



FES FCU instrument manual

Version 1.53

For instrument type: **FES-FCU 57**
Software version: 2.29



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1. Important notices

Please read this FCU Manual thoroughly. It contains important information about your FES system, having a vital importance to the flight safety.

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A Yellow triangle is shown for parts of the manual which should be read carefully and are important for proper operating of FCU and FES.



Notes with a red triangle describe procedures that are critical and may result in reduced flight safety or may lead to critical situation.



A bulb icon is shown when a useful hint is provided to the reader.

1.1 Limited Warranty

This LZ design FCU product is warranted to be free from defects in materials or workmanship for two years from the date of purchase. Within this period, LZ design will, at its sole option, repair or replace any components that fail in normal use. Such repairs or replacement will be made at no charge to the customer for parts and labour, the customer shall be responsible for any transportation cost. This warranty does not cover failures due to abuse, misuse, accident, or unauthorised alterations or repairs.

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To obtain warranty service, contact your local LZ design dealer or contact LZ design directly.

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2. General

This manual is intended for the users of FES system.

It is valid for current FCU software version 2.29. Earlier software versions have a bit less features, but in general is more or less the same!

FCU instrument was developed for LZ design's FES system by LXNAV Company, which is otherwise well known in gliding community by their excellent flight computers (LX8000, LX9000) and electronic variometers.

LXNAV produce FCU instruments exclusively for FES system of LZ design.

Technical specification:

- 1* RPM input
- 2* LED INPUT
- 1* digital output for BRAKE
- 1* analog output for POWER (adjustable with rotary knob)
- 4* temperature (Controller/Motor/ 2* battery)
- Audio signal
- 1* analog input for measuring current
- 1* analog input for measuring voltage
- 1* rs232 input for firmware update
- 1* input for canopy open switch
- 1* CAN bus
- 1* rotary and push button
- ON/OFF switch

Functions not supported by software, but supported in HW.

- 1* rs485
- 1* additional analog input

Sunlight readable QVGA LCD (320*240).

Consumption cca 100mA.

3. FCU installation

Install FCU into a standard small hole (diameter of 57mm) on instrument panel. Most instrument panels of modern sailplanes do not have much space available so this is the reason that we chose small size of instrument.

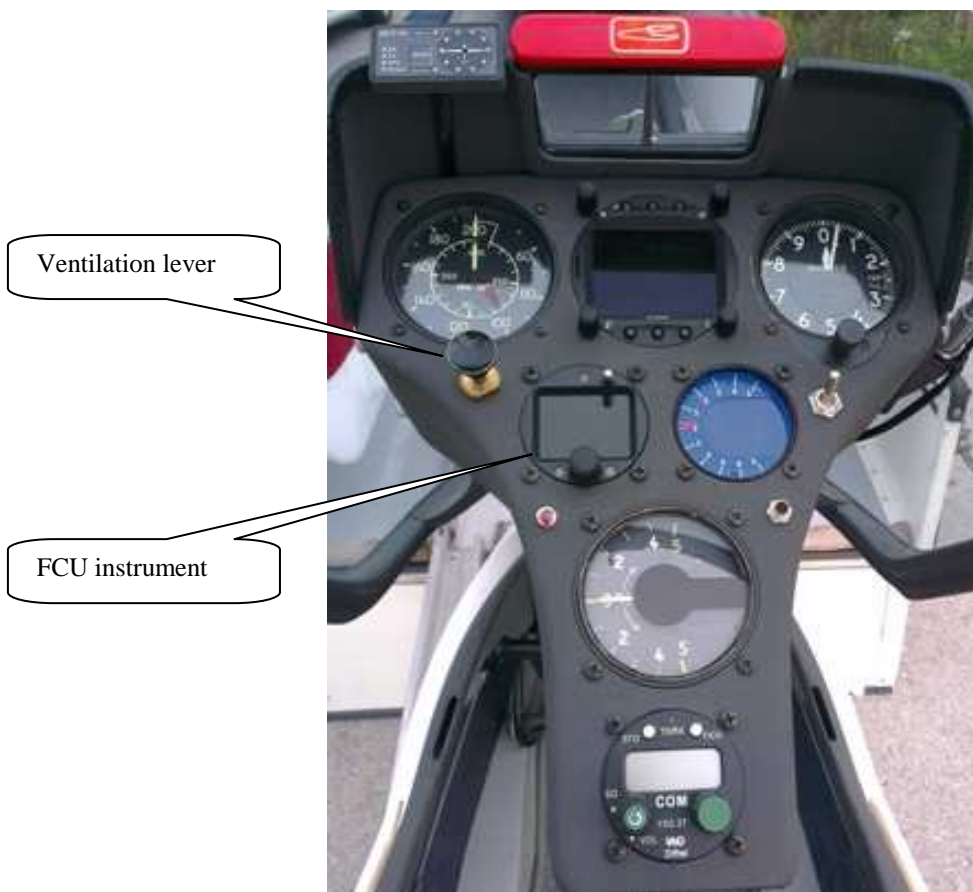
It is recommended that FCU is located on left side of instrument panel, so that screen is easily visible and throttle knob easily accessible to the pilot. Length of instrument should not present a problem during installation as instrument is very short.



We recommend you to remove protective plastic cover protection folia only when installation into instrument panel is complete!

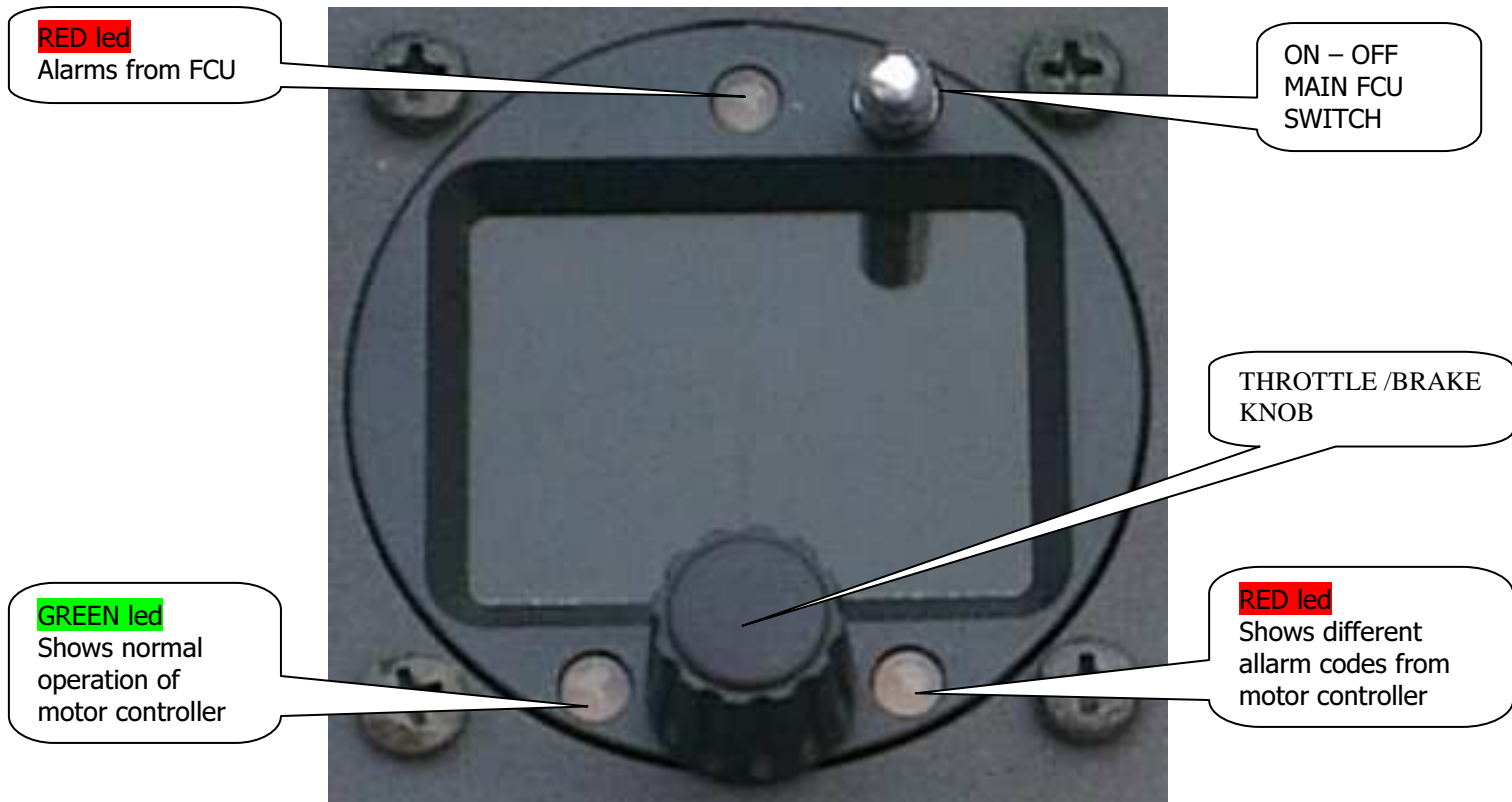


On back side of instrument are two male connectors. Carefully plug in FCU marked female 9 and 15 pins plugs which are on the end of signal cables, and fix them with 2 fixation springs which are on sides of each plug.



Suitable position of FCU instrument small panel of LAK17A FES

4. General layout of front FCU panel



1. ON/OFF switch - for FCU power supply
2. Throttle/brake knob (Rotary encoder button)
 - by rotation clockwise is used as throttle from 0 - 100% of Power
 - by rotation counter clockwise is used as electronic propeller brake
 - by pressing is used for changing menus and resetting alarms
3. Red led - shows different alarm codes from controller
4. Green led - shows normal operation of controller
5. Red led - turns on if there are some red warning messages from FCU active

5. Power switch

Important part of FES system is "Power switch", which is used to connect batteries with motor controller!

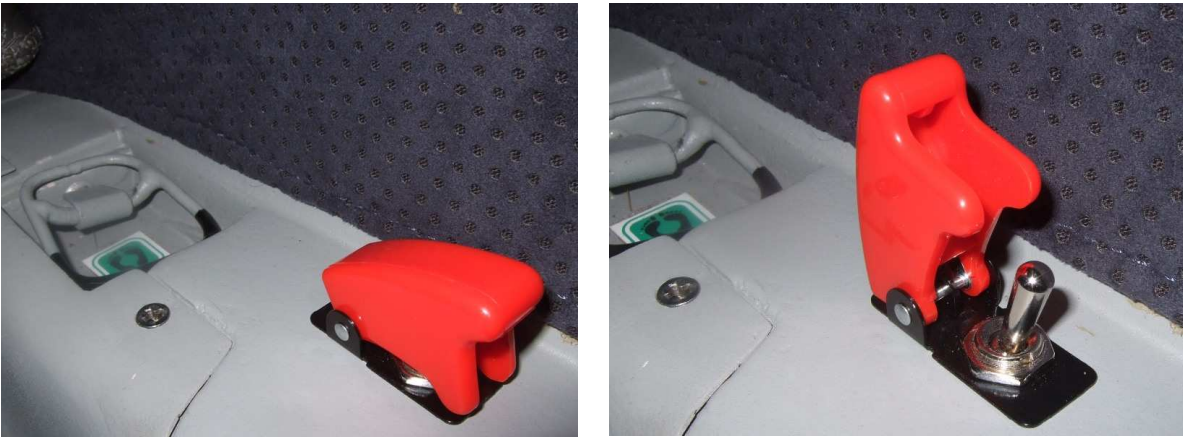
Always turn ON first FCU, and then "Power Switch" if you want to run motor!

Many pilots think that this is actually a "Master switch", and so they switch it ON first and then FCU!

This is not a Master switch, and this is wrong procedure!!!



Make sure that FCU instrument is switched ON, before Power switch is turned ON!



On LAK17A&B FES sailplanes Power switch is located on right side of cockpit. It is a **toggle switch** and is protected by red safety cover.

1. To turn it ON, open first safety cover and than flip toggle switch forward.
2. To turn it OFF, flip toggle switch backward and close safety cover.

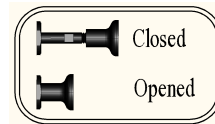


In case of emergency, you can just flip back safety cover, which will also push toggle switch lever backward to OFF position!

6. Ventilation lever

During powered flight, front ventilation valve in center of the spinner, should be opened. This is important as during powered flight, especially at high power settings, motor needs sufficient amount of cooling air.

On the instrument panel, close to the handle which operates ventilation valve, is a sticker, which clearly identifies in which position of control handle, ventilation is opened.



When is pushed **forward**, than ventilation is **opened**! Also from amount of air coming into cockpit and its noise, is quite evident to the pilot if ventilation is opened or not. So there is no indication on FCU about position of ventilation lever, however FCU instrument monitors how quickly motor temperature is rising in time.

If motor temperature rising is faster than it is usual, then pilot gets red warning message "Check ventilation".



If temperature of motor is raising too fast, check if ventilation valve is opened – ventilation lever must be pushed fully forward!

7. Using the FCU

7.1 Switching ON the instrument

To switch ON the FCU instrument, simply set the main FCU pull-switch to upward position. To do this slightly pull handle out, as it has protection for unintended switching off-on. The instrument screen illuminates starting with an internal check procedure. Then LXNAV and FES logo is shown, together with software version for about 1 second. All 3 LEDs illuminate in red and green color for a short time, so that you can check that all three LEDs are working properly.



Make sure that FCU instrument is always ON, before Power switch (switch with a key) is turned ON!

7.2 Initial screen

After a few seconds from turning on FCU, the initial main screen appears as below. Please find a description of the indications:



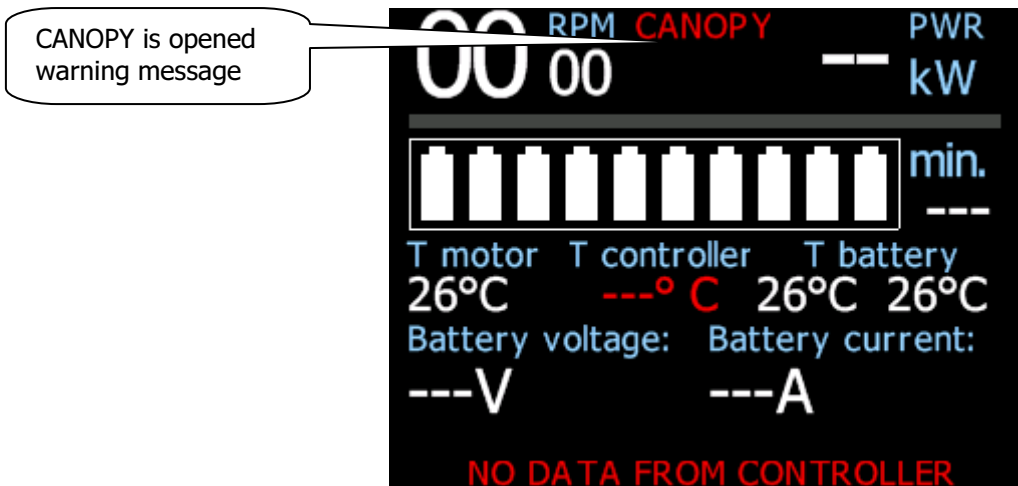
There should be visible temperature of motor and each battery pack. Temperature of controller is not visible if Power switch (key switch) is OFF. Also there is red message "NO DATA FROM CONTROLLER" on bottom line of the screen. If canopy is open there is also "CANOPY OPEN" message visible at the top of screen.

Before you start motor, make sure that nobody is around propeller. Only then you can turn ON Power Switch.

In case you will try to run a motor without Power switch ON, you will get a message "Check Power switch", as in stressful situation pilot might forget about. You should just press throttle button and message will disappear!

7.3 CANOPY warning!

It is not allowed to run motor with open canopy, as propeller blades and canopy could be strongly damaged. For this reason on your glider is installed a safety switch which will prevent you running a motor if you forget about.



When canopy is open there is a red **CANOPY** message on top middle part of the screen!

VERY IMPORTANT:



If pilot will try to run motor with open canopy, motor will not start but a **Warning, Canopy is open, Close Canopy! yellow warning message will appear on a FCU screen, informing you that you forget to close the canopy!**

Pilot needs to confirm by **pressing throttle knob!**

After canopy is closed, motor will start normally!



However if canopy will be still opened and you will again try to run a motor, than a second **Warning, Canopy is open, Close Canopy! red warning message will appear on a FCU screen, and motor will still not start.**

Pilot needs to confirm again by **pressing throttle knob!**

After two warnings pilot should really close the canopy!



In third try motor will always start, despite that safety switch "CANOPY" message is still active!

It is designed in such a way, so that pilot would be **still able to run motor** in case of canopy safety **switch failure!**

7.4 Power settings during flight



Power is increased by rotating the Throttle knob in clockwise direction and reduced by rotating Throttle knob in counter-clockwise direction!

There is no mechanical stop when increasing power setting, so when throttle bar reach 100%, power will not be further increased with rotating throttle knob a few more turns! To reduce RPM rotate the Throttle knob in counter-clockwise direction. Minimum possible setting is about 100RPM (2 steps clockwise from zero power)

Two steps counter-clockwise from minimum RPM the power indication shows 0. At this setting motor gives no power.

1. On the ground propeller will stop slowly!
2. In the air propeller will start rotating faster, due to wind milling effect (about 1500 RPM at 90km/h) even that there is no power from motor.

If you want to stop propeller in the air you need to use electronic braking!

7.5 Check Power switch warning

In case that pilot rotate throttle knob clockwise to start motor, but he simply forget to switch ON "Power switch" first, than a yellow warning message will appear: "**Check Power Switch!**", in order to remind a pilot about his mistake.



By pressing throttle knob, message will disappear! After "Power switch" is switched ON, throttle bar will go back to zero setting automatically and pilot will be able to start motor normally!



On earlier software versions, it was necessary to manually reduce throttle bar to zero (otherwise motor did not start).
When throttle was reduced to zero, than motor started normally !

7.6 Propeller stop with electronic braking

To stop propeller with electronic braking, you need to rotate Throttle knob in counter-clockwise direction for 1 step, from zero throttle, so that throttle line on display is start **blinking red!**



*For successful stop there must be some RPM (about 700 minimum), otherwise braking is not working, due to **too small induced voltage** (regeneration function of controller is used for propeller braking)*

In the air there is nearly always enough RPM. But if you want to test electronic braking on the ground, make sure you set at least 1000 RPM, and rotate throttle knob quickly in counter clockwise direction!

7.7 Propeller positioning

1. FES installations **without** automatic positioning:

If propeller stops in such position that pilot can see one of the blades trough the canopy, just start motor again to about 700 RPM and then stop it again. Repeat this procedure until blades are randomly positioned in suitable position!

2. FES installations **with automatic positioning**:

If your glider has installed automatic positioning of blades, just left, throttle bar at braking position, and wait 2 or 3 seconds, until RPM data shows zero RPM. After that automatic positioning will start! You can always stop automatic positioning by pressing throttle knob.



*Positioning does not work if **Canopy** message is active, or if throttle is set to zero power instead of braking!*

In settings is possible to adjust:

- time between steps from 50ms to 1 sec
- power used for positioning at 115V and at 90V
- number of steps after hall sensor for position is detected

7.8 Screen at Power switch turning ON

After turning ON Power switch, temperature of controller will become visible, and green "**CONTROLLER READY**" message will appear on bottom line. In time of few seconds also number with Voltage level will appear.



Green LED (left-bottom) will start illuminate continuously. This is a signal from a controller that everything is OK and he is ready for motor run. Now you can start gently rotating throttle in clockwise direction. Motor will start and centrifugal force will open propeller blades immediately.

7.9 Screen during motor run

When motor is working screen shows RPM, Current consumption and Power



Until there is not enough power consumption, remaining time endurance (in minutes) is not visible, as it is more than 99 minutes. It must be set at least 3kW of power so that remaining time becomes less than 99 minutes.



To reduce RPM you need to rotate Throttle knob in counter-clockwise direction. If you rotate it one step over zero throttle level, than throttle line starts **blinking red!**



This means that regenerative braking of propeller is active. However regenerative braking work only if there is still enough RPM, otherwise induced voltage is too low and does not work.

In flight there is nearly always enough RPM, as even at zero power setting, propeller starts wind-milling and RPM increase.



If you want that regenerative braking will work also on the ground, you need at least 1000RPM and then you just need to rotate throttle button, a little bit more quickly in counter-clockwise direction, until line start blinking red.

Throttle knob (rotary encoder), have additional **press button function!**

7.10 Battery packs energy consumption

Each of 10 illuminated battery bottles on the screen; represent 10% of total 100% available energy. Remaining energy is calculated, based on total capacity of battery packs (which is approximately 4,2kWh), and consumed energy in time. Consumed energy is dependent on actually used power settings during flight.

Calculation is quite accurate when **lower power settings are used**. At high power settings, voltage drop on battery packs is more significant, and actually usable battery capacity is reduced.

For this reason yellow warning message: "**Low voltage! Reduce power!**" will appear, even when there is still a few capacity bottles available on the screen.



FES system is most efficient at low power settings. With additionally very low drag of your FES powered sailplane under power, you will be able to cover the longest distances, when using the lowest power required for horizontal flight. This is just opposite compared to climb and glide (saw tooth mode) which is usually more efficient for retractable systems.



Minimum total voltage of both battery pack is **90V!** (for 14 cells per pack configuration, this is at 3,2V per cell). Pilot is informed about with red critical warning message: "**Battery empty! Stop FES motor!**"

Total voltage of both battery packs should never go much below 90V as battery packs might suffer unrecoverable damage to the cells!

More detailed information about warnings is available in next chapter!

8. Warnings

8.1 Different levels of warnings

At FCU instrument there are two levels of warning messages:



YELLOW Warning: This is 1st level of alarm which means that the pilot has to take care to the parameter indicated in Warning message and to manage the suggested solution to solve the problem. In any case the YELLOW warning means that there isn't an immediate danger.



RED Warning: This is 2nd level of alarm which means that the pilot has to manage the solution of the indicated problem **IMMEDIATELY**.



Reset of warning messages: *When a warning message appears on the instrument, the pilot has to push the throttle knob, as confirmation, that he is aware of the message, and the warning message will disappear!*



Recall possibility of RED warning messages: *By pressing a throttle knob again and again, all currently active RED Warning messages will reappear on the screen (in the same order as they appeared initially)*

8.2 Basic LED lights

FCU instrument is equipped with three very bright LED (Light Emitted Diode) lights, which are able to illuminate in **red** or **green** color. One LED light is located above display, and two LED lights are located below display. When FCU is turned ON, all three LEDs illuminate first in green and then in red color for a short time, so that is possible to check if all three LEDs are working properly.



Upper led start illuminating **red** continuously, together with appearance of yellow or red warning messages on FCU screen. It is very bright red, even at strong sunlight, so it is practically impossible that pilot would not recognize it. As such, effectively remind the pilot, to check the FCU, where he can read a message and short instructions which action is required (Reduce power or Stop FES motor)

Lower two LED lights gives some important information to the pilot regarding status of motor controller:

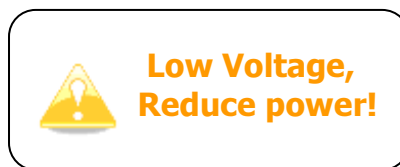
- Lower left LED becomes **green** when "Power switch" is turned ON, and informs the pilot that motor controller electronic is under power, and controller is ready for operation.
- Lower right LED, starts **blinking red**, if there is some errors on motor controller, and during propeller automatic positioning.

8.3 Screen messages

8.3.1 Voltage warnings

There are two important Voltage warnings based on total Voltage measurement by LXUI box:

1st: **Yellow warning** (which appear always first):



Appearance: When total Voltage of battery packs drops down to **95 Volts**

Required action: Pilot should reduce power, as it is not good for battery cycle life, to use high power settings when a voltage is reduced.



When using high power setting this message might appear, even if there are still a few capacity bottles illuminated on the screen.

2nd: **Red warning** (which appear always second):



Appearance: When total Voltage of battery packs drops down to **90 Volts!!!**

Required action: Pilot must stop motor, due to reached lower voltage limit, (even if there are still available 2 or 3 capacity bottles)



It is always pilot decision when to stop the motor! For instance if he is in critical situation, when his life might be dependable on a few more minutes of engine run, he can decide to discharge battery packs even lower!



However if battery packs will be discharged too low, charging system will refuse to charge them again (if any of the cells unloaded voltage is below 2,8V then BMS do not send suitable signal to charger to start charging), as it is not safe to charge such battery packs, which were discharged below critical voltage level !!!

Additionally there are four different voltage warnings, based on voltage measurement of each cell (only available at GEN2 battery packs) by measurements of internal BMS electronic circuit.

List of all Voltage warnings:

Condition	Level	Message, required action
Battery packs warning messages, based on total Voltage measurements		
Total Voltage level is low at 95V	Yellow	Low Voltage, Reduce power!
Total Voltage level is critical at 90V	Red	Critical Voltage, Stop FES motor!
Battery pack warning messages, based on each cell Voltage measurements *		
Cell difference in single pack more than 150mV	Yellow	Cells diff. > 150mV, Reduce power!
Cell difference in single pack more than 300mV	Red	Cells diff. > 300mV, Stop FES motor!
Difference between total voltage of each pack is more than 1.0V	Yellow	Battery diff. > 1.0V, Reduce power!
Single cell Voltage level below 2.8V	Red	Cell critical < 2,8V, Stop FES motor!

*only with GEN2 battery packs, and FCU software version higher than v2.24

8.3.2 Temperature warnings

There are three different warnings:
 -regarding Battery packs temperatures
 -regarding Motor temperature
 -regarding Controller temperature

List of all temperature warnings:

Condition	Level	Message, required action
Battery pack warning messages, based on temperature measurements of each pack		
Battery pack temperature is below 5°C	Yellow	Battery Low < 5°C, Do not self-launch!
Temperature difference between each Battery pack is more than 3°C	Yellow	Battery temp. diff. > 3°C, Reduce power!
Temperature difference between each Battery pack is more than 6°C	Red	Battery temp. diff. > 6°C, Stop FES motor!
Battery pack high temperature, more than 45°C	Yellow	Battery High > 45°C, Reduce power!
Battery pack extremely high temperature, more than 55°C	Red	Batt. Ext. High > 55°C, Stop FES motor!
Battery pack temperature is critical, more than 75°C	Red	Batt. Critical > 75°C, Land immediately!
Motor temperature warning messages		
Motor temperature is high, more than 70°C	Yellow	Motor High > 70°C, Reduce power!
Motor temperature is extremely high, more than 90°C	Red	Motor Ext. High > 90°C, Stop FES motor!
Controller temperature warning messages		
Controller temperature is high, more than 70°C	Yellow	Controller High > 70°C, Reduce power!
Controller temperature is extremely high, more than 90°C	Red	Contr. Ext. High > 90°C, Stop FES motor!

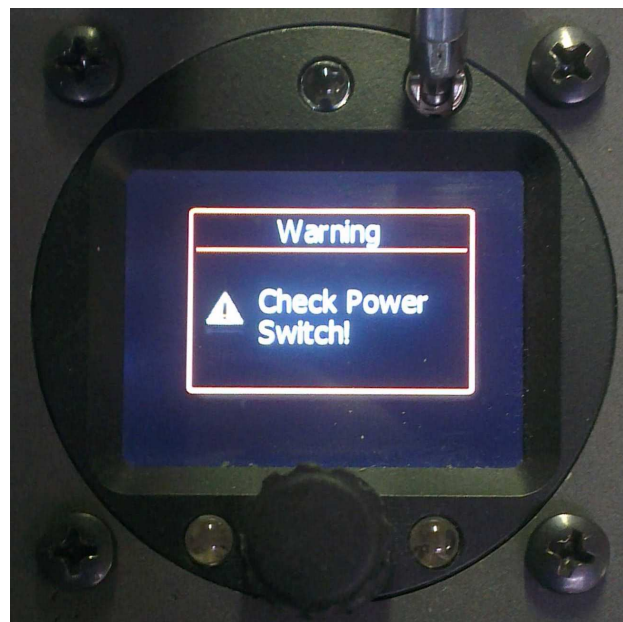
8.3.3 Other warnings

There are three other warnings:

- regarding Canopy
- regarding Power switch
- regarding Ventilation lever

List of other warnings:

Condition	Level	Message, required action
Canopy		
Canopy is opened	Yellow	Warning, Canopy is open, Close Canopy!
Canopy is still not closed	Red	Warning, Canopy is open, Close Canopy!
Power switch		
Motor do not start immediately	Yellow	Warning, Check Power switch!
Ventilation lever		
Motor temperature is rising too fast!	Red	Warning, Open ventilation!



9. Settings

FCU instrument has additional Settings page. You can reach it by long (about 3 seconds) press of Throttle knob.

You can choose there INFO page or PASSWORD page.



When motor is running, function of long press to reach this page is disabled!



9.1 Info page

Choosing Info by pressing throttle knob, next display appears:



Firmware: FCU software version (older version 2.23 is visible here)

Serial number: serial number of the instrument

LXUI: it shows serial number and software version of LXUI (box which is used for measurement of voltage and current) - N.C. if is not active or not connected

LX Prop. brake: : it shows serial number and software version of LX Prop brake electronic (only from version 2.24 on) used for alignment of propeller - N.C. if is not active or not connected as some earlier gliders do not have this electronic circuit which is located inside of connecting box and integrated directly on electronic circuit plate.

Totalizer: counted motor operation time in hours, minutes and seconds (here 6 minutes, 51 second)

Charge Cycle Count: number of batteries charge cycles (here 2 only)

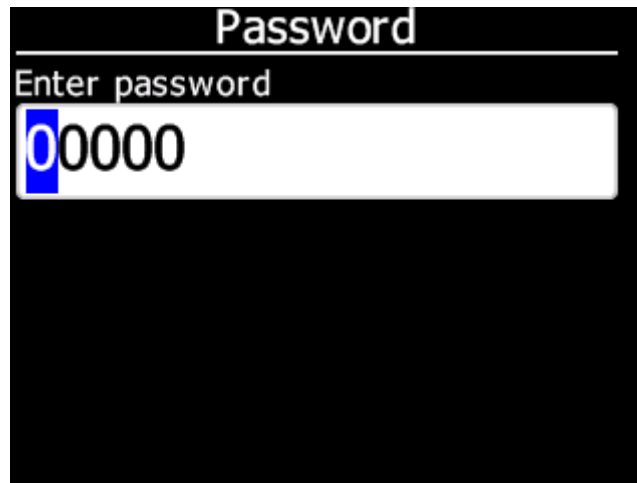
Last line is used for errors detections, by manufacturer in case of troubles.

9.2 Password



Do not try to enter into these menus if you are not authorized by manufacturer!

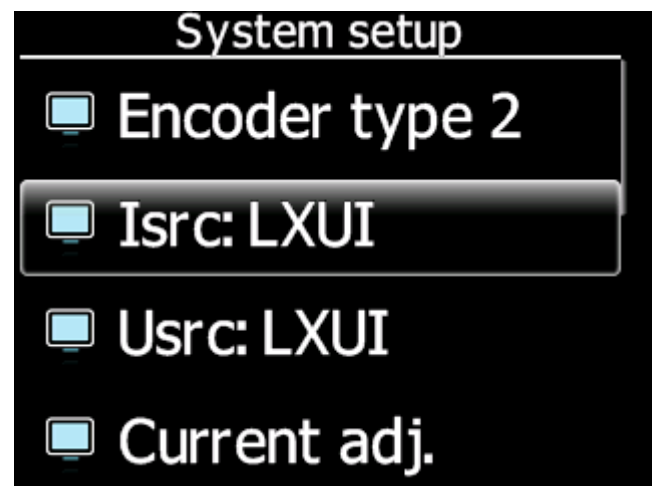
Choosing Password, next display appears:



With entering proper password code is possible to access to system setup menus of FCU. System setup has a few submenus are accessible by rotation of throttle knob in clockwise direction. With short press to throttle knob, is possible to enter to each submenu to modify settings.

List of System setup submenus:

- Encoder type (1 or 2)
- Isrc: (LXUI or HALL)
- Usrc: (LXUI, DivFcu, Kelly)
- Current adj. (setting of zero, with HALL)
- Voltage adj. (setting of divider, 1,07-1,09)
- Temp sensors (assigning of digital sensors)
- Prop. align offset (number of steps)
- Prop. align speed (Step delay: 70-90ms)
- Prop. align Power (at 115V and at 90V)
- Voltage warnings (critical, low, reset, battery full, battery capacity)
- Int. encoder or Ext. poti
- Cal.Ext.Thr. (Calibration)
- BaTemp: (DS or BMS)
- Current factor (for HALL only)
- Battery (Graphic representation, values of each cell and BMS)
- Info (more detailed info)
- Save data (saving changes)



10. FCU software updates

We are still working on operational and functional improvements of FCU software. It might be necessary or suitable to perform software update of your FCU instrument for better FES functionality. Consult with FES manufacturer regarding suitability of update.

10.1 Equipment

For FCU update you need:

-FlashLoader485App.exe, update software file (available for download [here](#))



*Available download is .zip file, which you need to extract first.
After extraction, run file FlashLoader485App.exe, and window will appear as below*

-Update file App_FES_2.XX.lxfw (number XX is version of file)

-PC (preferred a notebook) with Windows operating system

-Standard USB-RS 232 cable, (you can use also COM to COM if your PC still have a COM port)



Standard USB-RS232 cable

10.2 FCU update procedure

1. Plug in USB connector of update cable to free USB port of your PC. Wait until cable will be recognized and ready for use. It is recommended that you go to Control panel->System-> Device manager->Ports (COM and LPT) in order to check to which virtual COM port your USB-COM cable is assigned.
2. Open cover (some covers have a hole so is not necessary to open it) of Connecting box and plug in other side of update cable into free 9 pin female connector on middle of circuit board.



FCC (FES connecting circuit) box opened

3. Run Flash loader



4. Choose proper COM port and Baudrate 115200
5. Browse for FES update file `***.fw`

6. Press Flash button and turn ON FCU. On FCU screen it should appear message "Connected", and after that new screen with update line with progress and PROGRAMMING message as on picture below.



It takes about 1 minute so that update is finished.

7. When FCU start again automatically, you should see a new software version on starting screen!



With nearly the same procedure is possible to update also LXUI box, (which is used for accurate current and voltage measurements) if necessary!

10.3 After update

After update all settings in the FCU should remain the same. However some versions will need to insert some password codes if advised so by FES manufacturer before update. If you will have some problems before, between or after update, contact FES manufacturer.

11. Revision history

January 2011	Initial release of manual, Version 1.0
February 2013	Updates for FCU software version 2.13, Version 1.5
March 2013	Update about automatic propeller positioning, Version 1.51
July 2014	Update about ventilation, and warnings, Version 1.52
October 2014	Update about recall possibility of red warnings, Version 1.53