2.4 Power-plant, fuel and oil

Engine manufacturer:	SOLO Kleinmotoren GmbH
Engine model:	SOLO Typ 2350
Max. power, take-off:	*Not applicable*
Max. engine rpm, take-off:	*Not applicable*
Max. power, continuous:	24 PS / 18kW
Max. engine rpm, continuous:	5400 rpm
Max. cylinder head temperature:	275°C
Fuel:	2-stroke mixture from AVGAS 100LL or unleaded MOGAS min. 95 ROZ
Oil grade:	Fuel-oil mixture 1:40 2-stroke oil Castrol RS 2T, Castrol Super TT, Castrol TTS or Castrol Go!2T. If none of these oils is availiable, alternatively two stroke oil with the designation JASO FC can be used.
Propeller manufacturer:	Alexander Schleicher GmbH & Co
Propeller model:	AS2F1-3/L100-56-N2

2.5 Power-plant instrument markings

In the following table explains the meaning of the different lights of the power plant instrument:

Symbol	Green light	Yellow light	Red light
RPM	4400 to 5200 rpm	5200 to 5400 rpm	> 5400 rpm, continuous alarm, ignition is switched off

BAT	Flashes red: Battery voltage below11,5 V
	Green light: power-plant is extended
	Flashes red, pulsing alarm: pay attention to LCD display! "EXTRACT": Engine lever was moved further than „Extract"-position without the engine being completely extended. "SWITCH R" or "SWITCH E": Time for extension or retraction was too long, probably an end switch is faulty.
	Green light: power plant is retracted
	Yellow light: Valve between wing and fuselage tank is opened.

With the power plant (partially) extended, a continuous alarm sound points to a limit being violated (rpm, fuel capacity). A pulsing alarm points to an error (see LCD display for explanation)

Inflight Engine Start Procedure

①	Power-plant main switch ON
②	Airspeed below 140 km/h (76 kts)
③	Engine lever EXTRACT
④	Green LED beaming?
⑤	Engine lever DECO
⑥	Check: Stopper gave way to propeller?
⑦	Accelerate to 120 km/h (65 kts) (propeller starts turning)
⑧	Engine lever IGNITION ON (rpms increase to roughly 3000 rpm)
⑨	Wait until engine starts (rpms increase above 4400 rpm)
⑩	Slow down to intended airspeed

CAUTION: *Always regard the possibility of the engine not starting properly. Therefore, soar in such way, to always be able to reach an outlanding field, despite having an engine. The decision to start the engine must be made in sufficient and safe altitude.*

A minimum safe altitude to extend and start the engine must be maintained. The criterium is that it must be possible to retract the engine again and carry out a normal outlanding if the power-plant malfunctions. A valid value for this minimum safe altitude is about 400m (1300ft); however, this is depending strongly on pilot ability and geographic factors.

Height loss for extenting and starting engine,
usually about: 100 – 200 m (330 – 660 ft)

Time to extend and start the engine, about: 20 – 40s

CAUTION: *It may take longer if the fuel lines had been completely empty (e.g. if engine was not used for a long time)*

Speed of best climb-rate for a medium wing loading: 90 km/h (48 kts)

Maximum rpm: 5400 U/min

Remarks:

on ④: To stop the movement of the power-plant more smoothly, the jackscrew is actuated stepwise near the end positions. Do not move the engine lever to early, but wait for the green light on the power-plant instrument.
If the engine was not at one of its end positions, the movement will be stepwise from the beginning.

on ⑧: Opening the decompression is necessary in the beginning to overcome the top dead centre. Has the rotation speed ceased to increase, the decompression must be shut again. The air compressed in the cylinders now act as a spring and stores the energy applied. The rotational speed further rises.
Thereby engine noise amplifies, but only a glance on the tachometer or the variometer tells, whether the engine already produces power.

on ⑩: With cold engine and high airspeed, it is possible that the engine revs reach the maximum limit. In this case the power-plant instrument would switch off the ignition for short times. This must not irritate, it is just necessary to pull away the over-speed.

It is advisable to familiarize oneself with the extending and starting procedures in the first instance within safe reach of an airfield.

Before departing to a cross-country flight it is wise to start the engine for a short time. First, to ascertain of its operational readiness, and second it may help in the real thing when the fuel lines have already been filled.

If the engine fails to start, check it over as recommended in the Engine Manual.

Inflight Engine Stop Procedure

① Ignition OFF
(by moving engine lever to position
„PROP STOP DISENGAGED“)

② Reduce airspeed to 85–90 km/h (46–49 kts),
let the engine slow down

③ Engage propeller stopper
(by moving engine-lever to position „EXTRACT“)

④ When propeller is vertical (Mirror),
move engine-lever to position „RETRACT“

⑤ When geen LED beams,
move engine-lever to position „OFF“

⑥ Power-plant main switch OFF

Remarks:

on ③: The propeller must not stand direct above the propeller stopper. Only after the rotational speed has almost completely died down, the stopper may be swivelled into the arc of the propeller.

on ④: You can control the impetus, with which the propeller overcomes the top dead centres and finally comes to a halt at the stopper, by reducing or increasing airspeed.

Height loss during stopping and retracting the power-plant,
usually about: 100 m (330 ft)

Time to stop and retract the power plant, about: 50 – 70 s:

Powered Flight

CAUTION: *Medical investigations have shown, how much the interior noise of powered sailplanes with retractable engines can harm the unprotected ear. Therefore **always** wear ear protection during powered flight. To compensate for this, turn the radio louder.*

The largest cruising range can be achieved with a saw-tooth pattern. That means, to fly under power with the speed of the best climb-rate and glide with retracted engine and the speed of the best glide-ratio.

See section 5.3.6 for performance information.

CAUTION: *While the engine is running, the engine control device must continuously stay on!*
Switching on and off with the engine running, can lead to unpredictable reactions of the electronics.

Pay attention to the fuel amount in the fuselage tank, and – if installed – open the valve of the wing-tanks in time.

CAUTION: *The wing tanks valve will switch off automatically only if the tank selector is set to "AUTO". With manual position "ON" selected the valve will not close when the fuselage tank is full and fuel will be lost via the ventilation! Therefore, the fuel level indicator must be monitored and the wing tank valves closed in good time.*

A detailed description of the power-plant instrument is given under section 7.12.

5.3.6 Performance with engine running

The performance depends strongly upon altitude, temperature and wing loading. The following values refer to standard atmosphere and sea level.

Climb

Without water ballast a best climb rate of 1,2m/s (236ft/min) can be achieved at an airspeed of V_Y = 90km/h (48kts; 56mph).

Horizontal flight

The maximum speed for level flight without water ballast at sea level is V_H = 120km/h (64 kts; 75 mph). The airspeed for horizontal flight decreases with height.

An altitude of 2800m (9200 ft) MSL (standard atmosphere) can be maintained with maximum wing loading and an airspeed of $V_H = V_Y$ = 90km/h (48kts; 56mph).

Flight with high wing loading

With full wing loading the speed of best climb V_Y is approx. 5 – 8 km/h (3 – 4 kts; 3 – 5 mph) higher than the above mentioned values. Still the the climb rate is considerable lower, therefore it is recommended to dump the water ballast.

With full wing loading the speed for level flight at sea level is approx. V_H = 120km/h (64 kts; 75 mph).

Range

A full fuselage tank contains sufficient fuel for at least half an hour of powered flight

The largest range is possible in a saw tooth flight, climbing with the speed of the best climb-rate and gliding with retracted engine and the speed of the best L/D.

Regarding density altitude, actual climb-rate and height above ground it is favourable to use the engine in several climb phases in middle height.

From this results a theoretical range of:

In powered flight: 45 km / 24 Nm

Gained altitude: 2160m

Average altitude loss for 2x starting and retracting: 200m

Gliding with the speed of best L/D: 94 km / 51Nm (18m)
84 km / 45Nm (15m)

Sum: **139** km / 75Nm (18m)
129 km / 69Nm (15m)

5.3.7 Noise Data

A noise measurement was performed for the similar system in the ASW 27-18E according to „Bekanntmachung der Lärmvorschrift für Luftfahrzeuge (LVL) vom 01.08.04 gem. Nfl II 70/04“

Established value for the ASW28-18E with TN 9 $L_{A\ korr\ max}$	Limit value
XX,X dB(A)	64,0 dB(A)

Power-Plant Main Switch

A 12A circuit breaker serves as main switch. It is located in the instrument panel and labelled “Engine Master switch”. It is switched on by pressing the button, and opened with the red knob.

Power-Plant Instrument

The power-plant instrument of the ASW 28-18E fits in a Ø52mm housing in the instrument panel. It has several governance, monitoring and display functions:

① It controls the electric jackshaft, when the power-plant lever is placed in the corresponding position.

② It influences the ignition. Independently from the power-plant lever it shuts down the ignition, whenever the engine is not completely extended or the rotational speed exceeds the maximum permissible RPM.

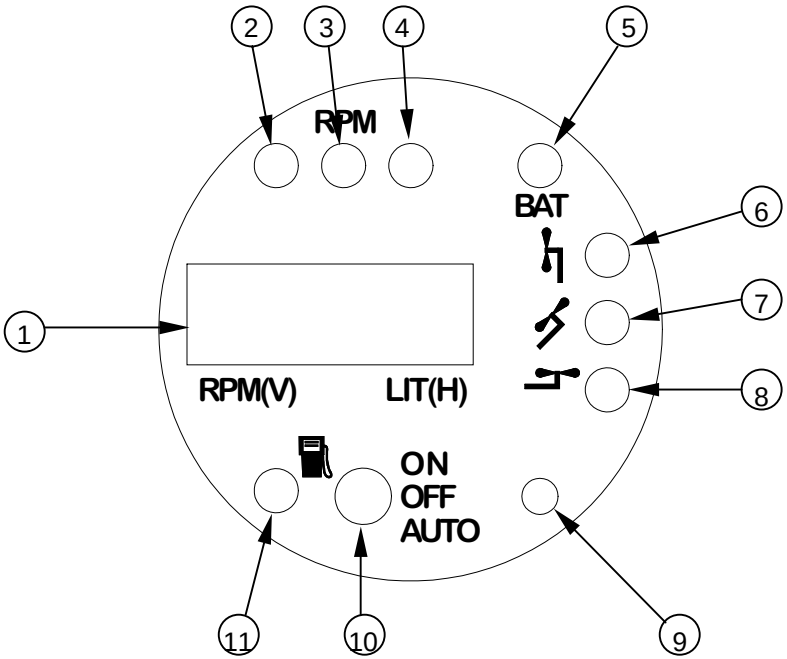
③ It displays the state of the power-plant (retracted or extended, rotational speed, fuel quantity, voltage, elapsed time) and supplies warnings in case of limit exceedance or maloperation.

④ It checks the fuel quantity in the fuselage tank and eventually opens the valve between the wing and fuselage tanks (optionally).

For few seconds after engaging the instruments switches all LEDs and the alarm sound on.

IMPORTANT NOTE: *A continuous alarms (=Caution) resound if limits are exceeded or undershot (rotational speed, fuel quantity, voltage). The alarm because of low fuel quantity can be acknowledged with button (9), quieting it for 4 min.*
Pulsing alarms (=Important notes) resound in connection with indications on the LCD display.

Front-display of the power-plant instrument:



1 LCD Display
2 LED green, for green rotational speed range
3 LED yellow, for yellow rotational speed range
4 LED red, for maximum rotational speed
5 LED red, for low voltage
6 LED green, for fully extended power-plant
7 LED red, for error messages
8 LED green, for fully retracted power-plant
9 Button for display selection
10 Switch for control of fuel valve (for optional wing tanks)
11 LED yellow: wing fuel tank valve opened

Numbers in brackets in the text refer to the numbers of this figure.

Control of electric jackscrew

To extend or retract the power-plant, bring the power-plant lever in the corresponding position (see section 4.5.3).

The green light (6) indicates, that the power-plant is fully extended. The green light (8) indicates the power-plant to be completely retracted.

To slow down the movement of the power-plant near its end position, the power-plant instrument repeatedly interrupts the current supply of the jackscrew. If the power-plant is started from a half extended position, the movement is pulsing from the beginning.
If the power-plant is not fully extended, but the power-plant lever is moved beyond position „EXTEND“, the red light (7) flashes, a pulsing alarm tone sounds and the LCD (1) displays the word „EXTRACT“.

If the power-plant lever does not receive a signal from the end-switch for an unusual long time, it stops the jackscrew. The red light (7) flashes, a pulsing alarm tone sounds and the LCD (1) displays „SWITCH R“ respectively „SWITCH E“. The possible fault may be either a faulty end-switch, a jammed engine mount or low voltage. The alarm can be acknowledged with button (9), restarting the jackscrew again. As long as there is no signal from the end-switch saying “fully extended”, the ignition is blocked. (see section 3.7)

Influence on ignition

The power-plant instrument features own relays to block ignition independently from the pilot’s ignition switch. It blocks ignition as long as the power-plant is not fully extended and as soon as the maximum rotational speed is exceeded.

IMPORTANT NOTE: *If the current supply of the power-plant instrument is interrupted, it cannot block the ignition.*

Control of the electric fuel pump

To support the pneumatic fuel pump, the power-plant instrument activates the electric fuel pump during windmilling.

Display of power-plant status

Section 2.5 describes the modes of the LCD-Display (1).

A sensor at the magnetic flywheel measures the rotational speed. It is displayed in the permanent display at the left side. When the engine runs with its target speed the green LED (2) lights. The yellow LED (3) warns of approaching the maximum RPM. When reaching the maximum rotational speed, the ignition is switched off and the red LED (4) beams.

The red LED (5) lights, whenever the battery voltage falls below 11,5V.

Fuel monitoring

A sensor monitores the content of the fuselage tank. The display is calibrated for flight attitude. Therefore, on ground, it deviates from the actual fuel quantity. Also in flight the angle of attack varies, thus a calibration more accurate than for half a liter (0.13 US Gal.) is not reasonable. The scale behind the backrest is calibrated for ground attitude.

When the fuel quantity of the fuselage tank sinks below 2,5Ltrs (0.66 US Gal) for over 5s, a alarm resounds and the display starts to blink.

Switch (10) controlls the fuel system, if flexible wing tanks are installed (optionally). The upper position “ON” opens the solenoid valve of the flexible wing tanks, simultaneously the yellow LED (11) lights up. The solenoid valves stay opened even if the fuselage tank is full. This position is intended to completely empty the wing tanks. The lower position “AUTO” triggers the automatic refill of the fuselage tank. When the fuel quantity in the fuselage tank sinks below 3,5Ltrs (0.92 US Gal), the solenoid valve opens automatically, LED (11) lights up and fuel can flow from the wings into the fuselage tank. As soon as the fuselage tank is full, the solenoid valve is closed and LED (11) extinguishes. Thereby it is excluded that fuel gets lost through the ventilation. See section 7.13 for handling of the fuel system.

IMPORTANT NOTE: *The solenoid valve is a bistable one, that needs only short impulses to toggle. To ensure the correct position of the valve, it gets a short pulse regularly. On ground this can be heard as a quiet click. This is no malfunction.*

The calibration of the fuel sensor was done with fuel-oil mixture based on AVGAS 100LL. Mixtures based on other fuel qualities may lead to deviating indications. Thereby the deviation is largest with full tank and zero with empty tank.

The power-plant instrument can be set to other qualities. The fuel tank must be filled with at least 6Ltrs (1.58 US Gall) and the power-plant retracted. Press button (9) four times until „Calibr.?“ appears at the display. Then keep button (9) pressed for five seconds to perform the calibration.

After the calibration, the power-plant instrument assumes that the signal from the fuel sensor corresponds a full tank. With a full tank, the difference between flight and ground attitude is small.

Display- and warning-ranges of the power-plant instrument:

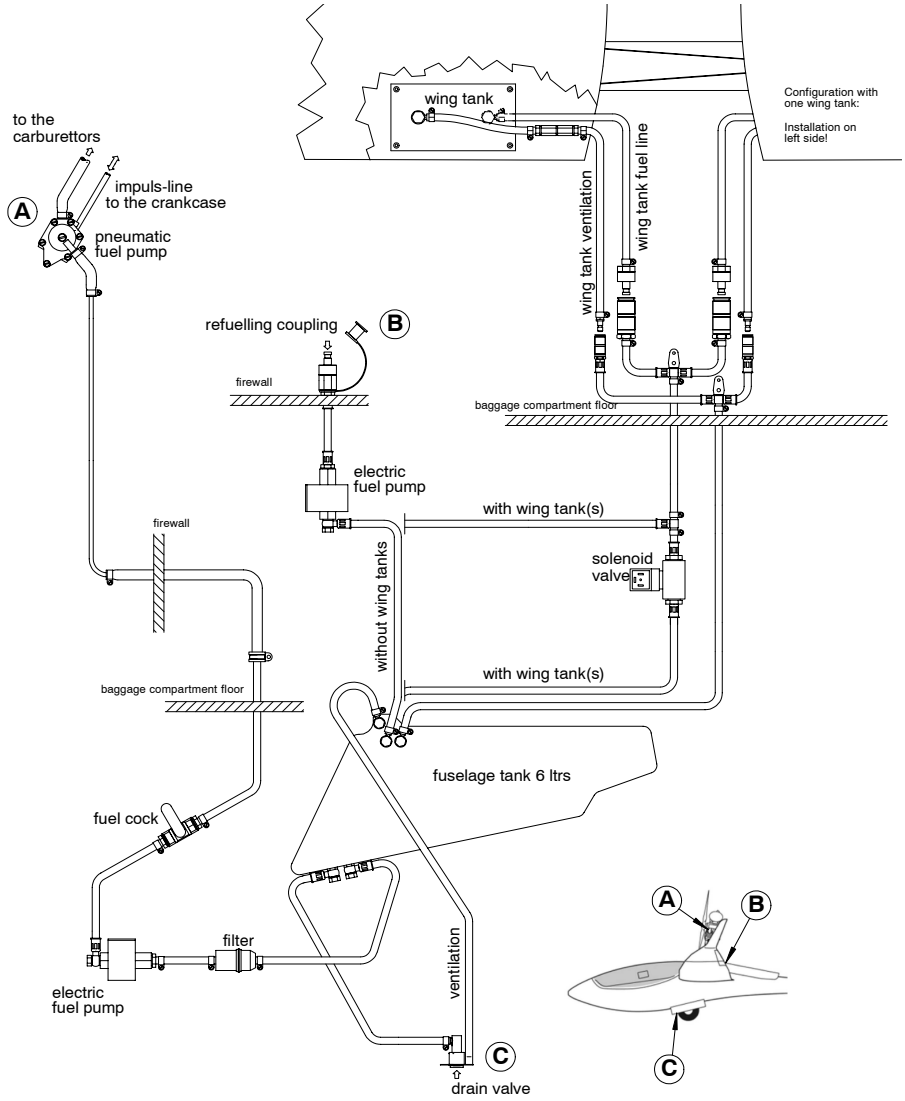
Type	Display-range	Optical	Acoustic
Rotational speed	400 – 9990 rpm	See section 2.5	> 5400 rpm permanent alarm
Battery voltage	10 – 15V	< 11,5V LED (5) blinks	< 11,5V permanent alarm
Fuel quantity	0 – 6,3Ltrs	< 2,5Ltrs LCD blinks	< 2,5Ltrs permanent alarm
Valve of wing tanks	If switch (10) is toggled to “AUTO“, the valve opens below 3,5Ltrs in the fuselage tank and closes at 6Ltrs	LED (11) lights, when valve open	
Elapsed time counter	Counts above 2000 rpm		
Electric fuel pump	Runs, when the engine is extended, rotational speed is below 4200 rpm and ignition is on		
Prop brake open and engine not fully extended		LED (7) blinks	Pulsed alarm
Running time of jackscrew		> 20s LED (7) blinks	> 20s pulsed alarm

Rear-view mirror

A rear-view mirror in the cockpit is necessary to check the correct position of the propeller before retracting the power-plant.

7.13 Fuel System

Overview of the fuel system:



The fuel system consists of a fuselage tank at the left hand side between landing gear box and sidewall, containing fuel for half an hour powered flight. The drain is located below the left landing gear door. The tank ventilation also ends there.

Optionally the ASW 28-18E can be equipped with one or two flexible fuel tanks. The fuel tanks deplete themselves into the fuselage tank via a solenoid valve. The wing tank ventilation also leads into the fuselage tank via a pressure relief valve.

A pneumatic fuel pump feeds the engine with fuel, driven by the pulsating crankcase pressure. An electric fuel pump is placed near the fuselage tank, only operating when the engine is extended, the ignition is on and the engine is running with less than 4200 rpm.

By default, a second electric fuel pump is installed, to refuel the fuselage tank as well as the wing tanks.

Refuelling

The engine must be extended for refuelling, this makes the refuelling coupling in the engine bay accessible. Here the refuelling hose, which is provided in series, is connected and put with its other end into the canister. The pump can be started with a switch at the instrument panel labelled “refuelling pump”.

When there is no wing tank installed (i.e. there are no couplings in the baggage compartment and no solenoid valve present) it is only necessary to observe the fuel quantity through the slot behind the backrest and stop the refuelling pump at a level of 6Ltrs.

If fuel tanks are installed, switch (10) on the power-plant instrument governs, whether wing or fuselage tanks are filled:

Refuelling of the fuselage tank	Refuelling of the wing tank
Toggle switch „ON“	Toggle switch „OFF“

Fuselage		
Length	6,585 m	(21,6 ft)
Height at T-tail incl. tail wheel	1,3 m	(4,27 ft)
Cockpit width (inside)	0,64 m	(2,1 ft)
Cockpit height	0,8 m	(2,62 ft)
Vertical Tail		
Height above tail boom top edge	1,2 m	(3,94 ft)
Surface area	1,0 m²	(10.76 ft²)
Airfoil Section	DU 86-131/30	
Rudder		
Surface area	0,3 m²	(3.23 ft²)
Horizontal Tail		
Span	2,85 m	(9,35 ft)
Surface area	1,0 m²	
Aspect ratio	8,22	
Airfoil Section	DU 92-131/25	
Elevator		
Surface area	0,22 m²	
Airbrake Blades (Schempp-Hirth-type, top surface only)		
Length	1,10 m	(3,61ft)
Surface area (both together)	0,36 m²	(3.88 ft²)
Max. Height above wing top surface	0,165 m	(0,54 ft)
Aileron		
Span	3,0 m	(9,84 ft)
Surface area (each)	0,267 m²	(2.87 ft²)

Masses (Weights)

Span		**18 m**		**15 m**	
Empty mass	approx.				
glider		283 kg	622,6 lbs	270 kg	594 lbs
self-sustaining powered sailplane		322 kg	708,4 lbs	309 kg	679,8 lbs
Mass of non-lifting parts	max.		285 kg	627 lbs	
Cockpit Load	max.		124 kg	272,8 lbs	
Pilot Seat Load	max.		115 kg	253 lbs	
Loading of baggage compartment	max.		12 kg	26,4 lbs	
All-up mass **with** water ballast	max.	575 kg	1265 lbs	525 kg	1155 lbs
without water ballast	max.	462 kg	1016,4 lbs	450 kg	999 lbs
Max Wing loading	approx.	48 kg/m²	9,83 lbs/ft²	50 kg/m²	10.2 lbs/ft²
Min Wing loading	approx.				
glider		29 kg/m²	5,94 lbs/ft²	32 kg/m²	6,55 lbs/ft²
self-sustaining powered sailplane		33 kg/m²	6,76 lbs/ft²	36 kg/m²	6,76 lbs/ft²
Trim ballast (battery) in the fin	max.		6 kg	13,2 lbs	
Trim ballast in the water tank in the fin	max.		5 kg	11 lbs	

See also **Flight Manual** section 2!
Authoritative information about empty mass and useful load are documented in the weighing record of the A-record or in the mass and balance form in chapter 6.2 of the flight manual.

Power Plant

Engine Manufacturer	SOLO Kleinmotoren GmbH
Engine	SOLO 2350
Continuous Power	24 PS / 18 kW
max. permissible Continuous Speed	5400 RPM
max. Cylinder Head Temperature	275°C
Fuel	2-stroke mixture with AVGAS 100LL or Super Petrol unleaded min. 95 ROZ
Lubrication	Lubrication mixture and 2-stroke-oil according to Flight Manual, section 2.4
Propeller Manufacturer	Alexander Schleicher GmbH & Co.
Propeller	AS2F1-3/L100-56-N2

Oxygen Installation

Oxygen equipment must be approved und must be free from hazard (take care of fuel, oil and grease!), especially in crash landings. There must be means available in flight to determine the quantity of oxygen in each source of supply and whether oxygen is being delivered to the dispensing equipment.

For oxygen systems fitted, the relevant section of the appertaining Inspection Release Certificate states the overhaul time limit. Over and beyond this, the oxygen bottles may have to be re-inspected by a technical inspection institute at other intervals in accordance with pressure vessel regulations existing in the country of operation.

Safety Harness

For the safety harness installed the life time limitation according to the appropriate maintenance instructions given by the harness manufacturer apply.

Engine

For the engine SOLO 2350 the maintenance instructions of the engine manual apply. Maintenance intervals are specified there. Latter information may be published in Technical Notes, if applicable.

Propeller

For the propeller AS2F1-3 the maintenance instructions of the propeller manual apply. Maintenance intervals are specified there. Latter information may be published in Technical Notes, if applicable.

Only applicable to U.S. registered gliders!

4.3 Airworthiness Limitations

This Airworthiness Limitations Section is FAA approved for U.S. registered gliders and specifies maintenance required under 43.16 and 91.403 of the Federal Aviation Regulations unless an alternative program has been FAA approved.

The following components are time limited or limited by number of launches:

1. The FRP-structure (FRP = Fibre Reinforced Plastic) is limited to 12000 service hours. Extension seems to be possible in the future. Special inspections starting at 3000 service hours have to be performed. For details, see chapter 4.1 of this manual.
2. The O-rings of the water ballast valves have a time limit of 5 years.
3. The brake line hose has a time limit of 6 years, which can be extended on a 100-hour inspection basis.
4. For the TOST tow releases see the instructions given by TOST with every individual tow release.
5. For oxygen supply systems regard the time limit of the individual pressure vessel as well as the individual overhaul time limits of the components.
6. For the safety harness system time limit, see the instructions given by the harness manufacturer with the individual harness system.
7. For the engine refer to the inspections defined by the engine manufacturer.
8. The propeller is to be inspected according to the propeller manual.

For details applying to 2. through 8. see chapter 4.2 of this manual.

12.4 List of Maintenance Documents for Fitted Equipment

a) Operating Manual for Tow Release Coupling Series "Europa G 88" Safety Tow Release, in the latest valid issue; or Operating Manual for the Tow Release Coupling, Series: Safety Tow Release "Europa G 72" and Safety Tow Release "Europa G 73", in the latest valid issue.
Operating Manual for Tow Release Coupling, Series Nose Tow Release Hook "E 85", in the latest valid issue. Or Operating Manual for Tow Release Coupling, Series Nose Tow Release Hook "E 72" and "E 75", in the latest valid issue.

b) WHEEL and BRAKE ASSEMBLIES CATALOGUE
Component Maintenance Manual,
Appendix A, Fits and Clearances
A-1. Brake Lining Wear Limits
A-2. Brake Disc Minimum Thickness
issued by Parker Hannifin Corporation, Avon, Ohio.

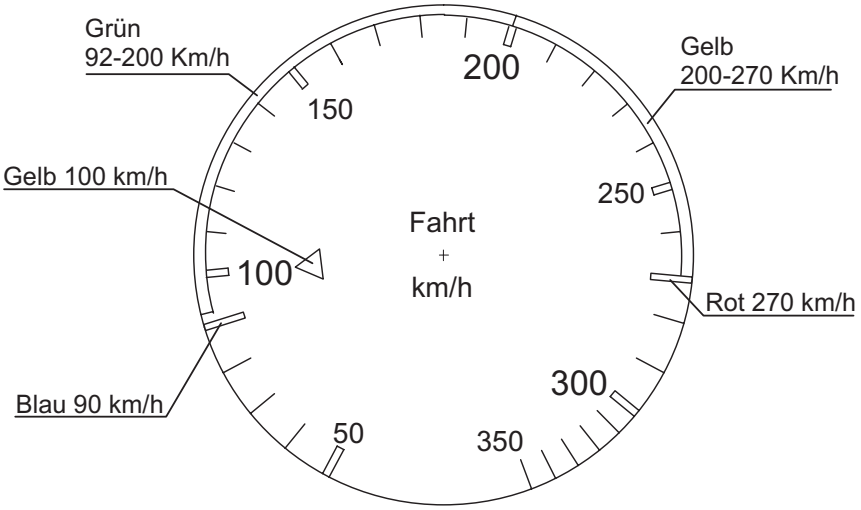
c) Engine Manual SOLO 2350, in its currently valid edition.
Instruction for special inspection of engine type SOLO 2350 after 5 years service life, in its currently valid edition.

d) Operating and Maintenance Manual for the propeller AS2F1, series AS2F1-3, in the latest valid edition.

Technical Note 2 for AS Propeller, in the latest valid edition, informing about service life limitations

12.5 Air Speed Indicator Markings

If the markings are on the cover glass of the instrument, there must be means to maintain the correct alignment of the glass cover with the face of the dial (JAR 22.1543 a).
Each arc and line must be wide enough, located to be clearly visible to the pilot, and must not mask any portion of the dial (JAR 22.1543 b).



	km/	kts	mph
Red radial line	270	145	167
Yellow arc	200 – 270	108 - 145	124 – 167
Green arc	92 – 200	40 – 108	57 – 124
Yellow triangle	100	54	62
Blue radial line	90	49	56