SE-EFI

Small Engine Electronic Fuel Injection

– Conversion Kit

Vanguard 993

Installation Manual

ECOTRONS LLC

V1.1

Briggs and Stratton 36HP Vanguard 993cc Engine Kit

Introduction

SE-EFI is an Electronic Fuel Injection conversion kit for small engines. This install procedure is a customized version for the Briggs and Stratton 36HP Vanguard 993cc engine. It is only a hardware installation guide. It does not cover any tuning or ECU Programming. The locations of the components are up to you, the ones shown here are preferred locations by some early adopters.

This EFI kit has below features:

- Electronic fuel injection (EFI)
- Quick engine start even at cold temperatures
- More power and torque than the carbureted version
- Close-loop controls with an O2 sensor (optional, not included)
- Dual fuel maps selectable by a manual switch (Performance Switch: ECO vs. RICH Mode)
- High fuel efficiency and low carbon emissions
- Decel-fuel-cut-off
- OBD - on board diagnosis
- Performance tuning for advanced users.

Parts:

1.ECU (aluminum housing, water proof)

2.Harness (including the connectors, waterproof)

3.Throttle Body Assembly

• 45mm Throttle body (compared to Briggs 32mm TB)

• TPS sensor

• Idle Air Control Motor (IAC)

4.Bolt-on intake manifold Assembly

• replacing the stock manifolds

• larger ports and more air flow compared to the Briggs manifolds

• 2x Fuel injectors (190g/min flow rate)

5.Fuel pump assembly

• External type fuel pump (Flow rate: 45L/h,120L/h)

• Fuel pressure regulator(3bar)

• Fuel filter (metal housing)

• fuel hoses and clamps

6.MAP sensor (1.05bar)

7.Engine temperature sensor

8.Intake air temperature sensor

9.Oxygen sensor and bungs (optional, not included)

10.Serial communication cable (to a computer)

11.Serial to USB converter (included)

12.CD - free tuning software (also downloadable)

13. An integrated bracket to hold the ECU and fuel pump on top of the throttle body assembly will be included soon

Note: the kit's installers need to take care of the below adaptation:

• This EFI kit requires a fuel return line back to the tank. Or if you have a vapor separator, you can route the fuel return line to the vapor separator.

• Depending on which boat manufacturer is the carb engine bought from, the throttle cable mechanism will be different. The installer may need to add some throttle cable bracket for the EFI system.

• It is recommended to have an adapter between the throttle body and the pod air filter (included in the EFI kit), which can fit / connect the stock crankcase vent hose, and also fit the intake air temperature sensor.

• The existing small plastic cover above the carburetor and manifold may not be usable any more, since the new manifold and throttle body assembly will take more room. You may need some new cover for rain or mud.

• You will need to keep the stock vacuum pump to feed the low pressure fuel to the EFI pump.

Though the EFI is meant to reduce the emissions than a carb system, this kit is not certified for any emission regulations. It is the user's responsibility to find out whether it's legal to use it.

Major components:

Throttle body and intake manifold assembly

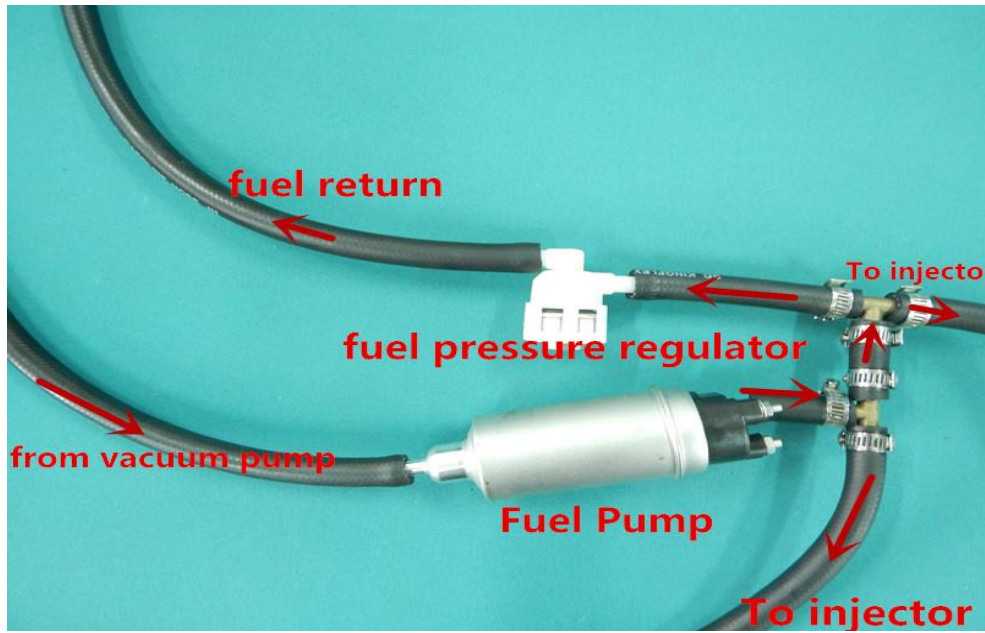The integrated bracket for ECU and pump with harness

MAP sensor

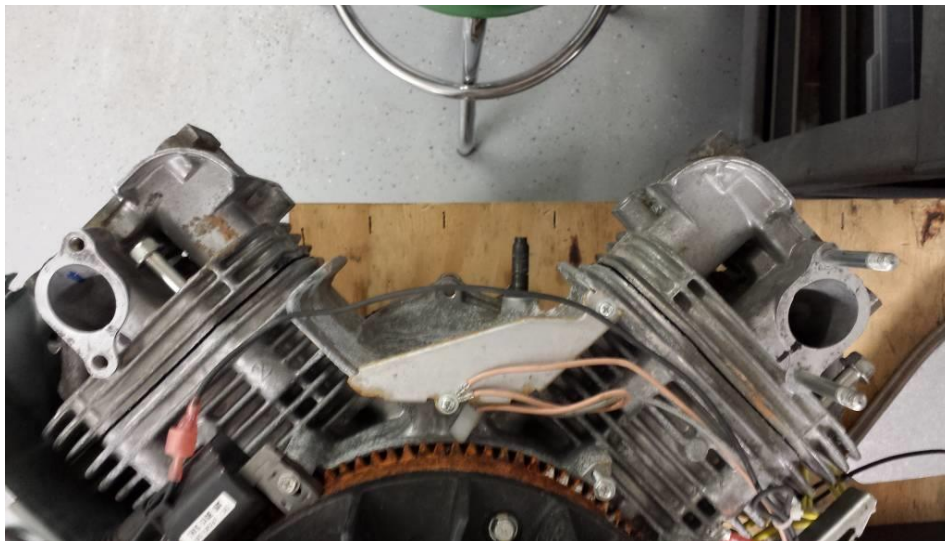**Temperature sensors**

Fuel pump assembly

Chapter 1 Installation Procedures

1. Replace the carburetor with the throttle body assembly

1.1 Remove the carburetor from the engine;

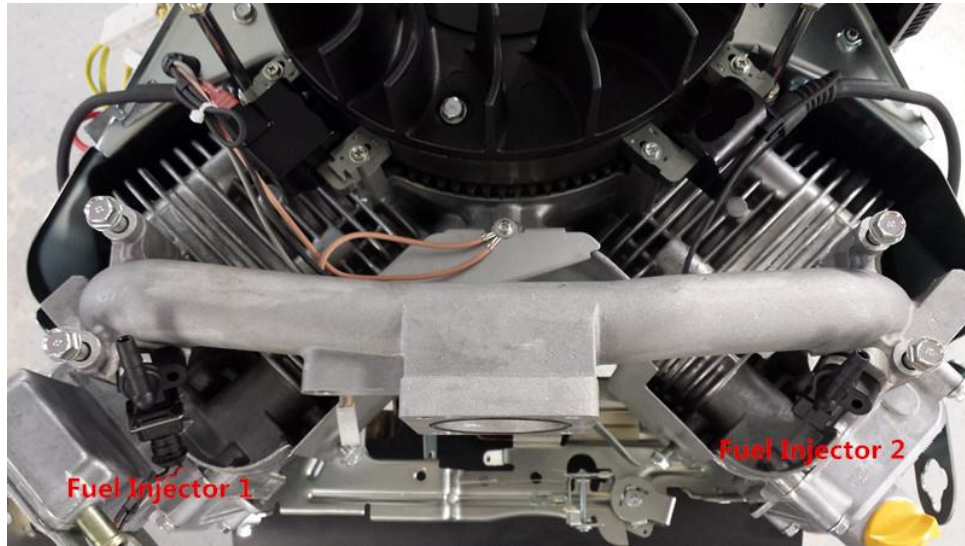   **1.1. 1** Disconnect and remove the battery if you have.

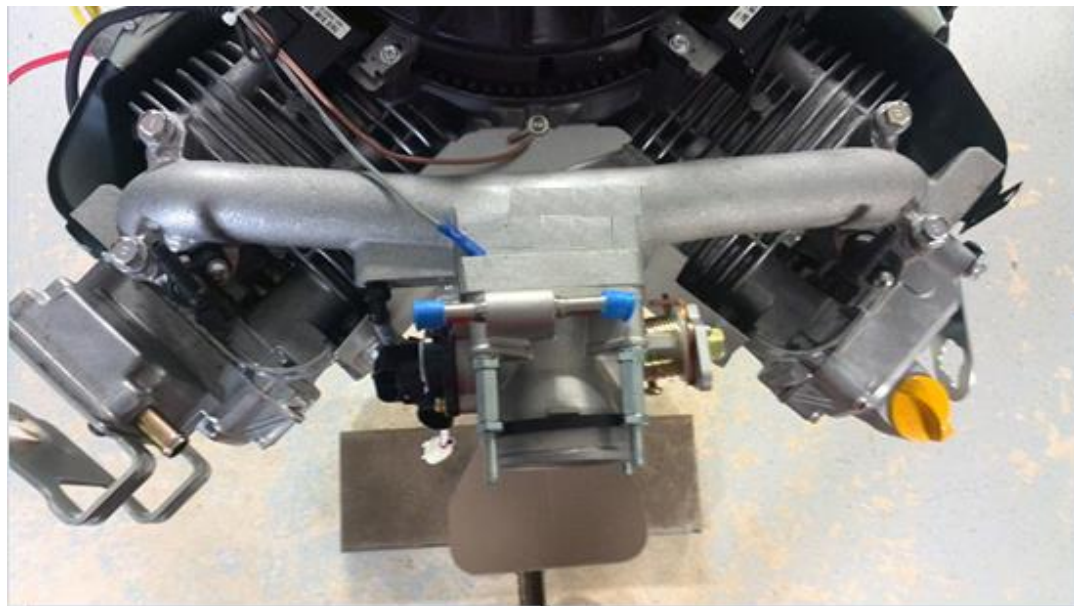   **1.1. 2** remove the air filter and the carburetor.

1.2 Install the throttle body.

Install the throttle body at the same location of the carburetor.
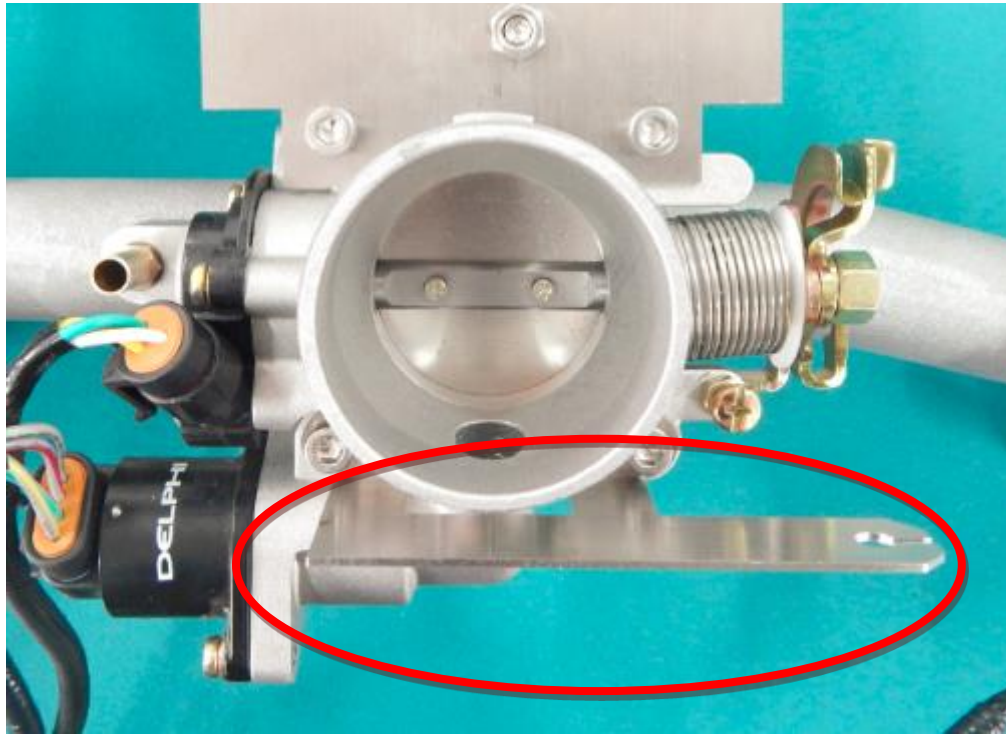
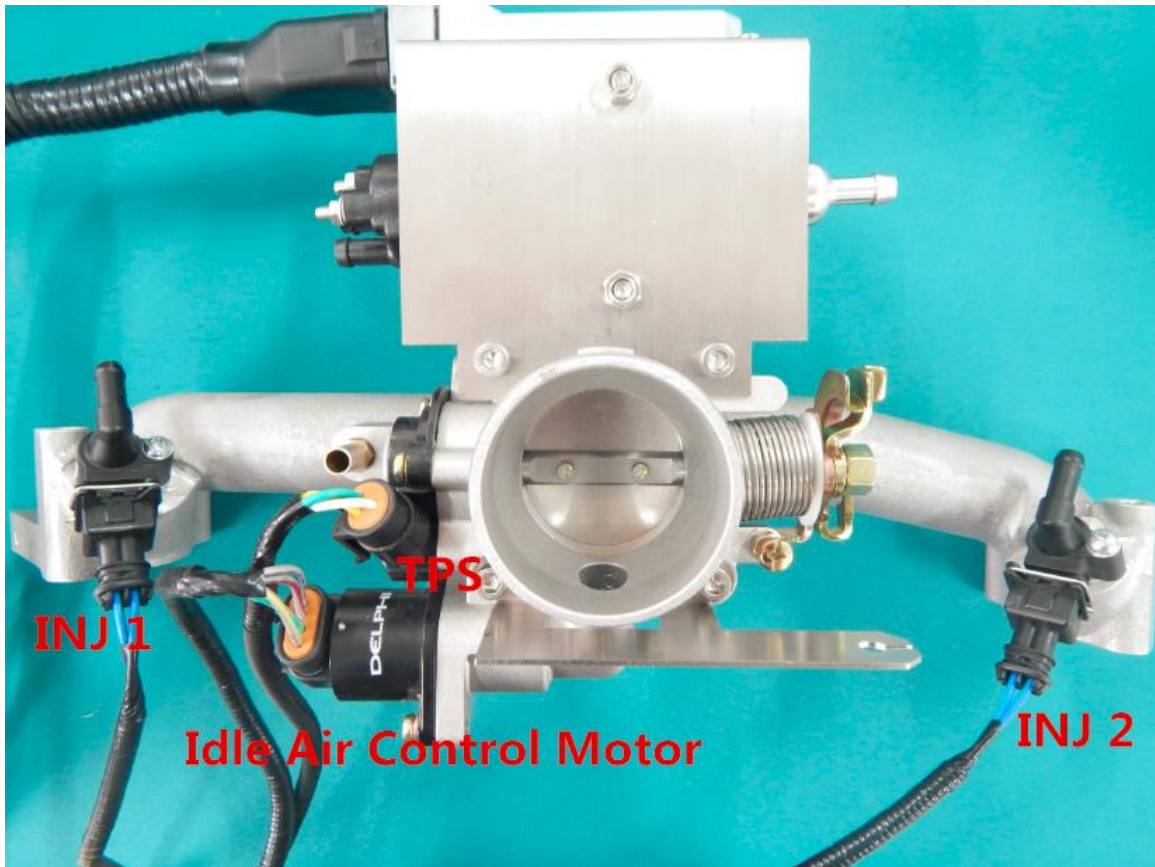   **1.2.1** Install the intake manifold with the fuel Injector.

1.2.2 Install the throttle body.

1.2.3 Install one suitable throttle cable to the throttle body. Maybe, the stock

exiting cable can't be used on the throttle body.

Note: The TPS sensor had been installed on the throttle body.

1.2. 4 Find a secure place to install the MAP sensor. You'd better fix it to the frame which can protect it from hot engine. And Connect the MAP sensor to the intake manifold with the small pipe.

Note:

1. The MAP sensor is fixed not closed to the engine for avoiding damaged the sensor because of high temperature.

2. The MAP sensor pipe should be about 5cm, but not longer than 10cm.

3. The sensor hose is not severely bent, or not routed in circle.

Attach the MAP Sensor connector:

MAP Sensor   Connector from harness
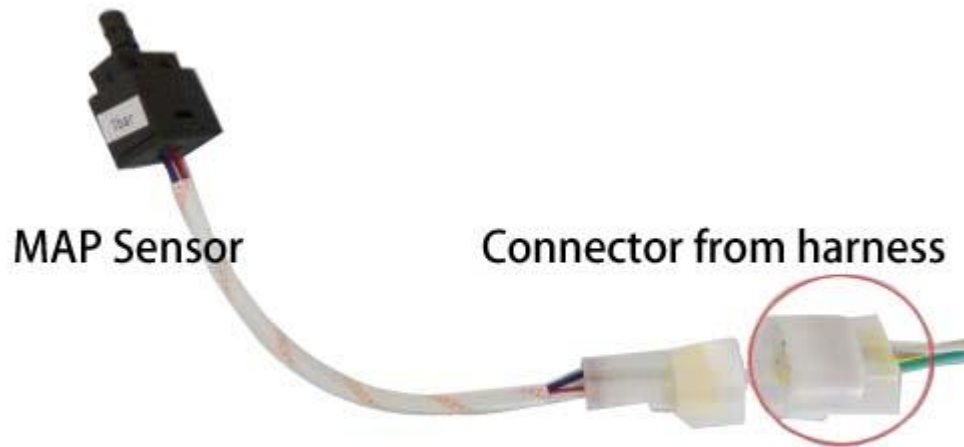
2. Fuel tank modification

2.1 You will need to keep the stock vacuum pump to feed the low pressure fuel to the EFI pump.
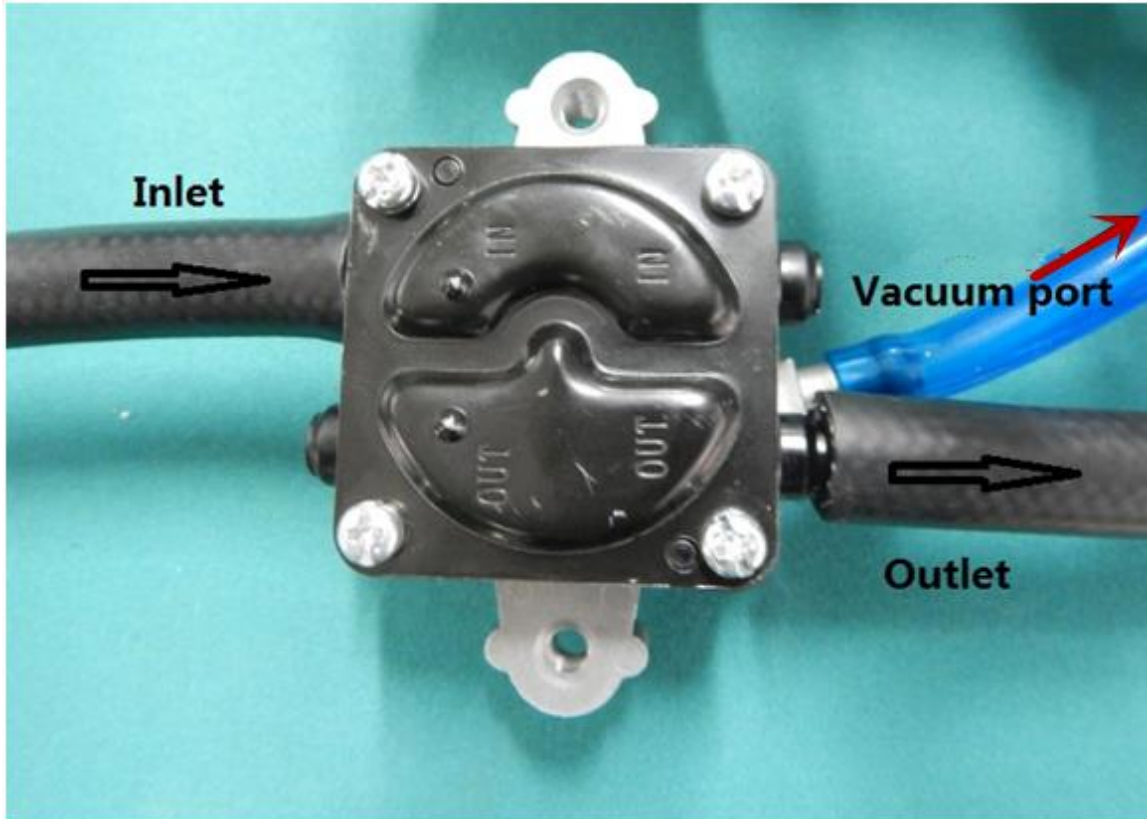
2.2 This EFI kit requires a fuel return line back to the tank. Or if you have a vapor separator, you can route the fuel return line to the vapor separator.

If you don't have the vapor separator, please fit the fuel returns line to the tank with the fuel tank adapter we provide,and you need to drill a hole on the tank. First, drain the fuel tank completely! (Warning: This will cause fire if you modify the fuel tank with any fuel!!!)

Please do as the following steps:

1) Please take the fuel tank off if necessary.
2) Drill a hole (diameter: 5mm~6mm) on the upper wall of fuel tank, or just below the fuel tank cap.

3) You can use the provided fuel tank adapter to fit the tank and to tighten it with a nut. And seal it.

4) Then clean the fuel tank if any debris falls into it. Install the fuel tank back

finally.

Fuel tank adapter

3. Install fuel supply system

3.1 Please install the fuel pump on the bracket which is provided by Ecotrons: it should be between the fuel tank and the throttle body, so that both the fuel feed line and the fuel return lines can be short; and it should be tied to the inside of the frame, so that it is protected by the frame. It should NOT be exposed to any external scratch or bump.

3.2 Connect the fuel feed line from the fuel tank outlet to the inlet of the fuel filter (fuel filter, by default, has been connected to the inlet of the fuel pump).

3.3 Connect the fuel feed line from filter outlet to the inlet of the vacuum pump.

3.4 Connect the fuel feed line from vacuum pump outlet to the inlet of the Ecotrons' fuel pump.

3. 5 Connect the high pressure fuel lines from the fuel pump to the fuel injector, which is located on the intake manifold or throttle body, and the fuel pressure regulator.

3.4 make the fuel pressure regulator return line return the fuel to the fuel tank.

3.5 Secure all fuel lines with supplied clamps, make sure no leak.

3.6 Connect the vacuum port of vacuum pump to the intake manifold.

3.7 The overview of the fuel supply system should be like the below pictures:
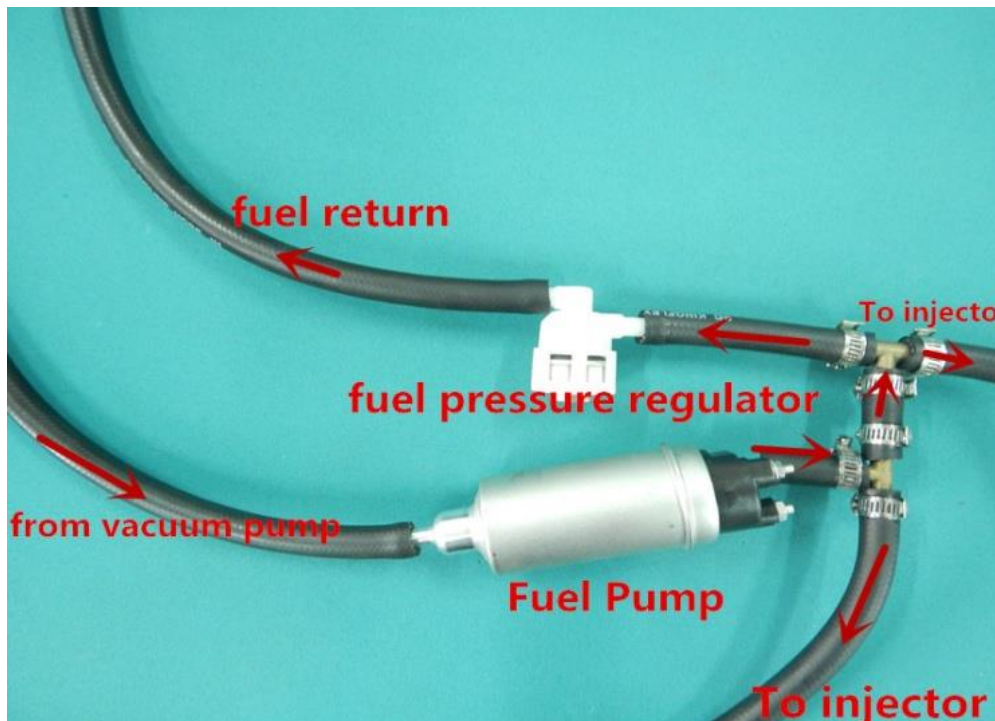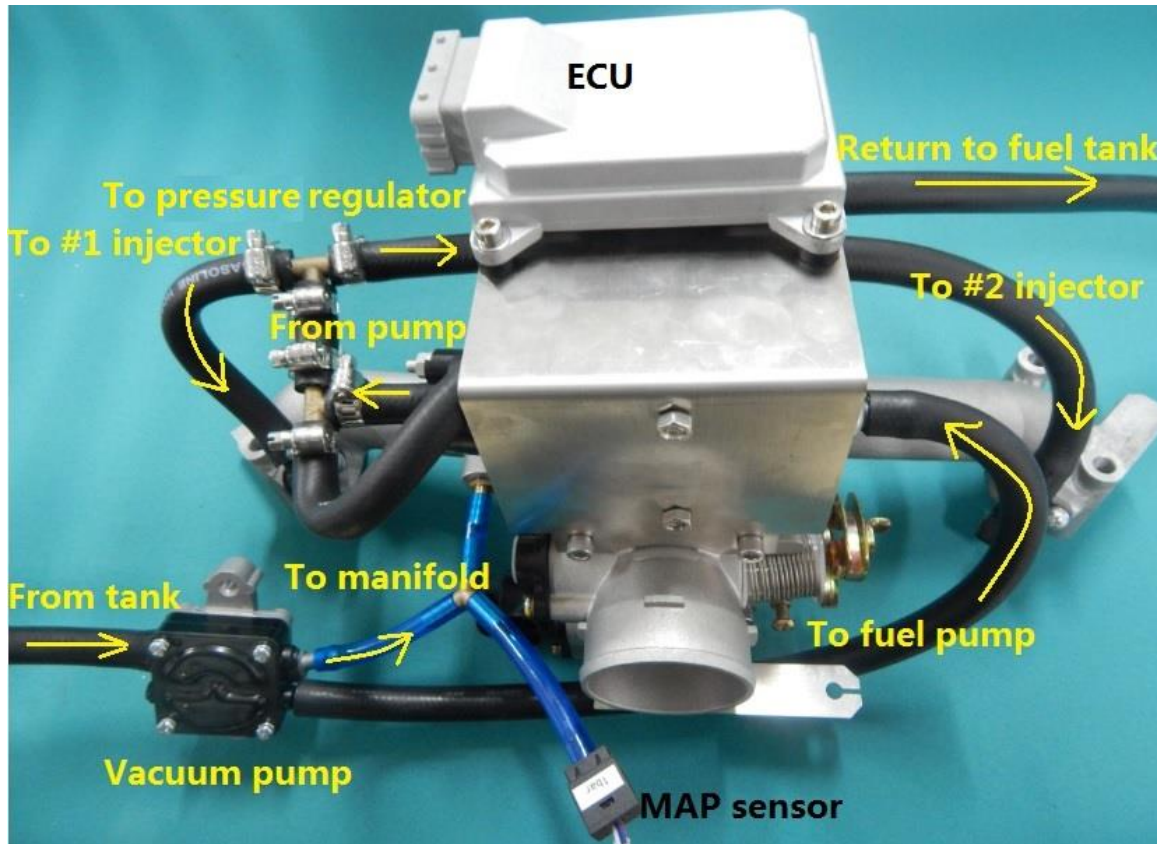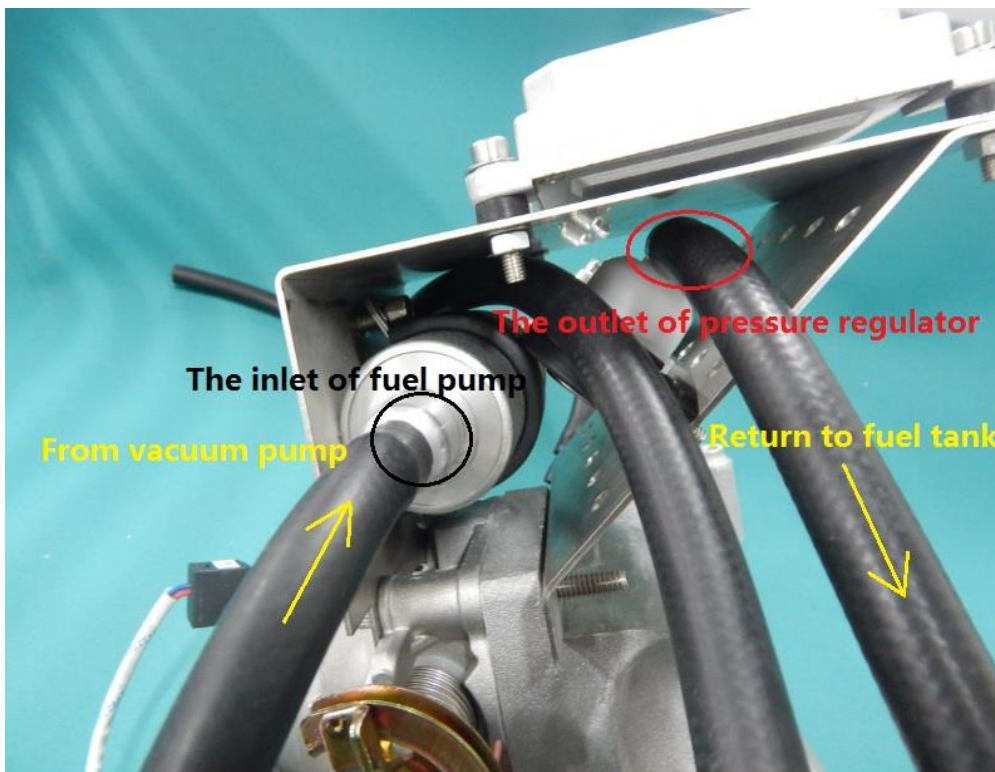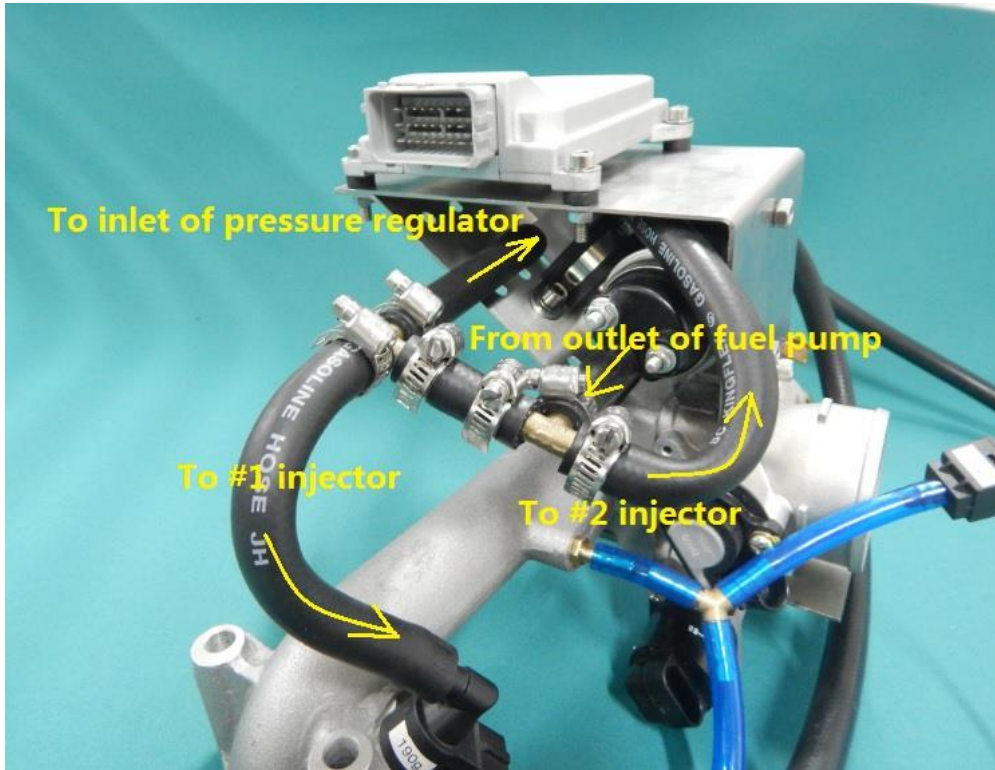
Install the power supply connector of fuel pump.
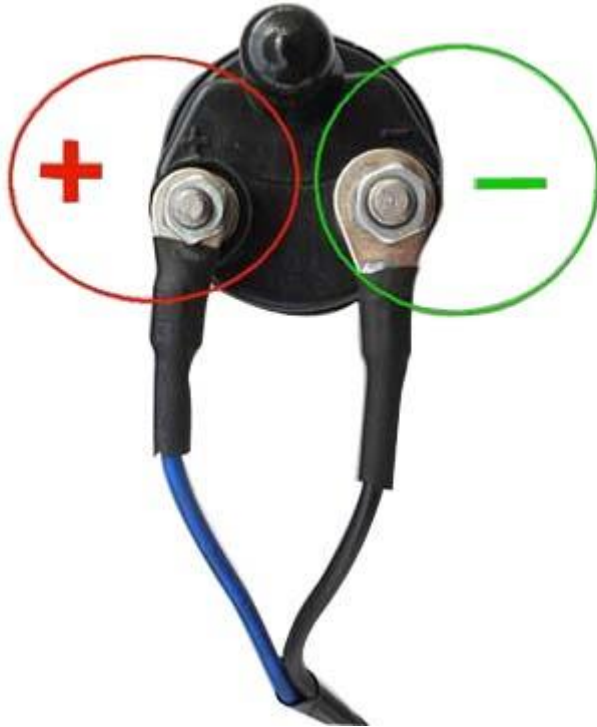
4. Connect the Kill Wire of stock ignition system to ECU harness.

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 of your ignition system
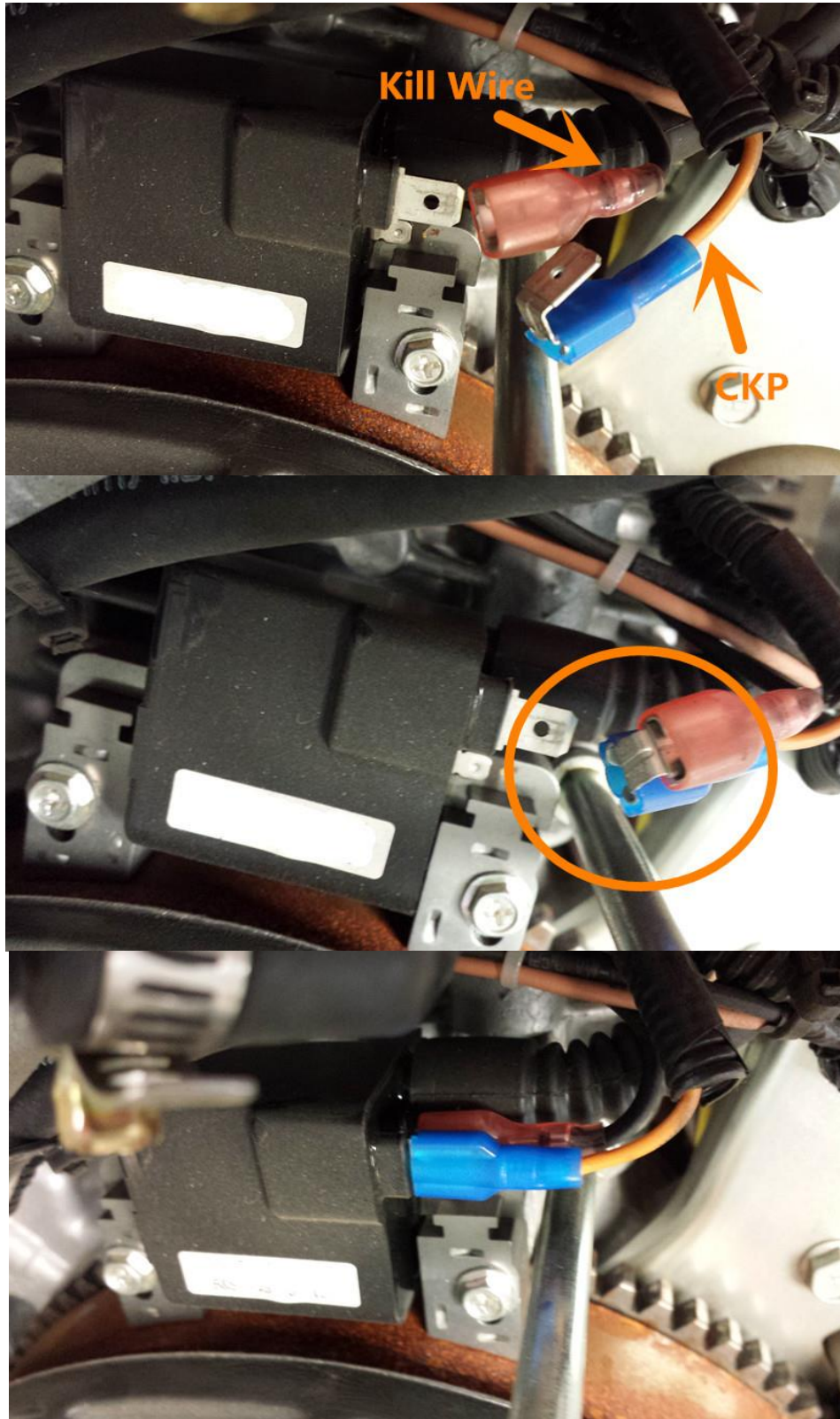
5. Install the Intake Air temperature sensor

It can be placed between the Throttle Body and Air Filter, or any convenient location where the intake air flows through.

Drill a small hole and insert the Sensor. Bond it with silicon sealer or other sealing agent.
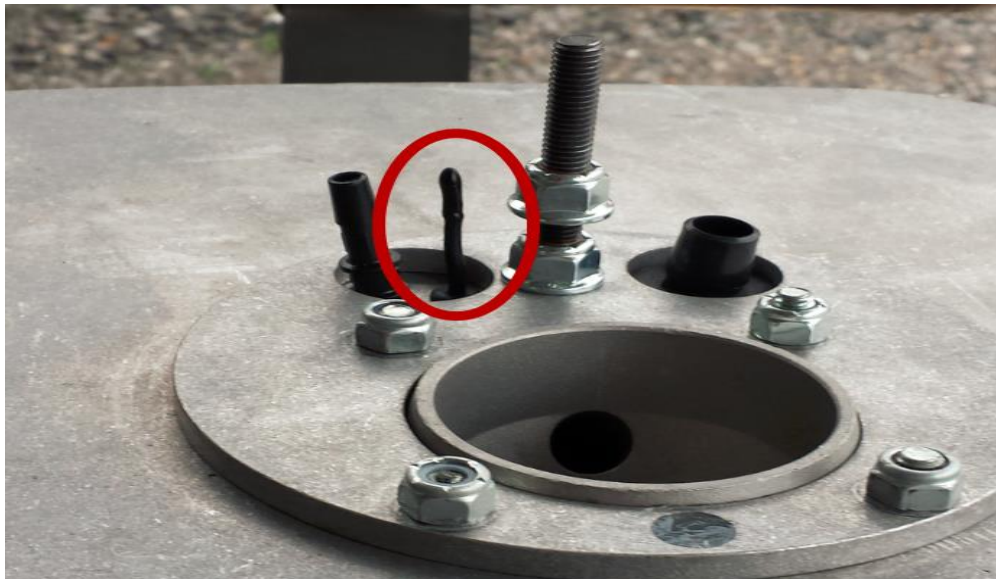
6. Install the engine temperature sensor.

Find a place on the cylinder header, where it has the lowest air flow (usually the backside of the engine), attach the sensor to a bolt and fix it.

7. KEYSW Installation

Splice the "key on switch" wire, and connect it to ECU "KEYSW" input (Pink wire). The "key on switch" is the 12V+ signal coming from the key-on signal; for some motorcycles, it also goes through "stop switch / kill switch". The location of the splice should be after the "stop switch" on the motorcycle, or after the "key switch" if there is no "stop switch". This is the ECU power-on trigger. Without this wire connected, ECU will not power on.

"KEYSW" wire can be connected to the 12V+ if there is no key-switch on the vehicle. But you must insert a manual switch between 12V+ and KEYSW input. For some customers, we pre-install a manual switch between KEYSW wire and 12V+ wire as requested.
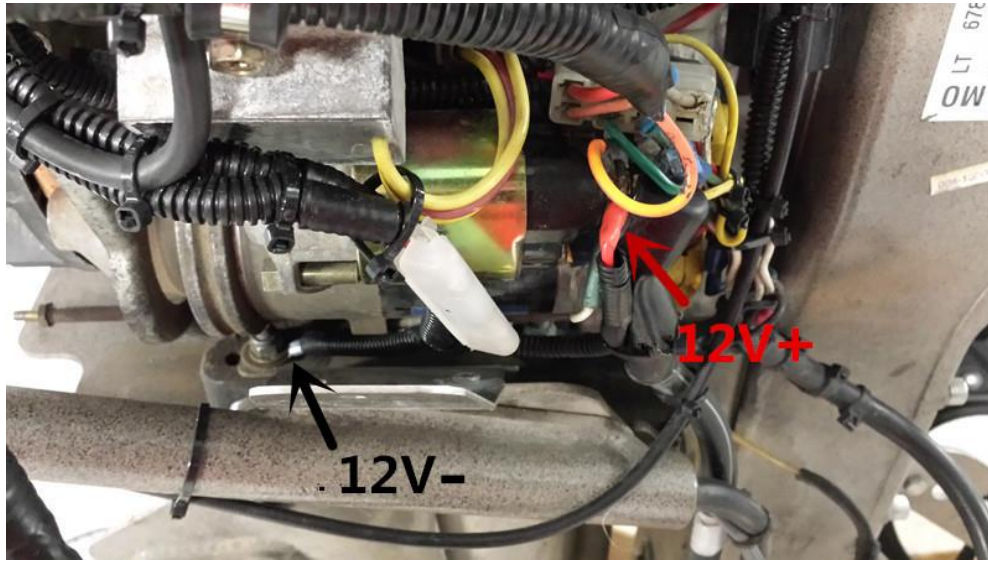
NOTE: the Vanguard 993 engine does not have a "key on switch", please add one, which can accept 5A current.

8. Install the 12V battery

Make sure the negative of battery is connected to the chassis ground! If your engine or vehicle did not have a 12V battery before, and you need add one good charging battery, in this case, you must connect the negative of battery to chassis.

You must connect the negative of 12V battery to chassis ground.

9. Electronic Control Unit.

Install Ecotrons' ECU unit at a suitable place, such as fixed it on the frame.

In order to ensure a high reliability, ECU installation should abide by the following principles:

1. You need to add the thermal insulation between the engine and ECU.

2. Avoid the dirty, wet, and splash water.

3. Avoid ECU supporting harness. Please set harness to avoid damage and

overheating.
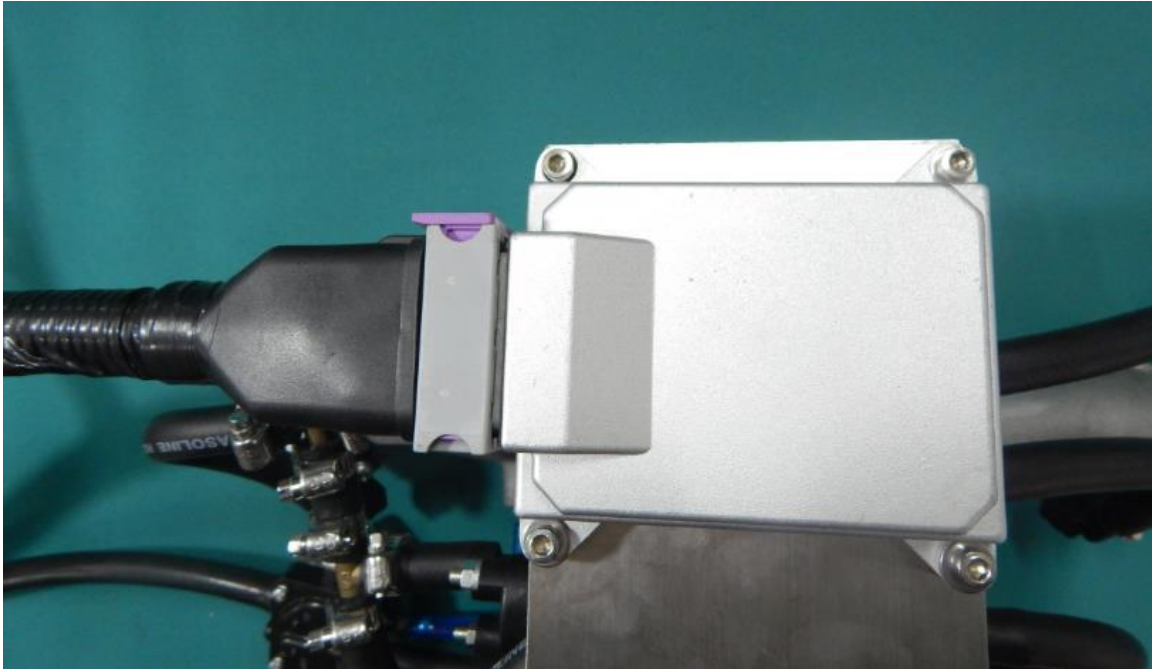
10. Harness Routing

Find suitable locations for the harness, see above the pictures as a reference.

Note: The only wire that can be connected to the +12V directly is the RED 12V+ wire. NONE of other individual wires should be connected to +12V battery directly. Otherwise the ECU could be damaged!

Here is a real harness picture:
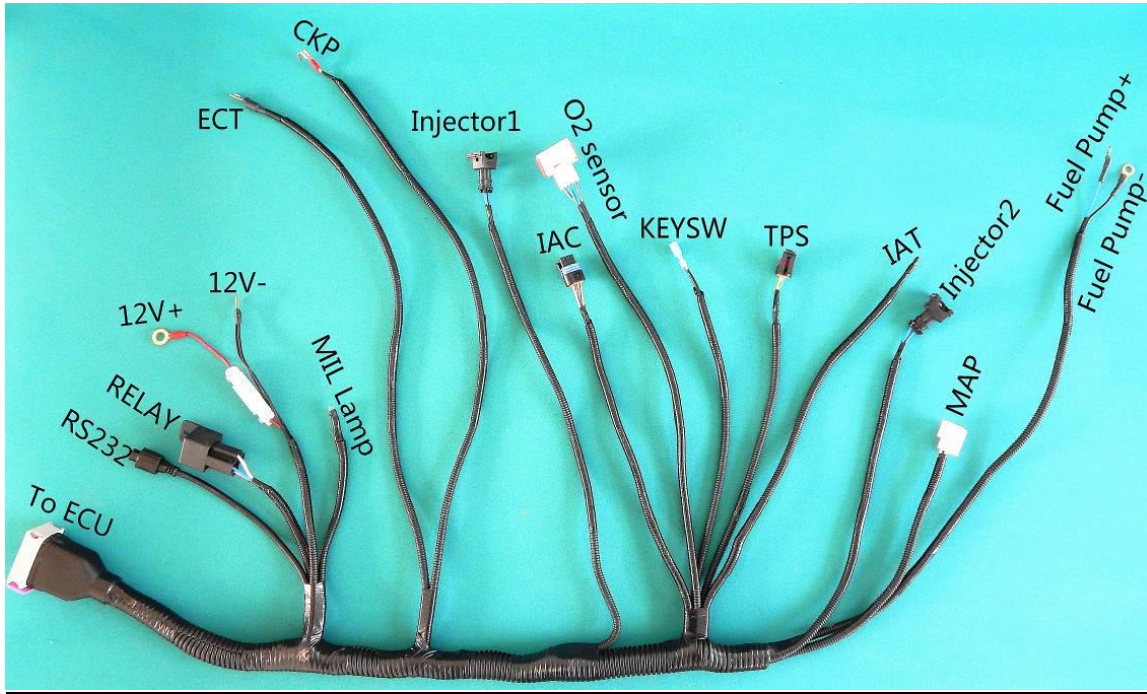
Label descriptions

label	Descriptions	Notes
ECU	Electronic Control Unit	
RS232	Serial comm. cable to a PC computer	
O2 sensor	Oxygen sensor	
Fuel Pump	Fuel pump power and ground	
12V-	Battery 12V-	
12V+	Battery 12V+	
IAT	Intake Air Temperature sensor	
ECT	Engine (Coolant) Temperature sensor	
TPS	Throttle position sensor	
MAP	Manifold absolute pressure	
INJ1	Injector1	
INJ2	Injector2	

CKP	Pick-up signal	Orange
IAC	Idle Air Control Motor	
KEYSW	Key On switch (previously called IGNSW)	Pink
IAC	Stepper motor	
MIL-Lamp	MIL-Lamp	

11. Attach the Injector connector to the injector. Be sure connector is locked in it.
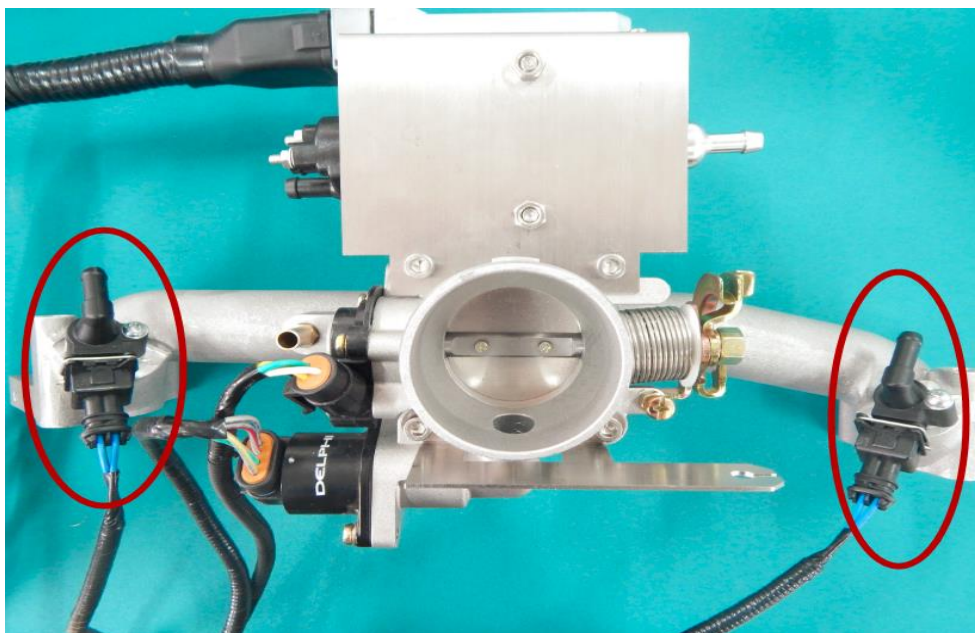
12. Attach the Throttle Position Sensor connector，and the Idle Air Control connector.

Copy rights ECOTRONS LLC   http://www.ecotrons.com
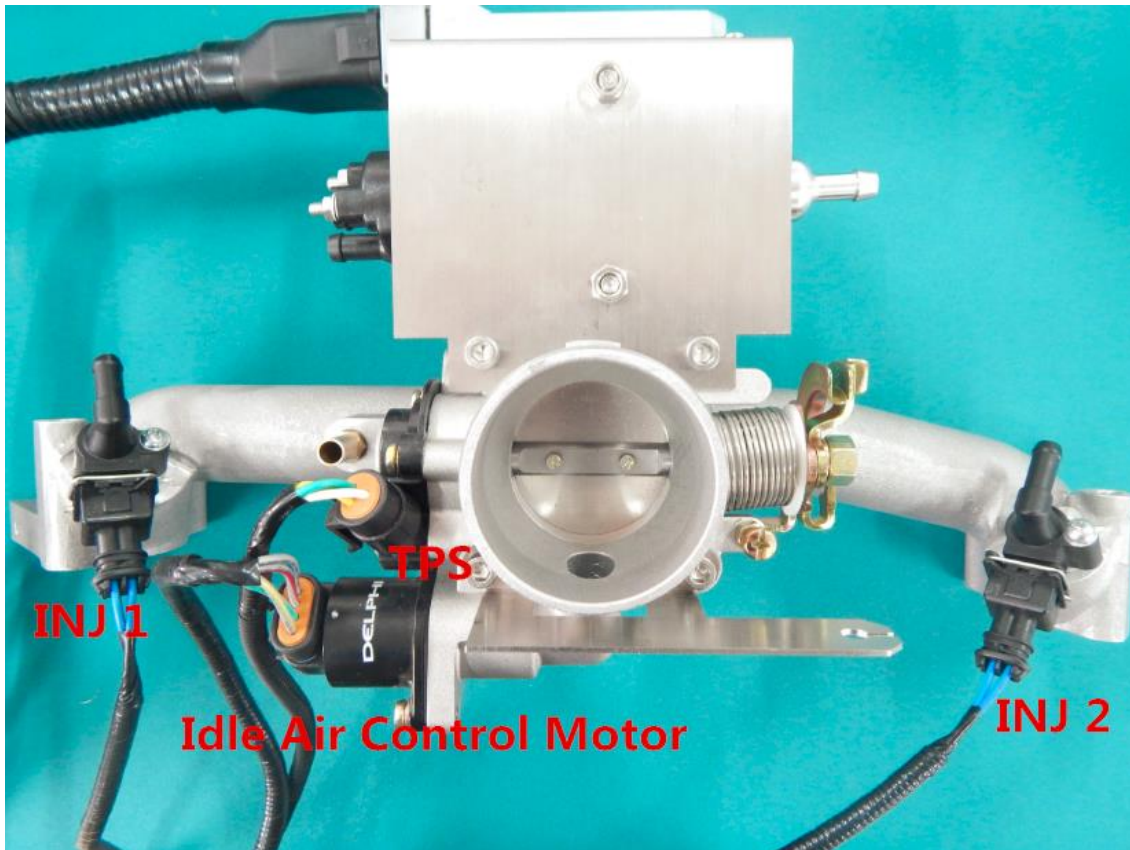
13. Connecting the throttle body inlet to the air hose from the air filter

14. O2 sensor installation.

If your kit includes an O2 sensor, please follow the below steps to install the O2 sensor:

1) Find the correct the location to install the O2 sensor. It needs to be close to the exhaust port, but not too close (3-5" away). Rule of thumb: the O2 sensor can take the advantage of the exhaust heat, so it does not have to be heated all by itself. But you don't want it to be heated too much, because the good temperature range is 300C to 900C.

2) The sensor needs to install with a tilt angle, meaning **the sensor head must point down with certain degree**, see the picture below. Otherwise the condensation could damage the sensor.
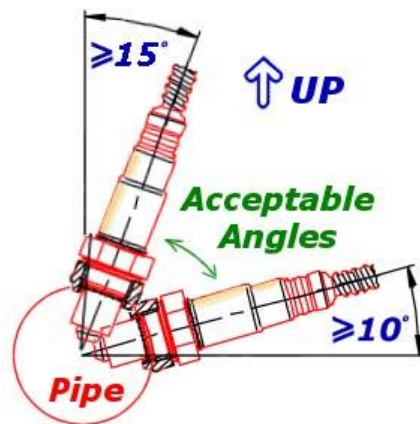
3) Drill a hole on the exhaust pipe. Weld the O2 sensor bung (provided) on the hole. Make sure the sensor head can be fully exposed to the exhaust gas; yet NOT to block the exhaust pipe.

4) Install the sensor in the bung. Connect the O2 sensor cable.

15. Double check and make sure all wires are connected as they should be.

16. You have finished with the initial hardware installation of the Vanguard 993 Ecotrons EFI kit.

Chapter 2 Initial test and diagnostics after the installation

1. Before you do the initial test of the EFI kit, make sure the installation is done as the previous section.
2. Key-on and **KEY-ON ONLY**!
3. You should hear fuel pump noise running for a few seconds, if this is not happening, you must have some wiring problem. Re-check all your wires! If every wire is sure correctly connected, then the ECU may have a problem.
4. If you hear the fuel pump running and then stop, this indicates the ECU is working. Now you can fill the fuel tank with the regular gasoline.
5. Repeat the above step 3 times, to make sure the fuel supply lines are filled up with fuel. No air pocket! No bubbles!
6. Sometime, you have to manually purge out all the air bubbles in the fuel supply system, because it is possible that if the fuel pump itself has a lot bubbles in there, it could not pump fuel at all, it is only spinning like idle without load. In this case the noise of fuel pump is little higher pitch than with fuel pumping. In this case you will not be able to start no matter what, because no fuel pumping. If you have any doubt that the fuel supply system has some air pocket or air bubbles, you can un-plug the high pressure fuel line, pointing it into a bottle, and key-on, you should see fuel sprout out if fuel pump is working and no air bubbles.
7. In many cases, you can visually see the fuel flow out of the fuel pressure regulator and return back to the tank if the fuel supply system is working normally. This is another indication you can check.
8. After you make sure the fuel supply system is working normally, try to key-start the engine.
9. First time you start the engine, there may be still some air bubbles in the fuel

supply system needs to be purged. So don't be surprised that the first start takes longer, or even you need to start multiple times to be successful.

10. If the engine does not start, go to the next section for diagnosis.

11. After the engine starts, if it's rough idling; let it warm up, and let the ECU self-adapting to the engine for a while.

12. After the idle stabilizes, drive the vehicle in a steady state (constant throttles or constant speeds) at different throttle/speeds. Let the ECU self-adapting further.

13. Then you can try different transient conditions, like fast opening of the throttle, etc.

My engine does not start, why?

1) Have you followed the installation manual completely?

1.1) Can you tell that the ECU is controlling the fuel pump?

1.1.1) when you turn on the key, do you hear the fuel pump running for a few seconds, and then stop? If not, you have wiring issues.

1.1.2) Key-off for 3s, and key-on, do you hear the fuel pump running for a few seconds, and then stop? If not, you have wiring issues.

1.1.3) Every time when you try to start the engine (engine spins), do you hear the fuel pump running until engine stalls? If not, your wiring has issues.

1.2) Do you have the fuel pump installed correctly?

1.2.1) is the fuel pump lower than the tank? The fuel pump must be lower than the tank to avoid fuel starvation. The fuel pump can be higher than the injector, if limited by the space.

1.2.2) Have you replaced the "petcock" tank valve with a manual valve? EFI does not work with the petcock that does not have a PRIME position.

1.2.3) Do you have a fuel return line back to the fuel tank? Our EFI kit currently needs a way to return the fuel to the tank.

1.2.4) Are there some impurity in the gasoline? Check your fuel filter.

1.3) Do you have the ignition pick up sensor connected correctly?

1.3.1) Do you have a correct pick up signal input to ECU (CKP wire on the harness)?

1.3.2) Do you have the ground wire of pickup sensor connected to ECU ground wire (GREEN wire on the harness)?

1.3.3) Are you using the stock ignition system (to isolate the starting problem, please use the stock ignition system)?

1.3.4) Can you tell the spark plug is firing whey you try to start?

1.4) Do you install the MAP sensor correctly?

1.4.1) Does the MAP sensor connect to the throttle body tube via the small hose (included in the kit)?

1.4.2) Is there whether the intake air system is air tight (no other way for free air going into the cylinder except through the throttle)?

2) Do you have the MIL Lamp on (if your harness comes with a MIL Lamp installed)? If yes, go to EcoCAL, and choose "Menu → Diagnostics → ECU Diagnostics →" , to get what's the TDC.

3) Install the EcoCAL (coming in the CD, or downloadable from our website):

3.1) EcoCAL does not support Windows Vista at this moment. Please use Windows XP (the most tested environment), or Win7, Win8.

3.2) EcoCAL can't talk to ECU when you finish installing EcoCAL on your computer: please check whether the USB adaptor is fully plugged in computer and whether EcoCAL communication setting is set to USB. More details, you can refer to our EcoCAL User Manual.

Or better: Use an old computer which has a built-in COM port to resolve the USB converter problem.

3.3) Establish the communication between the EcoCAL and the ECU: Menu → Run → Connect; then Menu → Run → Start measuring.

3.4) Read diagnostic trouble codes: Menu → Diagnosis → ECU diagnosis → Read DTC.

4) When the EcoCAL communicates with ECU successfully, please do the below tests:

    4.1) Try to start the engine (with the engine spinning), Read the measurement variables in EcoCAL:

    4.2) Does the signal "RPM" changing from 0 to some value > 300rpm?

    4.3) Does the "Map" signal drops from about 1013hPa to below 600hPa? If either of the above 2 is NO, there are maybe some wiring connecting problems. If both the above are YES, you could have fuel supply issue: air bubbles in the fuel lines, or fuel clogged somewhere.

5) To rule out the problem of the pickup sensor, please do the below tests:

    5.1) Please disconnect both CKP wire and GND wire from the ignition pickup sensor and tape them to make them not short circuit;

    5.2) Please make sure that the stock ignition system is untouched;

    5.3) Try to start the engine, and check the below:

Does the signal "RPM" changing from 0 to some value > 300rpm?

Does the "Map" signal drops from about 1013hPa to below 600hPa?

If either of the above 2 is NO, you could have some wiring problem. If both the above are YES, you could have fuel supply issue: air bubbles in the fuel lines, or fuel clogged somewhere.

With all the above questions and tests done, you cannot figure out why the engine does NOT start yet, please contact us directly:

info@ecotrons.com

Chapter 3 How to install the provided EcoCAL software to your computer?

For details on how to use EcoCAL software, please refer to the EcoCAL User Manual, downloadable here:

www.ecotrons.com/support

Run EcoCAL, you will see below windows:

When you start the EcoCAL at the first time when you finish installation, the EcoCAL will load the Demo files automatically with the default page settings.
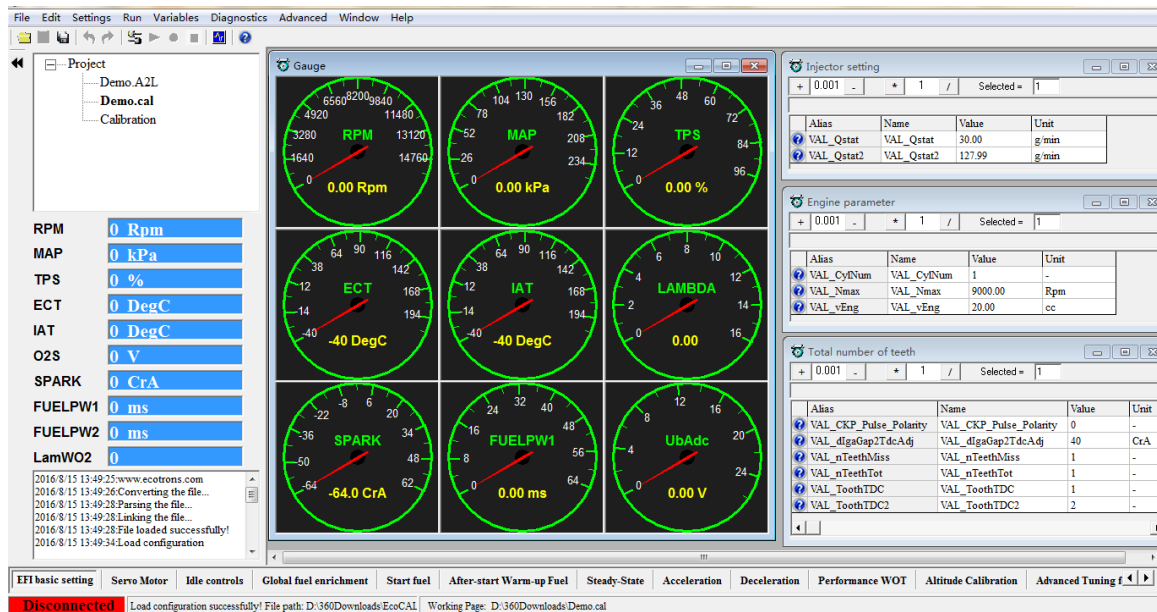
Note: If EcoCAL does NOT automatically load the default configuration, likely you do not have the necessary A2L file and CAL file, in the installation folder of "C:\EcoCAL". You should copy and paste the necessary A2L file and CAL file into that folder, if the folder contains no such files.
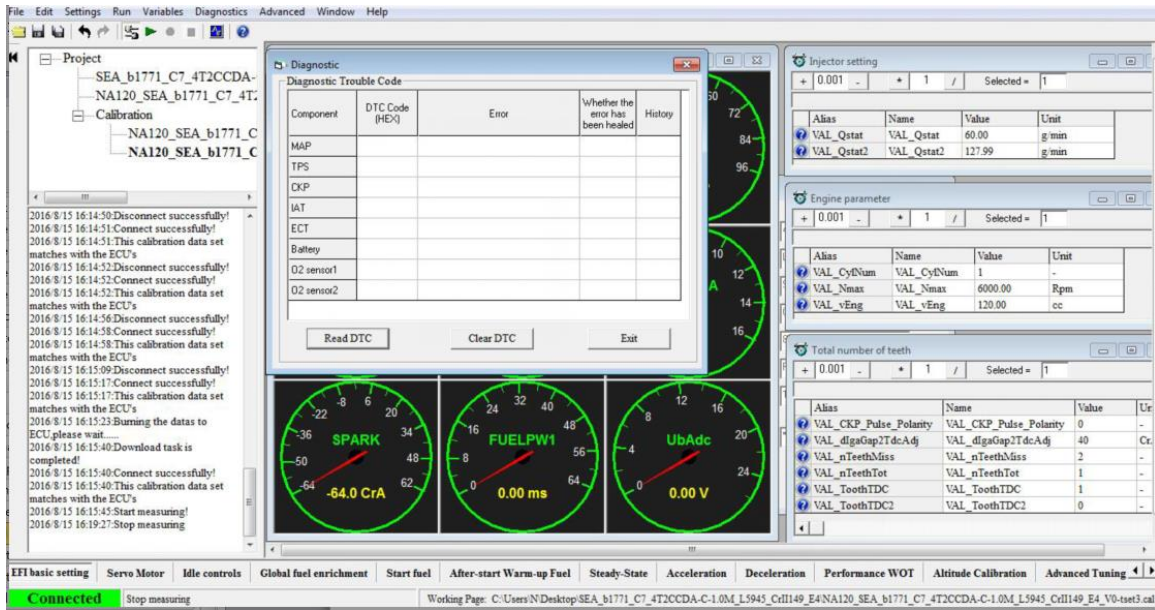
Connect ECU to laptop:

Go to menu->Run->Connect

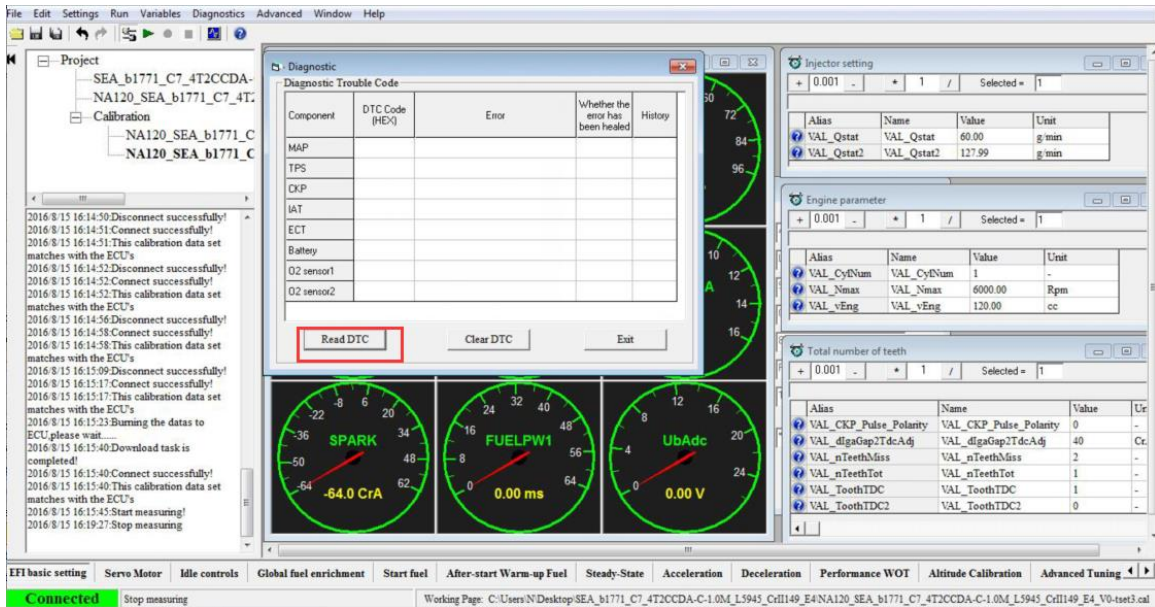You also can use the shortcut button ( ) of "Connect" to Connect to ECU

Read DTC:

Go to menu->Diagnostics->ECU Diagnostics

Click "Read DTC":

Supported DTC list (TBD)
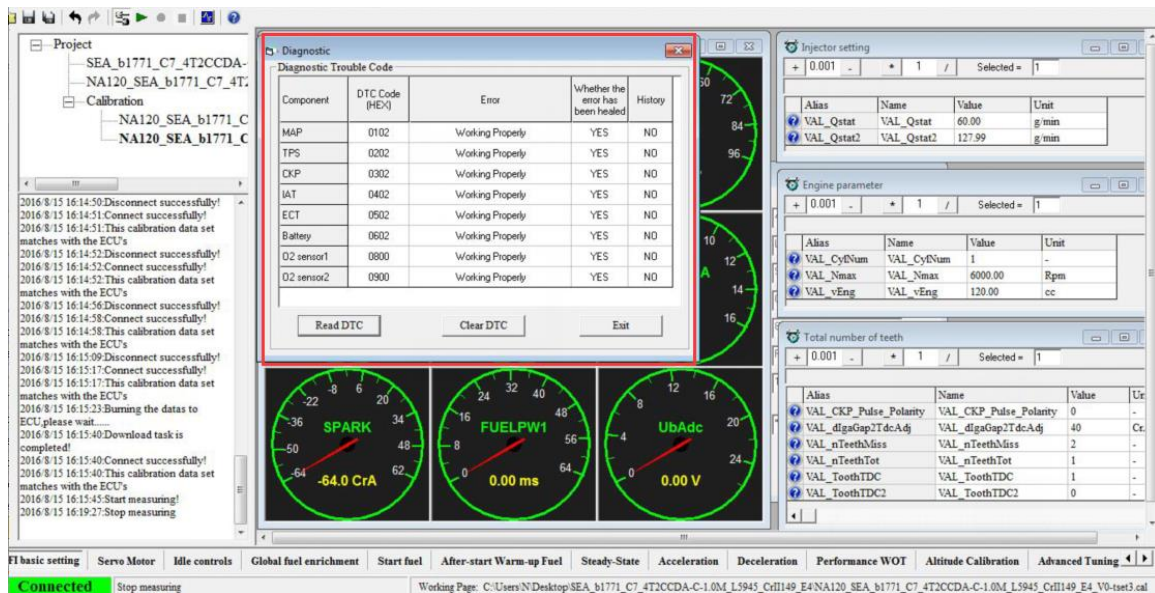
Diagnosis of the communications between your laptop and ECU:

1.1 Check your serial communication cable; make sure the cable is plugged in completely.

1.2 Check your USB adaptor; make sure it is fully plugged into your laptop.

1.3 If your laptop has a built-in COM port (many old laptops have that); you can use the COM port directly without the USB adaptor.

1.4 Go to "Menu→ setting→ communication settings" select correct port: USB or COM port or other.

1.5 Click "Connect" button in EcoCAL.

How to use EcoCAL to log data:

1) Run EcoCAL (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 (the numbers in the window should change now...)

5) Go to menu -> run -> start recording

Start the engine, You must keep your laptop awake all the time for logging.

6) When you done the test, go to menu -> run -> stop recording

7) Go to menu -> Run -> Play Back

8) In Data Analyzer, click "Open", it will pop up a window, show the folder: "xxx\record"; that's where the logged files are.

Or you can go to: "**C:\EcoCAL\Record**"

9) When you click down the button, EcoCAL will record the data automatically. And save the record file at the installation path of EcoCAL, "C:\EcoCAL\record", and it is named with the time of recording. For example, the record named "2015-7-25-9-31-35-986" is the record file in record. If you need us to help you on tuning, please send the recorded files to us. (**Don't change the file names**).

Appendix I: Wiring harness diagram

12V+ · GND · GND

GND-A · CKP · OPTIONAL

ROUT · VIGN · KEYSW · KEYSW

KEYSW

VIGN · GND

GND-A · SWITCH

GND-A · TXD · RXD

VCC · MAP · GND-A

P1 · P8
P16 · P9
P17 · P24

OPTIONAL · VIGN

INJ1 · VIGN

VCC · TPS · GND-A

IACD · IACC · IACB · IACA

GND-A · ECT

GND-A · IAT

O2IN1 · GND-A · VIGN · O2HOUT1 · INJ1
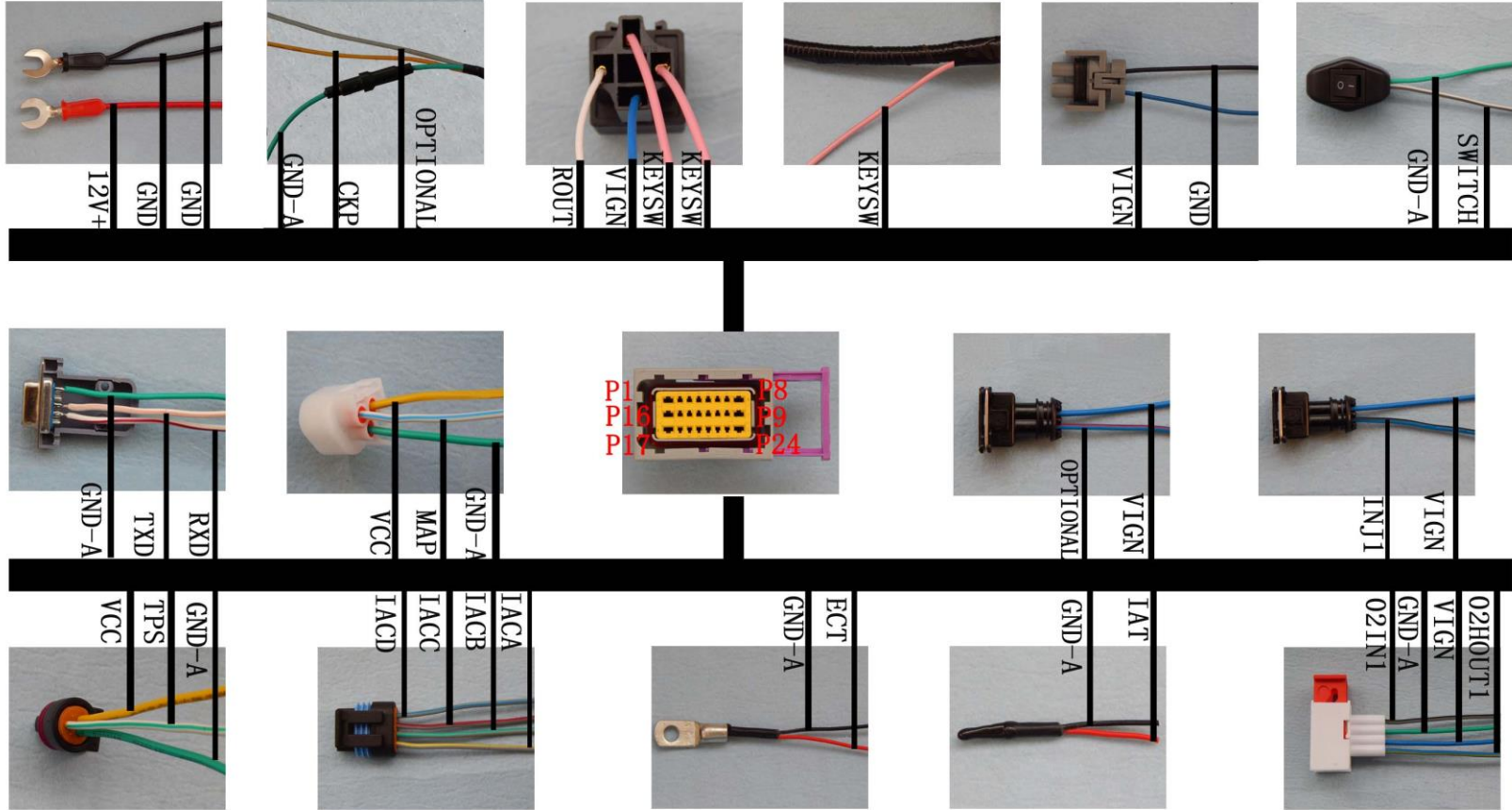
Appendix II: ECU main connector pin-out definition

Pin NO.	Component	Color	Description
P1	O2HOUT1	Blue yellow	O2 Sensor #1 Heater LS Driver output
P2	12V+	Red	Reverse Battery Protected Supply
P3	GND	Black	Power Ground
P4	VCC	Yellow	+5V Volt Supply Output
P5	RXD	White red	Sent Data to RS232
P7	TPS	White green	Throttle Position Sensor input
P8	GND-A	Green	Analog Ground
P9	IACA	Gray yellow	Idle Air Controller A
P10	MAP	White blue	Manifold Air Pressure Sensor Input
P11	IACD	Gray blue	Idle Air Controller D
P12	TXD	White pink)	Receive data from RS232
P13	IAT	White yellow	Intake Air Temperature Sensor
P14	KEYSW	Pink	Key On Switch
P15	INJ2	Blue red	Injector #2 LS Driver Output
P16	INJ1	Blue black	Injector #1 LS Driver Output
P17	GND	Black	Power Ground
P18	MIL_LAMP	Gray	Malfunction Indicator Lamp

P19	IACC	Gray red	Idle Air Controller C
P20	ROUT	White	Power relay LS Driver output
P21	ECT	White brown	Engine (coolant) Temperature sensor
P22	IACB	Gray green	Idle Air Controller B
P23	O2IN1	Gray black	Oxygen Sensor #1 input
P24	CKP	Orange	Crank Position Sensor (connect igniting pickup sensor signal)