SE-EFI

Small Engine Electronic Fuel Injection
– Conversion Kit

Suzuki DR-650

Installation Manual

ECOTRONS LLC

V1.3

Note: this manual is written based on a conversion with a Suzuki DR-650 engine, but it can also be used as guidelines for other similar engines. Some common sense shall be used to convert different engines. If you are not sure about any specific details, please contact us at info@ecotrons.com.


www.ecotrons.com
Harness
ECT
IAT
ECU
CDI --ECU controlled
USB-RS232
Communication Cable
Throttle body &
Fuel injector
Software-CD
Tank tap
MAP Sensor
Fuel return
line
Fuel pressure
regulator
Fuel pump
Oxygen Sensor
High pressure fuel line
Fuel filter
T-pipes

SE-EFI Kit

Introduction

SE-EFI is an Electronic Fuel Injection conversion kit for small engines. This install procedure is a customized version for the Suzuki DR-650. 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
- High fuel efficiency and low carbon emissions
- Decel-fuel-cut-off
- OBD - on board diagnosis
- Performance tuning for advanced users.

Parts:

1. ECU
2. Harness (including the connectors)
3. Throttle Body and Intake manifold Assembly
    - Throttle body (including TPS sensor and IAC motor)
    - Intake manifold (include the injector mount)
    - Fuel injector
4. Fuel pump assembly
    - Fuel pump (outside of the tank)
    - Fuel pressure regulator
    - Fuel filter
    - High pressure fuel line
    - Fuel hoses T-Pipes Clamps

5. MAP sensor
6. Engine temperature sensor
7. Intake air temperature sensor
8. Serial communication cable (to a computer)
9. USB adaptor – included
10. Oxygen sensor and bungs (optional)
11. CD for tuning software (downloadable from our website)
12. CDI – ECU controlled (optional, you can use your own CDI).
13. Ignition Coil – Either CDI driven or ECU driven inductive type coil (optional)

Note: **the kit needs 12V charging system for power supply.** The charging requirement is 4.5A current max or 70W power as the minimum. This kit may need tuning to achieve some desired results.

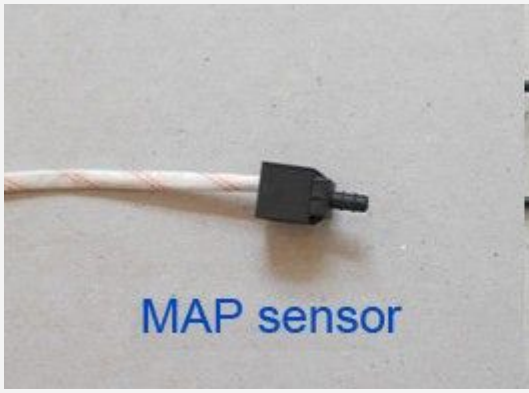
Though the EFI is meant to reduce the emissions than a carb system, this kit is not certified for any emission regulations. It is the user's responsibility to find out whether it's legal to use it.

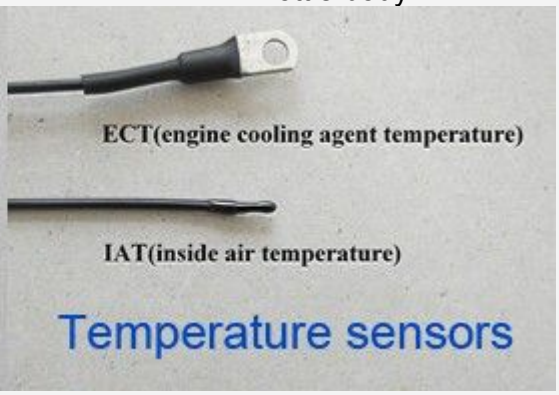
Major components:

ECU

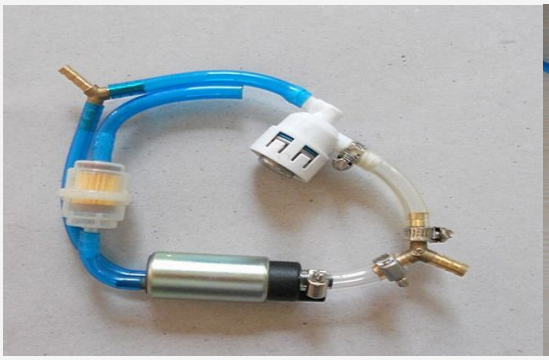
Harness

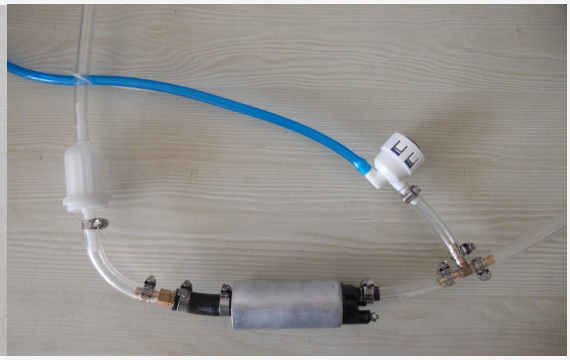
Throttle body





MAP sensor Temperature sensors





Small fuel pump Medium fuel pump

Fuel pump assembly

Installation Procedures

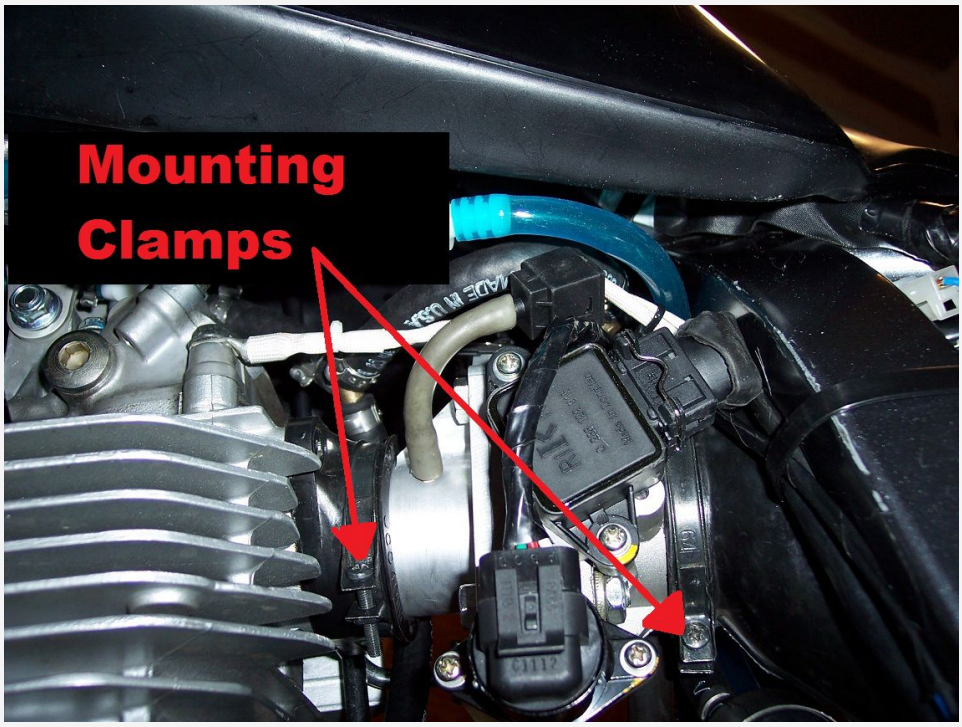
1. Replace the carburetor with the throttle body assembly

1.1 Remove the carburetor from the motorcycle;

1.1.1 Remove side covers, seat and fuel tank.

1.1.2 Disconnect and remove the battery.

1.1.3 Disconnect throttle cables from BST carburetor.



1.1.4 Loosed and remove the two carburetor mounting clamps.

1.1.5 Loosen and remove the 3 bolts holding the airbox in place. Slide the airbox back

1.1.6 Remove the carburetor and it's breather hose.

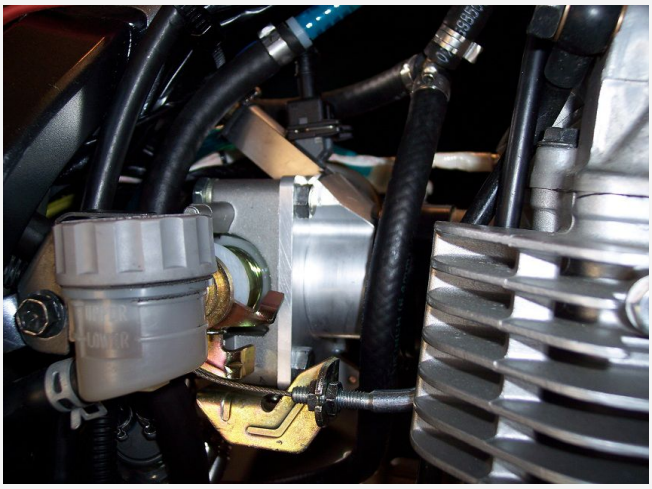
1.1.7 Disconnect the rear brake reservoir from the RH frame.

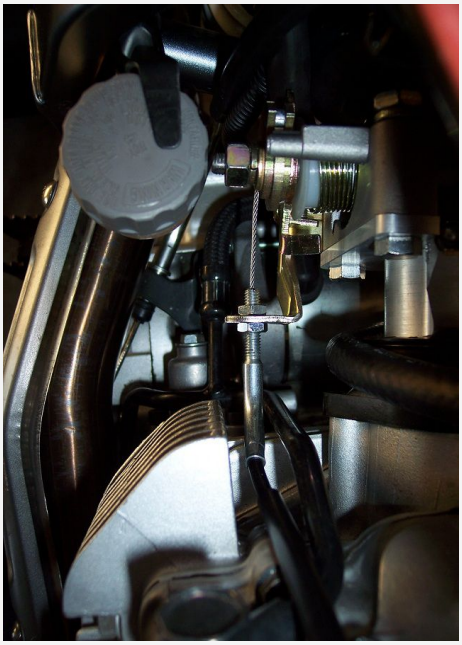
1.2 Install the new throttle body and the new intake manifold assembly:

1.2.1 Make sure intake and bell boot are fully seated. Re-install 3 bolts holding airbox in place and tighten clamps.

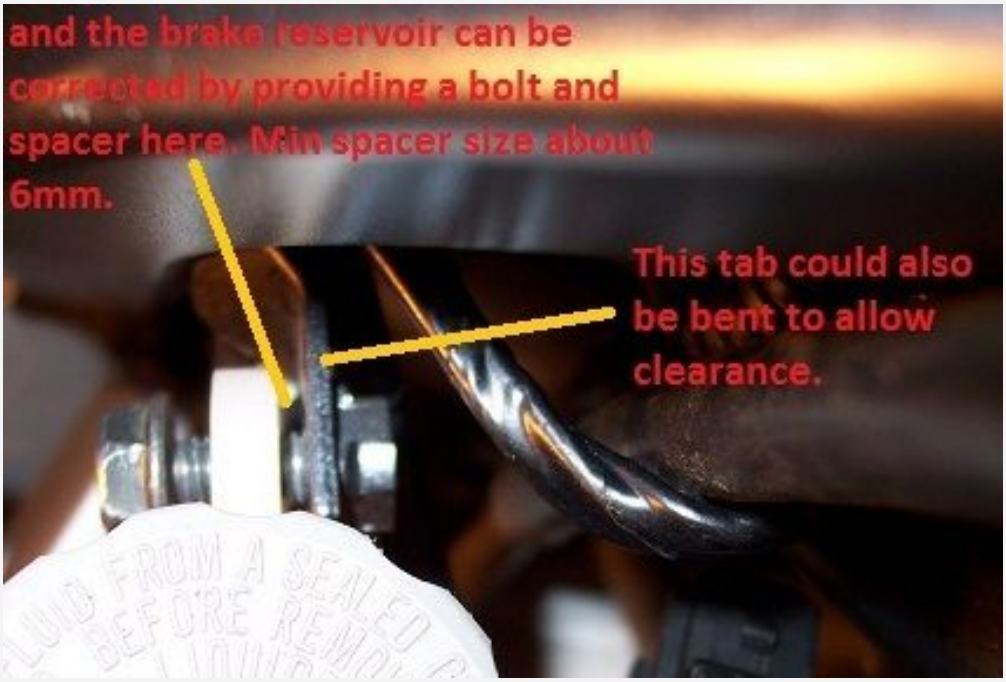
NOTE:
[An install video covering step 1 may be seen here:
http://www.youtube.com/watch?v=00CX8qCOUcw

1.2.2 Install the throttle cable. The Ecotrons 42mm Throttle Body only uses one pull throttle, and relies on the strong returning spring for throttle closing; so you may remove the “push” cable from the twist grip on the handlebar. Adjust for slight play.



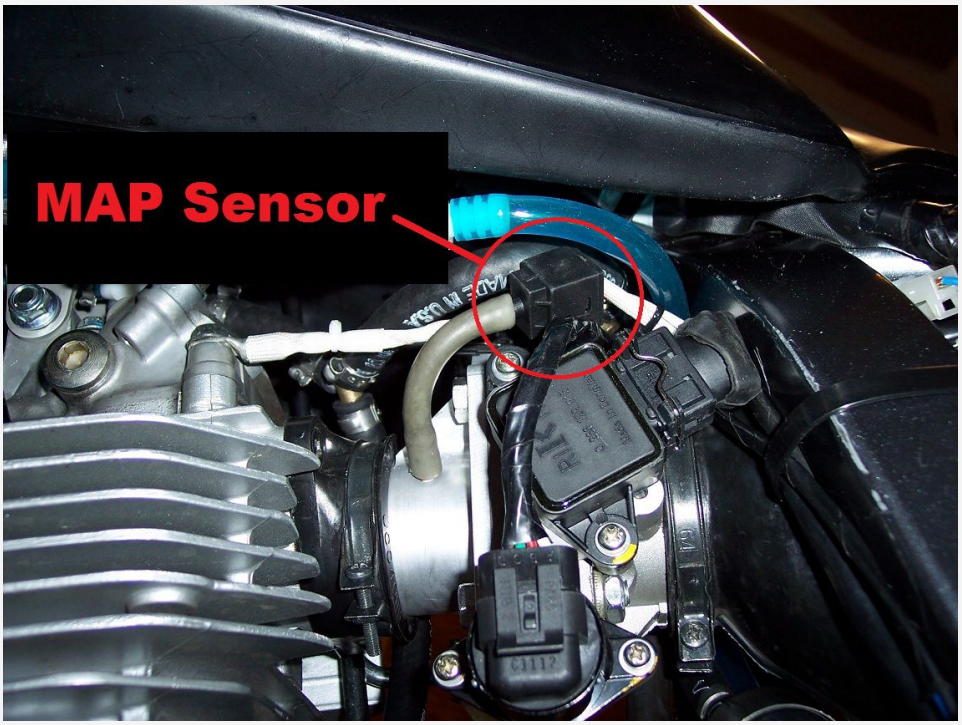


NOTE:
There is a clearance issue with the rear brake fluid reservoir, but that may be addressed by bending the mounting tab out slightly.



1.2.3 Find a secure place to install the MAP sensor, see the picture (a tie-wrapper can do the job).

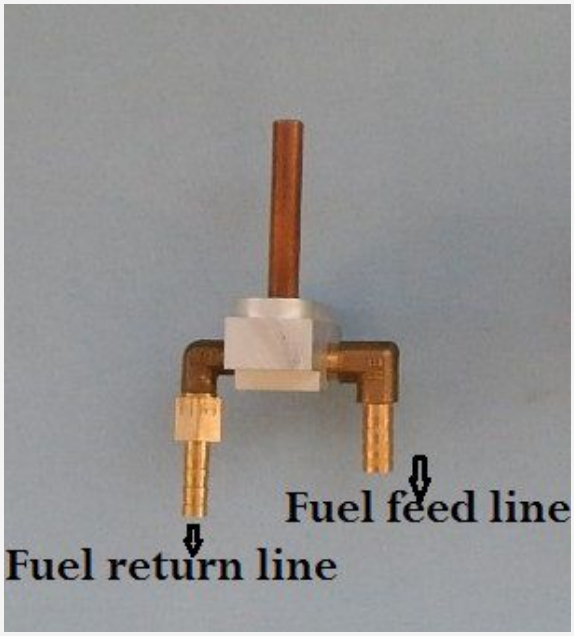
1.2.4 Connect the MAP sensor to the intake manifold with the small pipe (4mm diameter), sample picture:



the example to install the MAP sensor

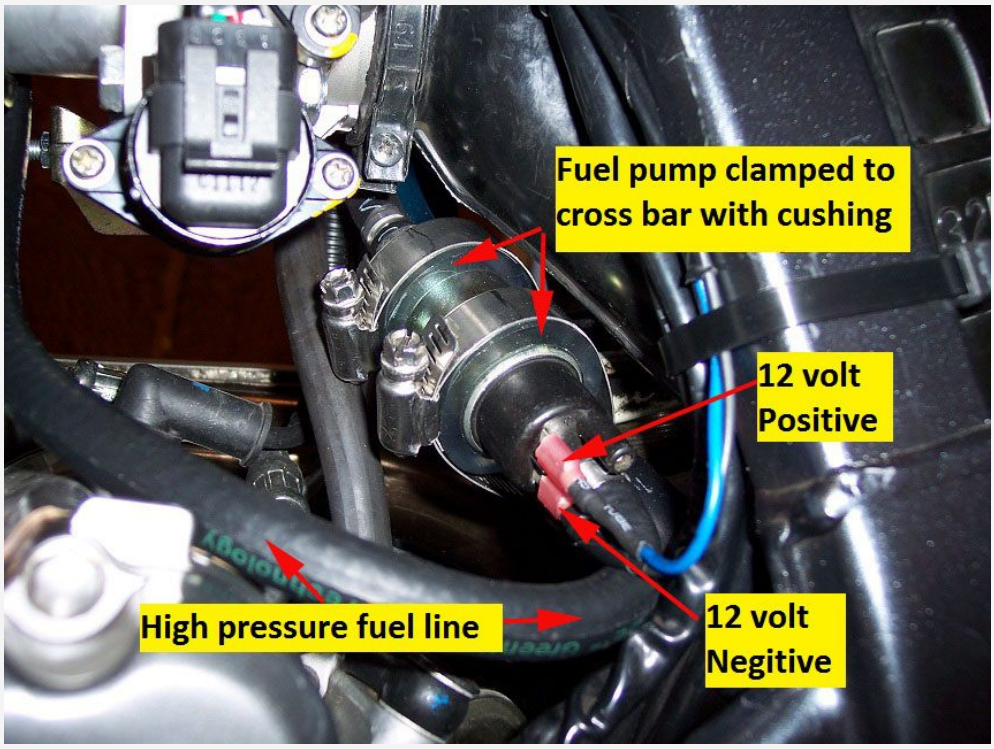
2. Fuel tank modification

This kit has a fuel return line which needs to be somehow feed-back to the tank. We now have a fuel tap for the DR-650. It has a feed-tube and return-tube built-in. The fuel tap replaces the stock petcock seamlessly. Use existing hardware to mount and reuse the stock gasket to seal.



3. Install the fuel pump assembly

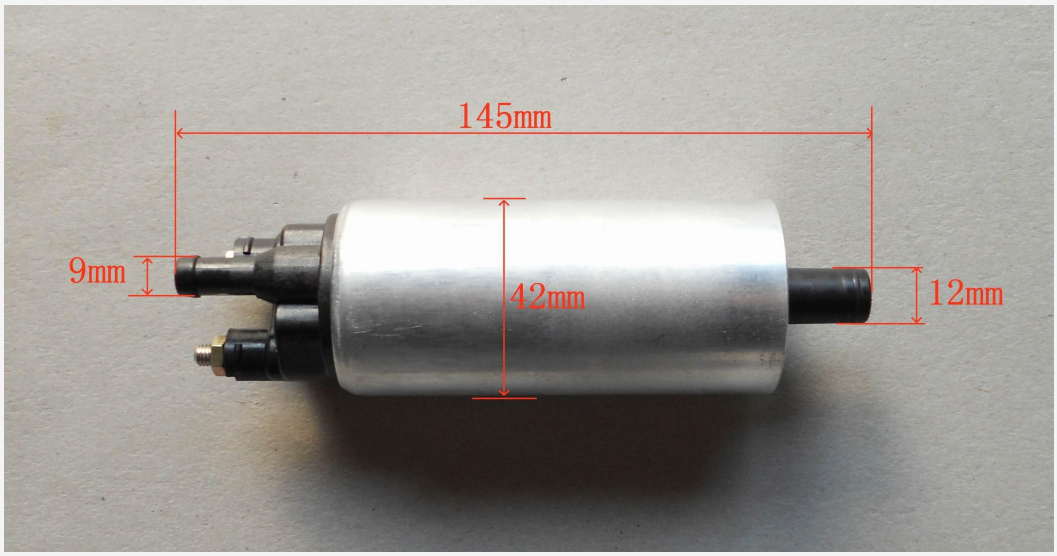
3.1 Find a **safe place** to install the fuel pump: it should be between the fuel tank and the throttle body, so that both the fuel feed line and the fuel return lines can be short; and it should be tied to the inside of the frame, so that it is protected by the frame. It should NOT be exposed to any external scratch or bump. It should not touch the ground when the motorcycle lies on the ground.



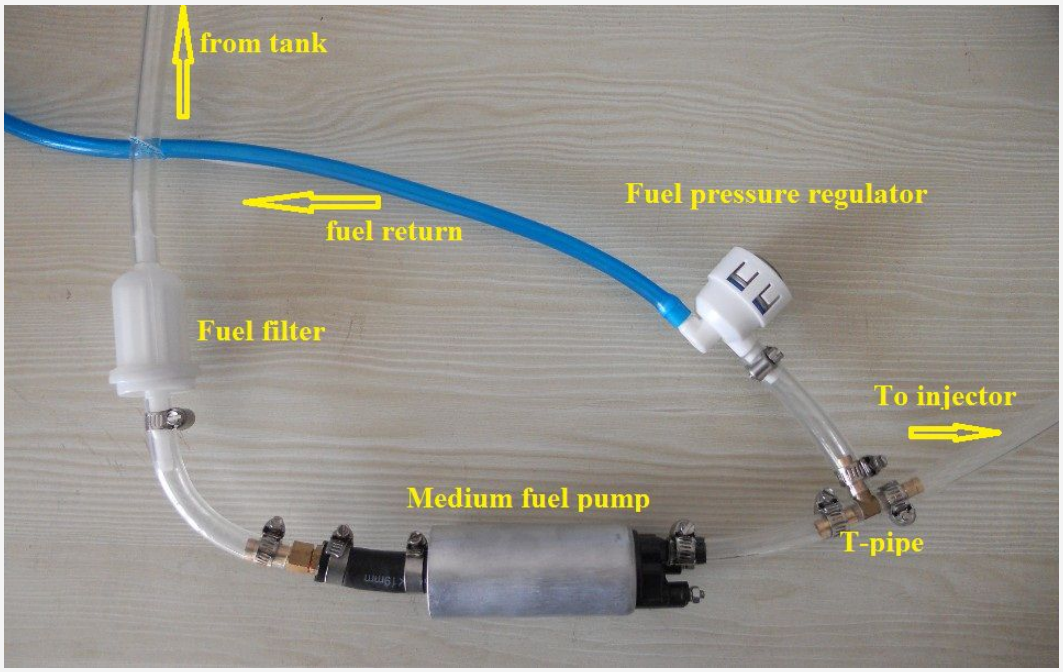
3.2 Connect the fuel feed line from the fuel tank outlet to the inlet of the fuel filter (fuel filter, by default, has been connected to the inlet of the fuel pump).

3.3 Connect the high pressure fuel line from the fuel pump to the fuel injector, which is located on the intake manifold or throttle body.

3.4 Note, 400-800cc EFI kit uses the medium size pump. It does not have fuel bubble port. Only one inlet, one outlet



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



Note:

- **The correct order** of fuel supply components should be (from high to low locations):
  Tank → fuel filter → Fuel Pump
  The fuel pump must be lower than the lowest point of the fuel tank.

See Appendix II (Fuel supply system schematics)

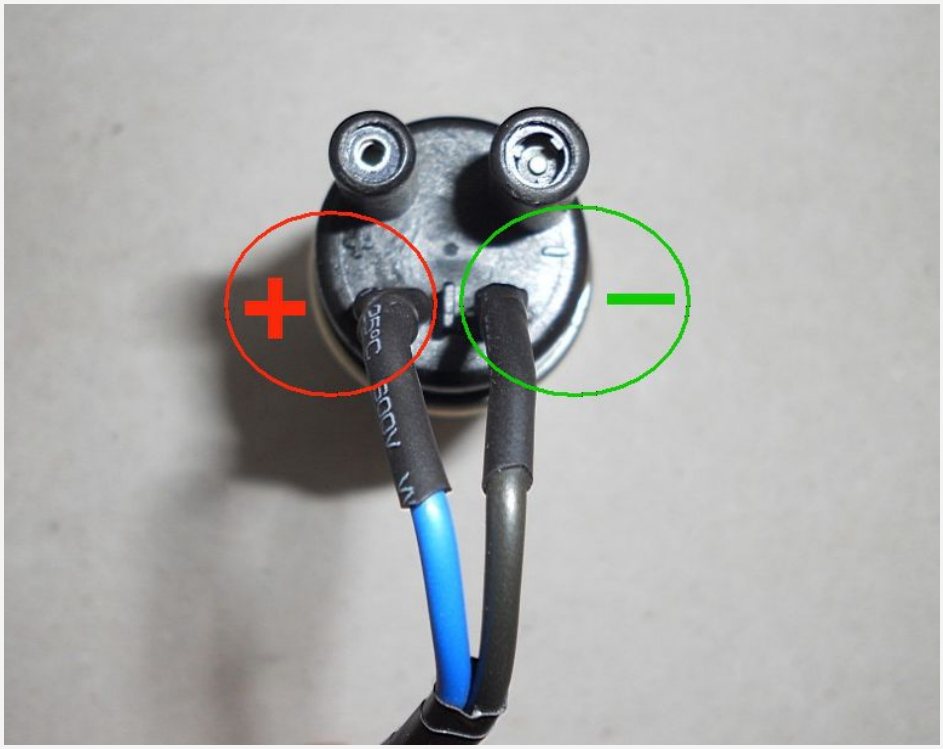
Fuel Pump wire connection

There are so far 2 types of fuel pumps supplied by Ecotrons. Small size and medium size.

Small fuel pump has a flow rate of 25L/H, it is suitable for 150cc, 250cc, up to 400cc engines. It may also run with smaller engines like 50cc, with some excess.

Medium pump has a flow rate of 45L/H, and it is suitable for 400cc up, like 650cc, 800cc and even 1100cc engines.

Both fuel pumps have 2 electrical terminals, and they are driven by 12v power. One terminal is “+” and one is “-“. There are 2 wires on the harness to be connected to the fuel pump. The “**BLUE**” wire is for the “+”; and the “**BLACK**” wire is for the “-“. As shown in the below pictures:



Small fuel pump terminals

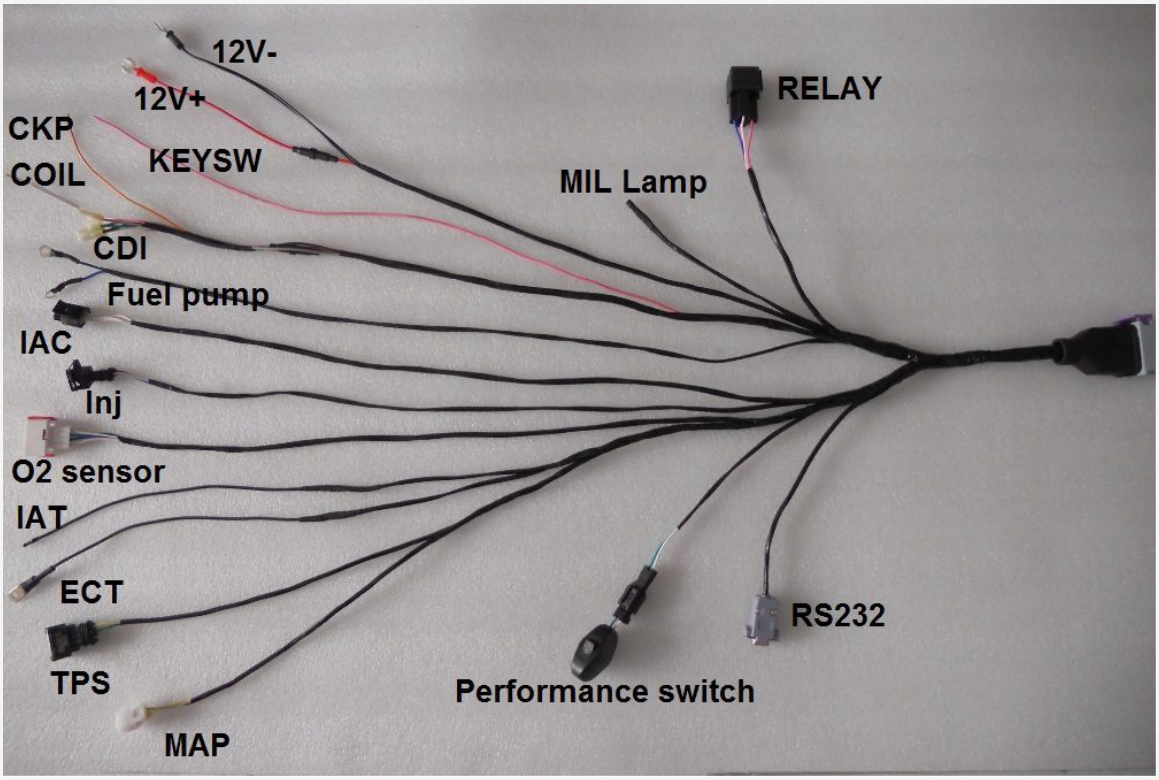
Medium fuel pump terminals

Note: For DR650 EFI system, we use the medium fuel pump

Section 2: Install ECU harness

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

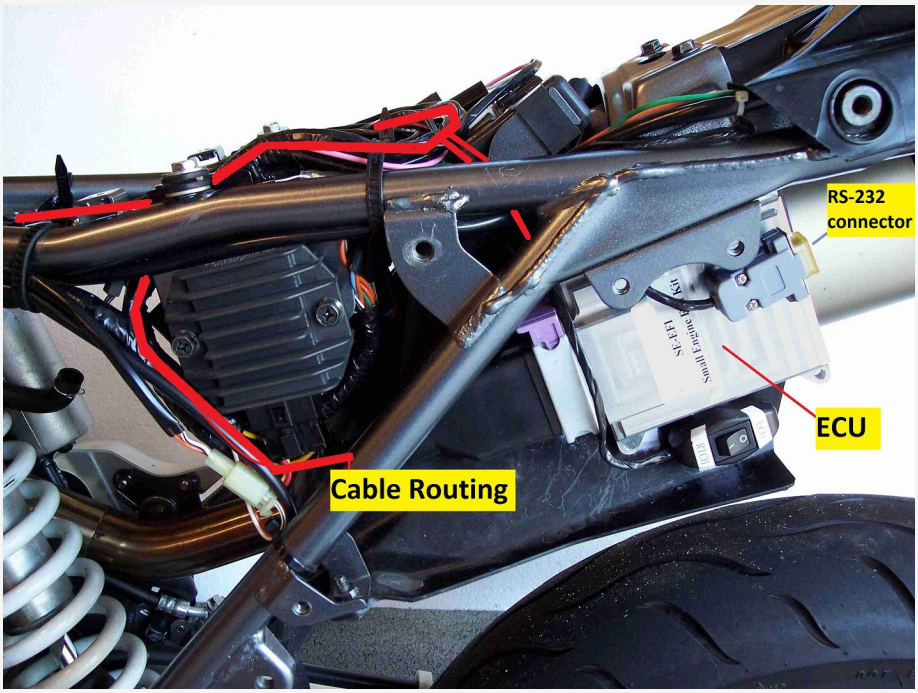
label	Descriptions	Notes
ECU	Electronic Control Unit	
RS232	Serial comm.cable to a PC computer	
O2S	Oxygen sensor	
Fuel Pump	Fuel pump power and ground	
12V-	Battery 12V-	
12V+	Battery 12V+	
IAT	Intake Air Temperature sensor	
ECT	Engine (Coolant) Temperature sensor	
Performance switch	Manual switch to select fuel tables: ECO mode vs. Rich mode	
TPS	Throttle position sensor	
MAP	Manifold absolute pressure	
INJ	Injector	
CKP	**Crank Position sensor Connect to Ignition pickup wire** (also called **VRS before**)	**Orange**
CDI-Ctrl	CDI control output from ECU	**Gray**
GND	Ground (previously called Analog Ground)	**Green**
KEYSW	Key On switch (previously called IGNSW)	**Pink**

Note: the wire color scheme may be different for old versions. If your harness looks different than the one in the picture, please contact us for exact wiring info.

Note: some abbreviations and gloss have been changed compared to previous versions:
CKP = VRS
CDI-Ctrl = CDI-PG (pulse generator)
GND = AGND
KEYSW = IGNSW

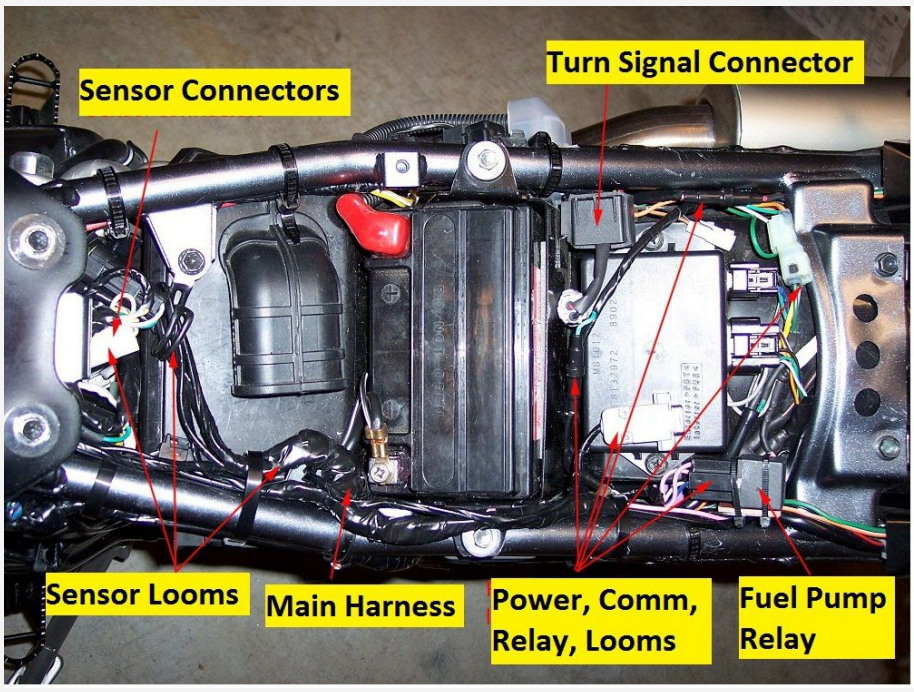
4 Electronic Control Unit

Mount Ecotrons ECU unit in suitable location.



5 Harness Routing

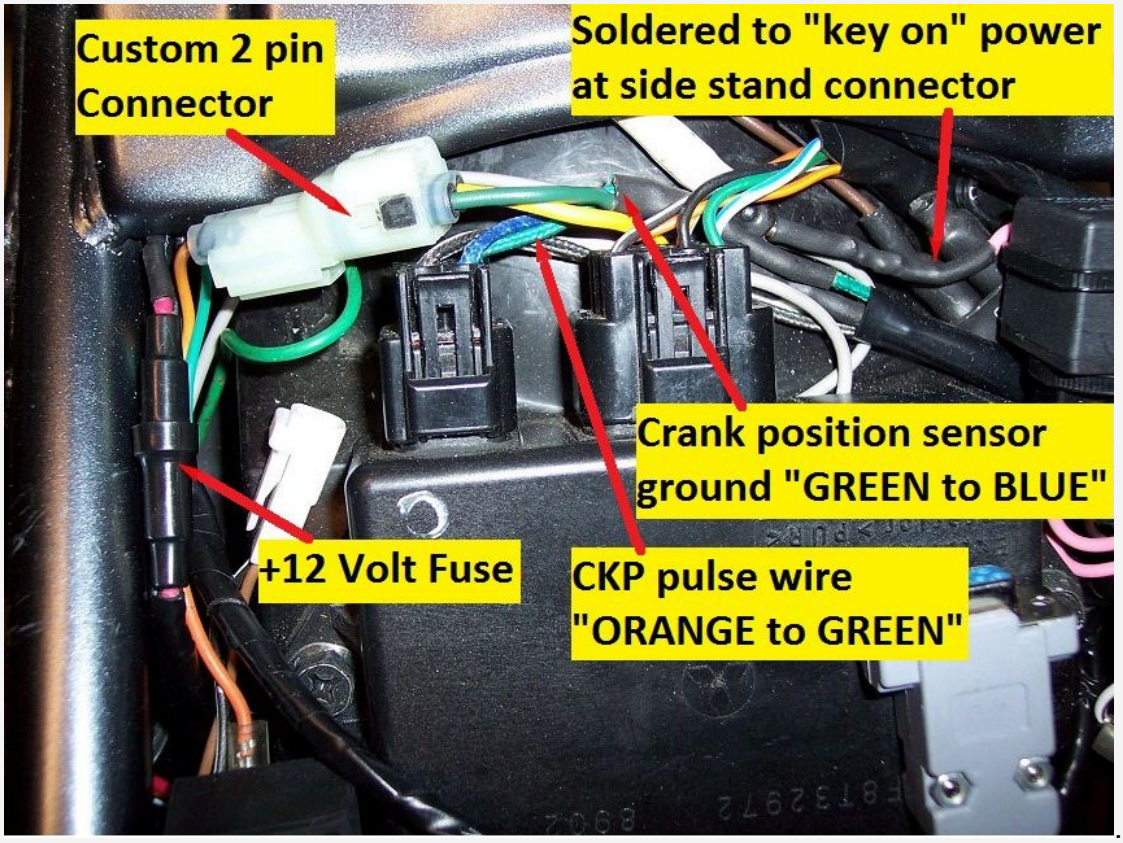
5.1 Route harness from ECU up beside airbox to battery box area. Separate wires so sensor wires go forward and all others go to the rear.



5.2 Find suitable locations for the fuel pump relay and mount securly.

6. Ignition pickup sensor wire splices

Identify the "**Ignition pickup sensor Signal and GND**" on your CDI box, refer to the below picture. Most CDIs use a small pickup sensor which is installed on the crankcase, next to the flywheel, as the trigger source. There is one metal tab / tooth (some engines have two), on the flywheel external surface; and when this metal tab passes by the pickup sensor, 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. For the DR-650 there are 2 wires coming out of this pickup sensor. One is trigger signal wire, the other is grounded. The trigger signal wire is the cloth covered **GREEN** wire. The grounded one is the cloth covered **BLUE** wire. To tell which wire is the **ignition pickup sensor wire** and which is the sensor **GND** wire on the connector of CDI, refer to the below picture.



6.1 Tap the "**Ignition pickup sensor wire**" (**GREEN** wire) with the ECU **CKP** wire, (**Orange** wire on the ECU harness); and then secure the splice with electrical tape or better solder it. This wire is the ignition pickup signal (or as we called it, the Crank Position sensor – also called VRS, variable reluctant sensor, before);

6.2 Tap the "**Ignition pickup sensor GND**" (**BLUE**) with the ECU **GND** wire (**Green** wire on the ECU harness).

7. KEY ON Switch

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.

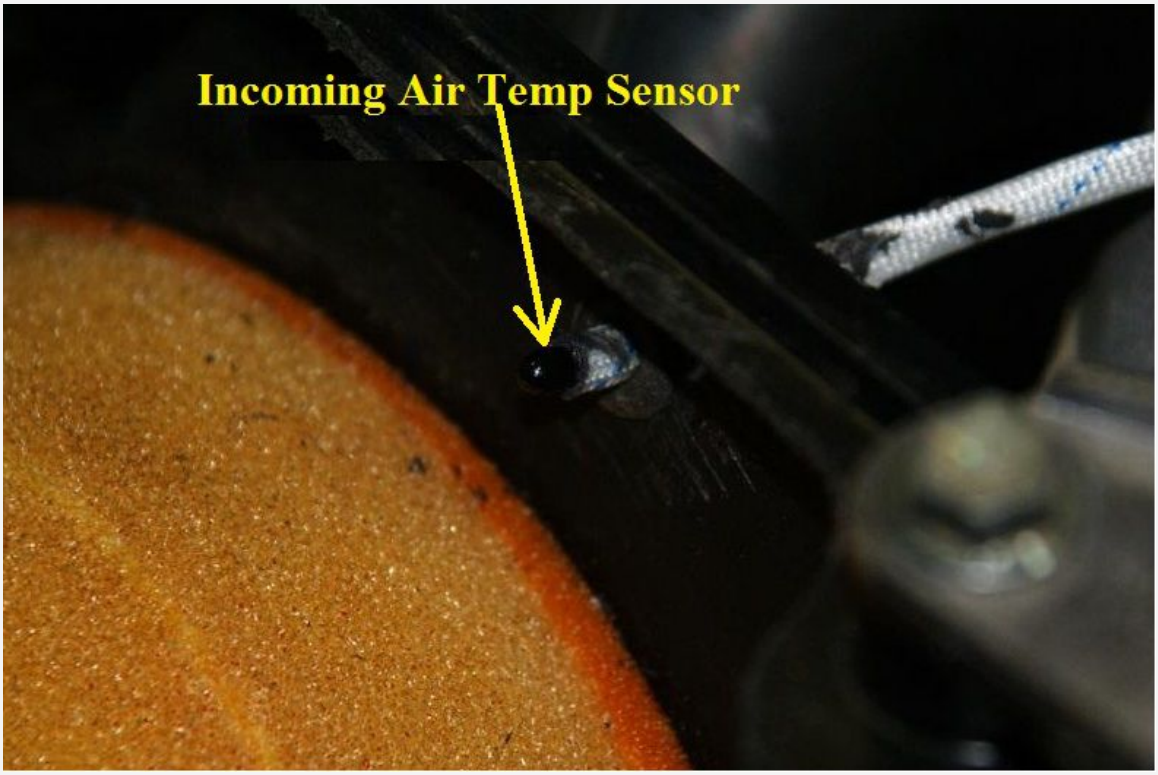
NOTE: For my DR-650 project I used the wire from the side stand switch (see above photo).

8. Route the connectors for the injector, sensors, and FP power wires

Under the front seat tab and feed them down to the Throttle Body.

9. Find a location to install the Intake Air sensor.

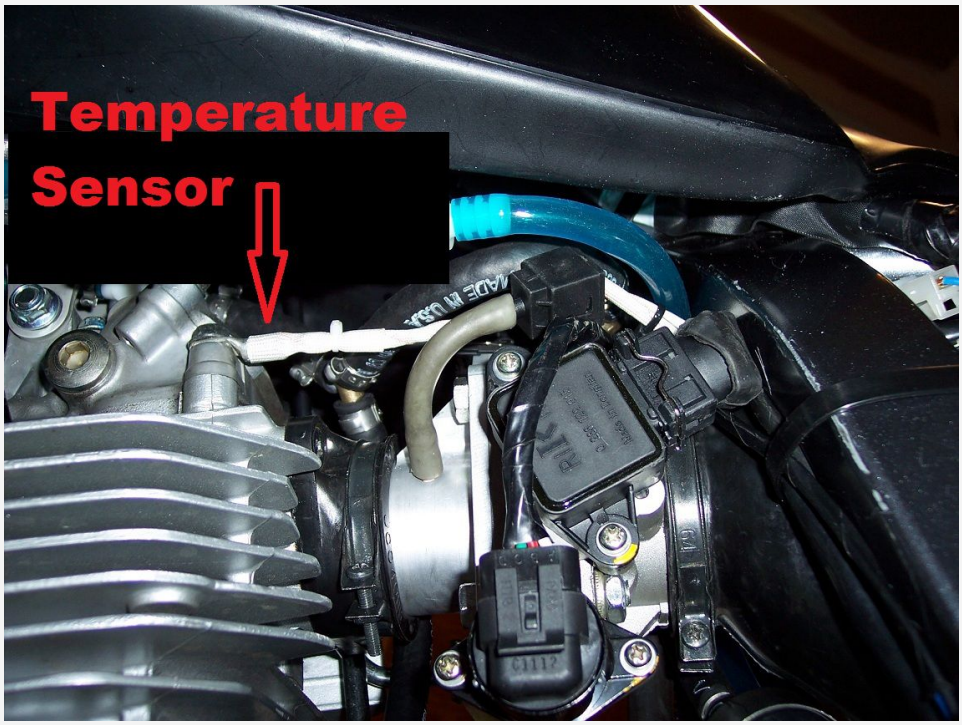
It can be between the Throttle Body and Air Filter, or any convenient location where the intake air flows by. Drill a small hole and insert the Sensor. Bond with silicon sealer or other sealing agent.



10. Install the engine temperature sensor.

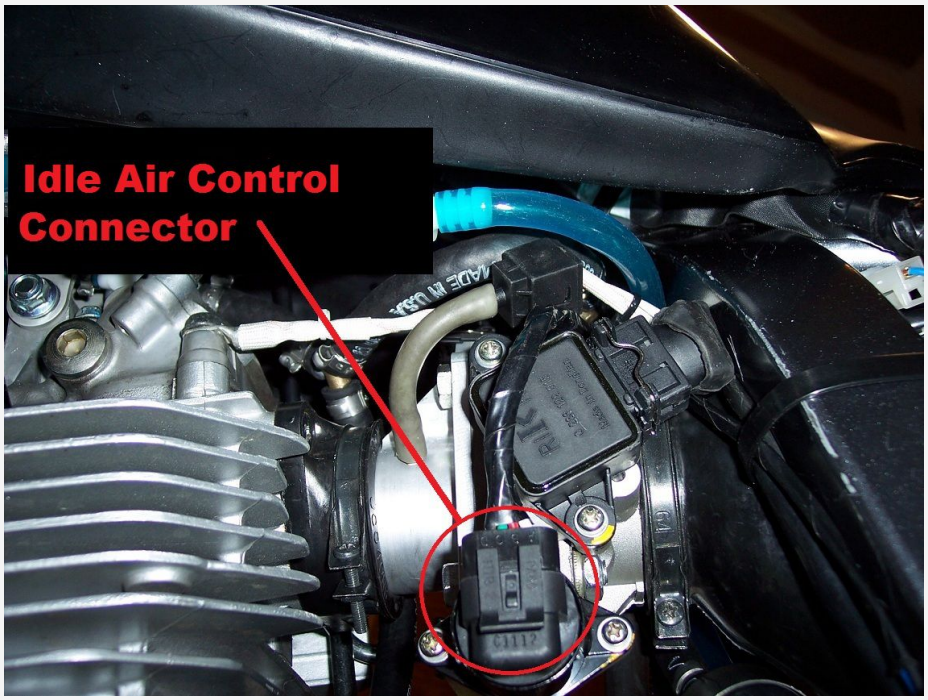
Find a place on the cylinder header, where it has the lowest air flow (usually the backside of the engine), attach the sensor to a bolt and fix it.

Note,: This location is critical. Avoid the cold air blowing the sensor; otherwise, your sensor reading could be misleading!



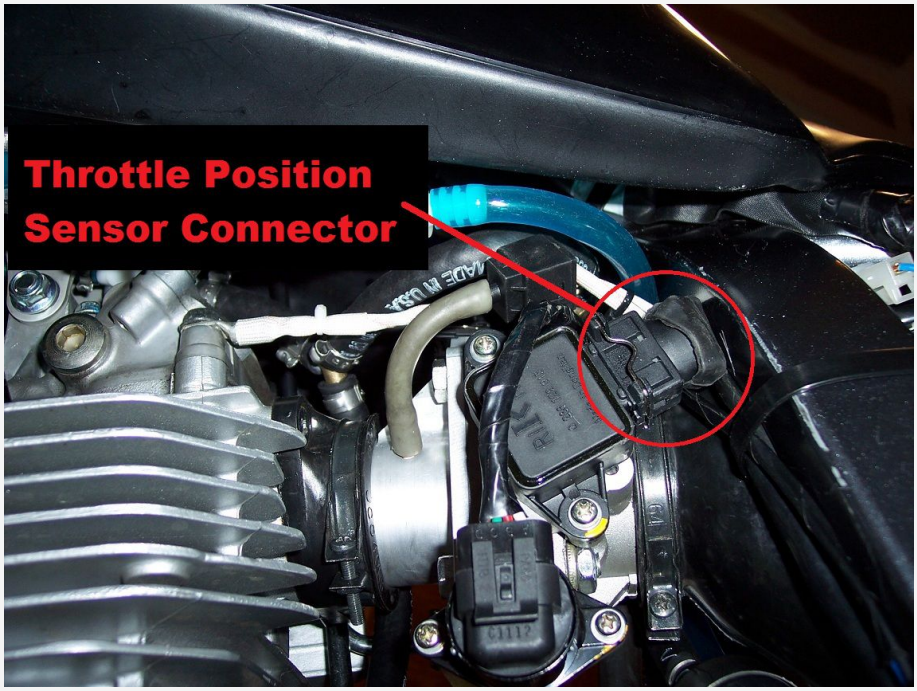
11. Attach the Injector connector to the injector. Be sure connector locks in place.

12. Attach the Idle Air Control connector.

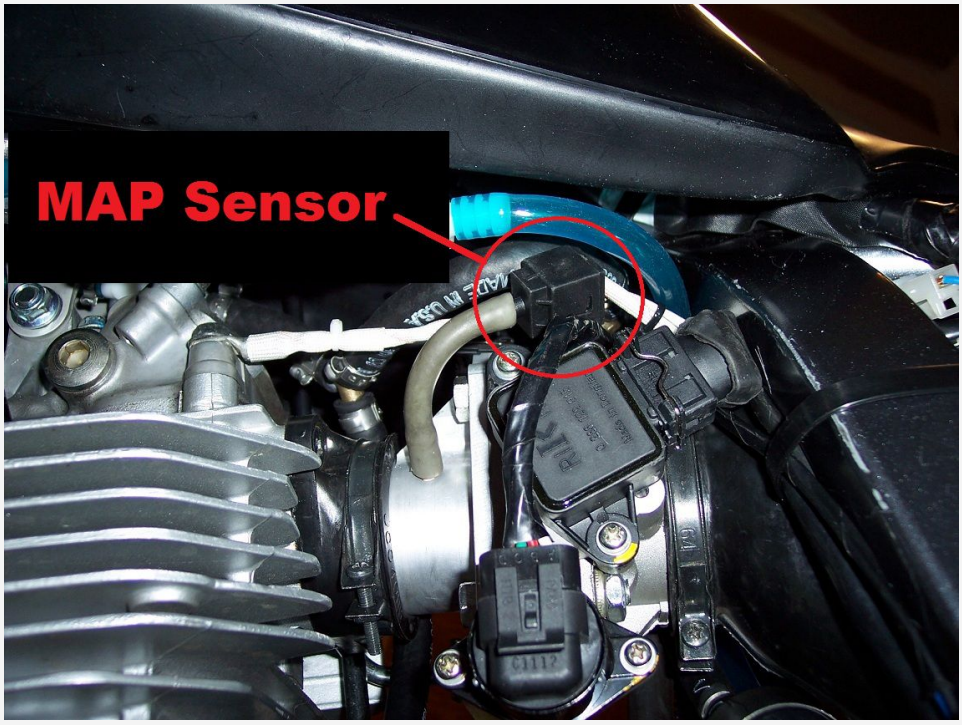


13. Attach the Throttle Position Sensor connector.

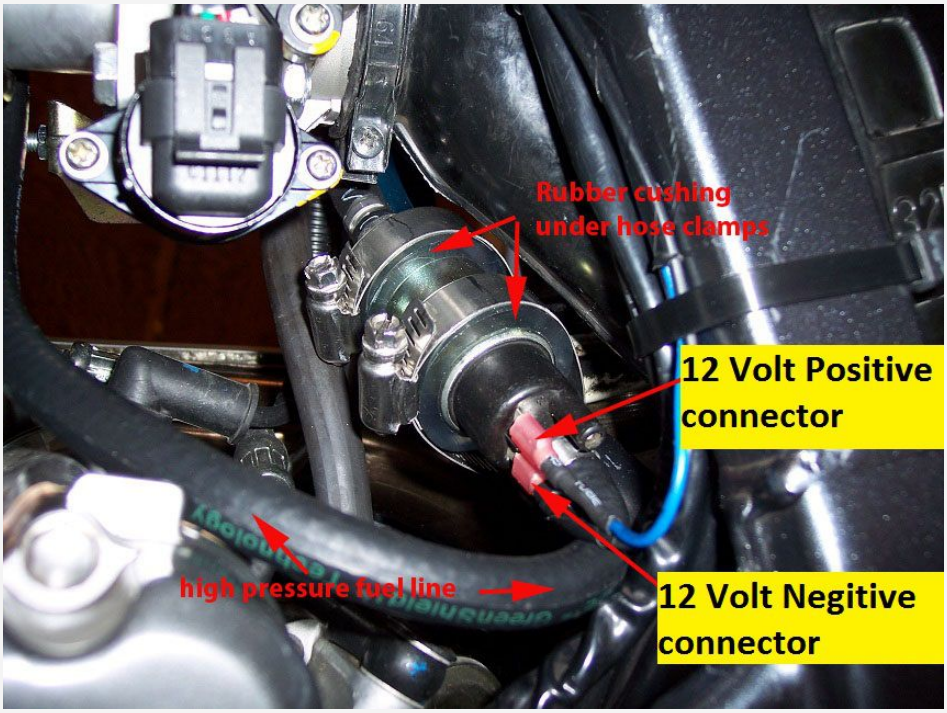
It may be necessary to loosen and rotate the Throttle Body or fold the rubber boot to install.



14. Attach the MAP Sensor connector.



15. Run the 12V+/- Fuel Pump power wires to the Fuel Pump and connect being aware of the terminal polarity.



16. **Reinstall the battery.**

17. **Attach the Ecotrons ECU to the 12V battery + and battery -.**

Make sure your 12V battery minus is connected to the chassis ground! If your engine or vehicle did not have a 12V battery before, and you just added one, in this case, you must connect the 12V – to chassis ground.

<u>you must connect the 12V – to chassis ground</u>.

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

19. You are finished with the initial hardware installation of the Suzuki DR-650 Ecotrons EFI kit.

<u>NOTE:</u>
A video of steps 2-17 may be seen here:
http://www.youtube.com/watch?v=vDvXnu2t7jo

The other components are not necessary for the “Initial Test” in the next section.

NOTE:

Using our ECU to control the CDI has **NOT BEED TESTED** on the Suzuki DR-650. It is recommended you bypass installing this as well as the narrow band oxygen sensor and bung. For further information please contact us.

Close loop fuel controls based on the NB O2 is still under tuning process. DR650 engine does not run well at 14.7 AFR in many conditions, esp. in idle. Running in open loop fuel is fine with this kit.

Initial test

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.
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?

Please follow the below trouble shooting procedures:

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.
- 1.1.4) if you have key on and off too many times without engine starts, you need to do this: with Key-ON only, disconnect the ECU from the harness, and connect it back. This is to give a power reset of the ECU, so some counters are reset to 0.

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) Is there 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 have the MAP sensor installed correctly?
- 1.4.1) is the MAP sensor connected to the throttle body tube via the small hose (included in the kit)?
- 1.4.2) is the intake air system air tight (no other way for free air

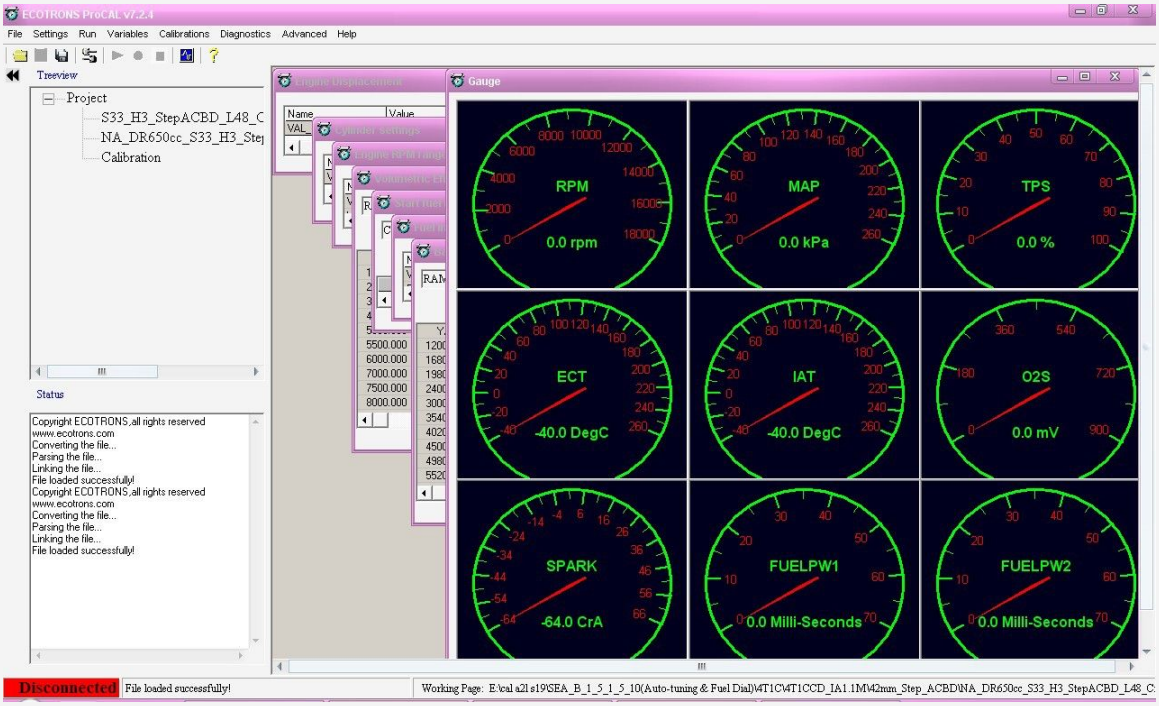
going into the cylinder except through the throttle)?

2) Do you have the MIL Lamp on (if your harness comes with a MIL Lamp installed)? If yes, go to install the ProCAL software and read the DTC

Install the provide ProCAL software into your computer:

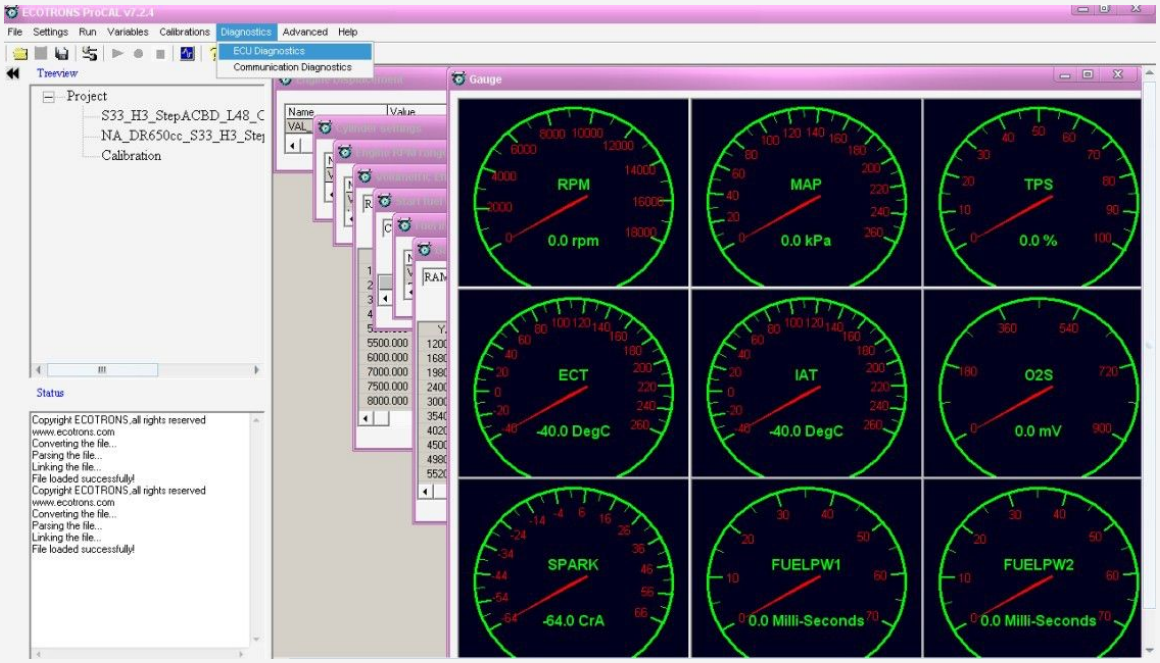
For details on how to use ProCAL software, please refer to the ProCAL manual, downloadable from our website.

Run ProCAL, you will see below windows (Load the correct A2l and CAL files):

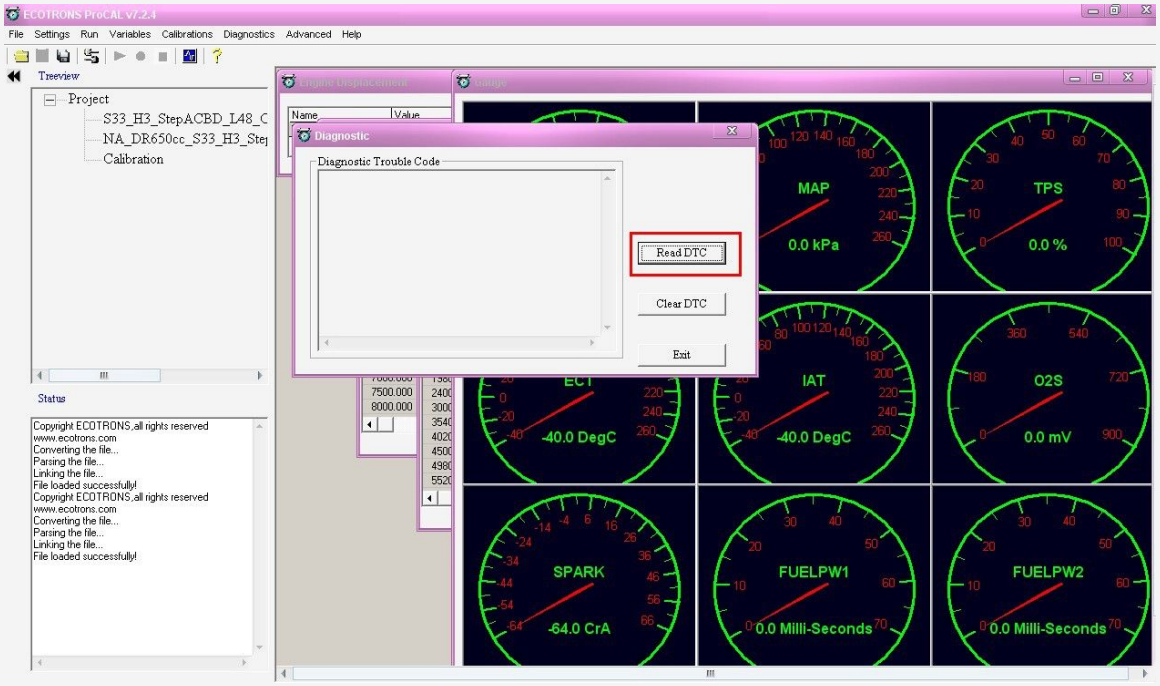


Click “Read DTC”:

Read diagnostic trouble codes by goto:
Menu → diagnosis → run diagnosis → read DTC



Click “Read DTC”



With all the correct installation and tests done, you still can not figure out why the engine does NOT start, please contact us directly:

info@ecotrons.com

Diagnosis of the communications between your laptop and ECU:

1.1 Check your serial communication cable; make sure the cable is pushed 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 communications” select correct port: USB or COM port.

1.5 Click “Connect” button in ProCAL.

Advanced Diagnosis:

The advanced diagnosis documentations are still under development; contact us for specific questions… It is always helpful if you can log the data with ProCAL and send us with your questions:

How to use ProCAL to log data:

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 (the numbers in the window should change now...)

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

Start the engine, do you test….

Note, 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: "...\record";

that's where the logged files are.

9) Note, every time, the ProCAL can log 3 .csv files, with the same name except the different suffix: _20ms, _100ms and/or _syn; these files are logged at the same time, but at different sampling rates. You will need to copy all those 3 log files, and send them to us (don't change file names).

How does the performance switch work?

"Performance Switch" has 2 positions: ECO vs RICH. In ECO position, the EFI will run the base fuel "map", or stoic metric AFR (normal cases), which gives the best fuel economy, and least emissions. In RICH mode, the EFI will run the enriched "map", or rich AFR (at high load, high RPM, esp. at WOT), which gives more power.

ECO mode: close loop fuel with O2 sensor feedback, with ECU self-tuning capability.

RICH mode: open loop fuel, fixed map, no ECU self-tuning capability.

RICH mode is only good if you have a well tuned engine mapping.

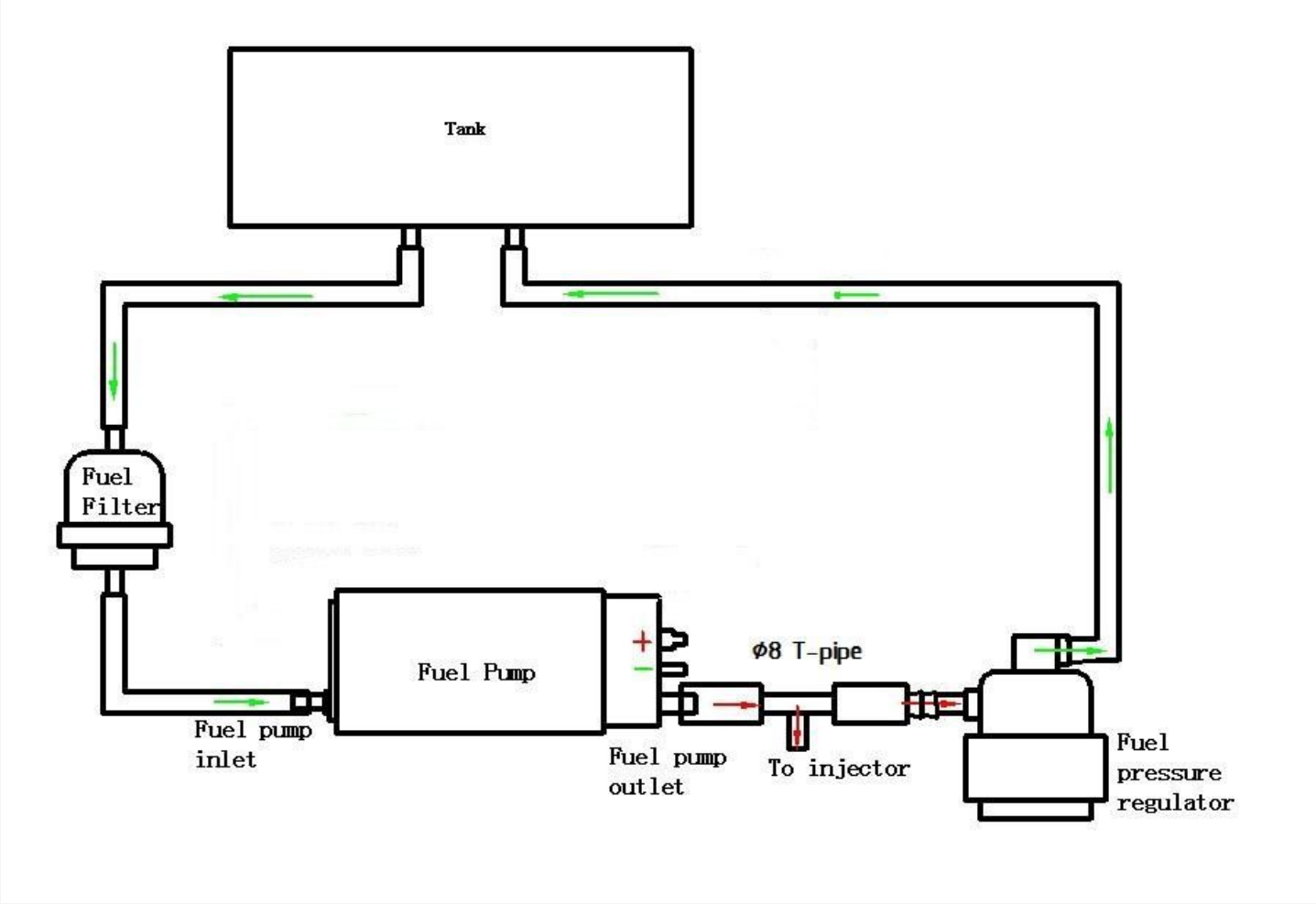
Recommend to use ECO mode most of time, and only use RICH mode for temporary fuel enrichment to gain some extra power.

"Performance Switch" is meant to let the user's easily switch between the economy and enrichment modes in real-time, so that he can run for economy when cruising around the town; and can immediately switch to performance mode as he wants.

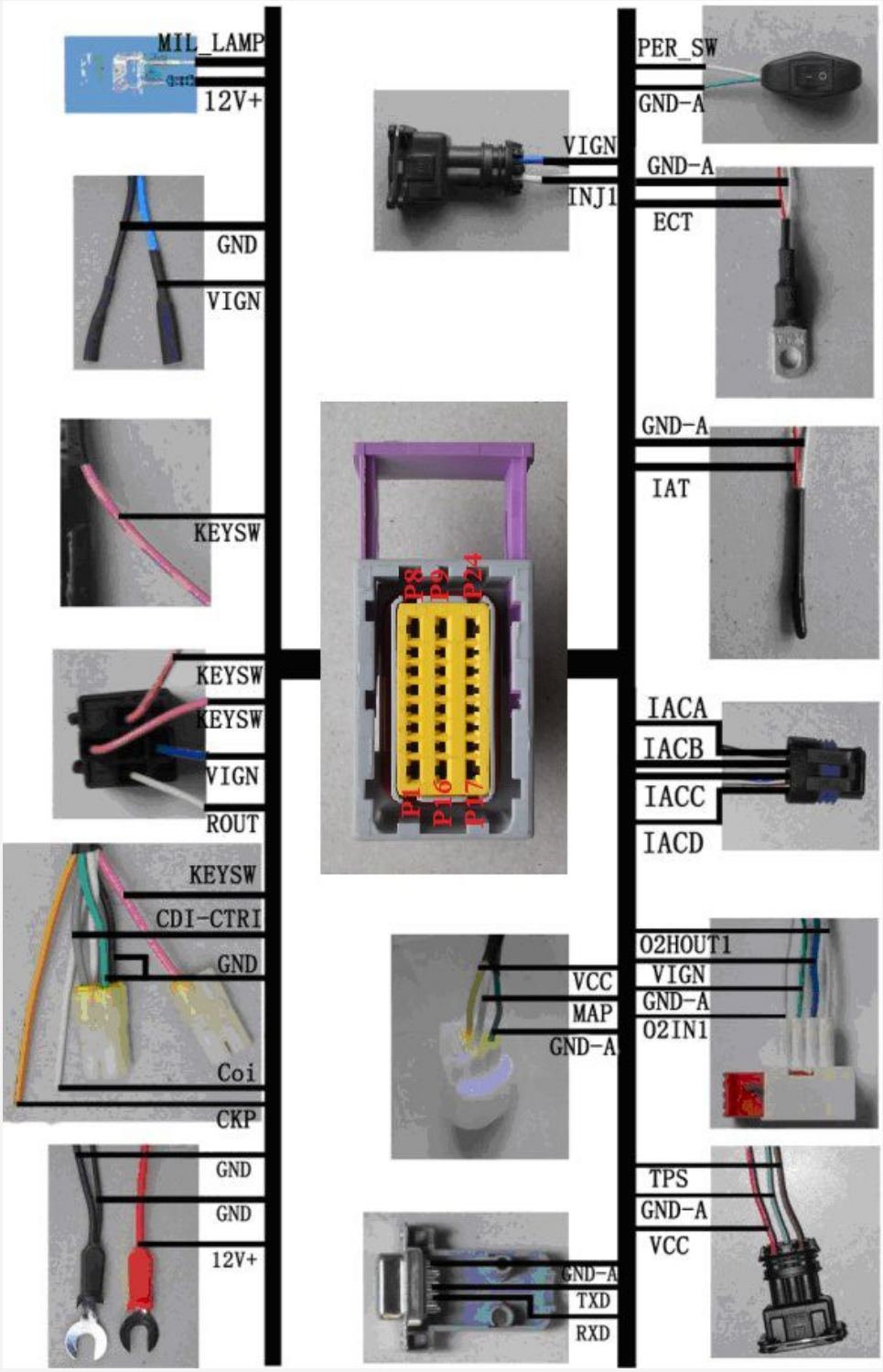
OFF -> ECO -> STOIC
ON->RICH -> POWER

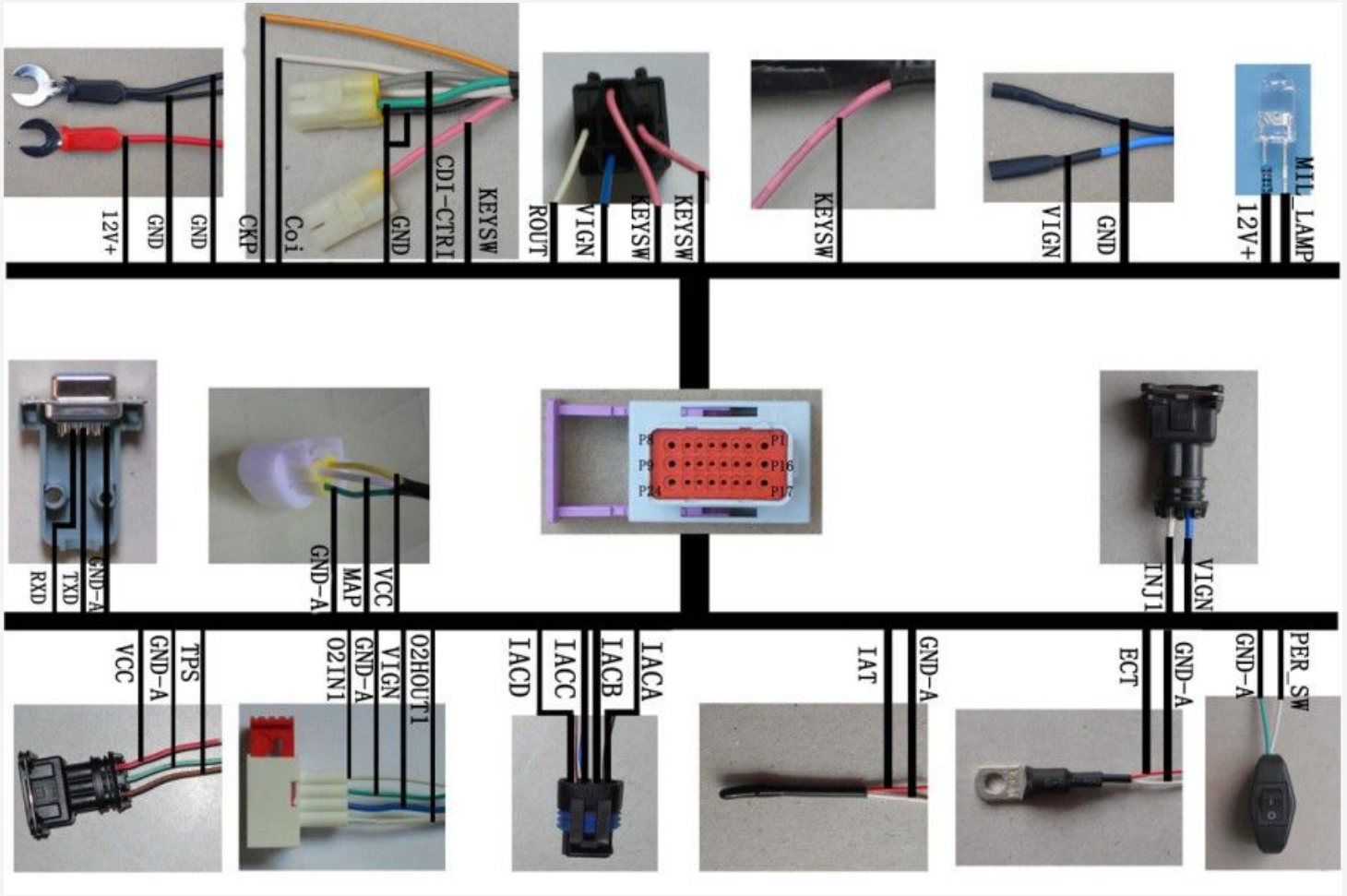
Appendix I: fuel supply systems,
Appendix II: ECU pin-out

Appendix II: Medium Fuel Pump fuel supply system schematics:



Appendix II: ECU main connector pin-out (24-pin)


MIL_LAMP
12V+
GND
VIGN
KEYSW
KEYSW
KEYSW
VIGN
ROUT
KEYSW
CDI-CTRI
GND
Coi
CKP
GND
GND
12V+
VIGN
INJ1
P8
P9
P24
P1
P16
P17
VCC
MAP
GND-A
GND-A
TXD
RXD
PER_SW
GND-A
GND-A
ECT
GND-A
IAT
IACA
IACB
IACC
IACD
O2HOUT1
VIGN
GND-A
O2IN1
TPS
GND-A
VCC



These wiring schematics are for 4-stroke 1 cylinder engine (1 injector, 1 O2 sensors) with idle control motor (4 wires

settings).

P1 O2HOUT1
--O2 Sensor 1 Heater LS Driver output

P2 12V+
--Reverse Battery Protected Supply

P3 GND
--Power Ground

P4 VCC
-- +5 Volt supply output

P5 RXD
--Send Data to RS232

P6 PER-SW
-- Performance Swith

P7 TPS
--Throttle Position Sensor input

P8 GND-A
-- Analog Ground

P9 IACA
--Idle Air Controller A

P10 MAP
-- Manifold Air Pressure Sensor input

P11 IACD
--Idle Air Controller D

P12 TXD
--Receive Data from RS232

P13 IAT
--intake air temp

P14 KEYSW
--Key On Swith

P15 MIL-LAMP
--Malfunction Indicator Lamp

P16 INJ1
--Injector 1 LS Driver output

P17 GND
--Power Ground

P18 CDI-CTRL
--CDI control output from ECU

P19 IACC
--Idle Air Controller C

P20 ROUT
--Power Relay LS Driver output

P21 ECT
-- engine (coolant) temp

P22 IACB
--Idle Air Controller B

P23 O2IN1
-- Oxygen Sensor 1 input

P24 CKP
-- Crank Position Sensor, connect to ignition pickup sensor signal