FES FLIGHT MANUAL

Version 1.18

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Table of Content

1. General

1.1 Introduction

The FES flight manual has been prepared to provide:

1. Pilots with information for the safe and efficient operation of the sailplanes equipped with Front Electric Sustainer Self-launcher system.
2. Sailplane manufacturers of specific sailplane types equipped with FES with all the information necessary to prepare the flight manual of the sailplane after FES installation.

Chapters of this manual are written as mandated by CS-22.

1.2 Certification basis

This type of powered sailplane has been designed following CS 22 Certification Specifications for Sailplanes and Powered Sailplanes and according to Special Conditions for electric powered sailplanes.

1.3 Warnings, cautions and notes

The following definitions apply to warnings, cautions, and notes used in the flight manual.

Warning: *Non-observation of the corresponding procedure leads to an immediate or important degradation of flight safety.*

Caution: *Non-observation of the corresponding procedure leads to a minor or extended degradation of flight safety.*

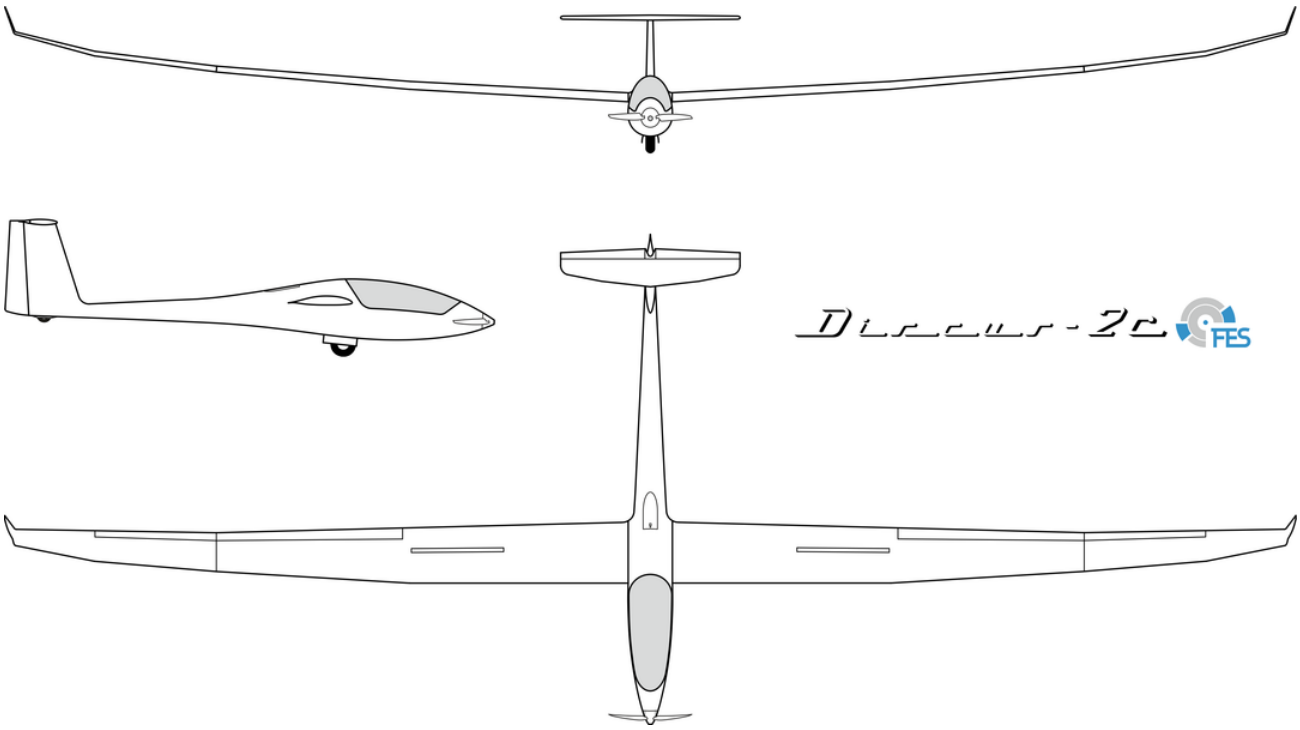
Note: *Draws the attention on any particular item not directly related to safety but is significant or unusual.*

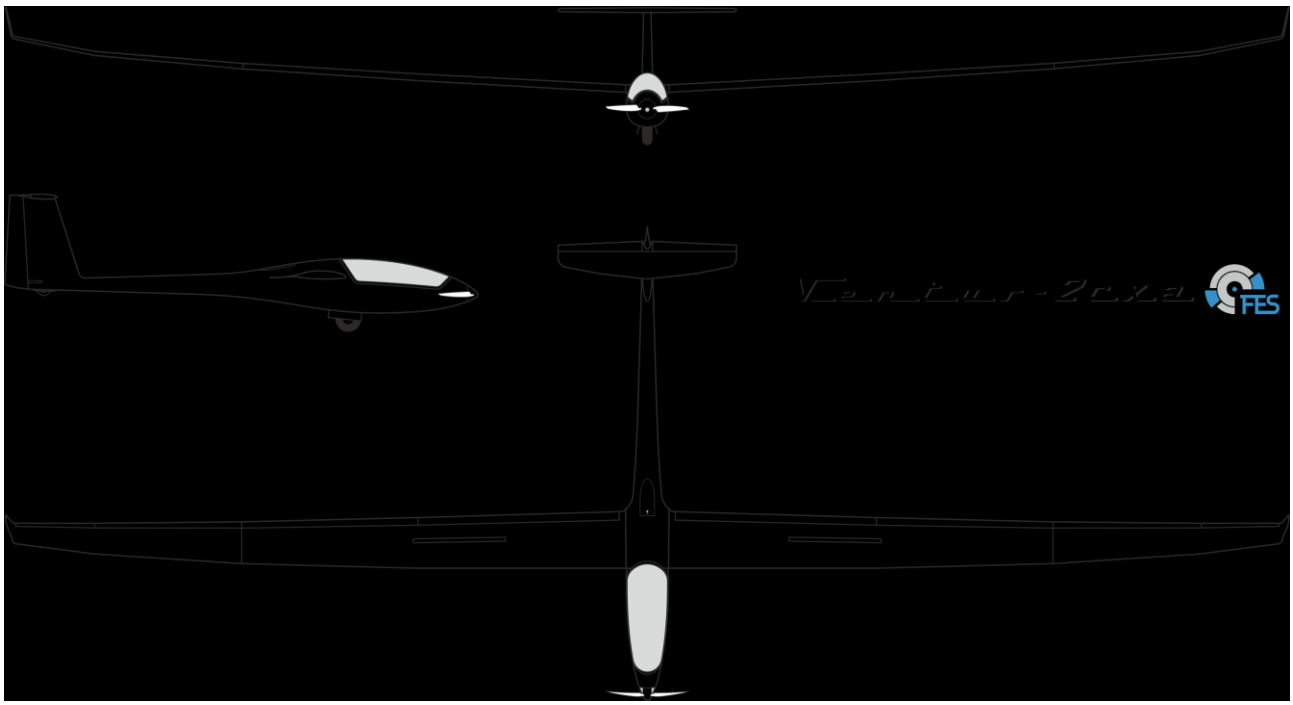
1.4 Descriptive data

The sailplane is equipped with a high-tech, powerful FES front electric propulsion system developed for high performance powered sailplanes. Main parts of the FES system are:

- Brushless electric motor
- Motor controller
- Foldable propeller
- FES GEN 2 Battery packs, with internal BMS (Battery Management System)
- Charger (600W, 1200W or 2000W)
- FCU (FES control unit) instrument
- LXUI box with Shunt (for current and voltage measurements)
- FCC box (FES connecting circuit)
- Power switch
- DC/DC converter (converts high voltage to 12V)

1.5 Three-view drawing





Typical FES equipped powered sailplanes are Discus 2c FES and Ventus 2cxa FES.

1.6 Abbreviations

CAS	Calibrated airspeed is an indicated airspeed of a sailplane, corrected for the position of the static ports on the fuselage and measurement error of the instrument. Calibrated airspeed is equal to true airspeed at sea level in the standard international atmosphere.
C.G.	Centre of gravity
daN	Decanewton
FES	Front Electric Sustainer/Self-launcher
FCU	FES Control Unit
FR	Flight Recorder
h	Hour
IAS	Indicated airspeed is the speed of a sailplane as measured by aircraft speed indicator connected to its pitot-static system and is uncorrected for the system error
MOP	Means Of Propulsion sensor
m	Meter
kg	Kilogram
km	Kilometre
s	Second
Ltr	Litre
L/D	Lift to Drag ratio (glide ratio)
°C	Degrees Celsius

1.7 Unit conversions

1 bar = 14,5 pounds per square inch (psi)
1 decanewton (daN) = 2,25 pounds force
1 kilogram (kg) = 2,2 pounds (lbs)
1 meter (m) = 39,4 inches (in.) = 3,28 feet (ft.)
1 millimeter (mm) = 0,0394 inches (in.)
1 liter = 0,2642 U.S. gal
1 square meter (m^2) = 10,764 sqare feet (sq.ft)
1 kg/m^2 = 0,204 lbs/sq.ft
1 m/s = 1,944 knots (kts)
1 km/h = 0,5396 kts
1 kW = 1,34 HP

2. Limitations

2.1 Introduction

This chapter includes operation limitations, instrument markings, and placards required for the safe operation of the sailplane equipped with a Front Electric Sustainer system.

2.2 Airspeed

Airspeed limitations for the use of the FES system and their operational significance are shown below:

Speed		IAS; km/h /(kts)	Remarks
V_{PO}	Maximum speed with a rotating propeller	160 / (86)	Do not exceed this speed with a rotating propeller (at any power setting)
V_{POmin}	Minimum speed to start the motor	80 / (43)	Do not start the motor below this speed
V_{POmax}	Maximum speed to start the motor	160 / (86)	Do not start the motor above this speed

Warning: *select your motor start/stop speed correctly:*

- flaps must be in a positive setting; (depending on glider type)

- make sure your chosen speed for motor start/stop is at least 8…10 km/h (4…5 kts) higher than the stall speed for your flight configuration.

2.3 Airspeed indicator markings

FES equipped sailplanes do not have additional indicator markings compared to pure gliders. Blue line marking on the airspeed indicator can be added, representing a range of speed with the best rate-of-climb. This range depends on the glider type. Usually, it is between 80-90km/h, with a positive flap setting.

Marking	(IAS) value or range	Significance
Blue line	80-90km/h	Best rate-of-climb speed

2.4 Powerplant

Warning: *When FES is installed on an 18m class sailplane like Ventus 2cxa or Discus 2c, it functions as a **sustainer system** only. Taking off using the FES is prohibited unless explicitly stated in the flight manual.*

*On lighter UL sailplanes like Silent 2 Electro or MiniLAK FES, the system functions as a **self-launch system**.*

2.4.1 Motor

Motor manufacturer: *LZ design d.o.o.*

Motor model: *FES-xxx-Myyy*

xxx - represents the version of the motor for a specific glider type

yyy - represents the motor length

Note: *You can find more details about the motor used on a specific type of a FES powered sailplane in the separate FES Motor manual.*

2.4.2 Propeller

Manufacturer: *LZ design d.o.o.*

Model: *FES-xxx-Pv-yyy*

xxx - represents the type of sailplane for which the propeller was designed

v - represents the version of the propeller for specific glider type

yyy - represents propeller diameter in mm

2.4.3 Battery packs

FES needs two battery packs wired in serial. Each battery pack has 14 cells. In total, the system has 28 cells.

Maximum allowed total voltage of both battery packs	118 V
Minimum allowed total allowed voltage of both battery packs	90 V
Nominal capacity of each cell	40 Ah
Energy storage capacity	4,2 kWh
Maximum voltage per cell	4,16 V
Middle voltage	3,7 V
Minimum voltage of each cell	3,2 V

Note: *You can find more details about the battery packs which are used on a specific type of FES powered sailplane in the separate FES Battery pack manual.*

2.5 Power-plant instrument markings

FES power-plant has a dedicated FCU instrument with a high-resolution sunlight-visible colour display mounted on the instrument panel.

Note: *You can find more data about the FCU and its operation in the separate FES FCU Instrument manual.*

2.6 Weight

FES system can be installed only on sailplanes with enough margin in the maximum weight of non-lifting parts. Total weight of all FES components, including battery compartment reinforcement ribs, is about 50kg. However, the system requires one 12V battery as a buffer – usually, the tail battery remains. Other 12V batteries are removed to save some weight (two standard 12V-7Ah Pb batteries weigh approximately 5kg).

Exact FES system weight depends on the type of sailplane and installed FES components.

2.7 Centre of gravity

Components of the FES system are positioned so that the location of the centre of gravity (C.G.) is comparable to the one of the pure sailplane. After the installation, we check the sailplane's C.G. and correct it if necessary.

Warning: *Flying without the motor is prohibited, if not specified differently for certain type.*

Warning: *Flying without the battery packs is prohibited,*

if not specified differently for certain type.

2.8 Approved manoeuvres

Aerobatic manoeuvres with FES equipped sailplanes are not permitted, unless it is specified differently for a certain glider type.

2.9 Maneuvering load factors

Manoeuvring load factors depend on the type of sailplane.

2.10 Flight crew

Flight crew depends on the type of sailplane.

2.11 Kinds of operation

Flights must be conducted in daylight under VFR conditions.

Warning: *Flying under power in heavy rain is not allowed! Make sure you seal the cover of the battery compartment with plastic tape.*

Warning: *Sailplanes equipped with the sustainer system are prohibited from taking off solely using their own power.*

2.12 Minimum equipment

As specified in the flight manual of the pure sailplane.

2.13 Aero-tow, winch and auto-tow launching

As specified in the flight manual of pure sailplane.

2.14 Other limitations

As specified in the flight manual of pure sailplane.

2.15 Limitations placards

Additional limitation placard must be added for FES equipped sailplanes:

Speed IAS:		km/h	Kts
Power-plant operation	V_{PO}	160	86
Max. engine start	V_{POmax}	160	86
Min. engine start	V_{POmin}	80	43

3. Emergency procedures

3.1 Introduction

According flight manual of pure sailplane.

3.2 Canopy jettison

Warning: *Before canopy jettison, stop the motor and switch OFF power switch, if there is enough time.*

3.3 Bailing out

Warning: *Before you bail out, stop the motor and switch OFF power switch, if there is enough time.*

3.3.1 Ballistic parachute

Sailplanes equipped with a ballistic parachute, have a switch installed which stops the motor automatically when the parachute is deployed.

3.4 Stall recovery

As specified in flight manual of pure sailplane.

3.5 Spin recovery

As specified in flight manual of pure sailplane.

3.6 Spiral dive recovery

As specified in flight manual of pure sailplane.

3.7 Motor failure

3.7.1 Motor fails to start

If the motor fails to start, continue flying the plane like a pure glider.

Note*: Check the power switch is* ***ON.***

The FCU displays a reminder "Check power switch" if you set throttle high enough.

3.7.2 Power loss during flight

If power is lost during flight, the propeller will windmill. Push the control stick forward gently, to sustain the desired airspeed! You can perform the following actions to try and restore power:

1. Check first if you unintentionally switched OFF the power switch!

Warning: This can happen in gliders that thave the landing gear lever and the power switch located on the same side of the cockpit when retracting the landing gear, i.e. *LAK17A&B FES.*

If this happens, switch power switch ON and adjust the throttle.

Note: *On earlier software versions (before v2.13), it was necessary to reduce throttle bar to zero manually; otherwise motor did not start due to safety. Motor restarted when the throttle was reduced to zero*

New versions (from FCU v2.13) automatically reset the throttle!

2. If the power switch is ON:

- Switch OFF the "Power switch" and the FCU.
- Turn ON the FCU and check for strange behaviour.
- If the FCU has no issues switch the power switch ON and try to start the motor.

The motor starts but behaves strangely under power:

- Stop the propeller from the windmilling with the electronic brake.
- When the propeller stops, switch OFF the power switch and the FCU.

If you are not able to stop the propeller with the electronic brake, you will need to land with a windmilling propeller. **Note: it is not possible to stop the propeller by reducing airspeed**. Try to land on both landing wheels simultaneously, to avoid potential damage of the propeller.

Note: *It is probably better to use a grass runway in good condition if one is available than a concrete runway. If the grass runway is in bad shape, use a concrete runway if one is available.*

Warning: *Try to avoid landing into high grass or similar.*

Note: The *L/D of a sailplane with a windmilling propeller is reduced only by a small amount. With enough altitude will have enough time to choose a suitable landing field.*

Please study the **FES FCU Instrument manual** for exact behaviour and necessary actions when error and warning messages are displayed.

3.8 Fire

3.8.1 Fire on the ground

- Switch OFF the "Power switch."
- Switch OFF all instruments and master switch
- Get out of the cockpit
- Extinguish the fire

3.8.2 Fire inflight

All FES equipped gliders have an independent fire warning system installed. The system uses a bright red LED to warn a pilot of a possible fire. It is mounted on the top centre of the instrument panel. The LED starts blinking when the temperature in the battery compartment reaches 88°C.

In some instances, you can recognize fire by smell also. In that case, we recommend you to:

- Stop the motor immediately!
- Switch OFF the "Power switch".
- Open the front ventilation.
- Open canopy side window
- Land as soon as possible, or bail out if need be.
- Extinguish the fire after landing

3.9 Other emergencies

3.9.1 Loss of 12V electrical power inflight

- During soaring:

  If electronic instruments (radio, flight computer, FCU etc.) stop working, during soaring, continue to fly as a pure sailplane. In such a case, you will not be able to start FES unless FCU still works.

- During a powered flight:

  If FCU stops working during a powered flight, the motor will stop. However, the propeller will continue rotating due to windmilling, and it will not be possible to stop it. You will need to land with a rotating propeller. Try to land on both landing gears simultaneously, to avoid damage of propeller.

  In case that only some of the instruments stop working during powered flight, but the motor and FCU are still working fine, you can continue using the motor.

4. Normal procedures

4.1 Introduction

This chapter provides checklists and explanations of procedures for conducting normal operating procedures. Normal procedures associated with optional equipment can be found in Chapter 9.

4.2 Rigging and de-rigging, charging, battery pack installation

4.2.1 Rigging and de-rigging of the sailplane

According to the flight manual of the pure glider version of the aircraft.

Warning: *Make sure that the cable connecting battery packs is not inserted if they are fixed inside the fuselage.*

4.2.2 Charging the batteries

- **Valid for FES self-launchers:**

  FES battery packs must always be fully recharged for self-launching, so that maximum power for best climb rate is available. This is especially important for:

  - cold batteries, when the voltage drop under high power load is bigger
  - short runways
  - high altitude runways
  - hot summer conditions

- **Valid for FES self-sustainers:**

  Before each flying day, battery packs should be recharged, primarily if the system was used substantially during previous flights and a long cross-country flight is planned; this way maximum energy will be available when needed.

Note: *It is advisable to recharge the battery packs just a day or two ahead of a planned flight. However, arrange enough time to complete the charging process!*

Find **detailed instructions on the charging of battery packs** in a separate FES Battery pack manual**.**

4.2.3 Installing the batteries

Warning: *Make sure both battery packs are fully charged before installation into the sailplane. Both battery packs **must have** approximately the same voltage level of cells – ca. 4.16 V per cell. There should be less than 1V difference, between the total voltage level of individual battery packs!*

1. Check batteries for visual damage

Warning: *Even small, visually detectable damage implies that the affected battery is not airworthy.*

2. Open the battery compartment cover.
3. Check: Power switch (key) OFF
4. Check: Sailplane main switch (fuse) OFF
5. Insert the first pack with terminals facing forward and slide it back to the rear of the compartment.
6. Insert the second pack with terminals facing rearward.
7. Place a pair of fixation plates in the middle of the rear pack, above the carrying strap and tighten the fixation knob.
8. Secure the forward battery in the same way as described in step 7.
9. Lift power cables from the side support
10. Plug the shorter cable with an 8mm in the BLUE (or BLACK) housing into the 8mm socket of front battery pack marked with a minus sign.
11. Plug the longer cable with a 10mm pin in RED housing into the 10mm socket of the rear battery pack marked with a plus sign.
12. Connect DATA cables to DATA ports on both battery packs.

Caution: *Before inserting the DATA cable connector, make sure the orientation is correct. Align the connector straight with the port before inserting it; otherwise, pins could be damaged.*

13. Close battery compartment cover.

4.3 Daily inspection

Keep in mind the importance of inspections after rigging the glider, and before the first take-off of the day. As a minimum check the following items. If any problems are found, they must be corrected before the flight.

- Check the sailplane according to its Flight Manual.
- Check the FES system visually, especially the condition of propeller blades.
- Check fire warning LED by pressing the test button. It must light up brightly, blinking about one time per second. Change the 9V battery if necessary.

4.4 Pre-flight inspection

- Check the sailplane itself before a flight.
- Perform a short preflight FES test run as described below.

4.4.1 Preflight test run

After recharging the battery packs, you must perform a short motor run, so that the FCU can detect the new charge level and store it to the FCU memory.

It is advisable to conduct a test run before the first flight on a flying day.

1. Remove propeller covers and tail dolly.
2. Open the battery compartment cover.
3. Check: Power switch OFF.
4. Switch ON the BMS on each battery pack and wait until the initial check is completed.
5. Connect the battery packs using the connecting cable.
6. Close the battery compartment cover and seal it with tape.
7. Sit into the glider and close the canopy.
8. Check that no one is around propeller zone, in front of the glider or in line of the propeller.
9. Switch ON the FCU instrument.
10. Switch ON the power switch.
11. Wait about 5 seconds for the FCU to show battery capacity.
12. Start the motor but use only low power to check proper operation.

Caution*: If you want to test the system at maximum power, somebody must hold the fuselage, so that glider cannot lift the tail, which could damage the propeller.*

Warning*: Do not run the motor for a longer time on the ground, especially not at high power! When the motor is not running, it does not cool itself. The motor temperature can rise very quickly, leading to a damaged motor!*

13. Stop the motor and check if automatic positioning is working fine.
14. Switch OFF the power switch.

4.5 Normal procedures and recommended speeds

As described in the manual of the pure glider version of the sailplane, but keep in mind that your FES equipped glider has higher wing loading. Adjust speeds accordingly.

4.5.1 Aero tow launch

Before take-off, always switch ON the FCU instrument. Double-check that the "Power switch" is OFF before somebody approaches the front area of the glider to attach a tow rope to the hook. The power switch must be OFF during aero-tow!

Warning: *It is not allowed to start the motor during aero tow!*

4.5.2 Winch launch

Before take-off, always switch ON the FCU instrument. Double-check that the "Power switch" is OFF before somebody approaches the front area of the glider to attach towing cable to the hook. The power switch must be OFF during winch launch!

Warning: *It is not allowed to start the motor during winch launch! Tow rope must be released before running the motor.*

4.5.3 Car tow launch

Before take-off, always switch ON the FCU instrument. Double-check that the "Power switch" is OFF before somebody approaches the front area of the glider to attach a tow rope to the hook. The power switch must be OFF during tow!

Warning: *It is not allowed to start the motor during auto tow launch! Tow rope must be released before running FES motor.*

4.5.4 Taxiing procedures

Warning: *Taxiing is not allowed when FES is installed as a sustainer system!*

Your sailplane needs to be factory equipped with a steerable tail wheel and small wing tip wheels to be suitable for taxiing. Do not taxi with the tail dolly attached.

Taxi only on concrete or grass runways with short grass and smooth surface. Do not taxi on rough runways; otherwise, you can damage the propeller!

To start taxiing, add a bit more power and decrease it as soon as the plane begins moving to stop it accelerating. Avoid using the wheel brake and apply it very carefully not to damage the propeller!

4.5.5 Self-launch and climb

Warning: Self-launch is not allowed when FES is installed as a sustainer system!

Before a self-launch always prepare yourself mentally. Think about the actions you will perform in case of motor failure in different stages of taking-off. Consider wind conditions, airfield altitude, length of the runway, obstacles at the end of the runway, air temperature etc.

Do not take off from short runways, with a lot of obstacles and no possibility for alternatives in case of motor failure.

Caution: *Always take off in the headwind direction!*

Self-launch procedure:

1. Check that tail dolly and propeller covers are removed.
2. Sit into the glider, fasten your seat belts and close the canopy.
3. Check that airbrake is closed and locked, and elevator trim set correctly.
4. Set flaps for take-off, depending on sailplane type.
5. Check that motor ventilation is opened.
6. Check that the propeller area and the area in front of the sailplane is free of people and obstacles. Shout "clear prop" loudly.
7. Switch ON the FCU instrument.
8. Switch ON the power switch and wait until all system parameters are displayed.
9. Ask for take-off permission and wait for the approval.
10. Start the motor by rotating the throttle knob clockwise, set it to low RPM.
11. Gently rotate throttle knob clockwise until maximum power is reached.
12. Accelerate, adjust flaps and gently lift off at an appropriate speed.
13. When safe altitude is reached, reduce power and continue climbing.
14. Retract landing gear.

Caution: *During self-launching, pay attention to the traffic in the circuit which may not be familiar with electric self-launching sailplanes and may not expect your aircraft to launch unassisted.*

4.5.6 Free flight

As described in the manual of the pure glider version of the sailplane, but keep in mind that your FES equipped glider has higher wing loading. Adjust speeds accordingly. Always keep the FCU instrument turned ON during soaring flight.

4.5.7 Low-speed flight and stall behaviour

As described in the manual of the pure glider version of the sailplane, but keep in mind that your FES equipped glider has around 5kg/m2 higher wing loading, and as a result, higher stall speed.

4.5.8 Cruise and climb with a running motor

FES can be used for a long continuous cruise at low power settings or for climbing at higher power settings.

Caution: *During motor operation, ventilation must be fully opened. The opening procedure depends on the type of sailplane; usually, the ventilation lever must be pushed fully forward.*

Warning: *I case that you forget to open ventilation; warning message "Check ventilation" will appear on the FCU screen. FCU monitors temperature rise gradient. When it becomes steeper than usual, the message will be displayed.*

Motor starting procedure during flight:

1. Check that all values on the FCU instrument are in the normal range. The FCU must always be switched ON during flight.
2. Turn ON the Power Switch.
3. Check if the green "OK" LED is ON. Check Voltage level.
   If there is no green LED or the red LED is blinking, the motor will not run. Read FES FCU instrument manual for a detailed description.
4. Start the motor by rotating the throttle knob clockwise gently.

Set power to 4kW for horizontal flight and more for climbing. Maximum climb rate depends on glider type, and it is affected by its weight, speed, flaps position etc.

Maximum available power is reduced slowly during operation, due to the voltage drop from draining power from battery packs. Maximum power is accessible until any of the temperature values reach a yellow warning level. These levels are 70°C for the motor and controller and 45°C for battery packs.

Note: *You can reduce power in thermals and use more energy in sinking air.*

Do not use high current when the total battery voltage is below 95V. Try to fly with lower power settings as much as possible, where the efficiency of the complete system is the best!

Always keep the FCU turned ON during flight.

Switch OFF the power switch if the motor is not running.

4.5.8.1 Stopping the propeller with electronic braking

To stop the propeller with the electronic brake, you need to rotate the throttle in the counter-clockwise direction until you set it 1 step away from zero power when the throttle line on the display starts blinking red!

Note: *To successfully stop the motor, it must reach around 1500 RPM; otherwise braking will not work, due to* ***insufficient induced voltage.*** *Propeller brake uses the regeneration function of the controller.*

In the air, there is enough RPM in most cases. But if you want to test electronic braking on the ground, make sure you set at least 1500 RPM, and then rotate the throttle knob quickly in a counter-clockwise direction!

4.5.8.2 Propeller positioning

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

   If the propeller stops in a position where you can see one of the blades through the canopy, just start the motor again to around 1500 RPM and then stop it again. Repeat this procedure until blades are positioned in a suitable position!

2. FES installations **with automatic positioning**:
   If your FES system has automatic propeller positioning, the electronics will rotate it in a horizontal position.

   After the electronic brake stops the motor, the automatic positioning will start after 2-3 seconds. You can always interrupt automatic positioning by pushing the throttle knob.

Note: *Automatic positioning will not work if canopy message is active, or if the throttle is set to zero power instead of braking!*

It is possible to adjust the following paramters in settings:

- the time between steps from 50ms to 1 sec;
- power used for positioning at 115V and 90V

  number of steps after the hall sensor detects the reference position of the propeller

4.5.9 Approach

As described in the manual of the pure glider version of the sailplane, but keep in mind that your FES equipped glider has around 5kg/m2 higher wing loading, so increase landing speed for 5 to 10km/h.

Check that propeller blades are parked in horizontal position and "Power switch" is switched OFF.

4.5.10 Landing

As described in the manual of the pure glider version of the sailplane, but keep in mind that your FES equipped glider has around 5kg/m2 higher wing loading, so increase landing speed for 5 to 10km/h.

Always land with the propeller blades in a horizontal position; otherwise, propeller blades might get damaged during landing or when the canopy is opened.

4.5.10.1 After Landing

Warning: *After landing (or if you decided not to fly) it is mandatory to unplug the "Connecting cable", from the battery packs! At the same time, switch off the BMS of each battery pack.*

Caution: *Make sure the "Power switch" is OFF before removing the connecting cable.*

Note: *Only when the connecting cable is unplugged, the FES system is completely deactivated. Otherwise, the system is consuming some current, which can discharge the battery packs below the critical level of 90V, if the connecting cable is left plugged in for a week or two. If this occurs, new battery packs are required.*

If the motor was used during flight, remove both batteries and recharge them according to charging instructions in FES Battery pack manual.

4.5.10.2 Removing the batteries

1. Check: Power switch OFF.
2. Check: Sailplane main switch (fuse) OFF
3. Open the battery compartment cover.
4. Remove the connecting cable from terminals of the battery packs.
5. Remove the red and blue power plugs from battery packs.
6. Fix both power cables on the right side of the battery compartment wall.
7. Remove DATA connectors from each battery pack.
8. Fix DATA cable to the side of the battery compartment.
9. Untighten both battery pack fixation knobs.
10. Take all fixation plates out.
11. Firmly grip the front battery by a carrier strap.
12. Lift the front battery out of the fuselage and lay it down in a safe place.
13. Firmly grip the rear battery by the carrier strap and slide it forward along the bottom of the compartment.
14. Lift the rear battery out of the fuselage and lay it down in a safe place.
15. Close battery compartment cover.

Caution: *Always use a transport box or similar for transport and storage of the batteries, which protects them from mechanical damage. Make sure you store the batteries in a dry and safe place. Please read FES Battery pack manual for detailed instructions.*

4.5.11 Flying with water ballast

As described in the manual of the pure glider version of the sailplane. For maximum climb rate performance and range under power, drop the water ballast.

4.5.12 High altitude flight

As described in the manual of the pure glider version of the sailplane. Review the chapter 5.3.4.3 Maximum operational altitude.

4.5.13 Flight in the rain

Never fly through heavy rain and thunderstorms. If you encounter rain, close the ventilation to prevent water from entering into the spinner. Before the flight, seal the battery compartment with tape, to prevent water from entering.

Warning: *Avoid flying close to areas with lightning activity!*

It is allowed to fly through light rain with the motor running. However, use lower RPM settings, suitable for horizontal flight, to avoid damaging the propeller blades. Stop the motor if the rain becomes stronger.

4.5.14 Aerobatics

Aerobatic manoeuvres are not permitted with an FES equipped sailplanes, unless it is not explicitly allowed for a certain FES equipped type!

5. Performance

5.1 Introduction

This chapter provides data for airspeed calibration, stall speeds and take-off performance and some further information. The data in the charts have been computed from actual flight tests with the sailplane in good condition using standard piloting techniques.

5.2 Approved data

5.2.1 Airspeed indicator system calibration

The airspeed indicator must be connected to the pitot pressure source located on the vertical stabilizer and to the static pressure source located on the aft part of the fuselage (detailed location of ports depends on specific glider type).

5.2.2 Stall speeds

As described in the manual of the pure glider version of the sailplane, but keep in mind that your FES equipped glider has a higher wing loading, and as a result, higher stall speed.

5.2.3 Take-off performance (only for self-launch approved types of sailplanes)

The take-off performance for aero tow, winch launch, or auto tow is the same as a pure glider version. However, due to the additional weight of the FES, the sailplane has a slightly higher wing loading, so liftoff must be performed at a higher speed.

Take-off run distance and climb performance during self-launch, primarily depend on sailplane take-off weight, its glide performance, quality of the runway and air density (airfield elevation, and outside temperature).

An important factor is also the temperature of the battery packs. Cold or overheated batteries can not supply the same maximum power as batteries at optimal temperature.

Warning: *Do not try to self-launch if the temperature of the battery packs is below 5°C!*

Note: *Store the batteries packs at room temperature during the night and not in a glider or trailer parked outside. Install them into the plane just before the flight to avoid taking off with cold batteries.*

Caution: *Keep propeller blades clean for self-launch take-offs, as bugs reduce propeller efficiency and thrust, resulting in a longer take-off run and reduced climb rate!*

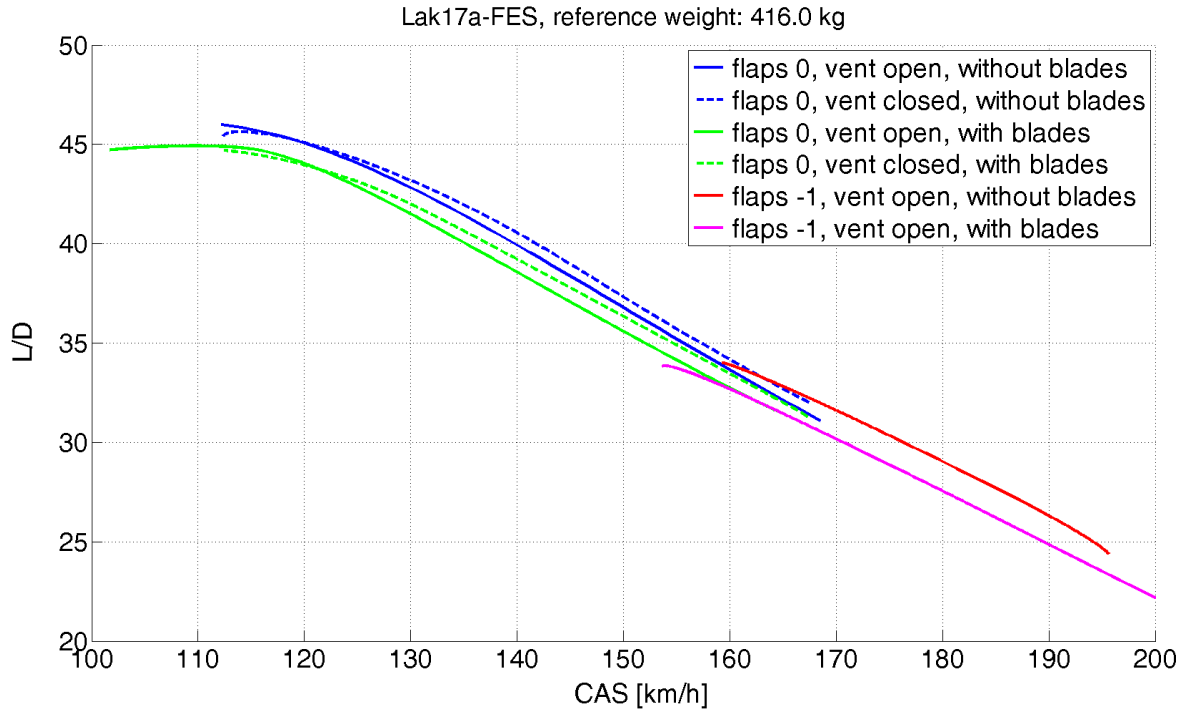
5.3 Non-approved further information

5.3.1 Demonstrated crosswind performance

FES equipped sailplane has the same crosswind performance as the pure glider version of the aircraft.

5.3.2 Glide performance

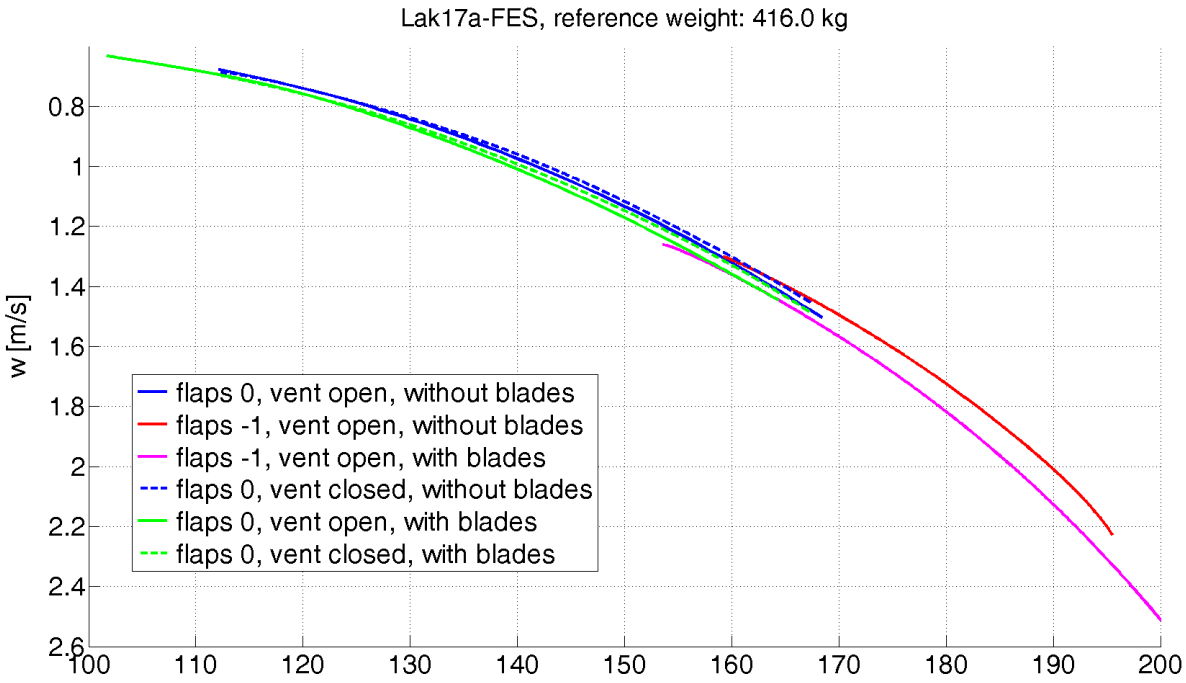
Idaflieg flight comparison measurements of the LAK17A FES (August 2012) showed only a minor effect of the propeller blades on glide performance. It is reduced by around 1 L/D point over the entire speed range.



As you can see from the graph above, even the cockpit ventilation has some effect on the flight polar (reduction of around 0,5 L/D point).

5.3.3 Flight polar

FES equipped sailplane has about 4-5kg/m2 higher minimum wing loading, compared to a pure glider version which is around 45kg lighter. Additional weight has the same effect on flight polar as adding water ballast (moving polar to the right). Best L/D speed and the minimum sink rate speed is about 5km/h higher, compared to a pure glider version.



The graph above shows the flight polar of LAK17A FES in 18m configuration at 416kg take-off weight (no water ballast and around 20kg of measurement equipment).

5.3.4 Powered flight performance

5.3.4.1 Rate of climb

The maximum rate of climb is available only for a few minutes with fully charged battery packs. As battery voltage is reduced, the maximum achievable climb rate is lower. The average rate of climb depends mostly on the type of sailplane and its take-off weight.

Maximum attainable altitude gain that in standard atmosphere conditions depends on the type of sailplane, its weight and aerodynamic qualities. To achieve the maximum altitude gain, use about 15kW of power. Do not use full power as the efficiency of the system is lower. Usually, 80-85 km/h is best for the climb with positive flap setting (the same setting as used while thermaling). Here are rough numbers:

- 1600 m (5200 ft) for UL sailplanes at 300kg take-off weight, i.e. Silent 2 Electro
- 1400 m (4500 ft) for the 18m class sailplanes at 400kg take-off weight (without water ballast), i.e. LAK17A FES
- 1200 m (3900 ft) for the 18m class sailplanes at 450kg take-off weight (without water ballast); LAK17B FES, Ventus 2cxa FES, Discus 2c FES, HPH 304ES

Caution: *Always make sure that propeller blades are clean. Dirty leading edge reduces propeller efficiency and climb rate.*

5.3.4.2 Cruise flight

The maximum range of powered cruising flight, without the water ballast, is around 100km (62 miles), depending on lift-sink conditions.

The optimum cruise speed and flap position depend on the type of sailplane. Usually, it is about 90 km/h (48 kts) at around 3000-3300 RPM and 4kW of power with a positive flap setting, as used in thermals.

5.3.4.3 Maximum operational altitude

There should be no problem to fly an FES equipped sailplane at high altitude, due to low pressure. Battery cells used in the FES battery packs passed eight different tests as required by UN transport regulations. The first test is an altitude simulation where cells were exposed to reduced pressure of 11.6kPa, equivalent to about 15.000m.

Cold outside temperatures down to -20°C do not represent a safety issue for battery packs (they usually stay warmer), or to other FES system components. However, if battery packs have a very low temperature, their performance is reduced, but it is unlikely that you will need to use FES at high altitude.

5.3.5 Noise data

Measurements of the motor noise level are lower compared to sailplanes equipped with combustion engines. The analysis was performed according to requirements for certification purposes of Silent 2 Electro, where the noise level was measured to be 57db. Maximum engine noise level is not regulated sustainer type gliders.

Engine noise level (ENL) signal for flight recorders:

Flight recorder (FR) will only record the engine noise level when the FES is running if the sound is loud enough. Therefore the flight recorder must be mounted on the instrument panel or equally close to the FES unit. Installing the FR elsewhere in the cockpit will require a separate MOP sensor. Please refer to the Annex B of the IGC Sporting Code for details.

5.3.6 Electromagnetic interferences

Proper construction of the motor prevents the magnetic field leaking outside of the housing. We did not find any issues with the instruments, including the magnetic compass, caused by the high power cables that are routed below the instrument panel.

6. Weight and balance

6.1 Introduction

The components of the FES elements should be arranged in such a way, that C.G. position does not change considerably in comparison to the pure glider version of the aircraft.

6.2 Weight and balance record and permitted payload-range

The same applies as for a pure glider version or a powered version of specific sailplane type.

6.3 Weight of all non-lifting parts

The weight of non-lifting parts of the sailplane includes weight of the pilot, the fuselage with rudder, horizontal stabilizer and elevator, the instruments and equipment and the FES installation (everything except wings).

The manufacturer sets the maximum weight of non-lifting parts for a specific type of the sailplane.

6.4 Maximum weight

Sailplane manufacturer sets the maximum approved take-off and landing weight.

Warning: *Do not use the full amount of water ballast, because the FES system already adds around 50kg to the take-off weight.*

Adjust the amount of water ballast, so that you do not exceed the maximum take-off weight. Overloading your sailplane will result in structural damage of the airframe.

7. General sailplane and systems description

7.1 Introduction

This Chapter describes the sailplane, its systems and provided standard equipment with instructions for use.

7.2 Cockpit controls

FES equipped sailplane adds a power switch to the controls of the standard version of the sailplane. The power switch can be implemented as a toggle switch or a key switch, depending on the type of sailplane. If a toggle switch is used, it is located on the right side of the cockpit, whereas the key switch is mounted on the instrument panel.

7.3 Instrument panel

The FES equipped version of the sailplane has an FCU instrument mounted on the instrument panel in addition to other instruments. The FCU should be in an easily accessible location on the left side of the panel. The most suitable place depends on the specific glider type and other instruments.

The **FCU instrument manual** describes the FCU instrument in detail.

7.4 Landing gear system

As described in the flight manual of the pure glider version of the sailplane.

7.5 Seats and safety harness

As described in the flight manual of the pure glider version of the sailplane.

7.6 Pitot and static system

The airspeed indicator must be connected to the pitot pressure source located on the vertical stabilizer and to the static pressure source located on the aft part of the fuselage (detailed location of ports depends on the specific glider type). On FES equipped sailplanes the pitot probe cannot be located on the nose!

Note: *Consult the sailplane manufacturer regarding the optimal configuration of pneumatic sources for a specific FES equipped sailplane type.*

For more info about measuring probes, visit www.esa-systems.com.

Total energy compensation source is generally located on the vertical stabilizer, below pitot source. When FES is installed on a used sailplane and there is only one port available (for total energy compensation but not for pitot), then this port is used as a pitot source. In this case, electronic compensation can be used instead.

7.7 Air brakes system

As described in the flight manual of the pure glider version of the sailplane.

7.8 Baggage Compartment

As described in the flight manual of the pure glider version of the sailplane.

Warning: *Heavier pilots flying an FES equipped sailplane can bring the weight of non-lifting parts close to the approved limit, especially if they are also using the tail water ballast.* ***Heavy pilots should avoid using any additional weight in the baggage compartment!***

7.9 Water ballast system

As described in the flight manual of the pure glider version of the sailplane.

Caution: *Close the battery compartment, when filling water ballast into wings!*

7.10 Power plant

A detailed description of the FES power plant can be found in the **FES maintenance manual,** where other manuals for the specific type of FES equipped sailplanes are also listed.

7.11 Battery packs

A detailed description of FES battery packs can be found in **FES battery packs manual.**

7.12 Electrical system

A detailed description of the FES electrical system can be found in **FES maintenance manual**

7.13 Miscellaneous equipment

A detailed description of FES BMS (Battery management system), FES Battery pack charger and BMS Control software can be found in **FES Battery packs manual.**

8. Sailplane handling, care and maintenance

8.1 Introduction

This chapter contains the manufacturer's recommended procedures for proper handling and servicing of the sailplane with FES. It also identifies certain inspection and maintenance activities, which are needed to retain performance and dependability.

8.2 FES inspection periods

The instructions for continued airworthiness as provided in the **FES Maintenance manual** must be followed.

8.3 Sailplane alterations or repairs

As described in the flight manual of the pure glider version of the sailplane.

8.4 Ground handling/road transport

a) Towing / Pushing

Follow the general information as described in the manual of the pure glider version with the addition of the following remarks.

Protect the propeller blades on the ground with the special blade protection cover, that prevents the propeller blades from opening. Do not forget to remove the propeller cover before the flight!

On some newer FES equipped gliders, propeller tips have integrated metal plates. Small permanent magnets are integrated into the fuselage to hold the propeller blades folded. In this case, protection covers can be used as well, but are not necessary!

Caution: *Make sure that the propeller is in a horizontal position when lifting aft part of the fuselage to attach tail dolly.*

Warning: *Newer use a propeller or spinner for pushing, pulling or lifting the tail!*

b) Hangaring

Follow the general information as described in the manual of the pure glider version. Observe FES-Battery specific instructions for storage. See FES BATTERY PACK GEN2 manual, section 8.

c) Tie-down

In dry conditions when rain is not expected during the night, the canopy cover is sufficient to protect the motor from moisture. FES batteries must be protected against moisture. It is enough to tape the battery compartment cover in dry conditions.

When rain is expected, do not leave an FES equipped sailplane outside it the rain,

unless it is covered with high-quality all-weather covers. It is recommended to remove FES batteries out of the glider and store them in a dry place!

d) Preparation for road transport

Warning: *If sailplane is parked, stored or transported remove the cable connecting the FES-battery packs!*

e) Transportation of batteries

When carrying the batteries by the carrier strap, care must be taken to prevent the batteries from getting damaged, e.g. by being dropped or hitting them on edges etc. Furthermore, the batteries must be protected against moisture.

When you are transporting the batteries (by car, in the trailer, etc.), they must be protected against mechanical damage and moisture. For the protection against mechanical damage, a solid box must be used. It is recommended to use original FES transport boxes.

For safety reasons, the transport box should be placed into the luggage compartment, pushed against the front wall. Transportation box should be additionally secured by straps so that it cannot move during acceleration or braking.

Warning: *For safety reasons, it is not allowed to transport the battery packs in the passenger compartment of the car, behind drivers or co-drivers seat or in front of the co-driver seat for instance. In case of an accident, this could be very dangerous!*

Note: *It is not recommended to transport battery packs in the front area of glider trailer. In heavy rain, most front hatches leak water, which could spill over the battery packs.*

Caution: *Do not leave battery packs in the parked car or trailer under the sun in summer, as they might be exposed to high temperatures.*

8.5 Sailplane trailer

A sailplane with an FES system should be transported and stored in a high-quality enclosed trailer constructed of metal or fibreglass reinforced plastics with proper insulation and ventilation characteristics.

- The forward fuselage support for **lighter fuselages** can be implemented as a nose cone support in the shape of the spinner with a recess big enough to clear the propeller blades in a horizontal position, covered with a soft thick material.
- The forward support for **heavier fuselages** must hold the fuselage behind the spinner. Otherwise, the loads on the motor and propeller blades could be too high. Such a nose is optionally available for Cobra trailers.

Note: *It is recommended to use soft cotton canopy cover that covers the entire nose of the sailplane which prevents the blades from opening. If the canopy cover is not used, use a fitted propeller cover with elastic straps, to prevent the blades from opening.*

On newer FES gliders the blades are held in position by the magnets integrated into the fuselage.

A fuselage dolly should support the fuselage positioned just forward of the main landing gear opening. The forward stop must be provided for the fuselage doll to prevent it from rolling forwards, leaving the fuselage with no support.

8.6 Cleaning and care

Avoid cleaning around the area of the FES motor and battery compartment with water. Clean the sinner and propeller blades with a wet sponge or soft cotton towel. Tape adhesives are best removed using pure petroleum spirits or nitro thinner.

9. Supplements

There are no supplements.

10. Revision history

April 2013	The initial release of manual, Version 1.0
October 2013	Minor updates, Version 1.1
February 2014	Minor updates, Version 1.11
June 2015	Minor updates, Version 1.12
February 2016	Minor updates, Version 1.13
September	Minor updates, Version 1.14
November 2016	New three-view drawings, Version 1.15
October 2017	New info about fire detection system, Version 1.16
September	Minor updates, Version 1.17
May 2020	Proofreading, Version 1.18