

# ***V2 ECU for AMT Netherlands gas-turbine***

Version 1.3



***AMT Netherlands***

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## 1. Electronic Control Unit V2

Each page can be recognised in the header by:

- page number
- revision number

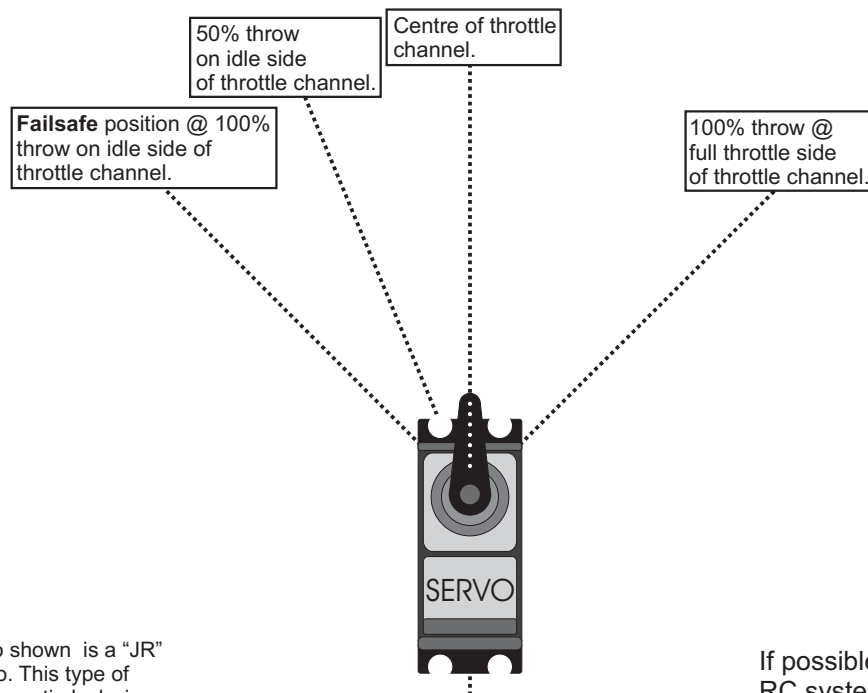
Text pages have been included as right-facing pages.

Pages with drawings have been included as left-facing pages and have been inserted opposite the relevant text, when possible. Pages with drawings have a reference to the matching text page in the header.

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figure 1.1

**Note:**

The servo shown is a "JR" type servo. This type of servo goes anti-clockwise at an input with a pulse with of 1.0 milli second.

If possible at your RC system; switch "off" trim when using dual-channel operation.

**Version 2 ECU. (E-start)**

figure 1.2



## **1.1 Description of ECU** (Version **V28** and up)

The Electronic Control Unit (ECU) controls the gas turbine within the safe software limits, which are pre-set by **AMT Netherlands**.

## **1.2 Which radio system, PPM or PCM are you going to use.**

In general there are 2 transmission systems available on the market, the older transmission system is called PPM, PPM stands for **P**ulse **P**osition **M**odulation and there is a PCM, PCM stands for **P**ulse **C**ode **M**odulation. When you decide to use a PPM system please go to chapter 1.3, as the failsafe option is not available in a PPM system.

If you are going to use a PCM system you can use the failsafe option of this type of ECU. AMT advises to use a PCM system.

### **1.2.1 Using a PCM system**

When you are using a PCM system it is necessary to study the failsafe options of your radio first, best is to power up the TX, connect 2 servo's and a battery to the receiver and get used to the radio. By doing this the operator can observe, visually, by the movement of the servos, the signals going to the ecu.

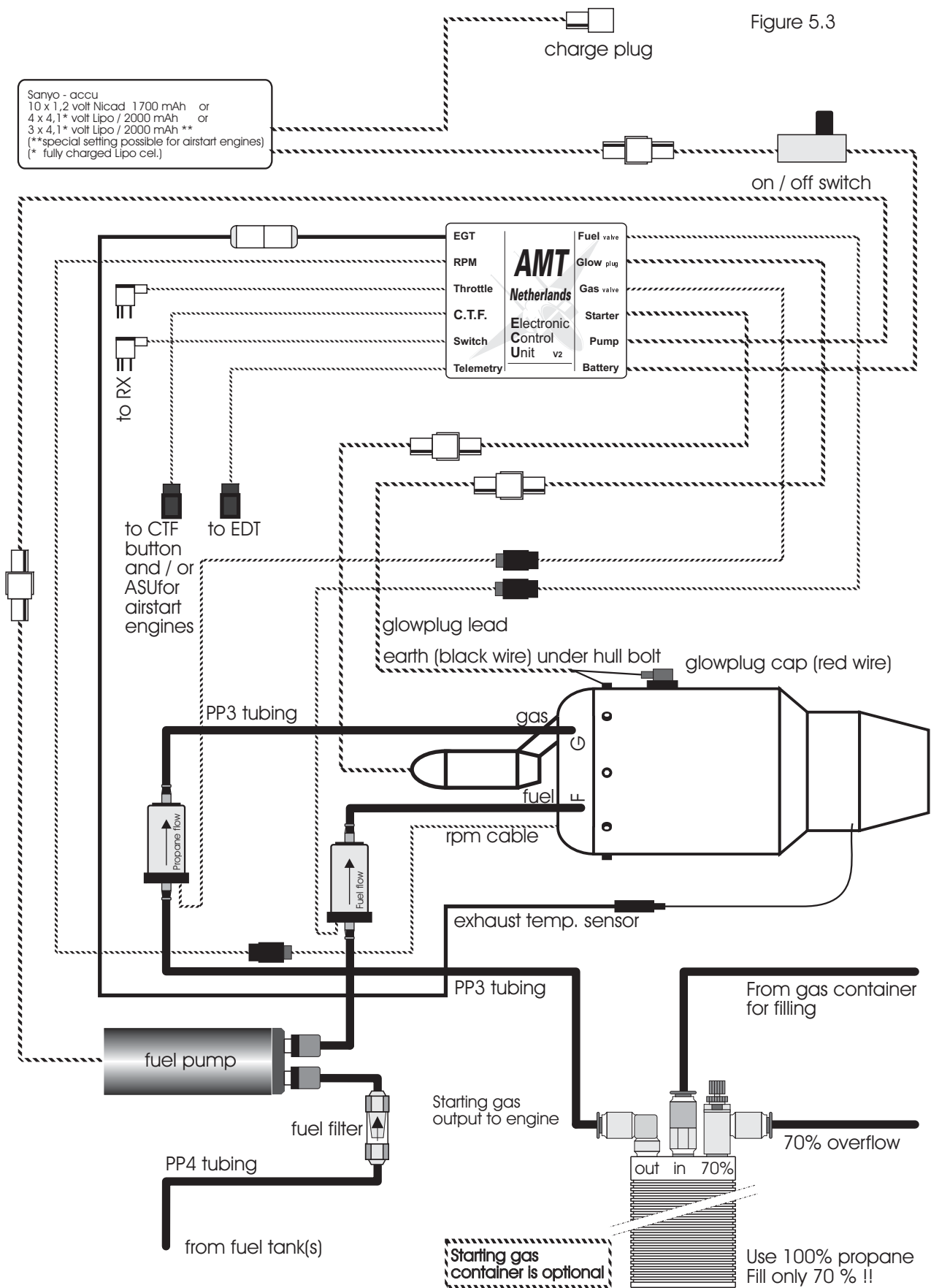
Program the throw for throttle and switch channel, if you are using dual channel operation, to 100% throw on both sides of the channel. If you are going to use dual channel operation switch off the trim of the throttle channel, if this is not possible leave the trim in the middle position and do not use it during calibration or later when you are operating the turbine.

Now go to the failsafe menu of your transmitter and set the failsafe function for your throttle and program the channel to go to "idle" in case of a failsafe condition. Check with a servo connected to the receivers throttle channel if the servo moves to the idle position in case of a failsafe condition. You can generate a failsafe to switch off your transmitter, at switching on the transmitter the servo should move again to the actual throttle position.

After the failsafe is programmed and tested the throw of the throttle channel has to be adjusted to 50% throw on the "idle" side of the throttle channel, the other side of the channel the "full throttle side" must remain on 100% throw.

Please check the throttle channel with a servo connected to the receiver and check if the failsafe indeed goes 10-20 deg further that the idle position. Later the ECU will detect this failsafe position and will shutdown the engine after the programmed failsafe time in the ECU. As standard, this failsafe timer is set to a 2-second delay.

---



### **1.3 Definition of input channels**

The ECU uses as inputs:

- A: Exhaust gas temperature (EGT).
- B: Rotation speed (RPM).
- C: Throttle channel (receiver).
- D: CTF input and ASU control for air start engines
- E: Switch channel (receiver).
- F: NiCad 12,0 volt (10cell) / 1700 mAh or  
LiPo 16,4 volt ( 4 cell) / 2AH

LiPo 12,3 volt ( 3 cell) / 2AH is possible for airstart with a special software battery setting.

The outputs present are:

- A: Fuel valve connection.
- B: Glow plug connection. (e-start only)
- C: Gas valve connection. (e-start only)
- D: Electric starter connection. (e-start only)
- E: Fuel pump connection.
- F: Telemetry, also for EDT connection.

#### **1.3.1 Temperature input A**

To this input channel a type K (Ni-Cr/Ni) thermo-couple must be connected.  
The end of the thermo-couple has to be mounted in the appropriate place in the exhaust nozzle of the turbine. (1 - 2 mm inside the exhaust nozzle)  
Be careful of the polarity of the thermo-couple, the plug and socket have one wide contact and one narrow contact.

#### **1.3.2 RPM input B**

To this input channel, which records the rate of shaft rotation, connect the plug from the RPM sensor. It is recommended that you use the supplied safety clip to properly fix the RPM connector. If necessary an extension cable is available. (JR type, max. 100cm)

#### **1.3.3 Regulator channel input D**

This input channel is connected to the receiver channel, which is controlled by the throttle stick of your transmitter.

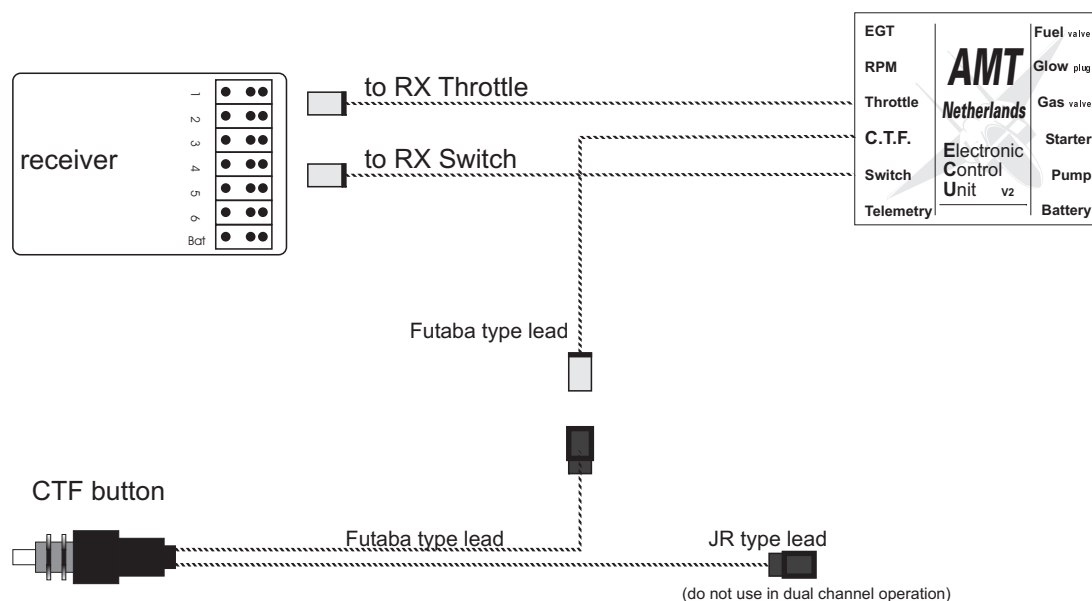
#### **1.3.4 CTF input E**

##### **1.3.4.1 CTF input E (Dual channel operation)**

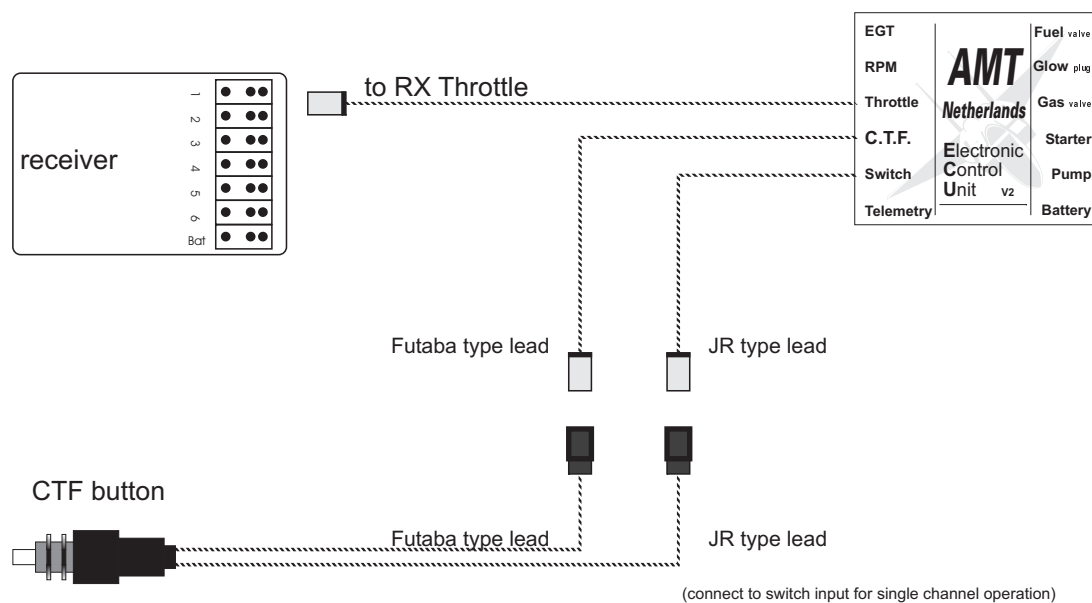
This input channel is to "teach" the ECU the pulse width of your radio system.  
To program the pulse width connect the CTF lead (Futaba plug) to the CTF input on the ECU, and leave the JR lead of the CTF switch unconnected.

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Wiring diagram of CTF button for dual channel operation.



Wiring diagram of CTF button for single channel operation.





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To program two channel motor operation follow this sequence:

- 1 Connect the throttle lead to the correct channel on your receiver.
- 2 Connect the switch lead to the correct channel on your receiver.
- 3 Switch "on" Transmitter and receiver.
- 4 Push down the CTF button, and hold it pushed down.
- 5 Switch "on" the ECU, after a few seconds you will hear a beep.
- 6 Release the CTF button.
- 7 Put the 3 pos. switch in the "Off" position and push and release the CTF button.  
(ECU will giving a beep for confirmation)
- 8 Put the 3 pos. switch in the "Middle" position and push and release the CTF button.  
(ECU will giving a beep for confirmation)
- 9 Put the 3 pos. switch in the "Start" position and push and release the CTF button.  
(ECU will giving a beep for confirmation)
- 10 Put the Throttle stick in the "Idle" position and push and release the CTF button.  
(ECU will giving a beep for confirmation)
- 11 Put the Throttle stick in the "Max throttle" position and push and release the CTF button.  
(ECU will giving a beep for confirmation)

Directly after program sequence no.11 the ECU will give a confirmation beep that all pulse widths are stored in the ECU. When no changes are made in the programming of throttle or switch channels in your transmitter you do not have to do this sequence again before each motor run.

You can now disconnect the CTF cord, and it is best to store it in your Transmitter case or to mount it in your model.

When you are using a PCM system you can check the failsafe routine by switching OFF your transmitter.

When the failsafe time has passed the ECU will sound with a **high/ low** beep tone. This failsafe beep tone has to be reset like an engine error, see chapter 1.5.2

**Note:**

**AMT Netherlands** recommends using the dual channel motor operation because it gives the best possibilities for operation of the turbine, meaning a separate switch for starting and stopping the turbine.

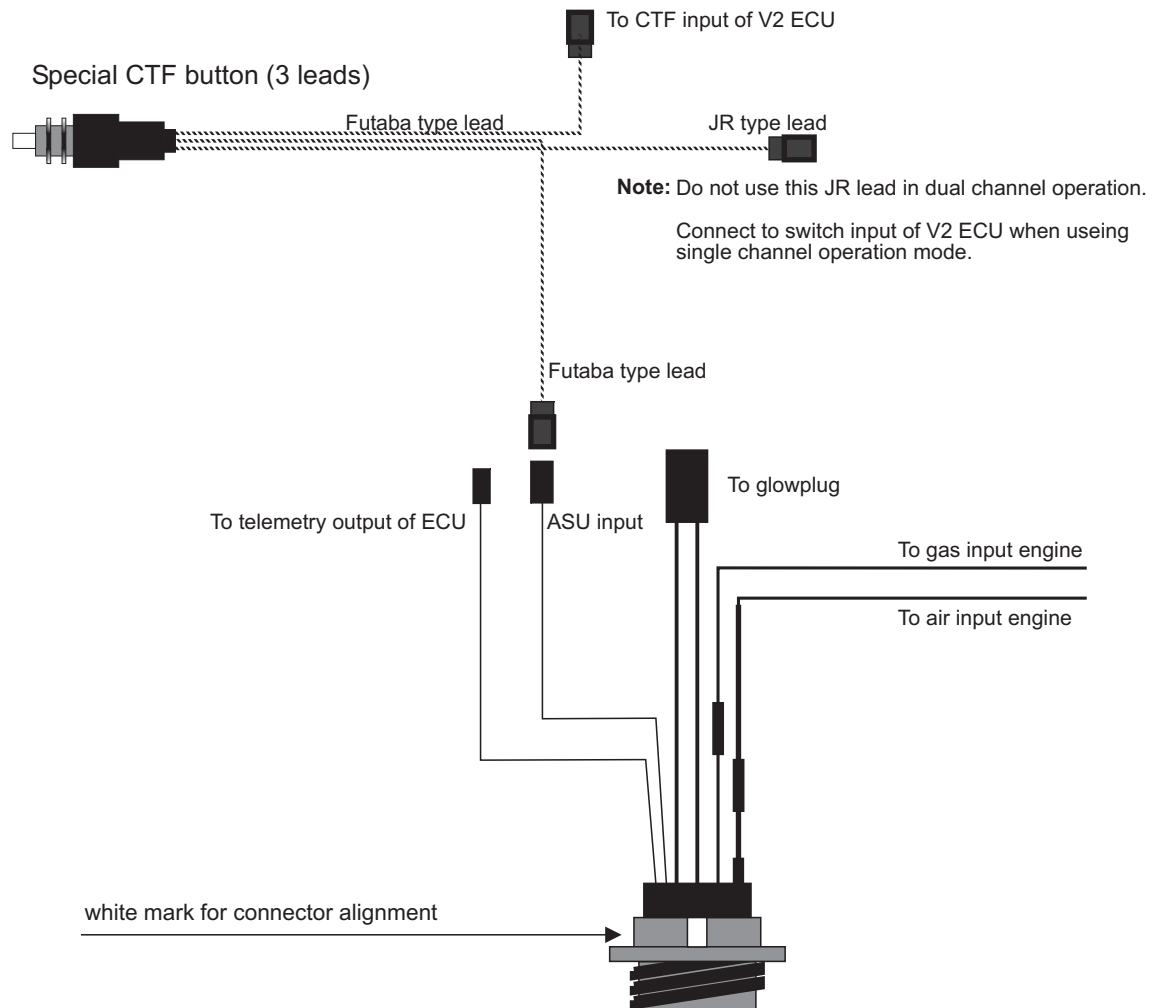
However if you fly a complicated model and you have only one channel left for operating the turbine you can use the combined throttle function as described in the next paragraph. With this combined throttle function the trim lever on your throttle channel acts as the three-position switch as described above.

When using the single channel function it is probably better to use a transmitter with a mechanical throttle trim rather than an electronic trim. A mechanical trim allows rapid and accurate positioning of the trim switch, important when the trim position is used to control engine functions as in single channel operation.

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Wiring diagram of special CTF button for **airstart engines** to use with an ASU.

This special CTF button is needed when using single channel operation and a ASU unit. When using dual channel operation and ASU connect, after programming, the CTF input of the ECU directly into the ASU input of the “female” connector.



Wiring diagram for **female ASU connector**, for use with Automatic Startup Unit

### 1.3.4.2 CTF input E (Single channel operation)

This input channel is to “teach” the ECU the pulse width of your radio system.

Connect the CTF lead (Futaba plug) to the ECU and plug the other side of the CTF lead (JR plug) to the switch channel input of the ECU.

**Note:** The moment you connect the switch channel input of the ECU into the JR side of the CTF lead, the ECU operates in single channel mode. (Combined Throttle Function)

To program the single channel operation follow this sequence:

- 1 Connect the throttle lead to the correct channel on your receiver.
- 2 Connect the switch lead on the ECU to the CTF lead (JR plug).
- 3 Switch “on” Transmitter and receiver.
- 4 Push down the CTF button, and hold it pushed down.
- 5 Switch “on” the ECU after a few seconds you will hear a beep.
- 6 Release the CTF button.
- 7 Put the throttle stick in the “Idle” position and put the trim of your throttle channel on your transmitter in the “Off” position which must be in the same direction as the “idle” position of your throttle stick and push and release the CTF button. ECU will give a beep for confirmation.
- 8 Put the trim of your throttle channel on your transmitter in the “Middle” position and push and release the CTF button. ECU will give a beep for confirmation.
- 9 Put the trim of your throttle channel on your transmitter in the “On” position which must be in the same direction as the “full throttle” position of your throttle stick and push and release the CTF button. ECU will give a beep for confirmation.
- 10 Leave the throttle stick in the “Idle” position and push and release the CTF button. ECU will giving a beep for confirmation.
- 11 Put the throttle stick in the “Max throttle” position and push and release the CTF button. ECU will give a beep for confirmation.

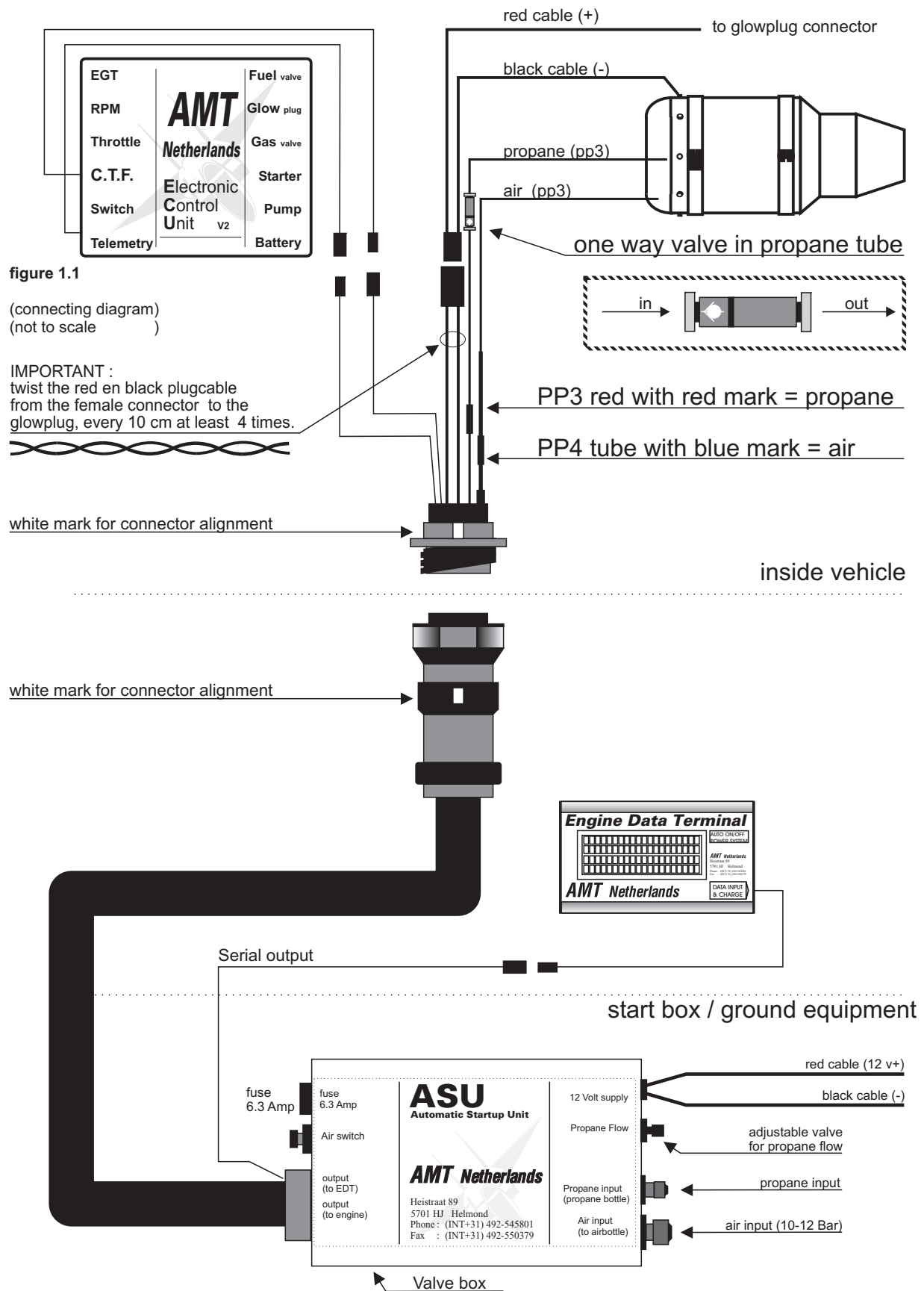
Directly after program sequence no.11 the ECU will give a confirmation beep that all pulse widths are stored in the ECU. When no changes are made in the programming of throttle or switch channels in your transmitter you do not have to do this sequence again before each motor run. You must leave the CTF cord connected to the ECU, and it should be mounted in a safe place in the model.

**Note:**

Be sure you have enough “throw” on your throttle trim when your throttle stick is set in the “idle” and in “max” throttle positions. If you are not sure check the throw with a servo connected to your receiver throttle channel.

The trim lever of your throttle channel now acts like a three position switch when your throttle stick is at the “idle” position. Best is to go to idle with your throttle stick and only then use the trim for switching purposes.

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When you are using a PCM system you can check the failsafe routine by switching OFF your transmitter.

When the failsafe time has passed the ECU will sound with a high low beep tone. This failsafe beep tone has to be reset like an engine error, see chapter 1.5.2

**1.3.4.3 CTF input E to operate Automatic Start-up Unit (air start)**

For operating and air start engine together with an **Automatic Start-up Unit** the CTF input also controls the starting sequence of the ASU unit.

The instructions for wiring the ASU to the new V2 ECU will be included in the box with the with the Automatic Start-up Unit.

**1.3.5 Switch channel input C**

For two-channel operation this input must be connected to the receiver channel that is controlled by a 3-position switch on the transmitter. This switch is used to switch the turbine into 'off', 'power-down' and 'start-up/run' modes.

When you are using single channel operation this input must be connected to the CTF switch.

**1.4 Definition of output channels****1.4.1 Fuel valve connection output A**

This output must be connected to the (red) fuel solenoid valve. When you connect the pp3 tubes to the valve be careful of the correct flow direction, which is clearly marked on the valve with an arrow. (not needed to operate the engine, but recommended by AMT Netherlands)

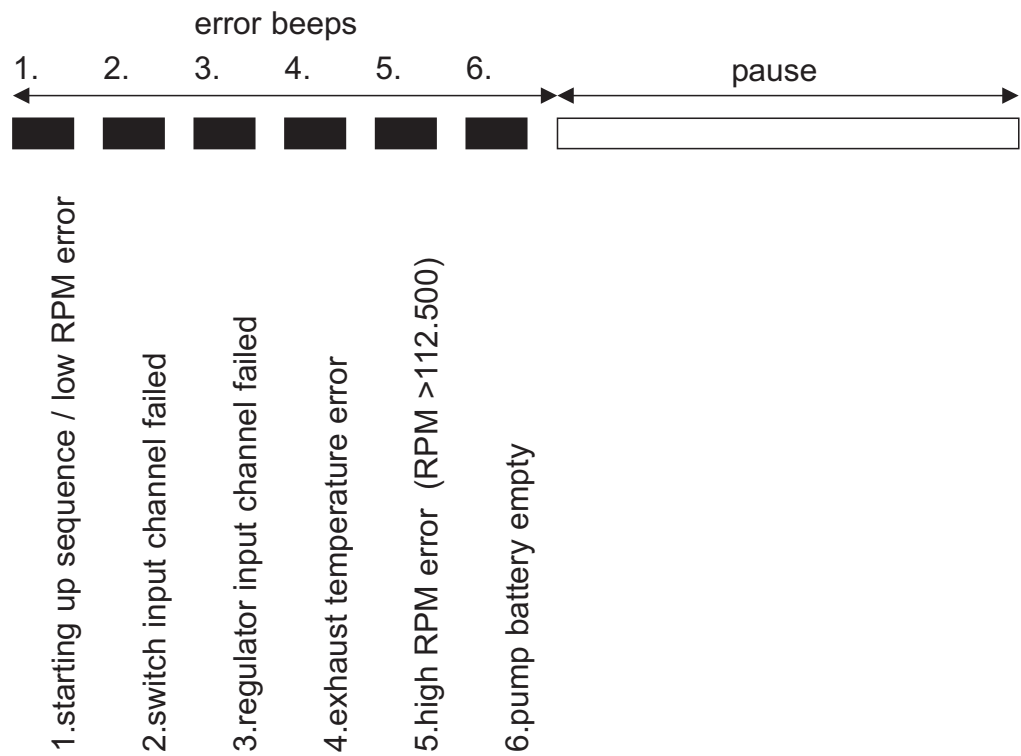
**1.4.2 Glow plug connection output B**

This output must be connected to the glow plug and “earth/negative” of the engine. Only use Rossi 8 glow plugs, as the high current of the ECU internal glow driver will destroy most other glowplugs. For the “earth” connection you should use one of the eight bolts of the engine casing. (E-start only)

**1.4.3 Gas valve connection output C**

This output must be connected to the (blue) propane solenoid valve. When you connect the pp3 tubes to the valve be careful of the correct flow direction, which is clearly marked on the valve with an arrow. (E-start only)

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(software version 23 or higher)

#### 1.4.4 Electric starter connection output D

This output must be connected to the electric starter of the engine. (E-start only)

#### 1.4.5 Fuel pump output E

The fuel pump is connected to this output channel with cables of a minimum cross-section area of 1,5 mm<sup>2</sup>. The maximum recommended length of cable from the fuel pump to the ECU is 50 cm.

#### 1.4.6 Serial port output F

This output can be connected to the **Engine Data Terminal** or to the serial port of a personal computer, which allows the input data to be visible on the screen. The telemetry software is available from your dealer or direct from AMT Netherlands.

### 1.5 Buzzer

#### 1.5.1 Buzzer beeps

The ECU has a built in buzzer which functions as an indicator of the actual state of the system. The different kind of beeps are:

OK beep:	This beep is a low pitch tone, immediately followed by a high pitch tone.
Starting beep:	When you activate the starting sequence you will hear a <i>series</i> of 5 beeps, after the fifth beep the starting sequence will take place.
No radio beep:	This beep is a low pitch tone with short intervals. It occurs when no switch channel is connected, or when the receiver is off (self resetting).
No start-up beep:	This beep is a high pitch tone with short intervals. It occurs when you attempt to start up your engine and the exhaust temperature is too high or thermo-couple is disconnected (self resetting).
Failsafe beep:	This beep is a high / low pitch tone. It occurs when the failsafe condition of the ECU is active.
Error beep:	This beep occurs when there is a system error. It consists of six short beeps with a high or low pitched tone. The high or low pitched tone indicates a non-fault, or Fault, condition. The position of the low pitch tone in the six beeps indicates the kind of error.

This beep is not self resetting!

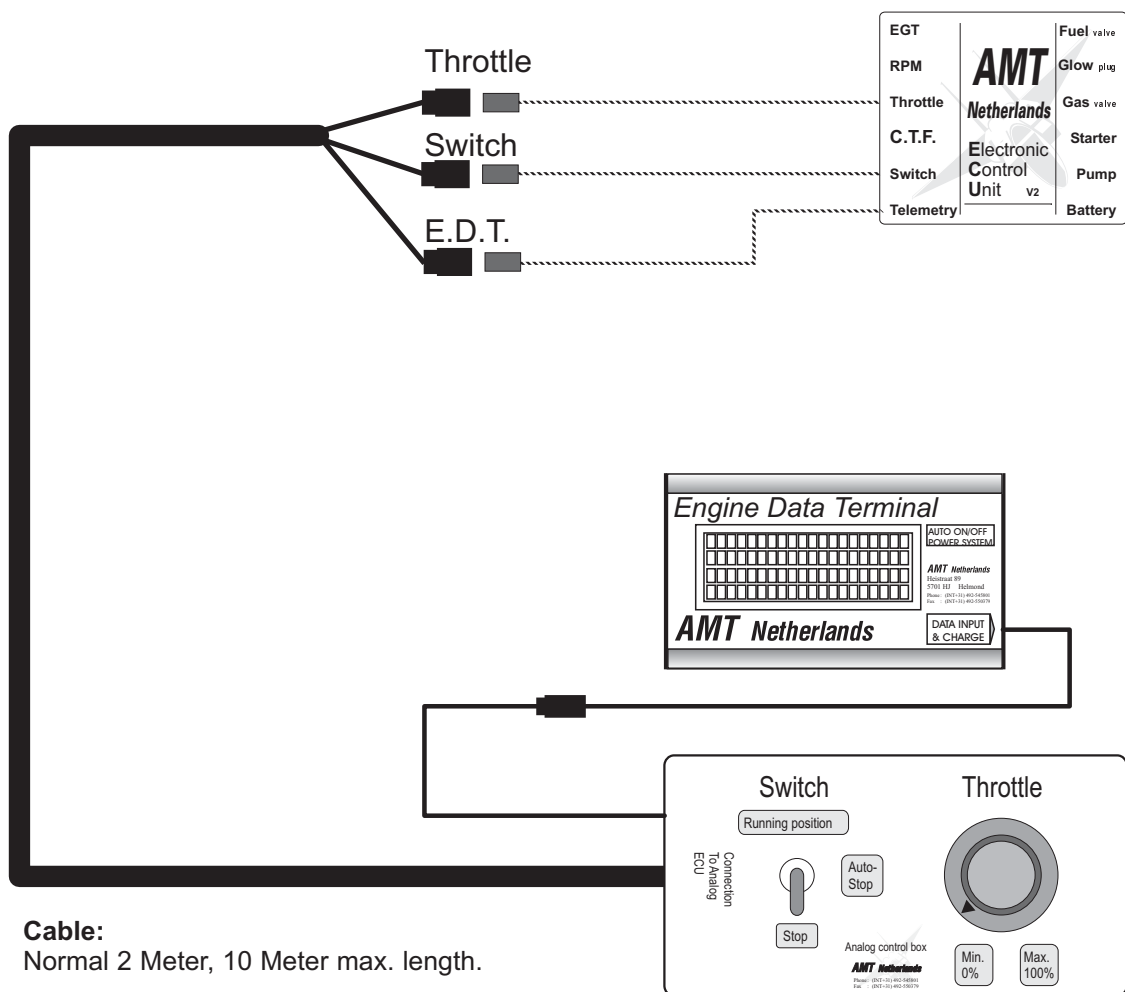
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figure 5.6

**Analog ECU and control box.**

AMT Netherlands can supply an analog ECU and control box, this type of ECU is often used when the turbine engine is used stationary in for example a university.

Now you do not need to use an RC equipment to operate the engine, this "analog" ECU works except for the 2 inputs, throttle and switch, the same as the "normal" ECU.





position 1: start-up sequence error or low RPM error.  
position 2: switch input channel failed.  
position 3: regulator input channel failed.  
position 4: exhaust temperature error.  
position 5: high RPM error.  
position 6: pump battery empty.

When an error occurs the type of error will be displayed on the bottom line of text on the EDT. When you reset the ECU error (5.4.2) also the error message in the EDT will be removed from the bottom line.

### **1.5.2 Resetting the error beep.**

When an error beep occurs, it must be reset before normal operation can proceed.

#### **Resetting errors for dual channel operation.**

To reset an error beep you must put the 3-position switch on the transmitter into the switch into the 'off' position (low pitch tone) and put the throttle stick into the full throttle position (high pitch tone). For a description of controls see manual section 7.2.

Also switching the ECU power off will reset the error message.

#### **Resetting errors for single channel operation.**

To reset an error beep you must put the throttle trim on the transmitter into the 'off' position (low pitch tone) and put the throttle stick into the idle throttle position (low pitch tone). Now push the CTF switch for 2-3 seconds to reset the error message.

For a description of controls see section 7.2 of the manual.

Also switching the ECU power off will reset the error message.

### **1.6 Analog ECU and control box.**

AMT Netherlands can supply an "analog " ECU and control box, this type of ECU is often used when the turbine engine is used stationary in for example a university.

With this ECU you do not need to use an RC equipment to operate the engine, this "analog" ECU works except for the 2 inputs, throttle and switch, the same as the "normal" ECU. For a description of controls see figure on the left.

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### 1.7 Extra features.

From software version **V24** and higher this Version 2 ECU has several options which are very useful especially when you are installing the system into a jet model.

As mentioned above these options are available in Version 24, probably higher versions will have more features as mentioned below. To know which version is available at this moment you can send an E-mail to [versioninfo@amtjets.com](mailto:versioninfo@amtjets.com), the AMT Netherlands E-mail server will send an E-mail with the current version number and its extra features in a list like below.

- 10% Not in use at this moment.
- 20% Not in use at this moment.
- 30% Glow plug switches on.** (will switch on glow plug.) (E-start only)
- 40% Not in use at this moment.
- 50% Priming function.** (will open fuel valve and activate fuel pump.)
- 60% Not in use at this moment.
- 70% Not in use at this moment.
- 80% Activation of starter motor.** (will activate electric starter.) (E-start only)
- 90% Clutch check.** (will activate clutch) (E-start only)
- 100% Quick cooling function.** (will activate speed-cooling\* function.)

\*At activating the quick cooling function, the E starter motor will keep the turbine shaft continuously spinning, even with released CTF button, until cool-down temperature is reached. A timeout of 1 minute will stop the E-starter in case of a damaged EGT probe.

The above features only with the ECU working in the dual channel mode, because the 3-position switch and the throttle stick have its unique position. To find an exact position of the throttle stick an **Engine Data Terminal** or a computer with our Telemetry program is necessary to use the above features.

To activate one of these features please handle as follows:

- Switch on the TX, RX and the ECU.
- Calibrate the ECU as described in chapter **1.3.4.1** for dual channel operation, when ECU was already in dual channel operation you do not have to do this again.
- Put the 3 position in the "off" position.
- Put your throttle stick the desired position. (e.g. 50% for the priming function).
- Now push the C.T.F. switch, after 2 seconds the selected feature will be activated.
- Releasing the C.T.F. switch will deactivate the function.

When there is a function which would be useful and not available in the above list please send us an E-mail with a description of its function.

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## 1.6 Powering up the system

It is necessary to calibrate the 2 input channels before you can operate the turbine because there are a variety of radio control systems with their own pulse widths.

For calibration see chapter **1.2.4.1** for dual channel operation, or **1.2.4.2** for single channel operation. Once this calibration sequence is done the pulse width is stored in the ECU and it does not need to be done again, unless the throttle or switch channel programming in your Transmitter is changed.

- 1 Be sure everything is properly connected to the ECU. Do not use dual rate, exponential or logarithmic servo control, servo limiting, idle trim or trim memory to either of the 2 input (throttle and switch) channels.
- 2 If you use a PCM transmitter switch on your transmitter before your receiver. After this switch on the ECU. You should hear the "OK beep". If you do not hear this beep please check your pump battery and its connections. If you hear a "no start up beep" (high pitch tone with short intervals) the thermocouple is disconnected or broken. If you hear a "hardware error beep" (continuous low pitch tone) please contact AMT Netherlands or your AMT NL dealer.
- 3 If you are using dual channel operation you should get the 3 beeps (low, middle and high) from the 3 position switch and 3 beeps from the throttle.
- 4 If you are using single channel operation you should get the 3 beeps (low, middle and high) from the throttle trim, when throttle is on idle, and 3 beeps from the throttle when you move the stick from idle the max throttle.

You can also monitor these positions when using the optional **Engine Data Terminal**.

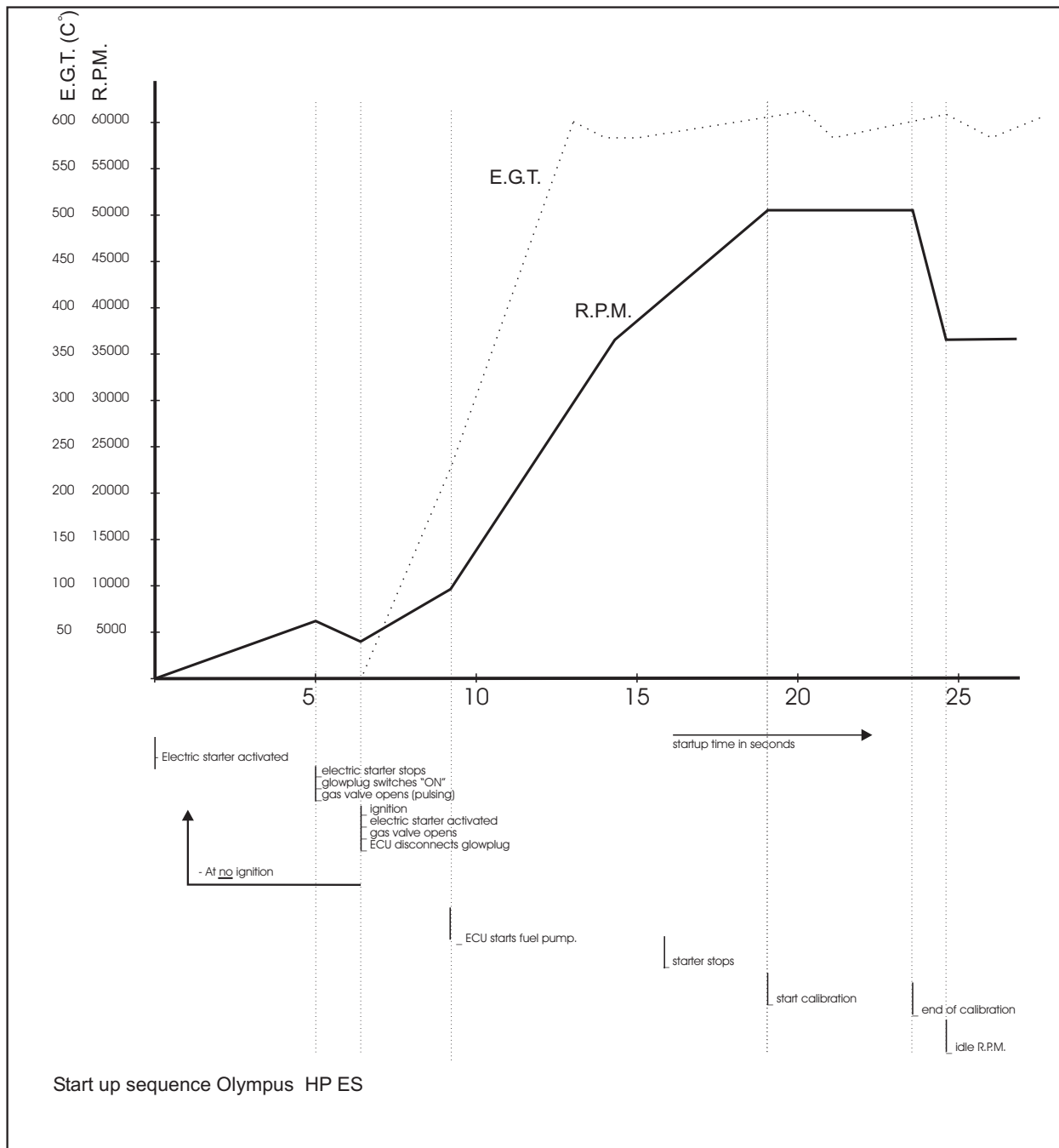
- 5 It is a good idea to check throttle and switch (or throttle and trim) operation before every flight, by listening for the beeps as described above.

## 1.7 Starting the engine (ECU software version V23 or higher)

**Note:** AMT recommends that you fully charge the ECU/pump NiCad battery before every flight, to be sure that you have the maximum energy available.

Power up the system as described in 1.6.

- 1 Put the throttle in the idle position (low pitched beep).
  - 2 Put the 3-position switch (or throttle trim lever for single channel operation) on the transmitter in the 'off' position (low pitched beep).
-



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- 3 When you use an external gas tank, instead of an internal gas container, connect this gas tank to the system and open the regulator valve fully. (e-start)
- 4 To start the turbine put the switch (or throttle trim lever) on the transmitter in the 'start/run' position (high-pitched beep). Now you will hear 5 beeps from the ECU, and then it will begin the start sequence and the electric starter motor or ASU will turn the turbine. The glowplug will be switched off automatically as soon as the turbine has ignition.

**Note:** *If you try to start the turbine and you hear a continuous high pitched tone with short intervals, the engine's exhaust temperature is too high for restarting. (Above 88°C). Leave the switch (or trim lever) in the middle position in order to cool the engine. When it has cooled down switch over to the starting position.*

- 5 The ECU will automatically start the fuel pump and open the fuel solenoid valve when the RPM reaches 9,000 RPM and the EGT exceeds 88 °C. (Olympus HP)  
If using an external gas container, keep the starting gas regulator fully open until the ECU is passing idle RPM (36,000 RPM). (Olympus HP)
- 6 The ECU will automatically throttle up the turbine to its calibration point at approx. 50,000 RPM. (Now you can disconnect and remove the external gas container, if used). The ECU will keep the turbine at approx. 50,000 RPM for about 5 sec and then it will automatically throttle back down to idle RPM (36,000). Idle RPM is now calibrated. (Olympus HP)
- 7 You now have control over engine thrust with the throttle stick on your transmitter.

**Note:** When you throttle up for the first time after starting, the engine power is limited to about 90% for 2 - 4 seconds for internal calibration of the ECU. Therefore when you want maximum power for take-off you should make sure that you have first throttled up to full power one time, and held the throttle stick there for at least 3-4 seconds.

If you are using our optional 'EDT' then as soon as you see "Max RPM set" in the bottom row of text, this is confirmation that you will have maximum power the next time you throttle up.

### 1.8.1 Stopping the engine

For the normal stopping of the engine you should use the automatic "power-down" sequence which functions as follows:

- Put the nose of the model into the wind if possible.
  - Put the switch (or trim lever) on your transmitter to the middle position to activate the automatic power-down sequence.
-





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- The ECU now regulates the engine to 30% throttle (approx. 60,000 RPM) for about 5 seconds and waits until the exhaust temperature stabilizes. Be careful - there is still about 2 kg of thrust at this RPM.
- After this the ECU will stop the engine.
- Then the ECU will automatically switch the Electric-starter on and off several times, until the EGT is below 88 °C. (Olympus HP)

The ECU is now ready for a new start-up.

**1.8.2 Switching off in case of an emergency**

If, in case of an emergency, the turbine needs to be switched off quickly, you can immediately switch over to position 1 "off" (low pitch tone) using the 3 position switch, or throttle trim lever if using single channel operation.

The ECU will now stop the turbine immediately from any RPM or power setting. You should only use this method in emergency cases and if fail-safe programming is possible in your transmitter (PCM transmission mode).

The advantage of the programmed 'power-down' sequence is that the turbine is switched off with the coldest possible motor and at a relatively low RPM, which is best for the fatigue and the wear of the ball bearings.

**1.9 Recommended fuelling and charging sequence**

From the experience of AMT staff we have found that the following sequence between flights works well. It allows the internal gas container the longest time to return to ambient temperature after filling, giving the most reliable starting because of the higher temperature and pressure in the container. (E-start)

1. Fill the internal gas container in the model before every flight with liquid propane, using the "70%" overflow valve to make sure that it is full. (E-start)
2. Connect fast NiCad- Lipo charger to the ECU/pump battery and start charging.
3. Fill fuel tanks while charging is taking place.
4. Recharge Receiver NiCad (and transmitter) if necessary.

**Note:** AMT highly recommend recharging the ECU/pump battery before every flight, and a complete slow discharge and recharge after each day of flying.

**Note:** AMT Netherlands recommends to cycle, discharge / charge, the a new NiCad battery at least 5 times before using them, to get the maximum capacity available.

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