



FES MOTOR MANUAL

Version 1.21

Type: **FES-HPH-M100**



LZ design d.o.o., • Brod 3D, 1370 Logatec, Slovenia • tel +386 59 948 898
info@lzdesign.si • www.front-electric-sustainer.com

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1. Important notices

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

Information in this document is subject to change without notice. LZ design reserves the right to change or improve their products and to make changes in the content of this material without obligation to notify any person or organization of such changes or improvements.

1.1 Limited Warranty

This motor 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 labor, the customer shall be responsible for any transportation cost. This warranty does not cover failures due to abuse, misuse, accident, or unauthorized alterations or repairs.

THE WARRANTIES AND REMEDIES CONTAINED HEREIN ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED OR STATUTORY, INCLUDING ANY LIABILITY ARISING UNDER ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, STATUTORY OR OTHERWISE. THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, WHICH MAY VARY FROM STATE TO STATE.

IN NO EVENT SHALL LZ DESIGN BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES, WHETHER RESULTING FROM THE USE, MISUSE, OR INABILITY TO USE THIS PRODUCT OR FROM DEFECTS IN THE PRODUCT. Some states do not allow the exclusion of incidental or consequential damages, so the above limitations may not apply to you. LZ design retains the exclusive right to repair or replace the unit or software, or to offer a full refund of the purchase price, at its sole discretion. SUCH REMEDY SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY BREACH OF WARRANTY.

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

2. General

Congratulations on your purchase. This is a high-end product of brushless synchronous permanent magnet motor with electronically controlled commutation system 3 phase, which will keep its capability for a long time if treated the right way.

The drive was developed and very elaborately tested by Ing. Matija Žnidaršič and Ing. Luka Žnidaršič.

The development objective was to build suitable motor for FES application which must be light and small enough to fit into sailplane front part of fuselage, but very powerful providing specific performance at highest efficiency.

This motor allows a gearless drive without the usually essential gear unit which cause power losses, additional weight, complexity and maintenances. Because of the little internal resistance of the motor, very good performances are achieved in a wide range and at an excellent efficiency.

Though many intensive tests had already been made and though the parts were produced by modern CNC machines, the drive is still not a real series product. Some manufacturing processes like windings are made by hand, what makes every drive of the first series unique.

3. Model designation

Motor model designation is the following:

FES-HPH-M100

(1) (2) (3)

where:

- (1) motor application
- (2) designed for sailplane model; HPH304ES
- (3) approximate motor length in mm

Motor serial-number is identified as number which follows model designation

sn: XXX

Motor identification numbers are engraved into rear Aluminum plate of motor.

NOTE: Motor type FES-HPH-M100 is identical like FES-DIS-M100. It is marked differently due to different manufacturer of the sailplane.

4. Technical data and limitations of motor

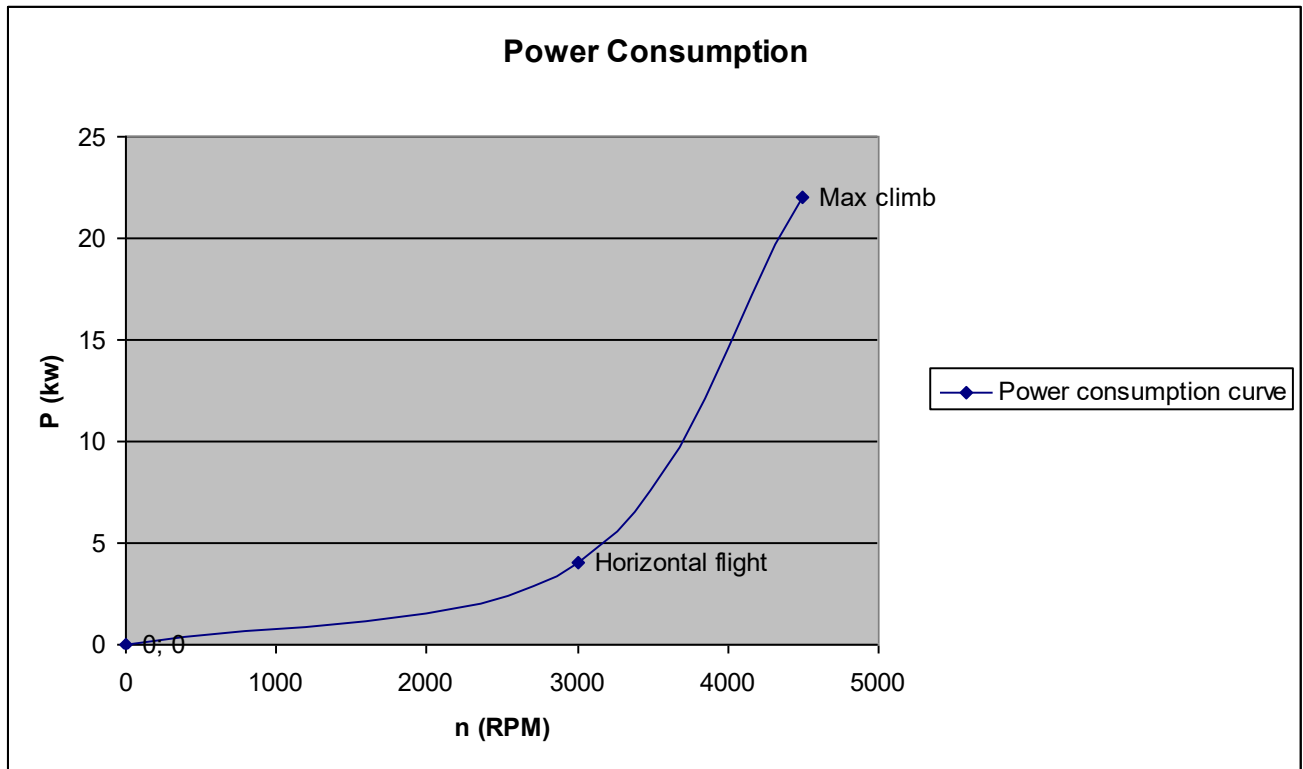
Motor construction is outrunner BLDC brushless synchronous permanent magnet motor with electronically controlled commutation system 3 phase. Rotor position is determined by 3 hall sensors and additional 4th hall sensor for automatic propeller positioning.

This motor can work only in combination with suitable electronic Controller which transform DC current from Battery packs to 3 phase current which supply motor. We use controller type which needs hall position sensors in motor, but this motor can work also with some sensorless controllers.

Electrical motor type FES-HPH-M100 power ratings at 116V on motor controller and loaded with FES-HPH-P1-102 propeller:

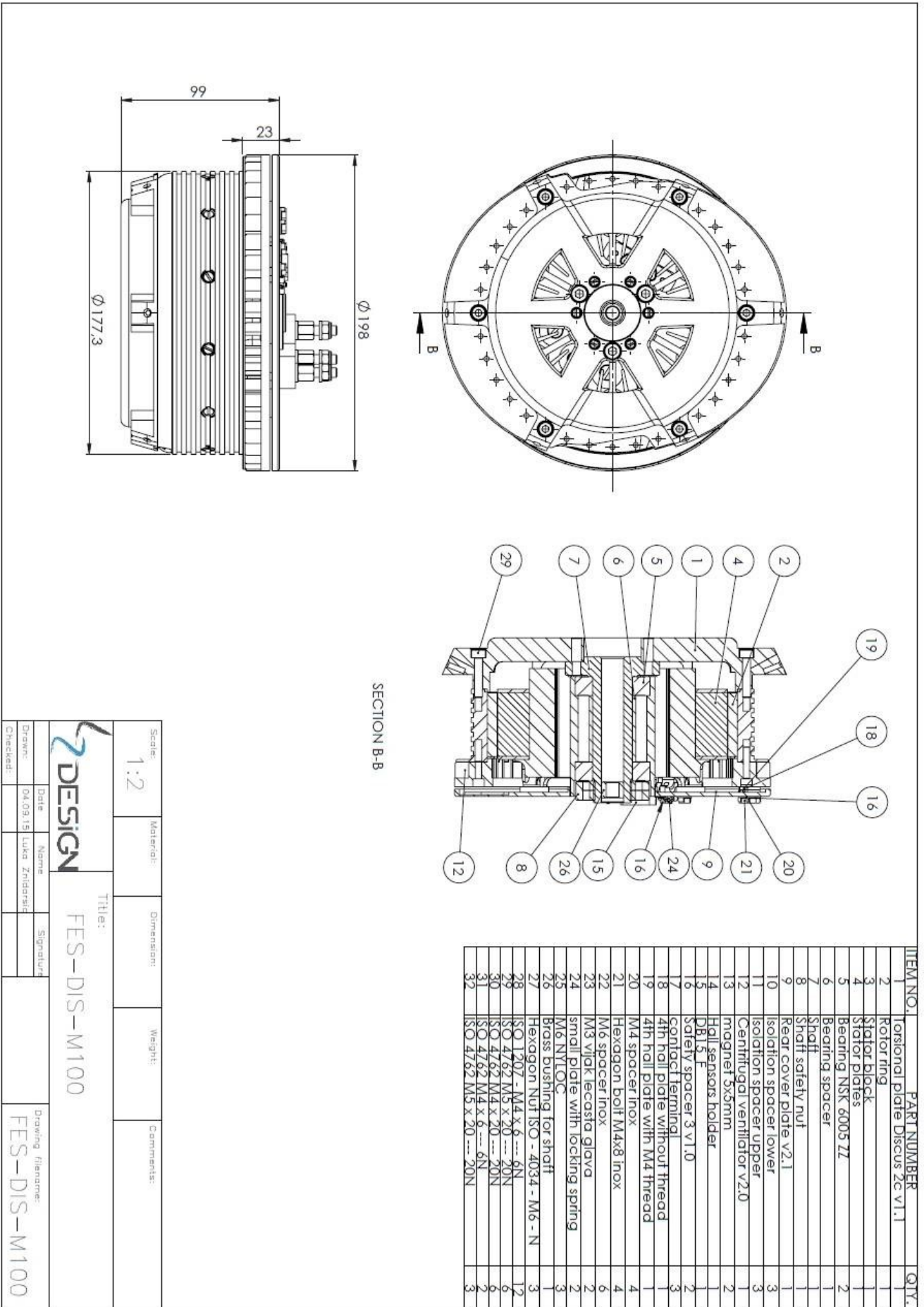
Maximum torque	75 Nm
Maximum current	200A
Maximum Voltage	116V
Rpm non loaded	45 rpm/V
Rpm non loaded (at 116V DC on Controller)	5300 rpm
Non loaded motor current (at 5300 rpm)	16-18 A
Rpm loaded with FES-HPH-P1-100 propeller (1m diameter)	4500 rpm
Battery current loaded (4500 rpm, 116V) with FES-HPH-P1-102	Up to 200 A
Rotor rink diameter	182mm
Motor length	100mm
Motor weight cca.	8,0 kg
Motor efficiency	82-95 %
Maximum allowed temperature	90 °C
Minimum allowed starting temperature	-20 °C

Power load on motor P (kW) is dependable of propeller diameter, geometry, pitch and its rotation speed n (RPM-rotation per minute). However rotation speed of motor is than dependable on available Voltage on controller. Higer Voltage, higher rpm!




Rpm versus Power

5. Drawing of motor



ITEM NO.	PART NUMBER	QTY.
1	Isolation plate Discus 2c v1.1	1
2	Rotor ring	1
3	Stator block	1
4	Stator plates	1
5	Bearing NSK 6005 ZL	2
6	Bearing spacer	1
7	Shaft	1
8	Shaft safety nut	1
9	Rear cover plate v2.1	1
10	Isolation spacer lower	3
11	Isolation spacer upper	3
12	Centrifugal ventilator v2.0	1
13	magnet 5x5mm	2
14	Hall sensors holder	1
15	DB1.5 F	1
16	Safety spacer 3 v1.0	2
17	contact terminal	3
18	4th hall plate without thread	1
19	4th hall plate with M4 thread	1
20	M4 spacer inox	4
21	Hexagon bolt M4x8 inox	4
22	M6 spacer inox	6
23	M3 vijak lecasta glava	2
24	small plate with locking spring	2
25	M6 NYLOC	3
26	Brass bushing for shaft	1
27	Hexagon Nut ISO - 4034 - M6 - N	3
28	ISO 1207 - M4 x 6 --- 6N	12
29	ISO 4762 M5 x 20 --- 20N	6
30	ISO 4762 M4 x 20 --- 20N	6
31	ISO 4762 M4 x 6 --- 6N	2
32	ISO 4762 M3 x 20 --- 20N	3

Scale:	1:2	Material:		Dimensions:		Weight:		Comments:	
									
Title: FES-DIS-M100									
Drawn:	04.09.15	Name:	Luka Znidarsic	Signature:		Drawing filename: FES-DIS-M100			
Checked:									

6. Operating instructions

6.1 Motor starting on the ground

1. Remove propeller covers and a tail dolly
2. Open battery compartment cover
3. Check that Power switch is OFF
4. Insert connecting cable between the battery packs
5. Switch ON BMS switch of each battery pack
6. Seal battery compartment cover with glider tape
7. Seat into the glider, and close canopy
8. Check that no one is around propeller zone, in front of glider or in line of propeller
9. Switch on FCU instrument
10. Switch on Power switch
11. Wait about 8 second, for FCU to show all battery bottles
12. Start motor but use only low power to check proper operation



Caution: *In case that you would like to test, system at maximum power, somebody must hold a fuselage tube down, so that glider can not lift tail, which could result in damaged propeller blades.*



Warning: *Do not run the motor for longer time, on the ground, especially not at high power! When motor is stopped, also cooling is stopped, and so motor temperature can rise very quickly, which can lead to damaged motor!*

13. Check if propeller braking and automatic positioning are working fine
14. Switch OFF Power switch
15. Switch OFF FCU

6.2 Motor starting procedure during flight:

1. Check that all values on the FCU instrument are in normal range (FCU must be always switched ON during flight)
2. Turn ON Power Switch
3. Check if there is green LED ON (left lower LED), check Voltage level
 1. (If there is no green LED or red LED is blinking motor will not run). Read FES FCU instrument manual for detailed FCU description
4. Start motor with Throttle knob rotating in clockwise direction gently.

Use about 4kW of power 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.

Available maximum power is reducing slowly due to voltage drop, during discharging of battery packs. Maximum power can be used only until any of temperature values reach yellow warning. (motor and controller at 70 deg, battery packs at 45 deg)!

Do not use high current at lower voltages; this mean below 95V.

Always try to fly as much as possible on lower power settings where efficiency of complete system is the highest!

During powered flight always keep the FCU turned ON. Switch OFF Power switch if motor is not running.

6.3 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 starts blinking red!



Note: *For successful stop the motor should reach about 1500 RPM, otherwise braking will not work, due to **insufficient 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 1500 RPM, and then rotate throttle knob quickly in counter clockwise direction!

6.4 Propeller positioning

After electronic braking stops motor, wait for 2-3 second, until RPM data shows zero RPM. After that automatic positioning will start! You can always stop automatic positioning by pressing throttle knob.



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

In settings it 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. Maintenance

The motor do not need any maintenance. Opening or disassembling of the motor would cause a forfeit of warranty claims! It could be also very dangerous, due to very strong magnets on rotor!

Though, it has to be considered that no foreign objects at all can enter the interior of the drive.

Further, it is necessary to protect the motor from humidity, dirt, paint, glues etc. If this is ignored, a proper functionality of the motor can not be guaranteed and irreparable damages are possible. In case of damage, ship the drive back to the manufacturer for repairs. Unintended handling leads to secondary damages.

Keep magnetic memory cards or electronic devices out of the rotor's close-up range, because the alternating magnetic field can cause a delete of data. Be also careful with medical devices (e.g. pacemakers) which are sensitive to alternating magnetic fields.

The small gap between the stator and the magnets of the rotor function-bound has a thickness of only a few tenth millimeters. Here, the danger of foreign objects accumulating in this gap exists but can be heard by scratching-sounds. In this case spinner should be removed and the motor should be blown-out with compressed air. Do not at all simply keep on using the drive. Be especially aware of cuttings which can almost irremovably stick to the magnets. In this case, the only thing that helps is a disassembly of the drive by the manufacturer.

8. Removal of motor

Removal of motor from sailplane is only allowed in case of **written permission** from manufacturer otherwise warranty is not valid any more!

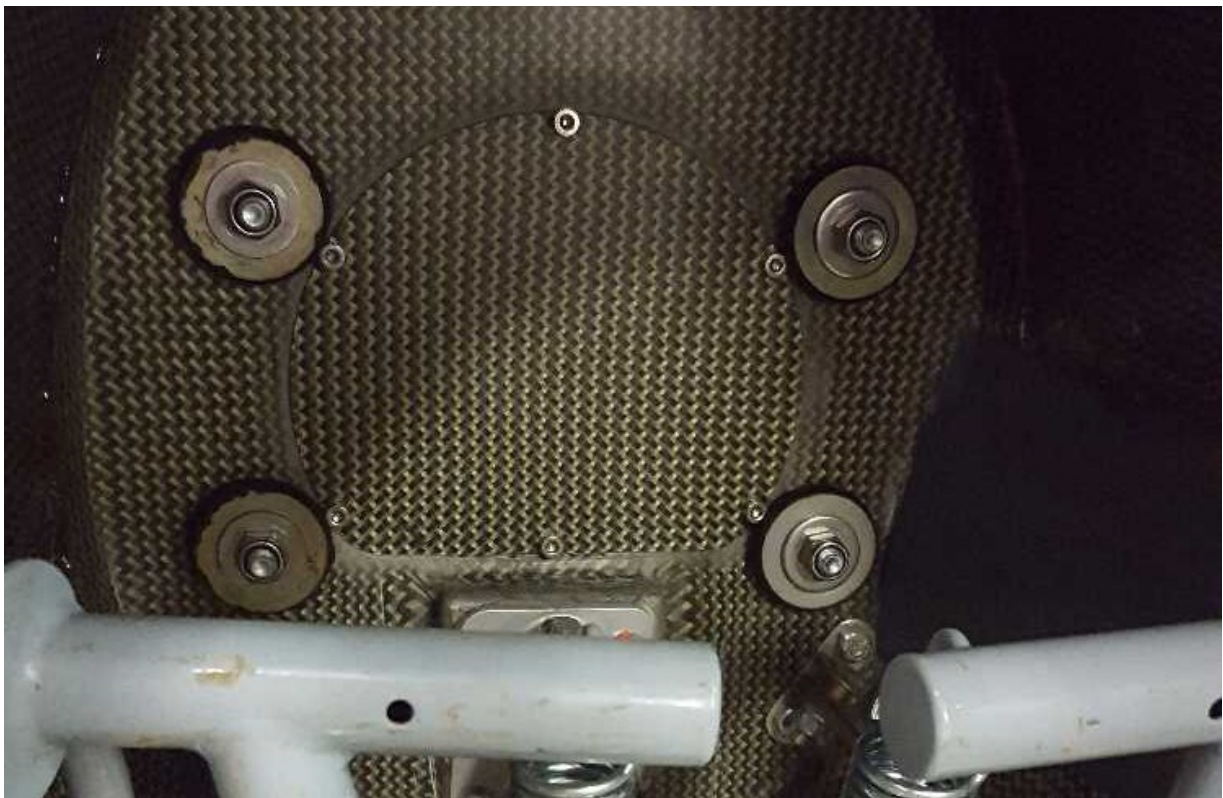
Warning!

It is not allowed to fly with removed motor from the sailplane, as C.G. position change significantly!

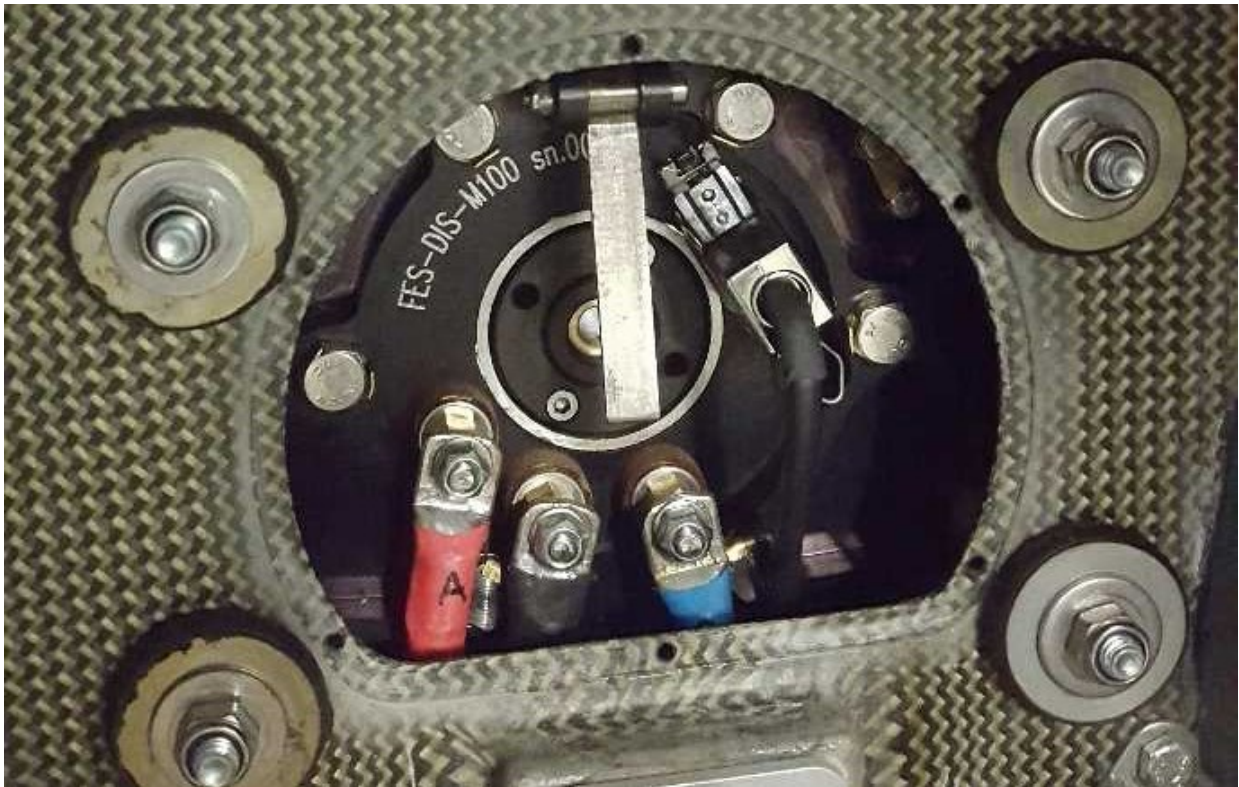
On back side of mounting wall are visible four M8 nuts tightened over big spacer and rubber silen blocks. Please leave them at they are. Proper way of removing motor is to follow next steps.

To remove the motor from the glider (complete with spinner and propeller)

1. Open ventilation (knob fully forward position)



2. Unscrew 6 M4 inbus bolts and remove composite cover from center of front motor mounting rib (from cockpit side)



3. Unlock springs which hold DB15 cable connector and than carefully unplug connector from motor rear wall.



4. Unscrew 3 self-locking nuts from rear motor wall and disconnect 3 power cables. Each is marked with different colour of isolation over cable shoe (red, blue and black). Take a photo so that you will know their proper order for assembly.

5. Unsecure six M8 bolts and unscrew them out. One of M8 bolts which is below powers wires have lower head. Hold motor assembly, and carefully take it out of fuselage.

Centrifugal ventilator on back side of has bigger diameter than rotor rink, so motor will not go out straight, as opening is now wide enough. You needs to rotate it about 30 degrees to one side in order to get it out. Be careful not to damage spinner, or plastic covers below spinner.

9. Installation of motor

To install motor back on glider, follow the reverse order of previous chapter.

Take care about additional steps:

1. Open ventilation fully - knob pushed forward.
2. It is recommended to use new bolt securing plates to secure M8 motor fixation bolts.
3. Make sure that power cables are connected in the same order as before (check taken photo for reference), as otherwise motor will not run or it might run in wrong direction. Use only new complete metal M6 self-locking nuts. Make sure that there is no contact between cable shoes and aluminum mounting wall or M8 fixing bolts. Air gap distance between each of these elements and each cable shoe should be at least 3mm. Below the middle cable, should be placed M8 bolt which has more shallow head (one of 6 bolts which holds motor).
4. Carefully plug in male DB15 connector (with signal wires) into motor rear wall female connector. Fix connector on both sides with lock springs.

After motor is reinstalled, check that:

- Spinner is nicely located in the center of the fuselage when spinner is in stop position. This means that surface of the spinner is as much as possible tangent to the fuselage contour in area of gap between spinner and fuselage.
- Gap between spinner and fuselage should be between 0,5-1mm. Gap should be equal all around (on top should be the same as on bottom side, on left side should be equal as on right side). If gap is wider than 1mm is not nice.
- All bolted connections assembled correctly and secured properly. Below six M8 bolts which hold motor in place are thin brass safety spacers, which needs to be bend 90 degrees against one of the 6 vertical surfaces of M8 hex head bolts.
- Start the motor on a ground and run it for a few seconds to check:

-that motor rotating direction is counter clockwise (looking in front of the propeller), and that motor is running smoothly

-that electronic braking of propeller works (above 1500 RPM)

-FCU instrument is functioning properly (check about all functions of the FCU in its dedicated FCU manual)

10. Repair and service

In case of a fault or damage, please contact manufacturer.

11. Revision history

July 2015	Initial release of manual, v1.0
August 2016	Chapter Operating instructions added. More info in chapter 7 and 8, v1.1
November 2016	New drawing of motor, v1.21

