	24.750	24.750	9.750	5.250	0.000	0.000	0.000

The pre-defined idle ignition output angle = MAP\_IgaIdc\_N\_Ld + CUR\_dIgaIdc\_Tm + CUR\_dIgaIdc\_Ub  
 And the close loop ignition angle control for idle speed control is based on this pre-defined ignition angle.

### EFI system without an IAC motor, and without ignition control

If the idle air is too much or too less, it leads the Engine idle RPM too high or too low.

Because ECU has no way to control the idle RPM, in this case, you may have to start with a high idle RPM and later on, to fine tune the throttle mechanical stop position or idle air screw position to get a compromise of idle RPM.

If the engine idle RPM is super high, like 3000rpm, ECU will cut the fuel, and the RPM may go up and down.

### 3.5 Idle fuel too rich because of minimum injector pulse width

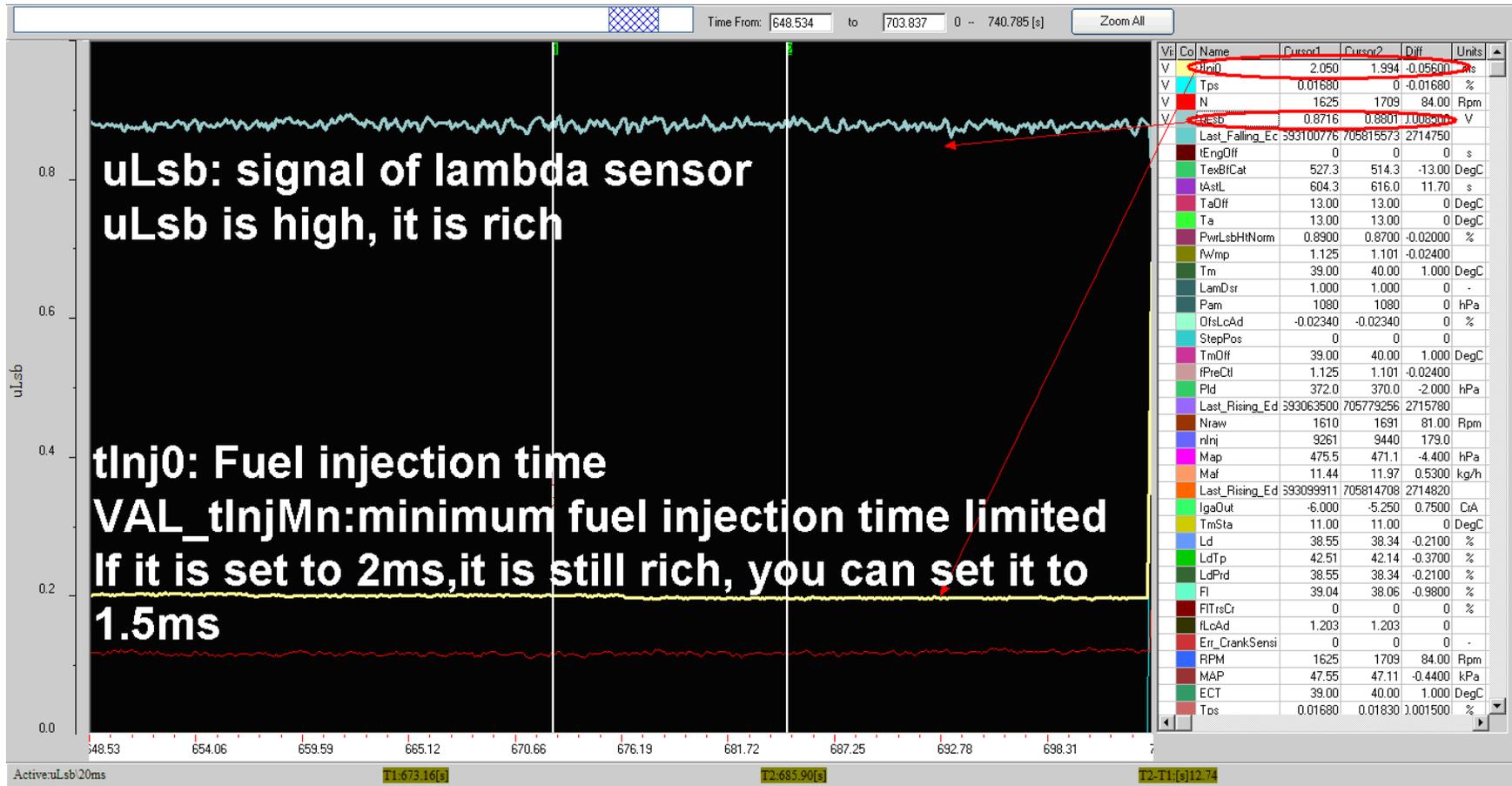
#### Q: How and why to adjust fuel injection time in idle?

No matter how much you have changed the base fuel mapping for idle, ( via VE table or TPS Load table), the engine still runs too rich. It seems no effect even you put the 0 in the table. It may be because the minimum fuel injection pulse width is limited. You need to change that limit lower, VAL\_tInjMin.

This calibration basically defines the minimum pulse width that can open the injector. This is the physical limit of an injector, usually in 1ms to 2ms range.

Go to "menu->Advanced->Add Advanced Calibrations" to add the VAL\_tInjMin. And decrease this value according to the actual engine running. This value by default is 2ms; or 2.2ms including the battery voltage compensation. The reason to have a 2ms min pulse width is because the injector has a better flow rate when it is bigger than 2ms. For many engines, the min pulse width could be smaller. Usually you can set it to 1.5ms or 1.0ms as the extreme minimum. Anything smaller than 1ms , you may not have fuel injection at all.

**For example:**



Name	Value	Unit	Description
VAL_tdUbAst	10.00	s	"time period for battery after start "
VAL_tdUbDg	5.00	s	"delay time of battery voltage diagnosis "
VAL_tInjIdleEst	10000.00	us	"injection time during idle, estimated; for kick start"
VAL_tInjMin	1.50	ms	"minimum possible injection time for an injector"
VAL_TmMx	150.00	DegC	"engine temperature max"
VAL_tooth_high_time_ma	15000.00	us	"max tooth level high time, for tooth validation"
VAL_tooth_high_time_mir	60.00	us	"min tooth level high time, for tooth validation"
VAL_tooth_level_verify_c	3.00		"low level cal, counter to verify the tooth level"
VAL_tooth_level_verify_c	2.00		"low level cal, successful counter to verify the tooth level"
VAL_tooth_level_verify_ir	8.00	us	"low level cal, interval break to verify the tooth level"
VAL_tooth_low_time_max	480000.00	us	"max tooth level low time, for tooth validation"

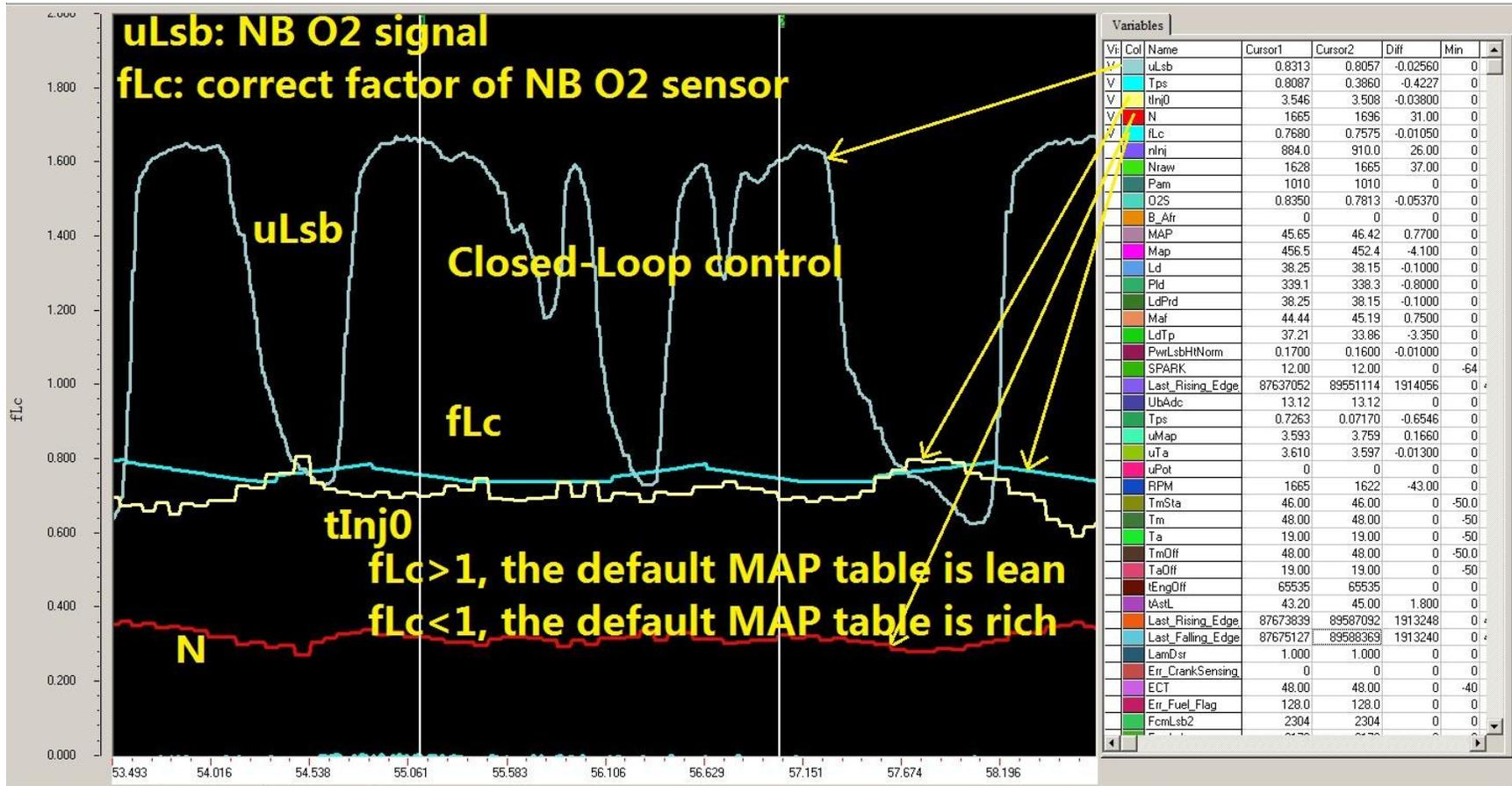
**Q: How do I know whether it is rich or lean?**

You can use the following method to know whether the engine runs too rich or too lean with a NB O2 sensor or a wideband ALM. Also you may know it by smelling the exhaust gas when it is too rich.

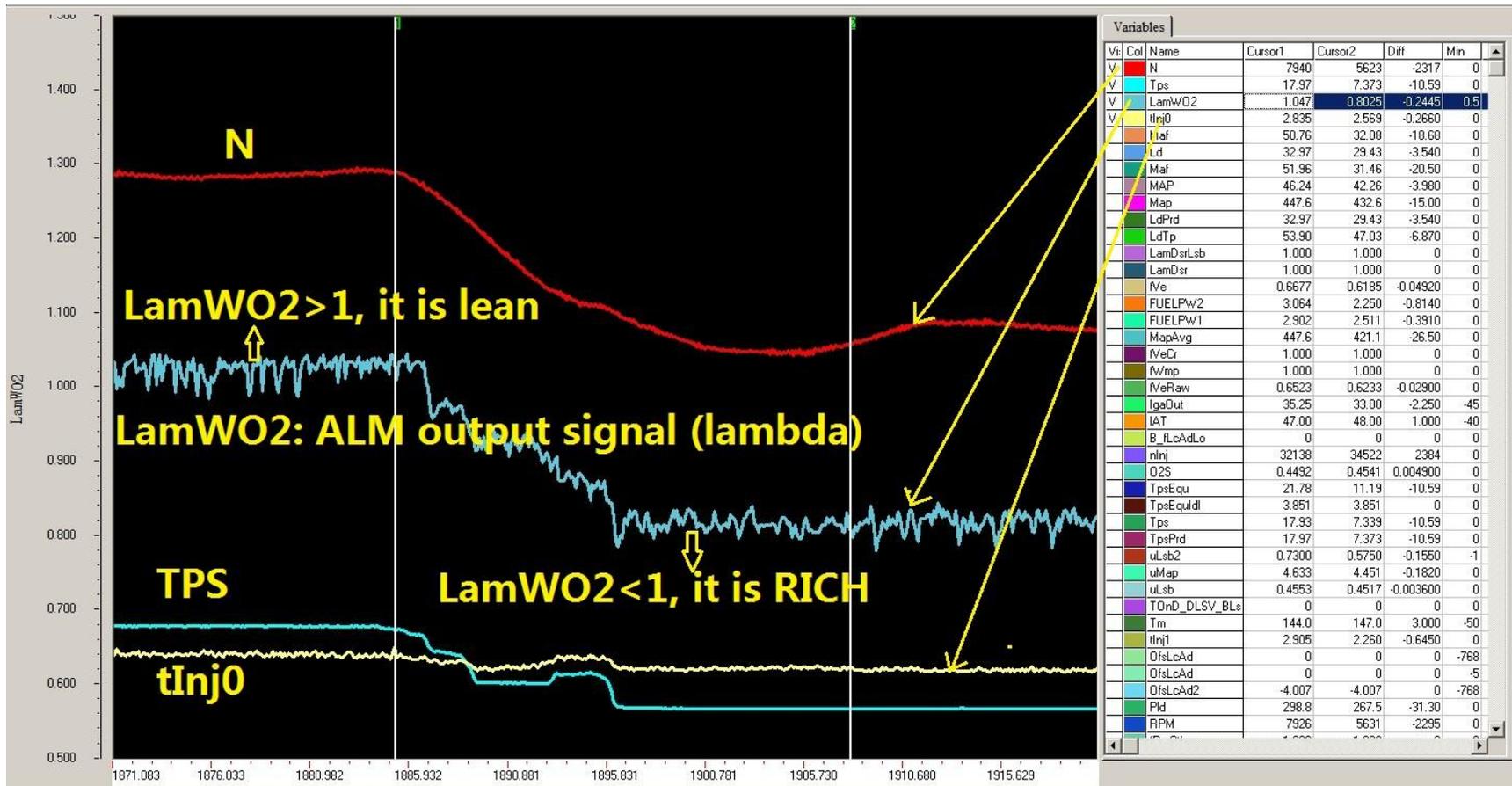
(1) With a NB O2 sensor. You can read the voltage of the NB O2 sensor in the ProCAL gauge, O2S; to know whether it is rich or lean.

**uLsb:** signal of lambda sensor, in the List of variables.

If it is higher than 0.45V, the engine runs rich. If it is lower than 0.45V, it runs lean.



(2) Read the AFR by using an ALM gauge, which you can buy from ECOTRONS. You can also read the real time lambda (LamWO2) in ProCAL, for which you need connect the ALM to ECU through the EFI harness. With the ALM, the advantage is that you can read / log the real-time AFR or lambda value, and even have Ecotrons' auto-tuning feature.



## Chapter 4 Open-loop and closed-loop fuel control

### 4.1 Open Loop Fuel Control

What is open loop fuel control, why do we have it?

Open loop fuel control is to run the engine without installing the O2 sensor. The reason we need to run it is a precautionary step to protect the O2 sensor; to have a stable engine running before plugging in the O2 sensor.

A good practice is to start and run the engine in the open loop mode, especially if your engine is very different than our base calibration engines (like a scooter GY6 150cc, which is the mostly tested engine). Or you have modified your engine significantly, like a big bore kit, a high cam, or a bigger intake manifold. All these differences will cause the big deviations in the air charge model pre-loaded in the ECU. Close-loop fuel control and self-learning is only supposed to correct the small errors from engine to engines. The big difference cannot be learnt by the ECU and could lead to the oscillations, or unstable running.

Without a comparatively stable engine running in open-loop, the exhaust from the engine could be erratically rich or lean or have fuel flooding, and random moistures in the exhaust, etc. These could damage the O2 sensor before you even have a chance to run close loop controls.

In open loop mode, ECU is reading the MAP sensor signal, TPS signal, and temperature signals to calculate the fuel, and control the fuel comparatively precisely.

In open loop mode, you can drive the vehicle around, and tip-in, tip-out, and you can do almost everything, except that the ECU does not really know whether you are running rich or lean. And the ECU cannot self-learn the engine for variations. The self-fine-tuning of the fuel is not happening.

Even in open loop mode, if tuned well, an EFI engine can run much better than a carb engine, NO QUESTION.

Many OEMs have open loop EFI engines certified with EPA / CARB emission regulations. The key is the tuning.

### **What if I cannot get a stable engine running in the open loop mode?**

If you "smell" it lean, a quick and dirty fix is to enrich the fuel with the global factor: "**VAL\_fFIApp**". And once you have a relative stable run, you can detune this factor by using other parameters.

If your idle speed is too low, and you cannot maintain the stable idle RPM, go to Chapter 3 (idle air adjustment).

For open loop tuning, you can find the details in Chapter 5. But you need to know what is a close loop control system first.

## **4.2 Closed Loop fuel control**

### **Q: How to tune the close-loop fuel?**

A: You do NOT need to tune it. You only need to make sure it's happening. ECU will automatically tune it (with the O2 sensor).

### **Q: How do I know it's in close-loop controls?**

First, you need to know a little bit of the O2 sensor.

The O2 sensor indicates lean or rich by a voltage signal.

When the O2 sensor is not active, the voltage should be about 450mV (or 0.45V);

When the O2 sensor indicates **rich**, the voltage should be **>** 450mV;

When the O2 sensor indicates **lean**, the voltage should be **<** 450mV;

**That's right! It's a narrow band O2 sensor. The wideband O2 sensor is too expensive to be included in the base kit. We do have a wideband kit, ALM, for your tuning purpose.**

When you see the O2 sensor voltage oscillating up and down around 450mV, that means the close-loop control is active.

**Q: How do I see the O2 sensor voltage?**

Easy way: in ProCAL, among a bunch of green/black gauges, there is an O2S gauge indicates the voltage.

Better way: You need to log the data and play it back to see what's going on.

In Data Analyzer, check the signal "uLsb", which is "voltage of lambda sensor (O2)".

**Q: My O2 sensor voltage is always 450mV (even after warm-up, 3 minutes later), what's wrong?**

Possible reason #1: you don't have it connected;

Possible reason #2: the sensor is broken, or the wire is broken;

Read the diagnostic DTC in ProCAL.

**Q: My O2 sensor voltage is always greater than 450mV, why?**

You are running rich all the time.

Case 1: for many engines, during idle, it has to run a little rich, just because the injector size is not small enough.

You are running in the minimum pulse width (calibrated as 2ms). This is OK.

Case 2: you are running rich at all operating conditions, idle, part-load, WOT, etc. This could be caused by: you have enriched too much or you have some wrong calibrations. Check your enrichment factors VAL\_FIApp; you fuel injector size, your engine displacement, etc, in ProCAL.

Case 3: The base engine calibration is way off for your engine. The ECU self-tuning is only capable of fine-tuning. You need to do some advanced tuning. Read the later chapters.

Case 4: The sensor is broken, or the wire is shorted.

**Q: My O2 sensor voltage is always smaller than 450mV, why?**

You are running lean all the time. It may happen if you have fuel supply issues. For example, your fuel pump is having air bubbles; or the fuel pressure is not low; or the pressure regulator is malfunctioning; or the battery voltage is too low, etc.

You have wrong calibrations. Check you fuel injector size, your engine displacement, etc.

The base engine calibration is way-off for your engine. The ECU self-tuning is only capable of fine-tuning. You need to do some advanced tuning. Read the later chapters.

The sensor is broken, or the wire is shorted.

**Q: How long does the ECU need to do the self-tuning?**

ECU self-tuning is only possible if you have a stable engine running in active close-loop controls. (meaning, engine has warmed up, O2 sensor is working, system is fault free, open-loop control is in the ball-park of the stoic AFR; close-loop is active, etc) .

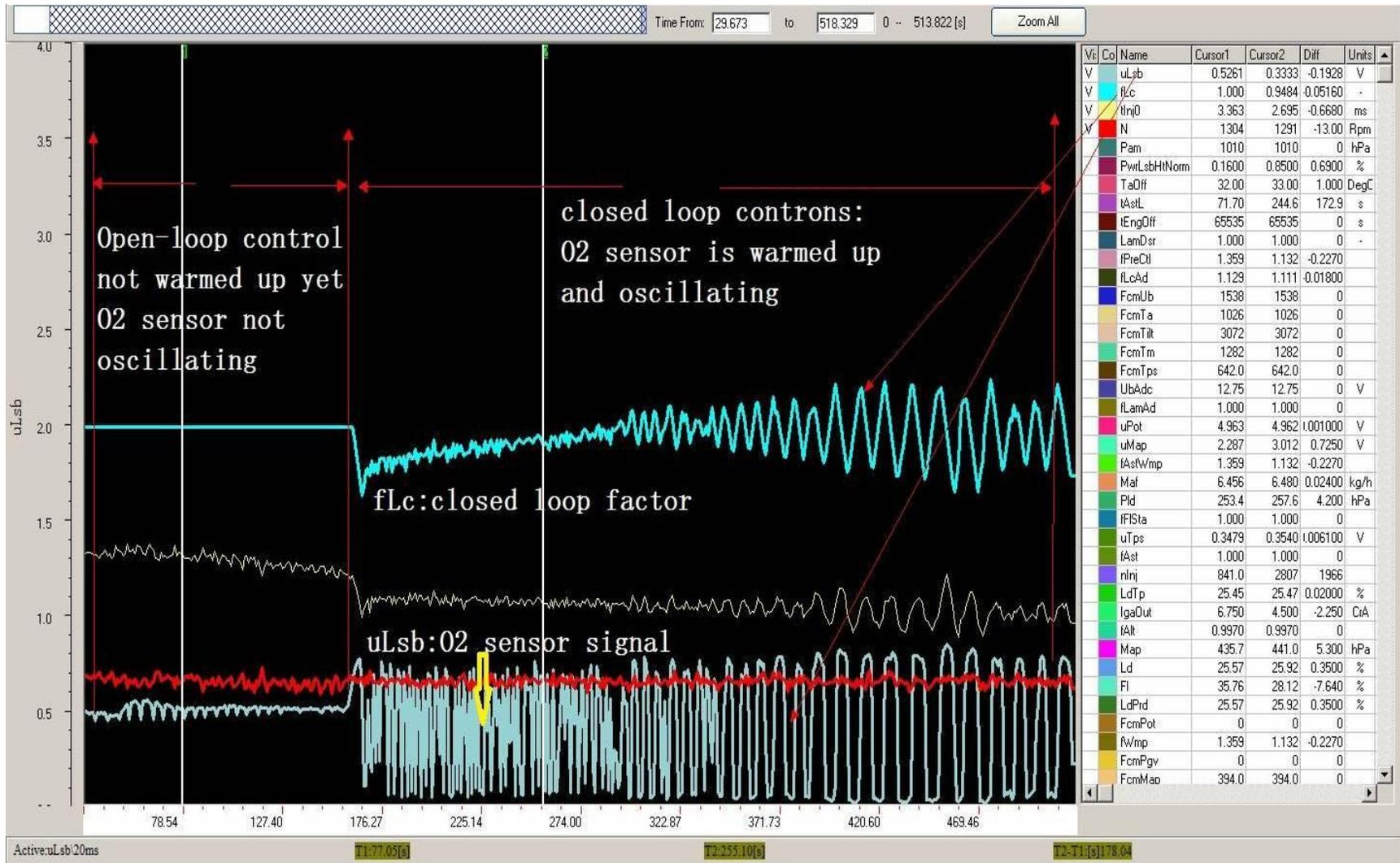
It does not take long for the self-tuning. It takes a few minutes for every different operating condition. The key is to run the engine in a steady-state and traverse though the common operating conditions (idle, part-load, high-load, WOT, etc.)

There are 2 key signals for you to check the self-tuning progress: "fLcAd" and "OfsLcAd". When you see they are slowly changing, the self-tuning is in progress; when they settle down at some non-1 value, the self-tuning is kind of done.

**Note:** This self-tuning is based on the Narrow Band O2. It only adjusts small errors. It only works if the base fuel mapping is good.

**Note:** This self-tuning is a life-long continuous process. It changes very slow, and takes only effect of long term factors

**Note:** During start and warm-up process, the engine is running in open-loop mode; the self-tuning only starts in the close-loop mode after the O2 sensor is warmed up (see the graph below):



## Chapter 5 VE table and Load table tuning

**Note:** EFI is an advanced technology compare to the carbs. It requires a thorough understanding of the electronics and software strategy to be able to tune the system.

Please educate yourself on the basics of engines and electronic fuel injections. There are tons of info on the internet, and all you need to do is find appropriate levels of materials and read them.

The first concept you need to understand is the "Volumetric Efficiency".

Warning: some users tried to tune the volumetric efficiency or throttle based fuel mappings, without fully understanding the EFI system, and ended up with the worse-running engine.

### Volumetric Efficiency – VE table

Volumetric efficiency is probably the most important characteristics of an engine.

It determines how efficient the engine is sucking the air into the cylinder, and therefore, how much torque it can generate, given the certain spark advance and air-fuel ratio.

It is the fundamental calibration of the engine tuning.

By definition, volumetric efficiency is the fresh air mass in the combustion chamber divided by the total air mass in it. Basically there is always some residual combustion gas trapped in the combustion chamber at the end of the engine exhaust stroke. The total air mass in the cylinder is the sum of the fresh air and the residual exhaust gas. To know exactly how much fuel you need to inject and to mix with the air in the combustion chamber, you have to know how much fresh air is in there instead of the total air mass, and that is why you have to know the volumetric efficiency.

With a MAP sensor based system, you can measure the pressure in the intake manifold, and use that as the pressure in the combustion chamber, and together with the intake air temperature, and engine displacement, you can calculate the air mass in the combustion chamber. This is called by the auto industry as "**Speed Density**" method.

Following the ideal gas law:

$$m = PV / RT$$

m - Air mass

P - Pressure

V - Volume or engine displacement

T - Air temperature

R - Gas constant

Once you know the manifold air pressure, intake air temperature, and the volumetric efficiency, you can calculate the fresh air mass in the cylinder and therefore the fuel quantity that needs to be injected.

Unfortunately, volumetric efficiency is not able to be measured directly with any sensor. You'd have to calibrate it one operating-point (RPM vs MAP reading) at a time.

The best way to tune volumetric efficiency is to put your engine on a dyno and use an accurate wideband air-fuel-ratio (lambda) meter to measure the mixture, and back-ward calculate the volumetric efficiency.

However, knowing most people don't have access to a dyno, we can propose a coarse way to tune the volumetric efficiency.

If you have a wideband controller, you can run the engine with the wideband controller together, or ride the bike in a steady state (comparatively constant throttles and RPMs); at a certain MAP signal and RPM, you can tweak the volumetric efficiency table until you get the stoic AFR read from your wideband controller.

Make sure you have an accurate and reliable wideband controller, or you could end up with wasting your time.

If you don't even have a wideband controller, you can use an even coarser way to tune it. Use the narrow band O2 sensor, which comes with the kit, and read the O2S gauge, lean or rich, at certain MAP signal and RPM, tweak the volumetric efficiency until O2S gauge indicates an oscillating voltages, up and down around the 450mV.

**Note:** NB O2 based tuning is only possible if you have everything running normally and in close-loop control.

### **LOAD based system**

To know more about the advance tuning with our EFI kit, you need to understand what the "LOAD" is.

"LOAD" by definition is the actual air mass charged into the cylinder divided by the ideal air mass that could be filled into the full cylinder.

What is the ideal air mass? When you have your cylinder fully filled with the fresh air at sea level (barometric pressure = 1 bar), and at the temperature of zero degree C (air temperature = 32 F), the mass of the air in the cylinder is

the ideal air mass. In other words, if your engine displacement is 150cc, the idea air mass is the 150cc fresh air mass at standard conditions (1 bar, 0 degree C).

"LOAD" is a relative value, in percentage, unit-less.

"LOAD" is not the throttle position, because you can have different air mass in the cylinder at the same throttle position.

Why making it so complicated? Because it is the only way, the RIGHT way, to control the engine.

"LOAD" tells the ECU how much fuel is exactly needed for the desired air-fuel-ratio. Because you can only calculate the fuel quantity, if you know how much air is in the cylinder.

"LOAD" based system makes the tuning process universal for all engines! It does not matter how big or how small your engine is.

"LOAD" based system makes the EFI system modularized. The subsystems can be tuned independently (namely air sub-system, fuel-subsystem, ignition-subsystem, etc.)

You may say: "Hey, I can just use the throttle position and RPM, to map the fuel pulse width on the dyno".

While, you will end up re-tune all your mapping for some small things that you overlooked, or any small changes of the engine. You will have to start the tuning for a new engine from the scratch every time.

LOAD based tuning makes most of our tuning data “portable” from one engine to another, with minimum changes. LOAD based tuning is the only professional way to tune.

### **TPS based LOAD mapping**

Once you know what the "LOAD" is, you can tune the TPS based load mapping.

Our system do not let you map the fuel pulse width directly out of the TPS / RPM table, because it is too coarse, and it is affected by too many factors (temperatures, altitude, speed, AFR, etc.). It may seem easier to map the engine in the coarse way, but it actually costs more time and efforts later on. You'll pay for that “short-cut” sooner or later.

Our system let you map the "LOAD" out of TPS/RPM table, and then the load is used everywhere else as the base inputs (fuel, ignition, lambda, etc). Why? Because LOAD is the most representative physical variable for air charge in the cylinder. Throttle position is not even proportional to the air mass. It has a non-linear relation to the air mass (if you know some math☺).

LOAD is normalized against the air temperature, and altitude, and pressure. This means, you base LOAD mapping is not affected by the altitude, temperature, density, etc. Those factors will be added in later. This is the fundamental of “model-based-design” , a modern method used by Ford and GM, etc. engineers.

The way to calibrate the LOAD mapping is similar to the "volumetric efficiency" table. The best way is to use an engine dyno. If not, use a wideband controller, and if not, use the narrow band O2 sensor to do "estimations".

At certain throttle position, and RPM, tweak your LOAD output, until you have a good AFR.

This is called "**Alpha-N**" model by the auto industry.

### **Blended Speed-Density and Alpha-N methods**

So, "Speed-Density", or "Alpha-N", which method is better for engine controls? There have been too many debates on this. Just google it.

But the truth is: neither is perfect. You need both. You need blend them together to have the best engine controls, especially for high RPM, sporty motorcycle engines.

As common sense, MAP sensor is a direct measure of air mass into the cylinder, while TPS sensor is an indirect measure of the air mass. It seems MAP sensor based "speed-density" is better than TPS based "Alpha-N" method for air charge detection. This is true at low RPM, and small loads when the MAP sensor signal has enough resolutions and the air mass calculated based on the instant manifold pressure is more accurate than the estimated by TPS position. TPS based air mass estimation has very poor resolution at low throttle opening. A small throttle position change at low throttle can cause big air mass change.

But as you may have noticed, small engines' manifold pressure is changing so dynamically, there is no "stable, constant" MAP signal; even you hold the throttle position unchanged. This becomes worse when you have large throttle opening, and you are running more than 6000 RPM. MAP sensor signal becomes un-stable and even not usable. For motorcycle sporty engines, at large throttle opening, which is usually accompanied by high RPMs, the air flow in the

manifold is so fast, that the pressure change cannot be detected by MAP sensor any more. The result: you open the throttle more, but your MAP sensor gives you the same pressure reading, which is certainly wrong, because you have more air flow into the cylinder. In this situation, you must use "Alpha-N" method to calculate the air charge.

So, in short, you should use "Speed-density" for low RPM, low loads; but use "Alpha-N" method for high RPM, high loads.

This is exactly how our system works.

We have a TPS characteristic curve that is based on RPM to split the fuel mapping between the "speed-density" and "alpha-N" methods. This curve is the threshold of TPS, that below it, you use "speed-density", and above it, you use "alpha-N". The curve is dependent on RPM.

You can find this curve in the advanced calibrations in ProCAL (this calibration is only available for certain users):

ProCAL → advanced → add advanced calibrations; Add:

**CUR\_TpsUnTp\_N** "Characteristic curve, TPS threshold, air flow is un-throttled and/or pressure change is insensitive."

N_b	780.000	1020.000	1440.000	1980.000	2340.000	2760.000	3300.000	3720.000	4380.000	5100.000	5580.000	6000.000
CUR_TpsUnTp_N	89.844	89.844	89.844	89.844	89.844	89.063	89.063	89.063	89.063	89.844	89.844	89.844

**Too complicated? I don't want to tune both tables, How about just one table?**

Of course, you can just use one method: "Speed-Density", or "Alpha-N". Only you don't have as much accuracy as the blended method. But most users do not really need that much of accuracy. Using one method is often good enough.

If you engine max RPM is less than **8000RPM**, "speed-density" method often gives good enough controls without using "alpha-N". Actually most of our base engine calibrations use the "speed-density" over the whole load / speed range.

This means you only need to tune the VE table.

Some other users prefer to using TPS based fuel mapping. And use MAP sensor only for Baro pressure reading (therefore adjust fuel for different altitude). This is especially true for 2-stroke engine tuning. As you know, 2-stroke engine does not have much meaningful manifold pressure to be used as air charge detection.

In this case, you only need to tune the "TPS based Load Mapping" table.

The disadvantage of "Alpha-N" method is that it does not adapt to the small changes in the intake air systems. Say, a small air leak will cause your idle AFR deviated.

For a sporty, high RPM engine, like Kawasaki Ninja 250r, which has a RPM range of 1500rpm - 13000rpm, the blended "speed-density" and "alpha-N" is a must to have a good control over the wide range.

**Specific examples:**

Ok, you have read and known the above information, let's try to tune it.

If your engine is running rich or lean in different throttle positions, you need do some advanced calibrations. There are two fuel mapping tables, one is "RAM\_MAP\_fVe\_Map\_N" which is based on pressure signal "Map" and RPM, the other table is "RAM\_MAP\_LdTp\_Tps\_N" which is based on Tps and RPM.

For **four-stroke** engines, the default fuel mapping usually is volumetric efficiency table (MAP\_fVe\_Map\_N), at least for all low RPM and mid-range RPM. For high RPM and WOT, it is based on "MAP\_LdTp\_Tps\_N". The split between the 2 tables is defined in "CUR\_TpsUnTp\_N" :

N_b	780.000	1020.000	1440.000	1980.000	2340.000	2760.000	3300.000	3720.000	4380.000	5100.000	5580.000	6000.000
CUR_TpsUnTp_N	89.844	89.844	89.844	89.844	89.844	89.063	89.063	89.063	89.063	89.844	89.844	89.844

If the throttle position (Tps) is bigger than the value of the table, it will be changed to use the Alpha/N model, otherwise it will use VE table.

**Example:**

- (1) You can use NB O2 sensor voltage in the closed loop control to know whether it is rich or lean.

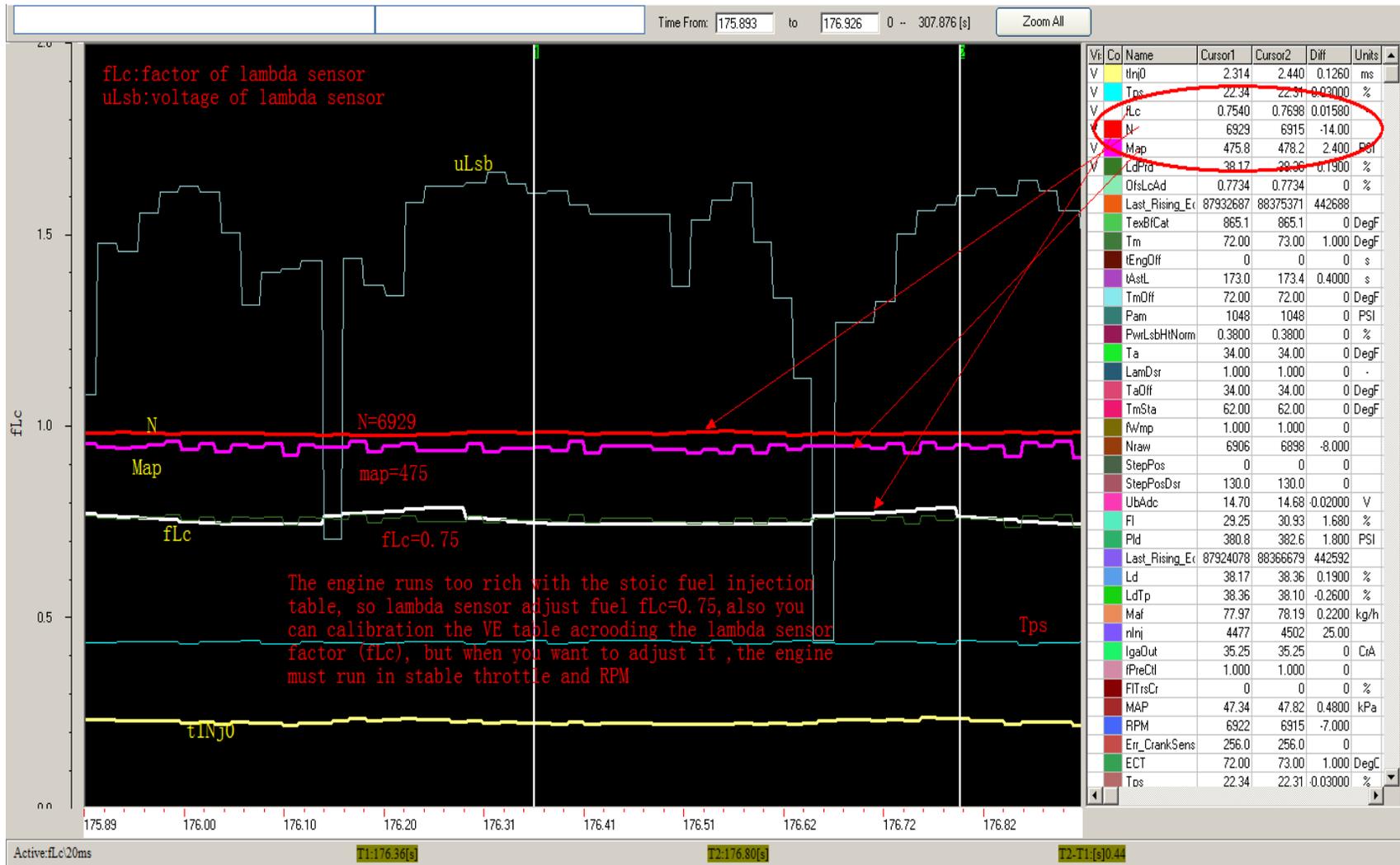


Figure 1

**Note:**  $f_{Lc}$  is the factor of lambda control, when closed-loop is active. It automatically changes based on the O2 sensor feedback. If it is smaller than 1 for a long time, it means the default VE table value is too bigger; you need change it to a smaller one to reduce the fuel quantity.

(2) Using the wideband ALM, you can read the AFR or lambda directly, and also log the real-time lambda ( $\lambda_{WO2}$ ) in ProCAL.

For details on how to integrate the wideband ALM to the ECU and enable the ALM based auto-tuning, please download our document of “ALM-ECU integration Manual” here:

[www.ecotrons.com/support](http://www.ecotrons.com/support)

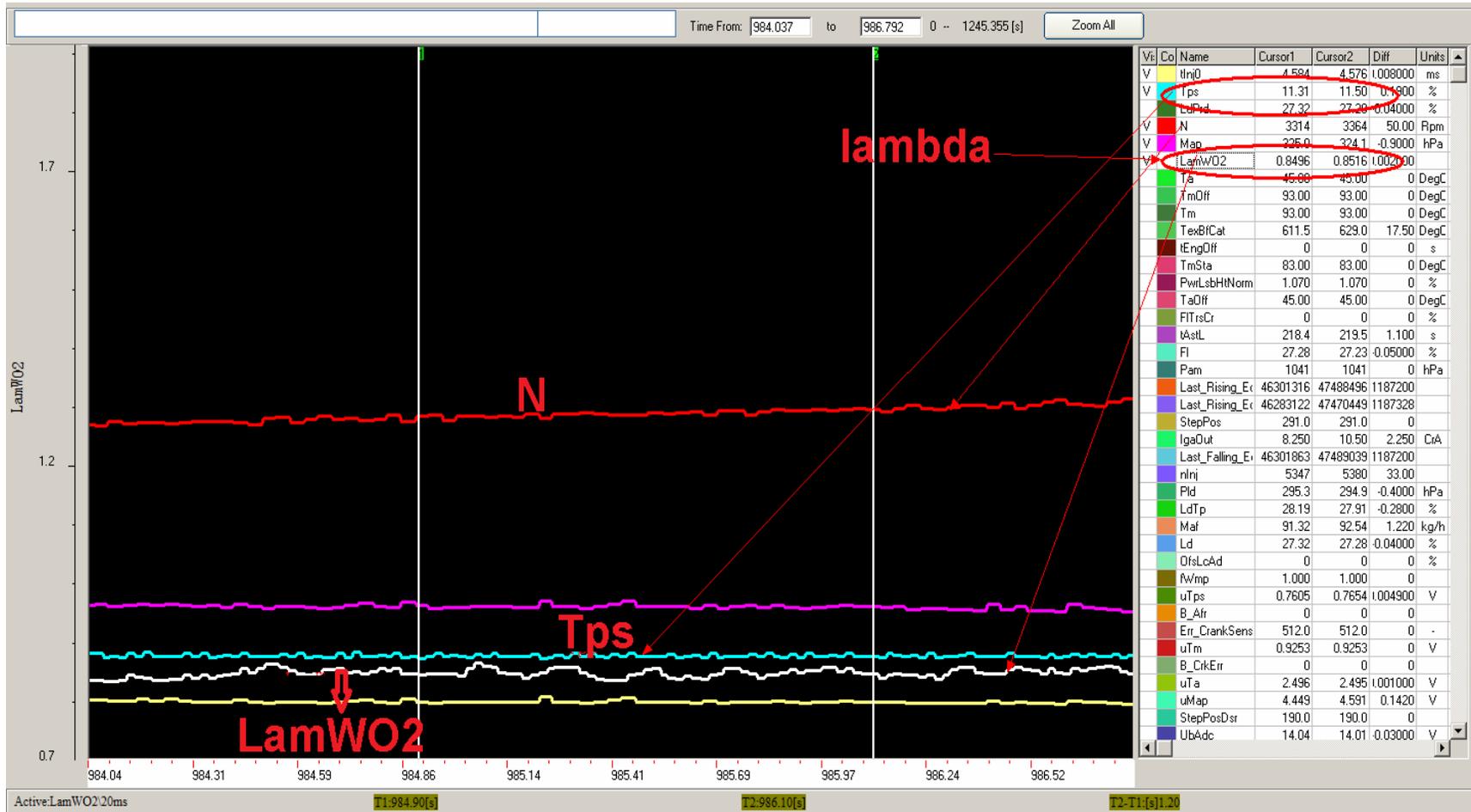


Figure 2

You can change the VE table value based on "Map" and "N", and adjust MAP\_LdTp\_Tps\_N based on "Tps" and "N". You can read the value of "Map" and "N" in ProCAL (Go to menu->Variables->Display Type->List).

**NOTE: If you want to tune the value of VE table or Alpha/N table, the engine must be warmed up, there is no enrichment factor, and you set it to ECO mode with the NB O2 sensor.**

Try to calibrate one cell value now, N=6929, Map=475, fLc (Or lamWo2) =0.75

MAP\_fVe\_Map\_N

X: Pim, [hPa], "intake manifold pressure"  
 Y: N, [Rpm], "Engine speed in Rpm"  
 MAP\_fVe\_Map\_N: [-] "Factor Volumatic Efficiency, dependent on pressure and engine speed"

Y/X	300.00	350.00	400.00	430.00	460.00	500.00	550.00	600.00	650.00	700.00	750.00	800.00	850.00	900.00	970.00	1050.00
1200.00	0.4627	0.5093	0.5419	0.5756	0.5962	0.6118	0.6293	0.6440	0.6634	0.6849	0.6841	0.6774	0.6546	0.6348	0.6159	0.6059
1400.00	0.4837	0.5293	0.5619	0.5856	0.5992	0.6218	0.6453	0.6675	0.6807	0.6911	0.6941	0.6784	0.6562	0.6362	0.6180	0.6059
1650.00	0.5037	0.5483	0.5819	0.6056	0.6262	0.6418	0.6653	0.6835	0.6989	0.6976	0.7043	0.6812	0.6661	0.6581	0.6359	0.6159
2000.00	0.5237	0.5663	0.6019	0.6256	0.6462	0.6612	0.6853	0.7044	0.7137	0.7182	0.7161	0.6937	0.6758	0.6744	0.6491	0.6291
2500.00	0.5437	0.5863	0.6219	0.6456	0.6662	0.6818	0.7053	0.7273	0.7373	0.7484	0.7412	0.7204	0.7019	0.6888	0.6616	0.6480
3000.00	0.5639	0.6037	0.6441	0.6698	0.6892	0.7032	0.7232	0.7498	0.7674	0.7843	0.7742	0.7475	0.7350	0.7221	0.7069	0.6865
3500.00	0.5898	0.6246	0.6673	0.6825	0.7017	0.7260	0.7485	0.7608	0.7839	0.8051	0.7964	0.7726	0.7602	0.7463	0.7218	0.7061
4000.00	0.6041	0.6412	0.6857	0.7013	0.7258	0.7477	0.7647	0.7904	0.8223	0.8489	0.8293	0.8155	0.8052	0.7976	0.7607	0.7491
5000.00	0.6204	0.6667	0.7051	0.7278	0.7495	0.7629	0.7886	0.8264	0.8623	0.8889	0.8693	0.8410	0.8356	0.8249	0.8015	0.7814
6000.00	0.6471	0.6841	0.7218	0.7427	0.7684	0.7828	0.8156	0.8484	0.8923	0.9089	0.8893	0.8710	0.8656	0.8649	0.8423	0.8297
7000.00	0.6422	0.6848	0.7247	0.7418	0.7669	0.7828	0.8156	0.8554	0.8923	0.9089	0.8893	0.8710	0.8656	0.8649	0.8591	0.8297
8000.00	0.6473	0.6839	0.7258	0.7437	0.7669	0.7828	0.8156	0.8554	0.8923	0.9089	0.8893	0.8710	0.8656	0.8649	0.8591	0.8297

To calculate the fuel injection quantity within the red circular area, for example, at 6929 RPM and 475 Map, because it is rich, and needs to reduce the value of this area to get less fuel quantity, according to the O2 sensor factor; you can multiply the value of “fLc” or “LamWO2” to the cell value and hit “ENTER”. See below:

Note: the VE table and LOAD table can be calibrated “on-the-fly”, meaning, it takes effect immediately.

MAP\_fVe\_Map\_N

X: Pim, [hPa], "intake manifold pressure"  
 Y: N, [Rpm], "Engine speed in Rpm"  
 MAP\_fVe\_Map\_N: [-] "Factor Volumatic Efficiency, dependent on pressure and engine speed"

Y/X	300.00	350.00	400.00	430.00	460.00	500.00	550.00	600.00	650.00	700.00	750.00	800.00	850.00	900.00	970.00	1050.00
1200.00	0.4627	0.5093	0.5419	0.5756	0.5962	0.6118	0.6293	0.6440	0.6634	0.6849	0.6841	0.6774	0.6546	0.6348	0.6159	0.6059
1400.00	0.4837	0.5293	0.5619	0.5856	0.5992	0.6218	0.6453	0.6675	0.6807	0.6911	0.6941	0.6784	0.6562	0.6362	0.6180	0.6059
1650.00	0.5037	0.5483	0.5819	0.6056	0.6262	0.6418	0.6653	0.6835	0.6989	0.6976	0.7043	0.6812	0.6661	0.6581	0.6359	0.6159
2000.00	0.5237	0.5663	0.6019	0.6256	0.6462	0.6612	0.6853	0.7044	0.7137	0.7182	0.7161	0.6937	0.6758	0.6744	0.6491	0.6291
2500.00	0.5437	0.5863	0.6219	0.6456	0.6662	0.6818	0.7053	0.7273	0.7373	0.7484	0.7412	0.7204	0.7019	0.6888	0.6616	0.6480
3000.00	0.5639	0.6037	0.6441	0.6698	0.6892	0.7032	0.7232	0.7498	0.7674	0.7843	0.7742	0.7475	0.7350	0.7221	0.7069	0.6865
3500.00	0.5898	0.6246	0.6673	0.6825	0.7017	0.7260	0.7485	0.7608	0.7839	0.8051	0.7964	0.7726	0.7602	0.7463	0.7218	0.7061
4000.00	0.6041	0.6412	0.6857	0.7013	0.7258	0.7477	0.7647	0.7904	0.8223	0.8489	0.8293	0.8155	0.8052	0.7976	0.7607	0.7491
5000.00	0.6204	0.6667	0.7051	0.7278	0.7495	0.7629	0.7886	0.8264	0.8623	0.8889	0.8693	0.8410	0.8356	0.8249	0.8015	0.7814
6000.00	0.6471	0.6841	0.7218	0.7427	0.5800	0.6000	0.8156	0.8484	0.8923	0.9089	0.8893	0.8710	0.8656	0.8649	0.8423	0.8297
7000.00	0.6422	0.6848	0.7247	0.7419	0.6000	0.6200	0.8156	0.8554	0.8923	0.9089	0.8893	0.8710	0.8656	0.8649	0.8591	0.8297
8000.00	0.6473	0.6839	0.7258	0.7437	0.7669	0.7828	0.8156	0.8554	0.8923	0.9089	0.8893	0.8710	0.8656	0.8649	0.8591	0.8297

You can use the same method to calibrate all other cells of the table, when you have finished the calibration, the table must be manually made smooth and burn it to ECU. It is critical to have a smooth transition from one operating point (one cell) to the next in the VE table, never ever leave a spike in the table (a good way is to export the table to EXCEL and plot 3D surf, and manually smoothen out any spikes). Spikes are no good for engine controls.

You can also use the real-time lambda (ALM output) to calibrate the table. Make sure to use the engine steady-state running signals.

The method to calibrate the MAP\_LdTp\_Tps\_N (Alpha/N model) is same as MAP\_fVe\_Map\_N, only different in the dependency of "Tps" and "N", throttle position and RPM.

**Note:** To make it easy on the time-consuming tuning, understand you don't want to tune each cell, we developed the "EXPORT" functions of the tables. You can modify the whole table in Microsoft EXCEL!

Right click the table, select "export", it will save the table in the CSV format. And you can do the editing in Excel, which most users are very familiar. After you done the editing in EXCEL, you right click the table in ProCAL again, and select "import", select the CSV file you saved, and it will import the whole table back in.

It is so easy to edit the table in EXCEL that it has become a must to use this feature to do the tuning. You can also do the 3D plots, and use EXCEL math functions to tweak the cell values, and smooth out the spikes.

You can calibrate CUR\_TpsUnTp\_N to choose when to use Alpha/N model.

If you want us to help you to tune the EFI, Please log data at different conditions, and have comparative steady state driving at different throttle positions.

For two-stroke engines, the default fuel mapping is Alpha/N method, "RAM\_MAP\_LdTp\_Tps\_N", so if you want to calibrate the fuel quantity for a 2-stroke engine, you just modify the LOAD table only. The procedure is same as the four-stroke system.

## Chapter 6 Ignition Timing Tuning

### Basic Ignition Angle mapping

Basic ignition angle is the spark advance that you can run the engine at the max torque (at given LOAD and RPM), without causing the knock.

Actually it is not 100% optimized. There are 2-5 degrees of buffer reserved to protect the engine. You cannot run 100% optimized spark advance unless you have a good knock control systems (with knock sensors, for additional cost, etc).

There is a 16x12 ignition angle table (based on RPM and Load) for you to tune at different operating conditions. There are other tables, to adjust ignition angles dependent on temperatures, AFR, altitude, etc. It is fully programmable ignition control systems, compared to a pre-set factory ignition curve only dependent on the RPM.

The 16x12 basic ignition table is dependent on RPM and Load, and you can tune it to whatever curve, or actually "surf" as you want. Factory CDI timing is usually a fixed curve - more advance at higher RPM. That's it.

ECU controlled ignition angle has much more flexibility: it also takes into account of AFR (rich or lean), temperatures (cold or hot), altitude, etc. You need to read through the strategy book to understand how these factors affect the final ignition angle output.

In ProCAL:

Menu → calibrations → ignition system → basic ignition angle →

RAM\_MAP\_Iga\_N\_Ld

X: Ld\_b, [%] "Load, or relative air charge (byte)"  
 Y: N\_b, [Rpm] "engine speed, byte value"  
 MAP\_Iga\_N\_Ld: [CrA] "characteristic map, basic ignition angle, dependent on engine sp

Y/X	20.250	26.250	32.250	38.250	44.250	50.250	56.250	62.250	68.250	74.250	80.250
1200.000	12.000	12.000	12.000	12.000	12.000	12.000	12.000	12.000	12.000	12.000	12.000
1680.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
1980.000	20.250	20.250	20.250	20.250	20.250	20.250	20.250	20.250	20.250	20.250	20.250
2460.000	22.500	22.500	22.500	22.500	22.500	22.500	22.500	22.500	22.500	22.500	22.500
3000.000	24.750	24.750	24.750	24.750	24.750	24.750	24.750	24.750	24.750	24.750	24.750
3540.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000	30.000
4020.000	30.750	30.750	30.750	30.750	30.750	30.750	30.750	30.750	30.750	30.750	30.750
4500.000	32.250	32.250	32.250	32.250	32.250	32.250	32.250	32.250	32.250	32.250	32.250
4980.000	32.250	32.250	32.250	32.250	32.250	32.250	32.250	32.250	32.250	32.250	32.250
5520.000	33.000	33.000	33.000	33.000	33.000	33.000	33.000	33.000	33.000	33.000	33.000
6000.000	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250
7020.000	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250
7980.000	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250
9000.000	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250
10020.000	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250
10200.000	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250	35.250

**Note:** The default ignition table is very close to the best ignition angle, so if you want to change it, please adjust it in a small step and range, such as 1 degree or 3 degrees (For example, if the default value is 36, you can change it to 38). It protects the engine from too aggressive ignition angle, which can damage the engine.

### Minimum Ignition Angle

Minimum ignition angle is the latest spark retard angle (refer to TDC) that you can still run the engine without misfiring.

Y/X	20.250	26.250	32.250	38.250	44.250	50.250	56.250	62.250	68.250	74.250	80.250
1200.000	-12.750	-21.000	-27.750	-33.000	-38.250	-42.000	-44.250	-45.000	-45.000	-45.000	-45.000
1680.000	-3.000	-11.250	-18.750	-24.750	-29.250	-33.000	-36.000	-39.000	-43.500	-45.000	-45.000
1980.000	0.000	-10.500	-19.500	-24.750	-28.500	-32.250	-35.250	-37.500	-39.750	-42.750	-45.000
2460.000	2.250	-11.250	-18.750	-24.000	-28.500	-31.500	-34.500	-37.500	-39.750	-42.750	-45.000
3000.000	2.250	-9.000	-16.500	-20.250	-25.500	-28.500	-31.500	-33.000	-33.750	-34.500	-36.000
3540.000	2.250	-4.500	-14.250	-19.500	-24.750	-27.000	-28.500	-29.250	-30.750	-33.750	-36.000
4020.000	6.750	-0.750	-8.250	-15.000	-18.750	-21.750	-24.000	-26.250	-28.500	-30.000	-32.250
4500.000	8.250	-0.750	-6.000	-11.250	-15.000	-17.250	-18.750	-20.250	-22.500	-24.750	-26.250
4980.000	15.750	5.250	-5.250	-11.250	-15.000	-18.000	-19.500	-21.000	-23.250	-24.750	-27.000
5520.000	20.250	11.250	2.250	-7.500	-14.250	-17.250	-19.500	-20.250	-21.000	-21.750	-23.250
6000.000	22.500	13.500	4.500	-3.750	-10.500	-13.500	-16.500	-18.000	-19.500	-20.250	-21.000
7020.000	23.250	13.500	4.500	-3.750	-8.250	-12.750	-15.000	-15.750	-17.250	-19.500	-21.000
7980.000	25.500	18.750	11.250	3.000	-3.750	-9.750	-14.250	-15.750	-17.250	-19.500	-21.000
9000.000	25.500	18.750	11.250	3.000	-3.750	-9.750	-14.250	-15.750	-17.250	-19.500	-21.000
10020.000	25.500	18.750	11.250	3.000	-3.750	-9.750	-14.250	-15.750	-17.250	-19.500	-21.000
10200.000	25.500	18.750	11.250	3.000	-3.750	-9.750	-14.250	-15.750	-17.250	-19.500	-21.000

### **Other Ignition Angle Adjustment**

Basic ignition angle will be adjusted according to temperature, altitude, lambda, knock limit, etc. That's probably why sometime you see the actual ignition angle is not the one you filled in the basic ignition able. It can be something in the middle of basic angle and minimum angle.

## Chapter 7 Advanced Tuning

### 7.1 Transient fuel

**To improve the performance of the throttle response, you need to change the transient fuel.**

When you open the throttle, if you feel the bike bogs or pops or doesn't have much power, it may be too rich or too lean, you can read the AFR/lambda by using the ALM wideband sensor. Then do some advance tuning according to the below instructions. Add two calibration variables by using the advanced calibration menu, "CUR\_Wf\_Ldp" and "VAL\_fTrsRedS"

"CUR\_Wf\_Ldp": the wall film fuel quantity during the transient, depend on the predicted LOAD.

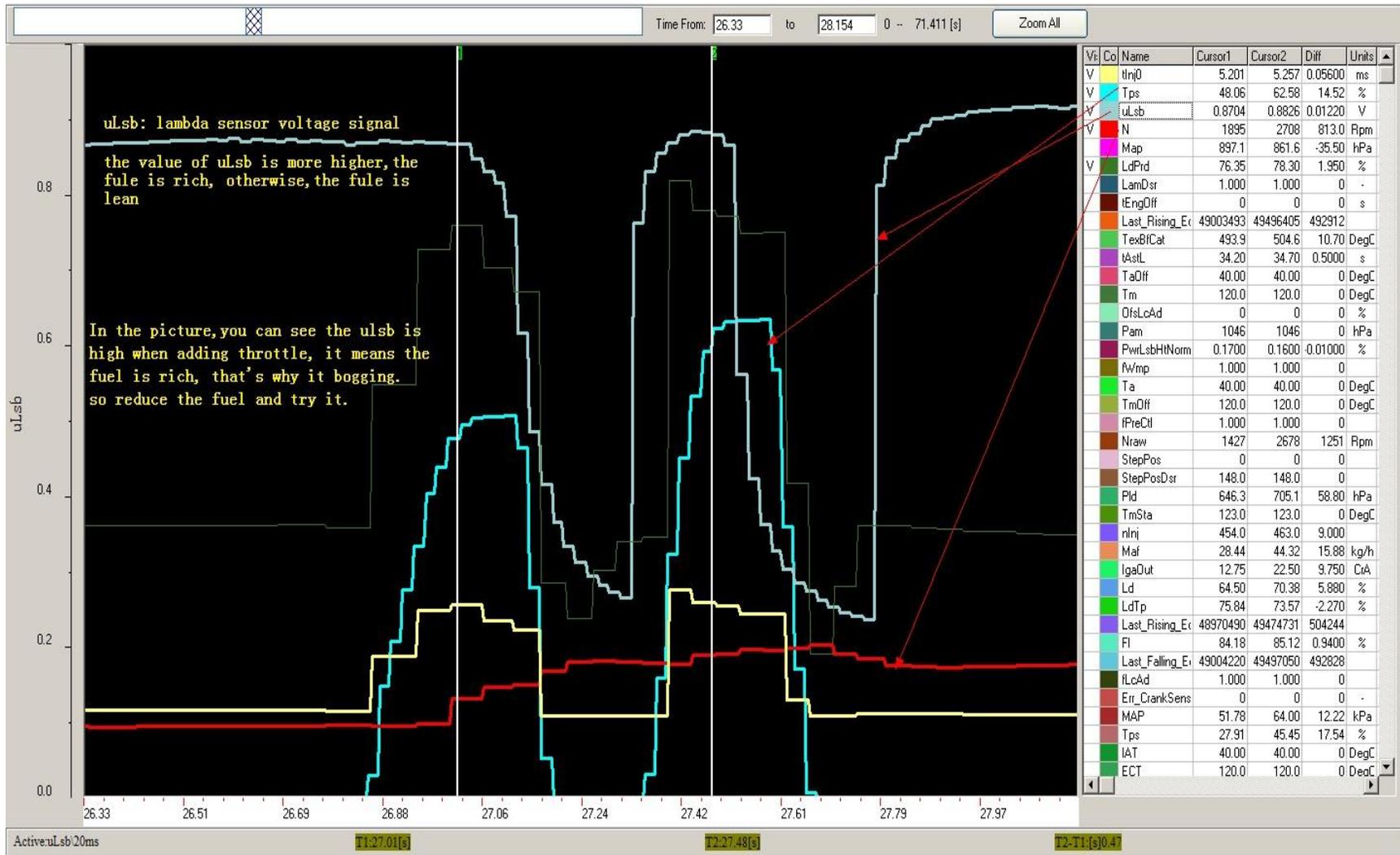
"VAL\_fTrsRedS": reduction factor of the short-term transient fuel

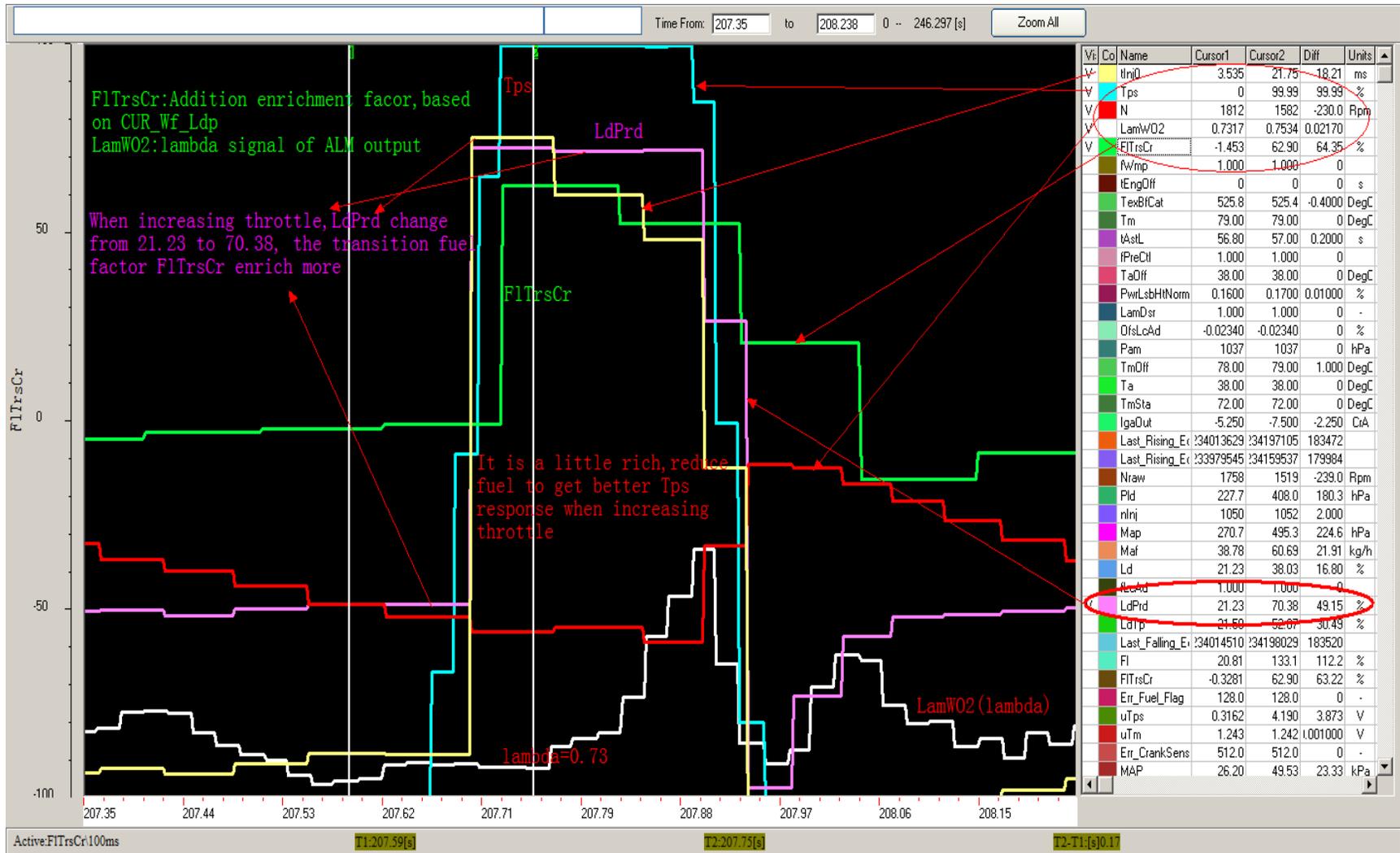
Our transient fuel tuning, is based on the Wall film model. Wall film fuel is the fuel stuck on the intake manifold wall or combustion chamber corner, clearance, that is not participating the combustion. Then you open the throttle or close the throttle, the wall film fuel will increase or decrease, and therefore change your desired AFR.

The transient fuel tuning is to model this wall film at different Load conditions, and then compensate the fuel that is caused by the wall film fuel changing.

The wall film fuel is modeled based on the "**Predicted LOAD**". Predicted load is the engine load of the next combustion cycle. You must use predicted load, not the current load, for the next cycle's fuel calculation. This is a whole advanced engine control theory, if you are interested.

Below are a couple of examples of transient fuel tuning.





You can calibrate the "CUR\_Wf\_Ldp" value based on the LdPrd, you can read the value of LdPrd in ProCAL.

LdPrd	0.00	6.00	12.00	18.00	24.00	30.00	36.00	42.00	48.00	54.00	60.00	66.00	72.00	78.00	84.00	90.00	96.00	102.00
CUR_Wf_Ldp	0.00	4.69	12.00	41.06	65.06	90.00	126.94	159.94	180.94	199.88	216.94	232.88	241.88	249.00	257.06	261.94	276.00	296.06

Vis	Col	Name	Value	Rate	Unit	Min	Max	Discription
		Fi	56.95	Syn	%	0	3072	"Relative fuel mass"
		IgaOut	35.25	Syn	CiA	-96	95.25	"Ignition angle output value"
		Ld	41.25	Syn	%	0	1536	"Load, or relative air charge"
		LdPrd	41.25	Syn	%	0	1535.977	"load predicted for injection time calculati"
		LdTp	41.25	Syn	%	0	1535.977	"Load through throttle valve"
		Maf	14.57	Syn	kg/h	0	1572	"Mass air flow"
		Map	2559.96	Syn	hPa	0	2560	"Intake manifold pressure measured with M"
V		N	2652.25	Syn	Rpm	0	16383	"Engine speed in Rpm"
		nInj	1288.00	Syn		0	65535	"number of injections "
		tInj0	3.37	Syn	ms	0	65.535	"injection time for injector #0 "
		fLc	1.0000	20ms		0	2	"Lambda controller output (word)"
		Map	2559.96	20ms	hPa	0	2560	"Intake manifold pressure measured with M"
		Nraw	2650.00	20ms	Rpm	0	16383.75	"Engine speed in rpm from LLD"
V		Tps	12.50	20ms	%	0	100	"throttle position with respect to lower mec"
		UbAdc	12.03	20ms	V	0	25.6	"battery voltage; scanned value of microp"
		uLsb	0.4541	20ms	V	-1	4	"Voltage signal from the lambda sensor be"
		uMap	4.9707	20ms	V	0	5	"Voltage signal of manifold pressure sensc"
		uPot	4.9756	20ms	V	0	5	"ADC-voltage of potentiometer sensor "
		uTps	4.9744	20ms	V	0	5	"ADC-voltage of throttle position sensor "

You can change the wall film quantity according to LdPrd before increasing the throttle and after increasing the throttle. The delta of the wall film quantity at different LdPrd is the base transient fuel. If you see lean conditions at the throttle opening, that means you need to add more wall film at high Load conditions (big LdPrd).

You can also try to adjust the value of "VAL\_fTrsRedS" to get different effects of the throttle opening conditions.

"CUR\_fwLdpMapTps\_N" is a weight factor for PN model and Alpha/N model in transient conditions.

Raise the value of CUR\_fwLdpMapTps\_N will make TPS-based prediction more weighting, when you increase throttle in acceleration condition.

When you begin to calibrate the transient fuel, the basic injection table must be stable, the engine must run normally. And to calibrate it, you need to repeat the test to get a better performance.

### **Advanced tuning for throttle blips**

If the response of throttle blip is not in favor, and you have the right software version from us for this issue, you can calibrate it by yourself, and find a suitable value to improve the response (usually for the big displacement engine).

#### **Injection compensation variables for throttle blips:**

VAL\_dtInjTpBlip\_Max --- max delta injection pulse width in ms when throttle blip happens.

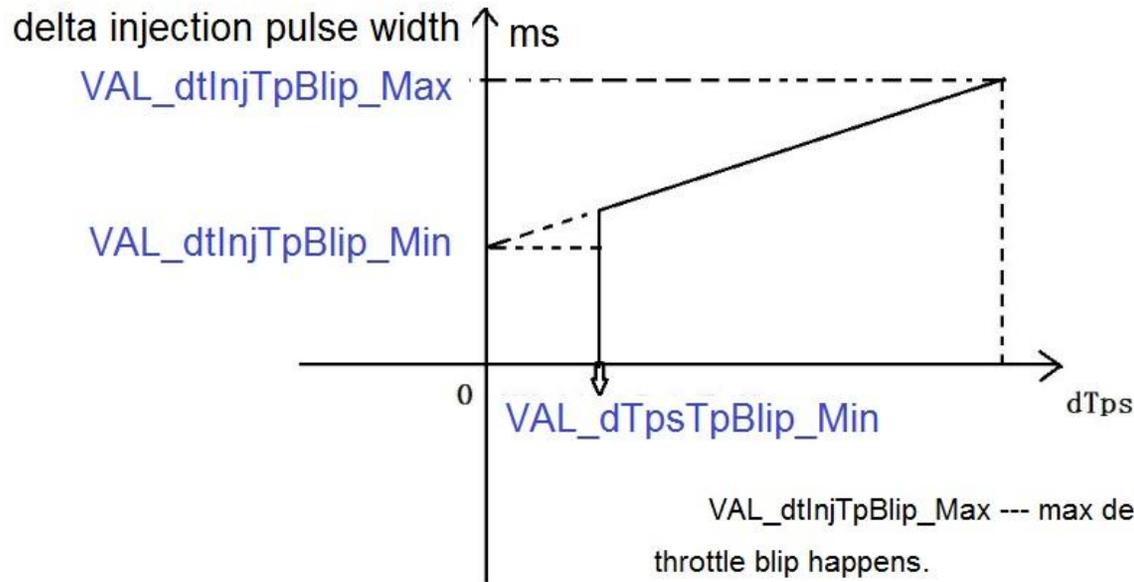
VAL\_dtInjTpBlip\_Min --- min delta injection pulse width in ms when throttle blip happens.

VAL\_dTpsTpBlip\_Min --- min delta Tps change in 20ms to recognize the throttle blip.

(If the Tps change is bigger than VAL\_dTpsTpBlip\_Min, it will enable the function to add fuel.)

VAL\_NTpBlip\_Max --- max RPM limited when throttle blip

(If the RPM is higher than VAL\_NTpBlip\_Max when the throttle blips, there is no additional fuel)



VAL\_dtInjTpBlip\_Max --- max delta injection pulse width in ms when throttle blip happens.

VAL\_dtInjTpBlip\_Min --- min delta injection pulse width in ms when throttle blip happens.

VAL\_dTpsTpBlip\_Min --- min delta Tps change in 20ms to recognize the throttle blip.

**Dashpot functions for deceleration:**

And if you have the software for deceleration to avoid a stall issue with the stepper motor control system, you also can calibrate the below variables.

VAL\_McDashpot\_DeltaDecrements: the step size of IAC ramp-down, range: 12-24; the bigger the value, the faster the ramp, but more likely to stall.

VAL\_McDashpotInitValue: initial position of the IAC motor for dashpot, range 640-320;

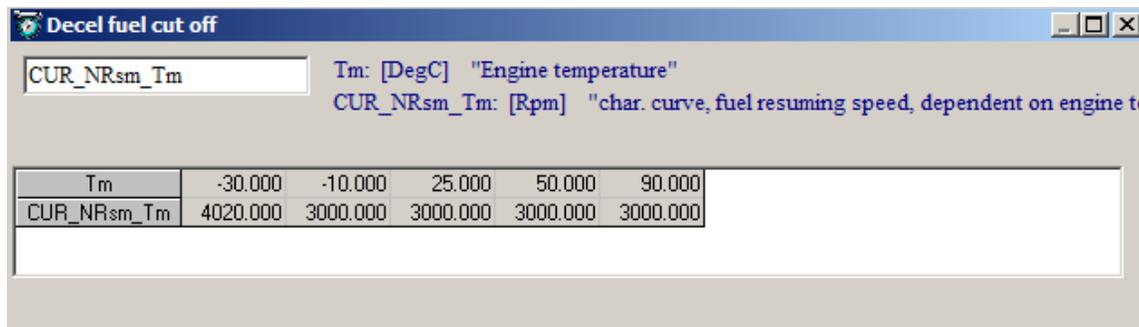
**Note:** You can find the variables in ProCAL if you have the correct A2L file, go to menu->Advanced->Add Advanced Calibrations. You need repeat the attempts to tune it.

## 7.2 Decel-Fuel-Cut-Off

Our EFI system by default has enabled the decel-fuel-cut-off function. It is RPM dependent, when you release the throttle to idle and RPM is higher than the table value, it will cut the fuel injection.

And you can adjust the table value to decide at what RPM to resume fuel.

Menu->Calibrations->Fuel system->decal-fuel-cut-off



**Note:** So if you want to disable decal-fuel-cut-off, you can adjust the table value to a bigger one. But don't disable the decal-fuel-cut-off, if you are running in a mountain area, and it may damage the engine in downhill driving because a lot of un-burnt fuel getting into the exhaust system.

### 7.3 Driver's desired lambda

- 1) Driver desired lambda is only feasible after you have the system running stably in close loop controls and the ECU has done the self-tuning. That means, the ECU can control the AFR in the vicinity of stoic AFR (14.7 for gasoline). Only after that, ECU can command a meaningful AFR other than the stoic. Otherwise, the driver desired lambda could have a big deviation from the actual lambda value.
- 2) Driver desired lambda is meant to give the user a way to command the AFR other than Stoic, either for performance purpose (more likely) or fuel saving purpose.
- 3) Default value of desired lambda is as below table. It is enriched at high end. 1 means stoic AFR (14.7 for gasoline).
- 4) Desired lambda table can be activated by turning on the "RICH" mode, by switching the "Performance switch" to ON position. By default, the engine is running in "ECO" mode; and the desired lambda table is not used.

**Some more comments on RICH mode:** Rich mode only works well after ECO mode is tuned.

RICH mode is actually an open loop mode, meaning, ECU will command the "desired Lambda" based on the ECO mode tuning. It assumes you have tuned the base mapping like VE table and TPS Load table close to Stoic AFR at all conditions. It then divides the desired lambda on the top of the base fuel quantity.

In RICH mode, you only tune the "desired lambda table", which should be between 0.8 to 1.2 ranges. This is nothing but a dividing factor on top of the base fuel mapping.

For example, your base fuel mapping outputs a fuel quantity of 3ms pulse width, and your desired lambda is 0.9; then your final fuel pulse output is  $3 / 0.9 = 3.33\text{ms}$ .

Menu->Calibrations->Driver's demand->desired lambda

**Desired lambda**

MAP\_LamDrv\_Tps\_N

X: N, [Rpm] "Engine speed in Rpm"  
 Y: TpsEqu, [%] "throttle position equivalent value, including the idle by-pass air flow"  
 MAP\_LamDrv\_Tps\_N: [-] "characteristic map, Driver desired lambda, dependent on TPS and N"

Y\X	1400.000	2000.000	2600.000	3200.000	3800.000	4400.000	5000.000	5600.000	6200.000	6800.000	7400.000	8000.000
0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
3.914	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.986	0.986	0.986	0.986
6.526	1.000	1.000	0.993	0.986	0.986	0.986	0.986	0.986	0.952	0.952	0.952	0.952
9.132	1.000	0.993	0.952	0.952	0.952	0.952	0.952	0.952	0.918	0.918	0.918	0.918
13.048	0.986	0.986	0.918	0.918	0.918	0.918	0.918	0.918	0.918	0.885	0.885	0.885
16.963	0.986	0.986	0.918	0.885	0.885	0.885	0.885	0.885	0.885	0.850	0.850	0.850
20.879	0.885	0.952	0.891	0.885	0.850	0.850	0.850	0.850	0.850	0.850	0.850	0.850
24.792	0.885	0.952	0.891	0.878	0.850	0.850	0.850	0.850	0.850	0.844	0.844	0.844
32.617	0.878	0.885	0.885	0.871	0.850	0.844	0.844	0.844	0.844	0.837	0.837	0.837
39.145	0.878	0.885	0.885	0.871	0.850	0.837	0.837	0.837	0.837	0.837	0.837	0.837
45.671	0.878	0.885	0.885	0.864	0.850	0.837	0.837	0.837	0.837	0.830	0.830	0.830
52.193	0.878	0.885	0.878	0.864	0.850	0.830	0.830	0.830	0.830	0.830	0.830	0.830
58.716	0.878	0.885	0.878	0.864	0.850	0.830	0.830	0.830	0.830	0.830	0.830	0.830
65.242	0.878	0.885	0.878	0.864	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830
78.290	0.878	0.885	0.878	0.864	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830
99.994	0.878	0.885	0.878	0.864	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830

## 7.4 Advance Calibration for engine timing

If you use Ecotrons ECU to control ignition system, you may do some advanced calibration on the ignition system to get a good performance.

### Pickup type

#### 1 One pulse per revolution.

[VAL\\_dIgaGap2TdcAdj](#): "Ignition angle adjustment from GAP to TDC, GAP is the missing tooth for the multi-tooth trigger wheel, or the pickup pulse location."

This is the first calibration you need to be sure. It determines the engine TDC position in regarding to the pulse generation.

**See Chapter 1, how to calibrate this variable.**

You can also adjust the injection timing, based on the pickup pulse. It is the mapping of "MAP\_InjAngEnd\_N\_Ld"  
"MAP\_InjAngEnd\_N\_Ld" is the end of injection angle referring to TDC; it means the angle from injection end to the ignition TDC position.

## **2 How to calibrate the ignition timing and injection timing with a multi-tooth trigger wheel installed on the crankshaft?**

### **VRS sensor installation for the multi-tooth trigger-wheel**

VRS need be installed the same way as the Hall Effect sensor. It generates AC pulses instead of square waves.

The metal sensing element (sensor head) needs to align well with the multi-tooth wheel.

The tooth width needs to be bigger than the sensing metal core, otherwise, the VRS signal will not be correct, and ECU will the distorted VRS signal, and EFI could not work.

Our EFI works with a wide range of multi-tooth trigger wheels. The typical trigger wheels have 12-1 tooth-wheel, or 24-1, 36-2, or 60-2 tooth wheels. Here, “12-1” tooth wheel means there are totally 12 teeth with one missing tooth. 36-2 means totally 36 teeth with 2 missing teeth, and so on. Our ECU supports different combinations of total teeth and missing tooth setting. The total number of teeth cannot be more than 60; the missing tooth can be 1 or 2.

Usually the higher the engine speed redline, the less the teeth. This is because at higher speed, the tooth signal becomes smaller and smaller, and eventually ECU cannot catch it anymore. For most 2 stroke engines, 12-1 tooth wheel , or 24-1 tooth wheel is typical, because usually 2 stroke engines are high speed ones. For most 4-stroke motorcycle engines, the tooth wheel is 36-2 setting.

If you want to have a good ignition control system, a high-tooth wheel is definitely way to go. And if you have the mechanical capability to add the tooth wheel to your engine, we recommend you to do so.

For multi-cylinder engines, and special engines, such as a V-twin engine, if you want EFI system to control the ignition, you need to install the tooth wheel.

Our CDI controlled ignition system is meant to be used for single cylinder engine. And the accuracy of the ignition timing is not as good as the trigger wheel based.

Let's see one example with 36-2 tooth-wheel.

Some calibration variables need to be defined:

**VAL\_nTeethTot:** ----- Total number of teeth on the tooth-wheel.

**VAL\_nTeethMiss:** ---- number of missing tooth on the tooth-wheel.

**VAL\_ToothTDC:** ----- tooth number of the ignition TDC for single cylinder.

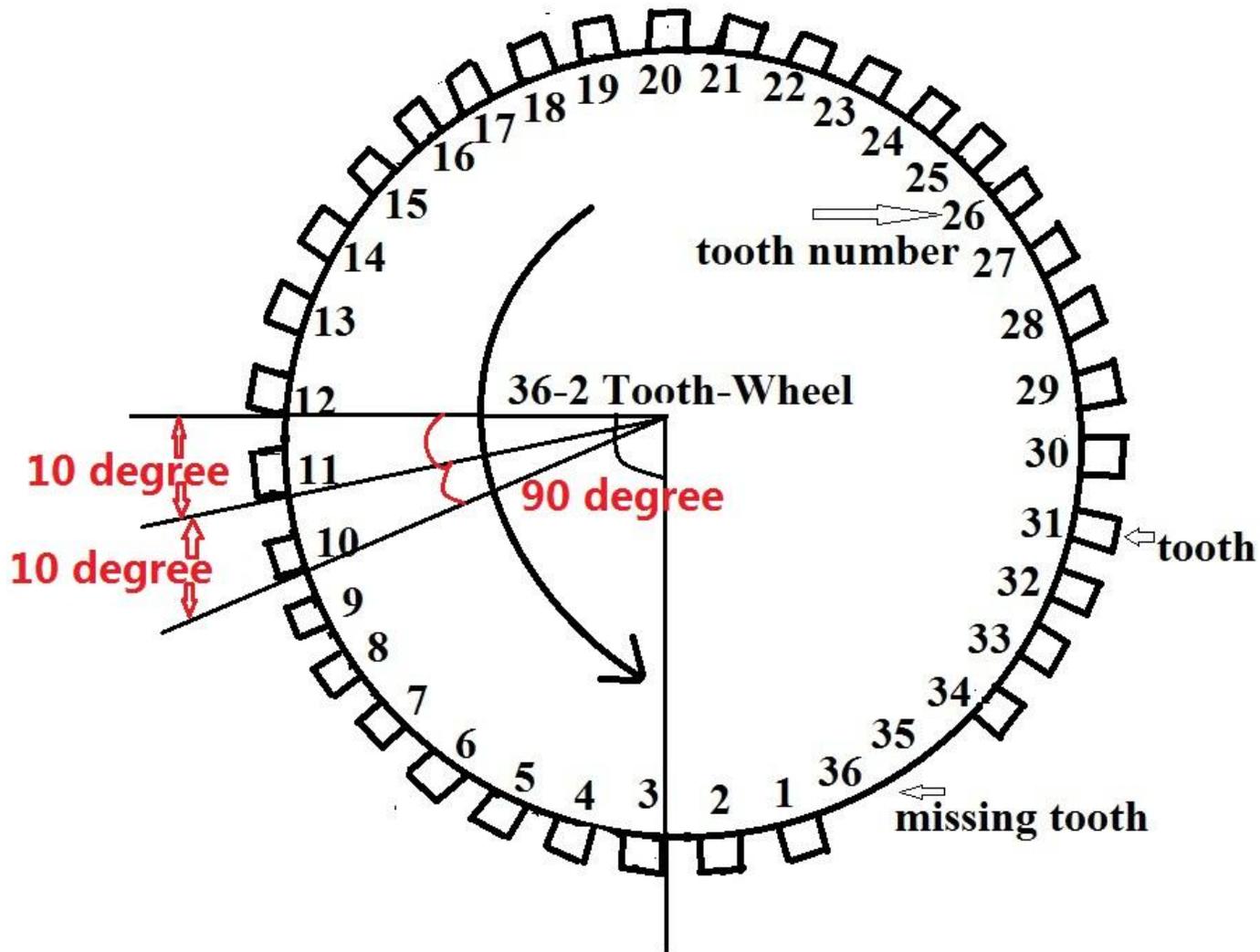
**VAL\_ToothTDC2:**----- tooth number of Cylinder #2 ignition TDC for two cylinder engines.

**MAP\_Iga\_N\_Ld:** -----basic ignition angle table

**MAP\_InjAngEnd\_N\_Ld-** injection end angle table

Below is an illustration of the 36-2 trigger wheel and the engine positions.

Each tooth is 10 degree ( $360/36=10$ ). The first tooth after missing teeth is marked as the #1 tooth.



First you need calibrate the parameters of the tooth-wheel:

`VAL_nTeethTot=36;`

`VAL_nTeethMiss=2;`

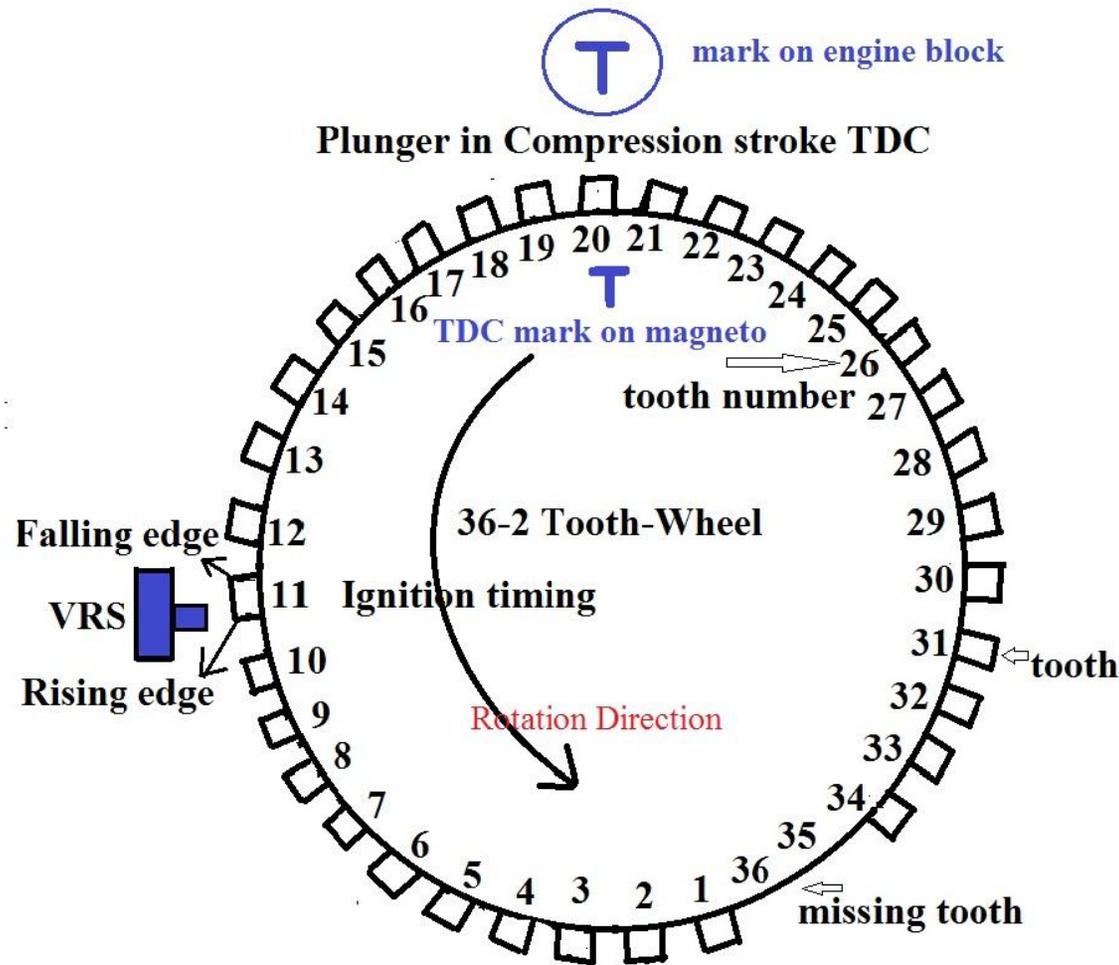
#### **Four-stroke engine:**

##### **1) Single cylinder engine:**

You need calibrate VAL\_ToothTDC

VAL\_ToothTDC is the tooth number of the ignition TDC.

To find it: spin the engine to the ignition TDC position, and count the tooth number from the missing tooth to the tooth that is under the VRS sensor. See the below picture, it is very clear.



VAL\_nTeethTot=36  
VAL\_nTeethMiss=2

Note: when crankshaft is in rotation, and engine in compression stroke TDC (Ignition TDC), the Rising edge of Num11 tooth pass through VRS sensor, it means the rising edge of Num11 tooth is ignition TDC, so VAL\_ToothTDC=11

In the above picture, you can see the #11 tooth is TDC, so VAL\_ToothTDC=11

## 2) Tow-cylinder engines:

You need calibrate VAL\_ToothTDC, VAL\_ToothTDC 2

The method to calibrate two-cylinder engine is same as a single cylinder engine. One thing to find out is how many degrees the two cylinders are apart.

Use one V-twin engine as an example; the two cylinders are separated by 90 degrees.

For 36-2 tooth-wheel, V-twin, a two-cylinder engine, the ignition TDC tooth of cylinder #1 is #11, and the two cylinders are 90 degree apart, so the ignition TDC of cylinder #2 is 270 (360-90) degree after the Cyl#1's. So the ignition TDC tooth of Cyl#2 is #38.

So VAL\_ToothTDC=11, VAL\_ToothTDC2=38.

**Note:** The value of the tooth number for 4 stroke engines is form 1 to 72, because 2 revolutions are one full engine cycle. The tooth number will increment by 1 into the next revolution, until 72. After number 72, the tooth number reset to 1.

**If the two cylinders are separate from 360 degrees, like a boxer twin engine:**

VAL\_ToothTDC=11, VAL\_ToothTDC2=47

**Note:** The method to calibrate 12-1, 24-1, 60-2, etc. tooth-wheels for four-stroke engines is same as to the 36-2 tooth-wheel.

### Two-stroke engines:

1) Single cylinder 2 stroke engine:

You need calibrate VAL\_ToothTDC

VAL\_ToothTDC is the tooth number of ignition TDC.

For example, for a 36-2 tooth-wheel, #11 tooth is the ignition DTC, so VAL\_ToothTDC=11

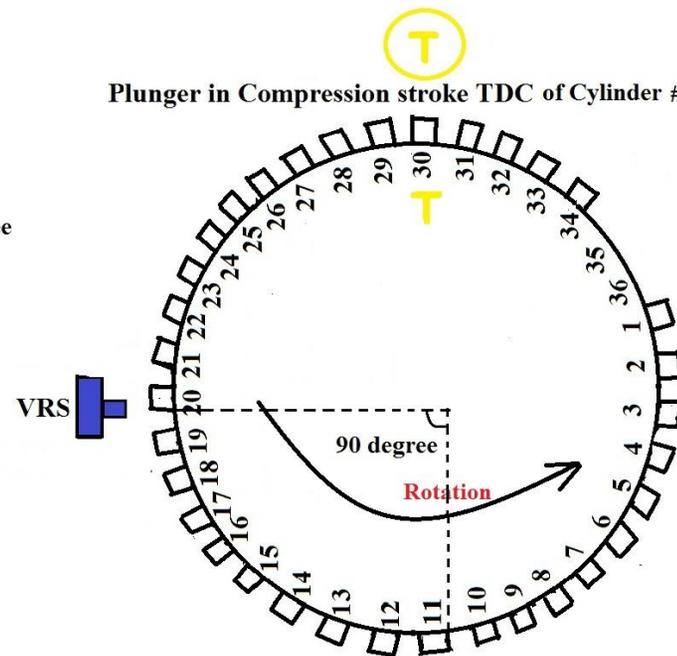
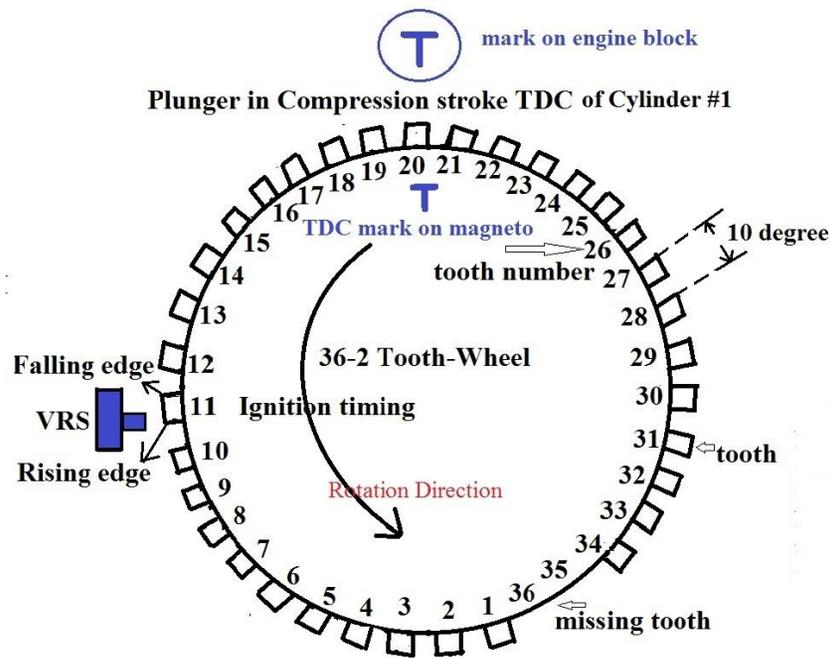
2) Two-cylinder 2 stroke engine

You need calibrate VAL\_ToothTDC, VAL\_ToothTDC 2

If the two cylinders are separate by 90 degrees,

VAL\_ToothTDC=11, VAL\_ToothTDC2=20 (each tooth angle is 10 degree)

**Note:** The value of the tooth number is form 1 to 36 for 2 stroke engines, because 1 revolution is one full engine cycle. The tooth number will be reset to 1 in the next cycle.



V-twin two-cylinder engine  
The two cylinders are 90 degree apart

VAL\_nTeethTot=36  
VAL\_nTeethMiss=2

Each tooth angle is 10 degree  
(360°/36=10°)

#11 tooth is Cyl#1 TDC  
#20 tooth is Cyl#2 TDC  
VAL\_ToothTDC=11  
VAL\_ToothTDC2=20

The method to calibrate 12-1, 24-1, 60-2, and etc. tooth wheels is same as to the 36-2 tooth-wheel.

And the ignition angle MAP table: MAP\_Iga\_N\_Ld

Injection end angle: MAP\_InjAngEnd\_N\_Ld

Both of them need be calibrated with the actual performance.

## Chapter 8 Sensors and actuators

### 8.1 Sensors' characteristics calibration

You only need to calibrate with this chapter if you are using sensors or actuators other than the ones provided by us.

(For example, you installed a throttle body from after-market or from another FI engine, which comes with the OEM's TPS, MAP sensors, and injector); or if you use our ECU only to replace the stock ECU on a FI engine.

**The best way to tune the sensor and actuator's characteristics is to find the manufacturer's data sheets. If you cannot get them, here are the ways to get coarse data for them.**

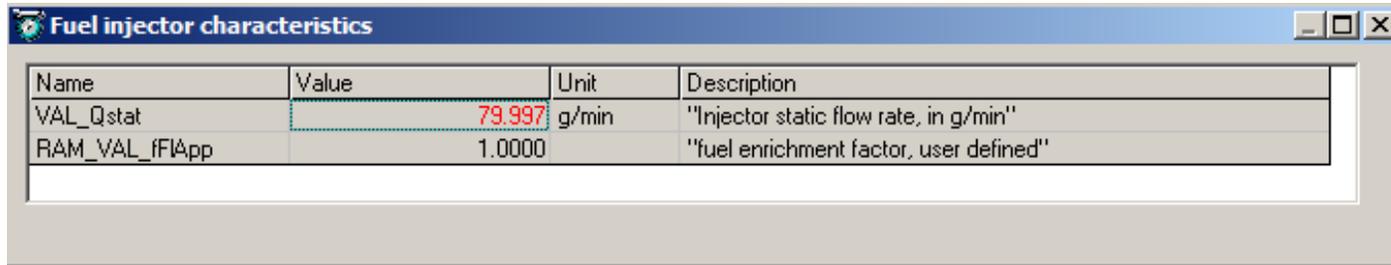
#### 8.1.1 Injector characteristics

**Static flow rate:**

**VAL\_Qstat:** injector static flow rate (g/min, or gram per minute)

This must be found out from the manufacturer's datasheet. Or you have to hire a professional company to measure it.

Menu->Calibrations->Fuel system->Fuel injector characteristics



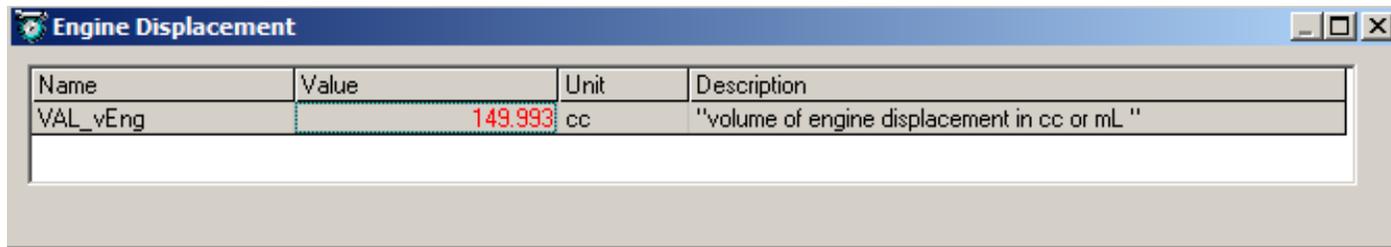
Name	Value	Unit	Description
VAL_Qstat	79.997	g/min	"Injector static flow rate, in g/min"
RAM_VAL_fIApp	1.0000		"fuel enrichment factor, user defined"

Together, it may be necessary to find out what is the fuel pressure in the fuel rail, or high pressure line. Make sure the "VAL\_Qstat" has the value which is associated with this fuel pressure. Otherwise it may need adjusted. Ask us how to.

### 8.1.2 Engine displacement

VAL\_vEng: volume of engine displacement (cc or milliliter)

**Menu->Calibrations->System parameters->Engine displacement**



Name	Value	Unit	Description
VAL_vEng	149.993	cc	"volume of engine displacement in cc or mL "

This might be the easiest one to figure out.

**Note:** If it's a 2 cylinder engine, this value needs to be divided by 2. Meaning this is the single-cylinder displacement.

### 8.1.3 MAP sensor

**Map:** manifold absolute pressure (hPa)

**uMap:** voltage of MAP sensor signal (V)

$$\text{Map} = \text{uMap} * \text{VAL\_PmapGrd} + \text{VAL\_PmapOfs}$$

Analog signal from the MAP sensor, uMap, is converted into absolute pressure in hPa. the conversion is linear, with slope of VAL\_PmapGrd, and offset of VAL\_PmapOfs.

"VAL\_PmapGrd" and "VAL\_PmapOfs" are calibrate-able variables in the ECU.

To find out these 2 values, you have below options:

Get it from the manufacturer, either from the vehicle manufacturer, or component manufacturer.

Measure it yourself, and you need 2 pairs of (pressure vs voltage) data points:

Use an accurate pressure gauge, measure the pressure point #1, P1, and at the same time use a multi-meter, measure the voltage of the MAP sensor signal wire, u1;

Measure the pressure point #2, P2, and at the same time use a multi-meter, measure the voltage of the MAP sensor signal wire, u2;

These 2 data points are preferred to be representative to the range of MAP sensor.

**For example;**

P1 can be the idle air pressure: 500hPa.

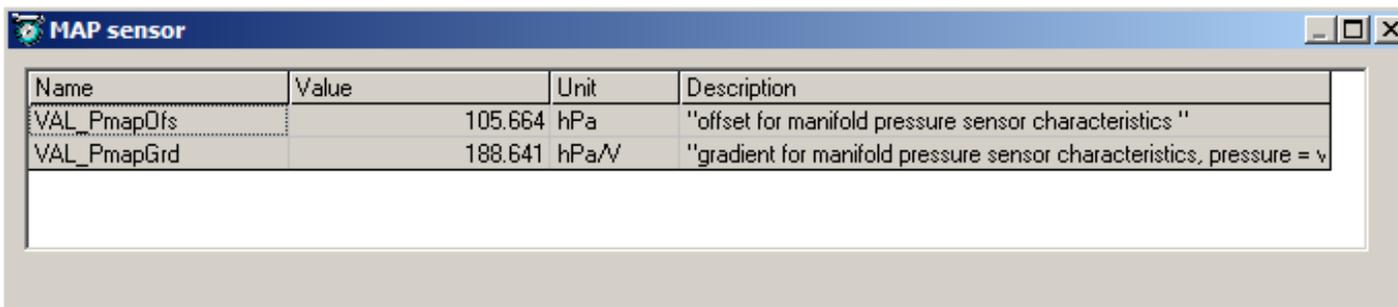
**Note:** When measuring the pressure, create a stable vacuum. Small engine manifold pressure is too dynamic for this measurement.

P2 can be the barometric pressure: 1013 hPa at sea level.

Then

$$VAL\_PmapGrd = (P2 - P1) / (u2 - u1)$$

$$VAL\_PmapOfs = P2 - u2 * VAL\_PmapGrd$$



Name	Value	Unit	Description
VAL_PmapOfs	105.664	hPa	"offset for manifold pressure sensor characteristics "
VAL_PmapGrd	188.641	hPa/V	"gradient for manifold pressure sensor characteristics, pressure = v

Menu->Calibrations->sensor characteristic-> Map sensor

### 8.1.4 IAT sensor

**IAT: intake air temperature sensor**

**Ta: Temperature of intake air ( °C)**

**uTa: voltage of air temperature sensor signal (V)**

Usually temperature sensors are NTC type: negative temp characteristics:

Assuming, as a first-order approximation, that the relationship between resistance and temperature is linear, then:

$$\Delta R = k * \Delta T$$

Where

$\Delta R$  = change in resistance

$\Delta T$  = change in temperature

k = first-order temperature coefficient of resistance

Contact us if you do not have sensor manufacturer's data.

By these relations, you can calculate the below table and fill in ProCAL:

Menu->Calibrations->sensor characteristic-> Air temperature sensor

uTa	0.3003	0.3699	0.4553	0.5872	0.7458	0.9705	1.3196	1.7725	2.5415	3.7427	4.2444	4.4934	4.6753	4.8022
CUR_Ta_uTa	150.000	135.000	125.000	113.000	102.000	90.000	76.000	62.000	43.000	15.000	0.000	-10.000	-20.000	-30.000

### 8.1.5 ECT sensor

**ECT: engine coolant temperature sensor**

**Tm: Engine (motor)Temperature ( °C)**

**uTm: voltage of engine temperature sensor signal (V)**

Usually temperature sensors are NTC type : negative temp characteristics:

Assuming, as a first-order approximation, that the relationship between resistance and temperature is linear, then:

$$\Delta R = k * \Delta T$$

Where

$\Delta R$  = change in resistance

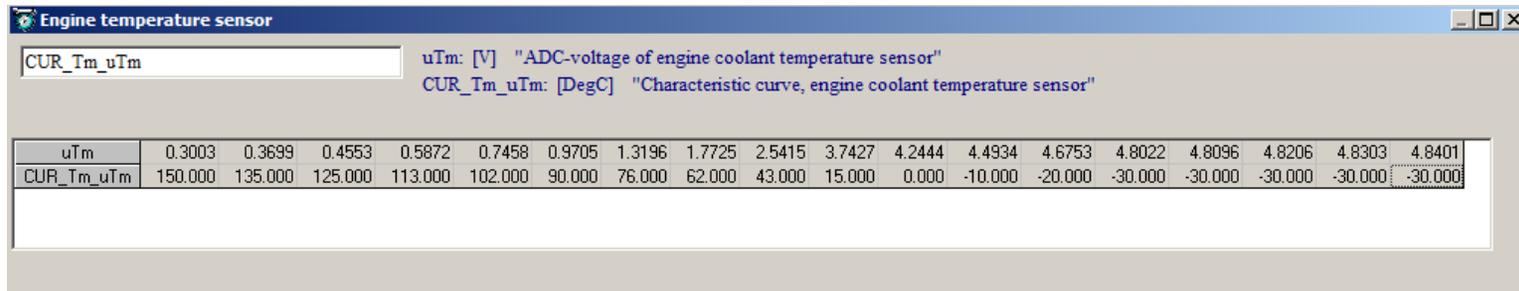
$\Delta T$  = change in temperature

k = first-order temperature coefficient of resistance

Contact us if you do not have sensor manufacturer's data.

By these relations, you can calculate the below table and fill in ProCAL:

Menu->Calibrations->sensor characteristic-> engine temperature sensor



**Calibration for your own temperature sensor (IAT or ECT):**

If you have the characteristic from the manufacturer, you can fill the table directly.

If not, you need measure it by yourself.

A rough but working one: put your temperature sensor into some coolant, which you can heat it up at different temp., and use a thermo-stat measure the coolant temp, and also measure the voltage with our software ProCAL, and fill in the CUR\_Tm\_uTm or CUR-Ta\_uTa.

**8.1.6 TPS sensor**

**Tps: throttle position sensor (%)**

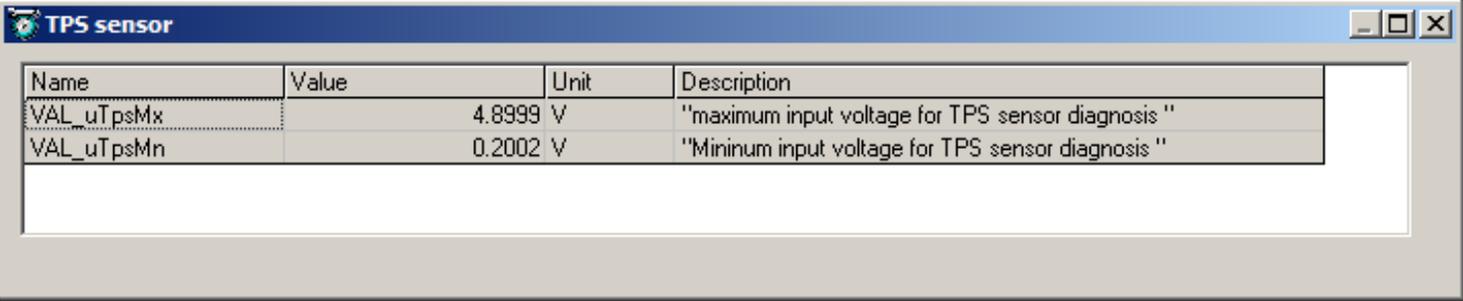
**uTps: voltage of TPS sensor signal (V)**

For throttle position sensors, you need to measure the idle position "uTps1", and WOT position "uTps2".

Then find the values for VAL\_uTpsMx and VAL\_uTpsMn, to make sure that:

$$+5V > VAL\_uTpsMx > (uTps2 + 0.1v)$$

$(uTps1 - 0.1v) > VAL\_uTpsMn > 0$



Name	Value	Unit	Description
VAL_uTpsMx	4.8999	V	"maximum input voltage for TPS sensor diagnosis "
VAL_uTpsMn	0.2002	V	"Minimum input voltage for TPS sensor diagnosis "

### TPS self-adaptation

When will the ECU run the TPS self-adaptation?

1. When ECU is replaced;
2. When either the TPS or the throttle body is replaced;
3. Your ECU cannot reach 100% TPS.
4. When ECU is first on after the TPS is mechanically adjusted.

How to do TPS self-adaptation?

1. Power on, and disconnect the ECU (power-fail) to reset the self-adaptation;  
For example, pull out the ECU from the connector after key on.
2. Power off, re-connect the ECU, and power on again.
3. Keep the throttle at "idle position" for more than 5S.



If you are fast enough, you can watch the TPS reading is changing from a small value to 0% by itself. Now you can read the “TPS” is 0% in ProCAL.

tlnj	1.963	20ms	ms	0	65.535
Tm	54.000	20ms	DegC	-50	205
TPS	0.000	20ms	%	0	100
TpsEqu	0.000	20ms	%	0	99.99847
UbAdc	15.781	20ms	V	0	25.6
uLsb	1.1670	20ms	V	-1	4

4. Keep the throttle at “WOT” (wide open throttle) for more than 5S.



Now you can read the “TPS” is almost 100% in ProCal.

	StepPosDsr	190.000	20ms		0	640
	Ta	19.000	20ms	DegC	-50	205
	TexBfCat_uEGT	280.957	20ms	DegC	-50	1230
	tInj	1.963	20ms	ms	0	65.535
V	Tm	53.000	20ms	DegC	-50	205
V	TPS	99.998	20ms	%	0	100
	TpsEqu	99.998	20ms	%	0	99.99847
	UbAdc	15.794	20ms	V	0	25.6
	uLsb	1.1719	20ms	V	-1	4
	uMan	1.8408	20ms	V	0	5

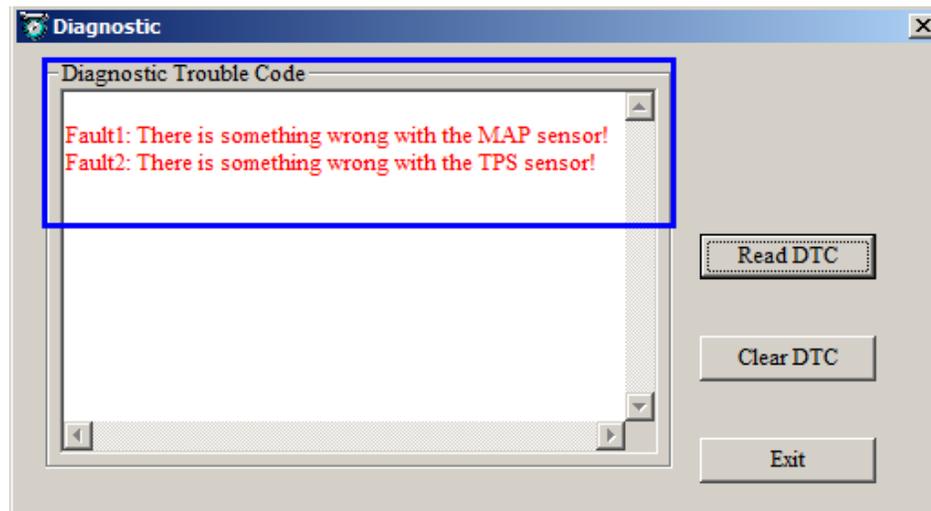
5. Double check TPS in “ProCAL”.

It is 0% when the throttle is at “idle position”, and it is almost 100% when the throttle is at “WOT” positions.

## 8.2 Diagnostic and Heal

Power on the EFI system, and if the MIL lamp (LED) is on, it means there is an error in the system. Please use ProCAL to read DTC, then check and solve it.

For example



### Diagnostic Trouble Code:

**Fault1:** There is something wrong with the MAP sensor!

Map sensor report error, please check the connection.

**Fault2:** There is something wrong with the TPS sensor!

Throttle body position sensor error, please check the connection, and see the voltage of fully closed and wide opened (4.8V>uTps>0.2V)

**Fault3:** There is something wrong with the O2 sensor!

Narrow band O2 sensor error, please check the installation and connection, and see the voltage of O2S is range from 0 to 1V

**Fault4:** There is something wrong with the CKP sensor!

Pick-up signal error, check the connection

**Fault5:** There is something wrong with the IAT sensor!

Intake air temperature sensor error, check the harness connection

**Fault6:** There is something wrong with the ECT sensor!

Engine temperature sensor error, check the harness connection

**Fault7:** There is something wrong with the VPWR!

Battery voltage error, if the voltage of battery is low to 10V and high to 16V, it will report error.

## 8.2.1 TPS sensor diagnostic

ECU reports TPS error

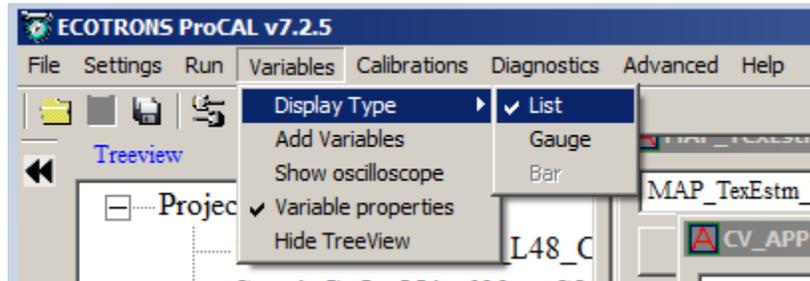
### 1) Connection problem

The Throttle position sensor is not connected well, please check the wire and reconnect it.

### 2) The voltage of TPS is out of measuring range

If the signal of TPS is out of range, you need to adjust it by using the following method

(1) Open ProCAL, then go to "Variables Type ->List"



(2) Read the voltage of throttle position Sensor : " uTps"

Pam	20ms	hPa	0	2560	"Ambient pressure"
StepPos	20ms		0	640	"Actual position of stepper motor"
Tps	20ms	%	0	100	"throttle position with respect to lower mechanical stop"
UbAdc	20ms	V	0	25.6	"battery voltage; scanned value of microprocessor ADC"
uLsb	20ms	V	-1	4	"Voltage signal from the lambda sensor before catalytic converter"
uMap	20ms	V	0	5	"Voltage signal of manifold pressure sensor "
uPot	20ms	V	0	5	"ADC-voltage of potentiometer sensor "
V uTps	20ms	V	0	5	"ADC-voltage of throttle position sensor "
B_CrkErr	100ms		0	1	"Error condition for crank sensor"
B_MapDrpErr	100ms		0	1	"Error condition for MAP sensor, no dropping during cranking"
B_StaEnd	100ms		0	1	"condition: end of start "
fPreCtl	100ms		0	64	"factor: pre-control fuel"
LamDsr	100ms		0	16	"Desired Lambda"
Ta	100ms	DegC	-50	205	"Intake air temperature"
tAstL	100ms	s	0	6553.5	"time after end of start(100ms)"

(3) Connect to ECU, to click "Run→Start Measuring"

(4) Remove the Tps sensor from the body, see the below picture.



(5) Install the throttle sensor.



(6) After installed, to mount the screw, it is better not to tight completely so you can adjust it conveniently.



(7) When the throttle fully closed, to see the value of voltage of TPS by ProCAL. ( $uTps > 0.3V$ )



B_CrkErr	0.0000	100ms		0	1	"Error condition for crank sensor"
tAstL	0.0000	100ms	s	0	6553.5	"time after end of start(long)"
B_StaEnd	0.0000	100ms		0	1	"condition: end of start "
uLsb	0.4529	20ms	V	-1	4	"Voltage signal from the lambda sensor before catalys
<b>uTps</b>	<b>0.6384</b>	<b>20ms</b>	<b>V</b>	<b>0</b>	<b>5</b>	<b>"ADC-voltage of throttle position sensor "</b>
fLc	1.0000	20ms	-	0	2	"Lambda controller output (word)"
LamDsr	1.0000	100ms	-	0	16	"Desired Lambda"
fPreCtl	1.0000	100ms		0	64	"factor: pre-control fuel"
uMap	4.5679	20ms	V	0	5	"Voltage signal of manifold pressure sensor "
uPot	4.9695	20ms	V	0	5	"ADC-voltage of potentiometer sensor "
Tps	7.7423	20ms	%	0	100	"throttle position with respect to lower mechanical stop

(8) When the throttles is widely open, to see the voltage. (uTps<4.8V)



	tAstL	0.0000	100ms	s	0	6553.5	"time after end of start(long)"
	B_StaEnd	0.0000	100ms		0	1	"condition: end of start "
	uLsb	0.4529	20ms	V	-1	4	"Voltage signal from the lambda sensor before catalys
V	uTps	4.4141	20ms	V	0	5	"ADC-voltage of throttle position sensor "
	fLc	1.0000	20ms	-	0	2	"Lambda controller output (word)"
	LamDsr	1.0000	100ms	-	0	16	"Desired Lambda"
	fPreCtl	1.0000	100ms		0	64	"factor: pre-control fuel"
	uMap	4.5667	20ms	V	0	5	"Voltage signal of manifold pressure sensor "
	uPot	4.9695	20ms	V	0	5	"ADC-voltage of potentiometer sensor "

(9) If the voltage of throttle sensor is not from 0.3V to 4.8V, you can rotate the sensor to adjust the voltage.



**Note:** The voltage of throttle sensor is normal in the range from 0.3 to 4.8V

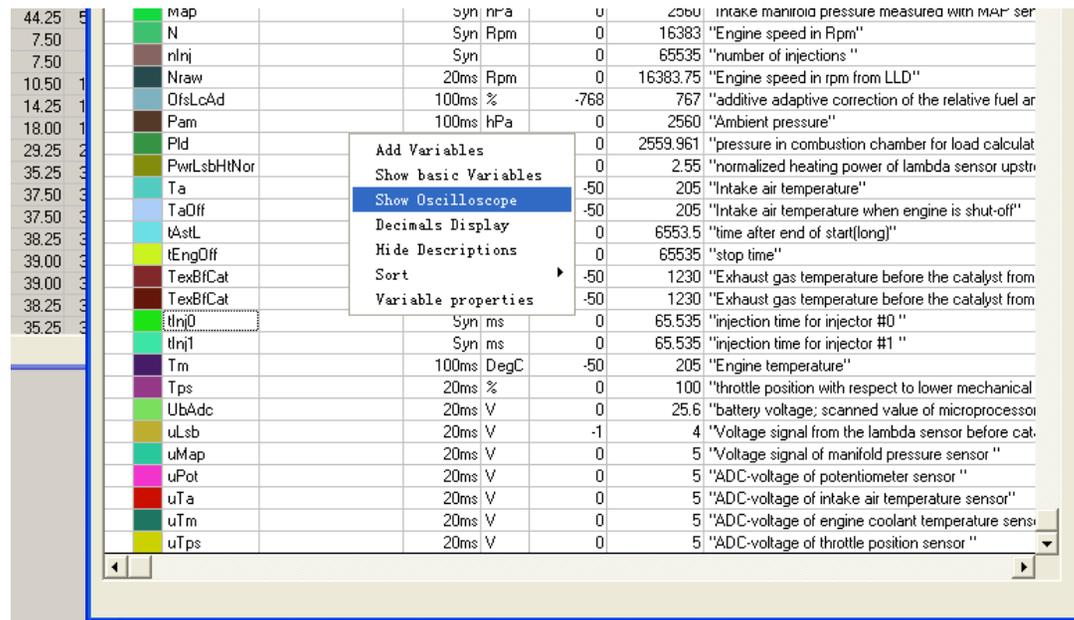
### 3) Reset the TPS position if Tps is not 0 when idle

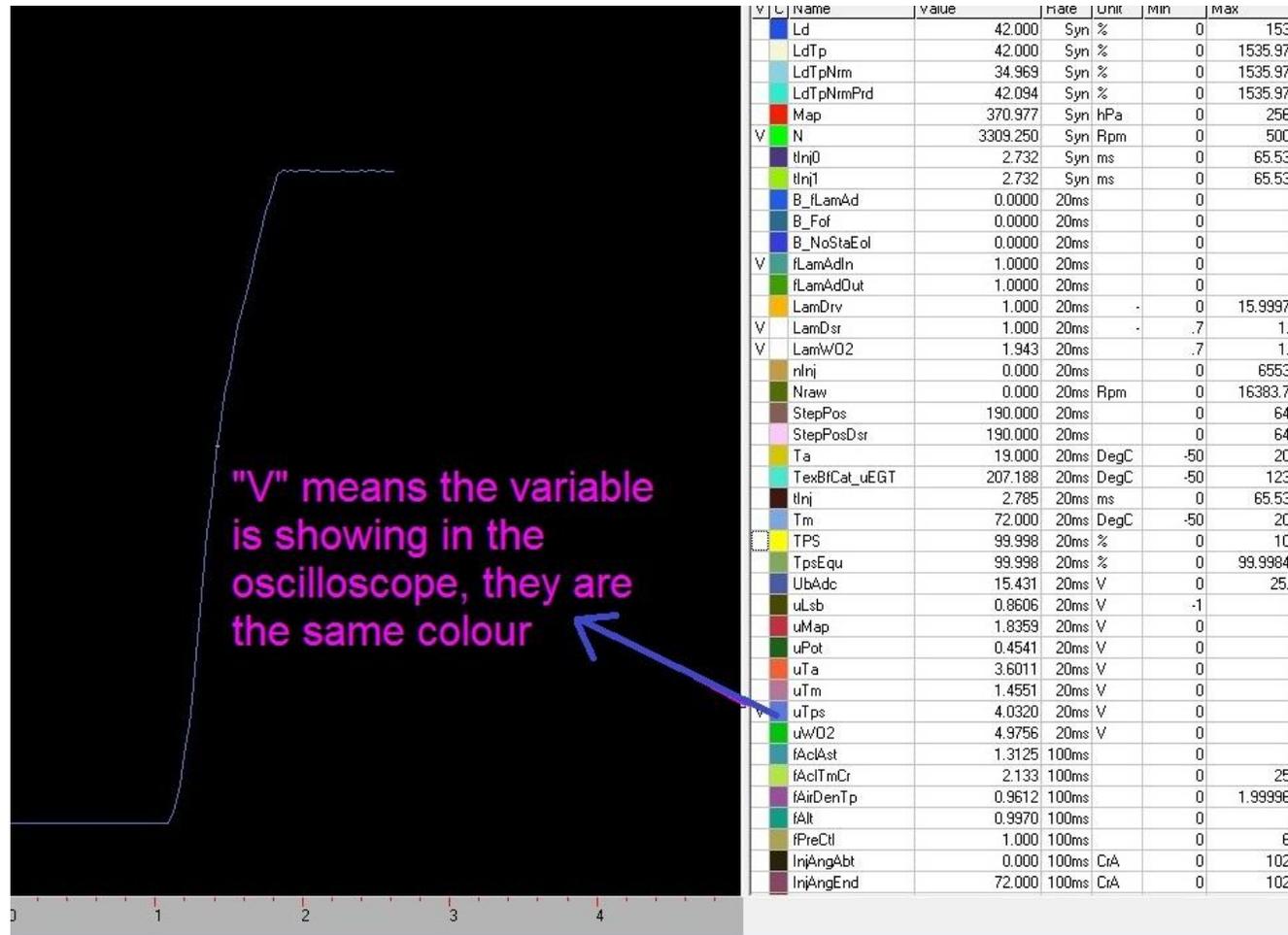
Key on the system, and key on only, disconnect the ECU from the main harness and reconnect it with keeping power on. Then you can see the Tps is changed to 0 when throttle is fully closed.

### 4) How to check the TPS signal rationality?

With the TPS is installed, the output voltage should be 0.3~4.8V DC. You can tell whether the TPS is broken by reading the virtual scope of the ProCAL

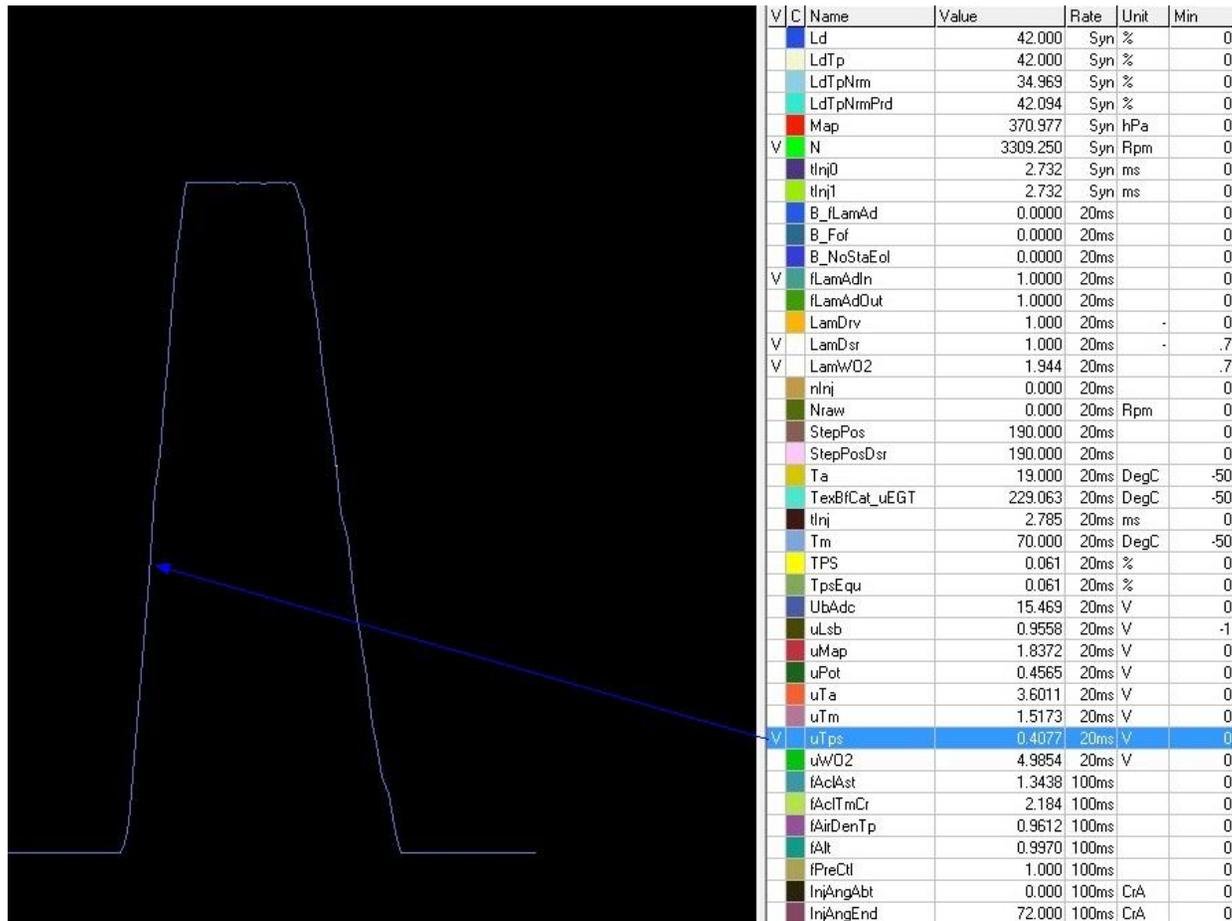
- 1) Show the “uTps” in the oscilloscope (right click on the list window).





- 2) Connect to ECU, to click “Run—Start Measuring”
- 3) Slowly open and close the throttle, and you can get a symmetrical curve on the virtual oscilloscope, which is 0.3V~4.8V, like picture 1.

If the line is not consecutive, like picture 2, you should replace it with a new TPS sensor.



Picture 1



**The signal is not consecutive.**

Picture 2

## 8.2.2 MAP sensor diagnostic

If you have installed the EFI system and key on the bike, engine is not starting, the ECU reports Map error, and there are two possible causes.

### 1) Connection error

The Map sensor is not connected intact. Please check it and reconnect it to ECU harness.

### 2) A bad sensor

The Map sensor is broken. Read the signal in ProCAL to check it.

Power on ECU and connect to ECU. Go to menu "Variables->Display Type->List". Then "Run->Start measuring"

uTps	0.2380	20ms	V	0	5	"ADC-voltage of throttle position sensor "
uLsb	0.4529	20ms	V	-1	4	"Voltage signal from the lambda sensor be
fLc	1.0000	20ms	-	0	2	"Lambda controller output (word)"
fPreCtl	1.00	100ms	-	0	64	"factor: pre-control fuel"
LamDsr	1.00	100ms	-	0	16	"Desired Lambda"
OfsLaAd	1.05	100ms	%	-768	767	"additive adaptive correction of the relativ
uMap	4.6448	20ms	V	0	5	"Voltage signal of manifold pressure sensc
uPot	4.3048	20ms	V	0	5	"ADC-voltage of potentiometer sensor "
UbAde	12.18	20ms	V	0	25.6	"battery voltage; scanned value of microp
Ta	27.00	100ms	DegC	-50	205	"Intake air temperature"
Tm	71.00	100ms	DegC	-50	205	"Engine temperature"
Map	1029.77	20ms	hPa	0	2560	"Intake manifold pressure measured with h
Pam	1030.20	100ms	hPa	0	2560	"Ambient pressure"
tEngOff	65535.00	100ms	s	0	65535	"stop time"

If the voltage of Map sensor (uMap) is 0V or 4.99V, it shows the Map sensor is broken, but make sure the Map sensor is connected well at first.

If the Map sensor is broken, contact us to get a good one. The normal voltage (uMap) is about 4.7V (1 Bar sensor) ; and about 1.8V (2.5Bar sensor) when system is just powered on and engine doesn't start.

### 3) Report an error when crank engine

If ECU reports MAP error (B\_MapDrpErr=1) when the engine starts or is running. The possible reason is the intake air is too less or there is some leak air.

uPot	20ms	V	0	5	"ADC-voltage of potentiometer"
uTps	20ms	V	0	5	"ADC-voltage of throttle position"
B_CrkErr	100ms		0	1	"Error condition for crank sensor"
B_MapDrpErr	100ms		0	1	"Error condition for MAP sensor"
P_StaEnd	100ms		0	1	"condition: end of start "
fPreCtl	100ms		0	64	"factor: pre-control fuel"
LamDsr	100ms	-	0	16	"Desired Lambda"

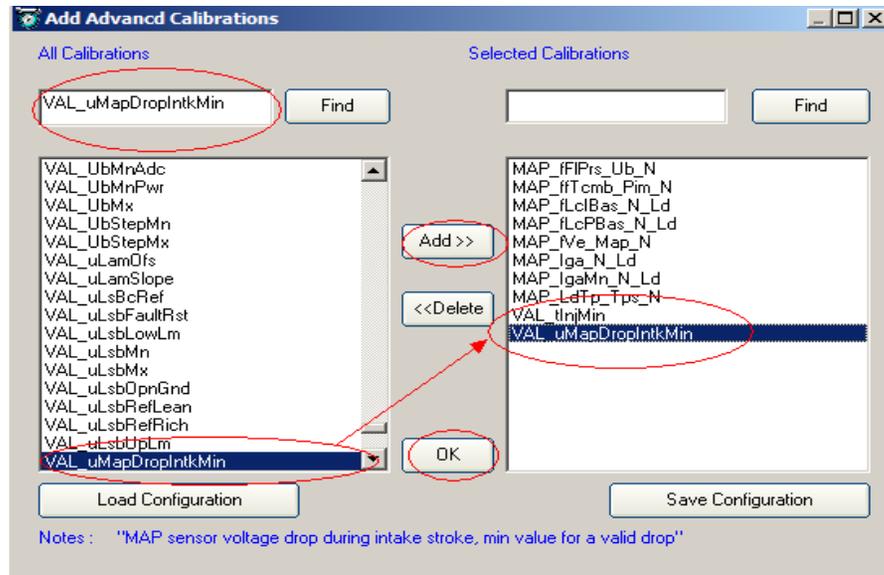
(3) First, check the Map sensor location, and connect the Map sensor to throttle body by a using a short hose.

Check it for air leaks and make sure that it is sealed properly.

Turn the idle air screw or stepper motor position to get more idle air.

Change the value of minimum Map voltage drop "VAL\_uMapDropIntkMin" during cranking.

In ProCAL, go to "menu->Advanced->Add Advance Calibrations"



VAL\_uMapDropIntkMin

Name	Value	Unit	Description
VAL_tSegMin_KickStartE	120000.00	us	"segment time > min-threshold, to enable kick start, kick-ste
VAL_UbMnAdc	2.50	V	"min. battery voltage (ADC) "
VAL_UbMnPwr	10.00	V	"min. battery voltage (power supply) "
VAL_uMapDropIntkMin	0.4004	V	"MAP sensor voltage drop during intake stroke, min value f
VAL_uMapDropVerifyInSy	0.0000	-	"MAP sensor voltage drop validation in synch mode enable
VAL_uMapMn	0.2002	V	"Minimum input voltage for MAP sensor diagnosis "
VAL_uMapMx	4.8596	V	"maximum input voltage for MAP sensor diagnosis "
VAL_UseMapLowestForL	1.0000	-	"Use the MAP sensor voltage signal lowest value for load c
VAL_uTpsMn	0.2002	V	"Minimum input voltage for TPS sensor diagnosis "
VAL_uTpsMx	4.8999	V	"maximum input voltage for TPS sensor diagnosis "
VAL_vEng	124.99	cc	"volume of engine displacement in cc or mL "

**Note:** The value of "VAL\_uMapDropIntkMin" cannot be smaller than 0.3V

### 8.2.3 Temperature sensor (IAT & ECT) diagnostic

**IAT:** Intake air temperature sensor

**ECT:** Engine temperature sensor

If ECU reports IAT or ECT error, there are two possible reasons for this

Possible reason #1: the connect wire break off

Possible reason #2: the temperature sensor is broken

**Note:** If there is an error about the temperature sensor, please repair it or replace it as soon as possible, because it will affect the fuel injection, it may be too rich or too lean, and the engine can't run normally.

### 8.2.4 NB O2 sensor diagnostic

If you have installed an O2 sensor and the O2 sensor signal is not changed, it still 450mv or bigger than 1V when engine is finished warmed up (engine is running about 3 minutes) and anything is connected well. It shows the O2 sensor is broken, please change another good O2 sensor.

And if the system reports O2S error, and you also need to check the connection whether it is short or broken circuit.

### **8.2.5 VRS signal diagnostic**

No matter which pick-up sensor you used, crankshaft sensor or hall sensor, you must make sure there is a clean signal to input ECU, otherwise, the EFI system will not work. The installation and connection and quality is more important.

### **8.2.6 Battery diagnostic**

If the system reports "VPWR" error, please check the voltage of battery or change a high voltage battery.

### **8.2.7 Actuator Diagnosis diagnostic**

**EFI system has some Actuators, such as Relay, fuel pump, injector, CDI.**

**If one of actuators doesn't work, the EFI system will not run, so make sure all of these must be keep in good repair.**

## Chapter 9 Advance functions of EFI

### 9.1 Fuel Dial Function

**Fuel Dial** means input an analog voltage signal to ECU, and use this signal to adjust the desired lambda (LamDsr) to modify the real-time lambda (AFR).

We use the "Perf-SW", performance switch, wire to connect the external signal input, such as a potentiometer.

**LamDsr = 1/ (uPot \* VAL\_uPot2Fct+VAL\_fLamDrvBas);**

VAL\_ LamLeanLim and VAL\_ LamRichLim are the limitation of LamDsr Max and Min value.

**VAL\_ LamLeanLim < LamDsr < VAL\_ LamRichLim;**

**lamDsr:** desired lambda which you want

**uPot:** The voltage signal of potentiometer input to ECU

**VAL\_fLamDrvBas:** Basic factor to calculate the lamDsr

**VAL\_uPot2Fct:** Change the input voltage signal to actual factor.

**VAL\_ LamLeanLim:** lambda lean condition limited

**VAL\_ LamRichLim:** lambda rich condition limited

**Default settings in CAL:**

VAL\_fLamDrvBas=0.5;

VAL\_uPot2Fct=0.2;

```
VAL_LamLeanLim=2;  
VAL_LamRichLim=0.5;
```

So, if uPot=0V, then LamDsr=2; and If uPot=5V, LamDsr=0.67.

You also can change the limitation value to limit the Max and Min value of lamDsr.

### Example:

If you want the value of LamDsr is 1, then

$uPot = (1/\text{lamDsr} - \text{VAL\_fLamDrvBas}) / \text{VAL\_uPot2Fct}$ ; so uPot=2.5V.

So if you have not changed the default settings, the output voltage of your potentiometer is 2.5V.

If you want to adjust the AFR (Lambda), you can pre-adjust the uPot to 2.5V (LamDsr=1) first, then you can change the potentiometer output to be bigger or smaller to get a rich or lean desired lambda, basing on the actual lambda.

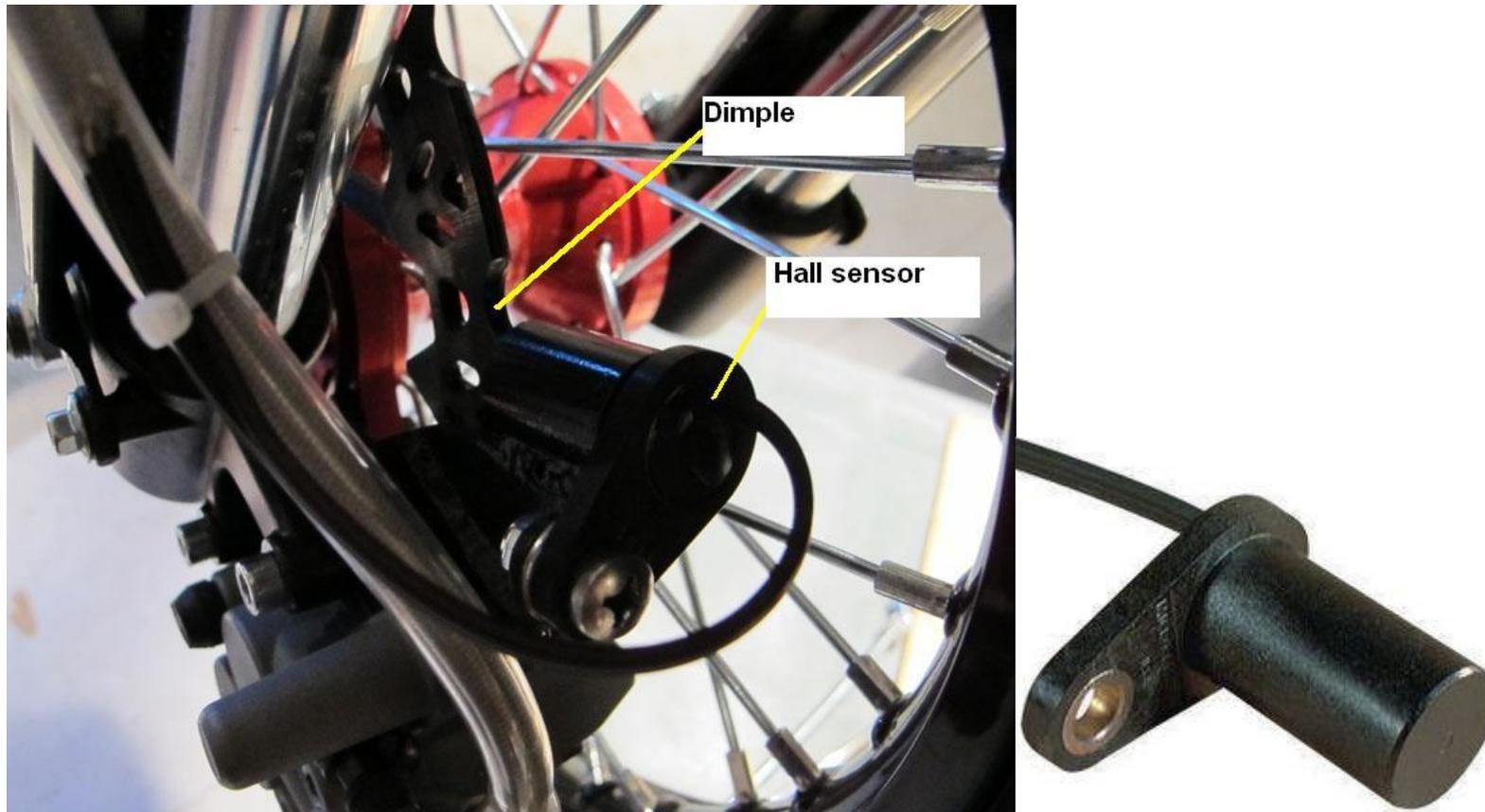
## 9.2 Traction Control function

### Traction Control function with Ecotrons EFI system

For traction controls of 2 wheelers or 3 wheelers, there must be 2 wheel speed sensors to detect the wheel speeds of non-driven wheel and driven wheel.

The ECU will compare the driven wheel speed to non-driven wheel speed. If driven wheel speed is higher than the non-driven wheel, which means there is a slip event. ECU will reduce the engine torque by retarding the ignition angle and / or cut the fuel to eliminate the slipping event.

For ECU to detect the wheel speeds, 2 wheel speed sensors are used, (Hall effect sensor, for example). User must install 2 trigger wheels on the 2 wheels. Or there may be already some "trigger wheels", like in the picture below that the bike comes with 2 wheels with dimples built-in from the OEM. You can use those dimples as the tooth patterns. In this case, all you need is to install 2 Hall Effect sensors.



There are some variables need to be calibrated if you use the traction control function and use two wheel speed sensors to measure the vehicle speed. So you need do some advanced calibration.

Find the variables in ProCAL: go to menu->Advanced->Add Advanced Calibrations. You can calibrate the variables based on your bike spec...

VAL\_DiamWhlNonDrv: Diameter of front Wheel (non-driven wheel), the tire size in meters.

VAL\_DiamWhlDrv: Diameter of rear Wheel (driven wheel), the tire size in meters.

VAL\_nTeethWhl: the total number of teeth on the trigger wheel of wheel speed sensor.

VAL\_dWhlSpdAsr - Delta wheel speeds to detect the slip event!

Measure-able variables:

Go to menu->Variables->Add Variables. Add the below variables in 20ms, so you can read them in ProCAL.

tToothDrv: "tooth period of driven wheel speed sensor"

tToothNonDrv: "tooth period of non-driven wheel speed sensor"

VspWhlDrv: "Vehicle Speed from the driven wheel speed sensor (Rear wheel)"

VspWhlNonDrv; "Vehicle Speed from the non-driven wheel speed sensor (Front wheel)"

### Note:

**The method to calculate vehicle speed as below:**

**V----- Vehicle speed in km/h.**

**D-----Diameter of wheel, form the tire size; converted into meter (Pi\*D) is the circumference.**

**1km/h=1m/3600ms**

**$V = (D * 3.1416 * 3600) / (VAL\_nTeethWhl * \text{tooth period})$**

**If (VspWhlDrv- VspWhlNonDrv)> VAL\_dWhlSpdAsr, then the traction control function is enabled.**

## Chapter 10 Auto-tuning with ALM

### How to connect ALM to ECU and enable the auto-tuning feature?

Auto-Tuning means ALM and ECU will work together and tune the AFR as you want. In ECU, AFR is represented by Lambda (equivalent AFR). Lambda = 1 means AFR 14.7 for gasoline.

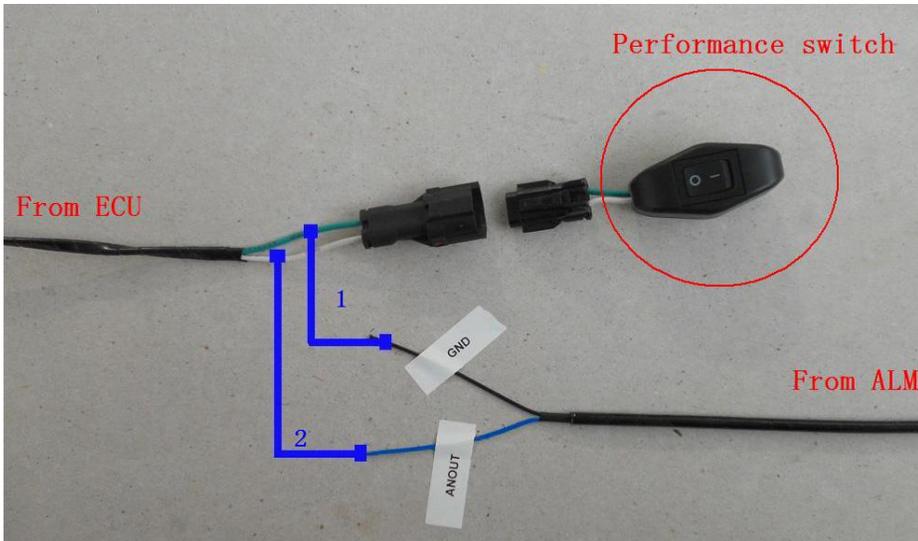
The default target Lambda is 1.0 across the board. You can define your own desired Lambda dependent on the RPM and TPS. Usually, a little rich AFR at high RPM / high TPS is preferred to have a better performance as well as engine cooling effect. A typical desired Lambda table could be 0.85 at high RPM and high TPS (>90%); and 1.0 everywhere else. The desired Lambda table should be engine specific. Some engines don't like 14.7 AFR at idle, and can only be stable if it is a little rich. In that case, you should define the desired Lambda to match the engine characteristics.

With the Auto-Tuning feature, ECU will read the ALM's real-time lambda input, and automatically adjust the fuel towards the desired Lambda at that RPM and TPS status. ECU will store the learnt data in its own memory. After you run the engine at different operating conditions (RPM & TPS) for a while; it will eventually learn most of operating points. And the engine is tuned then.

All you need to do is to drive your vehicle in different throttle positions and different RPM in “steady state driving”. (Steady state means holding throttle position at a certain RPM for about 10 seconds.) , ECU-ALM will take care of the rest.

### Section 1 Connect ALM to ECU

Previously we used the "Perf-SW", performance switch, wire to connect the ALM input. That causes the loss of dual fuel map feature.



Previous connection

Recently, we have changed that. We are now using the Narrow-band (NB) O2 input wire to connect the ALM analog voltage input, which allows for real-time lambda.

This means our ECU is actually hardware-compatible to both NB O2 and wideband (WB) O2 with the same input wire. The only difference is to download a different CAL file into ECU. This simplifies a lot of wire work.



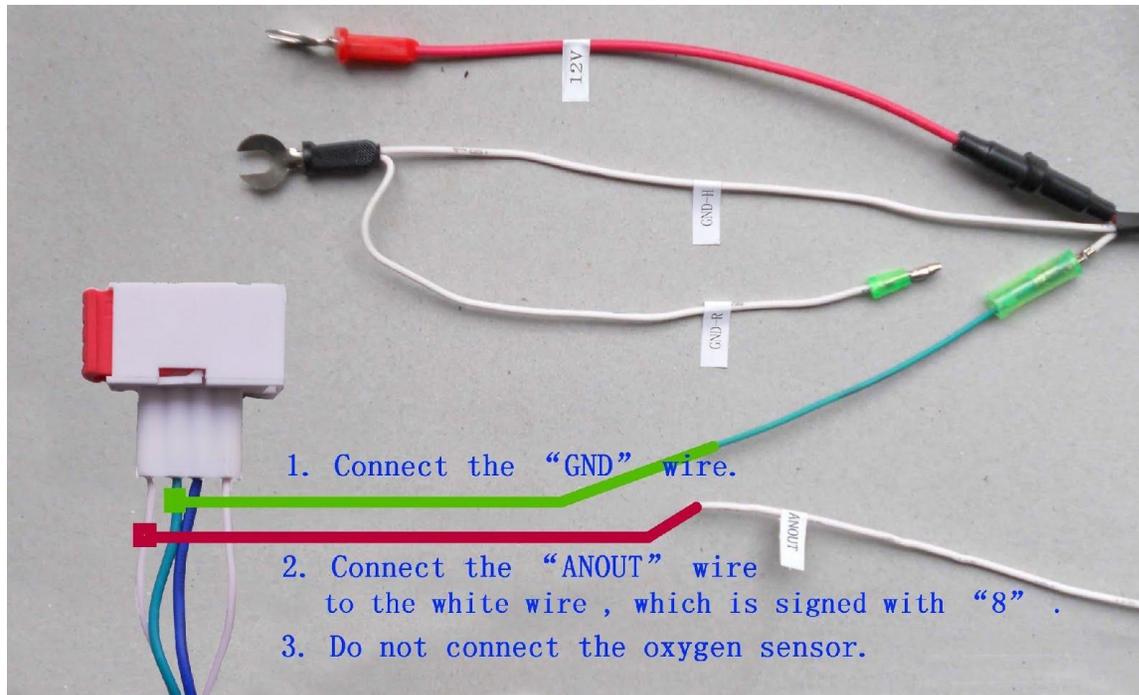
ALM



ALM\_S

### ALM

If you have one of our ALM (with LED display model) wideband kits, you shall connect the [ALM](#) to ECU as in the below picture:



Pin definition of the Narrow-band oxygen sensor connector (white/red), from right to left in the picture:

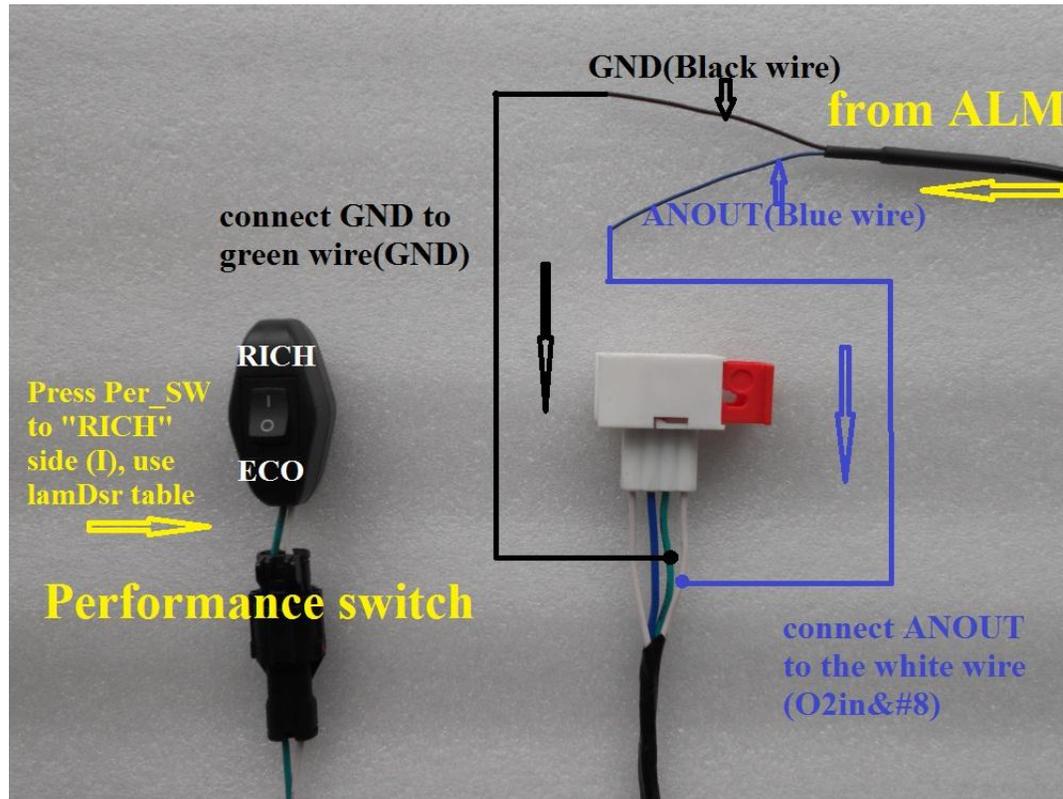
- Heater circuit + (White)
- Heater circuit - (Blue)
- Reference Ground (Green)
- O2in - O2 sensor input (White #8)

Connect the GND wire which labeled GND-R from harness to green wire from O2 sensor connector

Connect the ANOUT wire from ALM harness to the white wire which is signed #8

### ALM-S

If you have one of our ALM-S wideband kits, you shall connect the [ALM-S](#) to ECU as in the below picture:



Most of our 4-stroke EFI harness comes with a NB O2 sensor connector (white/red) which has 4 wires. From left to right in the picture:

- Heater circuit + (White)
- Heater circuit - (Blue)

Reference Ground (Green)

O2in - O2 sensor input (White)

Our ALM-S harness comes with 2 wires:

ANOUT (Blue) - analog output representing the lambda

GND (Black) - reference ground

You need to connect the ANOUT (Blue) to O2in (White) and GND (Black) to Ground (Green).

If your performance switch (Per-SW) is pressed down to the ECO mode, the target Lambda for auto-tuning will be 1.0 (14.7AFR) across the board.

If your Per-SW is pressed down to the RICH mode, the target lambda will be your desired lambda table: MAP\_LamDrv\_N\_TPS. You can open this table in ProCAL and change it as you want.

## **Section 2 Burn the correct CAL file**

After you connect the ALM or ALM-S to ECU as the previous section, you need to burn the correct CAL file into ECU.

When you buy our ALM and ECU combo setup, you will get a special CAL files:

- 1) "xxxx\_ALM\_Auto-Tuning\_Enabled.CAL". This CAL file will enable the auto-tuning and let ECU keep learning over the life.
- 2) "xxxx\_ALM\_Auto-Tuning\_Finished.CAL". This CAL file will stop the auto-tuning and retain the learnt data in ECU memory, and then you can use the ECU to read the lambda (AFR).

The way to burn the CAL file:

Run ProCAL and load the correct A2L and the CAL files.

**Note:** when you burn the CAL file into ECU, always make sure your 12V battery is well charged. Low battery will cause a failed burn, and your ECU will malfunction in that case.

Select "burn to ECU" after you have connected ProCAL to ECU via the serial cable.

### Section 3 Let Auto-Tuning Run

After you burn the Auto-tuning enabled CAL file into the ECU. You can start your engine and drive it out. Auto-tuning will start automatically once your engine is warmed up.

**Note:** engine warm-up condition is engine temperature is greater than 70 degree Celsius, or 158 degree Fahrenheit. Your engine needs to run more than 10-15 minutes to reach that temperature.

**Note:** To have better auto-tuning opportunities, you need to drive in steady-states with different throttle positions. For example, you drive the vehicle at 5%, 10%, 20% ... 100% throttles, and for every throttle position, you need to keep that for about 10 seconds. One indication of steady-state is that the RPM is relatively stable.

**Note:** Make sure your 12V battery is well charged, and your charging system has enough power for both EFI and ALM. All together, EFI and ALM require 3A to 5A current draw, which is about 70W total. You need also count the other electrical loads on your vehicle. Low battery or deficient charging system will cause malfunction of the auto-tuning.

**Note:** Remember, you can use the performance switch (Per-SW) to define what your target lambda (AFR) is. The auto-tuning will tune the lambda to 1.0 across the board in ECO mode, and tune the lambda to your desired lambda table in RICH mode.

**Note:** If your engine is not even able to keep running, (stall or sluggish), you may need to do some manual tune first to get the AFR to the ball park range. You can send us the logged data and we can do that for you. If your engine has already been setup by us or others with the kit, more then likely we have a calibration file available that's very close to what you need.

#### **Section 4 Auto-tuning finished**

When will the auto-tuning finished? It is depending on your feeling. If you feel the engine has been running much better and stable compared to the beginning, at variant throttle and RPM conditions, you can think the auto-tuning is finished.

After you have finished Auto-Tuning with ALM, you can burn the "xxxx\_ALM\_Auto-Tuning\_Finished.CAL" into the ECU. This CAL file will stop the auto-tuning but retain all the learnt tuning data in the ECU memory. ECU will still read ALM input, but not to use it for auto-tuning any more.

**Note:** If you load the default Cal file which comes with EFI kit and has no "enabled" or "finished" words in the name, you must disconnect the ALM from the ECU. Because the default CAL file is expecting NB O2 sensor input. You can re-install the NB O2 sensor back to the EFI system and running close-loop controls.

### **How to run your engine for ALM Auto-tuning?**

If you run your engine with ALM auto-tuning function, you need run your engine in stable condition (stable TPS and stable RPM) about 10 seconds, then it will modify the real lambda to desired lambda automatically.

For you to have a high efficiency auto-tuning, you can run your engine with the following progress as a reference.

When you load the correct Enabled CAL file or enable the auto-tuning in ProCAL, and connect the ALM to ECU with above method correctly, then you can start your engine.

Auto-tuning function will be enabled automatically when engine have finished warm-up (engine temperature is higher than 70 degree) or have run about 15 minutes.

Then drive it on road, to have better auto-tuning opportunities, you need to drive in steady-states with different throttle positions at different RPM's. It's better in a long straight road without many traffic lights.

For example, you drive the vehicle at 5%, 10%, 20% ... 100% throttles, and for every throttle position, you need to keep that for about 10 seconds. One indication of steady-state is that the RPM is relatively stable.

Driving conditions: after the engine is warmed up (about 10-15minutes); drive the bike in some kind of steady state: for example, on the flat road, hold the throttle position at 5%; at relative steady vehicle speed, and run it for 10-30s. Then move the throttle opening a little higher, like 10%, and hold it at 10% at relative steady vehicle speed for 10-30s; repeat this for 20%, 30% ...100% throttle positions.

After done a round of throttle positions, key off and wait for a while. This is a full cycle of auto-tuning.

Then repeat the above again if you want to do more auto-tuning.

The reason for key off when finished a driving cycle is that ECU will update the tuned data, and in next running ECU will use the tuned data to run, so it will have a better performance than last running.

Every driving cycle running, the stable condition (TPS and RPM) is not necessary to keep much longer time, just 10 seconds is enough. When every driving cycle is finished, you need key off then key on, engine will be calibrated well in some duty cycles. The real lambda will be closed to desired lambda.

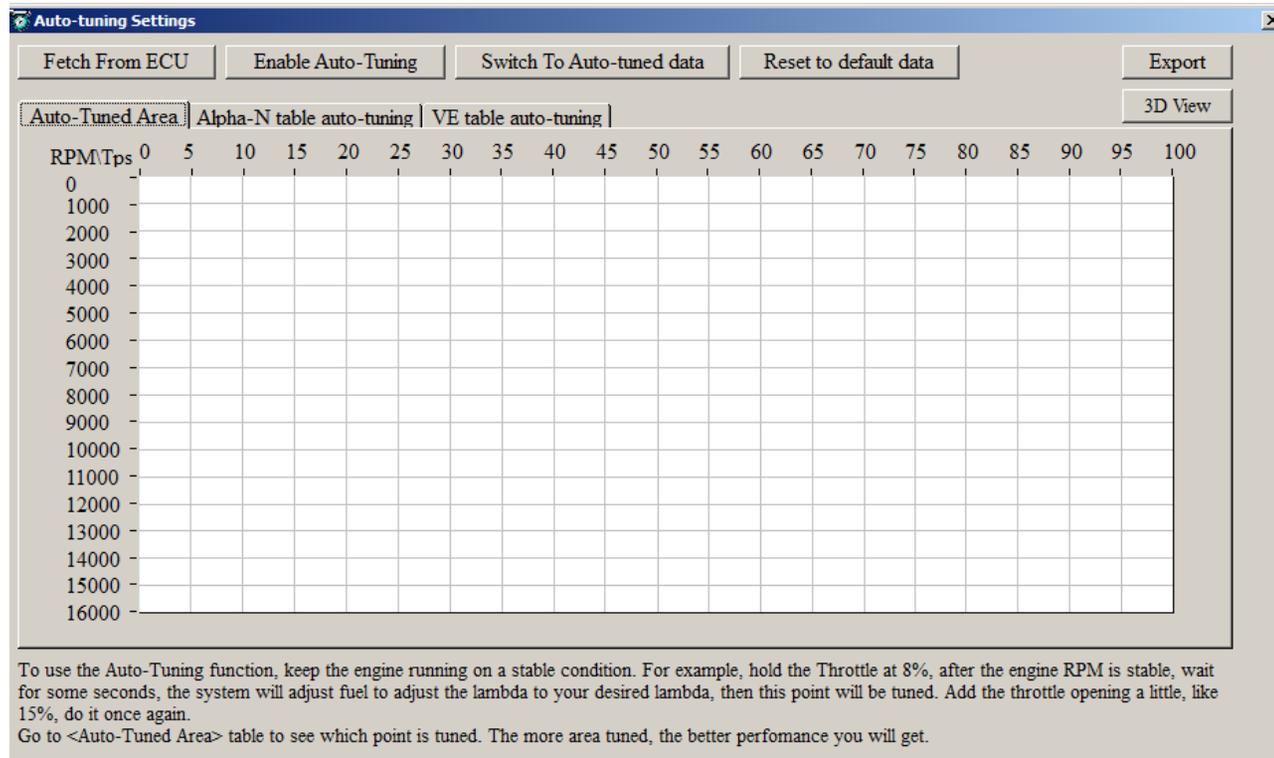
[If you have an engine with a transmission, you need run the duty cycle in different gears.](#)

## **ProCAL operation manual about Auto-tuning**

### **How to bring up the auto-tuning window in ProCAL?**

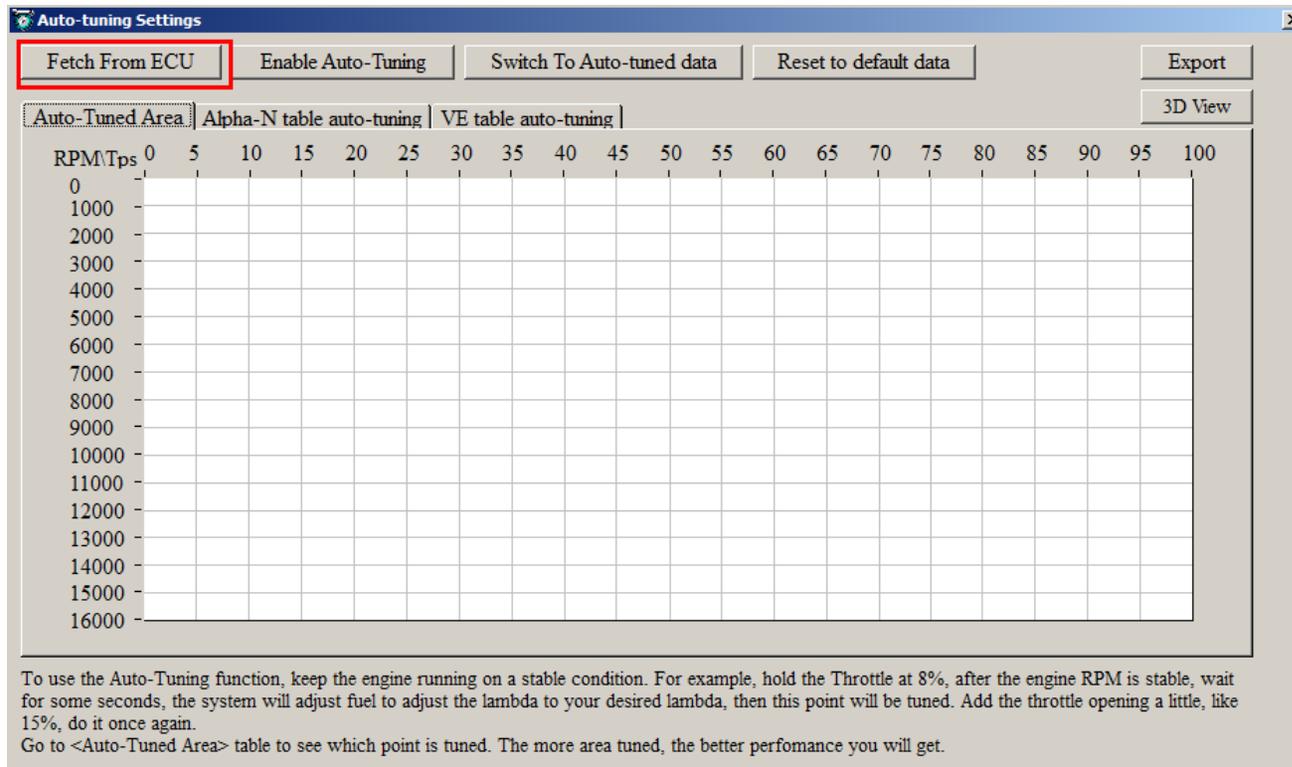
1. Load the correct A2I and CAL file with ProCAL V7.1.9.2 or later version.
2. Bring up the Auto-Tuning window:

[Menu->Calibrations->Auto-Tuning settings](#)



### How to fetch the data from ECU?

Fetch the current data from ECU; click “Fetch from ECU”, you can get the data in ECU.



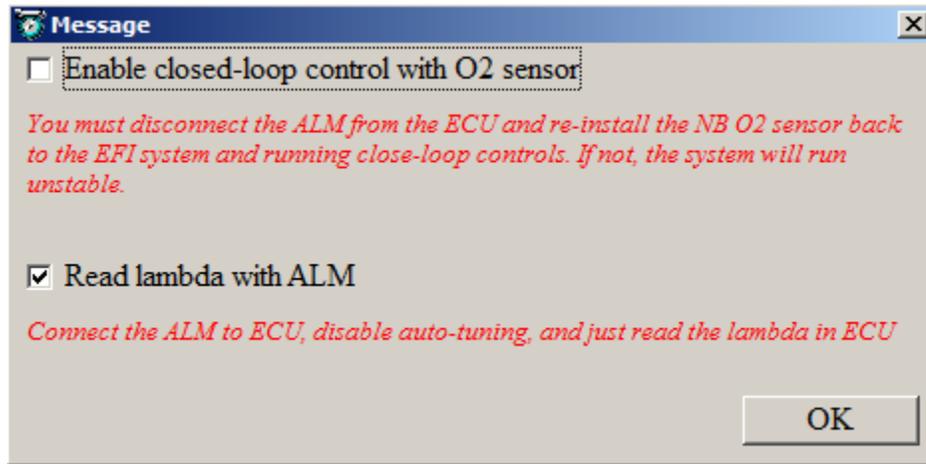
### How to enable or disable auto-tuning with ProCAL?

If you load the default CAL file, you can enable or disable auto-tuning.

**Enable Auto-Tuning:** enable auto-tuning function

**Disable Auto-Tuning:**

- (1): enable closed-loop control with NB O2 sensor
- (2): log lambda with ALM



**How to switch to use auto-tuned data or to use manual tuned data (default data)?**

**Switch to auto-tuned data:** ECU will use the auto-tuned data to run engine

**Switch to manual-tuned data:** ECU will use the default MAP value to run engine.

**Note:** If you have the Enabled auto-tuning CAL or other corresponding CAL file from us, you don't need change this in ProCAL.

Load the corresponding CAL file, so you can do the test.

“xxxx\_ALM\_Auto-Tuning\_Enabled.CAL”. This CAL file will enable the auto-tuning and let ECU keep learning over the life.

“xxxx\_ALM\_Auto-Tuning\_Finished.CAL”. This CAL file will stop the auto-tuning and retain the learnt data in ECU memory, and then you can use the ECU to read the lambda (AFR).

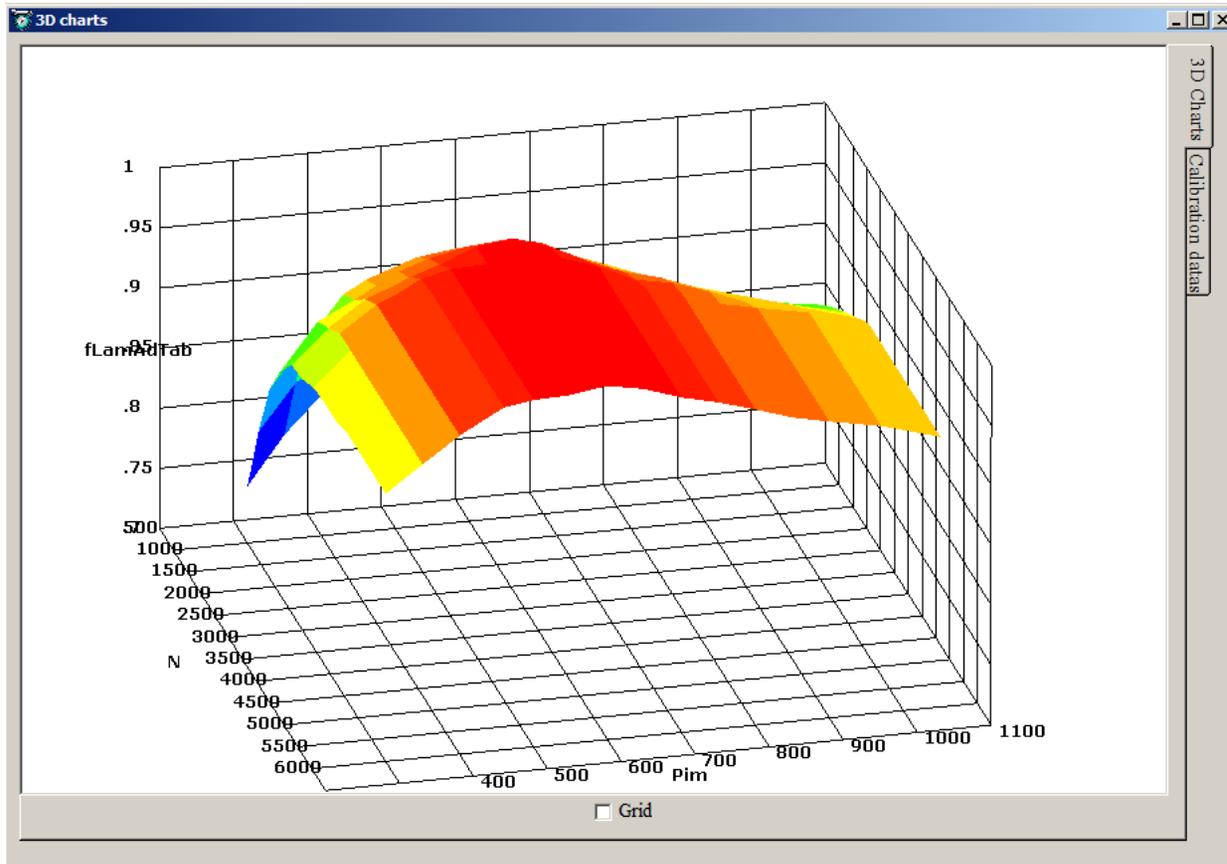
These two marked CAL file have been set to use auto-tuned data.

### How to save the auto-tuned data or see the table graph?

Export the auto-tuned data to CSV, it's convenient to save or modify the data in this form. You can also use the “3D view” function to see the graph of data.

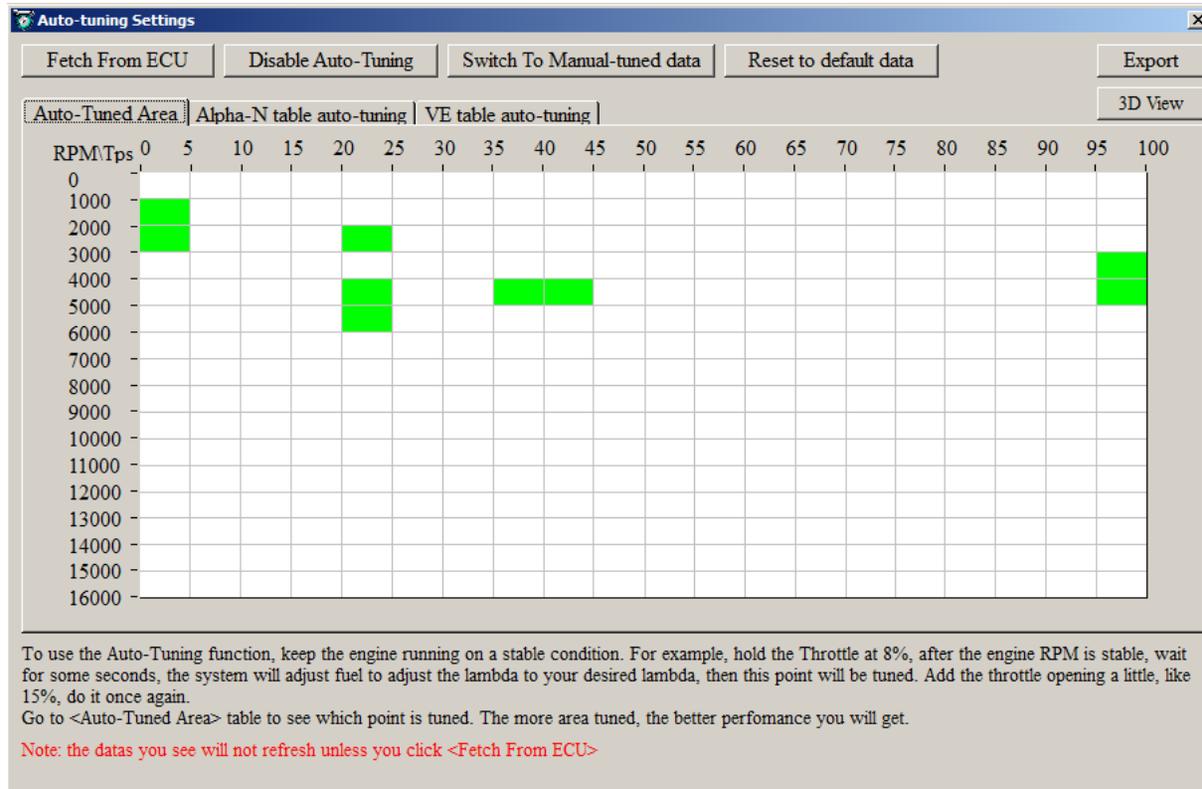
To use the Auto-Tuning function, keep the engine running on a stable condition. For example, hold the Throttle at 8%, after the engine RPM is stable, wait for some seconds, the system will adjust fuel to adjust the lambda to your desired lambda, then this point will be tuned. Add the throttle opening a little, like 15%, do it once again. Go to <Auto-Tuned Area> table to see which point is tuned. The more area tuned, the better performance you will get.

Note: the datas you see will not refresh unless you click <Fetch From ECU>



**How to know the current operating mode (Tps and RPM) has finished auto-tuning?**

The key point is the real-time lambda, making the desired lambda (LamWO2 close to LamDsr). When you fetch from ECU, you can see the cell is changed to green color in Auto-tuned Area, it means the lambda is closed to desired lambda, in other words, it has finished auto-tuning.



**Note:** when the color of cell in Auto-tuned Area has been changed to green, you can finish the auto-tuning, and disable it to see the performance.

**Variables:**

**SLM\_StableCondition=1**, means current condition is finished.

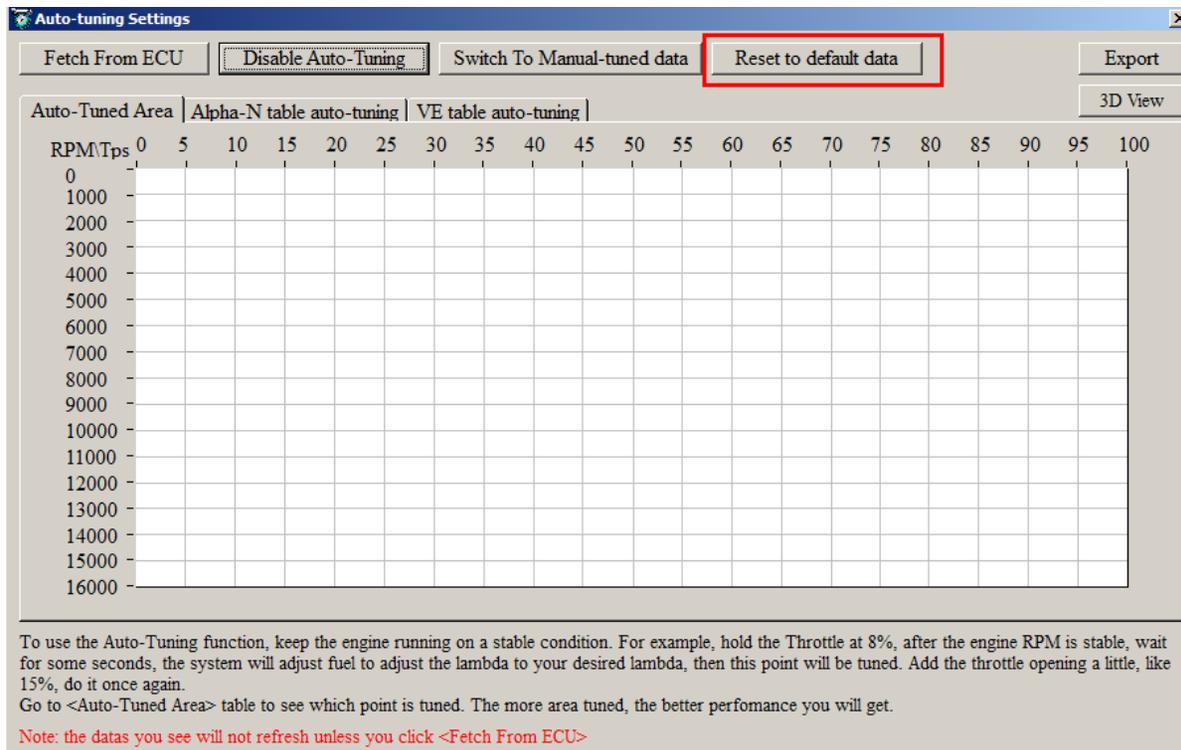
**B\_fLamAd=1**, the auto-tuning function has been enabled, so you can use the auto-tuning.

(Add this variable: Menu->Variables->display type->list,  
Then Right click in the selected variables list window, and add variable.)

The longer you run with the ALM auto-tuning on, the closer the calibration MAP table and lambda are to the real-time lambda.

### How to reset to default data?

If the auto-tuned data is not stable, or you don't want the auto-tuned data and want to start a new auto-tuning, you can erase the auto-tuned data and reset it to default data.



**Note:** You can only reset the data by using the ProCAL operation; other operations such as burn to ECU or power off can't do this.

**Attention again:** when you have finished a phase of auto-tuning with ALM, you need to stop the engine and key-cycle (key off and then key on), the auto-tuned data will be saved in the ECU, in the next auto-tuning running, it will use the auto-tuned saved data to run.

(You have to enable "Switch to auto-tuned data" button)

**Note:** there is a more complicated method in our ECU to do auto tuning with an ALM, as a close loop control method, which can automatically tune the fuel for your "desired lambda table". But that requires a lot of detailed conditioning, to make it work right. We do not recommend the users to use it. That is for only very experienced users and be familiar with our software.

## Chapter 11 How to check a non-working ECU

### How to tell the ECU is damaged?

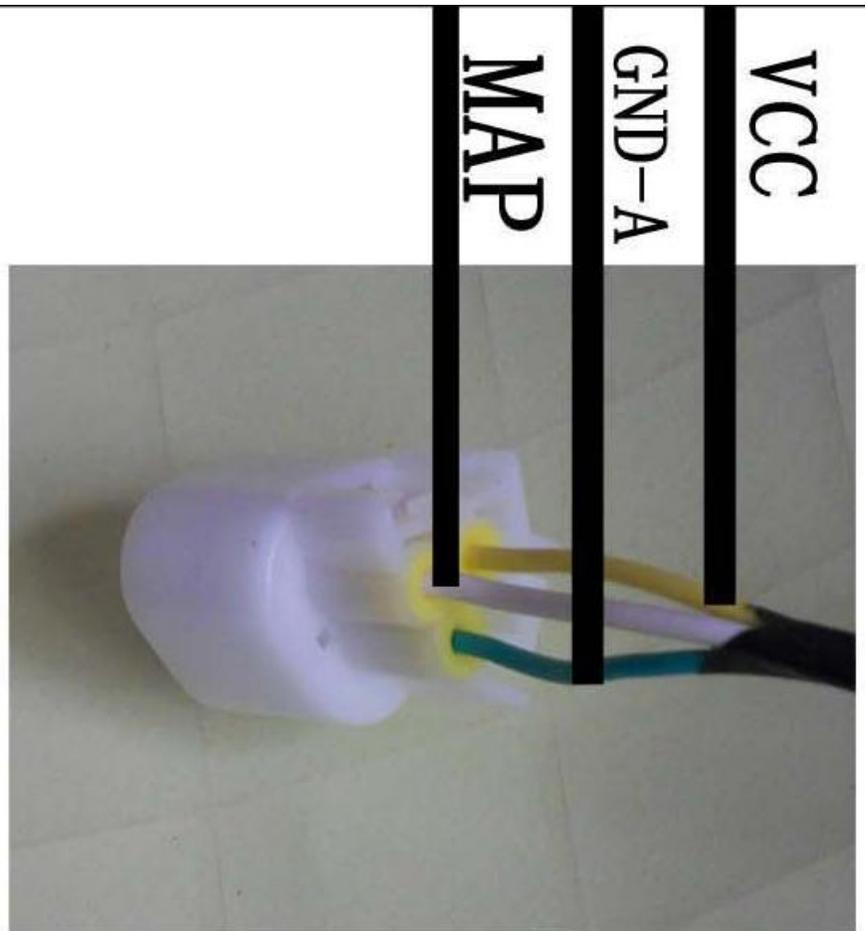
- 1) Key off, and disconnect 12V+ of ECU harness;
- 2) Disconnect the MAP sensor;
- 3) Use a multi-meter, Measure the resistance between the 2 wires on the connector of harness side, as in the below picture:

What is resistance between the 2 wires of “VCC” and “GND-A”?

If it is smaller than 100 ohm that means the ECU is damaged somehow. The normal value should be about 1K ohm.

If ECU is damaged, most likely some ground wire is accidentally shorted to the 12V+; or VCC is shorted to ground wire.

For example, the GND-A is connected to 12V+; or VCC.



When the ECU is broken and need to replace one, please check the actuator and sensor of system as follows.

- 1) Check the voltage of the battery. It should be lower than 16V, usually it is about 12V.
- 2) Check the connection as the pictures in manual. And notice whether the wire of harness is damaged.

3) Check the other parts of the system.

3.1) Test the resistance of the fuel injector. It is more than 3 ohm, normally 12~15 ohm.



Picture 1

Picture 2

3.2) Test the resistance of the fuel pump relay. It is more than 60 ohm.



Picture 3

3.3) Test the resistance of the oxygen sensor at room temperature. It is more than 6 ohm, range about 8~12ohm.



Picture 4

3.4) Test the resistance of the stepper motor which is mount on the throttle. It is about 45~55 ohm. Picture 5 and 6 are the way testing for stepper motor of **34mm throttle** body



Picture 5

Picture 6

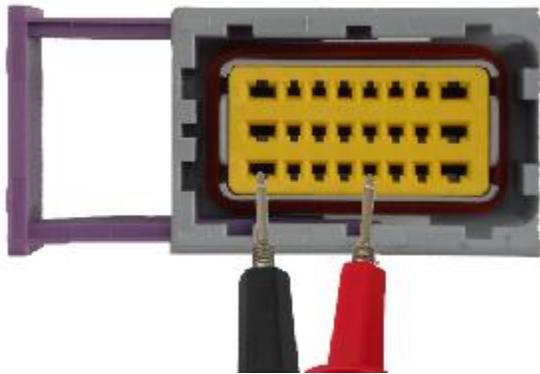
Picture 7 and 8 are the way testing for **other throttle**, 42mm, or 50mm TB.



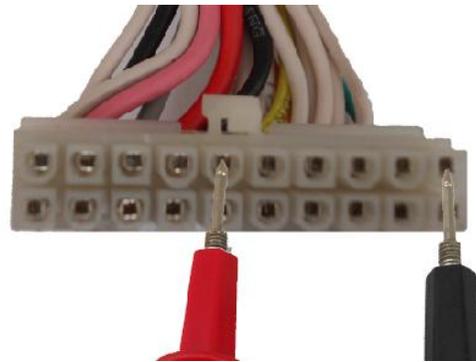
Picture 7

Picture 8

With the MAP and TPS sensor, oxygen sensor, IAT, ECT on the harness, test the resistance of the harness. It should be more than **1000 ohm**.



Picture 9



Picture 10

Test the max voltage used an oscilloscope if necessary.

	MAX voltage	Min voltage
Battery	16V	6V
Injector	40V	12V
Ignition coil (not CDI system)	400V	250V
Crank position sensor	150V	2V
VCC	5.1V	4.9V

## Chapter 12 On-the-fly Calibration Data

**On-the-fly** calibrations are something must have when tuning the engine on the dyno, so that you can make you calibration changes taking effect immediately by hit a "ENTER" key. No need to "Burn to ECU" or reprogram the ECU. Only by this way, you can keep the engine running without interrupted and at the same time find the sweet spots of the certain operating conditions. And you can tune your fuel / spark maps very quickly.

But the drawback of the "on-the-fly" calibrations is to use a lot of memory of ECU, because that's the way how this realizes. Basically any calibration data you want to do "on-the-fly" changes, you must double or even triple the size of the memory for that set of data. That would significantly increase the ECU cost.

ECU has a find a compromise to do this: only make certain critical calibration maps as "on-the-fly" capable. And most other non-critical calibrations, which are seldom changed by customers, stay the old way.

Mainly for most customers, the calibrations that need to be tuned for their engines are basic Fuel maps (VE table, TPS-load table), Spark maps, and some supplemental fuel/spark characteristic curves.

You can also use "**Save as**" feature at "File" menu to save your new calibrations to a new CAL file. And later on load it into ProCAL.

At this moment the below calibration maps, curves, and values are made "on-the-fly" capable:  
**RAM\_MAP\_LdTp\_N\_Tps:**

"Tps based Load mapping" ; this is the most important one for dyno tuning. It determines the commanded fuel at different throttle position and RPM. Especially at WOT condition, fuel is solely determined by this table. Because on the

dyno, the first thing to tune is the max power of the engine, and the max power is realized to optimize the AFR at the 100% TPS and max RPM. And the AFR at max RPM and 100%TPS is determined by this table.

### **RAM\_MAP\_fVe\_Map\_N:**

"Volumetric efficiency, dependent on MAP sensor and RPM" ; this is the fundamental calibration map of an engine, also called "speed-density" method.

It determines the commanded fuel at different manifold pressure and RPM. Basically, the volumetric efficiency determines the fresh air amount in the cylinder, and therefore the fuel needed for optimized AFR.

Our ECU software use the blended "speed-density" and "Alpha-N" methods, and at most RPM ranges and part loads, speed-density is primary method to calculate Fuel. Actually Alpha-N is only used at WOT and high RPM. So for most operating conditions, you should tune the VE table for optimized AFR.

Other on-the-fly calibrations data:

Basic Ignition angel table: RAM\_MAP\_Iga\_N\_Ld

After start and warm up factor: RAM\_CUR\_fAst\_TmSta, RAM\_CUR\_fWmp\_Tm

Globe enrichment factor: RAM\_VAL\_fFIApp

**Note: when you tune the data on-the-fly, please “Stop Measuring” . Otherwise it will not take effort.**

**And if the ECU power off, the data will be lost, so you need save the data and burn to ECU after you think the data is OK.**

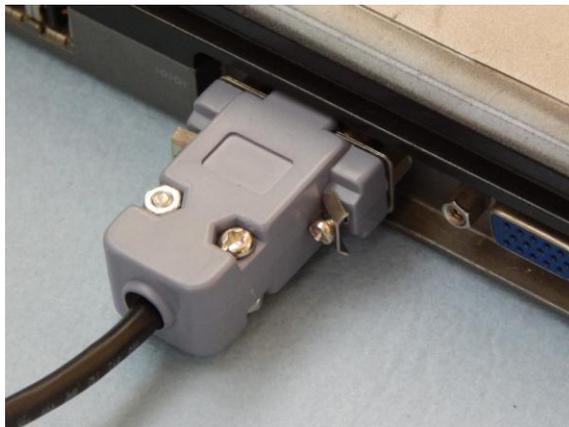
## Chapter 13 about Ecotrons software tools

### Flash GUI and ProCAL

#### 13.1 Flash ECU

##### How to program ECU with Flash GUI?

- 1) Connect your laptop with a USB or RS232 to ECU harness.



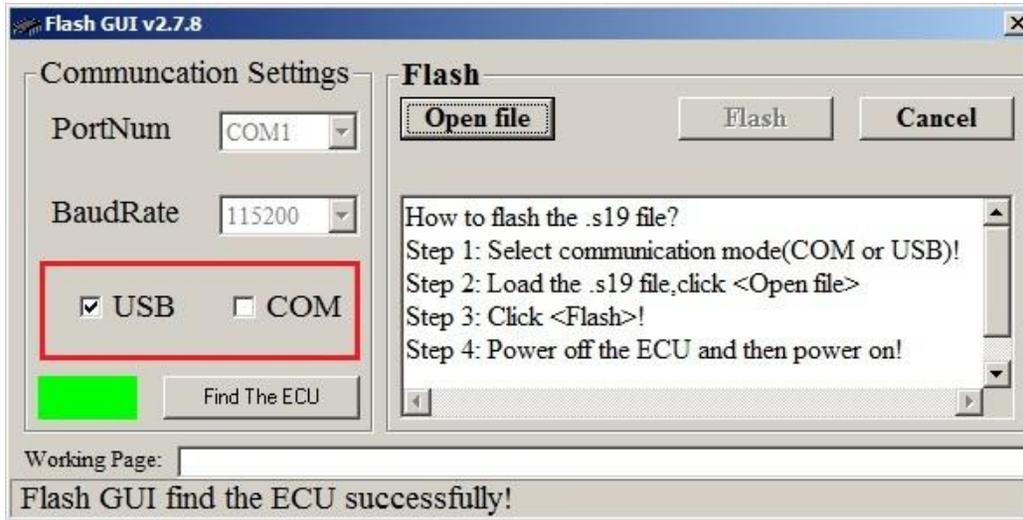
RS232 cable



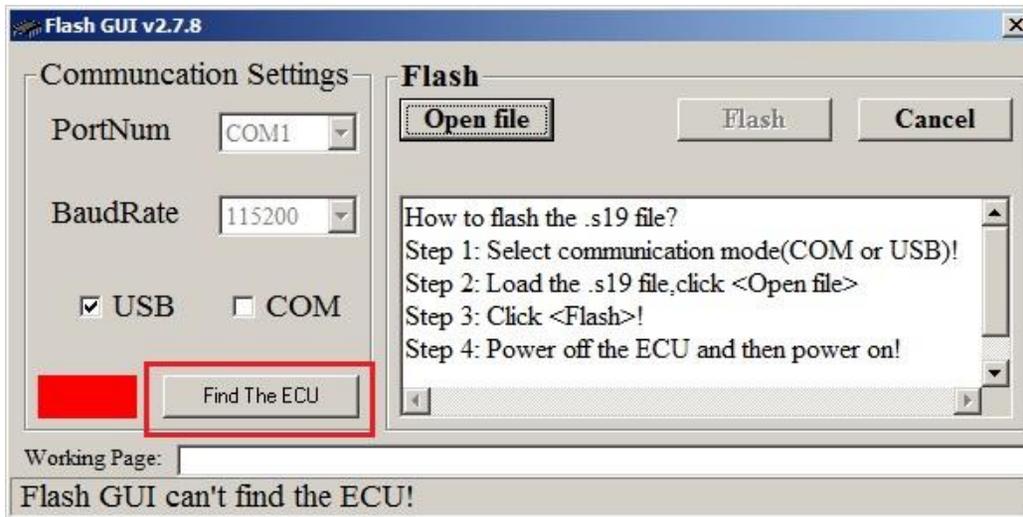
USB adaptor

**Note:** Make sure the connection between laptop and USB adaptor (Serial communication cable) is FULLY plugged in.

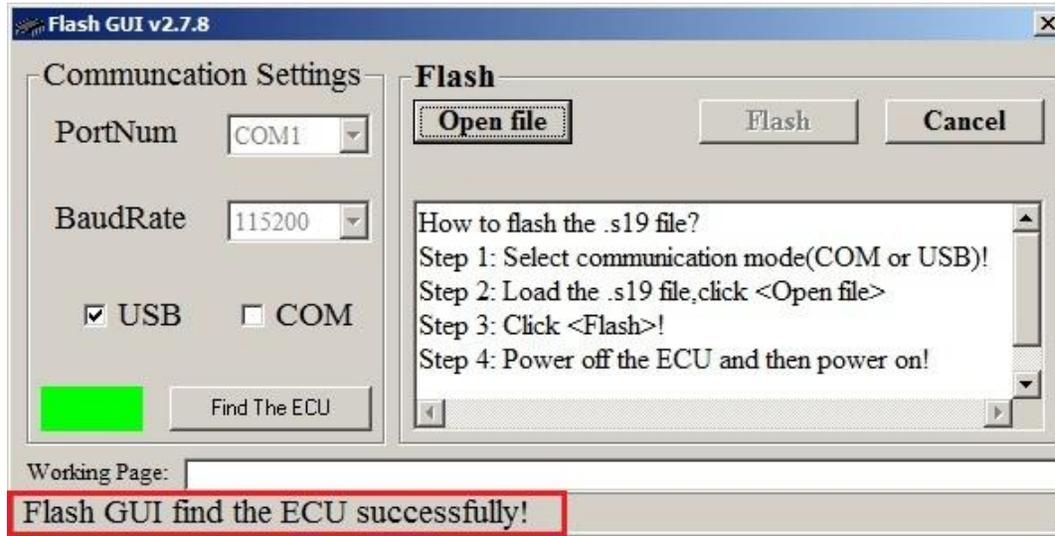
- 2) Select USB or COM.



**Note:** You can click “Find the ECU” to check the “USB” or “RS232” whether is available. **(Make sure the ECU is powered ON)**



Power on ECU (**Key ON**) first, then click “Find the ECU:



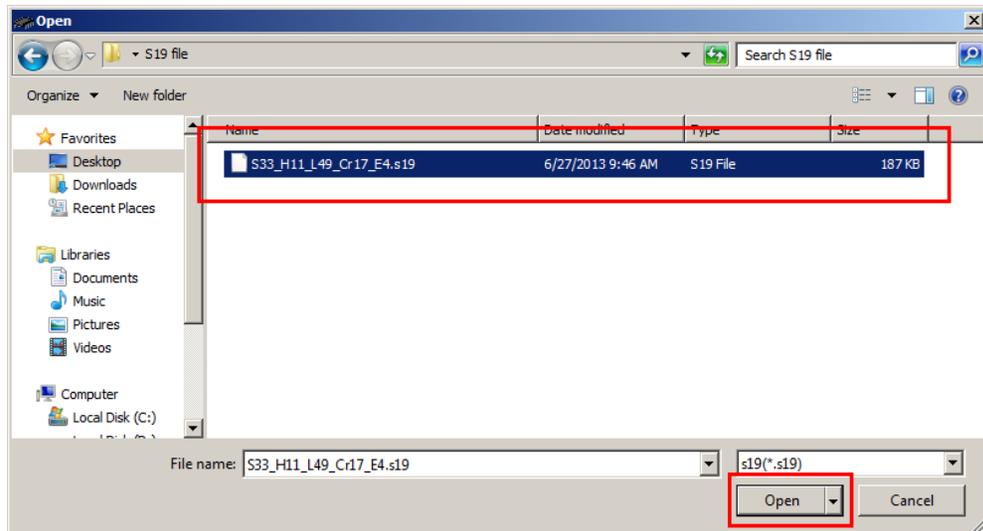
If the USB or RS232 is connected well, it will find the ECU and it will prompt information “Flash GUI find the ECU successfully”, then you can do the above steps to flash S19 to ECU.

Otherwise, you need check the connection or whether there are other programs that take up com port

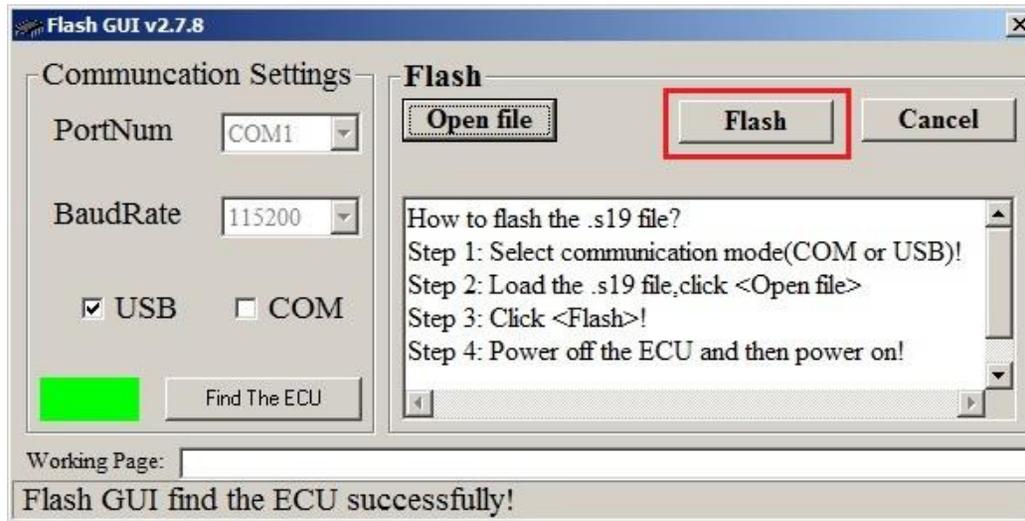
3) Click "Open file" button to open the S19 file



4) Find the “S19” file, and then click “Open”

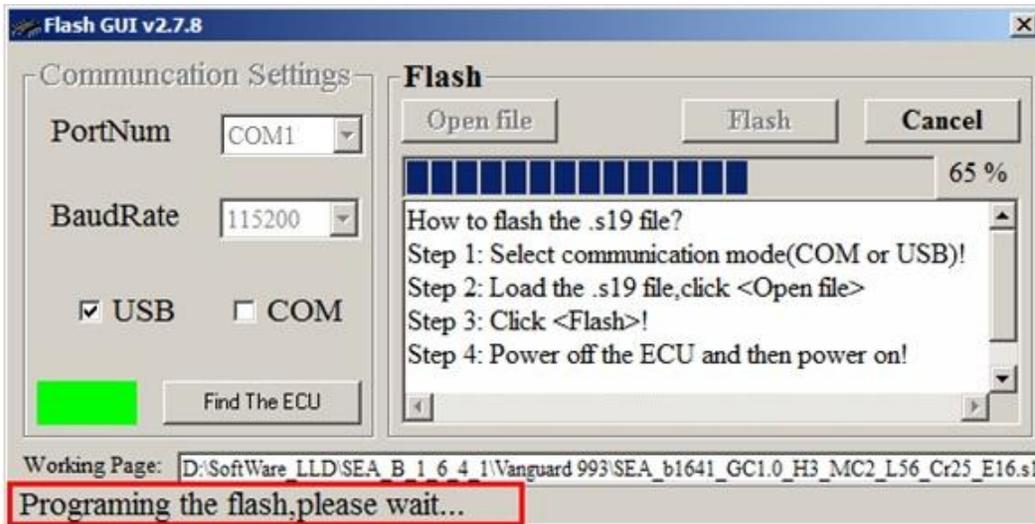
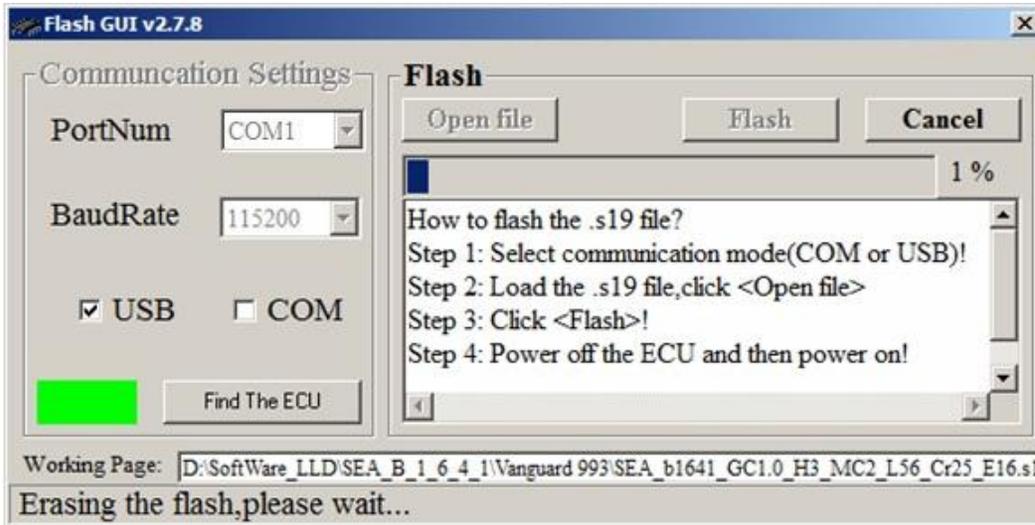


5) Click “Flash” to flash S19 file to ECU

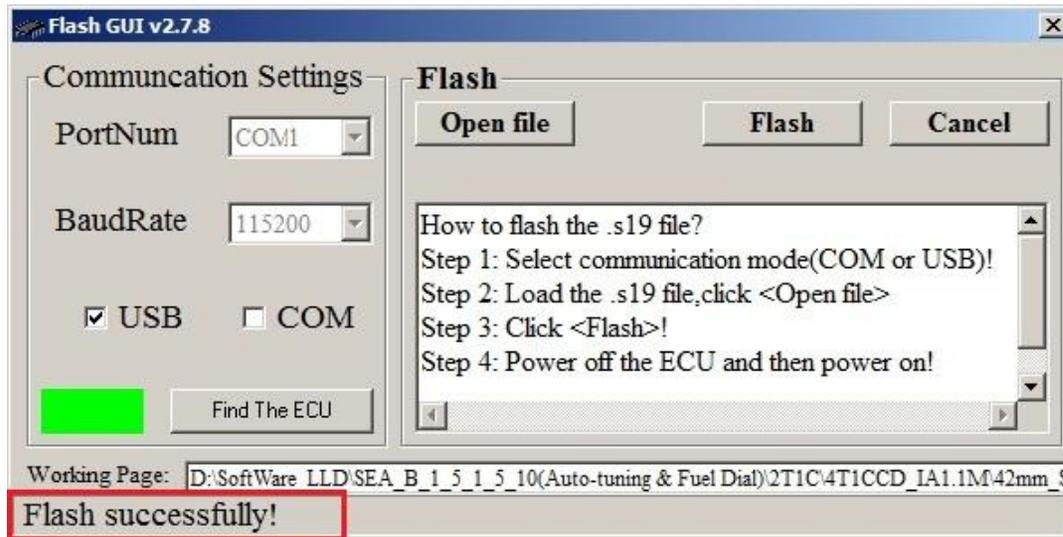


6) Turn off the key switch, and then turn on the key switch to power ECU. You will see the "Flash GUI 2.7.8" start to work and the blue progressing bar running...

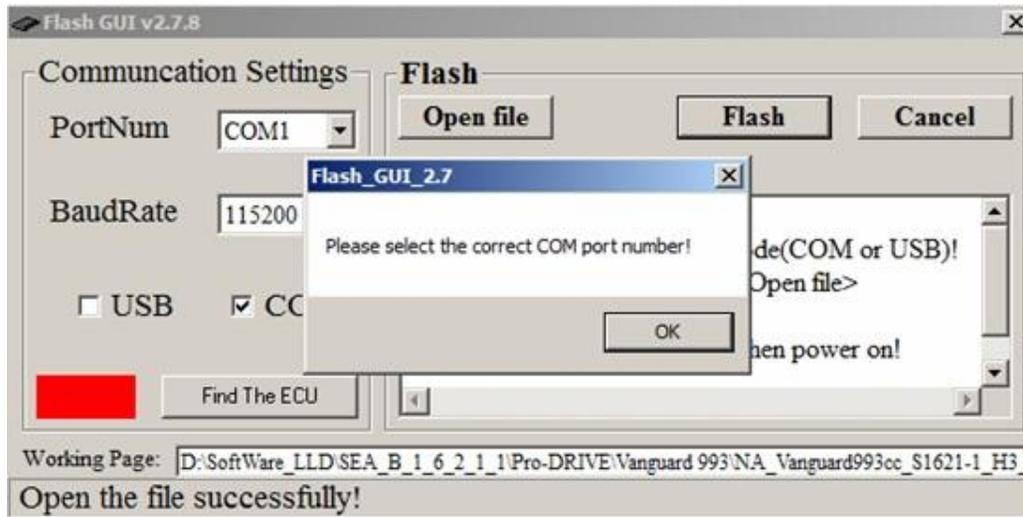
Wait it to finish.



When it Flashes successfully, it will prompt information "Flash successfully!" and you will hear the fuel pump running for a couple seconds.



**Note:** If you select COM, please make sure the serial port is not occupied in other settings. If COM is occupied, it will pop up a window.

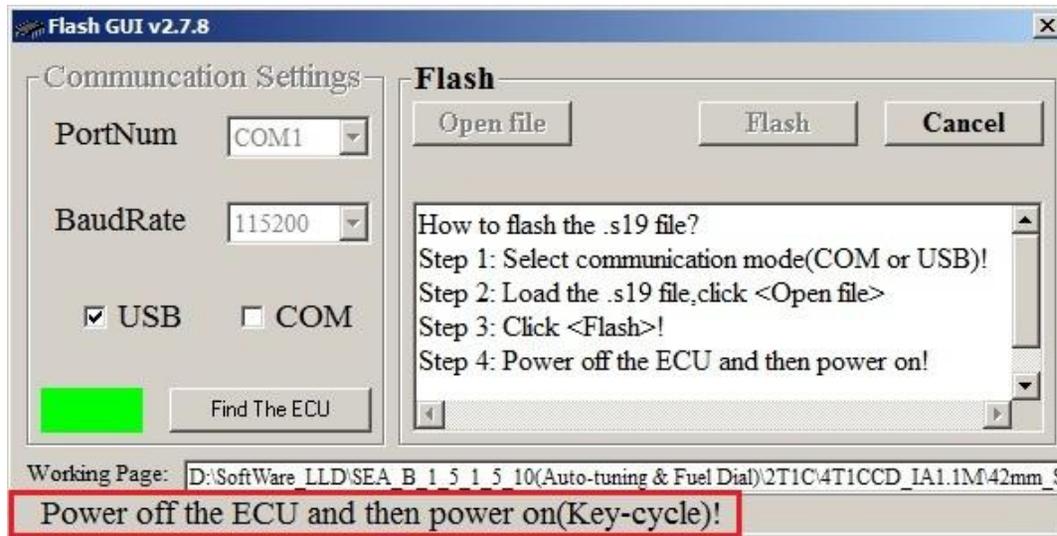


You need to check whether there are other programs that take up com port.

**Note:**

If the ECU has been powered on, when click the “Flash” button, it will report a message”**Power off the ECU and then power on (Key-cycle)**”.

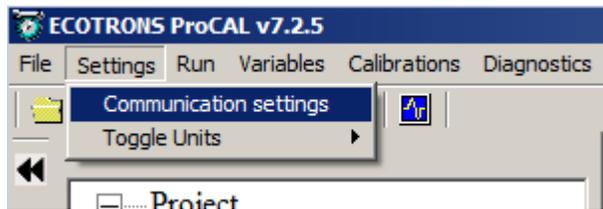
Please Key off then key on again (Key-cycle). And do the same above operation.



## 13.2 Check A2I or CAL which should be matching ECU

### How to find the A2L or CAL files is matching with ECU?

Connect your laptop with a USB or RS232 to ECU harness. First do some communications settings in ProCAL.



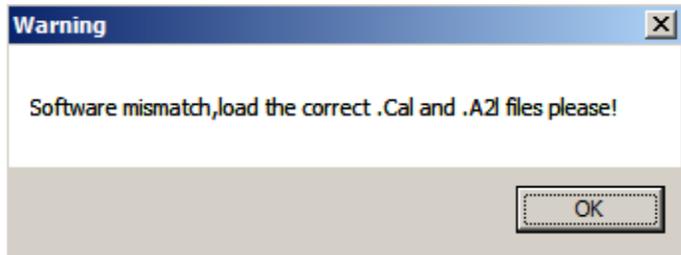
Select to the USB or COM or other according which you use. Then click "OK".



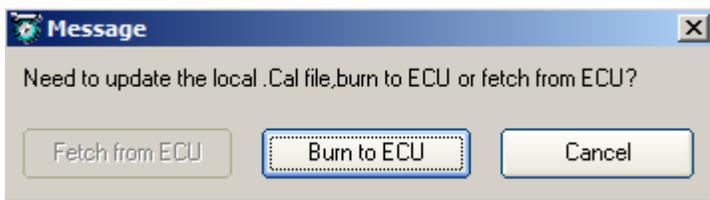
Connect to ECU: "Run->Connect"



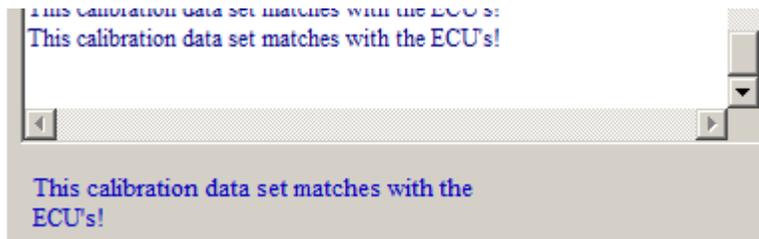
If it pop-up a warning box, so it is mismatching with your ECU. **Please connect us to get the right file.**



If it pop-up a message box, it means the settings of CAL is different from the ECU, you need to "Burn to ECU".



On the other hand, it will pop up a message "This calibration data set matches with the ECU's". It is right.



### 13.3 Burn to ECU successfully

#### How to make sure the "burn to ECU" is successful?

First, make sure the ECU is power on, and connect your laptop with a USB or RS232 to ECU harness.

When to burn to ECU, the power is still on and don't put the power switch off.

And if burn to ECU successfully, you will hear fuel pump running for a couple seconds. If not, please do again and check all of connection is right.

### 13.4 load configuration in variables list

For diagnosis and analyze the engine issue, sometime you need load the .ini file which we send you, and log data. You can do this by following example operation.

1) Choose “list”: In the interface Right Click ,then click “Display type→List”



2) In the list view , right-click , first , Click “Show All Variables“ , then right-click choose “Add Variables”

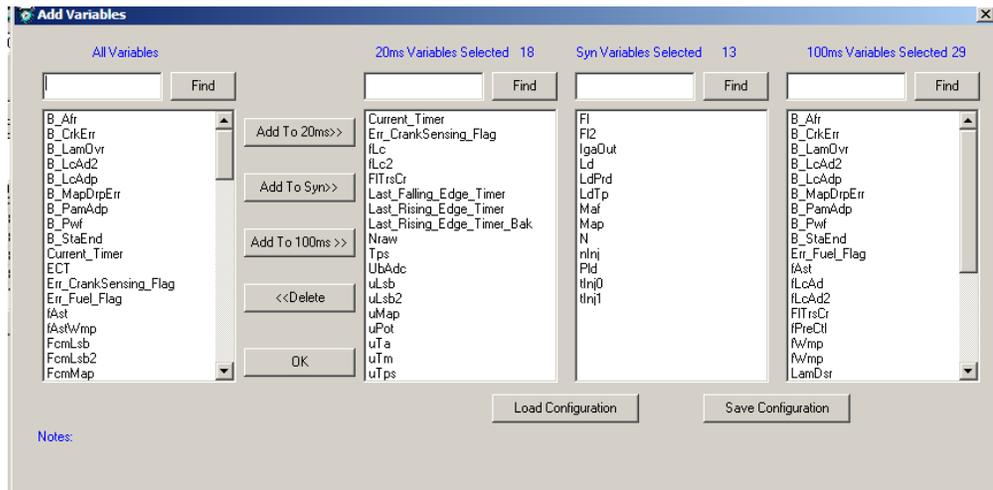
Map	Syn	hPa	0	2560	"Intake manifold pressure measured with hPa sensor"
N	Syn	Rpm	0	16383	"Engine speed in Rpm"
nInj	Syn		0	65535	"number of injections "
tInj0	Syn	ms	0	65.535	"injection time for injector #0 "
fLc		20ms	-	0	2 "Lambda controller output (word)"
Nraw		20ms	Rpm	0	16383.75 "Engine speed in rpm from LLD"
Tps		0ms	%	0	100 "throttle position with respect to lower mechanical stop"
UbAde		0ms	V	0	25.6 "battery voltage; scanned value of microprocessor"
uLsb		0ms	V	-1	4 "Voltage signal from the lambda sensor before catalytic converter"
uMap		0ms	V	0	5 "Voltage signal of manifold pressure sensor "
uPot		0ms	V	0	5 "ADC-voltage of potentiometer sensor "
uTps		0ms	V	0	5 "ADC-voltage of throttle position sensor "
B_CrkErr		0ms		0	1 "Error condition for crank sensor"
B_MapDrpErr		100ms		0	1 "Error condition for MAP sensor, no drop in pressure"
B_StaEnd		100ms		0	1 "condition: end of start "
fPreCtl		100ms		0	64 "factor: pre-control fuel"
LamDsr		100ms	-	0	16 "Desired Lambda"
OfsLcAd		100ms	%	-768	767 "additive adaptive correction of the relative lambda"
Pam		100ms	hPa	0	2560 "Ambient pressure"
Ta		100ms	DegC	-50	205 "Intake air temperature"

- Add Variables
- Show All Variables
- Show Oscilloscope
- Decimals Display
- Hide Descriptions
- Sort
- Variable properties

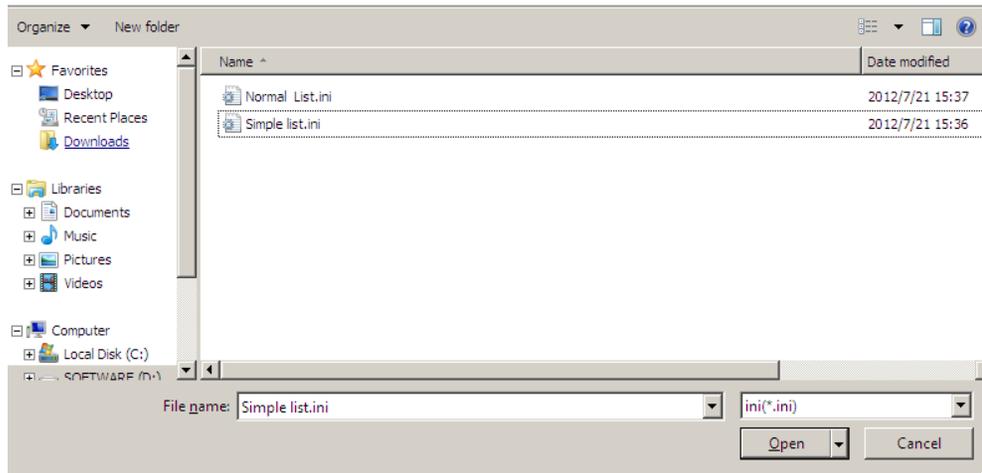
X: Ld_b, [%]	Pld	Syn	hPa	0	2559.961	"pressure in combustion chamber for load calculation"
Y: N_b, [Rpm]	tInj0	Syn	ms	0	65.535	"injection time for injector #0 "
MAP_Iga_N_b	tInj1	Syn	ms	0	65.535	"injection time for injector #1 "
2500 32.2500 38.2500	Current_Time	20ms		0	.294967E+09	"current timer of LLD "
5000 7.5000 7.5000	Err_CrankSer	20ms	-	0	65535	"bitFields crank sensing errors, stored in NVM"
5000 7.5000 7.5000	fLc	20ms	-	0	2	"Lambda controller output (word)"
5000 10.5000 10.5000	fLc2	20ms	-	0	2	"Lambda controller output "
2500 14.2500 14.2500	FITrsCr	0ms		0	1536	"rel. fuel mass transition compensation "
0000 18.0000 18.0000	Last_Falling_I	0		0	.294967E+09	"LLD timer"
2500 29.2500 29.2500	Last_Rising_I	0		0	.294967E+09	"LLD timer"
2500 35.2500 35.2500	Last_Rising_I	0		0	.294967E+09	"LLD timer"
5000 37.5000 37.5000	Nraw	0		0	16383.75	"Engine speed in rpm from LLD"
5000 37.5000 37.5000	Tps	0		0	100	"throttle position with respect to lower mechanical stop"
2500 38.2500 38.2500	UbAde	0		0	25.6	"battery voltage; scanned value of microprocessor"
0000 39.0000 39.0000	uLsb	20ms	V	-1	4	"Voltage signal from the lambda sensor before catalytic converter"
0000 39.0000 39.0000	uLsb2	20ms	V	-1	4	"Voltage signal from the lambda sensor before catalytic converter"
2500 38.2500 38.2500	uMap	20ms	V	0	5	"Voltage signal of manifold pressure sensor "
2500 38.2500 38.2500	uPot	20ms	V	0	5	"ADC-voltage of potentiometer sensor "
2500 38.2500 38.2500	uTa	20ms	V	0	5	"ADC-voltage of intake air temperature sensor"
2500 38.2500 38.2500	uTm	20ms	V	0	5	"ADC-voltage of engine coolant temperature sensor"
2500 38.2500 38.2500	uTps	20ms	V	0	5	"ADC-voltage of throttle position sensor "
	B_Afr	100ms		0	1	"ECU control for ECU switch off delay"
	B_CrkErr	100ms		0	1	"Error condition for crank sensor"
	B_MapDrpErr	100ms		0	1	"Error condition for MAP sensor, no drop in pressure"

- Add Variables
- Show basic Variables
- Show Oscilloscope
- Decimals Display
- Hide Descriptions
- Sort
- Variable properties

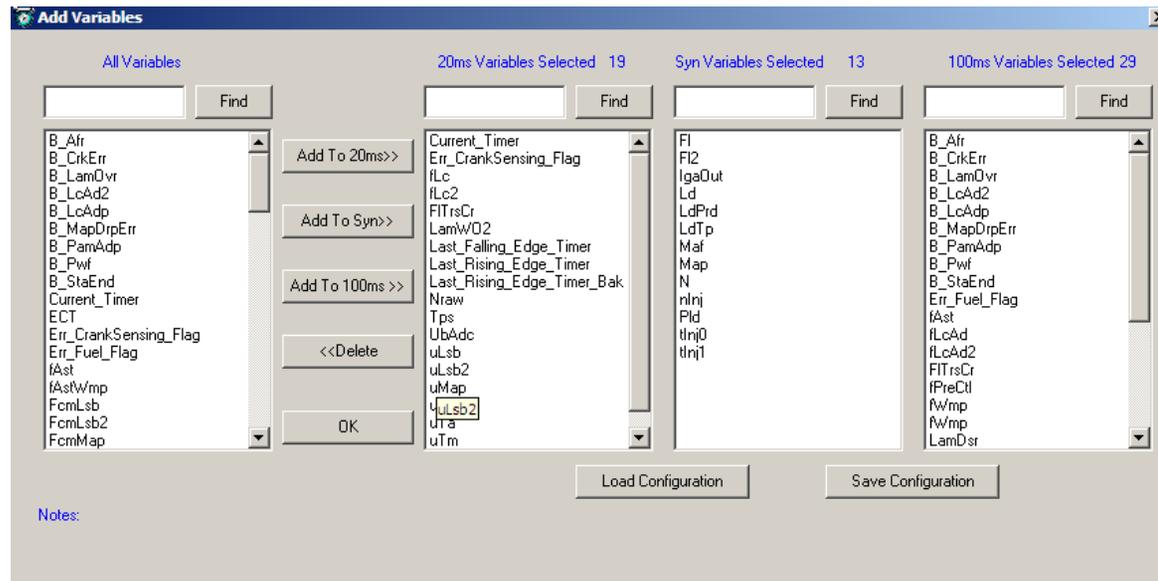
3) Click“Load Configuration”



4) Choose “Simple list.ini”, and then click “open”



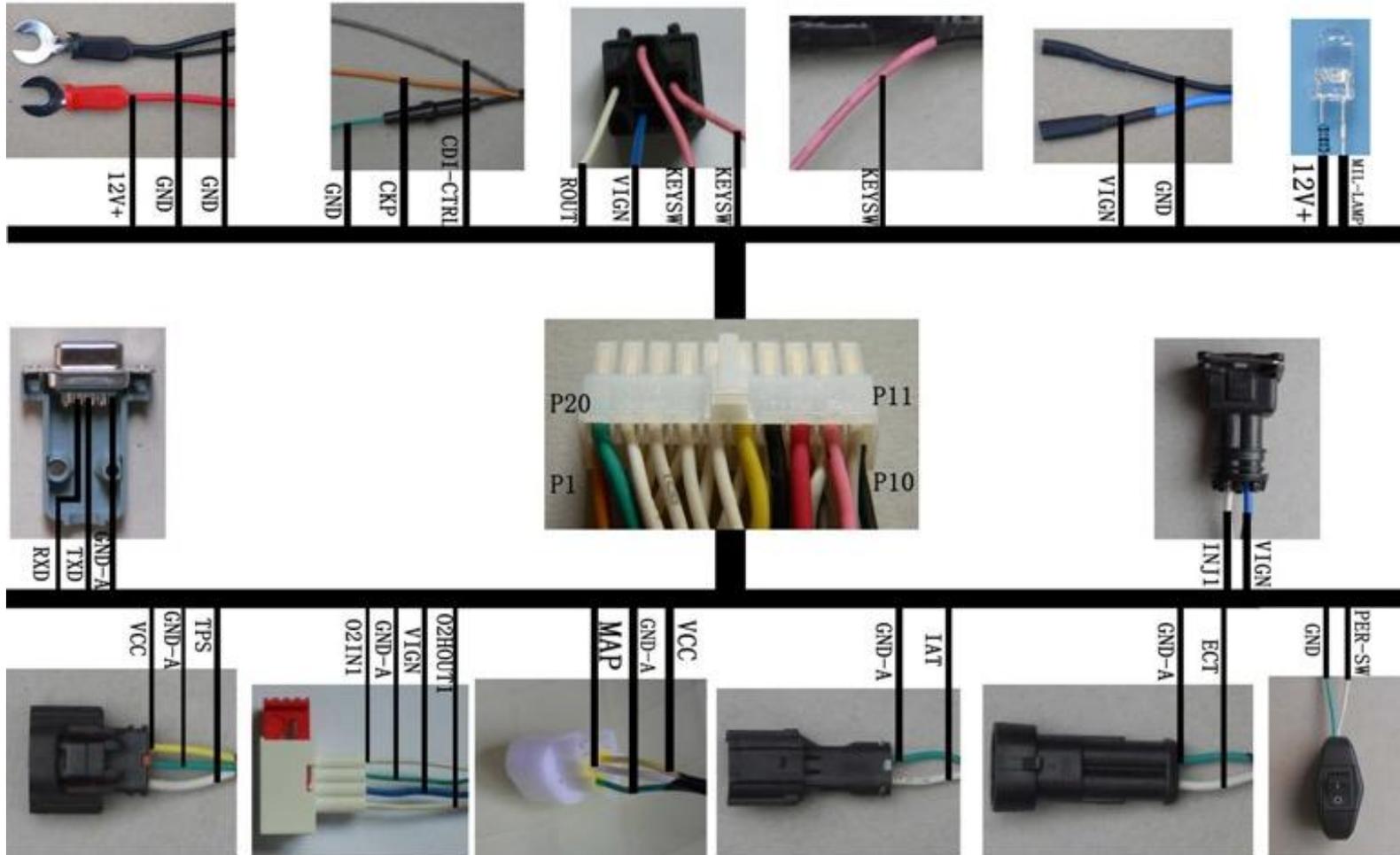
5) Click “OK”





P1	O2HOUT1	P13	IAT
	--O2 Sensor 1 Heater LS Driver output		--intake air temp
P2	12V+	P14	KEYSW
	--Reverse Battery Protected Supply		--Key On Swith
P3	GND	P15	MIL-LAMP
	--Power Ground		--Malfunction Indicator Lamp
P4	VCC	P16	INJ1
	-- +5 Volt supply output		--Injector 1 LS Driver output
P5	RXD	P17	GND
	--Send Data to RS232		--Power Ground
P6	PER-SW	P18	CDI-CTRL
	-- Performance Swith		--CDI control output from ECU
P7	TPS	P19	IACC
	--Throttle Position Sensor input		--Idle Air Controller C
P8	GND-A	P20	ROUT
	-- Analog Ground		--Power Relay LS Driver output
P9	IACA	P21	ECT
	--Idle Air Controller A		-- engine (coolant) temp
P10	MAP	P22	IACB
	-- Manifold Air Pressure Sensor input		--Idle Air Controller B
P11	IACD	P23	O2IN1
	--Idle Air Controller D		-- Oxygen Sensor 1 input
P12	TXD	P24	CKP
	--Receive Data from RS232		-- Crank Position Sensor, connect to ignition pickup sensor signal

### Appendix II: ECU main connector pin-out (20-pin)



This wiring schematic is for 4-stroke 1 cylinder engine (1 injector, 1 O2 sensor) settings.  
 For different engines, like 2-stroke, 1 cylinder, w/ 2 injectors, some pin-out definitions are different.

P1	CKP	P11	O2HOUT1
	-- Crank Position Sensor, connect to ignition pickup sensor signal		--O2 Sensor Heater LS Driver output
P2	MIL-LAMP	P12	KEYSW
	--Malfunction Indicator Lamp		--Key On Switch
P3	MAP	P13	12V+
	-- Manifold Air Pressure Sensor input		--Reverse Battery Protected Supply
P4	IAT	P14	GND
	--intake air temp		--Power Ground
P5	RXD	P15	VCC
	--Send Data to RS232		-- +5 Volt supply output
P6	TXD	P16	ECT
	--Receive Data from RS232		-- engine (coolant) temp
P7	ROUT	P17	TPS
	--Power Relay LS Driver output		--Throttle Position Sensor input
P8	CDI-CTRL	P18	O2IN
	--CDI control output from ECU		-- Oxygen Sensor input
P9	INJ1	P19	PER-SW
	--Injector 1 LS Driver output		-- Performance Switch
P10	GND	P20	GND-A
	--Power Ground		-- Analog Ground