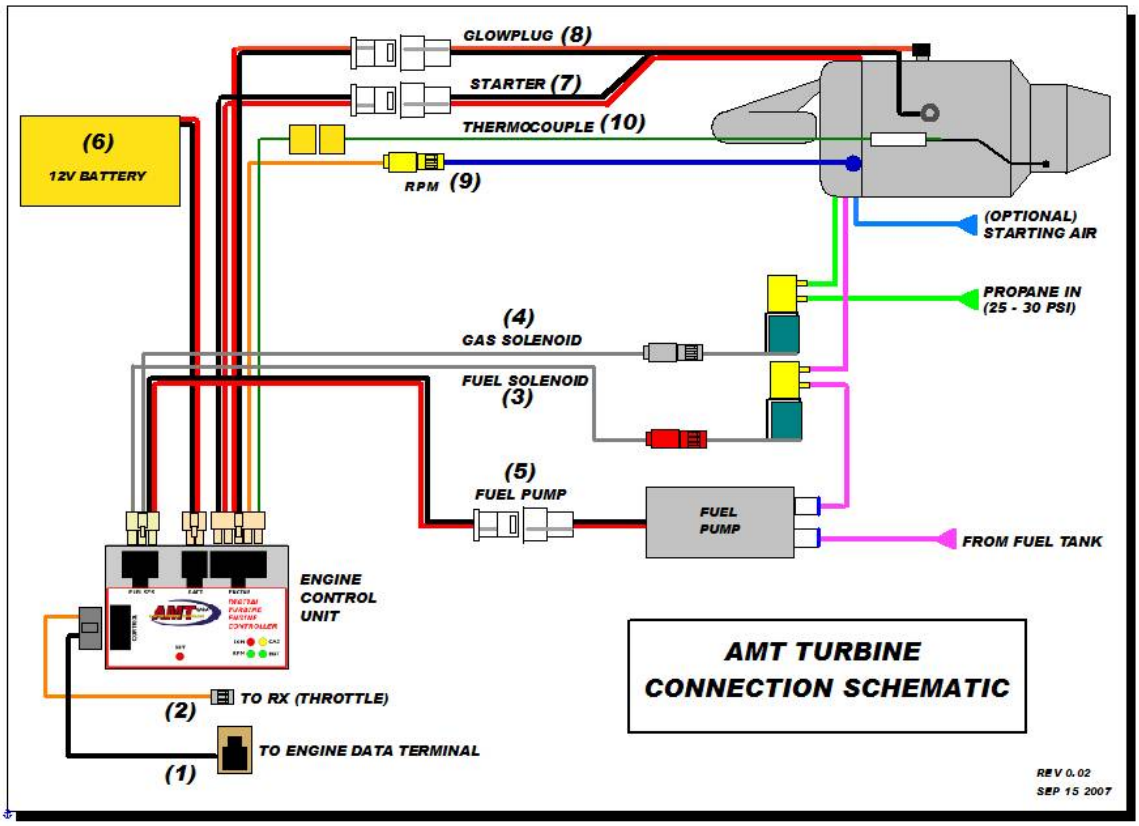
17 September 2007 **Rev 00.02**

AMT Turbine Digital Engine Control
User Manual



Features:

- ***Advanced high-speed*** Flash Microcontroller running at 32MHz.
- Built to exacting ***professional*** standards.
- Fully ***optically-isolated*** from the Rx to minimize RF interference.
- Easy, ***super*** user-friendly operation, with built-in ***fault-tolerance***.
- ***Simple*** one-button programming.
- Fully automatic start sequencing for ***easy, surefire, starting*** first time, every time.
- Full-time digital feedback control, ***self-compensating*** for battery voltage and fuel system fluctuations.
- Built-in ***expansion capability*** for future enhancements as technology advances.
- Easy-to-read and interpret Display Unit with ***no confusing menus***.

Design Philosophy: "No Hassles with the engine, just fly, fly, fly and fly!"

Inputs and Outputs

All connections are grouped into three heavy-duty connectors, so that the cables may be left together with the aircraft when transferring the engine and electronics from one aircraft to another. All mating plugs and sockets are either color-coded or polarized and can only fit one way, to avoid mistakes.

CONTROL Group

(1) Serial Cable from Off-board LCD Display

(2) Servo plug to Rx

Plugs into throttle channel.
Rx voltage 4.8V - 6V.
Pulsewidth 1000us - 2000us.
> 1800us = Full throttle
< 1300us = Minimum throttle
< 1050us = Fuel Shutoff
(Programmable using SET button, see "Setup" below)
Compatible with Futaba-J and JR. Adapters available for other radio brands..

FUEL SYS Group

(3) Output to Propane Solenoid

Starting propane flow controlled by ECU.

(4).Output to Fuel Solenoid

Fuel flow controlled by ECU.

(5) Output to Fuel Pump

Fuel delivery rate regulated by ECU.

BATTERY

(6) Battery

ENGINE Group

(7) Output to Electric Starter.

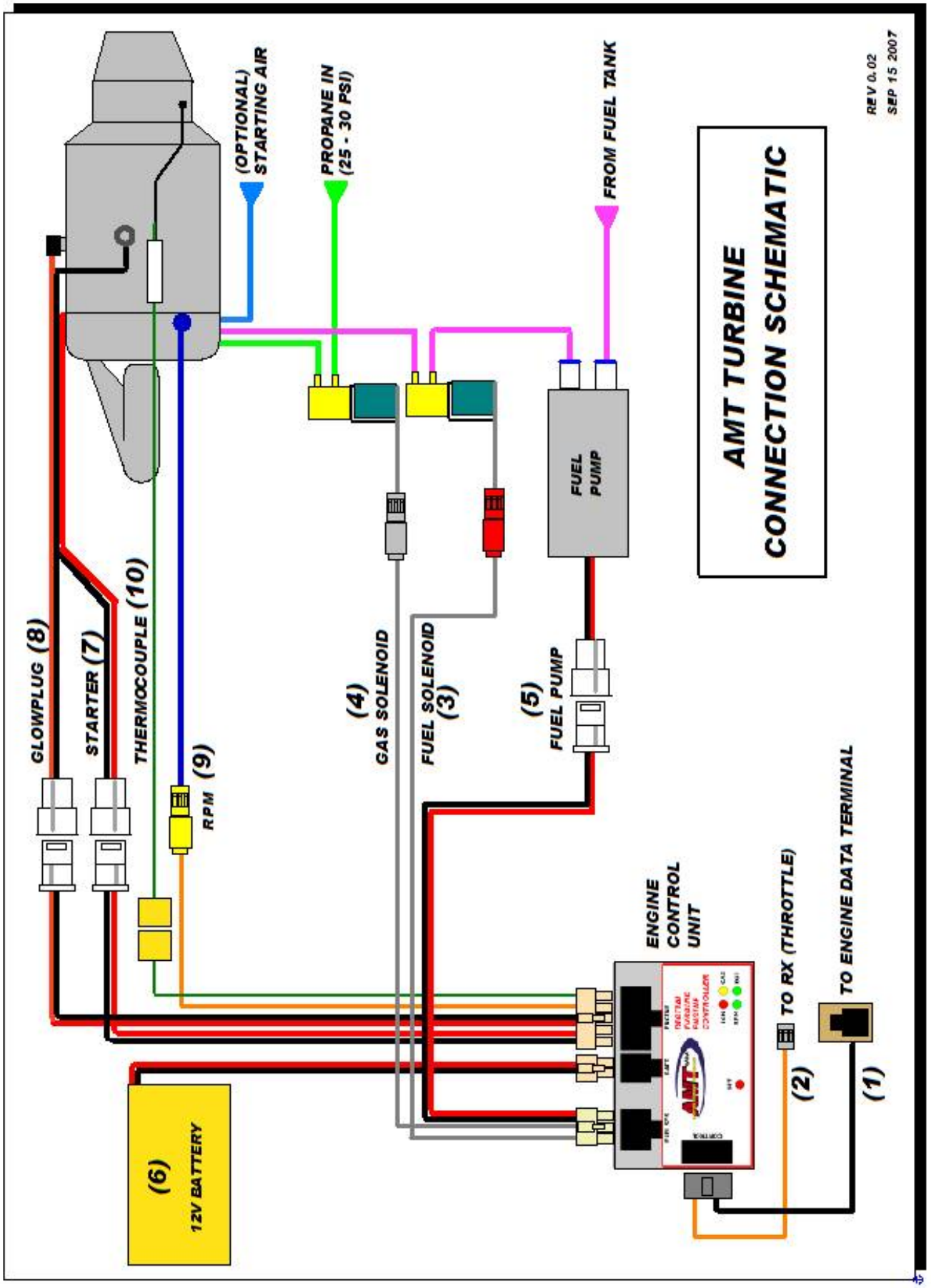
(8) Output to Glowplug.

Glowplug Ignition controlled by ECU.

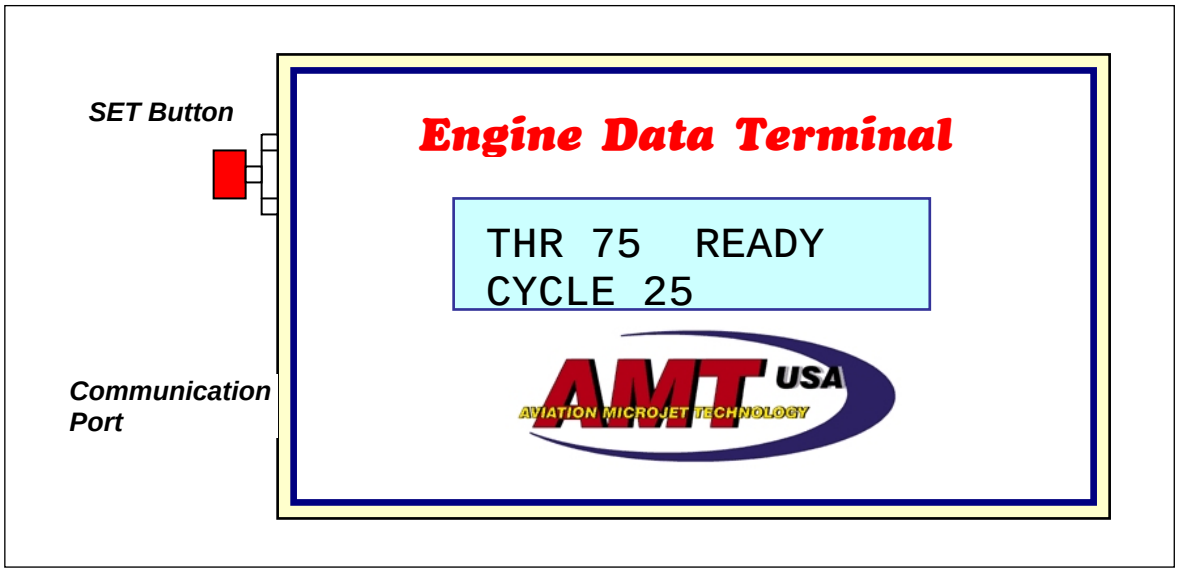
(9) RPM Sensor input

Plugs into the RPM sensor mounted on the engine.

(10) Socket to EGT Thermocouple


AMT TURBINE
CONNECTION SCHEMATIC
REV 0.02
SEP 15 2007
(OPTIONAL)
STARTING AIR
PROPANE IN
(25 - 30 PSI)
FROM FUEL TANK
FUEL
PUMP
GLOWPLUG (8)
STARTER (7)
THERMOCOUPLE (10)
RPM (9)
(4)
GAS SOLENOID
FUEL SOLENOID
(3)
(5)
FUEL PUMP
ENGINE
CONTROL
UNIT
TO RX (THROTTLE)
(2)
TO ENGINE DATA TERMINAL
(1)
(6)
12V BATTERY

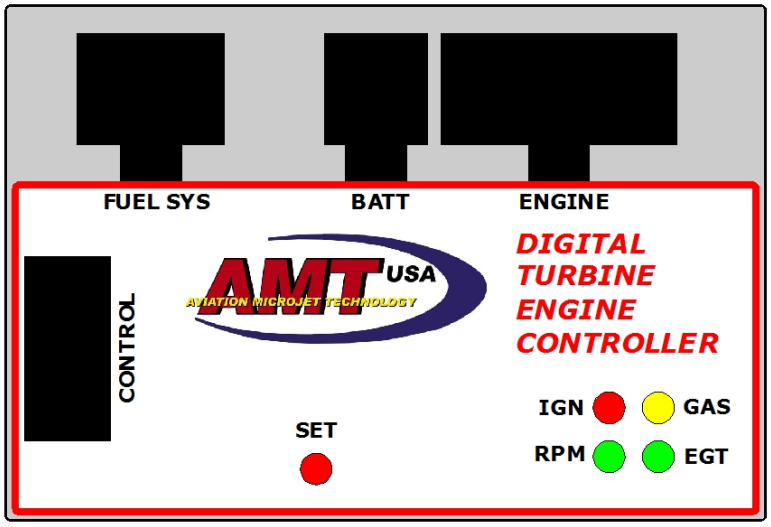
Engine Data Terminal



The Engine Data Terminal (EDT) is powered through the ECU, and connects to the ECU through a 6-pin coiled modular phone cable.

- ❑ The EDT is used during Setup, and to read engine performance parameters.
- ❑ The SET Button mirrors the SET button on the ECU, and is used during user setup, and to access special modes during operation.
- ❑ It is not necessary to have the EDT hooked up to the ECU for normal running, the ECU may be started and run without an EDT.

ECU



- ❑ Connectors
  - ❑ The CONTROL socket connects to:
    - EDT via a 6-pin Modular phone socket
    - Receiver via a JR-style Male servo connector (Black)
  - ❑ The FUEL SYS socket connects to:
    - Fuel Pump via AMT 2-pin Power Plug
    - Fuel Solenoid via JR-style Female connector (Red)
    - Starting Gas Solenoid via JR-style Female connector (Black)
  - ❑ The BATT connects to:
    - Battery via AMT 2-pin Power Socket
  - ❑ The ENGINE socket connects to:
    - Starter via AMT 2-pin Power Plug
    - Glowplug via AMT 2-pin Power Plug
    - RPM sensor via JR-style Female connector (Yellow)
- ❑ The SET Button mirrors the SET button on the EDT, and is used during user setup, and to access special modes during operation.
- ❑ IGN (Red) LED.
  The IGN LED normally indicate conditions related to the ignition (glowplug). In normal running operation, it glows steady when the glowplug is ON, and blinks if there is a fault in the glow plug circuit.

- GAS (Yellow) LED
  The GAS LED normally indicates conditions related to starting gas flow. In normal running operation, it glows when starting gas is flowing, i.e., the starting gas solenoid is open.

- RPM (Green) LED
  The RPM LED normally indicates conditions related to engine RPM. In normal running operation, it glows steady if the RPM is within operating limits, and blinks when there are faults related to RPM.

- EGT (Green) LED
  The EGT LED normally indicated conditions related to engine Exhaust Gas Temperature (EGT). In normal running operation, it glows steady when the EGT is within operating limits, and blinks when there are faults related to EGT.

The LEDs are also used in combinations at various engine states to annunciate other conditions, for instance during boot-up shutdown, and during the setup procedure. These conditions will be detailed in the appropriate sections below.

Quick Start

This section gets you up and running, without getting into too many details of "what and why's", so you can get the engine up and running quickly. Most users will find this is all that's needed to operate the engine.

A detailed description of the ECU operation is appended at the end of the Quick Start section.

WARNING!

The Automatic Engine Start Sequence is triggered by a particular sequence of movements of the throttle stick when the ECU (Receiver) is on.

DO NOT MOVE THE THROTTLE STICK CARELESSLY WITH THE ECU ON UNLESS YOU ARE PREPARED TO START THE ENGINE!!

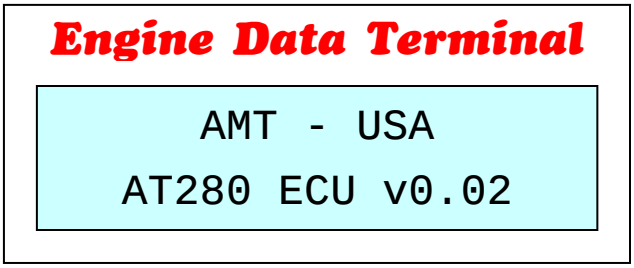
Setup

As a first step, you'll need to teach the ECU your particular radio's throttle stick settings. The ECU stores these settings in non-volatile memory. The memory will retain these settings for up to 15 years without need for backup battery power.

You should not need to re-teach the ECU unless you change your radio or want to change the thrust output of the engine, want to try a different Glowplug.

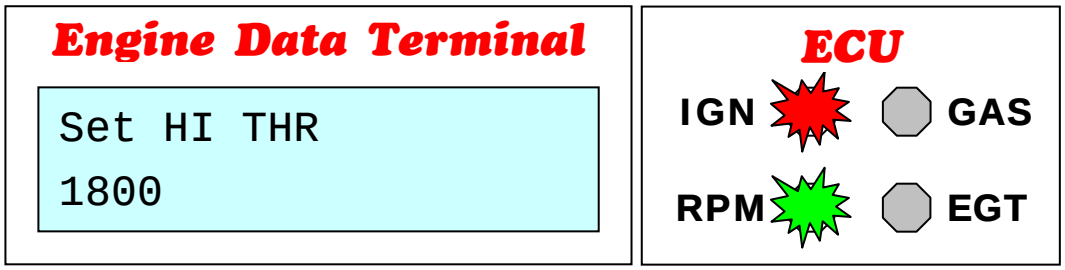
- ❑ Hook up the ECU, Battery, EDT and Radio.
- ❑ Switch on the Transmitter. make sure the the throttle channel is set to ***100% Travel (Endpoint) and NORmal*** direction.
- ❑ Press and hold the SET button, either on the ECU or EDT (they are exactly the same – we provide two buttons just for convenience)..
- ❑ Switch on the Receiver, which also switches on the ECU.

The EDT shows:



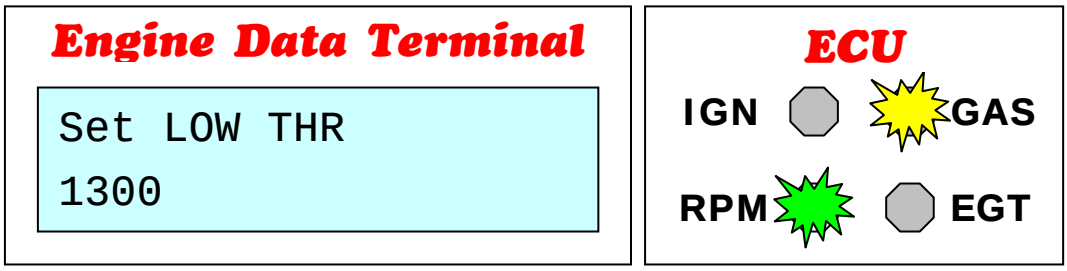
for approx. 5 seconds, and then enters the Learn Mode.

- ❑ **Teach the ECU your Full Throttle setting:**



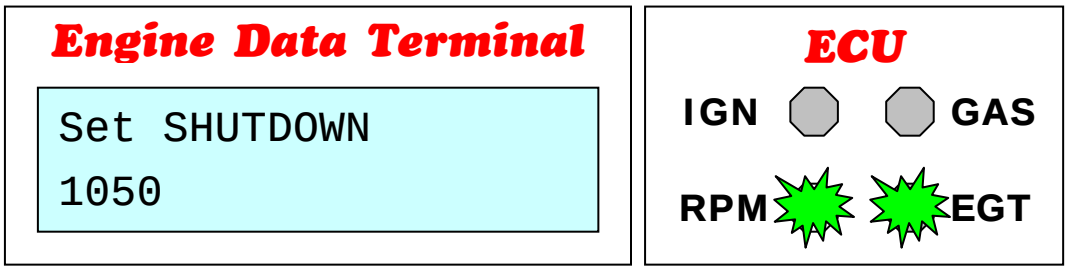
- ❑ Move the throttle stick to ***High Throttle, High Trim***.
- ❑ Make sure the number displayed in greater than 1800. If not, adjust the REV or Endpoint functions on the Tx. The IGN and RPM LEDs flash when the throttle is out of range, and glow steady when the throttle is within range.
- ❑ Push the SET button.

- ❑ **Teach the ECU your Idle Throttle setting:**



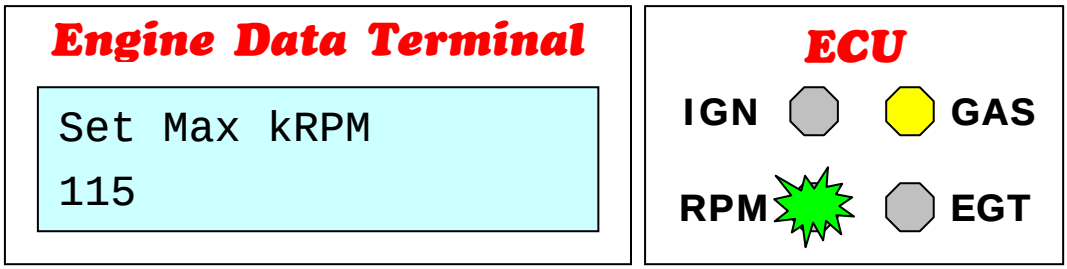
- ❑ Move the throttle stick to ***Low Throttle Middle Trim***.
- ❑ Make sure the number displayed is less than 1300. Adjust the Endpoint if necessary. The RPM and EGT LEDs flash when the throttle is out of range, and glow steady when the throttle is within range.
- ❑ Push the SET button.

- ❑ **Teach the ECU your Engine Shutdown setting:**



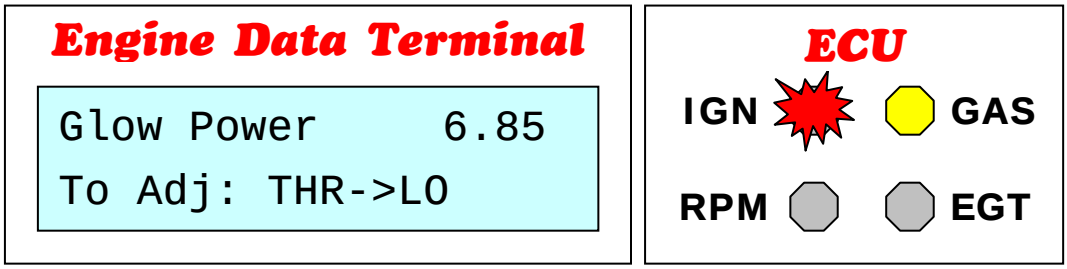
- ❑ Move the throttle stick to ***Low Throttle, Low Trim***. The RPM and EGT LEDs flash when the throttle is out of range, and glow steady when the throttle is within range.
- ❑ Push the SET button.

- ❑ **Set your desired Maximum RPM (to limit the thrust):**



- ❑ Move the throttle stick as required to set the desired maximum running RPM. The GAS LED glows steady while the IGN LED flashes (Indicating RPM setup).
- ❑ Push the SET button.

- ❑ **Set the Glowplug power to match your glowplug:**



The number is the percentage "duty cycle" of battery voltage applied to the glowplug. The GAS LED glows steady while the IGN LED flashes (Indicating Ignition setup).

The ECU remembers the "previous" setting of the glowplug voltage, so the display shows the old value programmed into its memory. If you are programming this for the first time, the factory default of 6.85% is approximately correct for Rossi 8 plugs.

IMPORTANT!
If you are installing a new type/brand of plug, we recommend unplugging the glowplug from the harness and removing the plug from the engine before proceeding.

- ❑ ***To change the power to the glowplug, you must first move the throttle stick down to Low Throttle***. This prevents sudden application of high power and inadvertently blowing out expensive plugs. The displayed number should go to zero when the stick goes to low throttle, and start following the stick as you move the stick up.

- ❑ Connect the new glowplug to the glowplug harness. Touch the body of the plug to the engine casing, and position the plug so that you can observe the filament brightness. **BE CAREFUL! The plug will get hot!**

- ❑ ***Carefully and <u>slowly</u>***, move the throttle up from Low throttle. The numbers should increase as the throttle stick moves up, and the plug should glow steadily brighter, with larger numbers giving a brighter glow.
  BE CAREFUL! The glowplug driver circuit is capable of instantly frying glowplugs!

- ❑ Adjust the plug filament brightness for a "yellow" glow, just beyond "bright orange".

<u>HINT:</u>

To quickly adjust glowplugs, there is a shortcut to get to the Glow Power Setup, bypassing the Throttle Stick and Max. RPM setup, <u>provided you have previously taught the ECU your Throttle settings:</u>

- ❑ In the "Set THR HI" phase, move the Throttle Stick and Trim to Low (Shutdown position), then push the SET button. The setup program will jump directly to Glow Power Setup.

- ❑ To memorize the Glowplug Power, push the SET button.

The ECU Setup is complete, and the ECU is now programmed to match your Tx stick position, your desired Max. RPM, and your brand of glowplug.

- ❑ **Switch off the radio / ECU.**

<u>Pre-start Prep</u>

Remember that a turbojet engine is very powerful and potentially very dangerous.

- ***Make sure the engine mounting is absolutely secure.***
- ***Observe all safety precautions as prescribed by the applicable governing bodies at your location.***
- ***Make sure you are prepared with adequate fire fighting and first aid equipment.***
- ***Check over the fuel and starting gas plumbing. Test thoroughly for leaks and correct as necessary.***

- ❑ Connect up the Starting Gas (Propane) source. Adjust the delivery pressure between 25 – 30 psi.
  - ❑ Adjust the pressure towards the low end of the range at higher density altitudes (hot day, high humidity, high altitude airfield).
  - ❑ Adjust the pressure towards the high end of the range at low density altitudes (cold and/or dry days, closer to sea level).

- ❑ Make sure there is fuel in the tank, and the manual fuel ball valve is turned on.

Starting and Running

WARNING!

The Automatic Engine Start Sequence is triggered by a particular sequence of movements of the throttle stick when the ECU (Receiver) is on.

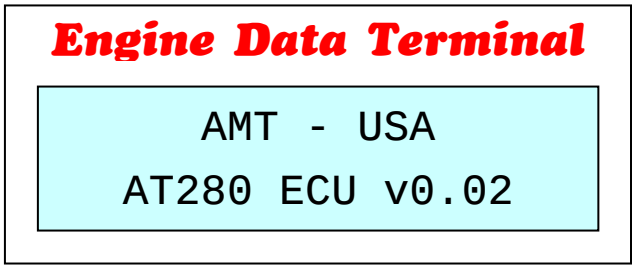
DO NOT MOVE THE THROTTLE STICK CARELESSLY WITH THE ECU ON UNLESS YOU ARE PREPARED TO START THE ENGINE!!

If at any time you hear or see something unexpected, Shut down the engine immediately and investigate. It is better to be safe than sorry!

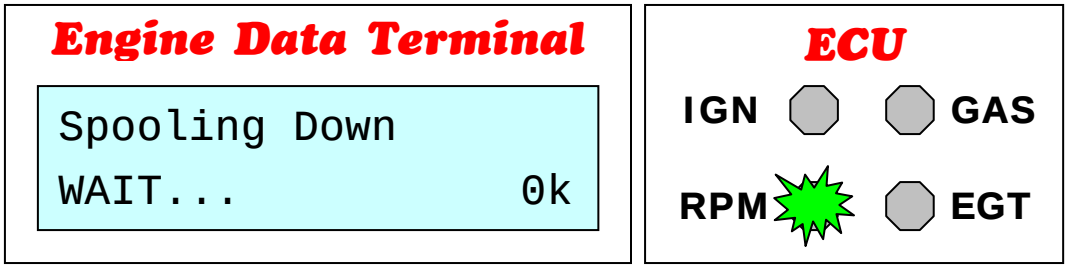
The Shutdown command is honored at any time. Simply move the Throttle/Trim to the Shutdown position.

During a start sequence, please be careful not to move the throttle inadvertently to Shutdown in the middle of the starting sequence, or the process will be immediately aborted.

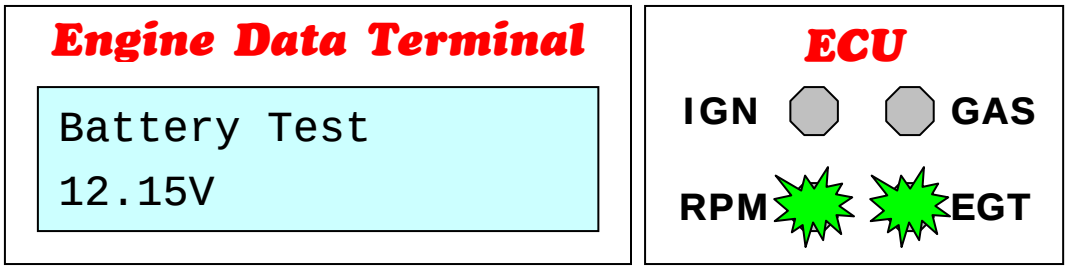
- ❑ Do a final safety check. Do not forget to ensure clear space beside and behind the engine, and that there are no loose items that may be sucked into the engine.
- ❑ **Switch on the radio / ECU.**
- ❑ The EDT shows for approx. 2 seconds,



and then:



until the engine stops rotating, then:

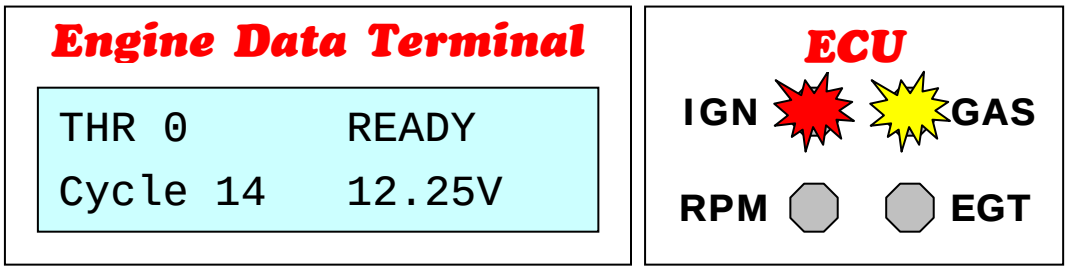


The IGN / GAS or RPM / EGT LEDs flash alternately, indicating the ECU is testing the battery under load.

The load used is the glowplug, run at approx. 50% of the value set during SETup. You may notice a slight buzzing as the glowplug is powered.

If your engine has some residual fumes inside the combustor, the battery test may cause the fumes to "pop". Do not panic, just be aware that a slight "pop" may happen in the engine during battery test.

❑ If the battery tests out at greater than 11.95V after 3 seconds, there is enough charge, and the ECU proceeds with the next step.



IGN and GAS LEDs flash, indicating the ECU is ready for Ignition and Propane (i.e., Start)

1. THR shows the Throttle Stick position in percent (0 -100% or OFF for ShutDown)
2. READY indicates the ECU is in the Ready State, ready for startup
3. Cycle shows the recorded number of Run cycles
4. The Battery voltage is shown in Volts

❑ **Prime the pump, if necessary.**
(You may skip this step, if the fuel lines are already primed from a previous run)

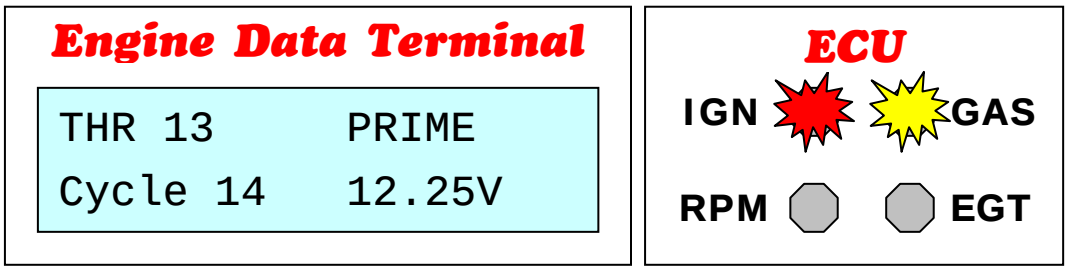
❑ Move the Throttle stick to Shutdown – the EDT shows "THR OFF.

- ❑ Push the SET button and hold down as necessary to fill the fuel line to the engine.
  - ❑ We recommend, for a first-ever start, disconnecting the fuel line from the engine and catching the fuel prime into an overflow bottle, to prevent flooding the engine.
  - ❑ For safety, once you let off on the SET button, it is locked out. You'll have to move the Throttle stick up a bit, then back to Shutdown to re-arm the SET button for another manual fuel prime.

- ❑ **Check the Propane pressure under actual delivery, if necessary.**
  (You may skip this step, if the Propane Regulator has been previously set up)
  - ❑ Move the Throttle stick to Idle – the EDT shows "THR 0.
  - ❑ Push the SET button and hold down as necessary to open the Gas valve and flow Propane into the engine.
  - ❑ Observe the Propane Regulator Pressure gauge, adjust if necessary.

CAUTION!
Do not over-do this, you may be filling your airplane with explosive Propane!

- ❑ **Manually spool up the engine with the starter, if necessary.**
  (You may skip this step)
  - ❑ Move the Throttle TRIM to High, with the stick at Low, push the SET button for approx. 1 second.



The Throttle Stick acts as a manual speed control for the starter motor. Be aware that the starter motor draws a lot of current, don't deplete the battery unnecessarily!

Use this function judiciously to clear any excess Propane or Fuel out of the engine.

- ❑ Return the Throttle Trim to center, and the stick to Low (i.e., the Idle position). The ECU returns to the Ready State.

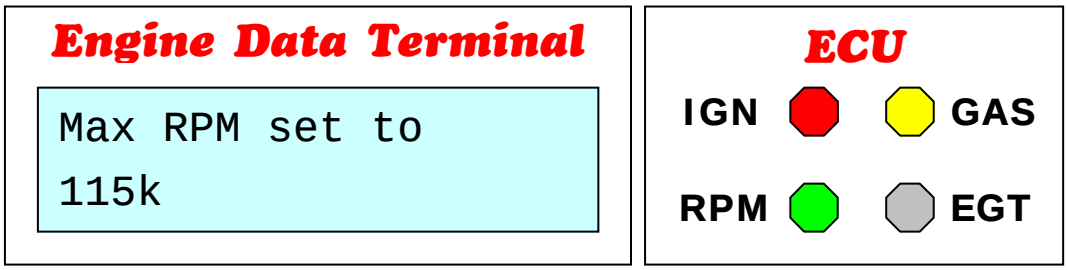
- ❑ **Check the throttle stick travel, if necessary.**
  (You may skip this step)
  - ❑ Move the throttle stick ***quickly*** from low to high ***and back*** again, ***without pausing***. Confirm that the THR number cycles from 0 through 100 and back again

You are now ready to start.

If, at any time, you need to abort, simply move the Throttle/Trim to the Shutdown position.

- ❑ ***Make sure the Throttle is at Idle.***
- ❑ Make sure the Propane source and the Fuel valve are ON..

- ❑ **Move the Throttle Stick to the Max. Position.**

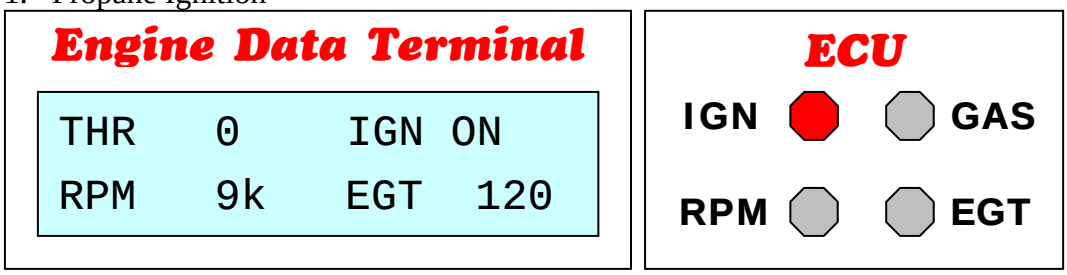


- ❑ The RPM LED glows steady, and the IGN, GAS and EGT light up in sequence, one by one, at 1-second intervals. The EDT shows the Max. RPM you programmed into the ECU during SETup.

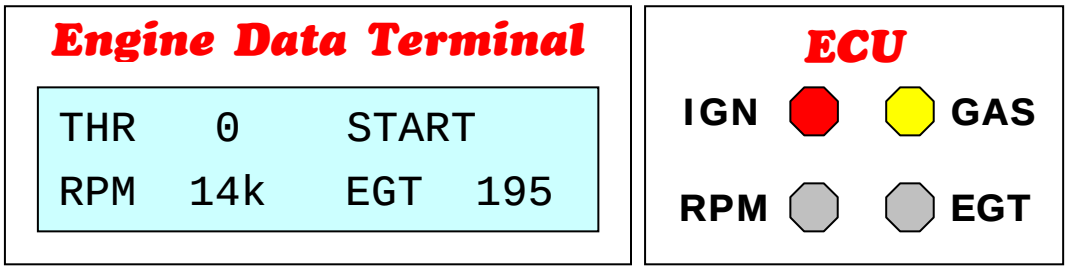
- ❑ After 4 seconds, all the LEDs flash in unison, indicating the ECU is ready to initiate an Autostart:

- ❑ **Move the Throttle to Idle to trigger the Autostart, then simply relax and enjoy the ride!**

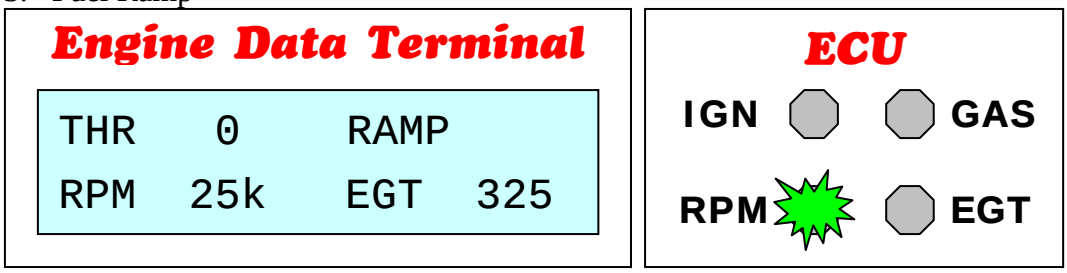
1. Propane Ignition



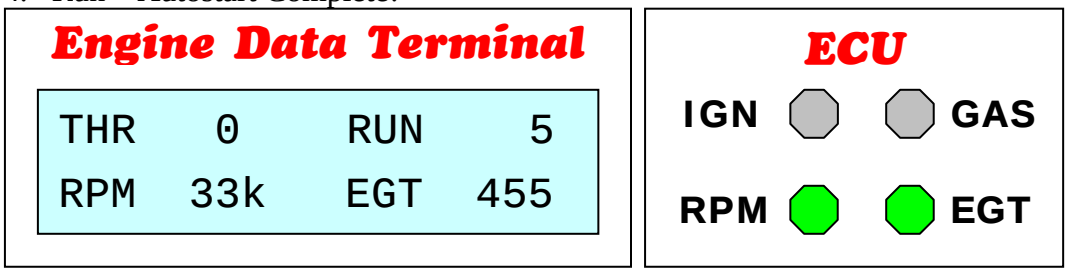
2. Start Kerosene Flow



3. Fuel Ramp



4. Run – Autostart Complete!



- **Note, FOR SAFETY, if the Throttle stick is at more than 2% when the automatic start sequence completes, the ECU will hold the engine at idle** until the throttle is brought to the Idle setting before handing over to pilot's control.

  If the Throttle is apparently "unresponsive" at the end of the Ramp, move it to Idle for a brief moment, it will then start responding.

You are now ready to fly!

Air Start engines

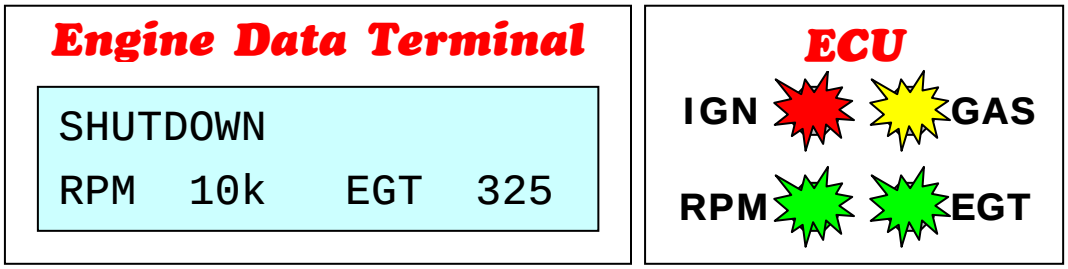
The ECU accommodates an Air Start engine with no modifications necessary. Simply follow the same sequence above, up to the point when the EDT and ECU show:

- **Move the Throttle to Idle to trigger the Autostart.**
  Squeeze the Air trigger handle gently to approx 50%, then continue squeezing to 100% when the propane lights, and hold until the ECU is in the RUN state.
  It is not necessary to "pulse" the air and then wait for propane ignition, the engine will light on Propane "on the way up".

Shutting Down

Simply move the Throttle / Trim to the Shutdown position!

The ECU shuts of the fuel pump and closes the Fuel Solenoid after ¼ second to verify that the Shutdown command was intentional.

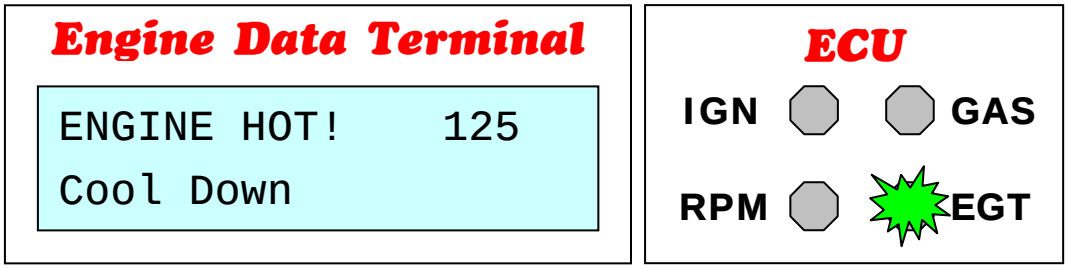


Usually, the Trim is set to its center position, so shutting down is simply a matter of moving the Throttle Stick to Idle, and pulling down the Trim.

Auto Cool-down

Whenever the ECU is powered up but not running (i.e., the Rx is ON but the engine is inert), the ECU evaluates the engine EGT. If the EGT is greater than 100°C, the Starter will be cycled, to pull cooling air thru the engine. This is entirely automatic, and requires no user intervention.

If, on power up, the engine is too hot, the ECU shows



The number displayed is the EGT.

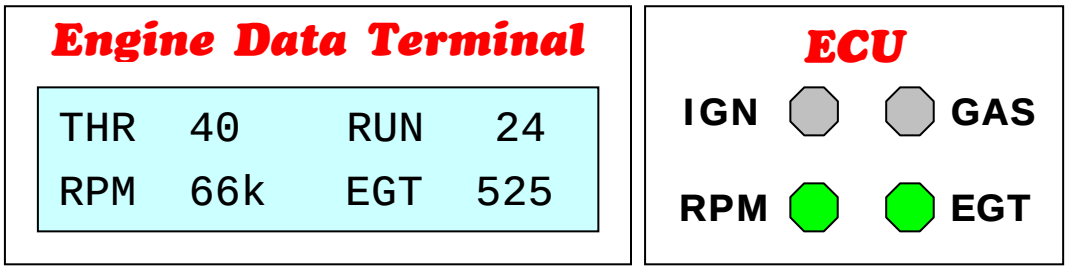
The ECU cycles the Starter until the EGT is less than 100°C, then automatically proceeds with normal boot-up, as described above.

Additional Notes

The ECU regulates the engine speed in proportion to the throttle stick position, from 0% (Idle RPM) to 100% (Max RPM set during the Setup Procedure earlier.). This is full digital feedback control, so the ECU will respond to fuel delivery and battery voltage variations by modulating the fuel to maintain constant RPM as commanded by the throttle stick.

You may "trim" the Idle by moving the Trim lever up from the Idle (or Throttle Low) position. The Idle trim is completely proportional.

The EDT Display is interpreted as follows:



- ❑ The THR number is the commanded throttle in percent. If the Throttle is set to Shutdown, the THR number becomes "OFF".
- ❑ The RUN number is the fuel delivery output in percent of maximum pump voltage.
- ❑ RPM displays RPM in thousands.
- ❑ EGT is the EGT in degrees Celsius.