

Xicoy

Electrónica SL

FADEC system - Autostart 10

Users Guide.



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Welcome!

Congratulations on the purchase of your new FADEC 10 controller. Xicoy are dedicated to the design and production of electronic controllers to the highest standards of quality and reliability to bring you the customer the very latest next generation designs. The FADEC 10 is the result of an intensive effort of design and tests.

PLEASE READ!

The Xicoy Electronica SL responsibility is limited exclusively to the repair of the FADEC and accessories which are outlined in the conditions of warranty.

Before using this controller please read this manual and agree to the conditions of warranty.

Customer satisfaction is important to us. Technical support is available through your local dealer and through our email.

Legal and Disclaimer

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Disclaimer

Gas turbine engines are a sophisticated piece of machinery. Care should be taken at all times when using these engines. They should only be operated by those with the appropriate skills and knowledge to do so. Incorrect operation or misuse can cause damage to property and bodily harm operators, spectators and animals. Xicoy Electronica SL accepts no liability for any kind of damage which may occur.

Xicoy Electronica SL assumes no responsibility for any errors contained in this document and is not liable for any damages resulting from such errors.

It is forbidden the use of this equipment outside Radio Control applications, specially those that power vehicles that carry people.

Warranty

The warranty period for the FADEC 10 is 1 year from the date of purchase. Warranty is valid solely for the original owner and is non transferable upon resale.

Warranty includes parts and labor and is limited to manufacturing and material defects only.

Damage or defective operation covered under the warranty terms will be repaired and tested at no cost to the original owner (other than postage and packaging). Repairs not covered under the terms of warranty will be carried out by Xicoy Electronica SL, or their appointed agents after agreement of costs.

Before returning any equipment for service of repair, please contact first to your local dealer or Xicoy central office to agree action and costs. Please check the "Limited warranty conditions" at the end of this document for details.

Description of the FADEC.

The FADEC (Full Authority Digital Engine Control) is a total system for the control of a model gas turbine engine. Its main function is to control and regulate the electric fuel pump, providing to the turbine engine the necessary amount of fuel for safe and controlled operation, and to operate the ancillary devices for starting. The FADEC measures the exhaust gas temperature, the relative position of the throttle stick and the rotor speed. It monitors all of the controls necessary to guarantee that the engine stays between the user defined parameters of operation, also providing failsafe shutdown of the engine when it has detected any important anomaly. In order to make this assessment, the FADEC has a rpm sensor, a thermocouple input, a throttle servo input, power connections for the fuel pump, starter, glow plug, fuel and gas valves and the battery and a proprietary digital port to program and read the engine data in real-time to a PC.

The measurements made by the FADEC are:

- Temperature of the exhaust gas
- Battery voltage
- Battery current
- Width of the throttle pulses from the radio transmitter
- Engine rotor RPM
- Engine run time.
- External analog signal (airspeed sensor)

Features:

- RPM input: Magnetic sensor up to 250.000 R.P.M. One pulse each turn.
- Temperature range up to 1000°C using a "K" type thermocouple
- PWM control of 8192 levels for pump, glow plug and starter motor.
- Adjustable power for the starter motor
- Build-in electronic brake for the starter motor to help the clutch to disengage.
- Blown glow-plug detector
- Adjustable glow-plug power
- Glow-plug temperature independent of the battery voltage
- Elapsed engine run timers
- Digital interface to a PC or to a handheld terminal.
- Black box function. Record the engine measures each 0.5sec up to 52 minutes.
- Radio link error counter
- Battery usage counter in mA/h
- Test functions for all connected devices.
- Start modes: Manual, Auto Gas and Kerostart (1)

(1) Currently Xicoy Electronica offer 2 models of Fadec 10, one that allow manual and gas start, and the second, that allow manual, gas and kerostart. In this manual all the comments about kerostart apply only to Kerostart FADECs. Ignore them if you own a Gas start FADEC.

Connections:

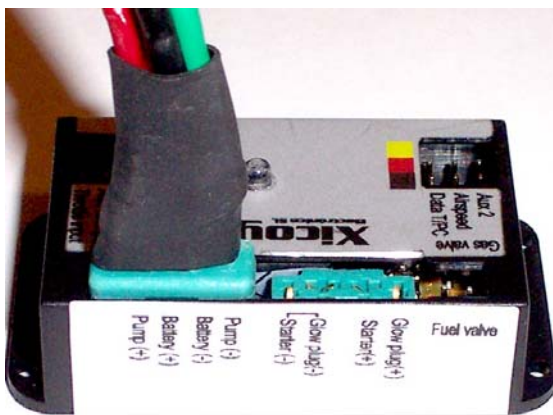


The FADEC have 3 types of connections:

Power connections: Two high quality MPX connectors carry all the power current.

Each power lead is identified by the label on the FADEC body.

The female MPX plug provides the power to the glow plug and starter motor. Use 0,5mm flexible cooper lead if the length is up to 0,5m, and 1mm if higher for Gas start engines, 1mm² minimum for Kerostart burner. Both negative leads are connected to same place inside the FADEC, so it is possible to use only 3 leads to the engine, sharing the negative between starter and glow plug. Take care of doing a neat installation to avoid short-circuits, specially in the starter connection, it is very easy that the soldering in the red lead touch to the starter cover in some engines.



The male MPX plug provides the connection to the pump and the battery. Use minimum 0,5mm cooper lead for the pump and 1mm for the battery. Keep all connections well isolated between them, and be sure to not reverse the battery polarity, the fadec will be burned out immediately. The battery voltage should be of around 7,2V, either 2s Lipo or 5 cells Nicd/Ni Mh for Kerostart. Gas start allows the use of A123 2s cell (6,6V).

DATA Connection:

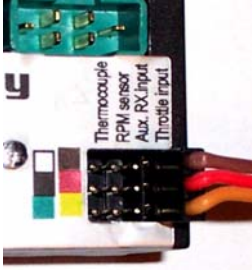
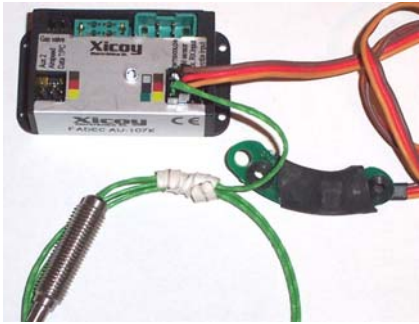
One 3 pin servo socket, placed on the left side of the FADEC, provides the connectivity to the handheld data terminal or a PC.

Signal connections:

4 JR type receptacles provide the connection to the RX and sensors

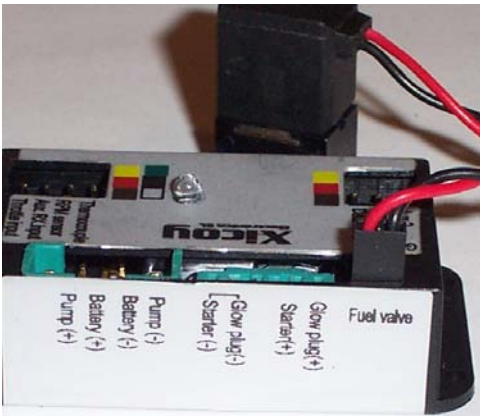
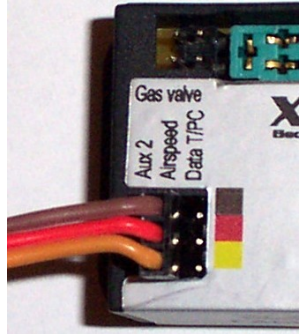


Connect the RPM sensor and thermocouple on its respective sockets, in the orientation that is shown in the colored labels on the fadec. If necessary, both leads can be extended using good quality servo extensions.



Connect the throttle lead from the RX in its place, in the upper position. Side socket is ready for a second servo signal but not used on present firmware

Airspeed (pitot) sensor, if used, must be connected as shown in the picture, at the side of the data terminal connection.



The last two sockets are used for the connection of the solenoid valves. Bottom position for the gas/keroburner solenoid, and the upper position (as shown in the picture) for the main fuel valve.



About solenoid valves, please note that they should be of the same rated voltage as the battery and consume less than 0,5A.

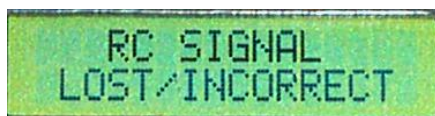
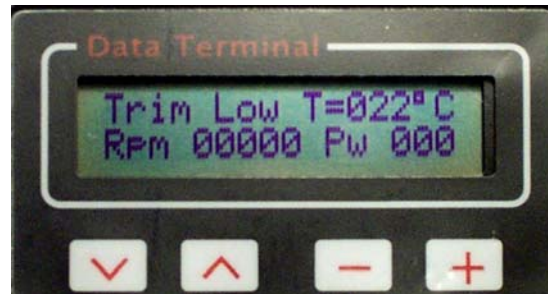
Using and Programming the FADEC:

All the programming and measures are done through the data terminal. Once the FADEC is programmed, it is not necessary its use and it is not recommendable to leave it inside the airplane to minimize the risk of interferences.

The data terminal has a 16 character LCD screen and 4 buttons.

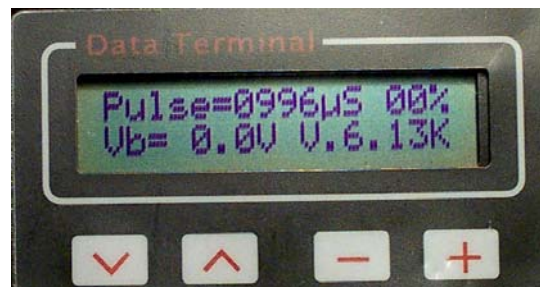
The first two buttons on the left side allow moving through the menus, and the two buttons on the right side allow changing the data.

Main screen, as shown in the picture, give to the user that main readings from the engine. These are the FADEC status, the EGT (temperature), RPM and pump power.



In the case of an error, this screen changes to the error screen each 2 seconds

Pressing the second button from the left (Menu Up) the second informative screen is shown. In the first line you have the measure of the pulse width received from your RC system, and the relative stick position. Second line shows the voltage of the battery and the software version. If the current drawn from the battery is higher than 0,5A, then the FADEC display the battery voltage and the battery current in Amperes. Gas start units have the software version finished with a "G", where Kerostart have a "K".



Next menu let you to choose in four submenus, selected by pressing the button under of each option.

Start: Jump to the parameters used on startup

Info: Information and test menus

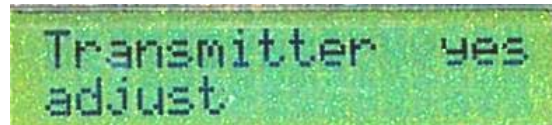
Radio: Adjust the radio throws

Run: Set the parameters used during engine run.

It is recommended that the first adjust be the one of the radio:

Aligning the transmitter with the FADEC

Turn on the transmitter and receiver. Using the "menu up" and (-) buttons move to the "Radio" menus. First screen will be this one:

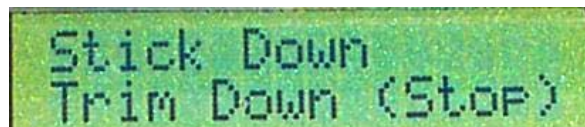


If you are sure that you want to modify the radio settings then press the right hand button (+) and the screen will change to:



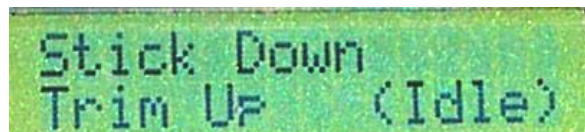
On your transmitter, raise first the trim to full and next the throttle stick to full. Ensure stick is firmly against the stop. Now holding the stick against the stop, press the right button (+) to store the current signal value into the FADEC. **IMPORTANT NOTE:** Pressing any other button the setting **WILL NOT** be stored.

The screen will now change to:



Move the trim (or switch the "engine cut" switch to on) and throttle stick back to zero and again press the right hand button (+) to store the position.

The display will now change to:



Leaving the throttle stick in the minimum position, raise the throttle trim to the full up position or switch "Engine Cut" switch to off, and again press the "+" button. The FADEC will store the current position as IDLE.

If you have done all steps correctly the blue LED will light up in the ECU when the "Idle" command, (trim and throttle stick set to idle positions on the transmitter). Lower your throttle trim and the LED will go out indicating correct reading of the transmitter engine shut off signal by the FADEC.

On rare occasions, usually when using a Futaba transmitter, it has been found that the throttle channel sense of movement may require reversing (Servo reverse) and repeat the transmitter alignment.

Correct reading of throttle % by the FADEC can be verified in the second screen, percentage of the throttle position is shown on, 0% in the position of engine stop (trim and stick down), 100% with stick/trim full up and between 10% and 30% at idle.

This now completes your radio setup and should only need doing again if the radio settings in the TX are changed.

Throttle curves.

By default the FADEC control the RPM in linear way, i.e., at half stick position the engine turn at half of the rotor RPM range. Jet engines develop the thrust in exponential mode, thus half RPM means approximately $\frac{1}{4}$ of thrust. On small engines with a high idle to full power rpm ratio, or in a high drag/low power planes, often only the last 1/3 of the throttle stick produce significant thrust, with the low half stick travel being not used. Although that with current digital TX the pilot can modify the throttle curve to suit his needs, three throttle curves have been added to simplify the setup for most of the installations:

FULL EXPO: Mean linear RPM, it is the default setting and the mode used for all previous software versions. Thrust develops exponentially, and it is the recommended curve for big engines or/and high thrust/weight ratio planes, as it ease the control in low power used during taxi.

LINEAR: Mean that the thrust develop linearly with the throttle setting. Could cause difficult taxi, as it would be difficult to fine adjust the power at low settings.

HALF EXPO: An intermediate setting between the other two modes.

MODE	Stick position					% of total thrust
	0% (Idle)	25%	50%	75%	100%	
FULL EXPO	Idle thrust	6%	25%	56%	100%	
HALF EXPO	Idle thrust	16%	38%	66%	100%	
LINEAR	Idle thrust	25%	50%	75%	100%	

Throttle curves can be changed while the engine running, so you can leave the throttle at a given position and switch between the curves to see the difference.

Info and test screens.

This submenu contains several screens that provide useful information and tools to get the maximum information on your system and to aid to correct any malfunction.

Running Time Counter.

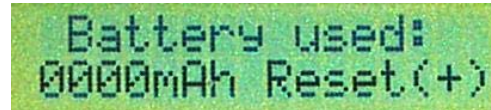
This screen contains a timer which shows:

Timer: Tot:0000m
Last:002s Cy:000

The total running time of the engine in minutes (Tot),
The time in seconds of the last engine run (Last)
The total number of starts (cycles - CY).
Use this screen to keep track of your total running time and starts.

Battery used Counter.

This screen display a mAh counter which shows the capacity used from the battery. The counter can be set to zero by pressing the (+) button.



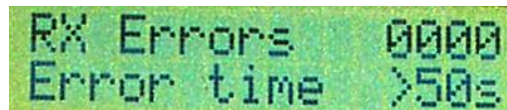
Battery used:
0000mAh Reset(+)

The use of this screen is to know the capacity of the battery used in a flight or in a session to decide when its time to recharge it.

NOTE: The precision of this counter is +/- 10%.

RX errors Counter.

The FADEC detect an error on the signal received from the RX when this signal is absent or outside from the valid window programmed during the Radio setup. The standard on RC systems is that servos should receive 50 control pulses/second from the RX, and each pulse duration should be between 1000 and 2000 microsecond.



RX Errors 0000
Error time >50s

The standard on RC systems is that servos should receive 50 control pulses/second from the RX, and each pulse duration should be between 1000 and 2000 microsecond.

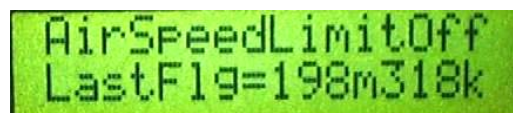
First line on this screen display the count of the pulses received that are shorter than the "STOP" signal or larger that "Full power" signal received by the FADEC during the Radio setup.

Second line shows the duration of the wrong signal, and this include the time that no pulses have been received.

On PCM and 2,4G systems, the signal issued by the RX during a radio link failure depends of the programming of the failsafe settings in your TX. If you program your failsafe settings to "hold" or set the throttle position during failsafe in a valid position for the fadec (signal between STOP and FULL POWER) the fadec will not detect any radio problem, so it don't will count any error. Our recommendation is to program the failsafe of your TX to issue a signal to the throttle channel of less value than the STOP signal. I.e., if your STOP position is -100% set the throttle failsafe to -125%. This will assure that the fadec will recognize a failsafe condition, record the time, and stop the engine after 2s if the radio link is not recovered. This last condition is obligatory in some countries and 100% recommendable. **Never fly your plane with the failsafe set to "hold" in the throttle channel.**

Airspeed.

If the airspeed sensor is connected to the FADEC, it will detect it at power-up and enable this screen. On first line it is possible to set the maximum airspeed allowed for the plane, between 32 and 250mph (50 to 400km/h), or OFF (no limit). The fadec will reduce automatically the throttle to keep the airspeed at or below the maximum. Please note that



AirSpeedLimitOff
LastFlg=198m318k

The fadec will reduce automatically the throttle to keep the airspeed at or below the maximum. Please note that

the fadec only can reduce the throttle, it never will give more power than the one set by the pilot trough the throttle command.

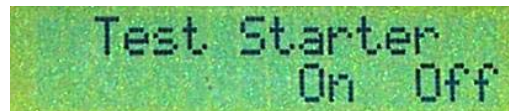
Second screen show the maximum airspeed reached on last flight in mph and km/h. This maximum is set to zero on next engine start.

Setting the throttle to higher than 50% (with engine off) the second line will change to "Current airspeed" to allow you to test the operation of the airspeed sensor.

Besides the maximum airspeed, the fadec record the current airspeed each 0,5s during the last 51 minutes and store it in its internal memory, along with the RPM, EGT, Throttle position and pump power. It is possible to download later these measures to a PC and see the airspeed of the plane during all flight phases.

Test menus

The Fadec provides several menus to test the starter motor, glow plug, pump and solenoid valves.



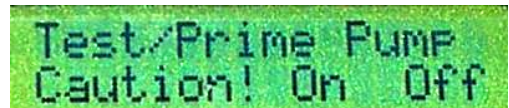
Test Starter
On Off

These test screens are only available when the Fadec is on "Trim Low" status, that is to say, recently powered up and receiving a STOP signal from the TX.



Test Glow-Plug
On Off

Pressing the (-) button (under the "ON" reading on the screen) will energize the selected device and pressing (+) will shut down.

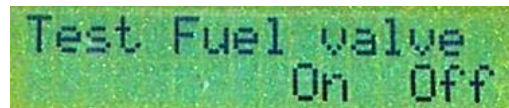


Test/Prime PUMP
Caution! On Off

Special care should be taken when testing the pump, as it is possible that some fuel be pumped in to the engine, flooding it, and causing a hot start on next startup



Test Gas valve
On Off



Test Fuel valve
On Off

RUN menus:

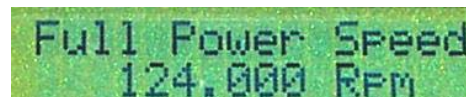
On these submenus the parameters used for the engine during normal run can be modified.



Normal RUN
Parameters

Note that some of these menus could not be available in your unit if your fadec belong to a production engine where the engine manufacturer have set these values at factory and restricted to the users to modify them.

Full power speed: On this screen you can set the RPM that the engine will run at 100% throttle. If the engine manufacturer has set an upper limit, you will be able to reduce the maximum speed, but not to increase it beyond the limit.



Full Power Speed
124.000 RPM

Idle speed: Set the RPM that the engine will run when the FADEC receive IDLE command. While the



Idle Speed
45.000 RPM

engine running the faDEC will adjust the rotor speed accordingly the throttle position in a closed loop system.

STOP speed: Set the minimum RPM that the engine is allowed to run. The FADEC will shutdown the engine if the rotor speed is below this setting.

Start/Min temperature: Set the minimum temperature that the engine is allowed to run, and in manual start operation, sets the temperature from witch the pump begin to run.



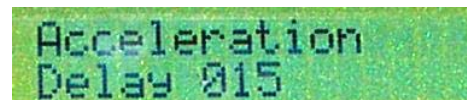
Start/Min. Temp
0100°C

Maximum temperature: Set the maximum temperature that the engine is allowed to run. The FADEC will reduce the acceleration rate if the EGT approaches to maximum and will reduce the pump power if necessary to keep the temperature below the maximum, but it don't will cut the engine if the temperature is too high, it will try always to keep the engine running by reducing the fuel flow .



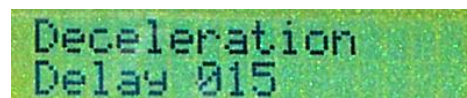
Max. Temperature
0800°C

Acceleration delay: Set the acceleration time on the engine. Higher values mean longer acceleration times. The real acceleration time is calculated using a complex algorithm that take in to account this value, temperature, current RPM, commanded RPM, and the tendency of EGT and RPM.



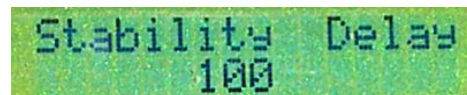
Acceleration
Delay 015

Deceleration delay: Similar to the acceleration, but used during throttle down. Higher values mean slower deceleration.



Deceleration
Delay 015

Stability delay: When the engine is running at constant throttle setting, the FADEC is adjusting continuously the pump power so that the rotor RPM mach exactly with the throttle signal. The speed of witch the faDEC adjust the pump power is set by this parameter. A value of 100 usually is the best for all engines. A too low value can cause instability on the RPM.



Stability Delay
100

Pump Limit: The Fadec can give to the pump the full battery voltage, but in most cases the voltage needed for the pump is only a fraction of the full battery voltage. Limiting the pump give a much smoother control of the engine and prevents that the pump could receive excessive voltage in the case of a problem in the fuel circuit, a clogged filter for example. This excessive power will cause a high pressure on the circuit that can cause leaks or blown tubes.

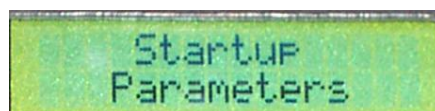


PUMP LIMIT
1020

Modifying this parameter is similar to reducing the battery voltage, so the accel and decel times will be modified. The recommended adjust of this setting is to set it to 1020 (no limit), run the engine, check and annotate the Pw of the pump displayed on the first screen when the engine is running at full power and then use this value as pump limit, increasing it in a 10%-20% to give a bit of margin for weak batteries and pump wear. Once the new value set, adjust the accel and decel delays for best engine handling.

START menus:


On this submenu you will find the parameters used during the engine startup. Like the "RUN" menus, some of these parameters could be not available in fadecs used in production engines.



Startup
Parameters



Start Mode
MANUAL



Start Mode
AUTO-GAS

There are 3 start modes available:

-**Manual**, where the user should do all the start sequence, and the fadec only control the pump and the fuel valve

-**AUTO-Gas**: The fadec do all the start sequence automatically controlling the starter, glow plug, pump and valves, using auxiliary start gas (propane-butane) for ignition.

-**AUTO-Kero**: The fadec do all the start sequence automatically controlling the starter, kerosene burner, pump and valves, using kerosene for ignition. This menu only appears in kerostart fadecs.

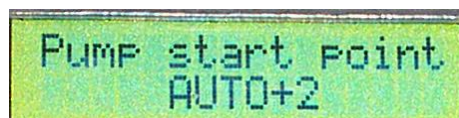
Depending on the selected start mode the parameters available are only those related with the selected mode.

Manual Start mode:

In order to start the engine in manual mode, the user must first raise the transmitter throttle trim and leave the throttle stick in idle/minimum position. The Light Emitting Diode (LED) on the FADEC illuminates, and the status screen show "Ready" indicating the system is "ready for start". Once in this position, the operator must 1) turn/spin up the engine with the starter motor / blower etc, 2) open the butane/propane gas, and ignite it. When the FADEC registers an exhaust temperature higher than the programmed start/minimum temperature and the rotor turning, the "Fuel Ramp" begins, the LED begins to blink and the system begins to pump fuel to the motor, raising the fuel pump power slowly until the idle speed is reached. This final condition is signaled by the system extinguishing the LED and the "Running" word on the status screen. The user now has control of the engine power trough the throttle stick. Setting the trim to LOW the engine will be shutdown.

Parameters used in "manual start" mode:

Pump Start point: Sets the power of the pump when it is started at beginning of the fuel ramp.



PUMP start point
AUTO+2

The FADEC have the ability of to automatically adjust the pump power to start it at the lowest possible speed, independently of the battery voltage and pump roughness. Also the user has the possibility to adjust the minimum pump power manually.

AUTO mode: The values of "Pump start point" from 0 to 8 are in AUTO mode. This means that the FADEC will adjust itself the pump power to start it slowly by measuring the voltage generated by the pump motor. The usual value for an unknown engine is AUTO+2, but after the first start you can increase or decrease the fuel flow if needed.

Manual mode: From values from 9 to 255 the power applied to the pump is fixed. It is necessary to test with the selected pump and battery the right value to have the pump to start at the desired speed.

Pump Start ramp: This parameter adjust the speed of the fuel increase during the "Fuel ramp" phase. Higher values mean a faster fuel flow increase.



Increase this value if the engine takes too long to arrive to idle, and decrease it if the starts are too hot, with the engine overshooting the idle speed.

Auto Start mode. GAS:

Ensure your engine operates correctly before attempting full auto-start operation. You can run the engine using the FADEC in manual mode, see "Manual Start mode" section.

Keep the magnetic RPM sensor clear of stray magnetic sources such as fuel pump and glow plug wire as the magnetic field generated can upset the rpm reading.

Ensure your starter operates smoothly and without sticking. You should be able to attain at least 1/3 of the idle RPM when the engine cold and 2/3 of the idle RPM during the engine starting with the starter powered directly with the battery.

Ensure that the filament of your glow plug is well exposed out of the plug to ensure prompt gas ignition.

A restrictor is sometimes required to control the flow rate of the start gas, especially if pure propane is used. Gas supplies must be gas only, dip-tube liquid feed types are not suitable. Propane/Butane mixtures work well in temperate climates. Beware of using too much gas in the belief this will ignite more easily. Keep the maximum gas pressure under 2 bar (25psi) to avoid damage to the solenoid valves.

Problems lighting the gas are mostly related to plug element exposure, ensure the element is pulled clear so the gas can really "see" the element. It needs to glow bright yellow for good ignition, so adjust the "glow power" voltage in the main menu as required.

If necessary, prime the fuel circuit using the "pump test function" on the INFO menus. Stop the pump when the fuel arrive close to the engine (10-20 cm) but avoid to fill the engine with fuel. Use this option only to fill the tubes after servicing, but not at each start.

Always set-up and confirm the operation of your Auto-start installation on the test-stand, before installing into your model.

The present version of Autostart uses only one channel for all of the engine functions: To trigger the autostart cycle, the process is as follows:

1. The user raises the trim. "Ready" will appear on the HDT (Hand data terminal) screen. The trim and stick should be where the engine is supposedly to be to idle once running. If the trim is on "stop" position, "Trim low" will be read on the HDT. If higher than idle, "StickLo!" will be read.

2. When "Ready" is displayed, the user should cycle the stick to full power and back to idle.
3. When the stick is at idle again, the start sequence begins.
4. The glow-plug is powered and checked. Once hot, the starter is engaged at reduced power (soft start) and the gas valve is energized. If the glow test fail, a "Glow Bad" message is displayed, and if the starter fails to have the rotor turning a minimum RPM in 2 seconds, a "start bad" message is issued, and the autostart function aborted.
5. When the rotor arrives at more than the "ignition max rpm" programmed parameter (default 4000), the starter is disconnected and the brake applied.
6. When the rotor RPM fall below than the "ignition min. Rpm" parameter (default 2000), the starter is switched on again to raise the rotor speed to the "ignition max rpm" and the cycle is repeated until the gas ignites or the system times out after 30s.
7. When the thermocouple register a increase of 50°C in temperature meaning that the ignition have occurred, the starter is switched on immediately at reduced power, increasing his power accordingly to the real rotor rpm. At the same time the pump is switched on at "pump start point" power, and the fuel valve is opened.
8. The engine begins to accelerate as soon as the fuel begins to burn, and the power of the pump is being increased trough the time at the "fuel ramp" slope. Once the rotor RPM arrive to the RPM set in "rpm switch off gas" parameter (usually set at 3/4 of the "starter off RPM") the gas valve is closed, and when the RPM arrive at the predefined "starter off RPM" value, the starter is switched off and the brake applied to it. The engine continues accelerating alone until the idle RPM are reached.
9. The user can finish the sequence in any moment, simply setting the trim to "off" position. If the engine was on "running" phase (above idle rpm), a cooling sequence will be triggered, cycling the starter motor until the EGT is below the minimum programmed temperature. This cooling sequence will be aborted if the trim is raised again.
10. If the engine is hot (EGT higher than the minimum temperature) at the moment that the user triggers the autostart cycle, then the FADEC will begin a cooling cycle until the temperature is below the minimum programmed temperature. At this moment it will continue with the normal autostart cycle if the trim is left in op position.

Parameters used in "Autostart GAS" mode:

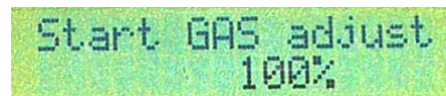
Pump Start point: Same use as in "manual start"

Pump Start ramp: Same use as in "manual start"

Glow plug power: Adjust the glow plug brightness, it should be adjusted depending on the plug type, Usual values are between 1,5 and 2V.



Start GAS adjust: The Fadec can cycle the solenoid valve to adjust the starting gas flow. 100% mean that the valve is all the time open, 50% half time open/half time closed, etc.



Low Batt. Volts: During on start phase the fadec check the battery voltage, and abort the start if the voltage falls below this setting. Once the engine is running, the FADEC ignore this voltage and keep the engine running until the battery is fully depleted.

```
Low Batt. Volts
6.00
```

Starter Power at Ignition: Sets the power applied to the starter during ignition phase. The power should be enough to assure a correct bendix engagement but not excessive to avoid to overload the starter and fadec, and to have the rotor turning too fast to blow the starting gas away.

```
Starter Power at
ignition: 090
```

Ignition MAX RPM: Sets the rpm where the starter will be switched off during ignition phase.

```
Ignition MAX RPM
05.000 Rpm
```

Ignition MIN RPM: Sets the rpm where the starter will be switched ON again during ignition phase. Do not set below 2000 nor equal or higher than the "Ignition MAX RPM"

```
Ignition MIN RPM
02.000 Rpm
```

Preheat time: Sets the time that the fadec wait after detecting ignition before to begin the fuel ramp to give time to the combustion chamber to warm-up and the pump to start.

```
Preheat 1 time:
2.0 5
```

Starter Power at preheat: Sets the power applied to the starter during the preheat time. The value usually is the same as "Starter Power at Ignition", but in some engines could be necessary to have higher power.

```
Starter Power at
preheat: 089
```

RPM 100% Starter: The power applied to the starter during the fuel ramp phase is increased accordingly to the real rotor RPM to keep the starter torque constant over all rpm margin. The minimum power is set trough the "Starter Power at preheat" and the maximum (full battery voltage to the starter) is applied when the rotor arrive to the RPM set on this parameter. Usual values are a 80% of the "no load" RPM of the starter motor at full battery voltage. This feature allows using small/ low voltage rated starter motors without the risk of burning them due at too much power in the low speed range.

```
RPM 100% starter
power:22.000 Rpm
```

RPM OFF Starter: Rotor RPM where the starter is switched off, usually at 90% of "no load" RPM of the starter motor at full battery voltage.

```
RPM OFF starter
30.000Rpm
```

RPM to reconnect Starter: If after the starter switch off the rpm of the rotor fall below this setting, the starter is switched on again. This is not a normal condition, if it does happen, then the fuel flow from the pump should be increased. (Increase the "pump start point" 1 unit).

```
RPM to reconnect
starter28.000Rpm
```

Always set this value at least 2000 rpm below than the "RPM OFF Starter".

Auto Start mode KERO:

PLEASE NOTE THAT:

- It is not easy to setup a kerostart system. Not a plug&play system. There are many variables to adjust, you must be an expert.
- Some engines are not compatible with kerostart due at combustion chamber or starter issues.
- It is very easy to convert an engine to a flamethrower. All tests must be done in a test bench equipped by fire suppressant devices.
- The FADEC V10K including the software has been used and sold on production engines from 2009 with hundreds of engines sold. It is a proven system, but this doesn't guarantee a success in your particular engine.
- The support from Xicoy Electronica will be limited to the present user's manual and clarifications to it. We will not supply turnkey systems, parameter list, etc, because it is impossible for us to test and know all the engines and engine variants in the market.

Setup:

-Read the "Start Gas" section regarding general engine setup, safety devices. Etc. **BE CAREFUL**. Kerosene doesn't dissipate quickly as the gas does, this could cause a intense fire if kerosene is left to pool inside the engine during failed start attempts.

- Use only a good 7,4V Lipo or NiCd for tests. Battery must be capable of to supply 20A.
- Assure that the battery leads and igniter leads are of at lest 1mm² cooper section.
- Install the 2 solenoid valves at the pump output, trough a "t" fitting. Connect the solenoid that feed the ignitor to the "gas valve" port.
- Prime both tubes, on the "INFO" menus there are one menu for each tube. DO NOT fill the engine with Kerosene.
- Have compressed air or a fire extinguisher handy, kero can pool inside the engine and you can have a really nasty surprise later.

To enable the "kerostart" function, on "start" submenu, choose the "AUTO-KERO" in Start mode.

Sequence:

1) Set trim to up. "Ready" will appear on the data terminal screen. Raise the stick to 50% and set back again, this will trigger the kerostart sequence. Raising the throttle to maximum will switch "on" the starter at full power to allow the operator to blow away any flames produced by a previous aborted start. Use this feature on emergency and only in short burst to prevent to overload the starter motor.

2) "Burner On" displayed. The kerosene is powered and the power increased gradually to keep the current below 12A to increase the life of burner, batteries and electronics. Final burner voltage is adjusted by the parameter "Glow Plug Power". Burner heating time may vary depending of burner temperature at startup, usually between 6 and 10s. If there is a

problem, like a disconnected burner or an overload, the sequence will be aborted and an error message will be displayed.

3) Once the burner is at temperature, the starter is powered. First 2s the power is set fixed by the parameter "Starter power at ignition" to assure a good bendix engagement. After these 2 seconds, the starter power is regulated automatically to have the rotor turning at the RPM set by "Rpm at ignition". Note that the fixed power set by the parameter "starter power at ignition" is the minimum possible that will be feed to starter, so if this power is set too high, the rotor will turn faster than the set rpm

4) Once the rotor is checked to be at the desired rpm for ignition, the pump and burner valve will be pulsed to feed fuel to burner in a very exact flow. The pump is energized by the power set by the parameter "Pump power ignition K". Set to about 45 for FW100, to 35 for a FW200, 25 for a Speed300. NEVER set in "AUTO".

5) The screen will show "ignition" and the system wait for a confirmation that there is ignition by checking for an increase of at least 6°C in EGT. During this phase, the parameters that are used by the system are:

- " **RPM IGNITION K** ". Set the rotor RPM. Usually between 2.000 and 5.000 rpm
- " **Pump Pw Ignit. K** " Set the power of the pump. The pulse time is fixed, so it adjusts the amount of fuel sent to burner.
- "**Ignition timeout**" Set the time that the system wait for ignition.
- "**Glow plug power**" Set the voltage of the burner.

6) Once there is a confirmation of ignition, the new phase is "Preheat". In this phase the burner continue with same electrical and fuel supply as the ignition phase, but at same time fuel is feed in to the vaporizers. Rotor RPM is controlled by a new parameter, "RPM PREHEAT K". This phase continue until the exhaust temperature (EGT) reaches a value set by parameter " EGT Begin Fuel Ramp:".

Parameters used on this phase:

- " **RPM PREHEAT K** ". Set the rotor RPM. Usually 2000 rpm more than ignition
- " **Pump Pw Ignit. K** " Set the amount of fuel sent to burner.
- "**Glow plug power**" Set the voltage of the burner
- " **Engine Fuel Preh. :** " Set the time of the vaporizer valve is open, thus adjusting the flow to the engine main injectors. Burner flow is the same as Ignition phase, using same parameters. Typical value is 40.
- "**EGT End Preheat:**" Set the EGT to be reached in "preheat phase" before continuing the sequence. Typical values 80-120°C

7) Once the EGT will arrive to the temperature set by parameter " EGT End Preheat", the "switchover" phase will be executed, where the fuel supply is progressively switched from burner to main injectors, and it will be done according to RPM and EGT. Pump power now is controlled by "pump start point", the pump run continuously and the valves cycled using a variable duty cycle from the value set by parameter "Engine min.Flow:" to the 100% accordingly with RPM increase. RPM are increased by 1000RPM for each 20°C of EGT increase, until the value of " RPM Fuel Ramp K" is reached.

Parameters used on this phase:

" **RPM Fuel Ramp K**" . Set the rotor RPM where the fuel will be feed only to main injectors only and the burner switched off. Typical values 6.000-12.000 RPM
" **Pump Start point**" Set the start power of the pump. Exactly same as gas start.
" **Glow plug power**" Set the voltage of the burner
" **Engine min.Flow:**" Set the percentage of time of the main fuel valve is open at beginning of the switchover phase. This percentage will increase automatically with RPM until arrive to fully open when the RPM of next phase are reached. The time where the burner valve is open is complementary to the injector time, so when the main valve is open at 80%, the burner is 20%. Typical value 50%-70%

8) Fuel Ramp: From here the startup progress like gas starts. Parameters used on this phase are exactly the same with same use, please read the "Gas start" sequence from point nr.8.

List of FADEC STATUS message codes

Here is a list of possible messages shown on the data terminal screen and their meaning.

TrimLow: Indicates that the signal received from the transmitter corresponds to the lowered trim, that is to say, engine OFF.

Ready: Indicates that the engine is ready for starting, and that the transmitter signal corresponds to IDLE, (green LED lit)

StickLo!: This indicates that the throttle stick is in a position above IDLE, the engine will not start with the stick in this position.

Glow Test: Verification of glow plug

StartOn: Test of the starter

Ignition: Gas ignition phase.

Preheat: Phase of heating of the combustion chamber after detecting the gas ignition.

FuelRamp: Phase of acceleration until speed of IDLE.

Running: Engine working correctly, pilot have full control of engine power.

Stop: Engine off.

Cooling: Starter operating to cool the engine.

GlowBad: Defective or disconnected glow plug.

StartBad: Defective starter, insufficient RPM reached during start, RPM sensor failure.

Low RPM: Engine speed below the minimum.

HighTemp: Excessive temperature

FlameOut: Exhaust GAS Temperature below the minimum.

List of FADEC Warning message codes:

RC SIGNAL LOST/INCORRECT: The signal received from the RX is wrong (outside calibration margin) or absent.

PUMP LIMIT REACHED: The faDEC have increased the pump power up to the value set on the "Pump Limit" parameter, but the engine hasn't arrived to full power. Causes could be flat battery, fuel restriction or anything that can cause a reduction in the fuel flow.

xxxx **OVERLOAD:** A excessive current is detected flowing to the specified output.

Diagnoses:

During engine operation the FADEC measures and stores all the engine operating parameters recorded during the last the 51 minutes of operation. These measures can be downloaded later to a PC to study the behavior of the engine in flight and to diagnose any possible problems.

Also, after each cycle of operation, the FADEC stores the last cause of shut down and the values of RPM, temperature and pump power at the moment of shutdown. In order to access these measures, it is necessary to reinitialize the FADEC (shut down and power-up). Set the trim down (TrimLow) and push the left button on the display. The FADEC will show the cause of shutdown and the measured values at the moment of shut down. These are as follows:

Diagnosis messages:

UserOff: The engine has been shut down because it has received the shut down command from the transmitter.

FailSafe: The engine has been shut down because of loss of the control signal from the transmitter. Once the Ecu detects a loss or invalid RC signal for over 0,5s, it sets engine power to idle, and if after another 1,5seconds a valid signal is still not received the engine is shut down.

SpeedLow: The engine has been shut down because the RPM has dropped below a minimum. Cause could be lack of fuel, air bubbles, problem with the batteries, or defective RPM sensor.

FlameOut: The engine has been shutdown because the temperature has dropped below the minimum of (100°C). (Usually a thermocouple failure).

RCPwFail: Lack of power from the radio receiver.

8. Limited Warranty:

The FADEC main unit and HDT are warranted to be free from defects in materials and workmanship for a period of one (1) year from the date of original purchase. This warranty is non-transferable. If your unit requires warranty service during this period, we will replace or repair it at our option. Shipping costs is your responsibility.

This limited warranty does not cover the problems that result from: External causes such as accident, abuse, misuse, polarity reversal, short-circuit, crash damage, servicing not authorized by us, usage that is not in accordance with product instructions and failure to follow the product instructions.

OUR RESPONSIBILITY FOR MALFUNCTIONS AND DEFECTS IN HARDWARE OR SOFTWARE IS LIMITED TO REPAIR AND REPLACEMENT AS SET FORTH IN THIS WARRANTY STATEMENT. ALL EXPRESS AND IMPLIED WARRANTIES FOR THE PRODUCT, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTIES AND CONDITIONS OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN TIME TO THE TERM OF THE LIMITED WARRANTY PERIOD AS DESCRIBED ABOVE. NO WARRANTIES, WHETHER EXPRESS OR IMPLIED, WILL APPLY AFTER THE LIMITED WARRANTY PERIOD HAS EXPIRED.

WE DO NOT ACCEPT LIABILITY BEYOND THE REMEDIES PROVIDED FOR IN THIS LIMITED WARRANTY OR FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES, INCLUDING, WITHOUT LIMITATION, ANY LIABILITY FOR THIRD-PARTY CLAIMS AGAINST YOU FOR DAMAGES TO PEOPLE OR PROPERTIES, FOR PRODUCTS NOT BEING AVAILABLE FOR USE, OR FOR ENGINE OR AIRFRAME DAMAGE. OUR LIABILITY WILL BE NO MORE THAN THE AMOUNT YOU PAID FOR THE PRODUCT THAT IS THE SUBJECT OF A CLAIM. THIS IS THE MAXIMUM AMOUNT FOR WHICH WE ARE RESPONSIBLE.

The user must provide an emergency shut-off (i.e. a servo operated cut-off valve) for increased security.

Please read and follow the GTBA code of practice.
(<http://www.gtba.co.uk/codes/index.htm>)